

**Board of Governors, State University System of Florida**  
**Request to Offer a New Degree Program**  
(Please do not revise this proposal format without prior approval from Board staff)

University of Central Florida  


---

**University Submitting Proposal**

Fall 2020  


---

**Proposed Implementation Term**

College of Sciences,  
College of Engineering and Computer Science  


---

**Name of College(s) or School(s)**

Statistics and Data Science, Mathematics,  
Computer Science, Industrial Engineering and  
Management Systems  


---

**Name of Department(s)/ Division(s)**

Data Science  


---

**Academic Specialty or Field**

B.S. in Data Science  


---

**Complete Name of Degree**

30.7001 (CIP2020)  


---

**Proposed CIP Code**

The submission of this proposal constitutes a commitment by the university that, if the proposal is approved, the necessary financial resources and the criteria for establishing new programs have been met prior to the initiation of the program.

\_\_\_\_\_  
**Date Approved by the University Board of Trustees**

\_\_\_\_\_  
**President**

\_\_\_\_\_  
**Date**

\_\_\_\_\_  
**Signature of Chair, Board of Trustees**

\_\_\_\_\_  
**Date**

\_\_\_\_\_  
**Vice President for Academic Affairs**

\_\_\_\_\_  
**Date**

Provide headcount (HC) and full-time equivalent (FTE) student estimates of majors for Years 1 through 5. HC and FTE estimates should be identical to those in Table 1 in Appendix A. Indicate the program costs for the first and the fifth years of implementation as shown in the appropriate columns in Table 2 in Appendix A. Calculate an Educational and General (E&G) cost per FTE for Years 1 and 5 (Total E&G divided by FTE).

Implementation Timeframe	Projected Enrollment (From Table 1)	
	HC	FTE
Year 1	140	105
Year 2	225	169
Year 3	365	274
Year 4	485	364
Year 5	540	405

Projected Program Costs (From Table 2)				
E&G Cost per FTE	E&G Funds	Contract & Grants Funds	Auxiliary Funds	Total Cost
\$1,728	\$181,443	\$0	\$211,080	\$392,523
\$1,311	\$530,984	\$0	\$0	\$530,984

Note: This outline and the questions pertaining to each section must be reproduced within the body of the proposal to ensure that all sections have been satisfactorily addressed. Tables 1 through 4 are to be included as Appendix A and not reproduced within the body of the proposals because this often causes errors in the automatic calculations.

## **INTRODUCTION**

### **I. Program Description and Relationship to System-Level Goals**

- A. Briefly describe within a few paragraphs the degree program under consideration, including (a) level; (b) emphases, including majors, concentrations, tracks, or specializations; (c) total number of credit hours; and (d) overall purpose, including examples of employment or education opportunities that may be available to program graduates.**

Data Science is an emerging discipline that seeks to infer insights from large amounts of data (“big data”) by using various statistical techniques and algorithms. The discipline is concerned with both statistical techniques that measure the validity of such insights and with computational techniques for managing data and resources efficiently. There is a great need for people with technical skills in these areas, prompted by the large amounts of information that governments and businesses are collecting. Thus, this degree program aims to train people to develop algorithms and computerized systems to facilitate the discovery of information from big data.

This will be an interdisciplinary Bachelor of Science program in Data Sciences, offered jointly by the departments of Computer Science, Statistics and Data Science, Mathematics, and Industrial Engineering and Management Systems at UCF.

While there will be no explicit tracks or specializations, the interdisciplinary program will emphasize the technical aspects of big data analytics, including algorithm design, programming, acquisition, management, mining, analysis, and interpretation of data. This program will entail 120 credit hours for graduation, with 49 credit hours of required courses. By graduation, students will be able to:

1. Use state-of-the-art software tools to perform data mining and analysis on large structured and unstructured data sets and transform such data into knowledge.
2. Implement algorithms for data mining and analysis and explain their time- and space-efficiency.
3. Perform data acquisition and management for large and dynamic databases.
4. Present and communicate knowledge derived from data in an unambiguous and convincing manner.

Thus, the overall goal is to provide technical skills in Data Science to undergraduate students. By 2020, zettabytes of data will be collected by governments and businesses. While governments want to use these data to improve the life of their citizens, businesses are keen on exploiting these data to better serve their clients. Consequently, there is an increasing demand for data analysts who can create, adapt, and use state-of-the-art tools to obtain insight from large structured and unstructured data sets, converting them into knowledge. Usually people with this training have the title of “data analyst” or “data scientist.” The US Bureau of Labor Statistics may classify people in these roles as statisticians, computer programmers, or other existing categories (such as “database administrator” or “software developer”). In addition to preparing graduates for immediate entry into careers and the job market, graduates of this program may also go on to pursue advanced degrees, such the UCF M.S. in Data Analytics program or a related MS degree, or a Ph.D. program in Computer Science, Statistics and Data Science or a related area, and may also seek professional distinction.

The curriculum of this degree program is designed to provide employable technical skills including the development of algorithms and computer systems to extract insight from big data. The curriculum includes 49 hours of required courses that ensure students have skills in algorithms and statistical techniques for extracting information, including:

- Computer Science I, which introduce students to algorithms and algorithm analysis for efficient computation,

- Programming for Scientists, which introduces students to computational data analysis using languages such as Python and R,
- Statistical Methods I and II, which introduces students to the statistical fundamentals of data analytics,
- Fundamentals of Data Science, which introduces techniques for collecting, analyzing, and processing and generating big data sets with a parallel, distributed algorithm on a cluster.
- Praxis in Data Science, which teaches students how to use standard tools for data analysis including data visualization and includes an applied learning component via a research project or intern experience.

Students will complete the degree by selecting electives (with advisor input) that complement the career, industry or advanced degree interests of the student. Areas of additional focus may include statistical theory, numerical methods, Bayesian analysis, cloud computing, or machine learning.

- B. Please provide the date when the pre-proposal was presented to CAVP (Council of Academic Vice Presidents) Academic Program Coordination review group. Identify any concerns that the CAVP review group raised with the pre-proposed program and provide a brief narrative explaining how each of these concerns has been or is being addressed.**

The CAVP approved this program on April 17, 2018. There were no concerns expressed. General comments for improving this proposal have been taken into consideration in this document.

- C. If this is a doctoral level program please include the external consultant’s report at the end of the proposal as Appendix D. Please provide a few highlights from the report and describe ways in which the report affected the approval process at the university.**

N/A

- D. Describe how the proposed program is consistent with the current State University System (SUS) Strategic Planning Goals. Identify which specific goals the program will directly support and which goals the program will indirectly support (see link to the SUS Strategic Plan on [the resource page for new program proposal](#)).**

The interdisciplinary program, which is being developed cooperatively between Computer Science, Statistics and Data Science, Mathematics, and Industrial Engineering and Management Systems meets several of the SUS goals<sup>1</sup>. The first of which is to *Increase the Number of Degrees Awarded in STEM and Other Areas of Strategic Emphasis*. The program is designed to teach students to become data scientists and to have the technical skills necessary to gain employment and leadership in the field of data science. It will also indirectly contribute to the goal to *Strengthen Quality & Reputation of Academic Programs and Universities*, as it will be the first stand-alone data science degree for the state of Florida and will serve as a forward-looking program in a state and U.S. economy that is increasingly reliant on data science.

The program will also indirectly contribute to the goal to *Increase Community and Business Workforce* as it will grow the state’s workforce in data science. According to the Bureau of Labor Statistics (BLS) publication “Working with big data<sup>2</sup>”, the author notes that “the growth in big data will continue to expand the kinds of work” (p. 7) in areas related to big data. Although the BLS does not track “data analyst” or “data scientist” as a job category, the article notes that the 2018 average annual wages for statisticians were \$84,760 and \$82,240 for computer programmers. The BLS predicts that the “collection

<sup>1</sup> [https://www.flbog.edu/pressroom/doc/2011-11-28\\_Strategic\\_Plan\\_2012-2025\\_FINAL.PDF](https://www.flbog.edu/pressroom/doc/2011-11-28_Strategic_Plan_2012-2025_FINAL.PDF) (p. 13)

<sup>2</sup> <http://www.bls.gov/careeroutlook/2013/fall/art01.pdf>

and use of big data continues to expand” (p. 8) in all areas that employ data analysts, and thus strong growth in data analytics is predicted. See II.A below for more about local demand.

**E. If the program is to be included in a category within the Programs of Strategic Emphasis as described in the SUS Strategic Plan, please indicate the category and the justification for inclusion.**

The Programs of Strategic Emphasis Categories:

1. Critical Workforce:
  - Education
  - Health
  - Gap Analysis
2. Economic Development:
  - Global Competitiveness
3. Science, Technology, Engineering, and Math (STEM)

**Please see the Programs of Strategic Emphasis (PSE) methodology for additional explanations on program inclusion criteria at [the resource page for new program proposal](#).**

This degree program is being proposed using the CIP 2020 code 30.7001 for Data Science, and is classified as a science, technology, engineering, and math (STEM) program. Although not noted in the SUS’s 2014 list of areas of programmatic strategic emphasis, we can easily foresee this program meeting the strategic needs for both a critical workforce and for economic development in STEM areas as it intends to address a nationwide shortage of data scientists.

**F. Identify any established or planned educational sites at which the program is expected to be offered and indicate whether it will be offered only at sites other than the main campus.**

The program will only be offered on the UCF main campus.

## **INSTITUTIONAL AND STATE LEVEL ACCOUNTABILITY**

### **II. Need and Demand**

- A. Need: Describe national, state, and/or local data that support the need for more people to be prepared in this program at this level. Reference national, state, and/or local plans or reports that support the need for this program and requests for the proposed program which have emanated from a perceived need by agencies or industries in your service area. Cite any specific need for research and service that the program would fulfill.**

“We believe that there is a strong need for employees who are familiar with the computational and statistics techniques necessary to make sense of the massive amounts of data that our business continuously generates. Employees who can design new algorithms and computerized systems to answer questions related to unique business needs are especially valuable to us” – Frank Wang, VP with IDN Decision Support Analytics

The demand for data scientists has been steadily increasing in the past years. A 2016 survey conducted by Harvey Nash/ KPMG CIO<sup>3</sup> determined that data analytics was the most in-demand technology need for the second year in a row. Nearly 40% of Information Technology leaders in the survey expressed concerns about having enough skilled professionals in the Big Data area. According to a 2017 study

---

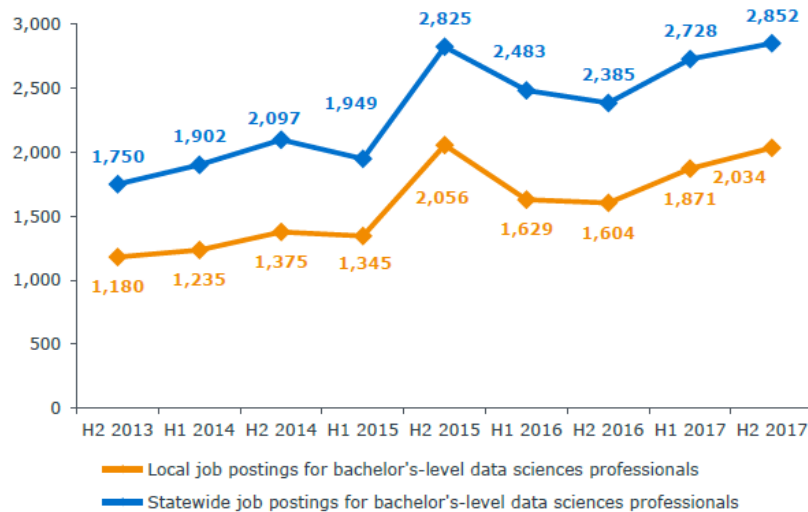
<sup>3</sup>[https://www.harveynash.com/usa/news-and-insights/Harvey%20NashKPMG\\_CIO\\_survey\\_2016\\_US.pdf](https://www.harveynash.com/usa/news-and-insights/Harvey%20NashKPMG_CIO_survey_2016_US.pdf)

commissioned by the Business- Higher Education Forum<sup>4</sup> an expected "2.72 million new jobs posted in 2020 will seek workers with skills in data science and analytics." On a national scale, the Bureau of Labor Statistics (BLS) expects nationwide employment of professionals in "management analyst" occupations, which include "business analysts," to increase 14% from 2016 to 2026<sup>5</sup>. Employment growth for these occupations should outpace employment across all occupations nationwide, which is expected to grow only 7.5% over the same time period.

In 2018, the university requested a market analysis report for the proposed B.S. program from EAB Global, Inc., a market research company. The EAB analysis, completed July 2018, reported that local employer demand for bachelor's-level data sciences professionals increased 72% as evidenced by an increase in job postings from 1,180 to 2,034 from H2 (fiscal year, second half) 2013 to H2 2017.

**Historical Demand for Bachelor's-Level Data Sciences Professionals**

H2 2013-H2 2017



Source: EAB 2016

Over the same period, statewide employer demand for bachelor's-level data sciences professionals increased 63% from 1,750 job postings to 2,852 job postings. This suggests local employers may also experience a higher demand for bachelor's-level data sciences professionals than other employers in Florida over the last 4.5 years. The full EAB report can be found in Appendix C.

According to the EAB report, local and statewide financial industry employers demonstrate high demand for bachelor's-level data sciences professionals. In a 12 month period (from H3 2016 to H2 2017), *local* financial industry employers account for six of the 20 local employers with the most demand for bachelor's-level data sciences professionals (e.g., Citi and the Raymond James Financial Incorporated). In addition, the professional services employers Accenture, Deloitte, and PricewaterhouseCoopers account for three of the 20 local employers who post the most jobs for bachelor's-level data science professionals over the last 12 months. These three employers account for 7% of local job postings (i.e., 328 of 4,413 job postings).

Though not included in the EAB report, Parveen Rao of Charter Communications (a corporate telecommunications and mass media company branded locally as Spectrum) writes in their letter of

<sup>4</sup> <https://www.insidehighered.com/news/2017/03/30/report-urges-data-science-course-work-all-undergraduates-close-growing-skills-gap>

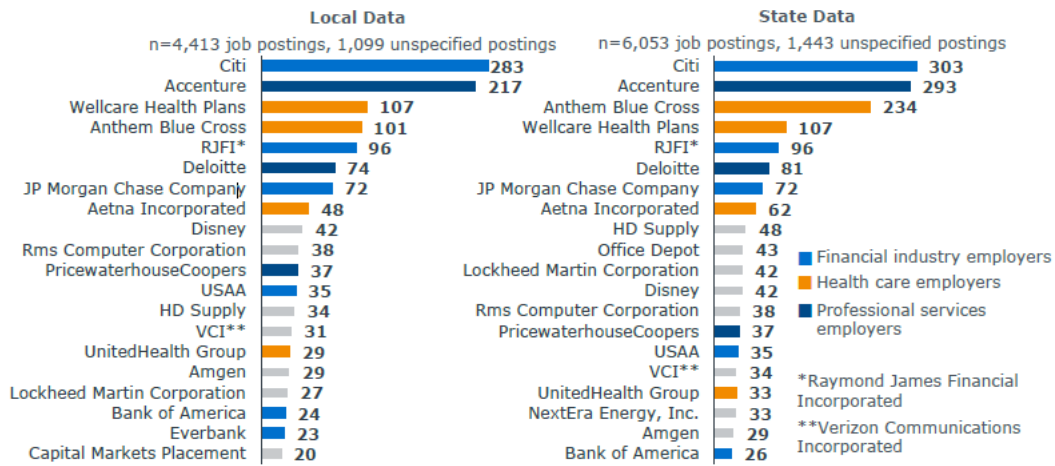
<sup>5</sup> <http://www.bls.gov/careeroutlook/2013/fall/art01.pdf>

support for this degree that “Charter Communications is working heavily in the field of Machine Learning and Data Science. We believe there is a strong need for employees who are familiar with the fundamentals of Data Science – specifically in math, statistics and computer science. We need employees who can design and create new algorithms that will help answer unique business questions so that we stay competitive in the industry.” (See letters of industry support in Appendix D.)

Similarly, financial industry employers account for five of the 20 *statewide* employers with the most demand for bachelor’s-level data sciences professionals in the same time period (e.g., JP Morgan Chase Company, USA).

**Employers with High Demand for Bachelor’s-Level Data Sciences Professionals**

June 2017-May 2018<sup>9</sup>



Source: EAB 2016

The following table from an IBM analytics report titled, “The quant crunch: How the demand for data science skills is disrupting the job market”<sup>6</sup>, shows the table “Share of DSA [Data Science and Analytics] Category Demand by Industry” and provides an analysis of data science and analytics job category demand by industry.

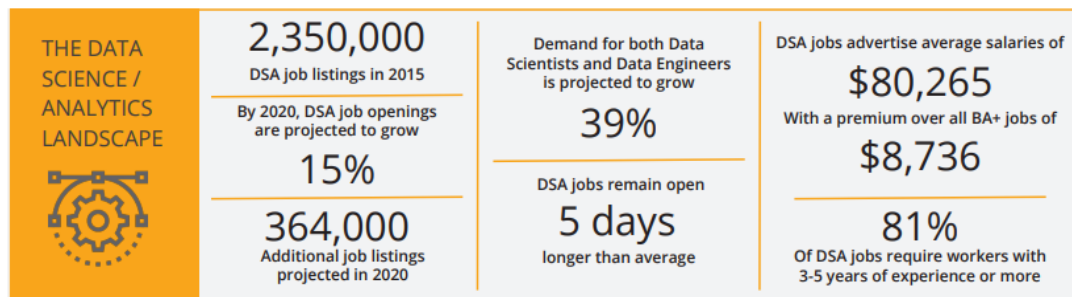
DSA Framework Category	Professional Services	Finance & Insurance	Manufacturing	Information	Health Care & Social Assistance	Retail Trade
Data-Driven Decision Makers	23%	17%	16%	10%	6%	6%
Functional Analysts	23%	34%	9%	5%	8%	4%
Data Systems Developers	41%	14%	14%	10%	5%	3%
Data Analysts	34%	25%	9%	6%	7%	3%
Data Scientists & Advanced Analysts	31%	23%	12%	10%	6%	4%
Analytics Managers	21%	41%	9%	9%	6%	3%

Key    41+%    31-40%    21-30%    11-20%    6-10%    0-5%

Source: IBM.com

A Forbes.com article further proclaimed that the annual demand for the fast-growing new roles of data scientists, data developers, and data engineers will reach nearly 700,000 openings by 2020<sup>7</sup>. By 2020, the number of jobs for all US data professionals will increase by 364,000 openings to 2,720,000 by IBM.

The following summary graphic from the same IBM report highlights how in-demand data science and analytics skill sets are today and are projected to be through 2020.



Source: IBM.com

Regarding salary, the Forbes.com article additionally provided the following summary point:

- The most lucrative analytics skills include MapReduce, Apache Pig, Machine Learning, Apache Hive and Apache Hadoop. Data Science and Analytics professionals with MapReduce skills are earning \$115,907 a year on average, making this the most in-demand skill according to the

<sup>6</sup> [https://www.ibm.com/downloads/cas/3RL3VXGA?mhsrc=ibmsearch\\_a&mhq=quant%20crunch](https://www.ibm.com/downloads/cas/3RL3VXGA?mhsrc=ibmsearch_a&mhq=quant%20crunch)

<sup>7</sup> <https://www.forbes.com/sites/louiscolombus/2017/05/13/ibm-predicts-demand-for-data-scientists-will-soar-28-by-2020/#23a1fe967e3b>

survey. Data science and analytics professionals with expertise in Apache Pig, Hive and Hadoop are competing for jobs paying over \$100K.

Earnings are represented in the following table, “Highest paying analytical skills (with at least 7,500 postings), pulled from the IBM.com report.

Skill Name	Average Salary
MapReduce	\$115,907
PIG	\$114,474
Machine Learning	\$112,732
Apache Hive	\$112,242
Apache Hadoop	\$110,562
Big Data	\$109,895
Data Science	\$107,287
NoSQL	\$105,053
Predictive Analytics	\$103,235
MongoDB	\$101,323

Source: IBM.com

Additional points from the Forbes.com article include:

- Machine learning, big data, and data science skills are the most challenging to recruit for and potentially can create the greatest disruption to ongoing product development and go-to-market strategies if not filled. The study found that the high cost to hire, a strong need for new training programs and the high risk to future productivity of these areas is one of the greatest challenges to organizations pursuing initiatives in these areas today.
- The fastest-growing roles are Data Scientists and Advanced Analysts, which are projected to see demand spike by 28% by 2020. Data Science and Analyst jobs are among the most challenging to fill, taking five days longer to find qualified candidates than the market average. Employers are willing to pay premium salaries for professionals with expertise in these areas as well. The study found employers are willing to pay a premium of \$8,736 above median bachelor's and graduate-level salaries, with successful applicants earning a starting salary of \$80,265. Experienced Data Scientists and Data Engineers are negotiating sales over \$100,000.



The IBM.com report also offered the following table of summary demand statistics:

DSA Framework Category	Number of Postings in 2015	Projected 5-Year Growth	Estimated Postings for 2020	Average Time to Fill (Days)	Average Annual Salary
All	2,352,681	15%	2,716,425	45	\$80,265
Data-Driven Decision Makers	812,099	14%	922,428	48	\$91,467
Functional Analysts	770,441	17%	901,743	40	\$69,162
Data Systems Developers	558,326	15%	641,635	50	\$78,553
Data Analysts	124,325	16%	143,926	38	\$69,949
Data Scientists & Advanced Analysts	48,347	28%	61,799	46	\$94,576
Analytics Managers	39,143	15%	44,894	43	\$105,909

The IBM.com report further states that 39% of Data Scientists and Advanced Analyst positions require a Master’s or Ph.D. In other words, this also shows 61% of the data scientists and analyst positions require a B.S. degree.

In recent weeks, UCF has hosted representatives from PCI, Deloitte Consulting, and NSA communicating with us thousands of positions in data science are unfilled, indicating interest in this bachelor’s programs in data science.

**B. Demand: Describe data that support the assumption that students will enroll in the proposed program. Include descriptions of surveys or other communications with prospective students.**

“We plan to continue to build competence in data analytics in the future and expect to hire these skills in an accelerated mode within the next 3-5 years. We have a company supported program to pay for educational opportunities for our employees and would encourage software developers and engineers to take the required courses and pursue the proposed degree.” - Bob LoGalbo, Chief Data Scientist with Leidos, Inc.

Glassdoor<sup>8</sup>, a popular job site, published a list of the “50 Best Jobs in America”<sup>9</sup>, and in 2019 (for the fourth year in a row) Data Scientist ranked as the number one job. Data scientist had an overall job score 4.2 out of 5, a \$110,000 median base salary, and over 4,000 job openings on Glassdoor. The U.S. Bureau of Labor Statistics predicts that jobs in this field will grow 11% by 2024. The high demand and high pay for data scientists will be important factors to attract students to enroll in this degree program. The EAB Report (Appendix C) states that most recently developed data science programs have experienced increased enrollments since program inception. The program at the Ohio State University, created in 2014, initially enrolled 10 students, most of whom transferred into the program from other degree programs within the university. That data analytics program now enrolls 50 to 60 students per year with over 130 total students. Similarly, contacts at the University of San Francisco report the bachelor’s-level data sciences program started with fewer than 10 students four years ago and now enrolls 65 students.

We will also put in efforts to recruit female and international students to increase student diversity. From the three universities (Ohio State University, University of San Francisco and Northern Kentucky

<sup>8</sup> [https://www.glassdoor.com/List/Best-Jobs-in-America-2018-LST\\_KQ0,25.htm](https://www.glassdoor.com/List/Best-Jobs-in-America-2018-LST_KQ0,25.htm)

<sup>9</sup> [https://www.glassdoor.com/List/Best-Jobs-in-America-LST\\_KQ0,20.htm](https://www.glassdoor.com/List/Best-Jobs-in-America-LST_KQ0,20.htm)

University) profiled in the EAB reports, it shows that female student population in these programs are 40%, 40% and 25%, respectively. It will be reasonable to expect that the female students will be about 30% of the student population in the data science program. Additionally, UCF is now a Hispanic-serving institution so a specific focus will be on recruiting students with Hispanic/Latinx background.

**Industry Support**

As a final indicator of the need for the proposed B.S. in Data Science, we obtained letters of support from business and academic institutions that we have partnered with the Department of Statistics and Data Science, and the Department of Computer Science. These letters of support are contained in Appendix D and are provided by:

*Industry and Businesses in Support of the Data Science B.S..*

Name	Company/Institution	Position
Patti Brownsord	Data Wonderment	President
Sreerupa Das	Lockheed Martin, Rotary and Mission Systems	Lockheed Martin Fellow
Marvin ‘Butch’ Gardner, Jr.	The Aerospace Corporation	Principal Director
Bob LoGalbo	Leidos, Inc	Chief Data Scientist
Jerry Oglesby	SAS Institute	Senior Director of Global Academic Programs
Praveen Rao	Charter Communications	Director of Data Science
Frank Wang	IDN Decision Support Analytics	Vice President

**Survey results**

To gauge students’ interest in pursuing a B.S. degree in data science, we conducted several surveys within each of the participating departments. The results of those surveys are as follows and the detailed survey results are reported in Appendix E.

Department of Computer Science:

Of a survey conducted among students in the computer science programs, 71% (of 175 surveyed) are interested in pursuing a degree in Data Sciences. This was further broken down as 33% being “very interested” and 38% being “somewhat interested” in the degree.

Department of Industrial Engineering and Management System:

The results of a small survey of students showed that 23% (7 out of 30) are interested in pursuing a B.S. degree.

Department of Mathematics:

Students in MAC 2311 were surveyed, and the results show that 30% (50 out of 165 students) are interested in the data science program.

Department of Statistics and Data Science:

A survey was conducted to students in the STA 2014 and STA 2023 classes. In STA2014, we found that 4% (of 527 surveyed) are interested in obtaining B.S. degrees in Data Sciences. The percentage for STA 2023 is 17%, out of 235 students surveyed.

In addition to departmental surveys, we also conducted a survey of an extended advisory board, consisting of members on our industrial advisory board and a few internal advisory board members. This survey intended to ascertain important skills, tools, and interest in employment. The results from the

respondents (n=21) are highlighted as follows, and the detailed survey results are also reported in Appendix E.

#### Size of Company Represented:

In order to understand the size of the data science market segment represented on the advisory board, the survey captured the number of the employees at each member company. We found that 47.6% represent companies with more than 10,000 employees. Another 14.3% represented companies with 2,501-10,000 employees.

#### Types of Data Science Tools used:

In the survey conducted, we wanted to capture the tools that our industry partners are currently using in the contemporary data science workspace. We found that 61.9% of respondents are using both Amazon Web Services (AWS) and Microsoft Azure for cloud computing services. Another 42% of respondents are using SAP. We found that Python was the most requested programming language with 95.2% of respondents listing it as a need. Similarly high, 90.5% of respondents requested that employees know SQL, a relational database language. Other languages such as C or C++ came in at 19% and 23.8% (respectively). The survey also found that Scikit-learn was the most requested machine learning programming skill with a 47.6% response rate. As far as the requested spreadsheet, business intelligence, and reporting tools used, the survey found that 90.5% of respondents used Excel, 38.1% used Power BI, and 85.7% of respondents listed Tableau as the most used visualization tool.

#### Important Data Science Tasks:

We wanted to understand how data scientists are utilized by our corporate partners represented on the advisory board. The survey segmented different types data science tasks into a task frequency model. We found that 90% of respondents indicated that data analysis is an important component of the data science role. Additionally, data cleaning (76.1%) and the ability to create visualizations (80%) were important tasks for data scientists.

#### Hiring Criteria:

We wanted to capture what our partner companies were looking for when hiring a data science college graduate. The survey showed that 71% of respondents need employees who have experience with coding languages, relational databases, machine learning and statistics tools. 33% mentioned that skills tests during the hiring process are used to determine fit. The survey also polled board members on how students should demonstrate data science proficiency. 81% of respondents indicated that projects or internships were equally as effective as full-time professional work experience. We found that 66.7% of the respondents thought that curricular based projects are important.

- C. If substantially similar programs (generally at the four-digit CIP Code or 60 percent similar in core courses), either private or public exist in the state, identify the institution(s) and geographic location(s). Summarize the outcome(s) of communication with such programs with regard to the potential impact on their enrollment and opportunities for possible collaboration (instruction and research). In Appendix C, provide data that support the need for an additional program.**

There is no university in Florida currently using CIP Code 30.7001. There is a program with similar curriculum within the state, the B.S. in Data Science program from Florida Polytechnic University; however this program uses a different CIP code, 11.0802, Data Modeling/Warehousing and Database Administration. (Each letter of support referenced in this section is found in Appendix F.) We contacted the chair of the department of Data Science and Business Analytics and Florida Polytechnic, and they were in support of the “joint effort between several departments at UCF in launching [the] B.S. degree” and though there were some similarities to their Data Modeling program, “there are also distinctions that make both programs unique.”

Because we are aware of interest among other state universities in developing a stand-alone degree of this sort, we also sought input and support from several other SUS institutions, including Florida State University (FSU), Florida Agricultural and Mechanical University (FAMU), and Florida Atlantic University (FAU). Each of these institutions supports this degree proposal stating that the program “is well designed to meet the big data challenge by integrating existing courses and developing new courses in data science from these departments” (FSU), pointing out that the program “is in an area of particular interest to students due to the projected large growth of employment opportunities” (FAMU), and applauding the “trans-disciplinary nature” (FAU) of the new degree.

- D. Use Table 1 in Appendix A (1-A for undergraduate and 1-B for graduate) to categorize projected student headcount (HC) and Full Time Equivalents (FTE) according to primary sources. Generally undergraduate FTE will be calculated as 30 credit hours per year and graduate FTE will be calculated as 24 credit hours per year. Describe the rationale underlying enrollment projections. If students within the institution are expected to change majors to enroll in the proposed program at its inception, describe the shifts from disciplines that will likely occur.**

In Table 1-A (found in Appendix A), in the first year we expect that approximately 75 upper-level students who are transferring from other majors within the university along with 50 FTIC students, 5 Florida College System transfers to the upper level, 5 new transfers to the upper level from other Florida colleges and universities and 5 transfers from out of state colleges and universities. Even though we only expect that 30 credit hours will be enrolled per year, the FTE number is derived by dividing the projected headcount by 40 credit hours; the federal methodology for calculating student FTE. With a full-time undergraduate student taking 30 credit hours per year (in the fall and spring semesters) that translates into  $30/40=0.75$  FTE per student. Our projected headcount FTE for year one of the program is  $140*0.75=105$ .

In the second year of the B.S. program, we expect to have 70 upper-level students who are transferring from other majors within the university (this includes students who entered the program in the first year who still have not graduated in addition to new internal-transfers), and we will recruit 75 new FTIC students, 5 new Florida College System transfers to the upper level, 5 new transfers to the upper level from other Florida colleges and universities, and 5 new Transfers from out of state colleges and universities into the major. This would give us a total of 225 students taking 30 credit hours per year. This translates into 168.75 FTE.

In the third year of the B.S. program, we expect to have 60 upper-level students who are transferring from other majors within the university (again including students who entered this program in the previous years and who still have not graduated as well as new, internal-transfer students), and recruit 85 new FTIC students, 40 new Florida College System transfers to the upper level, 10 new transfers to the upper level from other Florida colleges and universities, 10 new transfers from out of state colleges and universities, and 5 international students into the major. This would give us a total of 365 students and translates into 273.75 FTE.

In the fourth year of the B.S. program and anticipating a slow decline in internal-transfer numbers, we expect to have 55 upper-level students who are transferring from other majors within the university (again including students who entered this program in the previous years and who have not graduated yet as well as new, internal-transfers), and recruit 90 new FTIC students, 20 new Florida College System transfers to the upper level, 5 new transfers to the upper level from other Florida colleges and universities, 5 new transfers from out of state colleges and universities, and 5 international students into the major. This would give us a total of 485 students and translates into 363.75 FTE.

By the end of the fourth year, we expect the 50 FTIC students who were accounted for in the first year will have graduated. In the fifth year of the B.S. program, we expect to have 50 upper-level students who

are transferring from other majors within the university (including a smaller number of those who have not yet graduated as well as new, internal-transfers), and recruit 100 new FTIC students, 10 new Florida College System transfers to the upper level, 5 new transfers to the upper level from other Florida colleges and universities, 5 new transfers from out of state colleges and universities, and 10 international students into the major. This would give us a total of 540 students, which translates into 405 FTE.

- E. Indicate what steps will be taken to achieve a diverse student body in this program. If the proposed program substantially duplicates a program at FAMU or FIU, provide, (in consultation with the affected university), an analysis of how the program might have an impact upon that university's ability to attract students of races different from that which is predominant on their campus in the subject program. The university's Equal Opportunity Officer shall review this section of the proposal and then sign and date Appendix B to indicate that the analysis required by this subsection has been completed.**

The proposed B.S. program will attract students who are interested in applying data science methods to solve big data problems in business, industry, and government, as well as attract students who have an interest in pursuing graduate studies in the field of data sciences. Since the potential applicants cover a wide range of possibilities, the natural attraction of the program allows us to recruit students from a diverse range of backgrounds. This has been demonstrated in our Data Mining track of the Statistics M.S., which currently has a representative number of women (23 out of 54 or 43%) and Asians (22 out of 54 or 41%); as well as representation from Hispanic/Latino (4/54), American Indian/Alaska Native (1/54), and African-Americans (1/54).

As stated earlier, we will also put in efforts to recruit female and international students to increase student diversity. Nationally, similar programs shows that female student population can be as high as 40% (see the EAB Report found in Appendix C). It is reasonable to expect that the female students will be about 30% of the student population in this data science program.

We intend to take advantage of several minority and inclusive award opportunities to further diversify the students of this program. These scholarships include Barry Goldwater Scholarship, College of Sciences General Scholarship, Women in Science and Mathematics, among others. UCF is now a Hispanic Serving Institution so we can use this eligibility as a recruiting tool and will place a specific focus on recruiting students with Hispanic/Latinx background. To expand our recruiting efforts, we will also conduct a campaign (mailings, hand distribution of brochures, etc.) to the historically African-American organizations on campus (ex: clubs, organizations, fraternities and sororities), to African-American, Hispanic and Asian student associations, and to the local HBCUs and high schools within Florida and across the nation.

Within UCF, we will participate in university-sponsored recruiting events and hold targeted recruiting events for undergraduate students who may be interested in Data Sciences. To promote and recruit for the program, we will also have program faculty give talks in high schools in the State of Florida. This will help us get a larger pool of interested applicants from which we can select. To assist with all of this, the budget includes \$5,000 annually for such recruiting trips. We will use data analytics to see which recruiting strategies yield the largest percentages of women and minority recruits admitted into the program.

The university's Equal Employment Opportunity Officer has reviewed this section (see Appendix B).

### **III. Budget**

- A. Use Table 2 in Appendix A to display projected costs and associated funding sources for Year 1 and Year 5 of program operation. Use Table 3 in Appendix A to show how existing Education &**

**General funds will be shifted to support the new program in Year 1. In narrative form, summarize the contents of both tables, identifying the source of both current and new resources to be devoted to the proposed program. (Data for Year 1 and Year 5 reflect snapshots in time rather than cumulative costs.)**

As indicated in Table 2 (Appendix A), the costs for Year 1 totals \$539,723. This total cost comes from college funding and funds provided to the departments based on E&G re-allocation. The college's letters of commitment are found in Appendix G. In Year 1, the various budgetary aspects of the B.S. program support include the following:

Faculty Salaries and Benefits: \$134,743

- Program Director's one month summer salary plus benefit (\$17,366, recurring) and one course release
- Existing faculty will teach new courses for the B.S. program. This reallocation is \$117,377.

Assistantships: \$35,700

- Computer science and statistics and data science departments have agreed to reallocate graduate teaching assistants (GTA) to support the courses taught by the respective departments in the amount of \$35,700 (if necessary). No new stipend for new GTA is requested.

Expenses: \$222,080

- 10 Workstations with 4 Quadro RTX 6000 GPUs, each at \$21,108. Total \$211,080. This cost will be provided through an auxiliary, Technology Fee Request.
- Copy machine cost (\$2,000, recurring) and office supplies (4,000, recurring).
- Recruiting activities (\$5,000, recurring)

In Year 5 the costs total \$530,984. In addition to the continuing E&G base, these funds support the following:

Faculty Salaries and Benefits: \$356,436

- Program Director's one-month summer salary (\$17,366, recurring) and one course release during the nine-month appointment.
- One faculty member to teach four new courses (two in statistics and two in computer science). This joint hire between the Departments of Computer Science and Statistics and Data Science will be completed in Year 2. (\$147,200, recurring)
- Existing faculty will be teaching courses for the B.S. program. This reallocation is \$191,870.

USPS Salaries and Benefits: \$57,200

- One full-time USPS support position for logistics and administrative support with salary and benefits (\$57,200, recurring)

Assistantships: \$102,348

- Stipends for four new GTAs with a stipend of \$20,000 plus fringe and tuition (9hrs/term at \$5,187). These GTA positions will be funded by the colleges. (\$102,348, recurring)

Expenses: \$15,000

- Copy machine cost (\$4,000, recurring) and office supplies (6,000, recurring)
- Recruiting activities (\$5,000, recurring)

There is no need for fellowships or scholarships to be allocated; however, by Year 5, there is a need for four graduate teaching assistantships to support the undergraduate educational program with both classroom and laboratory support. These GTA positions will be reallocated from existing programs. We project that three of these positions will be used to support the courses directly taught by this program and one needed to staff the computer lab.

**B. Please explain whether the university intends to operate the program through continuing**

education, seek approval for market tuition rate, or establish a differentiated graduate-level tuition. Provide a rationale for doing so and a timeline for seeking Board of Governors' approval, if appropriate. Please include the expected rate of tuition that the university plans to charge for this program and use this amount when calculating cost entries in Table 2.

N/A

- C. If other programs will be impacted by a reallocation of resources for the proposed program, identify the impacted programs and provide a justification for reallocating resources. Specifically address the potential negative impacts that implementation of the proposed program will have on related undergraduate programs (i.e., shift in faculty effort, reallocation of instructional resources, reduced enrollment rates, greater use of adjunct faculty and teaching assistants). Explain what steps will be taken to mitigate any such impacts. Also, discuss the potential positive impacts that the proposed program might have on related undergraduate programs (i.e., increased undergraduate research opportunities, improved quality of instruction associated with cutting-edge research, improved labs and library resources).

From each of the participating departments, instructional resources will be reallocated to this program; however, the impacts will be minimal and will not have any negative impact on existing undergraduate programs. The coordinating departments are building on existing programs and course offerings and expanding their existing faculty instructional efforts to ensure these courses are offered. By Year 2, one new faculty line, jointly supported by reallocations from the participating colleges, will also teach the new courses.

Most of the required coursework for the program is comprised of existing courses taught by faculty members of the collaborating departments. The following eleven new courses are being created for the program, and the course syllabi are found in Appendix L:

- CAP 4670 - Algorithms for Machine Learning\* Credit Hours: 3
- COP 4283 - Data Science Programming\* Credit Hours: 3
- ISC 4241 - Data Science I Credit Hours: 3
- ISC 4242 - Data Science II Credit Hours: 3
- ISC 4301 - Predictive Analytics Credit Hours: 3
- ISC 4401 - Data Management Technology Credit Hours: 3
- ISC 4501 - Data Graphics and Visualization Credit Hours: 3
- ISC 4701 - Praxis in Data Science Credit Hours: 3
- MAP 4447 - Mathematical Foundations of Machine Learning and Artificial Intelligence\* Credit Hours: 3
- STA 4038 - Statistical Foundations of Data Science and Artificial Intelligence I Credit Hours: 3
- STA 4039 - Statistical Foundations of Data Science and Artificial Intelligence II Credit Hours: 3

\*These new courses will also be enrolled by students in existing programs in engineering (CAP 4670), physics (COP 4283), and mathematics (MAP 4447).

The current and new courses will be taught by the participating and one new faculty member as follows:

**Computer Science:**

Faculty	Courses Taught
New hire	ISC 4301

**Industrial Engr & Mgmt Systems**

Faculty	Course Taught
Ivan Garibay	ISC 4301

Sean Szumlanski	COP 3502C
Mark Llewellyn	ISC 4401
Liqiang Wang	COP 4283
Arup Guha	COT 3100C
Damla Turgut	COP 4331
Sumanta Pattanaik	ISC 4501
Gita Sukthankar	CAP 4670

Luis Rabelo	ISC 4701
Adan Vela	ISC 4242
Qipeng Zheng	ESI 4312

### Mathematics

Faculty	Courses Taught
Joseph Brennan	ISC 4242
Carlos Borges	ISC 4242, MAP 4447, ISC 4701
Xin Li	ISC 4242, MAP 4447, ISC 4701
Brian Moore	ISC 4242, ISC 4301
Marianna Pensky	ISC 4242, ISC 4301
Gary Richardson	ISC 4242, ISC 4301
Qiyu Sun	ISC 4242, MAP 4447
Gerrit Welper	ISC 4242, MAP 4447, ISC 4701
Teng Zhang	ISC 4242, MAP 4447, ISC 4701

### Statistics and Data Science

Faculty	Courses Taught
New Hire	STA 4038, STA 4039
Nizam Uddin	STA 2023, ISC 4241
Mengyu Xu	STA 2023, STA 4724
Alexander Mantzaris	ISC 4241, ISC 4301
Edgard Maboudou	STA 4163, STA 4241
Xin Yan	STA 4163, STA 4164
Chung-Ching Wang	ISC 4701, STA 4039

An overall positive impact of these reallocations to deliver this program will be expanded research and engagement opportunities for our undergraduate students both within and outside of the major. With the success of the program, we can additionally anticipate the development of a minor or undergraduate certificate program in the area of data science.

- D. Describe other potential impacts on related programs or departments (e.g., increased need for general education or common prerequisite courses, or increased need for required or elective courses outside of the proposed major).**

It is anticipated that some students who originally intended to pursue bachelors degrees in mathematics, computer science, industrial engineering and management systems or statistics and data science will choose the proposed B.S. in Data Science as their major.

- E. Describe what steps have been taken to obtain information regarding resources (financial and in-kind) available outside the institution (businesses, industrial organizations, governmental entities, etc.). Describe the external resources that appear to be available to support the proposed program.**

N/A

### IV. Projected Benefit of the Program to the University, Local Community, and State

Use information from Tables 1 and 2 in Appendix A, and the supporting narrative for “Need and Demand” to prepare a concise statement that describes the projected benefit to the university, local community, and the state if the program is implemented. The projected benefits can be both quantitative and qualitative in nature, but there needs to be a clear distinction made between the two



**in the narrative.**

The benefit to UCF will be a stronger connection to companies who use data science, by placing skilled and competent graduates in those companies. These will benefit the reputation of the departments involved at UCF. The degree program will also result in increased cooperation and collaboration among the undergraduate faculty in the Departments of Computer Science, Statistics and Data Science, Mathematics, and Industrial Engineering and Management Systems. This increased cooperation is already happening through the M.S. in Data Analytics degree that is offered jointly by the Departments of Computer Science, Statistics and Data Science, and Industrial Engineering and Management Systems and the Ph.D. program in Department of Statistics and Data Science. Indeed, this degree program will provide bachelors students who are prepared to enter the M.S. and Ph.D. programs.

The degree program will help Orlando's burgeoning computing industry, which has startup and established companies using data science. Marvin Gardner, principle director with the Aerospace Corporation, Eastern Range Directorate, a recent central Florida start-up, states that "as a manager within the Aerospace industry and as the current Chairman of The National Space Club Florida Committee we are continuing to anticipate a growing need for advanced analytics in many of the business and engineering activities within the aerospace community, and thus very strongly support UCF's proposed Bachelor of Science degree program in Data Science." (See full letter of support in Appendix D.)

Other industries in the area, particularly in the industries of health care (Florida Hospital, etc.), hospitality (Disney World, Universal Orlando Resort, etc.), and electronic video gaming (Electronic Arts), already make use of data analytics to increase revenues. We anticipate that these companies will partner with UCF to provide opportunities for internships for students in this program. The support letters available in Appendix D highlight existing relationships that UCF has with several companies. Capitalizing on these relationships, we established an advisory board, who will contribute to discussions about the how the program's curriculum supports industry expectations, how the program can best prepare graduates for industry, and how companies can participate and support the program and students. The members of the Advisory Board are identified in Section VIII.F.

The benefit to the state will be in increasing the pool of qualified employees in data science. Note that this is a STEM area that is projected to quickly grow and that can help many kinds of businesses be more competitive. As such, this program will expand the state's high technology business profile and will help encourage more businesses to locate in Florida. Jobs in data science are high paid technical positions which will aid in the development of Central Florida's high-tech industries.

**V. Access and Articulation – Bachelor's Degrees Only**

- A. If the total number of credit hours to earn a degree exceeds 120, provide a justification for an exception to the policy of a 120 maximum and submit a separate request to the Board of Governors for an exception along with notification of the program's approval. (See criteria in Board of Governors Regulation 6C-8.014)**

The total number of credit hours required will not exceed 120.

- B. List program prerequisites and provide assurance that they are the same as the approved common prerequisites for other such degree programs within the SUS (see link to the Common Prerequisite Manual on [the resource page for new program proposal](#)). The courses in the Common Prerequisite Counseling Manual are intended to be those that are required of both native and transfer students prior to entrance to the major program, not simply lower-level courses that are required prior to graduation. The common prerequisites and substitute courses are mandatory for all institution programs listed, and must be approved by the Articulation**

Coordinating Committee (ACC). This requirement includes those programs designated as “limited access.”

If the proposed prerequisites are not listed in the Manual, provide a rationale for a request for exception to the policy of common prerequisites. NOTE: Typically, all lower-division courses required for admission into the major will be considered prerequisites. The curriculum can require lower-division courses that are not prerequisites for admission into the major, as long as those courses are built into the curriculum for the upper-level 60 credit hours. If there are already common prerequisites for other degree programs with the same proposed CIP, every effort must be made to utilize the previously approved prerequisites instead of recommending an additional “track” of prerequisites for that CIP. Additional tracks may not be approved by the ACC, thereby holding up the full approval of the degree program. Programs will not be entered into the State University System Inventory until any exceptions to the approved common prerequisites are approved by the ACC.

There are no Common Prerequisites currently approved for the CIP 30.7001; therefore, we are concurrently proposing common prerequisites to the state Articulation Coordinating Committee. See the proposed common prerequisites in Appendix H. The common prerequisites proposed for this program include courses that establish a strong analytical background. In developing the common prerequisite application, we drew from established common prerequisite structures used in degrees for mathematics, computer science and statistics.

- C. If the university intends to seek formal Limited Access status for the proposed program, provide a rationale that includes an analysis of diversity issues with respect to such a designation. Explain how the university will ensure that Florida College System transfer students are not disadvantaged by the Limited Access status. NOTE: The policy and criteria for Limited Access are identified in Board of Governors Regulation 6C-8.013. Submit the Limited Access Program Request form along with this document.

We do not intend to seek formal limited access status for the proposed program.

- D. If the proposed program is an AS-to-BS capstone, ensure that it adheres to the guidelines approved by the Articulation Coordinating Committee for such programs, as set forth in Rule 6A-10.024 (see link to the Statewide Articulation Manual on [the resource page for new program proposal](#)). List the prerequisites, if any, including the specific AS degrees which may transfer into the program.

The program will not include an AS-to-BS capstone, but we may develop an AA-to-BS articulation agreement with Valencia College.

## **INSTITUTIONAL READINESS**

### **VI. Related Institutional Mission and Strength**

- A. Describe how the goals of the proposed program relate to the institutional mission statement as contained in the SUS Strategic Plan and the University Strategic Plan (see link to the SUS Strategic Plan on [the resource page for new program proposal](#)).

The proposed B.S. program in Data Science is consistent with these SUS goals of providing undergraduate education of the highest quality. It is also consistent with UCF’s distinctive mission of meeting the economic, intellectual and societal needs of Central Florida, the state of Florida, and the nation. In support of both the SUS and UCF’s strategic plan, this proposed B.S. will provide undergraduate education to serve the data analytics needs within the diverse state of Florida and the needs

of our global society. Focusing on the UCF-specific mission, this program supports UCF's mission by offering high quality undergraduate education and student development to train future data-based decision makers with state of the art techniques and equipment. This will be obtained through the productive faculty of UCF together with the strong students that we plan to recruit.

As the program matures, we anticipate increased cross-utilization of courses between students in our program and students in disciplines with large observational data sets such as sports, astronomy, education, psychology, marketing, public affairs, nursing, and biomedical sciences. Furthermore, the program will support UCF's mission of enhancing the economic development of the metropolitan area by enhancing and establishing partnerships with local businesses to provide state of the art data analytic techniques to improve productivity and increase their returns on investment through such endeavors as targeted advertising campaigns. For example, applying data analytic techniques to a customer database can identify individuals with very high likelihood of purchasing a particular product. Once identified, these individuals can be shown existing products that meet their needs or have products created to anticipate their future needs. Finally, the program will support UCF's mission by establishing a program as a major presence in data sciences as the first such multidisciplinary degree program in Florida.

**B. Describe how the proposed program specifically relates to existing institutional strengths, such as programs of emphasis, other academic programs, and/or institutes and centers.**

This program leverages the existing investment in data analytics at UCF. It provides a means by which students can enter the interdisciplinary area of data analytics as undergraduates to utilizing the faculty, research, industry partnerships, and graduate program strengths in computer science, statistics and data science, mathematics and industrial engineering and management systems. These are elaborated as follows:

The **Department of Computer Science (CS)** recently hired several faculty members in the area of data science and, along with the Department of Statistics and Data Science and the Department of Industrial Engineering and Management Systems delivers the M.S. in Data Analytics. Computer Science also cooperates with that department in offering the Ph.D. in Big Data Analytics. According to CSRankings.org (June 2019), CS is ranked 48<sup>th</sup> out of all Computer Science departments in the U.S. and UCF ranks 41<sup>st</sup> in the US in Artificial Intelligence research.

Several faculty members in CS conduct research in Machine Learning (ML), an important component of data science. These faculty members and their research areas of focus include:

- Dr. Liqiang Wang: Distributed ML, deep learning, and high performance computing
- Dr. Fei Liu: Natural language processing and data mining
- Dr. Gita Sukthankar: ML, multi-agent systems, and activity/plan recognition
- Dr. Ladislau Boloni: Deep learning, robotics, and human-robot teaming
- Dr. Kenneth Stanley: ML and evolutionary computation. Dr. Stanley is also the inventor of the NeuroEvolution of Augmenting Topologies algorithm.

The faculty in the UCF Center for Research in Computer Vision (CRCV) are part of CS. Computer vision has a significant overlap with data science, and the CRCV faculty are heavily engaged in research in ML, particularly Drs. Abhijit Mahalanobis (IEEE fellow), Ulas Bagci, and Mubarak Shah (IEEE fellow).

The CS bachelor's degree is accredited by ABET and features a data science track. A graduate of the CS Ph.D. program, Dr. Ivan Garibay, is now an assistant professor in the UCF Department of Industrial Engineering and Management Systems and directing the M.S. in Data Analytics program.

The **Department of Statistics and Data Science** has a well-established undergraduate programs offering B.S. degrees in Statistics and Actuarial Science, an M.S. degree in Statistical Computing with an award-

winning track in Data Mining, and a Ph.D. program in Big Data Analytics. The Statistics B.S. program is one of the largest statistics programs in the state of Florida. The table below shows the number of B.S. degrees awarded in Statistics and Actuarial Science.

Year	Statistics B.S.		Actuarial Science B.S.*	
	Majors	Minors	Majors	Minors
2014-15	25	18	0	13
2015-16	19	12	0	10
2016-17	26	12	0	15
2017-18	38	10	2	11
2018-19	44	16	4	6

\*The B.S. degree in Actuarial Science was restarted in 2017-18

The Statistical Computing M.S. program that offers the Data Mining track is one of the largest graduate programs at UCF and has maintained a headcount at about 50 students since fall of 2011. The average number of students graduating annually from the Data Mining track over the past several years is approximately 20. The success of the Data Mining program directly relies on the high quality undergraduate students who choose to enroll into the program. Students who graduate from the newly proposed B.S. program can be directly admitted to our Ph.D. program in Big Data Analytics and hence can serve as a conduit to the Ph.D. program by providing a steady supply of students interested in pursuing training beyond the B.S. level.

The faculty of the department have pioneered new techniques in data mining and have an ongoing collaboration with the SAS® Institute, the world’s leading data mining software provider, and Microsoft. Moreover, several faculty members have established consulting relationships with industrial clients such as Addition Financial (formerly CFE Credit Union), Citi Bank, Wyndham, Sodexo, Florida Blue, SAS, Johnson and Johnson, iCube CSI, Darden Restaurants and Health First, inspiring relevant research directions, student employment opportunities and enhanced curriculum case studies.

An additional indicator of the success of the department is the job placement of its graduates. The large majority of our students are finding jobs immediately after graduation with employers such as the CIA, FBI, JPMorgan Chase & Co., Bank of America, EverBank, Florida Blue, Health First, United Health Care, The Walt Disney Company and Universal Studios. The M.S. program serves as a conduit to the Ph.D. program by providing a steady supply of students interested in pursuing training beyond the master’s level.

The proposed B.S. program will feed students into the aforementioned M.S. and Ph.D. programs. Students who graduate from the B.S. program under the proposed curriculum will have the ability to complete their M.S. degrees in less than two years and Ph.D. study in four years due to having all of the necessary prerequisite and foundational course knowledge. With respect to the strengths of the statistics and data science department and this degree proposal, Jerry Oglesby, Senior Director with SAS Global Institute states, “I believe that the proposed data science program meets an urgent need for society and the advancement of analytics into the Big Data field. I strongly believe that the department has a great faculty that are well qualified to have such a program.”

The **Department of Industrial Engineering and Management Systems (IEMS)** is a well-established program and one with the largest growth in the country with more than 542 undergraduate students in the Academic Year of 2018-2019. Data science and analytics are very important areas for the industrial engineer. IEMS has helped found and Dr. Garibay (IEMS faculty member) is the current director of the M.S. in Data Analytics program at UCF. At #36 in 2018, Industrial Engineering was one of eight UCF graduate programs nationally ranked in the top 50 of their fields by U.S. News & World Report. The

Industrial Engineering graduate program remains at the top of rankings for industrial, manufacturing, and systems engineering and is the highest-ranked program in the College of Engineering and Computer Science at UCF.

Several members of the IEMS faculty conduct teaching and research in the areas of data science and analytics, they are:

- Dr. Richard Biehl: Data warehousing and healthcare analytics
- Dr. Vladimir Boginski: Modeling and analysis of big data
- Dr. Ivan Garibay: Big data, data analytics, simulation, and agent-based models
- Dr. Luis Rabelo: Big data, analytics, and artificial intelligence/machine learning
- Dr. Adan Vela: Data analysis, modeling, and simulation of air transportation systems
- Dr. Qipeng Zheng: Analytics and its connection to optimization modeling

The proposed program would enable the **Department of Mathematics** to continue its efforts to achieve its objectives of responding to the needs of the university, state and the country by providing training in the development of the technological expertise in the advancement of Florida’s high-technology future. The program in Data Science will also advance the department’s goals of offering the best undergraduate programs in mathematics in the State of Florida. The Department of Mathematics offers graduate coursework in mathematical aspects of machine learning and Bayesian methods in data analysis. The development of this undergraduate program and its resulting trained graduates will enhance the development of these approaches in our graduate programs.

- C. **Provide a narrative of the planning process leading up to submission of this proposal. Include a chronology in table format of the activities, listing both university personnel directly involved and external individuals who participated in planning. Provide a timetable of events necessary for the implementation of the proposed program.**

**Planning Process**

<b>Date</b>	<b>Participants</b>	<b>Planning Activity</b>
10/31/2017	Daniel Eilen, Ivan Garibay, Gary Leavens, Shunpu Zhang	Initiated the idea to develop the joint degree program in Data Science and decided that Statistics will be the home department of the degree program
05/01/2018	Xin Li, Gary Leavens, Shunpu Zhang	Discussed the formation of the proposal committee
09/20/2018	Joseph Brennon, Dan Eilen, Gary Leavens, Shunpu Zhang	1st meeting of the proposal committee. Discussed the timeline and the delegation of duties for completing the proposal for the joint degree program in Data Sciences. Joseph Brennon, Dan Eilen, Gary Leavens, Shunpu Zhang
09/24/2018	Joseph Brennon, Dan Eilen, Gary Leavens, Shunpu Zhang	2 <sup>nd</sup> meeting of the proposal committee discussed the curriculum and the Need and Demand section.
10/08/2018	Joseph Brennan, Dan Eilen, Gary Leavens, Sandy Avila (library), Buenaventura Basco (library), Shunpu Zhang	3 <sup>rd</sup> meeting of the proposal committee, discussed and reviewed the curriculum, Sections I and IV, and library resources
10/22/2018	Joseph Brennan, Gary Leavens, Shunpu Zhang	4 <sup>th</sup> meeting of the proposal committee discussed the curriculum and decided to form the Advisory board for the BS program, the need to get letters of support from local companies (Rosen, Hilton, Publix etc.), and financial support from the university/college for the B.S. program.
10/29/2018	Joseph Brennan, Gary Leavens, Dan Eilen, Luis Rabelo, Shunpu Zhang	5 <sup>th</sup> meeting of the proposal committee, discussed the curriculum and what resources (access to cloud storage, computing, etc.) should be available to the

		students in the B.S. program, also discussed the potential collaboration with Valencia College
10/30/2018	<p><b>Valencia College East</b>  Stacey Johnson, Campus President  Michelle Foster, Dean for Academic Affairs  Carin Gordon, Dean of Business/IT  Nasser Hedayat, AVP for Career and Workforce Education  Keri Siler, Dean of Math  Sidra Van De Car, Math Professor  Dave Brunick, Professor Computer Programming/Analysis</p> <p><b>UCF</b>  Jeff Jones, UCF Connect, Vice Provost  Pam Cavanaugh, UCF Connect, Associate Vice Provost  Harrison Oonge, College of Undergraduate Studies  Teresa Dorman, College of Sciences  Shunpu Zhang, Professor, Statistics and Data Science  David Nickerson, Professor, Statistics and Data Science  Xin Li, Professor, Mathematics  Joseph Brennan, Professor, Mathematics  Gary Leavens, Professor, Computer Science  Dan Eilen, Associate Director, Industrial Engineering and Management Systems</p>	VC/UCF Data Sciences Collaboration Discussion
11/06/2018	Shunpu Zhang, Joe Brennan, Dan Eilen, Dave Brunick, Sidra Van De Car, and Alison Hammack	6 <sup>th</sup> meeting of the proposal committee (a joint meeting with the Valencia counterparts), proposed and discussed an AA degree in Data Science for Valencia.
11/19/2018	Gary Leavens, Dan Eilen, Luis Rabelo, Shunpu Zhang	7 <sup>th</sup> meeting of the proposal committee
11/28/2018	Gary Leavens, Joseph Brennan, Dan Eilen, Luis Rabelo, Shunpu Zhang	8 <sup>th</sup> meeting of the proposal committee
12/10/2018	Gary Leavens, Dan Eilen, Shunpu Zhang	9 <sup>th</sup> meeting of the proposal committee
12/17/2018	Gary Leavens, Joseph Brennon, Shunpu Zhang	10 <sup>th</sup> meeting of the proposal committee
01/07/2019	Gary Leavens, Joseph Brennon, Dan Eileen, Luis Rabelo, Shunpu Zhang	11 <sup>th</sup> meeting of the proposal committee
01/14/2019	Gary Leavens, Dan Eileen, Luis Rabelo, Shunpu Zhang	12 <sup>th</sup> meeting of the proposal committee
01/24/2019	Gary Leavens, Joseph Brennon, Shunpu Zhang	13 <sup>th</sup> meeting of the proposal committee
02/04/2019	Gary Leavens, Joseph Brennon, Shunpu Zhang	14 <sup>th</sup> meeting of the proposal committee. Email sent to Florida Poly for a letter of support
02/28/2019	Gary Leavens, Xin Li, Michael Johnson, Michael Georgopoulos, Shunpu Zhang	15 <sup>th</sup> meeting of the proposal committee Meeting to discuss resources needed for the B.S. program
03/26/2019	Gary Leavens, Joseph Brennan, Dan Eilen, Shunpu Zhang	16 <sup>th</sup> meeting of the proposal committee Meeting, discussed the curriculum.
04/05/2019	Gary Leavens, Luis Rabela, Dan Eilen, Shunpu Zhang	16 <sup>th</sup> meeting of the proposal committee Meeting

04/17/2019	Gary Leavens, Joseph Brennan, Shunpu Zhang	17 <sup>th</sup> meeting of the proposal committee Meeting
05/03/2019	Joseph Brennan, Luis Rabela, Dan Eilen, Shunpu Zhang	18 <sup>th</sup> meeting of the proposal committee Meeting
07/31/2019	Joseph Brennan, Gary Leavens, Dan Eilen, Shunpu Zhang	19 <sup>th</sup> meeting of the proposal committee Meeting
08/09/2019	Teresa Dorman, Joseph Brennan, Gary Leavens, Dan Eilen, Shunpu Zhang	20 <sup>th</sup> meeting of the proposal committee Meeting with Dr. Teresa Dorman
08/13/2019	Joseph Brennan, Gary Leavens, Dan Eilen, Shunpu Zhang	21 <sup>st</sup> meeting of the proposal committee Meeting
08/19/2019	Joseph Brennan, Gary Leavens, Shunpu Zhang	22 <sup>nd</sup> meeting of the proposal committee Meeting
08/26/2019	Joseph Brennan, Luis Rabelo, Dan Eilen, Gary Leavens, Shunpu Zhang	23 <sup>rd</sup> meeting of the proposal committee Meeting
09/17/2019	Joseph Brennan, Luis Rabelo, Dan Eilen, Gary Leavens, Shunpu Zhang	24 <sup>th</sup> meeting of the proposal committee Meeting
09/20/2019	Joseph Brennan, Luis Rabelo, Gary Leavens, Shunpu Zhang	25 <sup>th</sup> meeting of the proposal committee Meeting
10/02/2019	Joseph Brennan, Luis Rabelo, Gary Leavens, Shunpu Zhang	26 <sup>th</sup> meeting of the proposal committee Meeting
10/03/2019	Michael Johnson, Michael Georgiopolous, Joseph Brennan, Dan Eilen, Shunpu Zhang	27 <sup>th</sup> meeting of the proposal committee Meeting
10/04/2019	Joseph Brennan, Luis Rabelo, Mark Henrich, Shunpu Zhang	28 <sup>th</sup> meeting of the proposal committee Meeting and Dr. Dorman
10/09/2019	Joseph Brennan, Luis Rabelo, Gary Leavens, Shunpu Zhang, Teresa Dorman	29 <sup>th</sup> meeting of the proposal committee Meeting
10/09/2019	Joseph Brennan, Luis Rabelo, Shunpu Zhang	30 <sup>th</sup> meeting of the proposal committee Meeting
10/10/2019	Joseph Brennan, Luis Rabelo, Mark Henrich, Shunpu Zhang	31 <sup>st</sup> meeting of the proposal committee Meeting
10/11/2019	Joseph Brennan, Luis Rabelo, Daniel Eilen, Shunpu Zhang	32 <sup>nd</sup> meeting of the proposal committee Meeting

### Events Leading to Implementation

Date	Implementation Activity
1/08/2018	Pre-proposal submitted to Dr. Elizabeth Dooley for approval
04/17/2018	Pre-proposal was approved by CAVP
05/30/2018	A request was sent to Educational Advisory Board (EAB) for market analyses of the proposed B.S. program in Data Science.
07/27/2018	EAB Market Research (Data Sciences) was received.
09/20/2018	Discussed the timeline and the delegation of duties for completing the proposal for the joint degree program in Data Sciences.
09/24/2018	Discussed the curriculum and the Need and Demand section.
10/08/2018	Discussed and reviewed the curriculum, Sections I and IV, and library resources
10/22/2018	Discussed the curriculum and decided to form the Advisory board for the BS program, the need to get letters of support from local companies (Rosen, Hilton, Publix etc.), and financial support from the university/college for the B.S. program.
10/29/2018	Discussed the curriculum and what resources (access to cloud storage, computing, etc.) should be available to the students in the B.S. program, also discussed the potential collaboration with Valencia College
10/30/2018	VC/UCF Data Sciences Collaboration discussed the intention to develop an AA degree in Data Science in Valencia, which will feed into the proposed B.S. degree in Data Science.
11/06/2018	A joint meeting with the Valencia counterparts, proposed and discussed an AA degree in Data Science for Valencia.

11/19/2018	Discussed the remaining (unfinished) part of the proposal: <ul style="list-style-type: none"> <li>● program review results from CS, IEMS and Math.</li> <li>● the information on Faculty Participation</li> <li>● the survey results from CS and Math</li> <li>● Section VIII (curriculum)</li> <li>● Section V (access/articulation) and for soliciting letters of support</li> <li>● Draft sections X (non-faculty resources)</li> <li>● Draft Table 4 (faculty participation),</li> <li>● Draft Table 2 and 3 (budget)</li> </ul>
11/28/2018	Discussed the remaining (unfinished) part of the proposal: <ul style="list-style-type: none"> <li>● program review results from CS, IEMS and Math.</li> <li>● the information on Faculty Participation</li> <li>● the survey results from CS and Math</li> <li>● Section VIII (curriculum)</li> <li>● Section V (access/articulation) and for soliciting letters of support</li> <li>● Draft sections X (non-faculty resources)</li> <li>● Draft Table 4 (faculty participation)</li> <li>● Draft sections IX (faculty resources)</li> </ul>
12/10/2018	Discussed changes in the curriculum and unfinished parts of the proposal
12/17/2018	Discussed the curriculum, reorganized the electives to five groups by incorporating the ESI courses to other groups.
01/07/2019	Discussed the remaining items which need to be finished in the proposal.
01/14/2019	Discussed the remaining items which need to be finished in the proposal.
01/24/2019	Discussed the remaining items which need to be finished in the proposal.
02/04/2019	Discussed the remaining items which need to be finished in the proposal.
02/28/2019	Discussed resources needed for the B.S. program. Will use the existing resources in the beginning, more resources will be provided if the student numbers grow. Condense the elective groups to six courses.
03/26/2019	Joe presented to the committee the revised curriculum by considering the deans' comments. The committee had some discussion of the revised curriculum.
04/05/2019	The committee discussed the revised curriculum and made the following recommendations/changes in Advanced Core.
04/17/2019	The committee discussed the revised curriculum and made the following recommendations/changes in Advanced Core: Removed COP 3223 Introduction to Programming in C.
05/03/2019	The committee discussed the revised curriculum and the curriculum path. The committee also discussed to form a committee to develop a GEP course in Data Science for UCF. The committee will consist of one member from each department from the following departments: CS, IEMS, MATH, STAT.
07/31/2019	The committee discussed the revised curriculum and the curriculum path, budget and tables. Joe provided the committee the CPP document.
08/09/2019	The committee met with Dr. Teresa Dorman and discussed the prefix of the new courses and several issues remained in the proposal.
08/13/2019	The committee discussed the curriculum and the curriculum path, articulation agreement and CPP, found a mismatch between the curriculum and the catalog.
08/19/2019	The committee discussed the need to submit course action plans/request/syllabi, worked on Tables 1-4 and concluded that the budget should include the cost for the summer support for the program director and the cost of a printer and office supplies. The committee also identified the need to contact some other Floridian universities (FIU, AMU, USF, UF, FSU) for letters of support.
08/26/2019	The committee discussed the course offerings from Year 1 to 5.
09/17/2019	The committee discussed the proposal. The following is a to-do-list: Joe: Upload the syllabi of all new courses in the google drive, revise and complete Table 4, complete part D of Section IX. Luis: Revise and complete Table 4. Gary: Upload the CS APR to the google drive. Dan: Add



	Advisory board survey and the narrative to the proposal. Shunpu: Fill the course planning template.
09/20/2019	The committee discussed the proposal. The following is a to-do-list: Joe: Letter of support from Deloitte and New college if possible. Section VII: A short paragraph. Section IX: Faculty participation. Luis: Shorten Section VII, IX. Shunpu: Inquire Teresa regarding the prefix and the space for the computer lab. Organize a budget meeting with the deans. Gary: Upload the CS APR to the google drive. Dan: Add Advisory board survey and the narrative to the proposal.
10/02/2019	The committee discussed and answered Teresa's comments in the proposal. The committee also worked out the requirements for a minor in Data Science (MAS 3105, COP 3502, STAT 4163, STA 4164, Data Science I, II, 19 credit hours total).
10/03/2019	The committee met with Dr. Michael Johnson and Dr. Michael Georgiopolous to discuss the budget.
10/04/2019	Dr. Dorman convened a meeting of the proposal committee and Dr. Mark Henrich (CS) to discuss the two deans (Dr. Michael Johnson and Dr. Michael Georgiopolous)'s comments on the budget.
10/04/2019	The committee discussed the outcome from the meeting with the deans on Oct. 03 and answered Teresa's comments in the proposal. Joe proposed course numbers for Stat foundations I (4308) and II (4309).
10/09/2019	Dr. Dorman convened a meeting of the proposal committee and Dr. Mark Henrich (CS) to discuss the two deans (Dr. Michael Johnson and Dr. Michael Georgiopolous)'s comments on the budget.
10/09/2019	The committee discussed Teresa's comments from another meeting in the morning of Oct 09. Worked on Table 4.
10/10/2019	The committee discussed Teresa's comments from another meeting in the morning of Oct 09. Continued working on Tables 2 and 4.
10/11/2019	The committee discussed the budget, added the cost for purchasing 10 workstations each with 4 GPUs.

## VII. Program Quality Indicators - Reviews and Accreditation

Each department and degree program undergoes a seven-year review conducted by the Academic Program Quality (APQ) office of the University of Central Florida as a part of the Academic Program Review process. This review process involves both internal and external evaluation of the department and degree programs. Additionally, as a part of the Institutional Effectiveness process, these programs are annually evaluated at the university level to ensure that annual goals and outcomes are met. As is the case with any new degree program, during the first several years, formative evaluations will take place to streamline the students' progression through the degree program.

The University of Central Florida is accredited by the Southern Association of Colleges and Schools Commission on Colleges (SACS-COC), and as such, the faculty of the program meet all credentialing to provide instruction to graduate students. UCF underwent SACS-COC accreditation reaffirmation in 2016 and received an exceptional review, meeting or exceeding all 90+ SACS-COC requirements and standards.

The APQ process involves extensive documentation and data related to the department and degree programs. As these artifacts are examined, self-studies are completed, indicators of program quality are developed, and outcomes are provided. The indicators of program quality measures:

- Instructional and Curriculum Effectiveness
- Adequacy of Experiences and Laboratories
- Connection with Industry
- Employment and Alumni Performance
- Research and Outreach Activities

These indicators are provided to external reviewers, the colleges, and the university to develop

recommendations that may include revisions to and improvements of the programs.

For each of the departments contributing to this degree program, we will provide relevant, summary points of the last APQ Academic Program Review regarding any recommendations, and responses to those recommendations, that relate to this proposed program.

### **Department of Statistics and Data Science**

In 2016-17, the statistics and data science department and the active undergraduate (B.S.) and graduate (M.S.) programs underwent external program review. As they pertain to the proposed B.S. program, the list of recommendations were extracted from the external consultant's graduate (M.S.) and undergraduate (B.S.) program review and can be found in Appendix I. The external consultants were Dr. John Stufken, Charles Wexler Professor in Statistics, Arizona State University and Dr. H. Joseph Newton, Dean Emeritus of Science, Professor Emeritus of Statistics, and Senior Professor of Statistics, Texas A&M University.

While there were no recommendations in this program review directly related to the development of a new degree program, one of the Statistics B.S. recommendations included exploring "the feasibility of developing research efforts in big data; work on applied research projects with government agencies and local and international companies to develop high-impact opportunities for students". This B.S. in Data Science will provide students with opportunities to engage with massive data sets used by governments and corporations and provide training and skills to prepare students for careers as data scientists. Furthermore, the ISC 4701 Praxis course of the program will offer an internship/practicum option to directly engage with local companies.

### **Department of Computer Science**

All the degree programs in Computer Science (CS) completed an Academic Program Review in 2011/12 and are currently undergoing a program review (final recommendations have not yet been submitted). The list of recommendations from the 2011/12 program review and can be found in Appendix I.

While there were no recommendations in this program review directly related to the development of a new degree program, one of the Computer Science B.S. recommendations included a request to "review current internship and co-op coordination and consider options for enhancing students and employer access". Through the ISC 4701 Praxis course of this program, the program will continue to cultivate existing industry partnerships to develop internship opportunities for students. These industry partnerships will enhance both student and employer access.

Because the undergraduate degree programs in CS and Information Technology (IT) are accredited by ABET, the external consultants focused on the graduate programs in the department and had little to say about the undergraduate programs. ABET reviews of the CS and IT bachelor's degree programs occurred in fall 2014. The CS B.S. degree has been accredited continuously since 1987. The fall 2014 review was passed (with only minor procedural suggestions for improvement). The IT B.S. degree was up for accreditation for the first time in 2014. As a result of suggestions by the accreditors, two new faculty members, Dr. Pamela Wisniewski and Dr. Liqiang Wang, were hired. One of the newly hired faculty, Dr. Liqiang Wang, does research in cloud computing and big data analytics.

### **Department of Mathematics**

In the 2016-17 academic year, the undergraduate and graduate programs of the Department of Mathematics: the Bachelors of Science degree in Mathematics the Masters of Science in Mathematical Sciences and the Doctor of Philosophy degree in Mathematics underwent external program review. The external consultants were Dr. Juan Manfredi at the the time Vice Provost for Undergraduate Studies and Professor of Mathematics at the University of Pittsburgh and Dr. Wayne Raskind, at the time Dean of the

College of Arts and Sciences at Wayne State University. The list of recommendations from the program review and can be found in Appendix I.

While there were no recommendations in this program review directly related to the development of a new degree program, one of the Mathematics B.S. recommendations included continuing “to develop opportunities for students to engage in high-impact practices emphasizing the benefits to the major.” The capstone course of this program (ISC 4701 Praxis) is a designated high-impact course and will provide students with the option of research or internship opportunities to ensure students can make connections between the knowledge and skills they will acquire with the degree and needs that industry has for the knowledge and skills.

### **Department of Industrial Engineering and Management Systems**

All the degree programs in the department of Industrial Engineering and Management Systems completed its last Academic Program Review in 2011/12 and are currently undergoing a program review (final recommendations have not yet been submitted). The list of recommendations from the 2011/12 program review and can be found in Appendix I.

While there were no recommendations in this program review directly related to the development of a new degree program, one of the Industrial Engineering B.S.I.E. recommendations included a request to “review current internship and co-op coordination and consider options for enhancing students and employer access”. (The same recommendation that the CS program received.) Through the ISC 4701 Praxis course of this program, the program will continue to cultivate existing industry partnerships to develop internship opportunities for students. These industry partnerships will enhance both student and employer access.

“Here at Lockheed Martin, we see opportunities for leveraging analytics in a wide number of domains such as, for better strategic and tactical decision making, improved performance of our products and services, optimization of resources, cost savings. I would recommend this program for many such needs, primarily in engineering and information technology. We also see the potential of leveraging data science and analytics in other domains as well and would recommend other degree programs incorporate portions of the curriculum for students in other disciplines, to gain an understanding of the value of information and analytics.” – Sreerupa Das, Lockheed Martin Fellow with Lockheed Martin, Rotary and Mission Systems

## **VIII. Curriculum**

- A. Describe the specific expected student learning outcomes associated with the proposed program. If a bachelor’s degree program, include a web link to the Academic Learning Compact or include the document itself as an appendix.**

The purpose of the bachelor of science in data science is to produce students with high competencies in the field of data science who can gain insight from data and communicate that insight. This field is an interdisciplinary area incorporating elements of the disciplines of computer science, industrial engineering, mathematics, and statistics to analyze large data sets. The Academic Learning Compact is included in Appendix J.

To be accomplished in this field, students are expected to have sufficient computational and applied background in order to understand the application of the tools, techniques and methods of these disciplines to the analysis of data. Students are also expected to be able to effectively understand the range of applicability of methods to the analysis of data. Lastly students are expected to acquire skills in the communication of the results and the limitations of the methods, results, and recommendations

provided by data science to audiences of varied technical backgrounds in an effective manner.

**B. Describe the admission standards and graduation requirements for the program.**

This is an open major, thus it is not limited- or restricted-access. Student will be recruited from incoming FTIC students, incoming transfer students, students of the articulated VC/UCF A.A. program, and those currently enrolled in other majors. Students will be admitted to the program through the standard UCF admissions process. Graduation requirements are the attainment of 120 credits, fulfillment of the requirement imposed by the state and university, and completion of the coursework for the program.

We are also working on an articulation agreement with Valencia College to offer courses that prepare students as major-ready transfers upon completion of an articulated A.A. We are developing this articulation agreement so a student who transfers into this degree will have completed all of the preferred and required general education courses and is ready to enroll into the upper-division courses of the program.

**C. Describe the curricular framework for the proposed program, including number of credit hours and composition of required core courses, restricted electives, unrestricted electives, thesis requirements, and dissertation requirements. Identify the total numbers of semester credit hours for the degree.**

The B.S. in Data Science is an interdisciplinary program involving a collaboration between the Department of Computer Science, Department of Mathematics, Department of Statistics and Data Science, and Department of Industrial Engineering and Management Systems at the University of Central Florida. It has been created to address the growing need for trained workers using data analytic methods to address problems in industry and government.

The B.S. in Data Science is a 120-credit hour degree program. The catalog copy for this degree program is included in Appendix K. The requirements of the program consist of 39 hours of General Education Program (GEP) courses (because of required prerequisite courses); 11 hours of common program prerequisites (CPP) not fulfilled by the GEP; core requirement at a basic level, which are all fulfilled by the GEP ann CPP; 49 hours of core coursework at an advanced level; and 21 credit hours of electives.

The core coursework is designed to provide the student with fundamental computer science, mathematical and statistical knowledge and skills to make progress in the field. The electives are chosen primarily from upper level courses after meeting with a program advisor. Courses may be selected from among those courses not completed within the advanced core or outside the coordinating departments. The courses selected should support and complement the student's academic and career goals.

Most of the required coursework for the program is comprised of existing courses in the collaborating departments. The following eleven new courses are being created for the program, and the course syllabi are found in Appendix L:

- |   |                 |
|---|-----------------|
| ● CAP 4670 - Algorithms for Machine Learning* | Credit Hours: 3 |
| ● COP 4283 - Data Science Programming*        | Credit Hours: 3 |
| ● ISC 4241 - Data Science I                   | Credit Hours: 3 |
| ● ISC 4242 - Data Science II                  | Credit Hours: 3 |
| ● ISC 4301 - Predictive Analytics             | Credit Hours: 3 |
| ● ISC 4401 - Data Management Technology       | Credit Hours: 3 |
| ● ISC 4501 - Data Graphics and Visualization  | Credit Hours: 3 |
| ● ISC 4701 - Praxis in Data Science           | Credit Hours: 3 |

- MAP 4447 - Mathematical Foundations of Machine Learning and Artificial Intelligence\* Credit Hours: 3
- STA 4038 - Statistical Foundations of Data Science and Artificial Intelligence I Credit Hours: 3
- STA 4039 - Statistical Foundations of Data Science and Artificial Intelligence II Credit Hours: 3

\*These new courses will also be enrolled by students in existing programs in engineering (CAP 4670), physics (COP 4283), and mathematics (MAP 4447).

**D. Provide a sequenced course of study for all majors, concentrations, or areas of emphasis within the proposed program.**

We provide a sequenced, four-year plan of study below that outlines the courses needed for a new student to complete this degree.

<u>Fall Semester Year 1</u>		<u>Spring Semester Year 1</u>	
ENC 1101	3	ENC 1102	3
MAC 2311	4	MAC 2312	4
GEP Cult/Hist Fnd, Area 1	3	GEP Cult/Hist Fnd, Area 2	3
SPC 1608	3	GEP Cult/Hist Fnd, Area 3	3
GEP Social Fnd, Area 1	<u>3</u>	GEP Social Fnd, Area 2	<u>3</u>
	16		16
<u>Fall Semester Year 2</u>		<u>Spring Semester Year 2</u>	
BSC 2010	4	COP 3223	3
MAC 2313	4	MAS 3105	4
PHY 2048	4	MHF 3302*	3
STA 2023	<u>3</u>	STA 4163	<u>3</u>
	15		13
<u>Fall Semester Year 3</u>		<u>Spring Semester Year 3</u>	
COP 3502	3	COP 4283	3
ISC 4241	3	ISC 4242	3
MAP 4447**	3	STA 4039	3
STA 4164	3	Elective I	3
STA 4038	<u>3</u>	Elective II	<u>3</u>
	15		15
<u>Fall Semester Year 4</u>		<u>Spring Semester Year 4</u>	
ISC 4301	3	ISC 4701 Praxis	3
ISC 4501	3	Elective IV	3
ISC 4401	3	Elective V	3
STA 4724	3	Elective VI	3
Elective III	<u>3</u>	Elective VII	<u>3</u>
	15		15

\*Students may instead take COT 3100

\*\*Students may instead take CAP 4670, ESI 4312 or STA 4241

**E. Provide a one- or two-sentence description of each required or elective course.**

Below we provide the course descriptions for each of the advanced core course requirements. All students are required to complete the following 14 courses:

**COP 3502C - Computer Science I**

This course covers problem solving techniques, order analysis and notation, abstract data types, and recursion.

**COP 4283 - Data Science Programming**

This is a course that focuses on the development of programming for modeling in data science.

**ISC 4241 - Data Science I**

An introductory study of the basic tools, theory and practice of Data Science: Data Science tools: Python R SQL; Data collection, preparation, cleaning, exploration; Modeling, inference and testing; MapReduce, Hadoop, Spark; Data visualization, communication/interpretation

**ISC 4242 - Data Science II**

Advanced methods for data visualization, statistical modeling, and prediction. Big data and database management, basic Bayesian methods, nonlinear statistical models, and unsupervised and supervised learning. Practice with problems from the industrial and complex domains using R and Python.

**ISC 4301 - Predictive Analytics**

This course addresses the methods and problems in extrapolating prediction for modeling large data sets.

**ISC 4401 - Data Management Technology**

This course addresses the problems in ensuring the stability and accessibility of very large databases with particular attention to computational optimization.

**ISC 4501 - Data Graphics and Visualization**

An introduction to using visuals to convey content of data analysis.

**ISC 4701 - Praxis in Data Science**

This course will provide the means for students to demonstrate their ability to work in teams to address data science problems in industry, government, and the non-profit sector.

**MAS 3105 - Matrix and Linear Algebra**

This course covers matrices, determinants, vector spaces over the reals, linear independence, basis, solutions of systems, range of linear transformations, eigenvectors, singular value decomposition.

**STA 4163 - Statistical Methods II**

This course covers methods of analyzing data, statistical models, estimation, tests of hypotheses, regression and correlation, an introduction to analysis of variance, chi-square, and nonparametric methods.

**STA 4164 - Statistical Methods III**

A continuation of STA 4163, this course includes a further study of regression, analysis of variance and covariance and multiple comparisons.

STA 4724 - Big Data Analysis Methods

This course covers principles of algorithms in analyzing data, computational concerns with statistics, principles of classification, association rules, belief networks, clustering, use of trees in decision making, visualization techniques, and the understanding of randomness in datasets.

STA 4038 - Statistical Foundations of Data Science and Artificial Intelligence I

This is a fundamental course for undergraduate students to learn the statistical foundations of Data Science and Artificial Intelligence.

STA 4039 - Statistical Foundations of Data Science and Artificial Intelligence II

This is a fundamental course for undergraduate students to learn the statistical foundations of Data Science and Artificial Intelligence.

Students will select one of the following two courses as a part of the advanced core requirements:

COT 3100C - Introduction to Discrete Structures

This course covers logic, sets, functions, relations, combinatorics, graphics, Boolean algebras, finite-state machines, Turing machines, unsolvability, computational complexity.

MHF 3302 - Logic and Proof in Mathematics

This course covers basic mathematical logic, methods of proof in mathematics, and application of proofs to elementary mathematical structures.

Students will select one of the following four courses as a part of the advanced core requirements:

CAP 4670 - Algorithms for Machine Learning

This course is an introduction to the basic principles of machine learning from the perspective of Algorithms using Computer Science.

ESI 4312 - Deterministic Methods for Operations Research

This course is an introduction to basic principles and deterministic techniques of operations research. topics include linear programming, integer programming, network flow problems, and non-linear programming.

MAP 4447 - Mathematical Foundations of Machine Learning and Artificial Intelligence

This course provides an introduction to both Machine Learning and Artificial Intelligence from the mathematical perspective. The emphasis in this course is to utilize techniques from linear algebra, probability theory, and optimization to develop and understanding of concepts in machine learning and artificial intelligence.

STA 4241 - Statistical Learning This course covers simple and multiple linear regression, cross-validation, bootstrapping, subset selection, shrinkage methods, dimension reduction, decision trees, bagging, random forests, boosting, principal components analysis, clustering methods.

- F. For degree programs in the science and technology disciplines, discuss how industry-driven competencies were identified and incorporated into the curriculum and indicate whether any industry advisory council exists to provide input for curriculum development and student assessment.**

For the proposed B.S. in Data Science, the academic components of the program have been designed in such a way that allows for the greatest level of data science theoretical understanding at the undergraduate

level while also instilling the skills and knowledge needed in the job market. The curriculum has been designed with this result in mind: gainful employment for graduates. The core competencies for the proposed degree are based on well-established principles of data science applications in business. The committee that developed the proposal have well over 100 years of combined experience in computer science, statistics, mathematics, and career placement.

We additionally sought input from the members of an industrial advisory board to ensure that the learning outcomes and skills of the program’s graduates would meet current industry needs. To support ongoing curricular development for this proposal, an industrial advisory board for this program was created using the pre-existing advisory councils that oversee all Master and PhD level Data Analytics programs at UCF. The members of the B.S. Industrial Advisory board are as follows:

<b>Name</b>	<b>Company/Institution</b>	<b>Position</b>
Brandon Shelton	LA Care	Director of Analytics
Daniel Bruce	Levatas	Chief Data Officer
Diala Gammoh	NBC Universal, Golf Channel	Head Data Scientist
Jerry Oglesby	SAS	University Liaison
Justin Scarborough	Lockheed Martin	Engineering Lead
Kat Walker	Orlando Health	Data Science Director
Kevin Miller	CFE	Business Analyst
Luna Anico Sanchez	AAA National	Senior Analyst
Marvin Gardner	The Aerospace Corporation	Director
Matt Broffman	City of Orlando	Director of Innovation
Nick Intintolo	SouthLake Group	Managing Partner
Par Ostberg	Siemens	Analytics Lead
Parker Lutz	Verizon	Data Scientist
Patti Brownsord	AAA National	Director of Data Analytics
Praveen Rao	Charter Communications	Chief Data Officer
Russell E. Denslow	Sodexo	Director of Analytics
Ryan Sleeper	PlayFair Data	Chief Executive Officer
Sreerupa Das	Lockheed Martin Fellow	Lockheed Martin
Susan Scrupski	Big Mountain Data	Chief Executive Officer

At a recent board meeting, the members voted to bring the Data Science B.S. program under their purview after the official launch date is announced. They will continue to provide curricular guidance based on the needs of their companies and industries well into the future.

**G. For all programs, list the specialized accreditation agencies and learned societies that would be concerned with the proposed program. Will the university seek accreditation for the program if it is available? If not, why? Provide a brief timeline for seeking accreditation, if appropriate.**

No applicable agencies or societies.

**H. For doctoral programs, list the accreditation agencies and learned societies that would be concerned with corresponding bachelor’s or master’s programs associated with the proposed program. Are the programs accredited? If not, why?**

N/A

**I. Briefly describe the anticipated delivery system for the proposed program (e.g., traditional delivery on main campus; traditional delivery at branch campuses or centers; or nontraditional**



delivery such as distance or distributed learning, self-paced instruction, or external degree programs). If the proposed delivery system will require specialized services or greater than normal financial support, include projected costs in Table 2 in Appendix A. Provide a narrative describing the feasibility of delivering the proposed program through collaboration with other universities, both public and private. Cite specific queries made of other institutions with respect to shared courses, distance/distributed learning technologies, and joint-use facilities for research or internships.

The delivery system for this program will be primarily a traditional, face-to-face program complemented with online learning tools. Due to the specific demands on students in fulfilling the program requirements, it is not anticipated that we will be collaborate directly with other partners in the State University System of Florida.

## IX. Faculty Participation

- A. Use Table 4 in Appendix A to identify existing and anticipated full-time (not visiting or adjunct) faculty who will participate in the proposed program through Year 5. Include (a) faculty code associated with the source of funding for the position; (b) name; (c) highest degree held; (d) academic discipline or specialization; (e) contract status (tenure, tenure-earning, or multi-year annual [MYA]); (f) contract length in months; and (g) percent of annual effort that will be directed toward the proposed program (instruction, advising, supervising internships and practica, and supervising thesis or dissertation hours).

Appendix A, Table 4, provides information about the 27 faculty members (26 current and 1 new line) who are expected to participate in the B.S. program by Year 5. Curricula vitae for the 26 active faculty members are included in Appendix M. All but one faculty member holds a Ph.D. as the terminal degree in their fields, and all are SACS-COC qualified to teach in their identified field. Presently ten hold the rank of professor, six are associate professors, seven are assistant professors and the remaining three are an associate lecturer, a lecturer, and a senior instructor. The new line will be an assistant professor hire. These 26 faculty members will immediately or eventually participate in the delivery of courses, and the currently active faculty have an international reputation and expertise in critical areas of research related to data science.

The Computer Science faculty include the following:

Faculty Name	Rank (in Jan. 2019)	Courses Taught
Sean Szumlanski	Lecturer	COP 3502C
Mark Llewellyn	Associate Lecturer	ISC 4401
Liqiang Wang	Associate Professor	COP 4283
Arup Guha	Associate Instructor	COT 3100C
New hire	Assistant Professor	ISC 4301
Damla Turgut	Professor	COP 4331
Sumanta Pattanaik	Associate Professor	ISC 4501
Gita Sukthankar	Associate Professor	CAP 4670

The Industrial Engineering and Management Systems faculty include the following:

Faculty Name	Rank (in Jan. 2019)	Courses Taught
Ivan Garibay	Assistant Professor	ISC 4301
Luis Rabelo	Professor	ISC 4701
Adan Vela	Assistant Professor	ISC 4242
Qipeng Zheng	Associate Professor	ESI 4312

The Mathematics faculty include the following:

<b>Faculty Name</b>	<b>Rank (in Jan 2019)</b>	<b>Courses Taught</b>
Joseph Brennan	Professor	ISC 4242
Carlos Borges	Assistant Professor	ISC 4242 MAP 4447 ISC 4701
Xin Li	Professor	ISC 4242 MAP 4447 ISC 4701
Brian Moore	Associate Professor	ISC 4242 ISC 4301
Marianna Pensky	Professor	ISC 4242 ISC 4301
Gary Richardson	Professor	ISC 4242 ISC 4301
Qiyu Sun	Professor	ISC 4242 MAP 4447
Gerrit Welper	Assistant Professor	ISC 4242 MAP 4447 ISC 4701
Teng Zhang	Assistant Professor	ISC 4242 MAP 4447 ISC 4701

The Statistics and Data Science Department faculty including the following

<b>Faculty Name</b>	<b>Rank (in Jan. 2019)</b>	<b>Courses Taught</b>
Nizam Uddin	Professor	STA 2023 ISC 4241
Mengyu Xu	Assistant Professor	STA 2023 STA 4724
Alexander Mantzaris	Assistant Professor	ISC 4241 ISC 4301
Edgard Maboudou	Associate Professor	STA 4163 STA 4241
Xin Yan	Professor	STA 4163 STA 4164
Chung-Ching Wang	Professor	Will serve as program director and receive one course release/year ISC 4701 STA 4039
New Hire	Assistant Professor	STA 4038 STA 4039

### **Faculty Advising**

All the participating faculty members will be involved in advising the students in the B.S. program;

however, a program director will be identified and serve as the lead advisor and be responsible for overall management of the degree program and coordinating advising.

### **Program Administration**

The Bachelor of Science program in Data Science is an interdisciplinary program with faculty participating from four departments within the College of Sciences and the College of Engineering and Computer Science.

#### Program Director

Executive authority will rest with the Program Director, who will be responsible for the day to day administration, direction, management and reporting responsibilities for the program in consultation with the program committee. The Program Director will serve a two-year term based on the following rotation (to be continued in perpetuity):

Statistics and Data Science (2020-2022, 2028-2030)

Computer Science (2022-2024, 2030-2032)

Mathematics (2024-2026, 2032-2034)

Industrial Engineering and Management Systems (2026-2028, 2034-2036).

The Program Director will be appointed starting in a summer semester and will terminate at the end of the spring semester after two years. The Program Director will also receive one course release per academic year and be paid one month summer salary for each academic year they serve. The Program Director will have office space in Technology Commons II, room 221.

The first appointed program director will be Dr. Chung-Ching Wang, professor of statistics.

#### Program Committee

The overall program administration, direction (including curriculum revision), management, and reporting will be accomplished by a Program Committee consisting of four faculty members that are teaching and advising for the program. The department chair for each of the four participating departments will select one faculty member to serve on the Program Committee for a duration of not more than four years. The Program Director will serve as a member of the Program Committee for their designated department and as specified by the two-year rotation schedule described above.

#### Program Support

To assist in the day-to-day administration of the program, the Program Director will be assisted by a Program Assistant starting in Year 5. The role of the Program Assistant is to serve as the principal contact for the program with students and the public. The Program Assistant will assist the Program Director in administration, management and reporting responsibilities for the program in addition to advising, budgetary, human resource issues, and secretarial needs of the unit. The Program Assistant will have office space in Technology Commons II, room 221.

- B. Use Table 2 in Appendix A to display the costs and associated funding resources for existing and anticipated full-time faculty (as identified in Table 4 in Appendix A). Costs for visiting and adjunct faculty should be included in the category of Other Personnel Services (OPS). Provide a narrative summarizing projected costs and funding sources.**

As indicated in Table 4 (Appendix A), we will have 27 faculty supporting this program, one of which will be a new, joint hire completed in Year 2. The costs associated with faculty include the following for Year 1, which will increase slightly by Year 5:

### **Program Director**

The program director's one month summer salary plus benefit (\$17,366, recurring) will be covered by the colleges (COS/CECS). In addition, the program director will be provided one course release, which will be covered by the home department of the faculty who holds the position.

### **New, Joint Faculty Member**

In Year 2, one new faculty member will be hired to teach three new courses. This will be a joint hire between the Departments of Statistics and Data Science (COS) and Computer Science (CECS) with salary and benefits split of 51/49%, respectively between the colleges. The total cost of this line will be \$147,200, on a recurring basis.

### **Current Faculty Members**

Twenty-six existing faculty members will teach the currently offered and new courses of the B.S. program with nine faculty active in Year 1 of the program. The costs of their instruction will be covered by a reallocation of \$117,377 from the participating departments.

- C. **Provide in the appendices the abbreviated curriculum vitae (CV) for each existing faculty member (do not include information for visiting or adjunct faculty).**

Curriculum vitae for each faculty are found in Appendix M.

- D. **Provide evidence that the academic unit(s) associated with this new degree have been productive in teaching, research, and service. Such evidence may include trends over time for average course load, FTE productivity, student HC in major or service courses, degrees granted, external funding attracted, as well as qualitative indicators of excellence.**

As evidenced below, each of the four departments participating in this degree program have faculty who are productive in teaching, research and service.

### **Department of Statistics and Data Science**

#### Teaching

Between academic years 2012-13 and 2016-17, the Department of Statistics and Data Sciences annually taught over 18,000 student credit hours (SCH).

We further illustrate teaching productivity by examining the ratio of total SCH (including undergraduate and graduate hours) to the number of full-time faculty (tenured, tenure-earning, lecturers and instructors). Between 2012-13 and 2016-17, we see that the per capita productivity SCH is consistently between 1,000 and 2,000 annually.

#### *Total FTE Productivity in Statistics and Data Science (Graduate and Undergraduate)*

	2014-15	2015-16	2016-17	2017-2018	2018-2019
Total SCH	17,779	18,167	18771	20,416	31,757
Number of Full-Time Faculty	11	11	16	14	15
SCH/F-T Faculty	1,616	1,651	1,173	1,458	2,117

Source: UCF Institutional Knowledge Management

In fall 2018, Statistics and Data Science enrolled 197 undergraduates, 34 masters, and 12 Ph.D. students. In academic year 2018-19, the department graduated 40 undergraduates and 15 master's students.

### Research and Funding

The Department of Statistics and Data Science is also productive in the area of research. Although the department has only an M.S. degree prior to 2018, we had steady output in the numbers of refereed articles, presentations, and contract and grant funding. With the addition of a Ph.D. in 2019 we expect to see a doubling in the number of refereed articles and grant funding in the next 3 to 5 years.

*Department of Statistics and Data Science Publications, Presentations and Grants*

	2014-15	2015-16	2016-2017	2017-18	2018-19
Number of Refereed Publications	17	18	17	17	25
Number of Non-Refereed Publications	4	1	1	0	0
Number of Presentations	4	29	60	16	14
New Grants (Dept's Portion)	\$965,556 (\$77,716)	\$3,440,468 (\$382,454)	\$917,013 (\$60,178)	\$4,457,130 (\$701,837)	\$744,733 (\$74,477)

The Department of Statistics and Data Science has a strong data mining component. The data mining effort at UCF commenced with the establishment of the graduate-level certificate program in Data Mining and strengthened with the Data Mining track of the Statistical Computing M.S. Several faculty conduct research in pure data mining and many have participated in projects with a big data component (ex: massive data sets, millions of rows and large numbers of variables, hundreds of predictors). Data mining is predicated upon sound statistical methodology for which the faculty have exhibited expertise in top tier journals covering bioinformatics, linear models, decision trees, experimental design, multivariate analysis, dimension reduction, and regression analysis.

The following are brief faculty bios offering an overview of each faculty member's research:

**Edgard M. Maboudou.** Dr. Maboudou is best known for his research on Multivariate Statistics Process Control, but has also contributed to High Dimensional hypothesis testing, multiple change point problems, support vector/matrix data. Also, his accomplishment got international recognition accentuated by invitation to give talks in international statistical meetings such as in Ouro Preto, MG, Brazil and in Padua, Italy.

**Alexander Mantzaris.** Dr. Mantzaris' research interests are in smart city analytics. The size of data and ubiquity of it allows us to not only look at averages of citizens but also investigate differences according to the spatial coordinates. New questions can be posed and answered about the nature of cross-city communication and affiliation. He is also continuing his work on community connectivity in large graphs constructed within the spheres of social media platforms.

**Mengyu Xu.** Dr. Xu is currently an assistant professor with the Department of Statistics and Data Science at University of Central Florida, Orlando, USA. Her research interests include the covariance matrix estimation and network recovery from high-dimensional time series and the distribution theory of quadratic forms and high-dimensional hypothesis test.

**Nizam Uddin.** Dr. Uddin's publications have appeared in top tier statistics journals including *Biometrika*, *Annals of Statistics*, *Journal of Statistical Planning and Inference*, *Statistica Sinica*, *Australian Journal of Statistics* and numerous other journals in healthcare, transportation, and business areas. He has received the university Teaching Incentive Program award and a Research Incentive award.

He has authored/co-authored over sixty research papers. Dr. Uddin's primary research is in Optimal Experimental Design. He has also contributed to interdisciplinary research projects of other colleagues within UCF and work on their externally funded projects. He was involved with research projects that resulted in cumulative funding of approximately \$1.5 million.

**Xin Yan.** Dr. Yan is a biostatistician with specialization for the design and analysis of clinical trials in various therapeutic areas including oncology, cardiovascular diseases, pulmonary diseases, hematology, and vaccines. Dr. Yan's publications have appeared in top tier journals such as *Statistics in Medicine*, *Statistics in Biopharmaceutical Research*, *Journal of Statistical Association*, *Statistical Computing and Graphics*, *Journal of Multivariate Analysis*, *Journal of Machine Learning*, etc. He is the author of the graduate textbook *Linear Regression, Theory and Computing* (2009) published by World Science Book Publisher.

Dr. Yan has served as primary consulting biostatistician on over 80 randomized controlled clinical trials. His clinical biostatistics research extends to all phases of clinical trials, including but not limited to: sample size estimation for longitudinal trails, sequential and two-stage design, evaluation of large number of non-inferiority trials, meta-analysis, detection of qualitative interaction in equivalence trials, analysis of count data, frailty model and its application in medical study, non-linear model and non-linear mixed effect model, multivariate survival models, propensity score method in large observational study, and non-ignorable missing data in longitudinal trials.

Dr. Yan actively serves as biostatistics expert in many medical research projects. He has received funding from UCF COS seed funds on Clinical Validation Study of a New Molecular Test for Aggressive Prostate Cancer Screening (\$45,000), NIH (2014-2018) on Oral Suction Protocol Intervention to Reduce Aspiration and Ventilator-events (\$2,400,000), NINR (2015-2018) on Promoting Cancer Symptom Management in Older Adults (\$470,000). In addition, he has jointly submitted with researchers in medicine/biology/healthcare more than 15 external proposals since joining the UCF.

**Morgan C. Wang.** Dr. Wang is the founding Director of Data Mining Program (funded in 1999) and Professor of Statistics and Data Science at the University of Central Florida (UCF). He is also an affiliated faculty with the School of Computer Sciences and College of Business Administration at UCF. He coached student teams to win the 2011 and 2012 SAS Data Mining Shootout Contest. He won the best conference award in the First Annual Conference on Engineering and Technology Innovation in 2008. He was the first prize-winner in Data Mining Competition of the 11<sup>th</sup> SIGMOD KDD (the most predigest data mining competition) conference in 2004 and the first prize winner in Data Visualization Contest of SUGI 25 conference in 2000, and was given invited talks on making intelligent decision based on big data analytics for more than eighty times for American Statistical Association, SIGKDD (leading conference in data mining), International Conference on Information Technology, SAS Global Forum, Well Fargo Bank, Republic Bank, Florida Blue, Disney, Kemper Preferred Auto Insurance, HealthFirst, QFOR, and many companies and universities around the world. He is a member of Ad Hoc Big Data Advisory Committee for the President of American Statistical Association (ASA) since 2019. His research interests include building predictive model automatically and intelligently, big data analytics, automatic time series model building, and meta-analysis.

### Service

The faculty in the department of Statistics and Data Science provide extensive professional service to the scientific community as well as the local community, as referees, editors, associate editors and editorial board members of scientific journals. Some of our faculty members are actively involved in community service, serving as judges in science fair, coaches and advisors of student clubs.

### **Department of Computer Science**

### Teaching

The 38 tenured and tenure track faculty in the department of Computer Science at UCF teach 3,230 undergraduate majors and 475 graduate students (as of fall 2018) and in the academic year 2018-2019 they graduated 517 undergraduate majors, 129 MS students, and 21 PhD students. The course load for research-active tenured and tenure-track faculty varies with their research productivity; it is 4 courses per year for faculty who have less than \$200k/year in research expenditures, 3 courses per year for faculty who have at least \$200k per year in research expenditures, and 2 courses per year for faculty who have at least \$300k per year in research expenditures. The course load for the 11 non-tenure-track faculty is 7 courses per year. The total 2018-19 undergraduate SCH productivity for the computer science department was 73,337.

### Research and Funding

The tenured faculty include three fellows of the Institute of Electrical and Electronics Engineers (IEEE), one of whom is also a fellow of the American Association for the Advancement of Science (AAAS) and two other professional societies. The faculty in Computer Science have been awarded six NSF CAREER awards since 2000 (and 4 since 2009), and average six journal and conference papers per faculty per year over the last three years. The 2018 USNWR ranking for the department was 82<sup>nd</sup> among the doctoral programs in Computer Science in the US, and the department ranks 50<sup>th</sup> in research on [csrankings.org](http://csrankings.org). At that website, the department ranks 31<sup>st</sup> among US departments in “interdisciplinary areas” (which includes HCI and bioinformatics) and 41<sup>st</sup> among US departments in “artificial intelligence” (including 5<sup>th</sup> in the US in Computer Vision.) Total research expenditures were \$6.89M in the 2017-18 academic year. Average expenditures are at the level of \$186k per year per T/TE faculty member in the 2017-18 academic year.

The following are brief faculty bios offering an overview of each faculty member’s research:

**Gita Sukthankar** is an associate professor with a PhD in Robotics from Carnegie Mellon University. She has also done a sabbatical at Xerox PARC, and a summer faculty fellowship at the Naval Research Laboratory. Prior to her PhD she worked at Compaq/HP Labs on their research staff. Her research is on autonomous agents, multi-agent systems, activity recognition, and other topics in Robotics and Artificial Intelligence. She won an NSF CAREER award in 2009 and an AFOSR Young Investigator award also in 2009.

**Damla Turgut** is a professor with a PhD in Computer Science from the University of Texas at Arlington. She has worked at UCF since 2002. Her research focus is on the value of information in wireless sensor and underwater networks and the value of privacy in Internet of Things systems. She has also done research on data analytics for STEM education and in computer networking more generally.

**Liqiang Wang** is an associate professor with a PhD in Computer Science from SUNY Stony Brook. He won an NSF CAREER award in 2011. Prior to coming to UCF he worked as an associate professor at the University of Wyoming and was a visiting research scientist at IBM T.J. Watson Research Center. His research focuses on integrating deep learning, parallel computing, and program analysis. In particular, he is interested in optimizing performance, scalability, resilience, and resource management of big data processing, especially on Cloud, GPU, and multicore platforms.

**Sarah Angell** is an instructor with an MS in Computer Science from UCF. She worked for Walt Disney World in 2009. She has made pioneering efforts to digitize courses using the Engineering Proficiency Center, and has taught several online courses including Computer Organization (CDA 3103) and Introduction to Programming with C (COP 3223C).

**Demetrios Glinos** is a lecturer with a PhD in Computer Science from UCF. He also has a law degree (JD)

from Georgetown University. He has taught courses in Artificial Intelligence, Natural Language Understanding, and other subjects. Prior to his work at UCF he taught at Stetson University and Valencia College. He started a company for natural language processing, Advanced Text Analytics, in 2011.

**Arup Guha** is an associate instructor with an MS in Computer Science from the University of Wisconsin, Madison. He previously worked at an adjunct teacher at University High School and Winter Park High School. He serves as a coach of the UCF programming team and has coached three world finalist teams. He received the UCF Excellence in Undergraduate Teaching award three times and twice received the UCF Teaching Incentive Program (TIP) award.

**Mark Llewellyn** is an associate lecturer with a PhD from UCF, which in the area of database management. He has been at UCF since 1998 and has also served as a consultant for several book publishers. He has taught courses in Enterprise Computing (CNT 4714), Database Systems (COP 4710), Systems Administration (CNT 4603) and several others. He has won UCF's Teaching Incentive Program (TIP) award twice.

**Sean Szumlanski** is a lecturer with a PhD from UCF, which was in the area of natural language processing. He worked for Google from 2014-15 and has been teaching at UCF since 2015. He is well known for his rigorous teaching of introductory courses in design and analysis of algorithms and discrete mathematics. He has received two teaching awards from UCF and was named a distinguished faculty member by UCF's dept. of housing and residence life.

#### Service

The faculty in the department of Computer Science (CS) also carry out extensive professional and community service efforts. Many CS faculty members are editors or associate editors of journals, and many of the tenured and tenure-track faculty are active in service on conference program committees and in refereeing papers for journals. In terms of community service, the department teaches programming to middle school students on Saturdays in its "Junior Knights" program. The department also runs a senior design program that provides applications for community groups and researchers at UCF who do not have the funds to pay professionals.

### **Department of Industrial Engineering and Management Systems**

#### Teaching

The 18 tenured and tenure track faculty in the department of Industrial Engineering and Management Systems (IEMS) at UCF teach 542 undergraduate majors and 285 graduate students (as of fall 2018). The program graduated in the academic year 2018-2019: 95 undergraduate majors, 102 MS students, and 19 PhD students. The course load for research-active tenured and tenure-track faculty varies; it is 4 courses per year for faculty who are not involved in research expenditures, 2 courses per year for faculty who are involved in sponsored research. The IEMS Department has 4 non-tenured track faculty who teach approximately 7 to 8 courses/year. The total 2018-19 undergraduate SCH productivity for the IEMS department was 3,559.

#### Research and Funding

The tenured and tenure track faculty has been growing in the last 2 years. For example, IEMS has completed hiring 4 new faculty (tenure-track):

- Dr. Ivan Garibay: Data Analytics, Complex Systems, Simulation
- Dr. Adan Vela: Optimization, Logistics, Analytics, Simulation
- Dr. Heather Keathley: Traditional IE, System Dynamics, Organizational Behavior/Engineering Management
- Dr. Ben Sawyer: Human Factors, Neuroergonomics and Human-systems Integration



This has been reinforced with two (part time) National Academy of Engineering Members:  
 Dr. Deborah Nightingale (<http://www.iems.ucf.edu/news/deborah-nightingale-nae-joins-iems>)  
 Dr. Gavriel Salvendy (<http://www.iems.ucf.edu/news/dr-gavriel-salvendy-nae-joins-iems>)

The faculty in IEMS has an average of 6 journal and conference papers per faculty per year. The NSF Doctoral Report states that UCF IEMS had the highest production of PhDs in Industrial Engineering in the nation during the years 2016 and 2017 (the second place was for Georgia Tech). The average sponsored research expenditures yearly: \$4million.

Service

The faculty in IEMS are involved in numerous professional and community service efforts. Faculty members are editors or associate editors of journals, and many of the tenured and tenure-track faculty are active in service on conference program committees and in refereeing papers for journals.

**Department of Mathematics**

Teaching

During the period from 2011-13 to 2018-19 the Department of Mathematics has significantly increased the number of SCH produced in response to student demand. This has resulted in an increase of 30% in the number of SCH produced over this period. The productivity of the Department of Mathematics is indicated in the high level of SCH produced per full time faculty member that is currently at the level of being between 1360 to 1475 SCH per faculty.

*Total FTE Productivity in Mathematics (Graduate and Undergraduate)*

	2014-15	2015-16	2016-17	2017-2018	2018-2019
Total SCH	59,983	65,624	68,977	72,843	75,201
Number of Full-Time Faculty	42	46	47	51	55
SCH/F-T Faculty	1,428	1,426	1,468	1,428	1,367

Source: UCF Institutional Knowledge Management

Research

The Department of Mathematics of is a highly productive research department that is active in a number of disparate areas of mathematics including researchers working in: algebra, analysis, combinatorics, computation, data science, dynamical systems, fluid mechanics, geometry, graph theory, harmonic analysis, machine learning, mathematical biology, mathematical finance, mathematical statistics, mathematics education, nonlinear systems, ordinary differential equations, optimization, partial differential equations, probability, tomography, and topology.

*Department of Mathematics Publications, Presentations and Grants*

	2014-15	2015-16	2016-17	2017-2018	2018-2019
Number of Refereed Publications	85	127	152	146	188
Number of Presentations	81	76	102	132	143
Grants Awarded	\$468,084	\$827,629	\$465,101	\$1,494,254	\$599,736

The Doctor of Philosophy degree program in mathematics has been run by the Department of Mathematics since fall semester 1993. The program has had 83 graduates through summer term 2019.

The following are brief faculty biographies offering an overview of the research of each Mathematics faculty member participating in the proposed Bachelor of Science in Data Science program.

**Joseph Brennan.** Dr. Brennan is interested in commutative algebra with a special direction towards homological properties of modules and associated combinatorial and simplicial structures. This is particularly related to the study of the algebraic geometry associated with data structures known as algebraic statistics.

**Carlos Borges.** Dr. Borges' research interests are in numerical analysis, inverse problems, wave phenomena and scientific computing. He is particularly interested in developing numerical methods and applying advanced fast direct solvers to solve the problem of reconstructing properties of compactly supported domains from measurements of the scattered field off of those domains. This type of problem has applications in radar, sonar, medical imaging, probing, sensing and non-destructive testing among many others. All those problems share the common concept of data science of obtaining information from a large set of data.

**Xin Li.** Dr. Li is the Chair of the Department of Mathematics. He has research interests in approximation theory and its applications. Particular applications of interest are to computer vision, machine learning, artificial intelligence and data analysis and modeling.

**Brian E. Moore.** Dr. Moore's research interests are in scientific computing and differential equations with emphasis on structure-preserving algorithms and lattice equations. His work has been useful for scientific studies in video surveillance of crowds, neurodegenerative diseases, environmental protection, landing rockets on granular surfaces, and many applications involving wave propagation.

**Marianna Pensky.** Dr. Pensky's works are in diverse areas of data science such as high-dimensional statistics, network science, image and signal analysis, inverse problems and bio-medical applications of statistics. She authored about 100 publications, the majority of which are published in the top journals and has had continuous NSF research funding for the last twenty years. She is an associate editor of the Journal of The American Statistical Association, The Journal of the Statistical Planning and Inference and The Journal of the Nonparametric Statistics.

**Gary Richardson.** Dr. Richardson holds two doctorates: one in mathematics and the other in statistics. His work is both in the topology of convergence spaces and in probabilistic structures in topology. that are related to topological data structures.

**Qiyu Sun.** Dr. Sun's research interests are in applied and computational harmonic analysis, sampling theory, phase retrieval and graph signal processing. Recently he considered mathematical foundation for data processing, signal sampling and dynamic control on spatially distributed networks that have been widely used in (wireless) sensor networks, smart grids and many real world applications. Dr. Sun received the 2019 SIAG/CST Best SICON paper prize for his work on sparsity and spatial localization on spatially distributed network.

**Gerrit Welper.** Dr. Welper is broadly interested in numerical analysis and scientific computing and more specifically in reduced order modeling, uncertainty quantification and connections to machine learning. His recent work is on the automated generation of computationally efficient, yet accurate "reduced" models for the simulation of physics and engineering problems with sharp features.

**Teng Zhang.** Dr. Zhang's research interests lie in the analysis of large-scale data sets and establishing the mathematical foundations of those procedures. Recently, he has been interested in robust estimators and theoretical guarantees for non-convex optimization. His works have real-life applications such as cyber-security systems and 3D reconstruction in cryo-electron microscopy.

Service

The Department of Mathematics is extensively engaged in outreach to both the community of mathematicians as well as the community of Central Florida. Faculty members in the department serve on editorial boards, as reviewers for the National Science Foundation, as reviewers for other universities. They both organize conferences and serve on scientific boards for conferences. Locally, the department has organized the Central Florida Math Circle to bring opportunity to area middle and high school students to explore the possibilities of mathematics.

**X. Non-Faculty Resources**

- A. Describe library resources currently available to implement and/or sustain the proposed program through Year 5. Provide the total number of volumes and serials available in this discipline and related fields. List major journals that are available to the university's students. Include a signed statement from the Library Director that this subsection and subsection B have been reviewed and approved.**

UCF's library current collections are sufficient to support the start of the proposed B.S. in Data Science. The program will share resources with the M.S. in Data Analytics, M.S. in Business Analytics, M.S. in Statistics and Ph.D. in Big Data Analytics. No additional funding for books, databases or journals is being requested by the library at this time. Three out-of-state institutions and one in-state university were selected in the benchmark assessment. The UCF Libraries' assessment concluded that the list of databases we currently hold compares favorably with that of the other institutions listed.

- B. Describe additional library resources that are needed to implement and/or sustain the program through Year 5. Include projected costs of additional library resources in Table 2 in Appendix A. Please include the signature of the Library Director in Appendix B.**

Through Year 5, no additional library resources are needed to support this program. The Library Director provides their support for this proposal in Appendix B and a detail of holdings are also found in Appendix N.

- C. Describe classroom, teaching laboratory, research laboratory, office, and other types of space that are necessary and currently available to implement the proposed program through Year 5.**

The majority of the program needs will be met with existing office, classroom and laboratory space. The program director and assistant will have office space in Technology Commons II, room 221. The lectures for the existing and new courses require classrooms with seating up to 50 students, which will be scheduled through standard university procedures. The majority of the existing instructional labs (those with individual computers) will serve the program's needs. One such lab Classroom Building, room 220, which allows in-class, real-time exposure to data mining packages. This is essential for the efficient delivery of data mining courses that involve sophisticated data mining and statistical computing software.

For the first year of the program, the B.S. program will share computer lab space in the Statistical Computing and Data Mining Lab that currently only supports the M.S. and the Ph.D. programs. The students of this program will use these machines to run special software or access restricted databases and cloud services. In support of class projects, this lab will be equipped with 10 workstations installed with high performance GPUs. As the program grows and additional specialized computers are needed, the program has the option of either expanding into portable labs (where personal laptops with access to restricted databases and cloud servers can be used to support class projects) and into expanded space that is currently under consideration.

- D. Describe additional classroom, teaching laboratory, research laboratory, office, and other space needed to implement and/or maintain the proposed program through Year 5. Include any**

**projected Instruction and Research (I&R) costs of additional space in Table 2 in Appendix A. Do not include costs for new construction because that information should be provided in response to X (E) below.**

As identified above and in Table 1-A, enrollment in this program should reach 200 by Year 2 and is expected to be over 500 by Year 5. For classes that will need access to cloud computing resources, such as Microsoft Azure or Amazon's AWS, pricing for on-demand use of AWS is a fraction of a cent per hour for all but the largest configurations and is expected to only incur minimal costs. If needed, course (materials and supplies) or program (equipment) fees may be put in place to offset the cost of accessing specialized software or accessing restricted databases and cloud services. These options will be examined as the need arises.

- E. If a new capital expenditure for instructional or research space is required, indicate where this item appears on the university's fixed capital outlay priority list. Table 2 in Appendix A includes only Instruction and Research (I&R) costs. If non-I&R costs, such as indirect costs affecting libraries and student services, are expected to increase as a result of the program, describe and estimate those expenses in narrative form below. It is expected that high enrollment programs in particular would necessitate increased costs in non-I&R activities.**

N/A

- F. Describe specialized equipment that is currently available to implement the proposed program through Year 5. Focus primarily on instructional and research requirements.**

The Data Mining lab in the Department of Statistics and Data Science will be shared with this program. The Data Mining lab currently has 10 high performance computers equipped with software such as R, Python and SAS, among others. These computers can also be used to access cloud computing services such as Azure and AWS.

- G. Describe additional specialized equipment that will be needed to implement and/or sustain the proposed program through Year 5. Include projected costs of additional equipment in Table 2 in Appendix A.**

To augment the current data mining lab, 10 workstations equipped with 4 Quadro RTX 6000 GPUs will be obtained to train students in conducting deep machine learning experimentation. These upgrades will be handled through a university Technology Fee. This will permit students to obtain familiarity with state of the art market driven skills in Data Science.

- H. Describe any additional special categories of resources needed to implement the program through Year 5 (access to proprietary research facilities, specialized services, extended travel, etc.). Include projected costs of special resources in Table 2 in Appendix A.**

Students will need to have access to large databases for projects. We will use free and publicly available databases that are supplemented by industry donations of databases, as feasible.

- I. Describe fellowships, scholarships, and graduate assistantships to be allocated to the proposed program through Year 5. Include the projected costs in Table 2 in Appendix A.**

There is no need for fellowships or scholarships to be allocated. However, by Year 5, there is a need for four graduate teaching assistantships (GTAs) to support the undergraduate educational program, all of whom will be provided by the participating programs. The additional GTAs will be funded by the

colleges.

**J. Describe currently available sites for internship and practicum experiences, if appropriate to the program. Describe plans to seek additional sites in Years 1 through 5.**

The proposed B.S. in Data Science will provide students with in-demand skills for the challenges that industries face today and will face tomorrow. The program offers an internship/practicum option within the ISC 4701 Praxis course, the capstone course of the degree. We expect this to be a very popular option for students, thus we will be taking advantage of existing resources offered through UCF's Office of Experiential Learning. While there are currently no internship sites established exclusively for this program, the program will continue to cultivate partnerships of this sort with industry resources and contacts that have been developed for the UCF data science related programs.

## **Appendices**

<b>Appendix A:</b>	<b>Tables 1 – 4 (see separate file)</b>
<b>Appendix B:</b>	<b>EEO/Library Director Signatures</b>
<b>Appendix C:</b>	<b>EAB Report</b>
<b>Appendix D:</b>	<b>Letters of Support from Industry</b>
<b>Appendix E:</b>	<b>Surveys</b>
<b>Appendix F:</b>	<b>Letters of Support from Academic Institutions</b>
<b>Appendix G:</b>	<b>Letters of Commitment from College Deans</b>
<b>Appendix H:</b>	<b>Common Prerequisite Application</b>
<b>Appendix I:</b>	<b>Academic Program Review - Final Recommendations</b>
<b>Appendix J:</b>	<b>Academic Learning Compact</b>
<b>Appendix K:</b>	<b>Data Science B.S. Catalog Copy</b>
<b>Appendix L:</b>	<b>New Course Syllabi</b>
<b>Appendix M:</b>	<b>Faculty Members' CVs</b>
<b>Appendix N:</b>	<b>Details of Library Holdings and Funding Needs</b>

# **Appendix A: Worksheet**

## APPENDIX A

**TABLE 1-APROJECTED HEADCOUNT FROM POTENTIAL SOURCES(Baccalaureate Degree Program)**

Source of Students (Non-duplicated headcount in any given year)*	Year 1		Year 2		Year 3		Year 4		Year 5	
	HC	FTE	HC	FTE	HC	FTE	HC	FTE	HC	FTE
Upper-level students who are transferring from other majors within the university**	75	56.25	70	52.5	60	45	55	41.25	50	37.5
Students who initially entered the university as FTIC students and who are progressing from the lower to the upper level***	50	37.5	125	93.75	210	157.5	300	225	350	262.5
Florida College System transfers to the upper level***	5	3.75	10	7.5	50	37.5	70	52.5	75	56.25
Transfers to the upper level from other Florida colleges and universities***	5	3.75	10	7.5	20	15	25	18.75	25	18.75
Transfers from out of state colleges and universities***	5	3.75	10	7.5	20	15	25	18.75	25	18.75
Other (Explain)***International students	0	0	0	0	5	3.75	10	7.5	15	11.25
<b>Totals</b>	<b>140</b>	<b>105.00</b>	<b>225</b>	<b>168.75</b>	<b>365</b>	<b>273.75</b>	<b>485</b>	<b>363.75</b>	<b>540</b>	<b>405.00</b>

\* List projected annual headcount of students enrolled in the degree program. List projected yearly cumulative ENROLLMENTS instead of admissions.

\*\* If numbers appear in this category, they should go DOWN in later years.

\*\*\* Do not include individuals counted in any PRIOR CATEGORY in a given COLUMN.



## APPENDIX A

### TABLE 2 PROJECTED COSTS AND FUNDING SOURCES

Instruction & Research Costs (non-cumulative)	Year 1								Year 5						
	Funding Source							Subtotal coulumns 1+...+7	Funding Source						Subtotal coulumns 9+...+ 14
	Reallocated Base* (E&G)	Enrollment Growth (E&G)	New Recurring (E&G)	New Non- Recurring (E&G)	Contracts & Grants (C&G)	Philanthropy Endowments	Enterprise Auxiliary Funds		Continuing Base** (E&G)	New Enrollment Growth (E&G)	Other*** (E&G)	Contracts & Grants (C&G)	Philanthropy Endowments	Enterprise Auxiliary Funds	
Columns	1	2	3	4	5	6	7	8	9	10	11	0	13	14	15
Faculty Salaries and Benefits	134,743	0	0	0	0	0	0	\$134,743	356,436	0	0	0	0	0	\$356,436
A & P Salaries and Benefits	0	0	0	0	0	0	0	\$0	0	0	0	0	0	0	\$0
USPS Salaries and Benefits	0	0	0	0	0	0	0	\$0	57,200	0	0	0	0	0	\$57,200
Other Personal Services	0	0	0	0	0	0	0	\$0	0	0	0	0	0	0	\$0
Assistantships & Fellowships	35,700	0	0	0	0	0	0	\$35,700	102,348	0	0	0	0	0	\$102,348
Library	0	0	0	0	0	0	0	\$0	0	0	0	0	0	0	\$0
Expenses	11,000	0	0	0	0	0	211,080	\$222,080	15,000	0	0	0	0	0	\$15,000
Operating Capital Outlay	0	0	0	0	0	0	0	\$0	0	0	0	0	0	0	\$0
Special Categories	0	0	0	0	0	0	0	\$0	0	0	0	0	0	0	\$0
<b>Total Costs</b>	<b>\$181,443</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$211,080</b>	<b>\$392,523</b>	<b>\$530,984</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$530,984</b>

\*Identify reallocation sources in Table 3.

\*\*Includes recurring E&G funded costs ("reallocated base," "enrollment growth," and "new recurring") from Years 1-4 that continue into Year 5.

\*\*\*Identify if non-recurring.

#### Faculty and Staff Summary

	Year 1	Year 5
Total Positions	0.80	1.17
Faculty (person-years)	0	0
A & P (FTE)	0	1
USPS (FTE)	0	1

#### Calculated Cost per Student FTE

	Year 1	Year 5
Total E&G Funding	\$181,443	\$530,984
Annual Student FTE	105	405
E&G Cost per FTE	\$1,728	\$1,311

**Table 2 Column Explanations**

Reallocated base (E&G) Enrollment	1	E&G funds that are already available in the university's budget and will be reallocated to support the new program. Please include these funds in
New Recurring (E&G)	2	Additional E&G funds allocated from the tuition and fees trust fund contingent on enrollment increases.
New Non- (E&G)	3	Recurring funds appropriated by the Legislature to support implementation of the program.
Contracts & Grants (E&G)	4	Non-recurring funds appropriated by the Legislature to support implementation of the program. Please provide an explanation of the source of
Endowment (E&G)	5	Contracts and grants funding available for the program.
Enterprise Auxiliary Funds	6	Funds provided through the foundation or other Direct Support Organizations (DSO) to support of the program.
Subtotal columns 1 + 7	7	Use this column for continuing education or market rate programs and provide a rationale in section III.B. in support of the selected tuition model.
Continuing base (E&G)	8	Subtotal of values included in columns 1 through 7.
New Enrollment (E&G)	9	Includes the sum of columns 1, 2, and 3 over time.
Other*** (E&G)	10	See explanation provided for column 2.
Contracts & Grants	11	These are specific funds provided by the Legislature to support implementation of the program.
Endowment	12	See explanation provided for column 5.
Enterprise Auxiliary Funds	13	See explanation provided for column 6.
Subtotal columns 9 + 14	14	Use this column for continuing education or market rate programs and provide a rationale in section III.B. in support of the selected tuition model.
	15	Subtotal of values included in columns 9 through 14.

**APPENDIX A**

**TABLE 3 ANTICIPATED REALLOCATION OF EDUCATION & GENERAL FUNDS\***

<b>Program and/or E&amp;G account from which current funds will be reallocated during Year 1</b>	<b>Base before reallocation</b>	<b>Amount to be reallocated</b>	<b>Base after reallocation</b>
Industrial Engineering Management Systems (16xx2074)	0	12,266	-\$12,266
Computer Science (16xx2074)	0	33,048	-\$33,048
Mathematics (24052074)	6,178,350	16,271	\$6,162,079
Statistics (24132074)	1,810,689	73,158	\$1,737,531
Computer Science (16xx0074)		20,400	-\$20,400
Statistics (24130074)	348,145	15,300	\$332,845
Statistics (24130001)	191,701	11,000	\$180,701
Joint Hire (16010101/24010101)	147,200	147,200	\$0
<b>Totals</b>	\$8,676,085	\$328,643	\$8,347,442

\* If not reallocating funds, please submit a zeroed Table 3

## APPENDIX A

**TABLE 4 ANTICIPATED FACULTY PARTICIPATION**

Faculty Code	Faculty Name or "New Hire" Highest Degree Held Academic Discipline or Speciality	Rank	Contract Status	Initial Date for Participation in Program	Mos. Contract Year 1	FTE Year 1	% Effort for Prg. Year 1	PY Year 1	Mos. Contract Year 5	FTE Year 5	% Effort for Prg. Year 5	PY Year 5
C	Joint New Hire, Ph.D. CS and STAT	Asst. Prof.	Tenure Earning	2021-22	0	0.00	0.00%	0.00	9	0.75	25.00%	0.19
A	Joseph Brennan, PhD	Prof.	Tenured	2023-24	9	0.75	0.00%	0.00	9	0.75	12.50%	0.09
A	Xin Li, PhD.	Prof.	Tenured	2024-25	12	1.00	0.00%	0.00	9	0.75	6.25%	0.05
A	Marianna Pensky, Ph.D.	Prof.	Tenured	2022-23	9	0.75	0.00%	0.00	9	0.75	12.50%	0.09
A	Luis Rabelo, Ph.D.	Prof	Tenured	2021-22	9	0.75	0.00%	0.00	9	0.75	6.25%	0.05
A	Gary Richardson, Ph.D.	Prof	Tenured	2023-24	9	0.75	0.00%	0.00	9	0.75	0.00%	0.00
A	Qiyu Sun, Ph.D.	Prof.	Tenured	2024-25	9	0.75	0.00%	0.00	9	0.75	12.50%	0.09
A	Damla Turgut, Ph.D.	Prof.	Tenured	2023-24	9	0.75	0.00%	0.00	9	0.75	0.00%	0.00
A	Nizam Uddin, Ph.D.	Prof	Tenured	2020-21	9	0.75	12.50%	0.09	9	0.75	12.50%	0.09
A	Chung-Ching Wang, Ph.D.	Prof	Tenured	2020-21	9	0.75	25.00%	0.19	9	0.75	0.00%	0.00
A	Xin Yan, Ph.D.	Prof.	Tenure Earning	2021-22	9	0.75	0.00%	0.00	9	0.75	6.25%	0.05
A	Edgard Maboudou, Ph.D.	Assoc. Prof	Tenure Earning	2021-22	9	0.75	0.00%	0.00	9	0.75	0.00%	0.00
A	Brian Moore, PhD.	Assoc. Prof	Tenured	2023-24	9	0.75	0.00%	0.00	9	0.75	0.00%	0.00
A	Sumanta Pattanaik, Ph.D.	Assoc. Prof	Tenured	2020-21	9	0.75	0.00%	0.00	9	0.75	12.50%	0.09
A	Gita Sukthankar, Ph.D.	Assoc. Prof	Tenured	2020-21	9	0.75	12.50%	0.09	9	0.75	12.50%	0.09
A	Liqiang Wang, Ph.D.	Assoc. Prof	Tenured	2020-21	9	0.75	12.50%	0.09	9	0.75	12.50%	0.09
A	Qipeng Zheng, Ph.D.	Assoc. Prof	Tenured	2020-21	9	0.75	6.25%	0.05	9	0.75	6.25%	0.05
A	Carlos Borges, Ph.D.	Asst. Prof	Tenure Earning	2020-21	9	0.75	6.25%	0.05	9	0.75	0.00%	0.00
A	Ivan Garibay, Ph.D.	Asst. Prof	Tenure Earning	2023-24	9	0.75	0.00%	0.00	9	0.75	0.00%	0.00
A	Alexander Mantzaris, Ph.D.	Asst. Prof	Tenure Earning	2020-21	9	0.75	12.50%	0.09	9	0.75	0.00%	0.00

A	Adan Vela, Ph.D.	Asst. Prof	Tenure Earning	2020-21	9	0.75	6.25%	0.05	9	0.75	6.25%	0.05
A	Gerrit Welper, Ph.D	Asst. Prof	Tenure Earning	2022-23	9	0.75	0.00%	0.00	9	0.75	0.00%	0.00
A	Mengyu Xu, Ph.D.	Asst. Prof.	Tenure Earning	2021-22	9	0.75	0.00%	0.00	9	0.75	0.00%	0.00
A	Teng Zhang, Ph.D.	Asst. Prof	Tenure Earning	2020-21	9	0.75	12.50%	0.09	9	0.75	0.00%	0.00
A	Mark Llewellyn, Ph.D.	Assoc. Lecturer	Not Tenured	2020-21	9	0.75	0.00%	0.00	9	0.75	12.50%	0.09
A	Sean Szumlanski, Ph.D.	Lecturer	Not Tenured	2021-22	9	0.75	0.00%	0.00	9	0.75	0.00%	0.00
A	Arup Guha, M.S.	Senior Instructor	Not Tenured	2021-22	9	0.75	0.00%	0.00	9	0.75	0.00%	0.00
<b>Total Person-Years (PY)</b>								<b>0.80</b>				<b>1.17</b>

Code		Source of Funding	PY Workload by Budget Classification	
			Year 1	Year 5
A	Existing faculty on a regular line	Current Education & General Revenue	0.80	0.98
B	New faculty to be hired on a vacant line	Current Education & General Revenue	0.00	0.00
C	New faculty to be hired on a new line	New Education & General Revenue	0.00	0.19
D	Existing faculty hired on contracts/grants	Contracts/Grants	0.00	0.00
E	New faculty to be hired on contracts/grants	Contracts/Grants	0.00	0.00
<b>Overall Totals for</b>			<b>Year 1</b>	<b>Year 5</b>
			0.80	1.17

## **Appendix B: EEO/OIE and Library Approvals**

**APPENDIX B**

Please include the signature of the Equal Opportunity Officer and the Library Director.


  
\_\_\_\_\_  
**Signature of Equal Opportunity Officer**      **Date**      10/23/19

\_\_\_\_\_  
**Signature of Library Director**      **Date**

This appendix was created to facilitate the collection of signatures in support of the proposal. Signatures in this section illustrate that the Equal Opportunity Officer has reviewed section II.E of the proposal and the Library Director has reviewed sections X.A and X.B.

**APPENDIX B**

Please include the signature of the Equal Opportunity Officer and the Library Director.

_____ Signature of Equal Opportunity Officer	_____ Date
 _____ Signature of Library Director	<u>2/8/2019</u> _____ Date

This appendix was created to facilitate the collection of signatures in support of the proposal. Signatures in this section illustrate that the Equal Opportunity Officer has reviewed section II.E of the proposal and the Library Director has reviewed sections X.A and X.B.



## **Appendix C: EAB Report**



MARKET RESEARCH BRIEF

# Market Demand for a Bachelor of Science in Data Sciences Program

Analysis of Local and Statewide Employer  
Demand, Peer Program Characteristics, and  
Student Trends

# COE Forum

**Gus Passov**

*Market Research Associate*

**Aliza Conway**

*Market Research Manager*

## LEGAL CAVEAT

EAB Global, Inc. ("EAB") has made efforts to verify the accuracy of the information it provides to members. This report relies on data obtained from many sources, however, and EAB cannot guarantee the accuracy of the information provided or any analysis based thereon. In addition, neither EAB nor any of its affiliates (each, an "EAB Organization") is in the business of giving legal, accounting, or other professional advice, and its reports should not be construed as professional advice. In particular, members should not rely on any legal commentary in this report as a basis for action, or assume that any tactics described herein would be permitted by applicable law or appropriate for a given member's situation. Members are advised to consult with appropriate professionals concerning legal, tax, or accounting issues, before implementing any of these tactics. No EAB Organization or any of its respective officers, directors, employees, or agents shall be liable for any claims, liabilities, or expenses relating to (a) any errors or omissions in this report, whether caused by any EAB organization, or any of their respective employees or agents, or sources or other third parties, (b) any recommendation by any EAB Organization, or (c) failure of member and its employees and agents to abide by the terms set forth herein.

EAB is a registered trademark of EAB Global, Inc. in the United States and other countries. Members are not permitted to use these trademarks, or any other trademark, product name, service name, trade name, and logo of any EAB Organization without prior written consent of EAB. Other trademarks, product names, service names, trade names, and logos used within these pages are the property of their respective holders. Use of other company trademarks, product names, service names, trade names, and logos or images of the same does not necessarily constitute (a) an endorsement by such company of an EAB Organization and its products and services, or (b) an endorsement of the company or its products or services by an EAB Organization. No EAB Organization is affiliated with any such company.

## **IMPORTANT: Please read the following.**

EAB has prepared this report for the exclusive use of its members. Each member acknowledges and agrees that this report and the information contained herein (collectively, the "Report") are confidential and proprietary to EAB. By accepting delivery of this Report, each member agrees to abide by the terms as stated herein, including the following:

1. All right, title, and interest in and to this Report is owned by an EAB Organization. Except as stated herein, no right, license, permission, or interest of any kind in this Report is intended to be given, transferred to, or acquired by a member. Each member is authorized to use this Report only to the extent expressly authorized herein.
2. Each member shall not sell, license, republish, distribute, or post online or otherwise this Report, in part or in whole. Each member shall not disseminate or permit the use of, and shall take reasonable precautions to prevent such dissemination or use of, this Report by (a) any of its employees and agents (except as stated below), or (b) any third party.
3. Each member may make this Report available solely to those of its employees and agents who (a) are registered for the workshop or membership program of which this Report is a part, (b) require access to this Report in order to learn from the information described herein, and (c) agree not to disclose this Report to other employees or agents or any third party. Each member shall use, and shall ensure that its employees and agents use, this Report for its internal use only. Each member may make a limited number of copies, solely as adequate for use by its employees and agents in accordance with the terms herein.
4. Each member shall not remove from this Report any confidential markings, copyright notices, and/or other similar indicia herein.
5. Each member is responsible for any breach of its obligations as stated herein by any of its employees or agents.
6. If a member is unwilling to abide by any of the foregoing obligations, then such member shall promptly return this Report and all copies thereof to EAB.

# Table of Contents

---

<b>1) Research Methodology</b> .....	<b>4</b>
Project Challenge .....	4
Methodology and Definitions .....	4
Burning Glass Labor/Insight™ .....	5
Project Sources .....	5
Profiled Institutions.....	6
<b>2) Executive Overview</b> .....	<b>7</b>
<b>3) Employer Demand</b> .....	<b>8</b>
Demand over Time .....	8
Employers with High Demand .....	9
Common Job Titles .....	10
In-Demand Skills.....	11
<b>4) Program Characteristics</b> .....	<b>12</b>
Program Structure .....	12
Program Curriculum and Differentiators.....	13
<b>5) Enrollment and Recruitment Trends</b> .....	<b>15</b>
Student Motivation .....	15
Enrollment Trends .....	16
Student Demographics .....	16
Marketing Strategies.....	17
<b>Appendix: Networking Contacts</b> .....	<b>19</b>

# 1) Research Methodology

---

**Project Challenge** Leadership at the University of Central Florida approached the Forum as they considered creating a bachelor’s-level data sciences program. Through a combination of qualitative interviews, quantitative data analytics, and secondary research the Forum sought to assess the market viability of a bachelor’s-level data sciences program.

EAB’s market research function provides insights which guide strategic programmatic decisions at member institutions. The Forum combines qualitative and quantitative data to help administrators identify opportunities for new program development, assess job market trends, and align curriculum with employer and student demand.

EAB reports rely primarily on labor market data from the Burning Glass Labor/Insight™ tool (description below). Reports occasionally use data from the United States Census Bureau and United States Bureau of Labor Statistics data to explore occupation and job trends. Market research reports may also incorporate Integrated Postsecondary Education Data System (IPEDS) data to assess student enrollment, demographics, and completion rates across competitor programs.

## Methodology and Definitions

**Methodology:** Unless stated otherwise, this report includes online job postings data from June 1, 2017 to May 31, 2018. The Forum analyzed in-demand skills, common job titles, employers with high demand, and demand over time for bachelor’s-level data sciences professionals locally and across Florida. To best assess demand for bachelor’s-level data sciences professionals, the Forum analyzed job postings for bachelor’s-level professionals with ‘big data,’ ‘business modeling,’ ‘data analysis,’ ‘data science,’ ‘data visualization,’ ‘statistical software,’ and other relevant skills. The Forum also excluded unrelated postings for roles as ‘industrial engineer’ and ‘sonographer’. The Forum also analyzed program characteristics for bachelor’s-level data sciences programs such as program modality, program structure, and curricular options.

**Definitions:** “Local” and “local data” refer to the following metropolitan statistical areas (MSAs) and additional counties in the Interstate 4 corridor:

- Jacksonville, FL MSA,
- Orlando-Kissimmee-Sanford, FL MSA,
- Tampa-St. Petersburg-Clearwater, FL MSA,
- Polk County, and
- Volusia County.

“Statewide” and “statewide data” refer to Florida.

Annual growth in job postings is measured in the change between July 2013 and December 2017 by six-month halves (i.e., H2 2013 is July 2013 to December 2013).

### EAB's Partner for Real-Time Labor Market Data

This report includes data made available through EAB's partnership with Burning Glass Technologies, a Boston-based leader in human capital data analytics. Burning Glass Technologies specializes in the use of web spidering technology to mine more than 80 million online job postings and analyze real-time employer demand. Under this partnership, EAB may use Burning Glass's proprietary Labor/Insight™ tool to answer member questions about employer demand for educational requirements, job titles, and competencies over time, as well as by geography. The tool considers job postings "unspecified" for a skill, industry, employer, geography, certification, or educational requirement when the job posting did not advertise for one of these particular job characteristics. Unspecified postings represent null values and should be excluded from the total number (n value) of job postings analyzed in the query. A more complete description of the tool is available at <http://www.burning-glass.com/products/laborinsight-market-analysis/>. For more information about the Labor/Insight™ tool, please contact Betsy Denious, Director of Business Development Learning & Policy at [bdenious@burning-glass.com](mailto:bdenious@burning-glass.com) or 301-525-6596.

## Project Sources

The Forum consulted the following sources for this report:

- American Statistical Association (ASA) (<http://www.amstat.org/>)
- EAB's internal and online research libraries ([eab.com](http://eab.com))
- National Center for Education Statistics (NCES) (<http://nces.ed.gov/>)
- National Center for Women & Information Technology (NCFWIT) (<https://www.ncwit.org/>)
- The Bureau of Labor Statistics (BLS) (<https://www.bls.gov/>)
- Profiled program websites:
  - Northern Kentucky University; Bachelor of Science in Data Science; accessed June 2018: <https://www.nku.edu/academics/informatics/programs/undergraduate/datascience.html>
  - Ohio State University; Bachelor of Science in Data Analytics; accessed June 2018: <https://data-analytics.osu.edu/>
  - Pennsylvania State University; Bachelor of Science in Data Sciences: accessed June 2018: <https://datasciences.psu.edu/>
  - University of San Francisco; Bachelor of Science in Data Science; accessed June 2018: <https://www.usfca.edu/catalog/undergraduate/arts-sciences/data-science/major>

## Profiled Institutions

The Forum interviewed program directors and profiled programs via secondary research at the following institutions. The Forum prioritized outreach to bachelor's-level data sciences programs specified as benchmark institutions by leadership at the **University of Central Florida**.

### A Guide to Institutions Profiled in this Brief<sup>1</sup>

Institution	Location	Approximate Institutional Enrollment (Undergraduate/Total)	Carnegie Classification
<b>Northern Kentucky University</b>	South	12,500 / 14,500	Master's Colleges & Universities: Larger Programs
<b>Ohio State University</b>	Midwest	46,000 / 59,500	Doctoral Universities: Highest Research Activity
<b>Pennsylvania State University</b>	Mid-Atlantic	41,500 / 48,000	Doctoral Universities: Highest Research Activity
<b>University of San Francisco</b>	Pacific West	6,500 / 11,000	Doctoral Universities: Moderate Research Activity

1) National Center for Education Statistics.

## 2) Executive Overview

---

**Increased local and statewide demand for bachelor’s-level data sciences professionals indicates an opportunity for the *University of Central Florida* to develop a bachelor’s-level data sciences program.** Local employer demand for bachelor’s-level data sciences professionals increased 72 percent in the last 4.5 years and statewide demand increased 63 percent over the same time period (i.e., local demand increased from 1,180 to 2,034 job postings and statewide demand increased from 1,750 job postings to 2,852 job postings). All profiled programs experienced increased enrollments in recent years. For example, at **Ohio State University**, program enrollments per cohort increased from 10 students in 2014 to between 50 and 60 in 2018.

**Encourage collaboration between departments to ensure curriculum confers analytical and technical skills across business, computer science, and mathematical fields.** At **Ohio State University**, administrators relied on the insights of students, employers, and faculty members from business, engineering, and statistics departments to develop program curriculum. Contacts recommend administrators encourage collaboration between departments reliant on data analysis to create a new bachelor’s-level data sciences program. Similarly, contacts at **Pennsylvania State University** note a multi-department approach to curriculum design creates coursework with greater breadth and depth and attracts more students.

**Confer skills in business, computing, and mathematics to prepare students for data sciences employment opportunities.** Data analytics professionals must possess foundational skills in computing/programming, statistics/mathematics, and business/communication.<sup>2</sup> The **University of Central Florida** should create core courses conferring these skills and rely on institutional strengths to create areas of further specialization within the program. Leadership at **Ohio State University** created five areas of specialization based on institutional strengths, student interests, and employer demand (e.g., “Biomedical Informatics,” “Business Analytics,” “Computational Analytics,” “Data Visualization,” and “Social Science Analytics”).

**Administrators at the *University of Central Florida* should advertise graduate outcomes and employer demand data to attract students.** Profiled program websites highlight increasing demand from employers nationwide for data sciences professionals as well as alumni outcomes. For example, the program website for the program at the **University of San Francisco** contains in-depth profiles of science program graduates as well as information about job placement rates and starting salaries.<sup>3</sup> Demonstrating the success of program graduates via student testimonials can encourage prospective students to enroll in the program.<sup>4</sup>

2) EAB Research: [Data Analytics: Capitalizing on Creative Disruption](#)

3) University of San Francisco: [Big Data](#)

4) EAB Research: [Competing on Student Outcomes to Attract Today’s Career Changer](#)



### 3) Employer Demand

#### Demand over Time

#### Increased Employer Demand for Bachelor’s-Level Data Sciences Professionals Indicates an Opportunity for Program Development

Local employer demand for bachelor’s-level data sciences professionals increased 72 percent from H2 2013 to H2 2017 (i.e., demand increased from 1,180 to 2,034 job postings). Over the same time period, statewide employer demand for bachelor’s-level data sciences professionals increased 63 percent (i.e., demand increased from 1,750 job postings to 2,852 job postings). This suggests local employers may demonstrate higher demand for bachelor’s-level data sciences professionals than other employers in Florida over the last 4.5 years.

In the last 12 months, postings by local employers who seek bachelor’s-level data sciences account for 73 percent of total postings by Florida employers (i.e., local postings account for 4,413 of 6,053 total postings).

The Bureau of Labor Statistics (BLS) expects nationwide employment of professionals in “management analyst” occupations, which include “business analysts,” to increase 14 percent from 2016 to 2026.<sup>5</sup> Employment growth for these occupations should outpace employment across all occupations nationwide. The BLS predicts employment across all occupations nationwide will grow 7.5 percent over the same time period.<sup>6</sup>

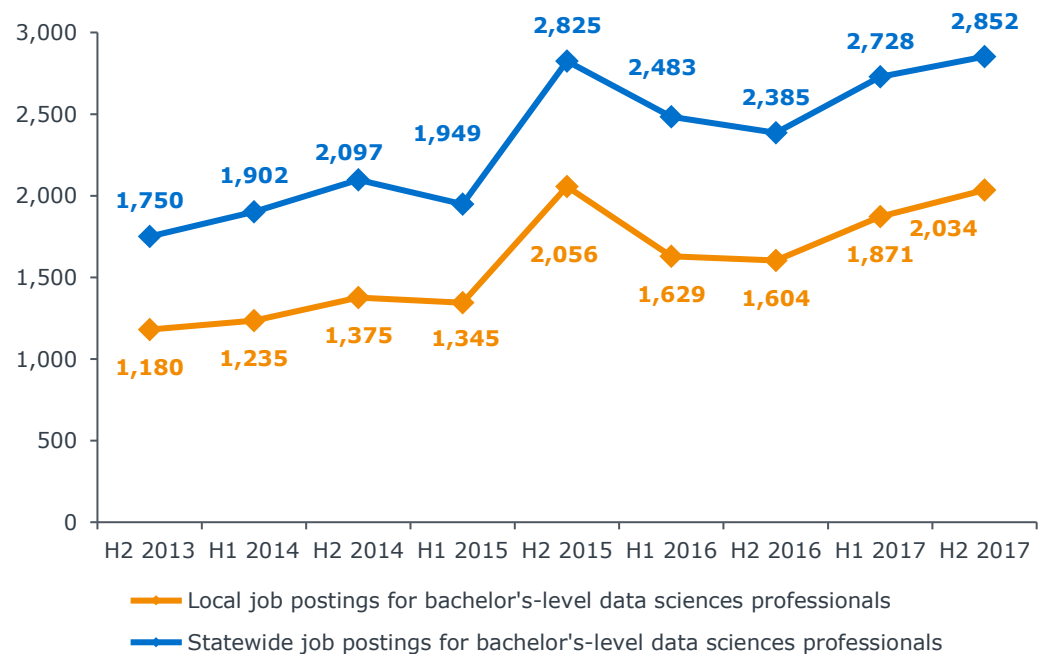
## 4,413

Over the last 12 months, local employers advertise 4,413 job openings for bachelor’s-level data sciences professionals.

Administrators at the **University of Central Florida** should note ‘business analyst’ represents the second-most commonly posted job title by local and Florida employers over the last 12 months (i.e., 226 and 259 job postings respectively). For more information on frequently posted job titles for bachelor’s-level data sciences professionals, see page 10.

#### Historical Demand for Bachelor’s-Level Data Sciences Professionals

H2 2013-H2 2017<sup>7</sup>



5) Bureau of Labor Statistics Occupational Outlook Handbook: [Management Analysts](#)  
 6) Bureau of Labor Statistics: [Employment Projections](#)  
 7) Burning Glass Labor/Insight™

## Employers with High Demand

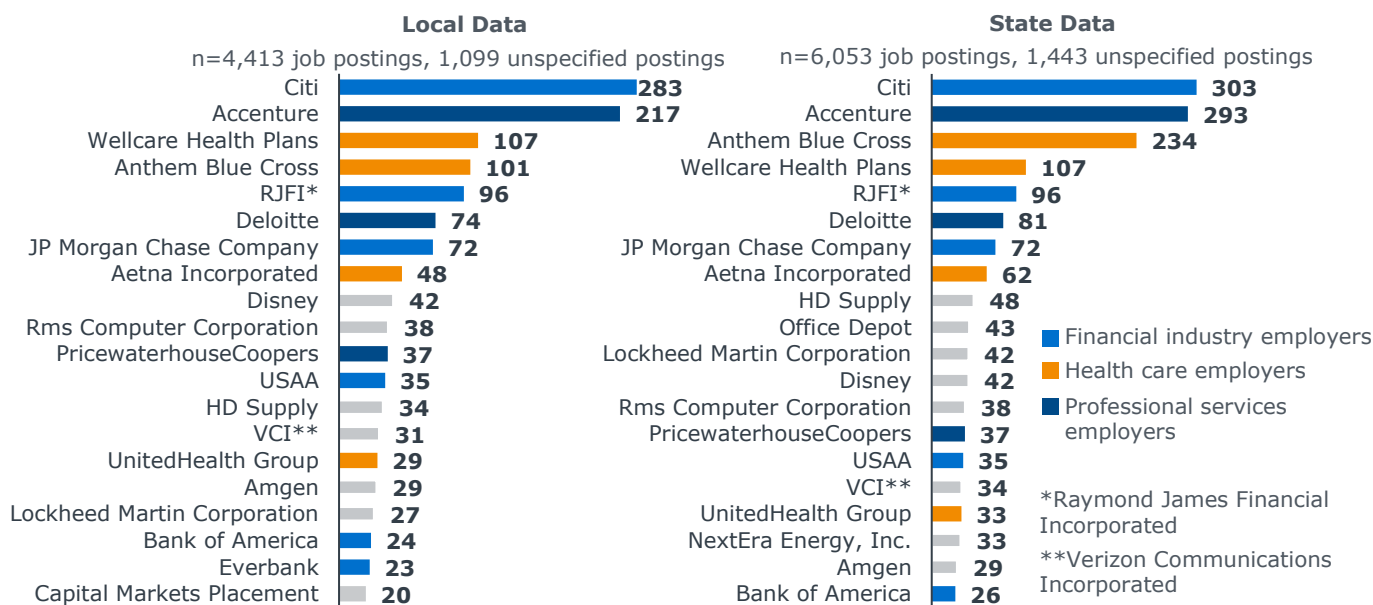
### Encourage Employers to Recruit Bachelor’s-Level Data Sciences Students for Internships, Which Can Lead to Employment after Graduation

The **University of Central Florida** should partner with local and statewide employers to create internship opportunities for enrolled students, which can lead to full-time positions after graduation. At **Ohio State University**, all students complete at least one internship, about 90 percent of graduates pursue employment directly after graduation, and 10 percent pursue master’s-level degrees. In addition, data sciences faculty members learn about industry trends directly from students who complete internships and incorporate these insights into program curriculum.<sup>8</sup>

Local and statewide financial industry employers demonstrate high demand for bachelor’s-level data sciences professionals. Over the last 12 months, local financial industry employers account for six of the 20 local employers with the most demand for bachelor’s-level data sciences professionals (e.g., Citi, Raymond James Financial Incorporated). Similarly, financial industry employers account for five of the 20 statewide employers with the most demand for bachelor’s-level data sciences professionals in the same time period (e.g., JP Morgan Chase Company, USAA). In addition, professional services employers Accenture, Deloitte, and PricewaterhouseCoopers account for three of the 20 local employers who post the most jobs for bachelor’s-level data sciences professionals over the last 12 months. These three employers account for seven percent of local job postings (i.e., 328 of 4,413 job postings). Graduates of the program at **Northern Kentucky University** secure employment at companies such as CyberArk, General Electric, 84.51, and regional insurance employers. At Ohio State University, companies such as Facebook, Google, JP Morgan Chase Company, and PricewaterhouseCoopers reach out to program administrators to recruit interns and ask faculty to recommend qualified candidates.

### Employers with High Demand for Bachelor’s-Level Data Sciences Professionals

June 2017-May 2018<sup>9</sup>



8) EAB Research: [Data Analytics: Capitalizing on Creative Disruption](#)

9) Burning Glass Labor/Insight™

## Common Job Titles

### Include Links to Data Sciences-Specific Job Databases on the Program Website to Increase Enrolled Student Awareness of Available Job Opportunities

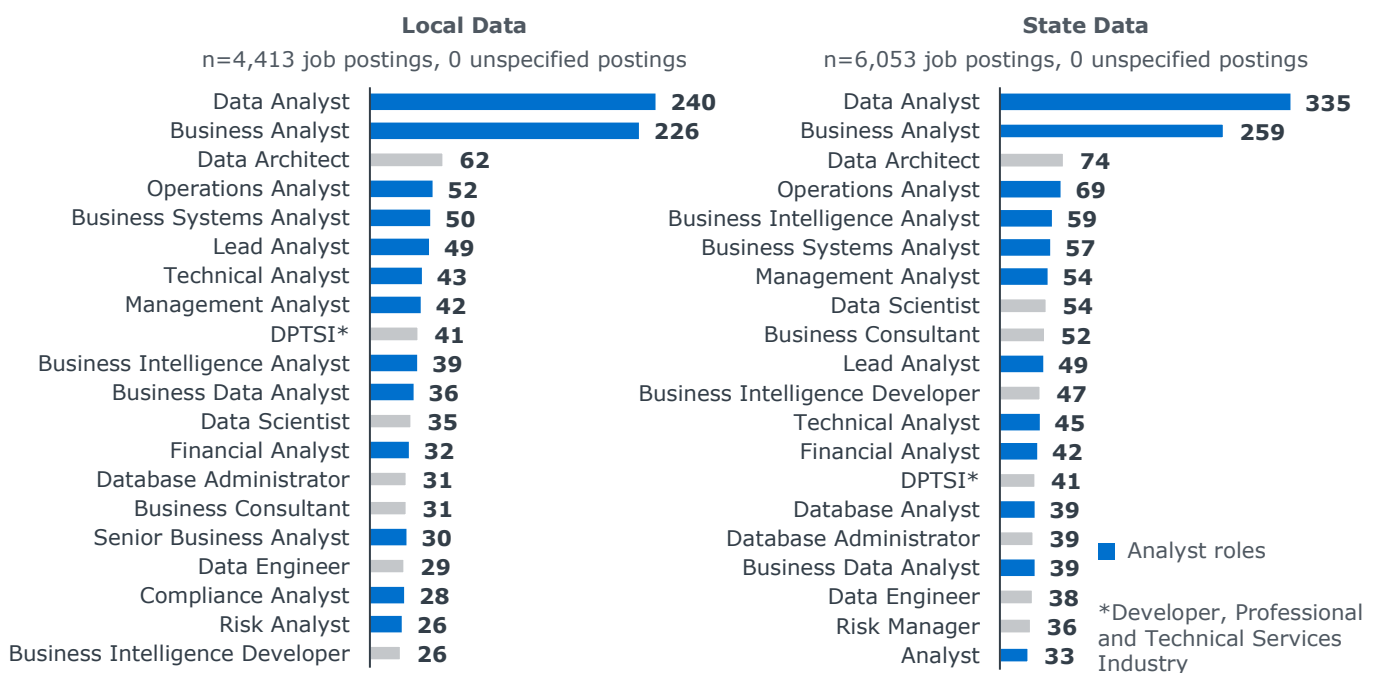
Administrators at the **University of Central Florida** should dedicate a program website section to data sciences-specific job boards so students can increase awareness of available opportunities. Currently, the Bachelor of Science in Data Analytics program website at **Ohio State University** includes links to six different data analytics-specific job databases such as [Analytic Talent](#) and [Icrunchdata](#). This section of the program’s website also includes data sciences-specific professional development resources such as [sample resumes](#) and [job search guides](#).<sup>10</sup>

Additionally, identify commonly posted job titles on the program webpage. Job titles that include the word “analyst” account for 13 of the 20 most commonly posted job titles by local employers for bachelor’s-level data sciences professionals over the last 12 months (e.g., ‘data analyst,’ ‘business analyst’). Similarly, job titles that include the word “analyst” account for 12 of the 20 most commonly posted job titles by statewide employers in the same time period. Six of 13 local roles and five of 12 statewide roles that include the word “analyst” advertise positions for business or financial analysts (e.g., ‘business analyst,’ ‘business intelligence analyst’). Other commonly posted titles by local and statewide employers over the past 12 months relate to data engineering and data science, such as:

- ‘Data architect,’
- ‘Data engineer,’
- ‘Data scientist,’ and
- ‘Developer, professional and technical services industry.’<sup>11</sup>

### Commonly Posted Job Titles for Bachelor’s-Level Data Sciences Professionals

June 2017-May 2018<sup>12</sup>



10) Ohio State University: [Jobs and Internships](#)

11) Burning Glass Labor/Insight™

12) Burning Glass Labor/Insight™

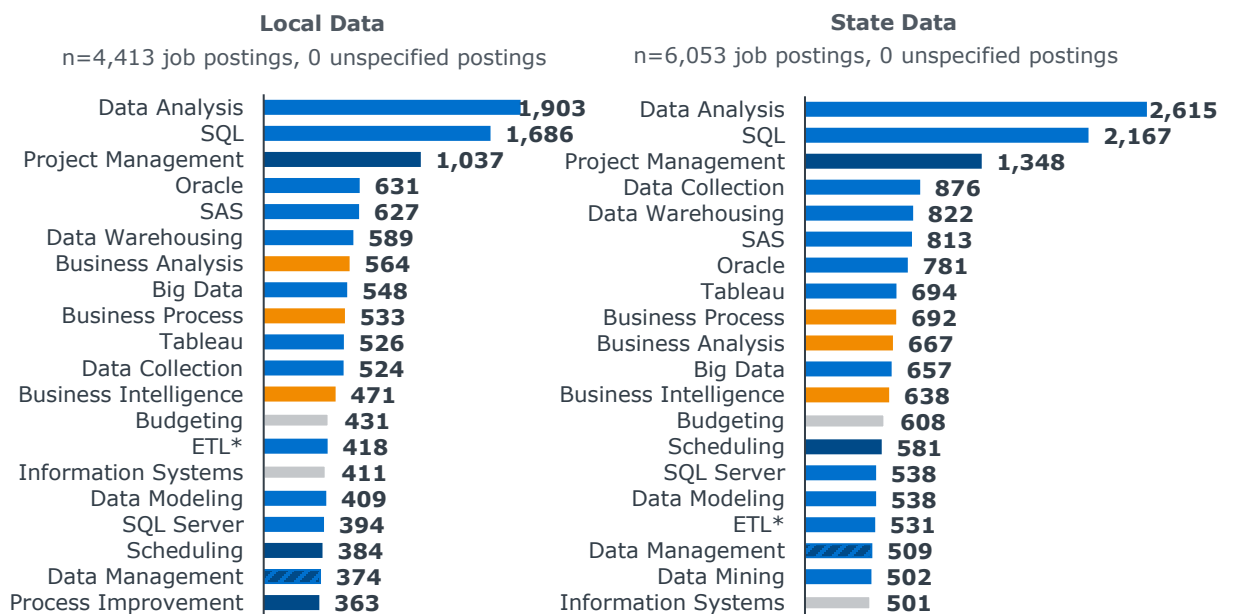
## Expect Program Graduates to Assume Data Analyst Roles before Data Scientist Roles, Which Require Advanced Technical Sophistication

Administrators at the **University of Central Florida** should expect enrolled students to assume data analyst roles before data scientist roles, which usually require an advanced degree. Data scientists typically possess more sophisticated technical skills than data analysts. However, all data analytics professionals, which include data analysts and data scientists, must possess foundational skills in computing/programming, statistics/mathematics, and business/communication.<sup>13</sup> Contacts at **Northern Kentucky University** note geography can influence the level of computational expertise students need to secure jobs. Administrators suggest local and regional employers do not seek professionals with advanced computational expertise for data scientist roles and instead recruit bachelor’s-level students to fill less computation-intensive data analyst positions. As a result, graduates do not pursue master’s-level degrees after graduation.

As expected, ‘data analysis’ and ‘SQL’ skills represent the two most commonly requested skills by both local and statewide employers over the last 12 months. Local employers seek bachelor’s-level data sciences professionals with ‘data analysis’ skills in 43 percent of postings and ‘SQL’ skills in 38 percent of postings (i.e., 1,903 of 4,413 job postings and 1,686 of 4,413 job postings respectively). Local employers also exhibit high demand for bachelor’s-level data sciences professional with business skills and management skills (e.g., ‘business analysis,’ ‘project management’). Local employers seek bachelor’s-level data sciences professionals with ‘business analysis,’ ‘business intelligence,’ or ‘business process’ skills in 36 percent of job postings over the last 12 months (i.e., 1,568 of 4,413 job postings).

### Skills Employers Frequently Seek in Bachelor’s-Level Data Sciences Professionals

June 2017-May 2018<sup>14</sup>



\*Extraction Transformation and Loading (ETL)      ■ Data analysis and data visualization skills      ■ Business skills      ■ Management skills

13) EAB Research: [Data Analytics: Capitalizing on Creative Disruption](#)  
 14) Burning Glass Labor/Insight™

## 4) Program Characteristics

---

### Program Structure

#### Consult Faculty from Multiple Departments to Develop a Multifaceted Program Curriculum

Administration at the **University of Central Florida** should encourage interdepartmental collaboration to facilitate bachelor's-level data sciences program development and expand curricular breadth and depth. At **Pennsylvania State University**, faculty from the colleges of engineering, information sciences and technology, and science collaborated to create the program's core curriculum. After completion of core curriculum focused on statistical modeling, mathematics, and programming, students choose one of three program tracks to specialize in (i.e., "Applied Data Sciences," "Computational Data Sciences," and "Statistical Modeling Sciences"). Similarly, **Ohio State University** administration relied on the insights of students, employers, and faculty from business, engineering, and statistics departments to develop a multidimensional program curriculum. Creating a data sciences course portfolio that supports a wide range of student interest areas can help curriculum evolve at the pace of technological trends and employer preferences.<sup>15</sup>

Administration at the University of Central Florida should consistently update the structure of the Bachelor of Science in Data Sciences program to align with student interests and industry trends. Contacts at Ohio State University describe the program structure as a "hub and spoke" model. After completion of core curriculum, the hub, which focuses on computer science and mathematics courses such as "Introduction to Database Systems" and "Linear Algebra," students specialize in one of five areas, or spokes (e.g., "Biomedical Informatics," "Business Analytics," "Computational Analytics," "Data Visualization," and "Social Science Analytics"). Leadership initially created the business and health informatics spokes because these domains account for a large market share in the United States economy. Later on, administration implemented the "Computational Analytics" specialization for students who want to pursue technical master's-level degrees after graduation. Additionally, student interest led to the development of the "Data Visualization" and "Social Science Analytics" specializations.

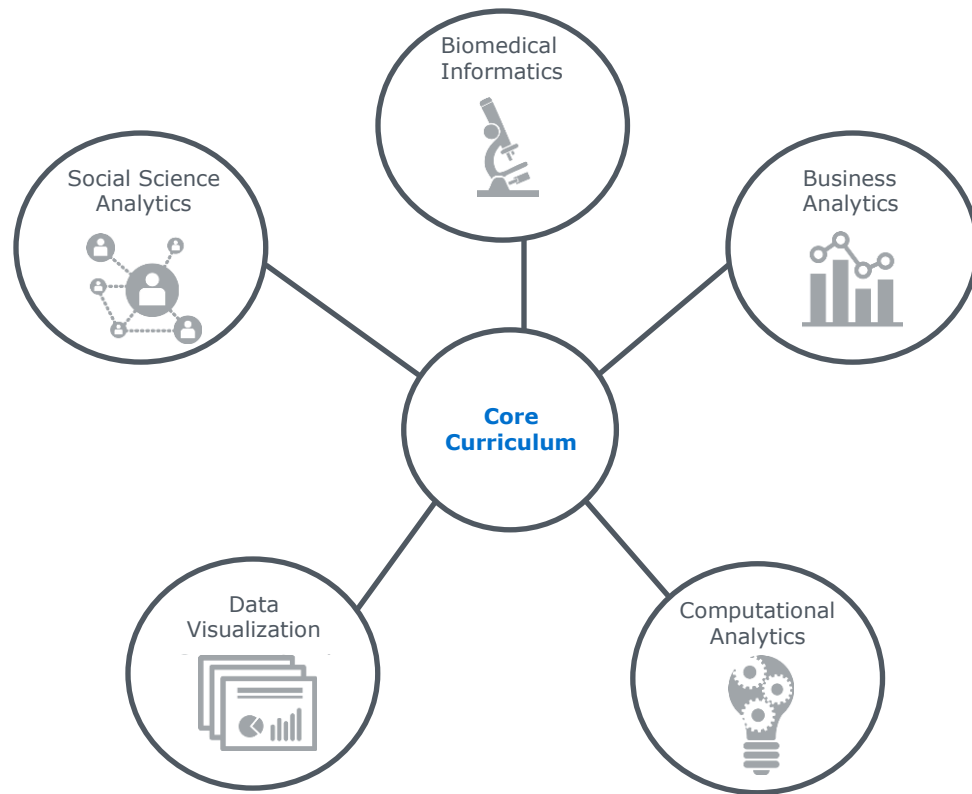


#### Deliver a Bachelor of Science in Data Sciences Program In-Person to Promote Student Engagement

All profiled programs currently deliver course material in a face-to-face format and only two of four institutions consider offering bachelor's-level data sciences program in a hybrid format. Contacts at **Northern Kentucky University** report administration decided to deliver the Bachelor of Science in Data Sciences program in-person to promote high levels of student engagement, but would consider a hybrid version if students begin to demonstrate interest. Similarly, contacts at the **University of San Francisco** report leadership has discussed modifying certain courses for online delivery, but no current plan exists for implementation.

<sup>15</sup>EAB Research: [Data Analytics: Capitalizing on Creative Disruption](#)

**Program Structure of the Bachelor of Science in Data Analytics Program at Ohio State University**



**Program Curriculum and Differentiators**

**Partner with Employers to Create Practical Capstone Projects for Enrolled Students**

Administrators at the **University of Central Florida** should partner with employers to create capstone projects where students can acquire hands-on data analytics experience. At **Ohio State University** students enrolled in each specialization within the Bachelor of Science in Data Analytics program complete capstone projects, typically during their junior year. For the “Business Analytics” specialization, students complete a capstone through the Fisher College of Business [Industry Immersion Program](#), a year-long program in which students take “Introduction to Business Analytics:

Defining and Applying “Big Data” during the fall semester and “Design and Development of Business Analytics Solutions” during the spring semester. The fall course introduces students to business analysis techniques and invites external representatives from partner organizations to speak to students about their functions within the broader company. Then, during the spring course, students work on two professor approved projects submitted by industry sponsors and present their solutions to company representatives. Sponsor organizations include:

**Engage Students Outside the Classroom by Hosting Hackathons or Similar Events**

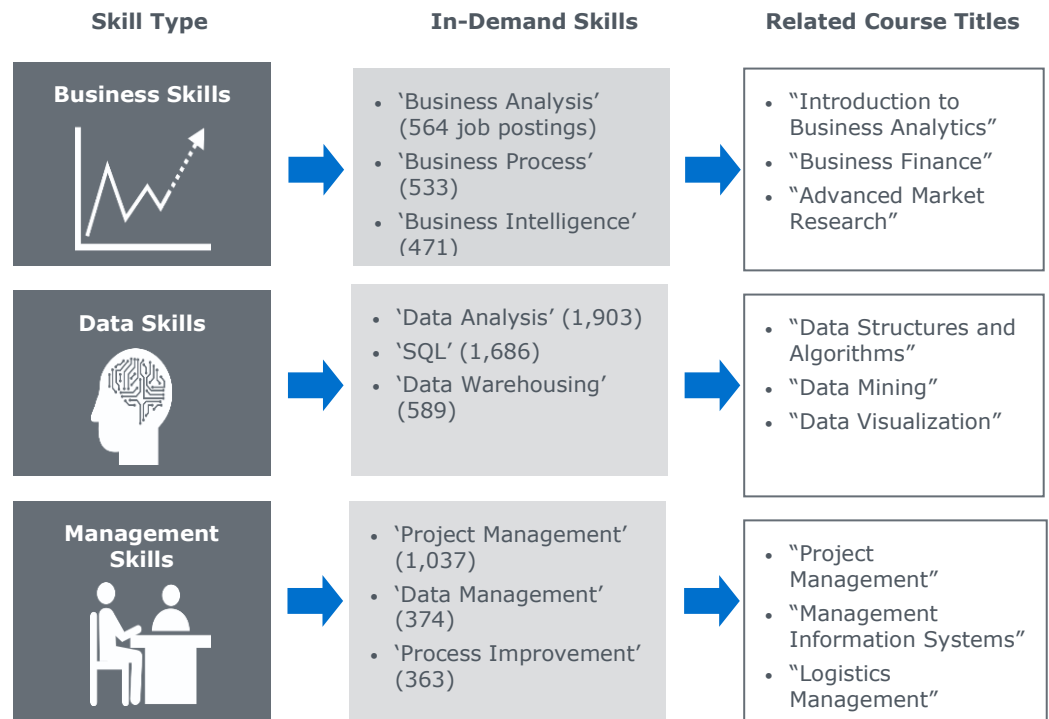
Leadership at the **University of San Francisco** created a [Data Science Association](#) in which undergraduate students from departments including data science, economics, mathematics, and psychology, participate in data-intensive challenges, such as hacking events.

- Cardinal Health,
- Facebook,
- Ford,
- Google,
- General Motors,
- JP Morgan Chase Company, and
- Nationwide.

A similar system exists at the **University of San Francisco**. During senior year, students work on projects for local and regional employers. The framework for this program grew out of a successful initiative, initially designed for students in the [Master of Science in Data Science Program](#), which allows students to work an average of 15 hours per week for nine months at companies in the San Francisco Bay Area. Contacts report this year alone over 150 employers requested to participate in the program, and administration approved 45. Administration at the University of San Francisco decided to create an undergraduate version of this initiative due to increased employer demand for bachelor’s-level data science professionals.

### Alignment of Curriculum at Profiled Bachelor’s-Level Data Sciences Programs to In-Demand Skills

June 2017-May 2018, Local and State Data<sup>16</sup>



16) Burning Glass Labor/Insight™

## 5) Enrollment and Recruitment Trends

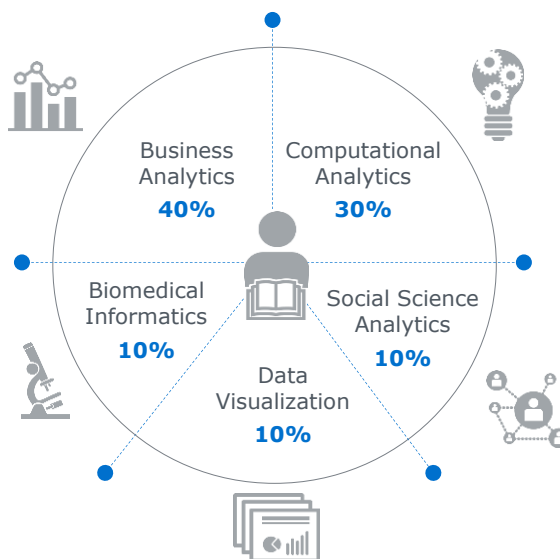
### Student Motivation

#### Consistently Review and Update Bachelor's-Level Data Sciences Program Curriculum to Maintain Industry Relevance

Administration at the **University of Central Florida** should consistently update courses to attract new students and ensure curricular offerings evolve at the pace of the broader data science field. Profiled institutions report students possess acute awareness of the lucrative jobs a data science degree allows them to obtain and high expectations for program curriculum. To ensure curriculum aligned with student and employer expectations, faculty at the **University of San Francisco** audited course offerings one year after inception. Contacts report faculty eliminated unnecessary courses and prioritized the conferral of skills directly related to entry-level data science jobs. Faculty prioritized foundational courses in computer science, mathematics, and statistics and eliminated more advanced data mining and mathematical modeling courses. To meet the expectations of local and regional employers and students who expect to secure lucrative jobs post-graduation, administrators plan to add more foundational statistics courses to program curriculum in the near future.

Create multiple specializations within a bachelor's-level data sciences program to attract students with diverse interests. Profiled institutions report students demonstrate interest in bachelor's-level data sciences programs due to the applicability of content to various fields (e.g., business, computer science, health care, social sciences). At **Pennsylvania State University** most students enroll in the "Applied Data Sciences" track of the program. Contacts report some students also use the "Computational Data Sciences" program track to secure computer science positions after graduation without majoring in computer science. At **Ohio State University** contacts report the breadth and depth of the Bachelor of Science in Data Analytics program attracts students. Students enrolled in the program can choose to pursue one of five specializations, such as "Business Analytics" or "Computational Analytics." Administration expects to see an uptick in students who pursue the "Data Visualization" specialization as employers begin place greater value on these skills.

#### Percent of Students Enrolled by Program Specialization at *Ohio State University*





## Enrollment Trends

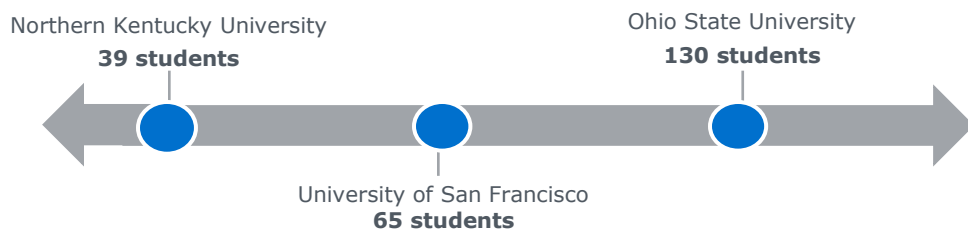
### Strong and Growing Enrollments in Profiled Programs Indicates an Opportunity for the *University of Central Florida* to Launch a Data Science Program

Most profiled programs experience increased enrollments since program inception. The program at **Ohio State University**, created in 2014, initially enrolled 10 students, most of whom transferred into the program from other degree programs at the University. Now, the data analytics program enrolls 50 to 60 students per year and over 130 total students. Similarly, contacts at the University of San Francisco report the bachelor's-level data sciences program started with fewer than 10 students four years ago and now enrolls 65 students. Administration seeks to hire additional faculty members as more students demonstrate interest in the program. Enrollments in the bachelor's-level data sciences program at **Northern Kentucky University** increased every year from program inception in 2013 until 2017, when enrollments declined from approximately 44 students to 39 students. Leadership suggests decreased enrollments may result from reduced program advertising.

Leadership at the **University of Central Florida** should expect some students to transfer out of a bachelor's-level data sciences program to major in mathematics or computer science. Administrators at **Northern Kentucky University** and the **University of San Francisco** report some students transfer out of the program to specialize in mathematics or computer science as opposed to developing proficiency in both via data sciences programming. Leadership at Northern Kentucky University suggest regional companies will retrain computer scientists as data scientists after offering them employment, which creates disincentives for students to enroll in the data sciences program and encourages transferring between programs.

Contacts at **Pennsylvania State University** did not share information about enrollments in the Bachelor of Science in Data Sciences Program.

#### Approximate Enrollments in Profiled Bachelor's-Level Data Sciences Programs



## Student Demographics

### Recruit Female and International Students to Increase Program Diversity

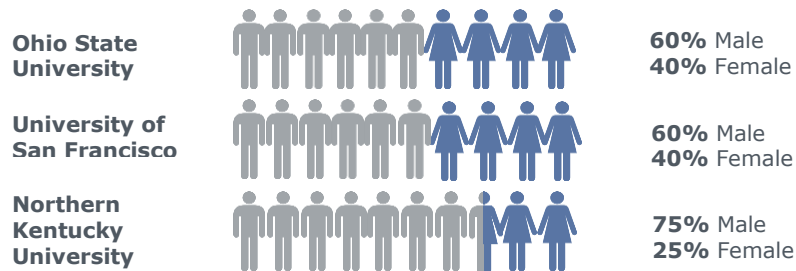
Profiled institutions enroll an increasing number of women to data science and analytics programs. At **Ohio State University** and the **University of San Francisco**, females compose approximately 40 percent of enrolled students. Similarly, women compose about 25 percent of students enrolled in the Bachelor of Science in Data Science program at **Northern Kentucky University**. Administrators at Northern Kentucky University report the program recently received a \$10,000 grant from the [National Center for Women & Information Technology \(NCFWIT\)](#) to further boost female student enrollments. If the Bachelor of Science in Data Sciences program at Northern Kentucky University can reach a certain threshold of enrolled female students, administrators can apply for a \$100,000 grant from the NCFWIT.

In addition to women, administrators at the **University of Central Florida** should focus recruitment efforts on international students to secure enrollments. International students compose at least 10 percent of enrolled students at Northern

Kentucky University and this number increases each year. Contacts note international students seek out the bachelor’s-level data sciences program and account for a larger percentage of students enrolled in the program than their percentage relative to the undergraduate student population as a whole. Similarly, international students account for about 15 percent of enrollments in Ohio State University’s program. Contacts report a large portion of these students come from China, India, and across Europe. At the **University of San Francisco**, students from Latin America, Asia, and the Pacific Islands frequently enroll in the program and the composition of students enrolled in the program closely mimics the rest of the undergraduate student body. All profiled institutions enroll traditional bachelor’s-level students and administer curriculum on campus in a face-to-face format.

Contacts at **Pennsylvania State University** did not share information about student demographics in the Bachelor of Science in Data Sciences Program.

### Percentage of Students Enrolled in Profiled Programs by Gender



## Marketing Strategies

### Advertise Graduate Outcomes and Employer Demand for Data Sciences Professionals Online to Increase Program Enrollments

Administrators at the **University of Central Florida** should advertise graduate outcomes and employer demand information for data sciences professionals to attract students to the program. All profiled program websites highlight increasing demand from employers nationwide for data sciences professionals. Administrators at **Ohio State University** allow prospective students to access informative articles directly from the program website, such as “[Data Scientist: Sexiest Job of the 21<sup>st</sup> Century](#),” which allow prospective students to develop a greater appreciation of a data science degree’s professional value. Additionally, the program website for the Bachelor of Science in Data Science program at the **University of San Francisco** contains in-depth profiles of master’s-level program graduates as well as information about job placement rates and starting salaries. Demonstrating the success of program graduates via student testimonials can encourage prospective students to enroll in the program.<sup>17</sup>

Once the bachelor’s-level data sciences program becomes established, administration should consider hosting an [American Statistical Association \(ASA\) DataFest](#) to advertise the program and connect students with employers. Bachelor’s-level programs at **Northern Kentucky University**, **Ohio State University**, and **Pennsylvania State University** hosted a DataFest, which consist of undergraduate coding competitions where teams of students work to find solutions to complex data-intensive problems, in 2018. Contacts report partial reliance on DataFest to advertise to prospective students and employers frequently attend DataFests to recruit bachelor’s-level data sciences students for post-graduation employment. In 2018, over 50 colleges and universities hosted or participated in DataFest hackathons between March and May.<sup>18</sup>

17) EAB Research: [Competing on Student Outcomes to Attract Today’s Career Changer](#)  
 18) DataFest: [Participating Institutions](#)

## Marketing Messages on Profiled Program Websites

### Profiled Programs

**Career prospects** in data analytics are very promising. Although it is a relatively new field, data science and analytics has been described by the Harvard Business Review as the [“sexiest job of the 21st century.”](#) Companies both locally and nationally are actively recruiting employees who have core and **specialized skills** in data analytics.

- Ohio State University

An estimated shortage of 140,000 to 190,000 data analysts in the U.S. has created **a boom for data scientists** equipped with the skills to shape the industry. Our program leverages San Francisco Bay Area’s influential, innovative technology culture. There’s no better place to acquire the skills for an evolving industry than at the **center of its transformation.**

- University of San Francisco

In today’s information society, **professionals who can make sense of big data are in high demand.** The new Data Sciences degree program at Penn State is part of **an intercollege initiative** between the College of Information Sciences and Technology (IST), College of Engineering, and Eberly College of Science to meet that need.

- Pennsylvania State University

# Appendix: Networking Contacts

---

## **Ohio State University**

Srini Parthasarathy  
*Co-Director, Data Analytics Program*  
614-292-2568  
[srini@cse.ohio-state.edu](mailto:srini@cse.ohio-state.edu)

## **Pennsylvania State University**

David Hunter  
*Professor of Statistics*  
814-865-1348  
[dhunter@stat.psu.edu](mailto:dhunter@stat.psu.edu)

## **University of Northern Kentucky**

Maureen Doyle  
*Department of Computer Science Chair*  
859-572-5468  
[Doylem3@nku.edu](mailto:Doylem3@nku.edu)

## **University of San Francisco**

Nathanial Stevens  
*Co-Director, Data Science*  
415-422-6747  
[ntstevens@usfca.edu](mailto:ntstevens@usfca.edu)

## **Appendix D: Letters of Support from Industry**

### **Industry and Businesses in Support of the Data Science B.S..**

Patti Brownsord, President - Data Wonderment

Sreerupa Das, Lockheed Martin Fellow - Lockheed Martin, Rotary and Mission Systems

Marvin 'Butch' Gardner, Jr., Principal Director - The Aerospace Corporation

Bob LoGalbo, Chief Data Scientist - Leidos, Inc

Jerry Oglesby, Sr. Director of Global Academic Programs - SAS Institute

Praveen Rao, Director of Data Science - Charter Communications

Frank Wang, Vice President - IDN Decision Support Analytics



Prof. Shunpu Zhang  
Chair, Dept. Of Statistics, College of Science  
University of Central Florida  
4000 Central Florida Blvd  
Orlando, FL 32816-2370

Patti Brownsord  
Data Wonderment  
(407) 369-9331  
patti@datawonderment.com

December 27, 2018

Dear Prof. Zhang,

At Data Wonderment, we are continuing to leverage advanced analytics in many of our business activities, and thus very strongly support UCF's proposed Bachelor of Science degree program in Data Science.

We believe there is a strong need for employees who are familiar with the computational and statistics techniques necessary to make sense of the massive amounts of data our clients continuously generate. Employees who can design new algorithms and computerized systems to answer questions related to unique business needs are especially valuable to us.

Here at Data Wonderment, we see opportunities in many areas of our company and would recommend this program for our interns. We also see opportunities to incorporate portions of the curriculum for students in other disciplines to gain an understanding of the value of information and analytics.

We plan to continue to build competence in data analytics in the future and expect to hire these skills in an accelerated mode within the next 3-5 years.

Overall, from our perspective, we anticipate a strong and continued demand for such talented employees to stay ahead of our competition and compete in the global marketplace.

If you have any questions, please do not hesitate to contact me.

Sincerely,

A handwritten signature in blue ink that reads "Patti Brownsord".

Patti Brownsord

Prof. Shunpu Zhang  
Chair, Dept. Of Statistics, College of Science  
University of Central Florida  
4000 Central Florida Blvd  
Orlando, FL 32816-2370

Dr. Sreerupa Das  
Lockheed Martin Fellow  
Lockheed Martin, Rotary and Mission Systems  
100 Global Innovation Circle  
(407) 306-6949  
sreerupa.das@lmco.com

11/30/2018

Dear Prof. Zhang,

At Lockheed Martin, Rotary & Missions Systems, we are experiencing a growing need for advanced Analytics and Data Science to improve our processes, products and services to better serve our customers. In order to meet the growing demand for this skillset, I strongly support UCF's proposed Bachelor of Science degree program in Data Science.

We believe that there is a strong need for employees who are familiar with the computational and statistics techniques necessary to process and discover meaningful insights from the massive amounts of data that our business continuously generate. Employees who can design new algorithms and computerized systems to answer questions related to unique business needs are especially valuable to us.

Here at Lockheed Martin, we see opportunities for leveraging analytics in a wide number of domains such as, for better strategic and tactical decision making, improved performance of our products and services, optimization of resources, cost savings. I would recommend this program for many such needs, primarily in engineering and information technology. We also see the potential of leveraging data science and analytics in other domains as well and would recommend other degree programs incorporate portions of the curriculum for students in other disciplines, to gain an understanding of the value of information and analytics.

We plan to continue to build competence in data science & analytics in the future and expect to hire these skills in an accelerated mode within the next 3-5 years. We have a company supported program to pay for educational opportunities for our employees and would encourage software developers and engineers to take the required courses and pursue the proposed degree.

Overall, from our perspective, we anticipate a strong and continued demand for such talented employees to stay ahead of our competition and compete in the global marketplace.

If you have any questions, please do not hesitate to contact me.

Sincerely,



Sreerupa Das, 407-306-6949

Prof. Shunpu Zhang  
Chair, Dept. Of Statistics, College of Science  
University of Central Florida  
4000 Central Florida Blvd  
Orlando, FL 32816-2370

M. E. Gardner, Jr.  
The Aerospace Corporation  
Eastern Range Directorate  
321-853-6666  
marvin.e.gardner@aero.org  
03 December 2018

Dear Prof. Zhang,

As a manager within the Aerospace industry and as the current Chairman of The National Space Club Florida Committee we are continuing to anticipate a growing need for advanced analytics in many of the business and engineering activities within the aerospace community, and thus very strongly support UCF's proposed Bachelor of Science degree program in Data Science.

We believe that there is a strong need for employees who are familiar with the computational and statistics techniques necessary to make sense of the massive amounts of data within the aerospace industry. Employees who can design new algorithms and computerized systems to answer questions related to unique business needs are especially valuable to the industry.

We see opportunities in many areas of our industry and would recommend this program for many of the current roles, primarily engineering and information technology. We also see opportunities in other areas and would recommend other degree programs incorporate portions of the curriculum for students in other disciplines, to gain an understanding of the value of information and analytics.

Overall, from our perspective, we anticipate a strong and continued demand for such talented employees to stay ahead of our competition and compete in the global marketplace.

If you have any questions, please do not hesitate to contact me.

Sincerely,



M.E. "Butch" Gardner  
National Space Club Florida Committee – Chairman

Principal Director  
The Aerospace Corporation  
Eastern Range Directorate  
321-853-6666 - Office  
321-698-1298 - Cell



Prof. Shunpu Zhang  
Chair, Dept. Of Statistics, College of Science  
University of Central Florida  
4000 Central Florida Blvd  
Orlando, FL 32816-2370

Bob LoGalbo, Chief Data Scientist  
Leidos, Inc.  
+1-312-550-3146  
Robert.D.LoGalbo@leidos.com

27 Nov 2018

Dear Prof. Zhang,

At Leidos, we are continuing to leverage advanced analytics in many of our business and engineering activities, and thus very strongly support for UCF's proposed Bachelor of Science degree program in Data Science.

We believe that there is a strong need for employees who are familiar with the computational and statistics techniques necessary to make sense of the massive amounts of data that our business continuously generate. Employees who can design new algorithms and computerized systems to answer questions related to unique business needs are especially valuable to us.

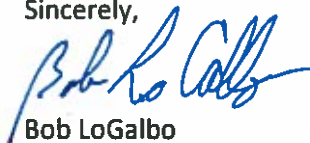
Here at Leidos we see opportunities in many areas of our company and would recommend this program for many of our current roles, primarily engineering and information technology. We also see opportunities in other areas and would recommend other degree programs incorporate portions of the curriculum for students in other disciplines, to gain an understanding of the value of information and analytics.

We plan to continue to build competence in data analytics in the future and expect to hire these skills in an accelerated mode within the next 3-5 years. We have a company supported program to pay for educational opportunities for our employees, and would encourage software developers and engineers to take the required courses and pursue the proposed degree.

Overall, from our perspective, we anticipate a strong and continued demand for such talented employees to stay ahead of our competition and compete in the global marketplace.

If you have any questions, please do not hesitate to contact me.

Sincerely,



Bob LoGalbo

November 28, 2018

Prof. Shunpu Zhang  
Chair, Dept. Of Statistics, College of Science  
University of Central Florida  
4000 Central Florida Blvd  
Orlando, FL 32816-2370

Jerry L. Oglesby, Ph.D.  
SAS Institute, Inc.  
919-677-8000  
jerry.oglesby@sas.com

Dean Prof. Zhang,

On behalf of SAS, I am writing to express my support for the proposed Bachelor of Science degree program in Data Science at the University of Central Florida.

SAS, established in 1976, is a privately-owned company that provides analytics software and services to industry, government, academia and researchers around the world. SAS is used at more than 65,000 sites in more than 135 countries, including 90 of the top 100 companies on the Fortune Global 500 list.

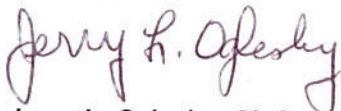
As a leading global company that provides data analytics software solutions, we have observed a strong growth for data science related positions in industry. It is great that the University of Central Florida is developing an undergraduate program in this high-demand field. We believe that there is a strong need for employees who are familiar with the computational and statistics techniques necessary to make sense of the massive amounts of data that business continuously generate. Employees who can design new algorithms and computerized systems to answer questions related to unique business needs are especially valuable.

We have provided free trainings to your students and faculty to help them gain data analysis skills using SAS. We plan to continue our support for your program through trainings and access to our software products and academic resources.

Finally, I believe that the proposed data science program meets an urgent need for society and the advancement of analytics into the Big Data field. I strongly believe that the department has a faculty that are well qualified to have such a program. I wish you and your colleague's great success in bringing the program to fruition.

I believe this program will further strengthen our partnership.

Best Regards,



*Jerry L. Oglesby, Ph.D.*  
Senior Director  
Global Academic Programs  
Education Division

Prof. Shunpu Zhang  
Chair, Dept. Of Statistics, College of Science  
University of Central Florida  
4000 Central Florida Blvd  
Orlando, FL 32816-2370

November 27, 2018

Dear Prof. Zhang,

Charter Communications is working heavily in the field of Machine Learning and Data Science. We believe there is a strong need for employees who are familiar with the fundamentals of Data Science – specifically in math, statistics and computer science. We need employees who can design and create new algorithms that will help answer unique business questions so that we stay competitive in the industry.

We plan to build competence in Data Analytics and Data Science and are in need of qualified candidates.

As such, we very strongly support for UCF's proposed Bachelor of Science degree in Data Science.

Please contact me if you have any questions.

Sincerely,

Praveen Rao  
Director, Data Science  
Charter Communications  
407-745-2534  
praveen.rao@charter.com

Prof. Shunpu Zhang  
Chair, Dept. Of Statistics, College of Science  
University of Central Florida  
4000 Central Florida Blvd  
Orlando, FL 32816-2370

Frank Wang  
System VP,  
IDN Decision Support Analytics  
Health First, Inc.  
3300 Fiske Blvd.  
Rockledge, FL 32955

Date 12/6/2018

Dear Prof. Zhang,

At Health First we are continuing to leverage advanced analytics in many of our business and engineering activities, and thus very strongly support for UCF's proposed Bachelor of Science degree program in Data Science.

We believe that there is a strong need for employees who are familiar with the computational and statistics techniques necessary to make sense of the massive amounts of data that our business continuously generate. Employees who can design new algorithms and computerized systems to answer questions related to unique business needs are especially valuable to us.

Here at Health First we see opportunities in many areas of our company and would recommend this program for many of our current roles, primarily engineering and information technology. We also see opportunities in other areas and would recommend other degree programs incorporate portions of the curriculum for students in other disciplines, to gain an understanding of the value of information and analytics.

We plan to continue to build competence in data analytics in the future and expect to hire these skills in an accelerated mode within the next 3-5 years. We have a company supported program to pay for educational opportunities for our employees, and would encourage software developers and engineers to take the required courses and pursue the proposed degree.

Overall, from our perspective, we anticipate a strong and continued demand for such talented employees to stay ahead of our competition and compete in the global marketplace.

If you have any questions, please do not hesitate to contact me.

Sincerely,

A handwritten signature in black ink, appearing to read 'Frank Wang', written in a cursive style.

Frank Wang

# **Appendix E: Surveys**

Computer Science

Industrial Engineering & Management Systems

Mathematics

Statistic and Data Science

Advisory Board

# Survey for BS in Data Science

---

## Start of Block: Default Question Block

Q1 Survey for Bachelor's Degree in Data Science Data Science is an emerging discipline that seeks to infer insights from large amounts of data (“big data”) by using various statistical techniques and algorithms. The discipline is concerned with both statistical techniques that measure the validity of such insights and with computational techniques for managing data and resources efficiently. There is a great need for people with technical skills in these areas, prompted by the large amounts of information that governments and businesses are collecting. Thus, UCF is planning to start a bachelor's degree program that aims to train people to develop algorithms and computerized systems to facilitate the discovery of information from big data. UCF is planning an interdisciplinary Bachelor of Science Program in Data Sciences, offered jointly by the departments of Computer Science, Statistics, Mathematics, and Industrial Engineering and Management Systems. We would like to gauge your interest in this degree program.

---

Q2 How interested are you in pursuing a Bachelor's degree in Data Science at UCF, starting in Fall 2020?

- Very interested (1)
- Somewhat interested (2)
- Neutral (3)
- Not interested (4)
- Very uninterested (5)

*Skip To: Q6 If How interested are you in pursuing a Bachelor's degree in Data Science at UCF, starting in Fall 2... = Very interested*

*Skip To: Q6 If How interested are you in pursuing a Bachelor's degree in Data Science at UCF, starting in Fall 2... = Somewhat interested*

---

Q4 How interested might you be in pursuing a Bachelor's degree in Data Science if you were not already enrolled in your current degree program?

- Very interested (1)
  - Somewhat interested (2)
  - Neutral (3)
  - Not interested (4)
  - Very uninterested (5)
  - Click to write Choice 6 (6)
- 

Q6 What is your present degree program?

- Computer Science (CS) Bachelor's degree (1)
- Information Technology (IT) Bachelor's degree (2)
- Computer Engineering Bachelor's degree (3)
- Physics Bachelor's degree (5)
- Mathematics Bachelor's degree (6)
- Other Bachelor's degree (7)
- None or a Graduate degree (4)

End of Block: Default Question Block

---

# Survey for BS in Data Science

Industrial Engineering and Management Systems (IEMS) Department

Q1 Survey for Bachelor's Degree in Data Science. Data Science is a very important discipline that includes the principles for Engineering Analytics.

Are you interested in pursuing a BS in Data Science? Y/N

This question was sent by email to 110 students of the BS in Industrial Engineering (Junior level).

Response to Survey: 30 Respondents, and 7 were interested out of 30.



---

**From:** Piotr Mikusinski  
**Sent:** Tuesday, November 27, 2018 4:52 PM  
**To:** Joseph Brennan  
**Cc:** Xin Li  
**Subject:** Re: Data Science Survey question

165 students in my Calc 1 class responded.

Yes: 50 (30%)

No: 115 (70%)

**From:** Joseph Brennan <[Joseph.Brennan@ucf.edu](mailto:Joseph.Brennan@ucf.edu)>  
**Date:** Monday, November 26, 2018 at 11:31 AM  
**To:** Piotr Mikusinski <[Piotr.Mikusinski@ucf.edu](mailto:Piotr.Mikusinski@ucf.edu)>  
**Subject:** Re: Data Science Survey question

Yes/No

---

**From:** Piotr Mikusinski  
**Sent:** Monday, November 26, 2018 11:23:57 AM  
**To:** Joseph Brennan; Zixia Song  
**Subject:** Re: Data Science Survey question

Do they want a “yes or no” survey or something like the following.

\item[A] Definitely interested.

\item[B] Possibly interested.

\item[C] Not interested.

Joe

---

On Nov 26, 2018, at 9:04 AM, Joseph Brennan <[Joseph.Brennan@ucf.edu](mailto:Joseph.Brennan@ucf.edu)> wrote:

Piotr and Zixia,

Can you ask this of your students this week?

Joe

---

Data Science is an emerging discipline that seeks to infer insights from large amounts of data (“big data”) by using various statistical techniques and algorithms. The discipline is concerned with both statistical techniques that measure the validity of such insights and with computational techniques for managing data and resources efficiently. There is a great need for people with technical skills in these areas, prompted by the large amounts of information that governments and businesses are collecting. Thus, UCF is planning to start a bachelor's degree program that aims to train people to develop algorithms and computerized systems to facilitate the discovery of information from big data.

This will be an interdisciplinary Bachelor of Science Program in Data Sciences, offered jointly by the departments of Computer Science, Statistics, Mathematics, and Industrial Engineering and Management Systems at UCF. We would like to gauge your interest in this degree program.

**From:** Brittany Durrani <Brittany.Durrani@ucf.edu>  
**Sent:** Wednesday, September 19, 2018 10:12 PM  
**To:** Shunpu Zhang <Shunpu.Zhang@ucf.edu>; Daniel Inghram <Daniel.Inghram@ucf.edu>; Kathleen Suchora <Kathleen.Suchora@ucf.edu>; Nizam Uddin <Nizam.Uddin@ucf.edu>  
**Subject:** Re: A simple survey

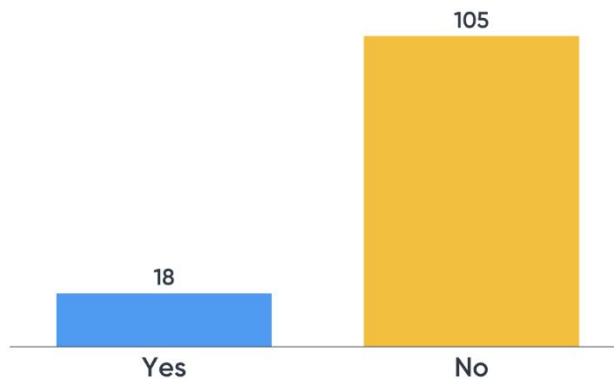
I gave the survey at the beginning of each of my 2023 classes. Participation was obviously not at 100%, but the results are attached.

---

Brittany Durrani  
Instructor  
Department of Statistics  
407.823.6522  
Technology Commons II 209B  
[brittany.durrani@ucf.edu](mailto:brittany.durrani@ucf.edu)  
Office hours for Fall: MW 2:30-3:30, TR 10:30-11:30, 12:30-1:00

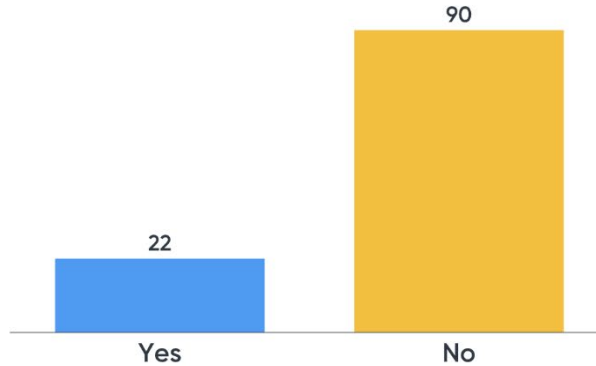
## Are you interested in pursuing a bachelors degree in Data Sciences?

The data sciences degree will be a program collaboration between the Statistics, Math, Computer Science, and Industrial Engineering departments.



# Are you interested in pursuing a bachelors degree in Data Sciences?

The data sciences degree will be a program collaboration between the Statistics, Math, Computer Science, and Industrial Engineering departments.



---

**From:** Daniel Inghram  
**Sent:** Monday, September 24, 2018 8:11:48 AM  
**To:** Shunpu Zhang  
**Subject:** RE: A simple survey

Shunpu:

**Attached** (and pasted below) are my results for [STA2014C.001](#) and [STA2014C.002](#).

## Poll Question



Read the following about "data science" then answer the question.

*Data science is an interdisciplinary field that uses scientific methods, processes, algorithms and systems to extract knowledge and insights from data in various forms, both structured and unstructured, similar to data mining.*

*Data science is a "concept to unify statistics, data analysis, machine learning and their related methods" in order to "understand and analyze actual phenomena" with data.*

*Data Science employs techniques and theories drawn from many fields within the context of mathematics, statistics, information science, and computer science.*

Are you interested in pursuing a BS degree in Data Sciences?

Choice	Results
Yes	22
No	505

[Return to Poll](#)

Please let me know if you need anything else regarding this matter.

Thank you,  
Danny

**From:** Shunpu Zhang

**Sent:** Thursday, September 20, 2018 7:22 AM

**To:** Brittany Durrani <[Brittany.Durrani@ucf.edu](mailto:Brittany.Durrani@ucf.edu)>; Daniel Inghram <[Daniel.Inghram@ucf.edu](mailto:Daniel.Inghram@ucf.edu)>; Kathleen Suchora <[Kathleen.Suchora@ucf.edu](mailto:Kathleen.Suchora@ucf.edu)>; Nizam Uddin <[Nizam.Uddin@ucf.edu](mailto:Nizam.Uddin@ucf.edu)>

**Subject:** Re: A simple survey

Good morning!

Thanks again for working on the survey. If you haven't done so, could you please add a little introduction about data science to the survey? Here is what I found on Wikipedia.

**Data science** is an interdisciplinary field that uses scientific methods, processes, algorithms and systems to extract **knowledge** and insights from **data** in various forms, both structured and unstructured,<sup>[1][2]</sup> similar to **data mining**.

Data science is a "concept to unify statistics, data analysis, machine learning and their related methods" in order to "understand and analyze actual phenomena" with data.<sup>[3]</sup> It employs techniques and theories drawn from many fields within the context of **mathematics**, **statistics**, **information science**, and **computer science**.

Have a good day!

-----  
Shunpu

# UCF Data Science Advisory Board Survey

## UCF Data Science Advisory Board: Skills and Hiring Survey

The Data Science Advisory Board at the University of Central Florida is collecting data on the relevant tools and skills in the industry today. Your responses will help inform curriculum choices for our undergraduate and graduate programs geared at educating the next generation of data scientists.

This survey will take 10 minutes to complete. Thank you for investing your time in the development of our students!

- 1) What is your job title? \*
- 2) What is your company's business or industry? \*
  - a. Cloud Services / Hosting / CDN
  - b. Computers / Hardware
  - c. Consulting (IT)
  - d. Search / Social Networking
  - e. Security (computer / software)
  - f. Software (incl. SaaS, Web, Mobile)
  - g. Advertising / Marketing / PR
  - h. Banking / Finance
  - i. Carriers / Telecommunications
  - j. Consulting (non-IT)
  - k. Education
  - l. Government
  - m. Healthcare / Medical
  - n. Insurance
  - o. Manufacturing (non-IT)
  - p. Nonprofit / Trade Association
  - q. Publishing / Media
  - r. Retail / E-Commerce
  - s. Venture Capital / Investment Banking
  - t. Other:
  - u.
- 3) How many employees work at your company?
  - a. 1
  - b. 2-25
  - c. 26-100
  - d. 101-500
  - e. 1001-2500
  - f. 2501-10000
  - g. 10000+
- 4) How long has your company been employing data scientists?

- 5) Which of the following statements about your work are true? (Check all that apply) \*
- a. I am a data scientist.
  - b. I regularly engage in projects with data scientists.
  - c. I work as a supervisor of data scientists.
  - d. I hire or recruit for data scientists at my company.

## Tools

### What systems, software, and languages are in the data science tool-box at your company?

- 6) Which of the following operating systems do the data scientists at your company use? (Check all that apply)
- a. Linux
  - b. Unix
  - c. Mac OS X
  - d. Windows
  - e. iOS (as a developer)
  - f. Android (as a developer)
  - g. Other:
  - h.
- 7) Which of the following cloud computing services do the data scientists at your company use? (Check all that apply) \*
- a. Amazon Web Services
  - b. Kamatera
  - c. Microsoft Azure
  - d. Google Cloud Platform
  - e. Adobe
  - f. VMware
  - g. IBM Cloud
  - h. Rackspace
  - i. Red Hat
  - j. Salesforce
  - k. Oracle Cloud
  - l. SAP
  - m. Verizon Cloud
  - n. Navisite
  - o. Dropbox
  - p. Egnyte
  - q. None/Not Applicable
  - r. Other:
  - s.

8) Which of the following programming languages do the data scientists at your company use?  
(Check all that apply) \*

- a. Bash
- b. C
- c. C#
- d. C++
- e. Clojure
- f. Erlang
- g. F#
- h. Go
- i. Haskell
- j. Java
- k. JavaScript
- l. Julia
- m. LISP
- n. Lua
- o. Matlab
- p. Objective-C
- q. Octave
- r. Perl
- s. Python
- t. R
- u. Ruby
- v. SAS
- w. Scala
- x. SQL
- y. Swift
- z. Visual Basic/VBA
- aa. None/Not Applicable
- bb. Other:
- cc.

9) Which of the following relational databases do the data scientists at your company use? (Check all that apply) \*

- a. Aster Data (Teradata)
- b. EMC/Greenplum
- c. IBM DB2
- d. Microsoft SQL Server
- e. MySQL
- f. Netezza (IBM)
- g. Oracle
- h. Oracle Exascale
- i. PostgreSQL
- j. SAP HANA
- k. SQLite
- l. Sybase ADaptive Server



- m. Sybase IQ
- n. Teradata
- o. Vertica
- p. None/Not Applicable
- q. Other:
- r.

10) Which of the following Hadoop tools do the data scientists at your company use? (Check all that apply)

- a. Amazon Elastic MapReduce (EMR)
- b. Apache Hadoop
- c. BuiltToScale
- d. Cloudera
- e. EMC/Greenplum
- f. Hortonworks
- g. IBM
- h. MapR
- i. Oracle
- j. None/Not Applicable
- k. Other:
- l.

11) Which of the following data management tools and big data platforms do the data scientists at your company use? (Check all that apply) \*

- a. Accumulo
- b. Amazon DynamoDB
- c. Amazon RedShift
- d. BuiltToScale
- e. Cascading
- f. Cassandra
- g. Couchbase
- h. Google BigQuery/Fusion Tables
- i. Hbase
- j. Hive
- k. Impala
- l. Jaql
- m. Kafka
- n. MongoDB
- o. Neo4J
- p. Pig
- q. Redis
- r. Riak
- s. Spark
- t. Splunk
- u. Storm
- v. Toad
- w. Zookeeper
- x. None/Not Applicable

y. Other:  
z.

12) Which of the following spreadsheet, BI, and reporting tools do the data scientists at your company use? (Check all that apply)

- a. Alteryx
- b. Actuate/BIRT
- c. Adobe Analytics
- d. BusinessObjects
- e. Cognos
- f. Datameer
- g. Excel
- h. IBM BigSheets
- i. Jaspersoft
- j. Microstrategy
- k. Oracle BI
- l. Pentaho
- m. Power BI
- n. PowerPivot
- o. QlikView
- p. Spotfire
- q. None/Not Applicable
- r. Other:  
s.

13) Which of the following visualization tools do the data scientists at your company use? (Check all that apply)

- a. D3
- b. ggplot
- c. Google Charts
- d. JavaScript InfoVis Toolkit
- e. Matplotlib
- f. Processing
- g. Processing.js
- h. Protoviz
- i. Qlik
- j. Raphael
- k. Shiny
- l. Tableau
- m. None/Not Applicable
- n. Other:  
o.

14) Which of the following machine learning and statistics programs or tools do the data scientists at your company use? (Check all that apply)

- a. BigML
- b. Google Prediction
- c. GraphChi

- d. Dato / GraphLab
- e. IBM Big Insights
- f. IBM SystemML & Nimble
- g. H2O
- h. KNIME
- i. LIBSVM
- j. Mahout
- k. Mathematica
- l. Scikit-learn
- m. RapidMiner
- n. Salford Systems
- o. SAS Enterprise Miner
- p. SkyTree Analytics
- q. SpaCy
- r. Spark MLlib
- s. Stata
- t. TensorFlow
- u. Theano
- v. Vowpal Wabbit
- w. Weka
- x. None/Not Applicable
- y. Other:
- z.

### Tasks

What do the data scientists at your company spend their time doing?

15) How engaged are the data scientists at your company in the following data processing tasks?

	Never	Occasionally	Often	Daily
ETL	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Data cleaning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Feature extraction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Basic exploratory data analysis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Creating visualizations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Setting up / maintaining data platforms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Conducting data analysis to answer research questions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16) How engaged are the data scientists at your company in the following software development tasks?

	Never	Occasionally	Often	Daily
Collaborating on code projects (reading/editing others' code, using git)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Planning large software projects or data systems	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Developing prototype models	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Implementing models/algorithms into production	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Developing data analytics software	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Developing products that depend on real-time data analytics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Developing dashboards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Developing hardware	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17) How engaged are the data scientists at your company in the following communication and strategy tasks?

	Never	Occasionally	Often	Daily
Teaching/training others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Organizing and guiding team projects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Using dashboards and spreadsheets (made by others) to make decisions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Identifying business problems to be solved with analytics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Communicating findings to business decision-makers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Communicating with people outside your company	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## Hiring Criteria

Tell us what you look for when you are filling data science roles at your company.

18) How important are the following when making hiring decisions?

(Likert Type)

- a. Demonstrated experience with THE SAME programming languages used by the data scientists at your company
- b. Demonstrated experience with THE SAME relational databases used by the data scientists at your company
- c. Demonstrated experience with THE SAME Hadoop tools used by the data scientists at your company
- d. Demonstrated experience with THE SAME data management tools or big data platforms used by the data scientists at your company
- e. Demonstrated experience with THE SAME spreadsheets, BI, and reporting tools used by the data scientists at your company
- f. Demonstrated experience with THE SAME machine learning and statistics tools used by the data scientists at your company
- g. Demonstrated experience with ANY programming languages
- h. Demonstrated experience with ANY relational databases
- i. Demonstrated experience with ANY Hadoop tools
- j. Demonstrated experience with ANY data management tools or big data platforms
- k. Demonstrated experience with ANY spreadsheets, BI, and reporting tools
- l. Demonstrated experience with ANY machine learning and statistics tools
- m. Bachelor's degree in a STEM field
- n. Master's degree in a STEM field
- o. Doctoral degree in a STEM field
- p. Demonstrated experience with data processing
- q. Demonstrated experience with software development
- r. Demonstrated experience with communicating project results
- s. Demonstrated experience with project management
- t. Ability to work in a team structure
- u. Ability to make decisions
- v. Ability to communicate verbally with people inside and outside an organization
- w. Ability to plan, organize and prioritize work
- x. Ability to create and/or edit written reports
- y. Ability to sell and influence others

19) How do you expect candidates for data scientist roles to demonstrate their skills? (Check all that apply)

- a. Projects completed as part of university curriculum
- b. Projects completed voluntarily (as part of competitions or online collaborations)
- c. Projects completed as part of internship
- d. Certification(s)
- e. Full-time work experience
- f. Skills test given during the hiring process
- g. Other:
- h.

20) Do you have any further comments to help us understand how you evaluate candidates for data scientist roles at your company?

21) Are you willing to be contacted for a follow-up? If yes, please provide your name and email address.

## **Appendix F: Letters of Support from Academic Institutions**

Florida Agricultural and Mechanical University (FAMU)

Florida Atlantic University (FAU)

Florida Polytechnic University (FLPoly)

Florida State University (FSU)

University of Florida (UF)



# Florida Agricultural and Mechanical University

TALLAHASSEE, FLORIDA 32307-3400

TELEPHONE: (850) 599-3755

FAX: (850) 599-8480

COLLEGE OF SCIENCE AND TECHNOLOGY  
DEPARTMENT OF MATHEMATICS

## MEMORANDAUM

September 11, 2019

**TO:** Board of Governors  
State University System of Florida

**FROM:** Dr. Pierre Ngnepieba  
Chairperson, Department of Mathematics

**RE:** Letter of Support for the new B.S. in Data Science at the University of Central Florida

On behalf of the Department of Mathematics at Florida A&M University, I wish to state our strong support for the proposed new B.S. in Data Science in the College of Science and the College of Engineering and Computer Science, University of Central Florida. When this program joins the existing programs in the departments of: Statistics and Data Science, Mathematics, Computer Science, and Industrial Engineering and Management Systems in the fall 2020, it will strengthen the collaborative interdisciplinary efforts among both College of Science and College of Engineering and Computer Science colleges.

The proposed new program is in an area of particular interest to students due to the projected large growth of employment opportunities. It promises to attract new students to University of Central Florida in a program which will benefit the College of Science and the College of Engineering and Computer Science. It also reflects the emerging new trend of interdisciplinary research and educational programs.





Charles E. Schmidt College of Science  
Department of Mathematical Sciences  
777 Glades Road  
Boca Raton, FL 33431  
tel: 561.297.3340  
fax: 561.297.2436  
[www.math.fau.edu](http://www.math.fau.edu)

Associate Dean of Academic Affairs  
Statistics Professor and Advisor  
Email: [Lqian@fau.edu](mailto:Lqian@fau.edu)

February 14, 2019

Shunpu Zhang, Ph.D.  
Chair and Professor of Statistics  
Department of Statistics  
University of Central Florida  
4000 Central Florida Blvd  
Orlando, FL 32816-2370

Dear Professor Zhang,

This letter supports the proposed B.S. program in Data Science at UCF. The proposed program involves four departments (Computer Sciences, Industrial Engineering and Management Systems, Mathematics and Statistics), hence it is trans-disciplinary in nature. The industry partners proposed in the program will bring the educational program with real-world data (RWD) and train future data scientists with hands-on experience in analyzing RWD, hence it makes the proposed program meet the skills of demand for future scientists.

I support BS in Data Science at UCF fully.

Sincerely yours,

Lianfen Qian

**From:** Shahram Taj <[staj@floridapoly.edu](mailto:staj@floridapoly.edu)>

**Sent:** Friday, February 22, 2019 6:01 PM

**To:** Shunpu Zhang <[Shunpu.Zhang@ucf.edu](mailto:Shunpu.Zhang@ucf.edu)>

**Cc:** Reinaldo Sanchez-Arias <[rsanchezarias@floridapoly.edu](mailto:rsanchezarias@floridapoly.edu)>; Tom Dvorske <[tdvorske@floridapoly.edu](mailto:tdvorske@floridapoly.edu)>

**Subject:** RE: B.S. program in Data Science

Dear Dr. Zhang,

Dr. Sanchez-Arias and I have reviewed the B.S. program in Data Science that you are currently developing at UCF. We do support the joint effort between several departments at UCF in launching B.S. degree in Data Science as a field with increasing demand for foreseeable future. Your proposed program is distinct from our B.S. in Data Science at Florida Polytechnic University. Here are distinctions and similarities:

1. The B.S. in Data Science at Florida Polytechnic University is offered by the Department of Data Science and Business Analytics, while at UCF, the program would be jointly offered by Departments of Computer Sciences, Industrial Engineering and Management Systems, Mathematics and Statistics.
2. Both curricula are designed to meet the big data challenge by developing new courses in data science.
3. An important component of both programs is partnership with industry to train students. At Florida Poly, students take year-long industry sponsored capstone projects.
4. UCF focus is in a general synthesis of Computer science, mathematics, Industrial Engineering and Statistics, or a specialization, which draws from these departments.
5. At Florida Poly, students also have the options of state-of-the-art innovative concentrations.

In conclusion, even with similarities between the two programs, there are also distinctions that make both programs unique. I do support your effort in launching your program at UCF and hope we can do a collaboration in the near future.

Best Regards,

**Shahram Taj, Ph.D.**

Chair, Department of Data Science & Business Analytics

Professor of Logistics & Supply Chain Management  
Florida Polytechnic University

W: 863.874.8521  
4700 Research Way  
Lakeland, FL 33805-8531  
[staj@floridapoly.edu](mailto:staj@floridapoly.edu)



**Department of Statistics**  
117 N. Woodward Avenue  
P.O. Box 3064330  
Tallahassee, Florida 32306-4330  
(850) 644-4008, [niu@stat.fsu.edu](mailto:niu@stat.fsu.edu)

August 21st, 2019

Shunpu Zhang, Ph.D.  
Chair and Professor  
Department of Statistics and Data Science  
University of Central Florida  
Orlando, FL 32816-2370

Dear Dr. Zhang,

I am writing to strongly support the proposed B.S. program in Data Science at the University of Central Florida, which will be jointly offered by Departments of Computer Sciences, Industrial Engineering and Management Systems, Mathematics and Statistics at UCF. The curriculum of the proposed program is well designed to meet the big data challenge by integrating the existing courses and developing new courses in data science from these departments. An important component of this program will be partnership with industry to train students. The proposed program supports the UCF's mission to offer the best undergraduate education available in Florida, to become more inclusive and diverse, and to be America's leading partnership university.

I am looking forward to close collaboration between FSU and UCF on Data Science Programs, which will produce high quality undergraduate and graduate students for the State of Florida.

Sincerely,

A handwritten signature in blue ink, appearing to read "Xu-Feng Niu".

Xu-Feng Niu, PhD  
Professor and Chair  
Department of Statistics  
Florida State University



Herbert Wertheim College of Engineering  
Computer & Information Science & Engineering

E301 CSE Building  
PO Box 116120  
Gainesville, FL 32611-6120  
352-392.1200 Voice  
352-392-1220 Fax

September 19, 2019

Dear Dr. Leavens,

after a careful review of the proposed BS degree in Data Science, the faculty in the CISE department at the University of Florida do not have any objections to UCF starting the proposed BS degree program.

Sincerely,

A handwritten signature in black ink that reads 'Juan E. Gilbert'.

**Juan E. Gilbert, Ph.D.**

Andrew Banks Family Preeminence Endowed Professor & Chair  
Computer & Information Science & Engineering Department (CISE)  
Herbert Wertheim College of Engineering  
University of Florida  
P.O. Box 116120, Gainesville, FL 32611  
352.392.1527 (V)  
juan@ufl.edu

# **Appendix G: Letters of Commitment from College Deans**

College of Engineering and Computer Science

College of Sciences

# **Appendix H: Common Prerequisite Application**

Common Prerequisite Application for Unique CIP/Degree Program

Degree Program Name: Data Science B.S. CIP Code: 30.7001 (CIP2020)

Anticipated Degree Total Hours: 120

Are other degree programs under this name currently found in the Common Prerequisite Manual (CPM)?  Yes  No

If yes, under what CIP code: \_\_\_\_\_ Track \_\_\_\_\_

*If your degree program is the same as above, you should use the **Application to Modify Currently Approved Common Prerequisites**.*

Institution Requesting Program Added: University of Central Florida

Name of Contact Person: Prof. Shunpu Zhang

Email Address of Above: shunpu.zhang@ucf.edu Phone Number: (407)-823-1566

1. Please list your proposed common prerequisites, along with the additional information requested below. You can find details about individual courses at the following hyperlink to the Statewide Course Numbering System ([SCNS](#)). Type in the prefix and four digit number of the proposed course. The hyperlink leads to a page with two worksheets: statewide course detail and institutions. Clicking on the institutions page will identify the institutions offering the course. Be aware that there may be institutions besides Florida College System (FCS) and State University System (SUS) institutions listed.

Add additional lines if necessary.

Proposed Course Prefix and Number	Title of Proposed Course	# Credit Hrs	Will count as general ed at your institution?	# FCS Currently Offering Course	# SUS Currently Offering Course	Additional recommended alternative courses to primary
BSC X010	General Biology	4	Y	28	11	
COP XXXX	Intro Programming in C, C++, JAVA or equivalent language	3	Y	tbd	3	COP 2220
MAC X311	Calculus with Analytic Geometry I	4	Y	28	11	
MAC X312	Calculus with Analytic Geometry II	4	N	28	11	



MAC X313	Calculus with Analytic Geometry III	4	N	27	11	
STA X023	Statistical Methods I	3	Y	28	11	
PHY X048	General Physics with Calculus I	4	Y	27	11	CHM X045 Chemistry Fundamentals I

2. Is the credit hour total for required work more than 24?

- a. Yes  b. No

If yes, how do you anticipate students meeting the general education requirement:

- a.  Course(s) are anticipated to be "core" general education;  
 b.  Anticipate that institutions will have course(s) as part of their institution's general education program.  
 c.  Other (please specify):

3. If your request includes course(s) that are offered currently at 3 or less FCS institutions, please provide a justification as to why these courses are critical for a student's success in your upper division

Not Applicable

4. If your request includes courses that are offered currently at only your institution, do you have the same amount of elective credit hour space in your upper division so that the associate in arts transfer student is held harmless in excess hours and time?

- a. Yes  b. No

Not Applicable

5. If your request includes courses that are offered only currently at your institution, are you willing and able to offer these courses online or during the summer so that transfer students may pick up the courses without delaying admission for the fall?

- a. Yes  b. No

Not Applicable

# **Appendix I: Academic Program Review - Final Recommendations**

Computer Science

Industrial Engineering and Management Systems

Mathematics

Statistics and Data Science



2011-12 Academic Program Review Results  
College of Engineering and Computer Science  
Department of Electrical Engineering and Computer Science  
Computer Science Division

**Computer Science, B.S.**

Strengths

- faculty members
- facilities
- industry board support and engagement
- leadership
- high demand for graduates
- successful high school programming contest that serves as strong recruiting tool
- Research Experience for Undergraduates (REU)
- strong sense of community across divisions
- students, including national recognition of programming teams
- expertise in virtual environments, computer vision, and machine intelligence
- program advances state STEM goals

Weaknesses

- undergraduate student-faculty ratio limits student feedback and creates office hour congestion; instructional demands threaten faculty retention, particularly for tenure-earning faculty members
- faculty and student gender diversity
- insufficient number of graduate teaching assistants to support instruction
- graduate teaching assistants' English communication skills
- internship and co-op coordination
- transfer student preparation for rigor of major, particularly in math skills

Recommendations

- develop a strategic plan within the context of the college strategic plan; assure clear articulation of program goals; invest current and new resources in accordance with the plan
- develop and implement a plan to address program and department human-resource needs that considers current and future resources
- develop a plan to increase faculty and student gender diversity
- review faculty workload policy and adjust as appropriate
- review allocation of graduate teaching assistantships and adjust if appropriate

- assure teaching assistants assigned to program courses have appropriate communication skills
- review current internship and co-op coordination and consider options for enhancing student and employer access
- the Office of Undergraduate Studies on curricular alignment with partner institutions to assure student preparation for program rigor; work with partner institutions and UCF advising units to improve student advising on identifying a path to success
- improve coordination of courses across computer science and electrical and computer engineering divisions
- assure student access to faculty members
- enhance program visibility (e.g., nominate faculty members and students for national awards; circulate annual report to other engineering schools; expand advisory board to include members outside local area)

## **Computer Science, M.S.**

### Strengths

- faculty member quality and scholarly productivity, including notably strong recent junior faculty hires
- staff member quality
- leadership
- expertise in computer vision, machine learning, and virtual reality
- local industry connections and advisory board
- high demand for graduates
- benchmarking
- laboratory facilities and equipment
- strong sense of community across divisions
- program advances state STEM goals

### Weaknesses

- instructional loads, due to department undergraduate student-faculty ratio, detract from faculty focus on graduate education, as well as scholarly and other activities that promote program reputation; instructional demands threaten faculty retention, particularly for tenure-earning faculty members
- faculty and student gender diversity
- diffuse program focus
- insufficient number of faculty members for current program offerings
- elective course availability
- time-to-degree
- student retention
- student recruitment and ability to attract higher numbers of high quality students
- program rigor
- inability to address industry demand in certain areas (e.g., computer security, software

engineering, computing theory, and theoretical computer science)

#### Recommendations

- develop department strategic plan within the context of the college strategic plan; assure clear articulation of program goals and target balance between graduate and undergraduate activities; invest current and new resources in accordance with the plan
- develop and implement a plan to address program and department human-resource needs that considers current and future resources
- develop and implement a plan to increase faculty and student gender diversity
- review faculty workload policy and adjust as appropriate
- work towards engaging center and institute faculty in department instructional activity
- review curriculum, including rigor, and adjust as appropriate (e.g., narrow program focus in light of available resources)
- assure reasonable availability of courses to facilitate efficient time to graduation; review multi-year course schedule and assure it is realistic; review appropriateness of minimum enrollment to offer course; improve coordination of courses across computer science and electrical and computer engineering divisions
- review enrollment and retention trends across all programs; develop and implement an action plan for improvement
- develop and implement a recruitment plan to attract greater numbers of high quality domestic and international students
- assure student access to faculty members
- explore additional avenues to foster research funding and student support
- enhance program visibility (e.g., increase program presence at professional meetings; nominate faculty members and students for national awards; circulate annual report to other engineering schools; expand advisory board to include members outside local area)
- work with appropriate units on campus (e.g., College of Optics and Photonics, Nanoscience Technology Center) to expand elective course offerings for electrical engineering students

### **Computer Science, Ph.D.**

#### Strengths

- faculty member quality and scholarly productivity, including notably strong junior faculty members with exceptionally strong research programs
- student quality and satisfaction
- staff member quality
- leadership
- expertise in computer vision, machine learning, and virtual reality
- local industry connections and advisory board
- internal and external partnerships
- high demand for graduates
- benchmarking
- laboratory facilities and equipment

- strong sense of community across divisions
- program advances state STEM goals

#### Weaknesses

- instructional loads, due to department undergraduate student-faculty ratio, detract from faculty member focus on graduate education, as well as scholarly and other activities that promote program reputation; instructional demands threaten faculty retention, particularly for tenure-earning faculty members
- faculty and student gender diversity
- diffuse program focus
- insufficient number of faculty members for current program offerings
- availability of elective courses
- time-to-degree
- student retention
- decreasing number of Ph.D. degrees awarded across college
- student recruitment and ability to attract higher numbers of high quality students
- level of rigor and breadth of knowledge in student qualifying process
- insufficient number of graduate teaching assistantships to support instructional demands; GTA workload detracts from students' own education
- graduate teaching assistants' English communication skills
- current university methodology for assigning international student GPAs can adversely affect rankings
- inability to address industry demand in certain areas (e.g., computer security, software engineering, computing theory, and theoretical computer science)

#### Recommendations

- develop department strategic plan within the context of the college strategic plan; assure clear articulation of program goals and target balance between graduate and undergraduate activities; invest current and new resources in accordance with the plan
- develop and implement a plan to address program and department human-resource needs that considers current and future resources;
- develop and implement a plan to increase faculty and student gender diversity
- review faculty workload policy and adjust as appropriate
- work towards engaging center and institute faculty members in department instructional activity
- review curriculum, including rigor, and adjust as appropriate (e.g., narrow program focus in light of available resources; assure appropriate rigor and breadth in qualifying process)
- assure reasonable availability of courses to facilitate efficient time to graduation; review multi-year course schedule and make sure it is realistic; review appropriateness of minimum enrollment to offer course; improve coordination of courses across computer science and electrical and computer engineering divisions
- review enrollment and retention trends across all programs; develop and implement an action plan for improvement that is consistent with the department strategic plan

- develop and implement a recruitment plan to attract greater numbers of high quality domestic and international students
- assure appropriate rigor in student qualifying process
- review allocation of graduate teaching assistantships and adjust if appropriate
- assure teaching assistants assigned to undergraduate courses have appropriate communication skills
- explore additional avenues to foster research funding and student support
- enhance program visibility (e.g., increase program presence at professional meetings; nominate faculty members and students for national awards; circulate annual report to other engineering schools; expand advisory board to include members outside local area)
- work towards engaging center and institute faculty members in department instructional activity
- work with appropriate units on campus (e.g., College of Optics and Photonics, Nanoscience Technology Center) to expand elective course offerings that electrical engineering students could take
- work with the College of Graduate Studies to review methodology used to assign GPA to international students and adjust as appropriate

## **Digital Forensics, M.S.**

### Strengths

- program leadership
- demand for graduates
- quality and quantity of students
- computer equipment
- availability of highly-qualified adjuncts in the area
- up-to-date curriculum
- time-to-degree
- strong sense of community across divisions
- program advances state STEM goals

### Weaknesses

- impending retirement of the program's only full-time faculty member - coordinates and teaches most of the classes
- insufficient faculty office space limits capacity for growth
- faculty and student gender and ethnic diversity
- frequency of course offerings from partner units
- quality and rigor of student-learning outcomes
- lack of integration with other departmental programs

### Recommendations

- develop department strategic plan within the context of the college strategic plan; assure clear articulation of program "fit" and goals; invest current and new resources in accordance

with the plan

- develop and implement a plan to address program and department human-resource needs including program viability that considers current and future resources (e.g., identify assistant program director)
- develop and implement a plan to increase faculty member and student gender diversity
- review faculty workload policy and adjust as appropriate
- work with partner units to assure reasonable availability of courses to facilitate efficient time to graduation; review multi-year course schedule and make sure it represents a realistic picture; review appropriateness of minimum enrollment to offer course
- review enrollment and retention trends across all programs; develop and implement an action plan for improvement that is consistent with the department strategic plan
- review curriculum and adjust as appropriate (e.g., assure rigor is appropriate to a master's level program)
- revise programs' target student-learning outcomes; develop formal measures to evaluate the effectiveness of the program; continue to monitor metrics to improve the program
- explore options to engage faculty members from other programs
- assure student access to faculty members
- enhance program visibility (e.g., increase program presence at professional meetings; nominate faculty members and students for national awards; circulate annual report to other engineering schools; expand advisory board to include members outside local area)

## **Information Technology, B.S.**

### Strengths

- faculty members
- facilities
- industry board support and engagement
- leadership
- high demand for graduates
- student quality
- program advances state STEM goals

### Weaknesses

- program is the only non-accredited bachelor's degree program in the college
- courses taught mainly by non-tenure track faculty members
- faculty and student gender diversity
- insufficient number of graduate teaching assistants to support instruction
- disconnect between student expectations and program delivery

### Recommendations

- develop a strategic plan within the context of the college strategic plan; assure clear articulation of program vision and goals; consider appropriateness of pursuing accreditation by the Accreditation Board for Engineering and Technology (ABET) and resources necessary



to assure program viability to meet demand for majors; invest current and new resources in accordance with the plan

- develop and implement a plan to address program and department human-resource needs that considers current and future resources
- develop and implement a plan to increase faculty and student gender diversity
- review faculty workload policy and adjust as appropriate
- review allocation of graduate teaching assistantships and adjust if appropriate
- take appropriate steps to assure prospective majors are adequately apprised of program focus
- assure student access to faculty members
- enhance program visibility (e.g., nominate faculty members and students for national awards; circulate annual report to other engineering schools; expand advisory board to include members outside local area)



2011-12 Academic Program Review Results  
College of Engineering and Computer Science  
Department of Industrial Engineering and Management Systems

**Industrial Engineering, B.S.I.E.**

Strengths

- industry relations
- facilities and equipment
- alumni engagement through department advisory board
- accelerated B.S. to M.S. degree program
- program advances state STEM goals

Weaknesses

- program coordinator nearing retirement
- internship and co-op coordination
- no linear algebra requirement
- required course availability
- transfer student preparation for rigor of major, particularly in math skills

Recommendations

- review and update the department strategic plan within the context of the college strategic plan; assure clear articulation of program goals; distribute current and new resources in accordance with the plan
- develop and implement a plan to assure a smooth transition following program coordinator's impending retirement
- review current internship and co-op coordination and consider options for enhancing student and employer access
- assure teaching assistants assigned to B.S.I.E. courses have appropriate communication skills
- review curriculum and course scheduling and adjust as appropriate (e.g., consider adding a linear algebra requirement; assure appropriate availability of required courses)
- review faculty workload policy and adjust as appropriate
- work with the Office of Undergraduate Studies on curricular alignment with partner institutions to assure student preparation for program rigor; review restricted access requirements and update as appropriate; work with partner institutions and UCF advising units to improve student advising on identifying a path to success
- assure student access to faculty members

- enhance program visibility (e.g., nominate faculty members and students for national awards; circulate annual report to other engineering schools; expand advisory board to include members outside local area)

## **Industrial Engineering, M.S./M.S.I.E.**

### Strengths

- industry relations
- facilities and equipment
- alumni engagement through advisory board
- accelerated B.S. to M.S. degree program
- program advances state STEM goals

### Weaknesses

- program focus
- overlap between bachelor's and master's program courses
- availability of elective courses
- resource imbalance between master's and Ph.D. degree programs

### Recommendations

- review and update the department strategic plan within the context of the college strategic plan; assure clear articulation of program goals, strategic niche, and target balance between full-time and part-time students, as well as allocation of resources between master's and Ph.D. programs; invest current and new resources in accordance with the plan
- review curriculum and adjust as appropriate (e.g., reduce and narrow areas of program focus; streamline curriculum; assure differentiated content and rigor between bachelor's and master's degree programs); assure appropriate availability of elective courses
- increase recruitment of high quality, full-time domestic students to enhance program reputation
- review admissions standards and adjust if appropriate (e.g., consider requiring GRE)
- review faculty workload policy and adjust as appropriate
- assure student access to faculty members
- explore additional avenues to foster research funding and student support
- enhance program visibility (e.g., increase program presence at professional meetings; nominate faculty members and students for national awards; circulate annual report to other engineering schools; expand advisory board to include members outside local area)

## **Industrial Engineering, Ph.D.**

### Strengths

- industry relations
- facilities and equipment

- alumni engagement through advisory board
- program advances state STEM goals

#### Weaknesses

- program focus
- availability of elective courses
- resource imbalance between master's and Ph.D. degree programs
- uneven faculty research productivity
- current university methodology for assigning international student GPAs can adversely affect rankings

#### Recommendations

- review and update the department strategic plan within the context of the college strategic plan; assure clear articulation of program goals, strategic niche, and target balance between full-time and part-time students, as well as allocation of resources between master's and Ph.D. degree programs; invest current and new resources in accordance with the plan
- review curriculum and adjust as appropriate (e.g., reduce and narrow areas of program focus; streamline curriculum); assure appropriate availability of elective courses)
- increase recruitment of high quality, full-time domestic students to enhance program reputation
- improve balance of faculty research productivity
- work with the College of Graduate Studies to review methodology used to assign GPA to international students
- review faculty workload policy and adjust as appropriate
- assure student access to faculty members
- explore additional avenues to foster research funding and student support
- enhance program visibility (e.g., increase program presence at professional meetings; nominate faculty members and students for national awards; circulate annual report to other engineering schools; expand advisory board to include members outside local area)



2016-17 Academic Program Review Results  
College of Sciences  
Mathematics Programs

## Department-level Recommendations

- develop a faculty advisory group to provide additional advising for undergraduates
- develop a structure to engage research faculty members in undergraduate student advising (e.g., mentoring)
- develop and implement a plan to address current and anticipated human-resource needs that aligns with strategic planning priorities, considers the appropriate faculty mix, and takes into account current and future resources
- develop formal faculty mentoring for research and grant writing with junior faculty members

## Mathematics, B.S. (27.0101)

### Major Changes since Prior Review

- streamlined the curriculum
- reinstated tracks in the degree program for better accounting of students
- removed tracks in pure and applied mathematics
- added tracks in mathematical biology and general mathematics
- revised tracks in computational mathematics, mathematical economics, and engineering and physics
- reduced the minimum number of required courses
- clarified grade point average requirements for the major

### Strengths

- student quality
- ability to effectively teach large number of service courses to multiple disciplines
- opportunities for student engagement in research and Honors in the Major
- enhanced instructional delivery strategies for MAC1105 resulting in a significant reduction to failure and withdrawal rates

### Weaknesses

- program concentrations cause advising confusion and scheduling issues
- lack of alignment among upper-division courses leads to students having different outcomes and experiences
- insufficient data on alumni placement and employment
- limited experiential learning and high-impact practices particularly in terms of applied experiences
- high course failure and withdrawal rates among transfer students

### Recommendations

- develop streamlined advising guides to ensure clarity of program pathways for better advising and schedule planning
- assure the reasonable availability of courses, especially upper-division courses
- work with appropriate units to improve the collection of alumni information including information on placement and employer satisfaction
- continue to develop opportunities for students to engage in high-impact practices emphasizing the benefits to the major

- explore curricular modifications to assist at-risk transfer students who struggle in courses with high failure and withdrawal rates
- explore the feasibility of reducing recitation sections taught by graduate teaching associates to provide students more opportunities for one-on-one assistance
- consider engaging peer advisors and graders to support large, lower-division courses
- expand high school recruiting and marketing of the major

### **Mathematical Science, M.S. (27.0301)**

#### Major Changes since Prior Review

- revised the industrial mathematics track to align the program with the Society of Industrial and Applied Mathematics recommendations
- revised core course work to better align with the first year of the doctoral degree program

#### Strengths

- quality courses
- faculty support of students
- faculty member quality and breadth of faculty expertise

#### Weaknesses

- program marketing does not recruit students who do not wish to seek a doctorate
- lack of program vision and identity

#### Recommendations

- consider delivering some courses online or in a hybrid format; conduct an assessment of the demand for the degree in an online or executive format; expand recruitment efforts to include local employers and students not pursuing a doctorate degree
- evaluate the curriculum to ensure alignment with the mission and purpose of the degree program

### **Mathematics, Ph.D. (27.0301)**

#### Major Changes since Prior Review

- revised the first year's core course work and the qualifying examinations
- separated the candidacy examination and the dissertation proposal examination to decrease the time required to enter candidacy

#### Strengths

- well-qualified and dedicated faculty members
- comprehensive curriculum

#### Weaknesses

- high attrition rate
- lack of systematic recruitment efforts
- lack of competitive student stipends
- curriculum is narrowly focused on limited career outcomes

#### Recommendations

- review current program requirements to enter candidacy and adjust as appropriate
- explore internal and external opportunities to enhance student financial support (e.g., Graduate Assistance in Areas of National Need grants)
- develop a more focused and deliberate recruiting strategy
- review the curriculum and align it more closely to a variety of career outcomes
- collect feedback from alumni and employers to inform the assessment of career preparation



2016-17 Academic Program Review Results  
College of Sciences  
Statistics Programs

## Department-level Recommendations

- develop a department strategic plan within the context of the college's strategic plan; assure clear articulation of program goals and target balance between graduate and undergraduate activities; invest current and new resources in accordance with the plan
- develop and implement a plan to address current and anticipated human-resource needs that aligns with strategic planning priorities, considers the appropriate faculty mix, and takes into account current and future resources
- review and update promotion and tenure guidelines and criteria for faculty annual evaluations as appropriate
- strengthen the junior faculty mentoring program
- pursue opportunities for interdisciplinary research collaborations to secure more external funding
- explore options to meet space needs
- review the department's faculty workload policy and assure that it aligns with the department's goals
- improve the department's web presence to better promote faculty research and programs, improving visibility and recruitment

## Statistics, B.S. (27.0501)

### Major Changes since Prior Review

- adjusted the frequency with which certain core and elective courses are offered to accommodate student demand
- started offering some sections of a core course online
- modified the requirements for the minor in actuarial science
- required all statistics majors to take the Society of Actuaries exam as part of their graduation requirements
- clarified the grade point average requirement for the major
- reactivation of the actuarial science degree program

### Strengths

- growth and reputation of degree program
- dedicated full-time faculty members

### Weaknesses

- limited opportunities for high-impact practices, particularly in terms of research and capstone course experiences
- high failure and withdrawal rate in one course
- insufficient data on alumni placement and employment

### Recommendations

- develop an interdisciplinary general education course in big data analytics
- explore the feasibility of developing research efforts in big data; work on applied research projects with government agencies and local and international companies to develop high-impact opportunities for students
- consider developing a biostatistics course with the College of Medicine

- ensure that the curriculum meets the American Statistical Association's Guidelines for Assessment and Instruction in Statistics Education college report recommendations
- evaluate the need for the P-exam exit requirement
- examine the failure and withdrawal rate in relevant course and consider pedagogical changes
- work with appropriate units to improve the collection of alumni information including information on placement and employer satisfaction

### **Statistical Computing, M.S. (27.0501)**

#### Major Changes since Prior Review

- created two market-rate-tuition master's degree programs in conjunction with the College of Business Administration and the College of Engineering and Computer Science to meet industry demand for training in business and data analytics
- hired new faculty members to help support the data-mining track
- hired a new department chair
- developed a partnership with Capital University of Economics and Business in Beijing, China

#### Strengths

- dedicated faculty members
- collegial departmental atmosphere
- national reputation for excellence in data mining
- strong connections to businesses in Central Florida

#### Weaknesses

- assessment includes only course performance metrics and does not consider preparation for employment or further study
- limited exposure to research
- high attrition rate
- exposure to limited number of statistical software packages
- inadequate space

#### Recommendations

- explore ways to increase research opportunities for students
- work with appropriate offices to identify reasons for student attrition, and then develop and implement a retention plan (e.g., assure students follow a plan of study)
- collect feedback from alumni and employers to inform the assessment of program effectiveness
- review the curriculum and update it as appropriate
- consider the relationship of the master's degree program with the planned doctoral degree program
- explore options to meet space needs



## **Appendix J: Academic Learning Compact**

## Academic Learning Compact

### Data Science – B.S.

#### Discipline Specific Knowledge, Skills, Behavior and Values

1. Students will demonstrate an understanding of probability and distribution theory
2. Students will demonstrate an understanding of data structures
3. Students will identify and employ statistical methods for the analysis of data
4. Students will identify and employ mathematical techniques for the analysis of data.
5. Students will identify and employ techniques of computer science for the analysis of data.
6. Students will design appropriate and effective methodologies for the analysis of large data sets
7. Students will effectively communicate data analysis recommendations in written reports.
8. Students will effectively communicate data analysis recommendations through oral reports.
9. Students will demonstrate the ability to effectively deliver data analysis reports.

#### Critical Thinking

1. Students will master appropriate mathematical methods to address issues in data analysis
2. Students will master appropriate statistical methods to address issues in data analysis
3. Students will master appropriate computer methods to address issues in data analysis.
4. Students will design, implement and evaluate methods of data science on large data sets.
5. Students will evaluate the merits of different methods of analysis on a data set and design a method of analysis that addresses the issues of the data set.

#### Communication

1. Students will effectively communicate data analysis recommendations in written reports.
2. Students will effectively communicate data analysis recommendations through oral reports.
3. Students will demonstrate the ability to effectively deliver data analysis reports to audiences of varied technical background.

#### Assessment of Data Science – B.S. Outcomes

The learning outcomes for the Data Science –B.S. program will be assessed by using a variety of assessment instruments including

- examinations, and tests,
- projects,
- presentations.

## **Appendix K: Data Science B.S. Catalog Copy**

## Data Sciences (B.S.)

### College of Sciences

Department of Statistics and Data Science; Department of Mathematics

<https://sciences.ucf.edu/statistics>

<https://sciences.ucf.edu/math/>

### College of Engineering and Computer Science

Department of Computer Sciences; Department of Industrial Engineering and Management Sciences

<https://www.cs.ucf.edu/>

<http://www.iems.ucf.edu/>

### Program Administration

Dr. Morgan Wang

Email: Chung-Ching.Wang@ucf.edu

Phone: 407/823-2818

## Description

Data Science is an emerging discipline that seeks to infer insights from large amounts of data (“big data”) by using various statistical techniques and algorithms. The discipline is concerned with both statistical techniques that measure the validity of such insights and with computational techniques for managing data and resources efficiently.

The Data Science B.S. is an interdisciplinary degree that is offered jointly by the departments of Computer Science, Statistics and Data Science, Mathematics, and Industrial Engineering and Management Systems. This program emphasizes the technical aspects of big data analytics, including algorithm design, programming, acquisition, management, mining, analysis, and interpretation of data. This program aims to train students to develop algorithms and computerized systems to facilitate the discovery of information from big data.

In addition to preparing graduates for immediate entry into careers and the job market, graduates of this program may also go on to pursue advanced degrees, such the UCF M.S. in Data Analytics program or a related MS degree, or a Ph.D. program in Computer Science, Statistics and Data Science or a related area, and graduates may also seek professional distinction.

## Admission Requirements

- None

## Degree Requirements

- Students who change degree programs and select this major must adopt the most current catalog.

- With the exception of the Capstone course, co-op or internship credit cannot be used in this major. Students should consult with a departmental advisor.
- All prerequisites of courses taught within the College of Sciences and the College of Engineering and Computer Science will be enforced.
- Courses designated in the General Education Program (with the exception of prerequisite courses) may be spread over 4 years, and those designated in the Common Program Prerequisites section must be completed within the first 60 hours.
- Students must earn at least a "C" (2.0) in each advanced core required course for the major.
- Students must achieve a minimum cumulative GPA of 2.0 in all courses satisfying major requirements. Data Science students must have continual access to a computer. Contact the UCF Technology Product Center or see the website (<http://www.cstore.ucf.edu>) for the minimum hardware and software specifications.

### **General Education Program (GEP) (39 Credit Hours)**

- Certain courses must be selected in the GEP for this major bringing the total hours to more than 36.
- At least one course completed in each Foundation area must be a designated State General Education Core Course.

### **Communication Foundations (9 Credit Hours)**

- ENC 1101 - Freshman Composition 1 Credit Hours 3 (Required)
- ENC1102 - Freshman Composition II Credit Hours 3 (Required)
- Select one course from Area 3 Credit Hours 3

### **Cultural & Historical Foundations (9 Credit Hours)**

#### **Mathematical Foundations (7 Credit Hours)**

- MAC 2311C - Calculus with Analytic Geometry I Credit Hours: 4 (Required)
- STA 2023 - Statistical Methods I Credit Hours: 3 (Required)

#### **Social Foundations (6 Credit Hours)**

#### **Science Foundations (8 Credit Hours)**

- BSC 2010C - Biology I Credit Hours: 4 (Required)

Select one:

- CHM 2045C - Chemistry Fundamentals I Credit Hours: 4
- PHY 2048C - General Physics with Calculus I Credit Hours: 4

#### **Common Program Prerequisites (CPP) (11 Credit Hours)**

- BSC 2010 - General Biology Credit Hours: (GEP)
- COP 3223 - Introduction to Programming with C Credit Hours: 3
- MAC 2311C - Calculus with Analytic Geometry I Credit Hours: (GEP)
- MAC 2312 - Calculus with Analytic Geometry II Credit Hours: 4
- MAC 2313 - Calculus with Analytic Geometry III Credit Hours: 4
- STA 2023 - Statistical Methods I Credit Hours: (GEP)

Select One:

- CHM 2045 - Chemistry Fundamentals I Credit Hours: (GEP)
- PHY 2048 - General Physics with Calculus I Credit Hours: (GEP)

### Core Requirements: Basic Level

The basic core is fulfilled by GEP and CPP course completion.

- BSC 2010 - General Biology Credit Hours: (GEP)
- COP 3223 - Introduction to Programming with C Credit Hours: (CPP)
- MAC 2311C - Calculus with Analytic Geometry I Credit Hours: (GEP)
- MAC 2312 - Calculus with Analytic Geometry II Credit Hours: (CPP)
- MAC 2313 - Calculus with Analytic Geometry III Credit Hours: (CPP)
- STA 2023 - Statistical Methods I Credit Hours: (GEP)

Select One:

- CHM 2045 - Chemistry Fundamentals I Credit Hours: (GEP)
- PHY 2048 - General Physics with Calculus I Credit Hours: (GEP)

### Core Requirements: Advanced Level (49 Credit Hours)

Complete all of the following courses:

- COP 3502C - Computer Science I Credit Hours: 3
- COP 4283 - Programming for Scientists Credit Hours: 3
- ISC 4241 - Data Science I Credit Hours: 3
- ISC 4242 - Data Science II Credit Hours: 3
- ISC 4301 - Predictive Analytics Credit Hours: 3
- ISC 4401 - Data Management Technology Credit Hours: 3
- ISC 4501 - Data Graphics and Visualization Credit Hours: 3
- ISC 4701 - Praxis in Data Analysis Credit Hours: 3
- MAS 3105 - Matrix and Linear Algebra Credit Hours: 4
- STA 4038 - Statistical Foundations of Data Science and Artificial Intelligence I Credit Hours: 3
- STA 4039 - Statistical Foundations of Data Science and Artificial Intelligence II Credit Hours: 3
- STA 4163 - Statistical Methods II Credit Hours: 3
- STA 4164 - Statistical Methods III Credit Hours: 3
- STA 4724 - Big Data Analysis Methods Credit Hours: 3

**Select One:**

- COT 3100C - Introduction to Discrete Structures Credit Hours: 3
- MHF 3302 - Logic and Proof in Mathematics Credit Hours: 3

**Select One:**

- CAP 4670 Algorithms for Machine Learning Credit Hours: 3
- ESI 4312 Deterministic Methods for Operations Research Credit Hours: 3
- MAP 4447 Mathematical Aspects of Machine Learning and Artificial Intelligence Credit Hours: 3
- STA 4241 Statistical Learning Credit Hours: 3

### **Electives (21 Credit Hours)**

- Select primarily from upper level courses after meeting with a departmental advisor. Courses may be selected from among those courses not completed within the advanced core or outside the participating departments.

### **Capstone Requirements**

- ISC 4701 - Praxis in Data Analysis (Adv Core)

### **Foreign Language Requirements**

#### **Admissions**

- Two years high school, or one year college language (or equivalent proficiency exam) prior to graduation.

#### **Graduation**

- None

### **Additional Requirements**

- None

### **Required Minors**

- None

### **Departmental Exit Requirements**

- All students will complete an exit interview.
- Students must earn at least a "C" (2.0) in each advanced core required course for the major.
- Students must achieve a minimum cumulative GPA of 2.0 in all courses satisfying major requirements.

### **University Minimum Exit Requirements**

- A 2.0 UCF GPA
- 48 semester hours of upper division credit completed
- 30 of the last 39 hours of coursework must be completed in residency at UCF.
- A maximum of 45 hours of extension, correspondence, CLEP, Credit by Exam, and Armed Forces credits permitted.
- Complete the General Education Program, the Gordon Rule, and nine hours of Summer credit.

**Total Undergraduate Credit Hours Required: 120**

### **Additional Information**

#### **Honors In Major**

- Application and admissions through The Burnett Honors College. More information about Honors in the Major can be found at [honors.ucf.edu/research](http://honors.ucf.edu/research).

**Related Programs**

- Actuarial Science (B.S.)
- Computer Science (B.S.)
- Industrial Engineering (B.S.)
- Mathematics (B.S.)
- Statistics (B.S.)

**Certificates**

- None

**Related Minors**

- Actuarial Science Minor
- Business Minor
- Computer Science Minor
- Economics Minor
- Information Technology Minor
- Leadership Studies Minor
- Mathematics Minor
- Secure Computing and Networks Minor
- Statistics Minor
- Technological Entrepreneurship Minor

**Advising Notes**

- It is the student's responsibility to ensure they have satisfied course prerequisites before registering for a class. Students should consult with a program advisor.
- Contact your college advisor in the College of Sciences Advising Services (COSAS) office (CSB 250) for more information about overall progress toward your degree, GEP and other university requirements, academic probation, special problems as well as general academic advising.

**Transfer Notes**

- Lower division courses do not substitute for upper division courses.
- Courses transferred from private and out-of-state schools must be evaluated for equivalency credit. The student must provide all supporting information.
- Submit your requests for College of Sciences course evaluations at <https://sciences.ucf.edu/cosas/> and click on "COS Course Evaluation".
- Courses transferred for equivalency to courses in the College of Engineering and Computer Science must be formally evaluated for equivalency by the relevant department.

**Acceptable Substitutes for Transfer Courses**

The following substitutions are acceptable for Common Program Prerequisites if taken as part of the AA course work:

- Any COP programming language course will satisfy the CPP. However, COP 3223C (Introduction to Programming with C) is a prerequisite for Computer Science courses and still needs to be taken.
- COP2220 (C Programming) will be substituted for COP3223.



### **Program Academic Learning Compacts**

- Program Academic Learning Compacts (student learning outcomes) for undergraduate programs are located at: [http://www.oas.ucf.edu/alc/academic\\_learning\\_compacts.htm](http://www.oas.ucf.edu/alc/academic_learning_compacts.htm)

### **Plan of Study**

- This is one of numerous possible plans of study. See program description for all requirements.
- Consult the program director for alternate, new or more appropriate selections.
- Use your Pegasus Path planning tool in your myUCF portal to plan your courses through to graduation.
- Prior to enrolling in Chemistry, take Chemistry Placement Test ~ <https://www.sdes.ucf.edu/placement-tests/>
- Prior to enrolling in Math, take Math Placement Test ~ <https://www.sdes.ucf.edu/placement-tests/>
- Although all classes are listed as being taken during the academic year, you may be required to complete 9 hours of them during the Summer. Consult with an advisor to determine if you are exempt.

### **Freshman Year - Fall (16 Credit Hours)**

- ENC 1101 - Composition I Credit Hours: 3
- MAC 2311C - Calculus with Analytic Geometry I Credit Hours: 4
- SPC 1608 - Fundamentals of Oral Communication Credit Hours: 3
- GEP Cultural/Historical Foundation, Area 1 Credit Hours: 3
- GEP Social Foundation, Area 1 Credit Hours: 3

### **Freshman Year - Spring (16 Credit Hours)**

- ENC 1102 - Composition II Credit Hours: 3
- MAC 2312 - Calculus with Analytic Geometry II Credit Hours: 4
- GEP Cultural/Historical Foundation, Area 2 Credit Hours: 3
- GEP Cultural/Historical Foundation, Area 3 Credit Hours: 3
- GEP Social Foundation, Area 2 Credit Hours: 3

### **Sophomore Year - Fall (15 Credit Hours)**

- BSC 2010C - Biology I Credit Hours: 4
- MAC 2313 - Calculus with Analytic Geometry III Credit Hours: 4
- PHY 2048C - General Physics Using Calculus I Credit Hours: 4
- STA 2023 - Statistical Methods I Credit Hours: 3

### **Sophomore Year - Spring (13 Credit Hours)**

- COP 3223C - Introduction to Programming with C Credit Hours: 3
- MAS 3105 - Matrix and Linear Algebra Credit Hours: 4
- STA 4163 - Statistical Methods II Credit Hours: 3
- Select One:
  - COT 3100C - Introduction to Discrete Structures Credit Hours: 3

- MHF 3302 - Logic and Proof in Mathematics Credit Hours: 3

**Junior Year - Fall (15 Credit Hours)**

- COP 3502C - Computer Science I Credit Hours: 3
- ISC 4241 - Data Science I Credit Hours: 3
- STA 4038 - Statistical Foundations of Data Science and Artificial Intelligence I Credit Hours: 3
- STA 4164 - Statistical Methods III Credit Hours: 3
- Select One:
  - CAP 4670 Algorithms for Machine Learning Credit Hours: 3
  - ESI 4312 - Deterministic Methods for Operations Research Credit Hours: 3
  - MAP 4447 - Mathematical Aspects of Machine Learning and Artificial Intelligence Credit Hours: 3
  - STA 4241 - Statistical Learning Credit Hours: 3

**Junior Year - Spring (15 Credit Hours)**

- COP 4283 - Programming for Scientists Credit Hours: 3
- ISC 4242 - Data Science II Credit Hours: 3
- STA 4039 - Statistical Foundations of Data Science and Artificial Intelligence II Credit Hours: 3
- Elective 1 Credit Hours: 3
- Elective 2 Credit Hours: 3

**Senior Year - Fall (16 Credit Hours)**

- ISC 4301 - Predictive Analytics Credit Hours: 3
- ISC 4401 - Data Management Technology Credit Hours: 3
- ISC 4501 - Data Graphics and Visualization Credit Hours: 3
- STA 4724 - Big Data Analytics Methods Credit Hours: 4
- Elective 3 Credit Hours: 3

**Senior Year - Spring (15 Credit Hours)**

- ISC 4701 - Praxis in Data Science Credit Hours: 3
- Elective 4 Credit Hours: 3
- Elective 5 Credit Hours: 3
- Elective 6 Credit Hours: 3
- Elective 7 Credit Hours: 3

## **Appendix L: New Course Syllabi**

CAP 4670

COP 4283

ISC 4241

ISC 4242

ISC 4401

ISC 4501

ISC 4701

MAP 4447

STA 4038

STA 4039

## **CAP 4670: Algorithms for Machine Learning**

**Instructor:** Machine Learning and AI Technical Research Area Committee (Gita Sukthankar)

**Credit Hours:** 3.0

**Prerequisite(s):** COP 3503C and STA 2023 each with a grade of “C” (2.0) or better

**Corequisite(s):** None.

### **Course Description**

Machine learning is the study of algorithms that allow computer programs to learn from experience. This course will provide an overview of the most commonly used algorithms for supervised, unsupervised, and reinforcement learning, along with an introduction to experimental design, evaluation metrics, and applications of machine learning.

### **Student Learning Outcomes**

- Learn the most commonly used algorithms for supervised and unsupervised learning algorithm
- How to compare the performance of machine learning algorithms
- Application of machine learning to practical problems

### **Grading Scheme**

Homework: Machine Learning Implementation/Evaluation

Three homeworks (15%) each:

Code plus written summary of results

- k Nearest Neighbor
- Neural Network: Autoencoder
- Reinforcement Learning

Midterm Exam (25%)

In class exam with math problems and short answer questions

Final Group Project (30%): Application of Machine Learning

Presentation and written report comparing the performance of existing machine learning algorithms on a standard dataset

### **Textbook (optional)**

Machine Learning: An Algorithmic Perspective (2nd ed), Stephen Marsland

### **Topics**

1. Introduction to Machine Learning
2. Experimental Design; Usage of Testing, Training and Validation Sets and Evaluation Metrics (Accuracy, ROC Curve Precision/Recall)

3. Supervised Learning
  - a. K Nearest Neighbor
  - b. Probabilities: Naive Bayes
  - c. Linear and Logistic Regression
  - d. Kernel Methods: Support Vector Machines
  - e. Neural Networks
  - f. Decision Trees
  - g. Ensemble Learning
4. Unsupervised Learning
  - a. Principal Components Analysis (PCA)
  - b. K-Means Clustering
5. Reinforcement Learning
  - a. Q-Learning
6. Applications

# COP4283 – Programming for Scientists

**Textbook** (Recommended) Python for data analysis: Data wrangling with Pandas, NumPy, and IPython, Wes McKinney, 2017, O'Reilly Media, Inc.  
(Recommended) SAS and R: Data management, statistical analysis, and graphics, Nicholas J Horton and Ken Kleinman, 2014, Chapman and Hall/CRC  
(Recommended) Data Science with Julia, Paul D. McNicholas and Peter Tait, 2019, Chapman and Hall/CRC

**Instructor** Dr. Liqiang Wang Office: HEC 437E  
Office Hours: TBD E-Mail: [Liqiang.wang@ucf.edu](mailto:Liqiang.wang@ucf.edu)

**Prerequisites** COP 3223C

## Catalog Description

3(3,0) Programming for data processing and analytics, including languages and platforms used in science such as SAS, R, Julia, and Python. Intensive coding projects.

## Course Goal and Topics

Programming is becoming an essential skill for data scientists. This course introduces practical programming about data processing and analytics for students majored in data science. We will cover major programming languages and platforms widely used in data science, which include SAS, R, Julia and Python. Programming and project assignments are based on analytical tasks that might be faced by data scientists. The course will include four major modules: (1) SAS and R introduction and core skills; (2) Python for data analysis; (3) Data science with Julia; (4) Problem solving skills. The course emphasizes hands-on training with essential data processing, analysis, and computing techniques, and problem solving skills. Intensive coding and project assignments will be involved in this course.

**Learning Outcomes** Through this course, students are required to master essential programming skills for data science, and should be able to design efficient and robust programs to handle real-world problems.

**Assignments** Assignments will be posted on [Webcourses@UCF](mailto:Webcourses@UCF) and announced in class. Assignments should be finished individually if without specific team-work requirement. Late submission will have a penalty of 10% per day.

**Projects** A course project will be posted on [Webcourses@UCF](mailto:Webcourses@UCF) and announced in class in the middle of the semester. The project will encourage you to design a practical application on cloud computing platforms.

**Exceptions** In general, I will not accept make-up tests. I may make exceptions before the assignment due date or test date only in well-documented extreme circumstances.

**Attendance** Class attendance is required, and accounts for 5% in your final score.

**Grading** Grades will be based on the percentage listed below and a curve at the end of the semester. A plus or minus grade will be used. I may adjust the grade scale in the class's favor.

Assignments	45%
Project	15%
Comprehensive Exam	35%
Attendance	5%

**Ethics** As reflected in the UCF creed, integrity and scholarship are core values that should guide our conduct and decisions as members of the UCF community. Plagiarism and cheating contradict these values, and so are very serious academic offenses. Penalties can include a failing grade in an assignment or in the course, or suspension or expulsion from the university. Students are expected to familiarize themselves with and follow the University's Rules of Conduct (see <http://www.osc.sdes.ucf.edu/>).

**Disabilities** The University of Central Florida is committed to providing reasonable accommodations for all persons with disabilities. If you need accommodation, you must register with Student Accessibility Services in the Student Resource Center (phone number 407-823-2371, TTY/TDD number 407-823-2116). SAS will work with you to set up your accommodation, and you can either inform me of your request directly or allow them to.

**Copyright** This course may contain copyright protected materials such as audio or video clips, images, text materials, etc. These items are used with regard to the Fair Use doctrine in order to enhance the learning environment. Please do not copy, duplicate, download or distribute these items. The use of these materials is strictly reserved for this online classroom environment and your use only. All copyright materials are credited to the copyright holder.

**Revision** I may revise any aspect of this syllabus at any time.

## Course Schedule

Week 1: Introduction to Jupiter Notebook programming platform and Github

Week 2: Data input, output, and management in R and SAS.

Week 3: Essential statistical and math functions in R and SAS

Week 4: Common statistical procedures and Programming interfaces in R and SAS

Week 5: Visualization in R and SAS

Week 6: Python data structures, functions, and files

Week 7: NumPy Basics

Week 8: Data Operation

Week 9: Visualization in Python

Week 10: Data Analytics Case Studies in Python

Week 11: Core Julia Structures

Week 12: I/O and Paralleling Computing with Julia

Week 13: Julia Visualization Package and other libraries

Week 14: Project presentation

Week 15: Final exam





ISC 4241  
Data Science I  
Day(s), Time,  
Place

Professor Name                      GTA:  
  
em@il address @ucf.edu              em@il address  
@ucf.edu      Webcourses@UCF  
Office Location TC II                      Office  
Location TC II Office Hours: TBD              Office  
Hours: TBD Office Phone: (407) 823-0000

**Course Description:** An introductory study of the basic tools, theory and practice of Data Science:

- Data Science technical tools: Python R SQL
- Data collection, Data Preparation, Cleaning
- Data exploration
- Statistical modeling and hypothesis testing
- Making inference on data (regression, classification, and clustering)
- Scaling up analytics with MapReduce, Hadoop and Spark
- Data visualization, and communication/interpretation of results.

**Prerequisite(s):** MAC 2313, STA 2023, COP 3502, and COP 3503. Knowledge of Python and R will be useful for the assignments.

**Credit Hours:** 3

**Text(s):** *Doing Data Science* by Cathy O’Neil and Rachel Schutt; ISBN-13: 978-1-4493-5865-5  
*Python for Data Analysis*, 2nd Edition by Wes McKinney; ISBN-13: 978-1-4919-5766-0

**Course Objectives:**

This course is an introduction of the methods, tools and applications of Data Science. This course explores the rapidly developing field of Data Science in the context of its applications. After completion of this course, Students will be prepared to take more advanced courses in Data Science. **Student**

**Learning Outcomes:**

At the completion of this course, through course assignments, labs and examinations students will:

1. Gain experience in using Python and R to address problems in Data Science
2. Gain experience in using SQL to address problems in Data Science
3. Gain experience in using Hadoop, Spark and MapReduce to address problems in Data Science

4. Gain understanding the role of Machine Learning Fundamentals in Data Analytics
5. Gain experience in methods and procedures for developing models for Data Science
6. Gain understanding of Privacy and Data Security in Data Science
7. Gain experience in use of graphics in data science
8. Gain experience in presenting data science results to end users.

**Grade Distribution:**

Class Participation and labs:	20%
Assignments	30%
Quizzes	5%
Midterm Exam	20%
Final Project (in groups):	25%
'Bonus'	5%

**Letter Grade Distribution:**

$\geq 93.00$	A	73.00 - 76.99	C
90.00 - 92.99	A-	70.00 - 72.99	C-
87.00 - 89.99	B+	67.00 - 69.99	D+
83.00 - 86.99	B	63.00 - 66.99	D
80.00 - 82.99	B-	60.00 - 62.99	D-
77.00 - 79.99	C+	$\leq 59.99$	F

**Course Policies:**

- **General**

- Quizzes and exams are closed book, closed notes.
- **No makeup quizzes or exams will be given.**

- **Grades**

- Grades in the **C** range represent performance that **meets expectations**; Grades in the **B** range represent performance that is **substantially better** than the expectations; Grades in the **A** range represent work that is **excellent**.
- Grades will be maintained in the Webcourses@UCF. Students are responsible for tracking their progress by referring to the online gradebook.

- **Labs and Assignments**

- Students are expected to work independently. **Offering** and **accepting** solutions from others is an act of **plagiarism**, which is a serious offense and **all involved parties will be penalized according to the Academic Honesty Policy**. Discussion amongst students is encouraged, but when in doubt, direct your questions to the professor, or GTA.
- **No late assignments will be accepted under any circumstances.**

- **Attendance and Absences**

- Attendance is expected and will be taken each class. You are allowed to miss **1** class during the semester without penalty. Any further absences will result in point and/or grade deductions.

- Students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.

### **STUDENT ASSESSIBILITY SERVICES (SAS):**

Statements taken from SAS website: The University of Central Florida considers the diversity of its students, faculty, and staff to be a strength and critical to its educational mission. UCF expects every member of the university community to contribute to an inclusive and respectful culture for all in its classrooms, work environments, and at campus events. Dimensions of diversity can include sex, race, age, national origin, ethnicity, gender identity and expression, intellectual and physical ability, sexual orientation, income, faith and non-faith perspectives, socio-economic class, political ideology, education, primary language, family status, military experience, political beliefs, cognitive style, and communication style. The individual intersection of these experiences and characteristics must be valued in our community.

Title IX prohibits sex discrimination, including sexual misconduct, sexual violence, sexual harassment, and retaliation. If you or someone you know has been harassed or assaulted, you can find resources available to support the victim, including confidential resources and information concerning reporting options at [www.shield.ucf.edu](http://www.shield.ucf.edu)

If there are aspects of the design, instruction, and/or experiences within this course that result in barriers to your inclusion or accurate assessment of achievement, please notify the instructor as soon as possible and/or contact Student Accessibility Services.

For more information on diversity and inclusion, Title IX, accessibility, or UCF's complaint processes contact:

- Title IX EO/AA- <http://www.eeo.ucf.edu/> and [askanadvocate@ucf.edu](mailto:askanadvocate@ucf.edu);
- Disability Accommodation Student Accessibility Services- <http://sas.sdes.ucf.edu/> and [sas@ucf.edu](mailto:sas@ucf.edu);
- Diversity and Inclusion Training and Events- [www.diversity.ucf.edu](http://www.diversity.ucf.edu);
- Students Bias Grievances Just Knights response team- <http://jkrt.sdes.ucf.edu/>;
- UCF Compliance and Ethics Office-<http://compliance.ucf.edu/>, [complianceandethics@ucf.edu](mailto:complianceandethics@ucf.edu);
- Ombuds Office- <http://www.ombuds.ucf.edu>.

### **ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES**

Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the UCF's goal to provide flexible and individualized accommodation to students with disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students should contact the Student Accessibility Services office, Ferrell Commons 185, 407-823-2371.

### **ACADEMIC INTEGRITY POLICY**

UCF is committed to a policy that entitles honesty in academic affairs. Any conduct that comprises a breach of this policy shall result in academic and/or disciplinary action which affects students' grades and enrollment status. All students should be familiar with the following definitions and should comply with the UCF policy. Cheating: non-permissible use of written, visual, or oral assistance including but not limited to that obtained from another student. Unauthorized possession/use of examination or course related material may also constitute cheating. Plagiarism: another's work is deliberately used or appropriated without any indication of the original source,

thereby attempting to convey the impression that such work is the students own. Any student failing to properly credit ideas or materials from another student or source has plagiarized. Similarly, a student who has assisted another student in any of the aforementioned breach of standards shall be considered equally culpable.

Zero-tolerance policy: any violation of honor codes (e.g., cheating in hws, projects, tests, etc) will result in an automatic F in this class.

### **UCF Financial Aid Requirement and Academic Engagement Assignment**

All instructors/faculty are required to document students academic activity at the beginning of each course. In order to document that you began this course, please complete the following academic activity by the end of the first week of classes or as soon as possible after adding the course. Failure to do so may result in a delay in the disbursement of your financial aid.

### **Campus Safety Statement**

Emergencies on campus are rare, but if one should arise in our class, we will all need to work together. Everyone should be aware of the surroundings and familiar with some basic safety and security concepts.

- In case of an emergency, dial 911 for assistance.
- Every UCF classroom contains an emergency procedure guide posted on a wall near the door. Online version at [http://emergency.ucf.edu/emergency\\_guide.html](http://emergency.ucf.edu/emergency_guide.html).
- If there is a medical emergency during class, we may need to access a first aid kit or AED (Automated External Defibrillator).
- To stay informed about emergency situations, sign up to receive UCF text alerts by going to [my.ucf.edu](http://my.ucf.edu) and logging in. Click on Student Self Service located on the left side of the screen in the tool bar, scroll down to the blue Personal Information heading on your Student Center screen, click on UCF Alert, fill out the information, including your e-mail address, cell phone number, and cell phone provider, click Apply to save the changes, and then click OK.
- If you have a special need related to emergency situations, please speak with me during office hours.
- Consider viewing this video (<https://youtu.be/NIKYajEx4pk>) about how to manage an active shooter.

**Deployed Active Duty Military.** If you are a deployed active duty military student and feel that you may need a special accommodation due to that unique status, please contact your instructor to discuss your circumstances.

### **Data for Research Disclosure:**

Any and all results of in-class and out-of-class assignments and examinations are data sources for research and may be used in published research. All such use will always be anonymous.

**Tentative Course Outline:**

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments.

<b>Week</b>	<b>Content</b>
Week 1	<ul style="list-style-type: none"><li>• Introduction/Data Science Process</li></ul>
Week 2	<ul style="list-style-type: none"><li>• Data Preparation</li></ul>
Week 3	<ul style="list-style-type: none"><li>• Tabular Data: SQL</li></ul>
Week 4	<ul style="list-style-type: none"><li>• Data Science with Python and R</li></ul>
Week 5	<ul style="list-style-type: none"><li>• Data Cleaning and Integration</li></ul>
Week 6	<ul style="list-style-type: none"><li>• Exploratory Data Analysis</li></ul>
Week 7	<ul style="list-style-type: none"><li>• Probability and Statistics - The Science of Uncertainty and Data</li></ul>
Week 8	<ul style="list-style-type: none"><li>• kNN, Linear Regression, k-Means</li></ul>
Week 9	<ul style="list-style-type: none"><li>• Naive Bayes, Logistic Regression, Trees and Forests</li></ul>
Week 10	<ul style="list-style-type: none"><li>• Algorithms</li></ul>
Week 11	<ul style="list-style-type: none"><li>• Scaling Up Analytics: MapReduce, Hadoop and Spark</li></ul>
Week 12	<ul style="list-style-type: none"><li>• Visualization</li></ul>
Week 13	<ul style="list-style-type: none"><li>• Privacy and Data Security</li></ul>
Week 14	<ul style="list-style-type: none"><li>• Final Project Presentations</li></ul>
Week 15	<ul style="list-style-type: none"><li>• Final Project Presentations</li></ul>

**ISC 4242 3(3,0)**  
**SPRING 2021**

DATA SCIENCE 2

**Instructor Information.**

- **Name:** Luis Rabelo
- **Office:** Eng. 2, 417
- **Office Hours:** 8:00-10:00 TR.
- **Telephone:** 407.823.2710
- **e-mail:** [luis.rabelo@ucf.edu](mailto:luis.rabelo@ucf.edu) [use the subject line 'ISC XXXX' in the e-mail]

**Course Description.** Advanced methods for data visualization, modeling, and prediction. Big data and database management, basic Bayesian methods, nonlinear models, and unsupervised and supervised learning. Practice with problems from the industrial and complex domains using R and Python.

**Course Goals.** This course will provide advanced concepts and methodologies in Data Science. Students will demonstrate their ability to work in teams with assignments and a final project that require these advanced concepts and methodologies.

**Prerequisite.** The prerequisite for this course is ISC3201 (Data Science 1) with a grade of C(2.0) or better, or consent of instructor.

**Textbook.** An Introduction to Statistical Learning: with Applications in R (Springer Texts in Statistics) 1st ed. 2013, Corr. 7th printing 2017 Edition by Gareth James (Author), Daniela Witten (Author), Trevor Hastie (Author), Robert Tibshirani (Author)

Handouts, PowerPoint presentations, homework, and midterms will be posted on Webcourses.

**Course Requirements and Student Evaluation.**

**Grade Distribution:**

Class Participation and attendance	10%
Assignments	30%
Quizzes	10%
Midterm Exam	25%
Final Project (in groups):	25%

**Letter Grade Distribution:**

$\geq 93.00$	A	73.00 - 76.99	C
90.00 - 92.99	A-	70.00 - 72.99	C-
87.00 - 89.99	B+	67.00 - 69.99	D+
83.00 - 86.99	B	63.00 - 66.99	D
80.00 - 82.99	B-	60.00 - 62.99	D-
77.00 - 79.99	C+	$\leq 59.99$	F

**Midterm.** One midterm exam will cover material from lectures, assigned readings, and homework assignments. The midterm will be open-book.

**Final project.** Students in this course will be assigned to 4-5 person teams. Each team will prepare a report on an assigned analysis of a data set using methods techniques and procedures taught in Data Science 1 and 2.

**Course Attendance.** Attendance in all sessions of this course is mandatory.

**Make-up exams.** Make-up examinations will only be given upon prior arrangement with the instructor in those cases of students that meet the criteria established in University policy for those students who are absent while representing the University while observing a religious holy day, or absent due to court-imposed legal obligations.

**Recording Academic Activity.** All faculty members are required to document students' academic activity at the beginning of each course. To document that you began this course, please complete the registration validation quiz by the end of the first week of classes. Failure to do so will result in a delay in the disbursement of your financial aid.

**Ethics Statement.** UCF faculty support the UCF Creed. Integrity - practicing and defending academic and personal honesty - is the first tenet of the UCF Creed. This is, in part a reflection of the second tenet, Scholarship: - I will cherish and honor learning as a fundamental purpose of membership in the UCF community. - Course assignments and tests are designed to have educational value; the process of preparing for and completing these exercises will help improve your skills and knowledge. Material presented to satisfy course requirements is therefore expected to be the result of your original scholarly efforts.

Plagiarism and cheating - presenting another's ideas, arguments, words, or images as your own, using unauthorized material, or giving or accepting unauthorized help on assignments or tests - contradict the educational value of these exercises. Students who attempt to obtain unearned academic credentials that do not reflect their skills and knowledge can also undermine the value of the UCF degrees earned by their more honest peers.

**Academic Integrity Statement.** The Academic Integrity/Plagiarism Statement elaborates on the line between seeking help from other sources or students, and cheating, and the consequences for plagiarism. This statement will help define your attitudes towards cheating and help clarify further student expectations in the class. The following is a sample Plagiarism Statement: Plagiarism and Cheating of any kind on an examination, quiz, or assignment will result at least in an "F" for that assignment (and may, depending on the severity of the case, lead to an "F" for the entire course) and may be subject to appropriate referral to the Office of Student Conduct for further action. See the UCF Golden Rule for further information. I will assume for this course that you will adhere to the academic creed of this University and will maintain the highest standards of academic integrity. In other words, don't cheat by giving answers to others or taking them from anyone else. I will also adhere to the highest standards of academic integrity, so please do not ask me to change (or



expect me to change) your grade illegitimately or to bend or break the rules for one person that will not apply to everyone.

**Accessibility Statement.** This class is an accessible and welcoming experience for all students, including those with disabilities that may impact learning in this class. If anyone believes the design of this course poses barriers to effectively participating and demonstrating learning in this course, please meet with me (with or without a Student Accessibility Services (SAS) accommodation letter) to discuss reasonable options or adjustments. During our discussion, I may suggest the possibility/necessity of your contacting SAS (Ferrell Commons 185; 407-823-2371; sas@ucf.edu) talk about academic accommodations. You are welcome to talk to me at any point in the semester about course design concerns, but it is always best if we can talk at least one week before the need for any modifications.

**Deployed Active Duty Military.** If you are a deployed active duty military student and feel that you may need special accommodation due to that unique status, please contact your instructor to discuss your circumstances.

**Disclaimer Statement.** This document is furnished for student information only. It is subject to change without previous announcement.

## Weekly schedule for ISC 4xxx Data Science 2

WEEK	TOPIC
I	Introduction and Course Survey
II	Advanced Methods for Data Visualizaton 1
III	Advanced Methods for Data Visualizaton 2
IV	Modeling and Prediction 1
V	Modeling and Prediction 2
VI	Supervised Learning 1
VII	Supervised Learning 2
VIII	Final Project Explanation and Assignment, Ethics in Data Science
IX	Midterm
X	Big Data 1
XI	Big Data 2
XII	Unsupervised Learning 1
XIII	Unsupervised Learning 2
XIV	Basic Bayesian
XV	Final Project Presentation

## ISC 4401 – Data Management Technology

**Course Description:** Storage and access Structures, database models and languages, database design, parallel and distributed database techniques, emerging data management technology.

*Fall*

**Prerequisite:** COP 3502C and COP 4283

**Objectives:** As more and more data are brought on-line for information dissemination and electronic commerce and ever more historical data are maintained for data analytics to enable data-driven decision making, data management becomes one of the largest and most vigorous market segments. The purpose of this course is to prepare students for working in fields that involve design and implementation of database systems for data intensive applications.

**Outcomes:**

- The student will have good understanding of database management systems, including parallel and distributed techniques for high-performance data-intensive applications.
- The student will have the knowledge to design and implement database systems.
- The student will have general awareness of emerging data management technology and applications

**Topics to be covered:** The goal of this course is to present an in-depth introduction to data management technology, with an emphasis on both database system design and high-performance computing technology for data intensive applications. The following topics will be discussed in this course:

- |                                      |                                       |
|--------------------------------------|---------------------------------------|
| ▪ Entity-Relationship Model          | ▪ Query Processing                    |
| ▪ Relational Data Model              | ▪ Parallel Database Techniques        |
| ▪ Structured Query Language (SQL)    | ▪ Distributed Database Techniques     |
| ▪ Schema Refinement and Normal Forms | ▪ Emerging Data Management Technology |
| ▪ File Organizations & Indexing      |                                       |

**Text:** Database Management Systems, 3<sup>rd</sup> edition  
by *Raghu Ramakrishnan* and *Johannes Gehrke*

Class notes on parallel and distributed database techniques, and emerging data management technology

## ICS 4501: Data Graphics and Visualization

Data is being generated at an ever-increasing rate in all fields. Data visualization provides the most effective way to help us understand this data and communicate it to others. Data graphic enables us to represent the data by charts and graphs to create the visualization. In this course the students will learn basics of the graphical representations and key principles of data visualization. Students will use R and GGPLOT2 to code and practice creating the visualization in class.

### Topics

- Visual presentations of Data.
- Principles of effective presentation.
- Ethics and best principles of data visualization.
- Hands-on practice with R and ggplot2:
  - Includes collection, processing and visual presentation of data.

### Prerequisites

Some programming knowledge is required.

Prior R programming knowledge will be useful, but not mandatory.

### Textbooks

The following two online books will be used in the class. As and when necessary supplementary online and printed material will be provided.

- [Data Visualization with R](#) (an opensource text book). 2018 edition. by Robert Ira Kobacoff
- Introduction to Data Science: Data Analysis and Prediction Algorithms with R (2019 edition). by Rafael A. Irizarry. CRC Press. ([online edition available](#))

### Evaluation

Students will be evaluated regularly with in-class quizzes and class assignments. Class assignment will be written R. There will be a final project.

Public domain data from diverse fields such as health, economics and science will be used in the assignments and projects.

**ISC 4701 4(4,0)  
SPRING 2021**

PRAXIS IN DATA SCIENCE

**Instructor Information.**

- **Name:** Luis Rabelo
- **Office:** Eng 2, 417
- **Office Hours:** 9:00-11:00 TR.
- **Telephone:** 407.882.0091
- **e-mail:** [Luis.Rabelo@ucf.edu](mailto:Luis.Rabelo@ucf.edu) [use the subject line 'DSI 4701' in the e-mail]

**Course Description.** This course will provide the means for students to demonstrate their ability to work in teams to address data science problems in industry, government, and the non-profit sector..

**Course Goals.** This course will provide the means for students to demonstrate their ability to work in teams to address a data project.

**Prerequisite.** The prerequisite for this course is COP4283, DSI4202, DSI4301, DSI 4401, DSI 4501, and STA 4724, all with grade of C(2.0) or better, and senior standing in the Data Science BS major, or consent of instructor.

**Textbook.** There is no required text for this course.

**Course Requirements and Student Evaluation.**

**Course project.** Students in this course will be assigned to 4-5 person teams. Each team will prepare a report on an assigned project of a data set using methods techniques and procedures developed in course work for the degree. These data sets are provided by industry. The grade for this course will be based on the oral presentation and written presentation of the final report. All students will be expected to participate in both the written and oral presentations of the report.

The oral presentation of the report will be graded out of 400 points.  
The written presentation of the report will be graded out of 400 points.

**Course Attendance.** Attendance in all sessions of this course is mandatory. Course attendance will be graded out of 200 points.

**Grading.** Grading will be according to the following schema:

Grade	Points
A	800 - 1001
B	700 - 799
C	600 - 699
D	500 - 5999
F	≤ 499

Plus and minus grading will not be utilized in this course.

This course is not authorized for a grade of NC and this grade is not available in this class.

**Make-up exams.** Make-up examinations will only be given upon prior arrangement with the instructor in those cases of students that meet the criteria established in University policy for those students who are absent while representing the University, while observing a religious holy day, or absent due to court-imposed legal obligations.

**Recording Academic Activity.** All faculty members are required to document students' academic activity at the beginning of each course. In order to document that you began this course, please complete the registration validation quiz by the end of the first week of classes. Failure to do so will result in a delay in the disbursement of your financial aid.

**Ethics Statement.** UCF faculty support the UCF Creed. Integrity - practicing and defending academic and personal honesty - is the first tenet of the UCF Creed. This is in part a reflection of the second tenet, Scholarship: - I will cherish and honor learning as a fundamental purpose of membership in the UCF community. - Course assignments and tests are designed to have educational value; the process of preparing for and completing these exercises will help improve your skills and knowledge. Material presented to satisfy course requirements is therefore expected to be the result of your own original scholarly efforts.

Plagiarism and cheating - presenting another's ideas, arguments, words or images as your own, using unauthorized material, or giving or accepting unauthorized help on assignments or tests - contradict the educational value of these exercises. Students who attempt to obtain unearned academic credentials that do not reflect their skills and knowledge can also undermine the value of the UCF degrees earned by their more honest peers.

**Academic Integrity Statement.** The Academic Integrity/Plagiarism Statement elaborates on the line between seeking help from other sources or students, and cheating, and the consequences for plagiarism. This statement will help define your attitudes towards cheating, and helps clarify further student expectations in the class. The following is a sample Plagiarism Statement:

Plagiarism and Cheating of any kind on an examination, quiz, or assignment will result at least in an "F" for that assignment (and may, depending on the severity of the case, lead to an "F" for the entire course) and may be subject to appropriate referral to the Office of Student Conduct for further action. See the UCF Golden Rule for further information. I will assume for this course that you will adhere to the academic creed of this University and will maintain the highest standards of academic integrity. In other words, don't cheat by giving answers to others or taking them from anyone else. I will also adhere to the highest standards of academic integrity, so please do not ask me to change (or expect me to change) your grade illegitimately or to bend or break rules for one person that will not apply to everyone.

**Accessibility Statement.** It is my goal that this class be an accessible and welcoming experience for all students, including those with disabilities that may impact learning in this class. If anyone believes the design of this course poses barriers to effectively participating and/or demonstrating learning in this course, please meet with me (with or without a Student Accessibility Services (SAS) accommodation letter) to discuss reasonable options or adjustments. During our discussion, I may suggest the possibility/necessity of your contacting SAS (Ferrell Commons 185; 407-823-2371; sas@ucf.edu) to talk about academic accommodations. You are welcome to talk to me at any point in the semester about course design concerns, but it is always best if we can talk at least one week prior to the need for any modifications.

**Deployed Active Duty Military.** If you are a deployed active duty military student and feel that you may need a special accommodation due to that unique status, please contact your instructor to discuss your circumstances.

**Disclaimer Statement.** This document is furnished for student information only. It is subject to change without previous announcement.

## Weekly schedule for ISC 4701

WEEK	TOPIC
I	Introduction and Course Survey
II	Project Assignment
III	Project Management for Data Science
IV	Leadership and Innovation in Data Science
V	Communicating Effectively and Ethical Issues in Data Science
VI	Proposal for Project
VII	Report Issues I
VII	Report Issues II
IX	Report Issues III
X	Project Review
XI	Oral Reports I
XII	Oral Reports II
XIII	Oral Reports III
XIV	Oral Reports IV
XV	Final Report and Presentation



**MAP 4447 SECTION 0001 3(3,0)  
FALL 2020**

MATHEMATICAL FOUNDATIONS OF MACHINE LEARNING AND ARTIFICIAL  
INTELLIGENCE

**Instructor Information.**

- **Name:** Teng Zhang
- **Office:** 202G MSB
- **Office Hours:** 09:00-10:30 TR
- **e-mail:** Teng.Zhang@ucf.edu [use the subject line 'MAP 4447' in the e-mail]

**Course Description.** Machine Learning, Artificial Intelligence, Expectation Maximization algorithm, Projections Principal Component Analysis, Mixture Models, Support Vector Machines, Kernel methods,

**Course Scope and Purpose.** This course addresses topics in artificial intelligence and machine learning from a mathematical perspective.

**Prerequisite and Co-requisite courses.** The prerequisite for this course is MAC 2313, and MAS 3105, or consent of instructor.

**Course Meeting.** This course is offered in the P (Face-to-Face) modality. Classroom attendance is expected. This course will meet 11:30am to 12:20pm Monday, Wednesday, and Friday prevailing local time in MSB 108.

**Student Learning Outcomes.**

1. Students will be able to demonstrate sufficient background in mathematics to study machine learning and artificial intelligence
2. Students will be able to make precise mathematics statements in machine learnings.
3. Students will be able to make precise statements in Artificial Intelligence.
4. Students will be able to solve problems using Expectation Maximization Algorithms
5. Students will be able to solve problems using projection mappings
6. Students will be able to solve problems using Principal Component Analysis
7. Students will be able to solve problems using mixture models
8. Students will be able to solve problems using the methods of Support Vector Machines

The Homework will assess outcomes 1, 2, 3, 4, 5 and 6. Midterm exam I will assess outcomes 1, 2, and 3. Midterm exam II will assess outcomes 4, 5, 6 and 7. The final exam will assess outcomes 1, 2, 3, 4, 5 6 and 7.

**Textbook.** The required text for this course is the book *Mathematics and Machine Learning* (seventh edition) by Marc Peter Deisenroth, A Aldo Faisal, and Cheng Soon Ong. It is published by the Cambridge University Press. The 13 digit ISBN for this book is 978-1108455145.

**Textbook Chapters.** We plan to consider Chapters 1 through 12 of the text

Chapter	Title
I	Introduction and Motivation
II	Linear Algebra
III	Analytic Geometry
IV	Matrix Decompositions
V	Vector Calculus
VI.	Probability and Distribution
VII	Continuous Optimization
VIII	When models meet data
IX	Chapter IX
X	Dimensionality reduction with Principal Component Analysis
XI	Chapter XI
XII	Classification with Support Vector Machines

### Course Requirements and Student Evaluation.

**Homework and Quizzes.** Homework assignments will be due at the end of weeks 2, 3, 4, 5, 6, 7, 9, 11, 13, 15.

Each homework quiz will count 25 points. This homework will be cumulatively worth 250 points

**Recording Academic Activity.** All faculty members are required to document students' academic activity at the beginning of each course. In order to document that you began this course, please complete the following academic activity by the end of the first week of classes, or as soon as possible after adding the course,. Failure to do so will result in a delay in the disbursement of your financial aid. The Academic Activity in this course is a quiz that is on Webcourses. Please access and complete this quiz as soon as possible. This quiz will be worth 1 point.

**Midterm Exams.** There will be two exams that will be given during the semester. Due to the nature of the course and the need to coordinate with other obligations the exams will be scheduled dynamically. These exams will be graded out of 250 points. These exams will be cumulatively worth 500 points.

**Final Examination.** There will be a Final Examination on Wednesday 09 December 2020 from 10:00 am to 12:50 pm prevailing local time. The exam will be graded out of 250 points. The final exam is a required part of the course. Failure to take the final exam will result in failure in the course.

**Grading.** Grading will be according to the following schema:

Grade	Points
<i>A</i>	800 – 1001
<i>B</i>	600 – 799
<i>C</i>	500 – 599
<i>D</i>	400 – 499
<i>F</i>	$\leq 399$

Plus and minus grading will not be utilized in this course.

This course is not authorized for a grade of NC and this grade is not available in this class.

**Make-up exams.** Make-up examinations will only be given upon prior arrangement with the instructor in those cases of students that meet the criteria established in University policy for those students who are absent while representing the University, while observing a religious holy day, or absent due to court-imposed legal obligations.

### Course schedule

WEEK	TOPIC	CHAPTER/SECTIONS
I	Course Introduction	I
II	Linear Algebra and Matrix Decompositions	II & IV
III	Analytic Geometry and Vector Analysis	III & V
IV	Probability and Distribution	§VI.1-4
V	Probability and Distribution	§VI.5-8
VI	Continuous Optimization	VII
VII	Models of Machine learning and AI	§VIII.1-3, Midterm Exam I
VIII	Models of Machine Learning and AI continued	§VIII.4-6
IX	Projections	IX
X	Dimension Reduction	§X.1-4
XI	Dimension Reduction continued	§X.5-7
XII	Mixture Models	§XII.1-3
XIII	Mixture Models continues	§XI.3, §XI.4
XIV	Support Vector Machines	§XII.1-XII.3
XV	Support Vector Machines continued	§XII.4, §XII.5 Midterm Exam 2

**Academic Integrity Statement.** Students should familiarize themselves with UCF's Rules of Conduct at <http://osc.sdes.ucf.edu/process/roc>

According to Section 1, "Academic Misconduct," students are prohibited from engaging in

1. Unauthorized assistance: Using or attempting to use unauthorized materials, information or study aids in any academic exercise unless specifically authorized by the instructor of record. The unauthorized possession of examination or course-related material also constitutes cheating.
2. Communication to another through written, visual, electronic, or oral means: The presentation of material which has not been studied or learned, but rather was obtained through someone else's efforts and used as part of an examination, course assignment, or project.
3. Commercial Use of Academic Material: Selling of course material to another person, student, and/or uploading course material to a third-party vendor without authorization or without the express written permission of the university and the instructor. Course materials include but are not limited to class notes, Instructor's PowerPoints, course syllabi, tests, quizzes, labs, instruction sheets, homework, study guides, handouts, etc.
4. Falsifying or misrepresenting the student's own academic work.
5. Plagiarism: Using or appropriating another's work without any indication of the source, thereby attempting to convey the impression that such work is the student's own.
6. Multiple Submissions: Submitting the same academic work for credit more than once without the express written permission of the instructor.
7. Helping another violate academic behavior standards.

For more information about Academic Integrity, students may consult The Center for Academic Integrity

<http://www.academicintegrity.org/icai/assets/FVProject.pdf>

For more information about plagiarism and misuse of sources, see "Defining and Avoiding Plagiarism: The WPA Statement on Best Practices"

<http://wpacouncil.org/node/9>

**Responses to Academic Dishonesty, Plagiarism, or Cheating.** Students should also familiarize themselves with the procedures for academic misconduct in UCF's student handbook, The Golden Rule

<http://goldenrule.sdes.ucf.edu/docs/goldenrule.pdf>.

UCF faculty members have a responsibility for students' education and the value of a UCF degree, and so seek to prevent unethical behavior and when necessary respond to academic misconduct. Penalties can include a failing grade in an assignment or in the course, suspension or expulsion from the university, and/or a "Z Designation" on a student's official transcript indicating academic dishonesty, where the final grade for this course will be preceded by the letter Z. For more information about the Z Designation, see <http://goldenrule.sdes.ucf.edu/zgrade>

**Course Accessibility Statement.** The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. Students with disabilities who need disability-related access in this course should contact the professor as soon as possible. Students should also connect with Student Accessibility Services (SAS) <http://sas.sdes.ucf.edu/> (Ferrell Commons 185, [sas@ucf.edu](mailto:sas@ucf.edu), phone: 407-823-2371). Through Student Accessibility Services, a Course Accessibility Letter may be created and sent to professors, which informs faculty of potential access and accommodations that might be reasonable. Determining reasonable access and accommodations requires consideration of the course design, course learning objectives and the individual academic and course barriers experienced by the student.

**Campus Safety Statement.** Emergencies on campus are rare, but if one should arise during class, everyone needs to work together. Students should be aware of their surroundings and familiar with some basic safety and security concepts.

- In case of an emergency, dial 911 for assistance.
- Every UCF classroom contains an emergency procedure guide posted on a wall near the door.
- Students should make a note of the guide's physical location and review the online version at [http://emergency.ucf.edu/emergency\\_guide.html](http://emergency.ucf.edu/emergency_guide.html)
- Students should know the evacuation routes from each of their classrooms and have a plan for finding safety in case of an emergency.
- If there is a medical emergency during class, students may need to access a first-aid kit or AED (Automated External Defibrillator). To learn where those are located, see <http://www.ehs.ucf.edu/AEDlocations-UCF> (click on link from menu on left).
- To stay informed about emergency situations, students can sign up to receive UCF text alerts by going to [my.ucf.edu](http://my.ucf.edu) and logging in. Click on "Student Self Service" located on the left side of the screen in the toolbar, scroll down to the blue "Personal Information" heading on the Student Center screen, click on "UCF Alert", fill out the information, including e-mail address, cell phone number, and cell phone provider, click "Apply" to save the changes, and then click "OK." Students with special needs related to emergency situations should speak with their instructors outside of class.
- To learn about how to manage an active-shooter situation on campus or elsewhere, consider viewing this video (<https://youtu.be/NIKYajEx4pk>).

**Deployed Active Duty Military Students.** A deployed active duty military student who feels the need for a special accommodation due to that unique status should contact their instructor to discuss the circumstances.

**Make-up assignments for Authorized university events or C0-curricular activities.** Students who represent the university in an authorized event or activity (for example, student-athletes) and who are unable to meet a course deadline due to a conflict with that event must provide the instructor with documentation in advance to arrange a make-up. No penalty will be applied. For more information, see the UCF policy at

<http://policies.ucf.edu/documents/4-401.2MakeUpAssignmentsorAuthUnivEventsorCocurricularActivities.pdf>

**Religious Observances.** Students must notify their instructor in advance if they intend to miss class for a religious observance. For more information, see the UCF policy at

<http://regulations.ucf.edu/chapter5/documents/5.020ReligiousObservancesFINALJan19.pdf>

# **STA 4038 Statistical Foundations of Data Science and Artificial Intelligence I**

**Credit: 3 hours**

## **Course Description:**

This is a fundamental course for undergraduate students to learn the statistical foundations of Data Science and Artificial Intelligence. Data Science and Artificial Intelligence use interdisciplinary techniques such as statistics, linear algebra, optimization, and computer science to create automated systems that can sift through large volumes of data at high speed to make predictions or decisions without human intervention. Machine learning as a field is now incredibly pervasive, with applications spanning from business intelligence to homeland security, from analyzing biochemical interactions to structural monitoring of aging bridges, and from emissions to astrophysics, etc. This class will familiarize students with a broad cross-section of models and algorithms for machine learning and prepare students for research or industry application of machine learning techniques.

**Prerequisites:** STA 2023, MAS 3105

## Overview

This course focuses on statistical foundations of data science and artificial intelligence including **probability, statistics theory, the optimization theory, and linear algebra**. This course provides a broad introduction to machine learning and statistical pattern recognition.

Topics include: (1) supervised learning (generative/discriminative learning, parametric/non-parametric learning, neural networks, and support vector machines); (2) unsupervised learning (clustering, dimensionality reduction, kernel methods); (3) learning theory (bias/variance tradeoffs; VC theory; large margins); and (4) reinforcement learning and adaptive control. The course will also discuss recent applications of machine learning, such as to data mining, bioinformatics, and text and web data processing.

## **Textbook:**

1. James, Witten, Hastie, and Tibshirani, *An Introduction to Statistical Learning*
2. Stephen Marsland, *Machine Learning: An Algorithmic Perspective*.

## Learning Outcomes

By the end of the course, students should be able to:

1. Develop an appreciation for what is involved in learning models from data. Understand a wide variety of learning algorithms.
2. Understand how to evaluate models generated from data.
3. Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

## Course Contents:

1. **Gradient descent and Hessian matrix methods:** Linear regression; SSE; gradient descent; closed form; normal equations; features
2. **Probability and resampling:** Overfitting and complexity; training, validation, test data, and introduction to R and Python, Ensemble methods: Bagging, random forests, boosting
3. **Probabilistic classification methods:** Bayes optimal decisions, Naive Bayes and Gaussian class-conditional distribution, Bayes' Rule and Naive Bayes Model
4. **Optimization theory:** Logistic regression, online gradient descent, Neural Networks
5. Applications: Text representations; naive Bayes and multinomial models

## COURSE REQUIREMENTS:

1. Regular class attendance is the main requirement of this course.
2. Active class participation, this means you must spend some quality time preparing for your next class.
3. Programming assignments, homework, and reports of hands-on labs must be turned in on time when they are due. Unfinished programs and non-working programs turned in on time will be graded; however, assignments not turned in on the due date will NOT be accepted. This means that you should start early to work on your programming assignments. Programs must be well- documented to be understood by a novice programmer.
4. Short quizzes may be given without prior notice and there will be no making up of missed quizzes.
5. Two examinations and a final examination will be given. There will be NO make up for missed exams.
6. You will be issued with one computer account for this class. You have a responsibility and an



obligation to prevent abuse and misuse of the university computer resources.

7. Individual extra credit assignments for the purpose of propping up a bad grade will NOT be given.

the website of the textbook for more resources.

### **Assignments & Readings**

Readings are announced on the course web site for each lecture. Students are expected to read the material before coming to class.

The detailed requirements for these assignments will be announced on the course web site. Late submission penalty is 10% of the grade per day.

### **Method of Evaluation:**

90+ = A; 80-89 = B; 70-79 = C; 60-69 = D; below 60 = F.

Assignments 30%

Course Presentation 10%

Course Project 20%

Exams (1 & 2) 20%

Final 20%

Total 100%

### **Justification**

This course is proposed to meet a growing business need of individuals skilled in artificial intelligence, data analytics, statistical programming and other software skills. The proposed course will combine theory and practice to enable the student to gain the necessary knowledge to compete in the ever-changing work environment. Students will learn concepts and methods designed to improve the business decision-making process by putting targeted information into the hands of those who need it most. They will understand business critical processes that drive organizational structures and systems within the context of varying stakeholder interests. Additionally, they will be able to define and evaluate potential initiatives that best fit organizational goals. Specifically, at the end of this course students should be able to effectively develop, manage, integrate, and use corporate information resources. Specifically, on successful completion of this unit, students will be able to: source and access data from a variety of databases; select and apply appropriate tools for data visualization; select and apply descriptive data analytics methods; select and apply predictive data

analytics methods; fit statistical models; use the results to produce business intelligence in a variety of settings; discover trends in analytical data stores using the data mining techniques of clustering, segmentation, association, and decision trees; and present data visually for clear communication to a managerial audience.

### **Academic Integrity**

Students should familiarize themselves with UCF's Rules of Conduct at <http://osc.sdes.ucf.edu/process/roc>. According to Section 1, "Academic Misconduct," students are prohibited from engaging in

1. Unauthorized assistance: Using or attempting to use unauthorized materials, information or study aids in any academic exercise unless specifically authorized by the instructor of record. The unauthorized possession of examination or course-related material also constitutes cheating.
2. Communication to another through written, visual, electronic, or oral means: The presentation of material which has not been studied or learned, but rather was obtained through someone else's efforts and used as part of an examination, course assignment, or project.
3. Commercial Use of Academic Material: Selling of course material to another person, student, and/or uploading course material to a third-party vendor without authorization or without the express written permission of the university and the instructor. Course materials include but are not limited to class notes, Instructor's PowerPoints, course syllabi, tests, quizzes, labs, instruction sheets, homework, study guides, handouts, etc.
4. Falsifying or misrepresenting the student's own academic work.
5. Plagiarism: Using or appropriating another's work without any indication of the source, thereby attempting to convey the impression that such work is the student's own.
6. Multiple Submissions: Submitting the same academic work for credit more than once without the express written permission of the instructor.
7. Helping another violate academic behavior standards.

For more information about Academic Integrity, consult the International Center for Academic Integrity

<http://academicintegrity.org>.

For more information about plagiarism and misuse of sources, see "Defining and Avoiding Plagiarism: The WPA Statement on Best Practices" <http://wpacouncil.org/node/9>.

### **Responses to Academic Dishonesty, Plagiarism, or Cheating**

Students should also familiarize themselves with the procedures for academic misconduct in UCF's student handbook, *The Golden Rule* <http://goldenrule.sdes.ucf.edu/docs/goldenrule.pdf>. UCF faculty members have a responsibility for students' education and the value of a UCF degree, and so seek to prevent unethical behavior and when necessary respond to academic misconduct. Penalties can include a failing grade in an assignment or in the course, suspension or expulsion from the university, and/or a "Z Designation" on a student's official transcript indicating academic dishonesty, where the final grade for this course will be preceded by the letter Z. For more information about the Z Designation, see <http://goldenrule.sdes.ucf.edu/zgrade>.

### **Course Accessibility Statement**

The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. Students with disabilities who need access to course content due to course design limitations should contact the professor as soon as possible. Students should also connect with Student Accessibility Services (SAS) <<http://sas.sdes.ucf.edu/>> (Ferrell Commons 185, [sas@ucf.edu](mailto:sas@ucf.edu), phone 407-823-2371). For students connected with SAS, a Course Accessibility Letter may be created and sent to professors, which informs faculty of potential course access and accommodations that might be necessary and reasonable. Determining reasonable access and accommodations requires consideration of the course design, course learning objectives and the individual academic and course barriers experienced by the student. Further conversation with SAS, faculty and the student may be warranted to ensure an accessible course experience.

### **Campus Safety Statement**

Emergencies on campus are rare, but if one should arise during class, everyone needs to work together. Students should be aware of their surroundings and familiar with some basic safety and security concepts.

- In case of an emergency, dial 911 for assistance.
- Every UCF classroom contains an emergency procedure guide posted on a wall near the door. Students should make a note of the guide's physical location and review the online version at <[http://emergency.ucf.edu/emergency\\_guide.html](http://emergency.ucf.edu/emergency_guide.html)>.
- Students should know the evacuation routes from each of their classrooms and have a plan for finding safety in case of an emergency.
- If there is a medical emergency during class, students may need to access a first-aid kit or AED (Automated External Defibrillator). To learn where those are located, see <<http://www.ehs.ucf.edu/AEDlocations-UCF>> (click on link from menu on left).
- To stay informed about emergency situations, students can sign up to receive UCF text alerts by going to <<https://my.ucf.edu>> and logging in. Click on "Student Self Service" located on the left side of the screen in the toolbar, scroll down to the blue "Personal Information" heading on the Student Center screen, click on "UCF Alert", fill out the information, including e-mail address, cell phone number, and cell phone provider, click "Apply" to save the changes, and then click "OK."
- Students with special needs related to emergency situations should speak with their instructors outside of class.
- To learn about how to manage an active-shooter situation on campus or elsewhere, consider viewing this video (<<https://youtu.be/NIKYajEx4pk>>).

### **Campus Safety Statement for Students in Online-Only Courses**

Though most emergency situations are primarily relevant to courses that meet in person, such incidents can also impact online students, either when they are on or near campus to participate in other courses or activities or when their course work is affected by off-campus emergencies. The following policies apply to courses in online modalities.

- To stay informed about emergency situations, students can sign up to receive UCF text alerts by going to <<https://my.ucf.edu>> and logging in. Click on "Student Self Service" located on the left side of the screen in the toolbar, scroll down to the blue "Personal Information" heading on the Student Center screen, click on "UCF Alert", fill out the information, including e-mail address, cell phone number, and cell phone provider, click "Apply" to save the changes, and then click "OK."
- Students with special needs related to emergency situations should speak with their instructors outside of class.

### **Deployed Active Duty Military Students**

Students who are deployed active duty military and/or National Guard personnel and require accommodation should contact their instructors as soon as possible after the semester begins and/or after they receive notification of deployment to make related arrangements.

### **Make-Up Assignments for Authorized University Events or Co-curricular Activities**

Students who represent the university in an authorized event or activity (for example, student-athletes) and who are unable to meet a course deadline due to a conflict with that event must provide the instructor with documentation in advance to arrange a make-up. No penalty will be applied. For more information, see the UCF policy at <<https://policies.ucf.edu/documents/4-401.pdf>>

### **Religious Observances**

Students must notify their instructor in advance if they intend to miss class for a religious observance. For more information, see the UCF policy at <<http://regulations.ucf.edu/chapter5/documents/5.020ReligiousObservancesFINALJan19.pdf>>.

# **STA 4039 Statistical Foundations of Data Science and Artificial Intelligence II**

Credit: 3 hours

## **Description**

The course covers the statistical foundations of the advanced models and algorithms of Data Science and Artificial Intelligence. The goal of the course is, on one hand, to understand high-level statistical foundations behind some of the state-of-the-art algorithms for a wide range of tasks including organization and visualization of data clouds, dimensionality reduction, network analysis, clustering, classification, regression, and ranking. On the other hand, students will be exposed to numerous practical examples drawn from a wide range of topics including social network analysis, finance, statistics, etc. There will be a strong emphasis on research opportunities.

**Prerequisites:** Data Science and Artificial Intelligence I

## **Instructor**

## **Teaching Assistant**

## **Time**

## **Location**

## **Textbook**

1. Russell and Norvig, *Artificial Intelligence - A Modern Approach*, 3rd edition, Prentice Hall (2009)

## **Online Resources**

The course web site is [Webcourses.UCF.edu](http://Webcourses.UCF.edu)

## **Course Objectives**

- (1) Students will learn about the broader context of artificial intelligence.
- (2) Students will learn core concepts in artificial intelligence, such as heuristic search, decision theory, machine learning, and natural language processing
- (3) Students will apply this knowledge in programming assignments

## **Course Topics**

1. **Distance and information diffusion methods:** Unsupervised learning: clustering, k-means, hierarchical agglomeration
2. **Stochastic iterative methods:** EM algorithms
3. **Projection and basis pursuit methods:** Latent space methods; PCA.
4. **Structural risk minimization method:** margin methods and support vector machines (SVM)
5. **Bayesian models:** Markov models; autoregressive models
6. Applications: clustering and latent space models, Natural Language Processing applications

### **Assignments & Readings**

Readings are announced on the course web site for each lecture. Students are expected to read the material before coming to class.

The detailed requirements for these assignments will be announced on the course web site. Late submission penalty is 10% of the grade per day.

### **Method of Evaluation:**

90+ = A; 80-89 = B; 70-79 = C; 60-69 = D; below 60 = F.

Assignments 30%

Course Presentation 10%

Course Project 20%

Exams (1 & 2) 20%

Final 20%

Total 100%

### **Justification**

This course is proposed to meet a growing business need of individuals skilled in artificial intelligence, data analytics, statistical programming and other software skills. The proposed course will combine theory and practice to enable the student to gain the necessary knowledge to compete in the ever-changing work environment. Students will learn concepts and methods designed to improve the business decision-making process by putting targeted information into the hands of those who need it most. They will understand business critical processes that drive organizational structures and systems within the context of varying stakeholder interests. Additionally, they will be able to define and evaluate potential initiatives that best fit organizational goals. Specifically, at the end of this course students should be able to effectively develop, manage, integrate, and use corporate information resources. Specifically, on successful completion of this unit, students will be

able to:

source and access data from a variety of databases; select and apply appropriate tools for data visualization; select and apply descriptive data analytics methods; select and apply predictive data analytics methods; fit statistical models; use the results to produce business intelligence in a variety of settings; discover trends in analytical data stores using the data mining techniques of clustering, segmentation, association, and decision trees; and present data visually for clear communication to a managerial audience.

### **Academic Integrity**

Students should familiarize themselves with UCF's Rules of Conduct at <http://osc.sdes.ucf.edu/process/roc>. According to Section 1, "Academic Misconduct," students are prohibited from engaging in

1. Unauthorized assistance: Using or attempting to use unauthorized materials, information or study aids in any academic exercise unless specifically authorized by the instructor of record. The unauthorized possession of examination or course-related material also constitutes cheating.
2. Communication to another through written, visual, electronic, or oral means: The presentation of material which has not been studied or learned, but rather was obtained through someone else's efforts and used as part of an examination, course assignment, or project.
3. Commercial Use of Academic Material: Selling of course material to another person, student, and/or uploading course material to a third-party vendor without authorization or without the express written permission of the university and the instructor. Course materials include but are not limited to class notes, Instructor's PowerPoints, course syllabi, tests, quizzes, labs, instruction sheets, homework, study guides, handouts, etc.
4. Falsifying or misrepresenting the student's own academic work.
5. Plagiarism: Using or appropriating another's work without any indication of the source, thereby attempting to convey the impression that such work is the student's own.
6. Multiple Submissions: Submitting the same academic work for credit more than once without the express written permission of the instructor.
7. Helping another violate academic behavior standards.

For more information about Academic Integrity, consult the International Center for Academic Integrity

<http://academicintegrity.org>.

For more information about plagiarism and misuse of sources, see "Defining and Avoiding Plagiarism: The WPA Statement on Best Practices" <http://wpacouncil.org/node/9>.

### **Responses to Academic Dishonesty, Plagiarism, or Cheating**

Students should also familiarize themselves with the procedures for academic misconduct in UCF's student handbook, *The Golden Rule* <http://goldenrule.sdes.ucf.edu/docs/goldenrule.pdf>. UCF faculty members have a responsibility for students' education and the value of a UCF degree, and so seek to prevent unethical behavior and when necessary respond to academic misconduct. Penalties can include a failing grade in an assignment or in the course, suspension or expulsion from the university, and/or a "Z Designation" on a student's official transcript indicating academic

dishonesty, where the final grade for this course will be preceded by the letter Z. For more information about the Z Designation, see <<http://goldenrule.sdes.ucf.edu/zgrade>>.

### **Course Accessibility Statement**

The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. Students with disabilities who need access to course content due to course design limitations should contact the professor as soon as possible. Students should also connect with Student Accessibility Services (SAS) <<http://sas.sdes.ucf.edu/>> (Ferrell Commons 185, [sas@ucf.edu](mailto:sas@ucf.edu), phone 407-823-2371). For students connected with SAS, a Course Accessibility Letter may be created and sent to professors, which informs faculty of potential course access and accommodations that might be necessary and reasonable. Determining reasonable access and accommodations requires consideration of the course design, course learning objectives and the individual academic and course barriers experienced by the student. Further conversation with SAS, faculty and the student may be warranted to ensure an accessible course experience.

### **Campus Safety Statement**

Emergencies on campus are rare, but if one should arise during class, everyone needs to work together. Students should be aware of their surroundings and familiar with some basic safety and security concepts.

- In case of an emergency, dial 911 for assistance.
- Every UCF classroom contains an emergency procedure guide posted on a wall near the door. Students should make a note of the guide's physical location and review the online version at <[http://emergency.ucf.edu/emergency\\_guide.html](http://emergency.ucf.edu/emergency_guide.html)>.
- Students should know the evacuation routes from each of their classrooms and have a plan for finding safety in case of an emergency.
- If there is a medical emergency during class, students may need to access a first-aid kit or AED (Automated External Defibrillator). To learn where those are located, see <<http://www.ehs.ucf.edu/AEDlocations-UCF>> (click on link from menu on left).
- To stay informed about emergency situations, students can sign up to receive UCF text alerts by going to <<https://my.ucf.edu>> and logging in. Click on "Student Self Service" located on the left side of the screen in the toolbar, scroll down to the blue "Personal Information" heading on the Student Center screen, click on "UCF Alert", fill out the information, including e-mail address, cell phone number, and cell phone provider, click "Apply" to save the changes, and then click "OK."
- Students with special needs related to emergency situations should speak with their instructors outside of class.
- To learn about how to manage an active-shooter situation on campus or elsewhere, consider viewing this video (<<https://youtu.be/NIKYajEx4pk>>).

### **Campus Safety Statement for Students in Online-Only Courses**

Though most emergency situations are primarily relevant to courses that meet in person, such incidents can also impact online students, either when they are on or near campus to participate in other courses or activities or when their course work is affected by off-campus emergencies. The following policies apply to courses in online modalities.

- To stay informed about emergency situations, students can sign up to receive UCF text alerts by going to <<https://my.ucf.edu>> and logging in. Click on "Student Self Service" located on the left side of the screen in the toolbar, scroll down to the blue "Personal Information" heading on the Student Center screen, click on "UCF Alert", fill out the information,



including e-mail address, cell phone number, and cell phone provider, click “Apply” to save the changes, and then click “OK.”

- Students with special needs related to emergency situations should speak with their instructors outside of class.

### **Deployed Active Duty Military Students**

Students who are deployed active duty military and/or National Guard personnel and require accommodation should contact their instructors as soon as possible after the semester begins and/or after they receive notification of deployment to make related arrangements.

### **Make-Up Assignments for Authorized University Events or Co-curricular Activities**

Students who represent the university in an authorized event or activity (for example, student-athletes) and who are unable to meet a course deadline due to a conflict with that event must provide the instructor with documentation in advance to arrange a make-up. No penalty will be applied. For more information, see the UCF policy at <<https://policies.ucf.edu/documents/4-401.pdf>>

### **Religious Observances**

Students must notify their instructor in advance if they intend to miss class for a religious observance. For more information, see the UCF policy at <<http://regulations.ucf.edu/chapter5/documents/5.020ReligiousObservancesFINALJan19.pdf>>.

# **Appendix M: Faculty Members' CVs**

(alphabetical order)

# Carlos Borges

University of Central Florida  
Department of Mathematics  
Orlando, FL 38216

Tel.: +1 (917) 687- 2417

[carlos.borges@ucf.edu](mailto:carlos.borges@ucf.edu)

<https://sciences.ucf.edu/math/borges/>

1333 Lake Baldwin Ln Apt 409

Orlando, FL 32814

Mobile: +1 (917) 687- 2417

## WORK

**Assistant Professor**, University of Central Florida (August 2018 – present)

## EXPERIENCE

**Peter O'Donnell Jr. Postdoctoral Fellowship**, Institute for Computational Engineering and Sciences, University of Texas at Austin (September 2016 – August 2018)

**Courant Instructor**, Courant Institute of Mathematical Sciences, New York University (July 2013 – August 2016)

**Teaching Assistant**, Worcester Polytechnic Institute (August 2008 – February 2012)

**Instructor**, Worcester Polytechnic Institute (Summer 2011)

**Computer Engineer**, Brazilian Army (December 2002 – July 2008)

## EDUCATION

**Military Institute of Engineering**, Rio de Janeiro, RJ, Brazil

B.Sc. Computer Engineering, December 2002. Final Project Adviser: Prof. Alex Garcia  
Project Title: A generator of compilers

**Institute of Pure and Applied Mathematics**, Rio de Janeiro, RJ, Brazil

M.Sc. Applied Mathematics, October 2007. Adviser: Prof. Marcus Sarkis. Co-adviser: Prof. Christian Schaerer.

Thesis Title: Coarse grid correction operator splitting for parabolic partial differential equations

**Worcester Polytechnic Institute**, Worcester, MA

Ph.D. Mathematics, February 2013. Adviser: Prof. Marcus Sarkis

Thesis Title: A Multifrequency Method for the Solution of the Acoustic Inverse Scattering Problem

## RESEARCH

Wave propagation

## INTERESTS

Electromagnetism

Forward and Inverse Scattering Problems

Mathematical Modeling

Numerical Methods

Fast Direct Solvers

## AWARDS

SIAM Travel Award to attend the 2019 International Conference in Industrial and Applied Mathematics (ICIAM 2019).

SIAM Early Career Travel Award to attend the 2019 SIAM Conference on Computational Science and Engineering (CSE19).

First place, Graduate Student Poster Competition: New England Numerical Analysis Day, April 2012.

Third place, Sciences Poster Competition: Graduate Research Achievement Day, Worcester Polytechnic Institute, March 2012.

Teaching Assistant of the Year (honorable mention): Department of Mathematical Sciences, Worcester Polytechnic Institute, 2012.

REVIEWER

**APS** Reviewer for APS – Physical Review Applied

**Elsevier** Reviewer for Elsevier – Journal of Computational Physics

**IOP Publishing** Reviewer for IOP Publishing – Inverse Problems

**Taylor & Francis** Reviewer for Taylor & Francis – Inverse Problems in Science and Engineering

PUBLICATIONS

C. Borges, G. Biros. **A domain decomposition preconditioning for the integral equation formulation inverse acoustic scattering problem**, arXiv:1901.09162 [math.NA]

C. Borges, G. Biros. **Reconstruction of a compactly supported sound profile in the presence of a random background medium**, *Inverse Problems*, **34** (2018), p. 115007

C. Borges, M. Sarkis. **A globalization technique based on geometric optics for the solution of the acoustic inverse scattering problem for convex obstacles**, in preparation

C. Borges, A. Gillman, L. Greengard. **High resolution inverse scattering in two dimensions using recursive linearization**, *SIAM J. Imaging Sciences*, volume **10**, no. **2**, pp. 641-664, 2017

S. Ambikasaran, C. Borges, L. Imbert-Gerard, L. Greengard. **Fast, adaptive, high order accurate discretization of the Lippmann-Schwinger equation in two dimension**, *SIAM J. Sci. Comput.*, **38**(3), A1770:A1787.

C. Borges, L. Greengard. **Inverse obstacle scattering in two dimensions with multiple frequency data and multiple angles of incidence**, *SIAM J. Imaging Sciences*, vol. **8**, no. **1**, pp. 280–298, 2015.

C. Borges. **A multifrequency method for the solution of the acoustic inverse scattering problem**. Ph.D. dissertation, Worcester Polytechnic Institute

C. Borges, M. Sarkis, C. Schaerer. **Coarse grid correction operator splitting for parabolic partial differential equations**. In proceedings: X Meeting in Computational Modeling, November 2007, Rio de Janeiro, Brazil.

C. Borges. **Coarse grid correction operator splitting for parabolic partial differential equations**. M.Sc. Thesis, Institute of Pure and Applied Mathematics, Rio de Janeiro, Brazil, October 2007.

C. Borges, H.P. Bruhn. **A generator of compilers**. Final Project, Military Institute of Engineering, December 2002.

ORGANIZED  
EVENTS

**9th International Congress on Industrial and Applied Mathematics - ICIAM 2019** Co-organizer of the Minisymposium in Fast algorithms for integral equations and their applications. (accepted)

**10th Applied Inverse Problems Conference** Co-organizer of the Minisymposium in Analysis and fast numerical methods for inverse problems and their applications. (accepted)

**SIAM 2019 CSE** Co-organizer of the Minisymposium in Fast Algorithms for Integral Equations and Their Applications. (accepted)

**9th Applied Inverse Problems Conference** Co-organizer of the Minisymposium in Fast algorithms for numerical simulation and their applications in inverse problems.

**SIAM 2018 Annual meeting** Co-organizer of the Minisymposium in Fast Algorithms for Integral Equations and their Applications.

**SIAM 2017 CSE** Co-organizer of the Minisymposium in Numerical methods for wave propagation and its applications.

**SIAM 2016 Annual meeting** Co-organizer of the Minisymposium in Computational Method for Waves in Inhomogeneous Media with Applications.

ORAL  
PRESENTATIONS

**Domain Decomposition Based Preconditioning for the Integral Equation Formulations of the Forward and Inverse Scattering Problem.** The V Applied Mathematics, Modeling and Computational Science (AMMCS) International Conference, Waterloo, Ontario, Canada, August 18–23, 2019.

**Deterministic and Stochastic Inverse Scattering Problems Using Fast Direct Solvers.** 32<sup>o</sup> Colóquio Brasileiro de Matemática, Rio de Janeiro, Brazil, July 31–August 02, 2019.

**Domain decomposition preconditioning for the integral forms of the forward and inverse scattering problems.** International Congress in Industrial and Applied Mathematics - ICIAM 2019, Valencia, Spain, July 15–19, 2019.

**A domain decomposition preconditioning for the integral equation formulation of the inverse scattering problem.** Applied Inverse Problems Conference - 2019, Grenoble, France, July 08–12, 2019.

**Reconstruction of a compactly supported sound profile in the presence of a random background medium.** Applied Inverse Problems Conference - 2019, Grenoble, France, July 08–12, 2019.

**Domain Decomposition Based Preconditioners for Forward and Inverse Scattering Problems.** SIAM Conference on Computational Science and Engineering (CSE19), Spokane, WA, February 25–March 01, 2019.

**Domain Decomposition for Integral Forms of the Forward and Inverse Scattering Problems.** 15<sup>th</sup> Annual Conference on Frontiers in Applied and Computational Mathematics (FACM '18), New Jersey Institute of Technology, Newark, NJ, August 24–26, 2018.

**Reconstruction of a compactly supported sound profile in the presence of a background random medium.** SIAM 2018 Annual Meeting, Portland, OR, July 12, 2018.

**Reconstruction of a compactly supported sound profile in the presence of a background random medium.** SIAM Imaging Sciences 2018, Bologna, Italy, June 8, 2018.

**Deterministic and Stochastic Inverse Scattering Problems Using Fast Direct Solvers.** Department of Mathematics, University of Central Florida, Orlando, FL, April 5, 2018.

**Deterministic and Stochastic Inverse Scattering Problems Using Fast Direct Solvers.** Department of Mathematics, Roger Williams University, Bristol, RI, March 23, 2018.

**Deterministic and Stochastic Inverse Scattering Problems Using Fast Direct Solvers.** Department of Mathematics, Florida Polytechnic University, Lakeland, FL, March 16, 2018.

**Deterministic and Stochastic Inverse Scattering Problems Using Fast Direct Solvers.** North Carolina Agricultural and Technical University, Greensboro, NC, Feb 27, 2018.

- Deterministic and Stochastic Inverse Scattering Problems Using Fast Direct Solvers.** Scientific Computing Seminar – Division of Applied Mathematics, Brown University, Providence, RI, Nov 10, 2017.
- Deterministic and Stochastic Inverse Scattering Problems Using Fast Direct Solvers.** Seminar on Numerical Methods – Department of Mathematical Sciences, Worcester Polytechnic Institute, Worcester, MA, Nov 09, 2017.
- Deterministic and Stochastic Inverse Scattering Problems Using Fast Direct Solvers.** Scientific Computing Seminar – Department of Mathematics, University of Houston, Houston, TX, Oct 31, 2017.
- Deterministic and Stochastic Inverse Scattering Problems Using Fast Direct Solvers.** Computational and Applied Mathematics Department Colloquium, Rice University, Houston, TX, Oct 30, 2017.
- Reconstruction of a compactly supported sound profile in the presence of a background random medium.** Texas Applied Mathematics and Engineering Symposium, University of Texas at Austin, Austin, TX, Sep 21–23, 2017.
- Reconstruction of a Compactly Supported Sound Profile In The Presence of Noisy Background Random Medium.** 14<sup>th</sup> Annual Conference on Frontiers in Applied and Computational Mathematics (FACM '17), New Jersey Institute of Technology, Newark, NJ, June 24–25, 2017.
- Using fast algorithms in the solution of the inverse medium problem.** 9th Applied Inverse Problems Conference, Hangzhou, China, May 31, 2017.
- High resolution solution of inverse scattering problems.** ICES Seminar-Numerical Analysis Series, Austin, TX, May 5, 2017.
- High resolution solution of inverse scattering problems.** SIAM Conference in Computational Science and Engineering, Atlanta, GA, March 2, 2017.
- High resolution solution of inverse scattering problems.** Numerical Analysis Seminar, University of Massachusetts, Lowell, MA, February 2, 2017.
- High resolution inverse acoustic scattering in two dimensions.** Numerical Analysis and PDE Seminar, University of Delaware, Newark, DE, October 20, 2016.
- Inverse Medium Scattering with Multiple Frequency Data and Multiple Angles of Incidence.** SIAM 2016 Annual Meeting, Boston, MA, July 14, 2016.
- Inverse Medium Scattering with Multiple Frequency Data and Multiple Angles of Incidence.** 13<sup>th</sup> Annual Conference on Frontiers in Applied and Computational Mathematics (FACM '16), New Jersey Institute of Technology, Newark, NJ, June 3, 2016.
- Inverse Medium Scattering with Multiple Frequency Data and Multiple Angles of Incidence.** Workshop on Inverse Problems for PDEs, University of Bremen, Bremen, Germany, March 29, 2016.
- Inverse Medium Scattering with Multiple Frequency Data and Multiple Angles of Incidence.** Numerical Analysis Seminar, Courant Institute of Mathematical Sciences, New York University, New York, NY, March 4, 2016.
- Application of a Speed Up Fast Direct Solver for the Solution of the Lippmann-Schwinger Equation.** SIAM Conference in Computational Science and Engineering, Salt Lake City, UT, March 13, 2015.
- Inverse Obstacle Scattering in Two Dimensions with Multiple Frequency Data and Multiple Angles of Incidence.** Applied and Computational Mathematics Seminar – IMPA, Rio de Janeiro, RJ, Brazil, January 16, 2015.
- Inverse Obstacle Scattering in Two Dimensions with Multiple Frequency Data and Multiple Angles of Incidence.** Fluids/Waves Seminar, New Jersey Institute of Technology, Newark, NJ, December 1, 2014.

**Using a fast solver to accelerate the inverse acoustic scattering problem.** Workshop on Fast Analysis-Based Solvers for Elliptic PDE, Dartmouth College, Hannover, NH, June 29, 2013.

**A Multi-frequency Method for the Solution of the Acoustic Inverse Scattering Problem.** Numerical Analysis Seminar, Courant Institute of Mathematical Sciences, New York University, New York, NY, December 6, 2013.

**A Multi-frequency Method for the Solution of the Acoustic Inverse Scattering Problem for Star-Shaped Objects.** Courant Instructor Day, Courant Institute of Mathematical Sciences, New York University, New York, NY, September 27, 2013.

**Multifrequency iterative integral equations method for the shape reconstruction of an acoustically sound-soft obstacle using backscattering.** Workshop Celebrating Diversity (WCD): Computational Mathematics Applied to Scientific Problems, SIAM 2012 Annual Meeting, Minneapolis, MN, July 10, 2012.

**Multifrequency iterative method for the shape reconstruction of an acoustically sound-soft obstacle using multiple scatterers.** Midwest Numerical Analysis Day 2012, University of Notre Dame, South Bend, IN, May 13, 2012.

**Multifrequency iterative integral equations method for the shape reconstruction of an acoustically sound-soft obstacle using multiple scatterers.** Applied Math Days, Rensselaer Polytechnic Institute, Troy, NY, March 31, 2012.

**Coarse grid correction operator splitting for parabolic partial differential equations.** X Meeting in Computational Modeling, Rio de Janeiro State University, Rio de Janeiro, Brazil, November, 2007.

REFERENCES

**George Biros**, Professor, W.A. "Tex" Moncrief, Jr. Simulation-Based Engineering Science Chair – 2, Department of Mechanical Engineering, University of Texas, Austin, TX, [biros@ices.utexas.edu](mailto:biros@ices.utexas.edu) , +1 (512) 232-9566

**Leslie Greengard**, Silver Professor of Mathematics and Computer Science, Department of Mathematics, Courant Institute of Mathematical Sciences, New York University, New York, NY, [greengar@cims.nyu.edu](mailto:greengar@cims.nyu.edu), +1 (212) 998 – 3306

**Marcus Sarkis**, Professor, Department of Mathematical Sciences, Worcester Polytechnic Institute, Worcester, MA, [msarkis@wpi.edu](mailto:msarkis@wpi.edu), +1 (508) 831– 5287

**Adrianna Gillman**, Assistant Professor, Department of Computational and Applied Mathematics, Rice University, Houston, TX, [adrianna.gillman@rice.edu](mailto:adrianna.gillman@rice.edu) , +1 (713) 348 – 5665

# JOSEPH BRENNAN

Department of Mathematics  
University of Central Florida  
Orlando, FL 32816-1364  
Phone: 407-323-3958  
Email: jpbrenna@mail.ucf.edu

## PROFESSIONAL QUALIFICATIONS

### ACADEMIC POSITIONS

University of Central Florida  
Professor, Department of Mathematics, 2011-present  
Associate Professor, Department of Mathematics, 2006-2011  
Secondary joint appointment, Nanoscience Technology Center, 2009-present

North Dakota State University  
Associate Professor, Department of Mathematics, 1995-2007  
Genomics graduate program committee member, 2001-2007  
Assistant Professor, Department of Mathematics, 1989-1995

National Science Foundation  
Program Director, Division of Mathematical Sciences, 1999-2001

Rutgers University  
Visiting Associate Professor, Department of Mathematics, 1996-1997

University of Mississippi  
Visiting Assistant Professor, Department of Mathematics, 1988-1989

Seton Hall University  
Assistant Professor, Department of Mathematics and Computer Science, 1986-1988

Michigan State University  
Instructor, Department of Mathematics, 1983-1986

### INDUSTRIAL POSITIONS

Vice President, Nano Discovery, 2007-present.

### EDUCATION

1977-1984 PhD in Mathematics, University of Illinois, Urbana-Champaign  
Thesis: Products in  $\lambda$ -rings  
Advisor: Robert M. Fossum

1973-1977 BA in Mathematics, University of Chicago

### HONORS

Fulbright Fellow Designee (1998)

### GRANTS

Jan. 1995-Dec. 1995 (PI) NSF-9414514 NSF/CBMS Regional Conference in the Mathematical Sciences \$24,999.

Aug. 2005-Aug. 2009 (PI 2007) NSF-0506531 NIRT Total chemical synthesis property and modeling studies of nanoparticle/polymer hybrid materials \$1,199,479.

July 2009-June 2010 (co-PI) Florida Department of Health, 1046499, Theoretical modeling of nanoparticle growth, aggregation and property of nanocomposite materials., 06/06/2007 to 07/31/2009, \$95,178.



## RESEARCH AREAS

Commutative algebra, algebraic geometry, representation theory of the symmetric group, invariant theory, cryptography, tropical geometry, nanomolecular kinetics, percolation

## Publications

1. Brennan, J. An algebraic periodicity theorem for spheres. *Proc. Amer. Math. Soc.* **90**(1984), 215--218.
2. Brennan, J.; Wolfskill, J. Remarks: "On the probability that the determinant of an  $n \times n$ -matrix over a finite field vanishes" by A. Mukhopadhyay. *Discrete Math.* **67**(1987), 311--313.
3. Brennan, J.; Herzog, J. Ulrich, B. Maximally generated Cohen-Macaulay modules. *Math. Scand.* **61** (1987), 181--203.
4. Brennan, J. Invariants of affine group schemes.  
In *Invariant theory* (Denton, TX, 1986), 33--38.  
Contemp. Math. **88**, Amer. Math. Soc., Providence, RI, 1989.
5. Brennan, J.; Vas Pinto, M.; Vasconcelos W. The Jacobian module of a Lie algebra. *Trans. Amer. Math. Soc.* **321**(1990), 183--196.
6. Brennan, J.P. The restriction of the outer plethysm to a Young subgroup. *Comm. Algebra* **21** (1993), 1029--1036.
7. Brennan, J.; Vasconcelos, W. Effective computation of the integral closure of a morphism. *J. Pure Appl. Algebra* **86**(1993), 125--134.
8. Brennan, J.; Piotrowski, W. The group of periods of the sum of two functions.  
In *Computational algebra* (Fairfax, VA, 1993), 17--30.  
Lecture Notes in Pure and Appl. Math. , **151**, Dekker, New York, 1994.
9. Brennan, J. On the normality of commuting varieties of symmetric matrices. *Comm. Algebra* **22**(1994), 6409--6415.
10. Brennan, J. Invariant theory in characteristic  $p$ :  
Hazlett's symbolic method for binary  $n$ -tics.  
In *Factorization in integral domains* (Iowa City, IA, 1996), 257--269.  
Lecture Notes in Pure and Appl. Math., **189**, Dekker, New York, 1997.
11. Brennan J.P.; Vasconcelos, W.V. On the structure of closed ideals. *Math. Scand.* **88**(2001), 3--16.
12. Brennan, J.P.; Ulrich, B.; Vasconcelos, W.V. The Buchsbaum-Rim polynomial of a module. *J. Algebra* **241**(2001), 379--392.

13. Katti, R; Brennan, J.P. Low complexity multiplication in a finite field using ring representation.  
*I.E.E.E. Trans. Computers* **52**(2003) [Special section on cryptographic hardware and embedded systems], 418--427.
14. Brennan, J.P.; Vasconcelos, W.V. Effective normality criteria for algebras of linear type.  
*J. Algebra* **273**(2004), 640--656.
15. Brennan, J.P.; Huo, Q.; Sun, W.; Zhong, W.H. Total chemical synthesis, modeling and property study of nanoparticle/polymer hybrid materials.  
In Nanoscale science and engineering (Arlington, VA, 2005) 192 National Science Foundation, 2005.
16. Liu, X. ; Worden, J. ; Huo, Q.; Brennan, J. A kinetic study of gold nanoparticle growth in solution by Brust-Schiffrin reaction. *J. Nanosci. Nanotechnol.* **6**(2006), 1054--1059.
17. Brennan, J; Liu, X.; Dai, Q.; Worden, J; Huo, Q.  
Stochastic model analysis of nanoparticle size polydispersity.  
*J. Comput. Theor. Nanosci.* **3**(2006), 417--422.
18. Brennan J.; Huo, Q.; Sun, W.; Zhong, W. Total chemical synthesis, property and modeling studies of nanoparticle/polymer hybrid materials  
In Proceedings of NSF Design, Service, Manufacturing Grantees and Research Conference. (St. Louis, 2006).
19. Brennan, J.P.; Liu, X; Huo, Q. Stochastic differential equation models of nanoparticle growth in Brust-Schiffrin reaction. *J. Compt. Theor. Nanosci.* **4**(2007) 127--132.
20. Brennan, J.P.; Cipalkatti, J.V.; Fossum, R.M. Apolarity and covariant forms.  
*Illinois J. Math.* **51**(2007) 21--27.
21. Liu, X.; Atwater, M.; J. Wang, J.; Dai, Q.; Zou, J.; Brennan, J.; Huo, Q.  
A study on gold nanoparticle synthesis using oleyamine as both reducing agent and protecting ligand. *J. Nanosci. Nanotech.* **7**(2007) 3126--3133.
22. Brennan, J. NSF proposal preparation: the view of an ex-program officer.  
*Notices of the Amer. Math. Soc.* **54**(2007) 1153--1157.
23. Brennan, J.; Katti, R., Montgomery multiplication over rings.  
*J. Franklin Inst.* **346**, (2009), 10-16.
24. Brennan, J.P.; Dupont, L.A.; Villarreal R., Duality, a-invariants and canonical modules of rings arising from linear optimization problems. *Bull. Math. Soc. Sci. Math. Roumanie (N.S.)* **51** (2008), 279—305.
25. Brennan, J.; Li, A.; Huo, Q., Advancing lattice path models for nanoparticle percolation of conductivity in a non-conductive matrix. *J. Compt. Theor. Nanosci.* **6** (2009) 519-524.
27. Brennan. J.; Ciuperca, C., Sequences that preserve the homological degree.  
*Comm. Algebra.* **37**(2009) 1647-1655.

28. Brennan, J; Chen, G., Toric geometry of series-parallel graphs. *SIAM J. Discrete Mathematics*. **23**(2009) 754—764.
29. Brennan, J.; Epstein, N., Noether normalizations, reductions of ideals, and matroids. *Proc. Amer. Math. Soc.* **139** (2011), no. 8, 2671–2680.
30. Wocjan, P.; Jordan, S.; Ahmadi, H.; Brennan, J. Efficient quantum processing of ideals in finite rings. arXiv:0908.0022v1..
31. Brennan, J; Chen, T., A stoichiometric model of the kinetics of nanoparticle configurations mediated by antigen-antibody pairs. *Journal of Computational and Theoretical Nanoscience* **8**(9): (2011) 1653-1658
32. Zhang, S.; Garcia-DeAngeli, A.; Brennan, J. Huo, Q. Predicting detection limits of enzyme-linked immunosorbent assay (ELISA) and bioanalytical techniques in general. *The Analyst* **139**(2): 4 (2014) 39-45.
33. Brennan, J; van Gorder, R. The generalized lucky ticket problem and closure relations satisfied by the Chebyshev polynomials. *Ramanujan J.* **37**(2015) 269-289.
34. Li, L., Juste, T., Brennan, J. Chang, C. Han D. Phase Retrievable Projective Representation Frames for Finite Abelian Groups. *J. Fourier Anal. Appl.* (2017).  
<https://doi.org/10.1007/s00041-017-9570-6>.
35. Brennan, J. P.; Trainor, K. The Italian identities for Hilbert series of hypergraphs. *Bull. Math. Soc. Sci. Math. Roumanie (N.S.)* **61**(109) (2018), no. 2, 157–166.
36. Brennan, J. P.; York, A.; An extension of a theorem of Frobenius and Stickelberger to modules of projective dimension one over a factorial domain. *J. Pure Appl. Algebra* **223** (2019), no. 2, 626–633.
37. Brennan, J. P.; York, A.; C-Gorenstein dimensions and linkage. *preprint*.
38. Brennan, J. P.; De Vas Gunasekara, A. R. C. Weierstrass vertices of graph families. *In preparation*
39. Brennan, J.; Epstein N. Cryptomorphisms for generic matroids. *In preparation*.

## Invited Talks

### International Meetings

- Valuation theory and Integral Closures in Commutative Algebra, Ottawa, Canada, July 2006.
- XL Coloquio Latinoamericano de Algebra, Cocoyoc, Morelos, Mexico, July 2003.
- Algebraic Geometry Conference, Annapolis, MD, October 2001.
- Workshop in Commutative Algebra, Grenoble, France, July 2001.
- Special Session on Algebraic Geometry and Commutative Algebra, AMS-SMM Joint Meeting, Denton, TX, May 1999.
- Special Session on Algebraic Geometry and Commutative Algebra, AMS-SMM Joint Meeting, Oaxaca, Mexico, December 1997.
- Special Session on Commutative Algebra and Coding Theory, AMS-SMM Joint Meeting, Guanajuato, Mexico, November 1995.
- Workshop in Algebra, Mexico City, Mexico, November 1995.
- Combinatorics and Commutative Algebra, Nagoya, Japan, August 1990.
- Group Actions and Invariant Theory, Montreal, Quebec, August 1988.
- Algebraic Groups, Warsaw, Poland, May 1988.

### AMS National Meetings

- Special Session on Invariant Theory, New Orleans, LA, January, 2007.
- Special Session on Invariant Theory, Orlando, FL, January 1996.
- Special Session on Invariant Theory, Baltimore, MD, January 1992.
- Special Session on Commutative Noetherian Rings with Applications in Algebraic Geometry, Orono, ME, Aug. 1991.

### AMS Regional Meetings

- Special Session on Commutative Algebra, Rutgers, NJ, October 2007.
- Special Session on Algebraic Geometry and Commutative Algebra, Nashville, TN, October 2004.
- Special Session on Commutative Algebra and Algebraic Geometry, Lawrenceville, NJ, October 2004.
- Special Session on Commutative Algebra, New York, NY, November 2000.
- Special Session on Commutative Algebra, Notre Dame, April 2000.
- Special Session on Commutative Algebra, Montreal, PQ, September 1997.
- Special Session on Commutative Rings, Iowa City, March 1996.
- Special Session on Invariant Theory, Denton, TX, October-November, 1986.
- Special Session on Connections between combinatorics, algebra, and geometry, Denton, TX, Oct.-Nov., 1986.
- Special Session on Plethysms, Chicago, April, 1985.

### Teachers Meetings

- NDCTM Fall meeting, Bismarck, ND, 2004
- NDCTM Fall meeting, Bismarck, ND, 200

### External Colloquia and Seminars

Georgia State University-University of South Carolina Commutative Algebra Seminar,  
Columbia, SC, January 2008  
Seminar, State University of New York, University at Albany, May 2007.  
Colloquium, Montclair State University, May 2007.  
Colloquium, Georgia State University, April, 2007.  
Colloquium, University of Central Florida, November, 2005.  
Colloquium, University of Science and Technology, Hufei, China, March, 2005  
Colloquium, University of Central Florida, December, 2004.  
Colloquium, University of Kentucky, February 2003.  
Colloquium, University of Montana, May 2001.  
Commutative Algebra Seminar, Rutgers University, April 2001.  
Colloquium, George Mason University, November 2001.  
Colloquium, George Washington University, November 2001.  
Colloquia, United States Naval Academy, April 2000, April 2001.  
Commutative Algebra Seminar, Rutgers University, 1996-7.  
Commutative Algebra Seminar, Michigan State University, December 1993.  
Colloquium, University of Maine, Orono, February 1992.  
Algebra Seminar, Rutgers University, January 1992.  
Colloquium, Lunds Universitet, January 1991.  
Colloquium, University of Toledo, April 1990.  
Algebra Seminar, Polish Academy of Science-Torun, March, 1990.  
Algebra Seminar, Rutgers University, February 1987.  
Commutative Algebra Seminar, Michigan State University, January 1987.  
Commutative Algebra Seminar, University of Chicago, March 1986.

#### **Summer/Winter Schools**

Computational Algebra with Applications, Rocky Mountain Mathematics Consortium,  
June/July 1999.

#### **Other Meetings (with invited talks)**

North Central Region Project Next Workshop, April 2006.  
40<sup>th</sup> Western Regional Meeting of the American Chemical Society, January 2006.  
WiegandFest, Lincoln, NE, May 2005.  
Nebraska Centennial Meeting, Lincoln NE, May 1998.  
Route 81 Conference, Albany, NY, October 1996.

#### **Conferences Organized**

Organizing committee, SIAM-SEAS meeting, Orlando, FL 2008.  
Co-organized Special Session on Monomials and Resolutions, Miami, FL 2006.  
Co-organized Nanoscience Workshop, Fargo, ND 2006.  
Co-organized MAA regional Meeting, Fargo, ND 1995, 2004  
Co-organized Special Session on Commutative Algebra, 1999  
Co-organized Scientific Program of Rocky Mountain Summer School, 1999  
Organized CBMS Meeting on Tight Closure, 1995  
Co-organized Special Session on Commutative Algebra, 1991  
Organized AMS regional meeting, Fargo, ND 1991  
Organized Special Session on Plethysms, 1985

## Teaching

### COURSES TAUGHT (since 1989)

#### University of Central Florida

**Undergraduate:** Calculus and Analytic Geometry I-II  
Applied Combinatorics  
Logic and proof in mathematics  
Modern Geometries  
Linear and Matrix Algebra  
Introduction to Number Theory

**Graduate:** Matrix Theory and Advanced Linear Algebra  
Abstract Algebra with Applications

#### North Dakota State University

**Undergraduate:** Finite Mathematics  
Applied Calculus I-II  
Calculus I-III  
Introduction to Differential Equations  
Linear Algebra  
Combinatorics  
Graph Theory

**Under/Graduate:** Introduction to Topology  
Axiomatic Geometry  
Abstract Algebra I-II  
Cryptography

**Graduate:** Algebra I-II  
Linear Algebra I-II  
Theory of Rings I-II  
Topology I-II  
Algebraic Curves  
Computational Methods in Commutative Algebra

#### Rutgers University

**Undergraduate:** Calculus II

## **COURSE DEVELOPMENT**

### **North Dakota State University**

Under/Graduate: Cryptography

Error-Correcting Codes

Integration on Manifolds

Molecular Topology

Mathematical Models in the Biological Sciences

Set Theory

Graduate: Algebraic Curves

Computational Methods in Commutative Algebra

Introduction to Bioinformatics

## **GRADUATE THESES**

### **Graduate Theses Supervised:**

#### **North Dakota State University:**

Michael Booth, MS (*Computations in hyperelliptic curves*, December 2005)

#### **University of Central Florida:**

##### **Masters Students:**

Ajani de vas Gunasekara, *Weierstrass vertices and divisor theory of graphs*, 2018.

##### **Doctoral Students**

Tang Chen, *Algebraic aspects of (bio) nano-chemical reaction networks and bifurcations in various dynamical systems*, 2011.

Sayed Hamed Ahmadi Abhari, *Quantum algorithms for quantum phase estimation, approximation of the Tutte polynomial and black-box structures*, 2013.

Kyle Trainor, *Hilbert series for graphs, hypergraphs and monomial ideals*, 2018.

Alexander York, *Quasi-Gorenstein modules*, 2018.

##### **External Reviewer for doctoral thesis:**

Tor Gunston, Rutgers University

Carlos Valencia, CINESTAV

Luis A. Dupont, CINESTAV

Jonathan Toledo CINVESTAV

## **Service**

**American Mathematical Society**

AMS-Pi Mu Epsilon Liaison Committee

**National Science Foundation**

IGERT program committee

Mathematical and Physical Sciences working group on education

NSF-EC research training network working group

**University of Central Florida**

Graduate Core Subcommittee

Strategic Planning Committee

Graduate Curriculum Committee

Graduate Recruitment Task Force

Student Affairs Committee

SIAM-SEAS Organizing Committee 2007-2008

**North Dakota State University****University Committees**

University Senate

University Assessment Committee

Graduate Council (2 terms)

Select Graduate Appeals Committee

Women's Studies Advisory Committee (2001-2007)

Program Review for Food and Nutrition Program

Program Review for Electrical and Computer Engineering

Ad hoc committee on graduate student stipends (chair)

Ad hoc committee on graduate faculty membership (chair)

**College Committees**

Student Progress Committee

Promotion and Tenure Committee (2 terms, 1 year as chair)

**Departmental Committees**

Assessment Committee (chair)

Newsletter Committee

Hiring Committee (multiple terms, with multiple terms as chair)

K.N. Rao examination committee (multiple terms)

Organizing committee for regional AMS meeting in Fargo (chair)

Organizing committee for regional MAA summer seminar

**Departmental Administrative Service**

Actuarial Program Director (multiple terms)

Undergraduate Program Director

**Reviewer**

American Mathematical Monthly

Boletín de la Sociedad Matemática Mexicana



Communications in Algebra  
Journal of Pure and Applied Algebra  
National Security Agency  
National Science Foundation  
Rocky Mountain Mathematics Journal  
Transactions of the American Mathematical Society

**Editorial**

Editorial Board, *Journal of the Franklin Institute* 2007-2013

**Current Professional Memberships**

American Mathematical Society (Life Member)  
Mathematical Association of America

## Ivan Garibay

Industrial Engineering and Management Systems  
University of Central Florida, Orlando, FL 32816  
Phone: (407) 882 1163; E-mail: Ivan.Garibay@ucf.edu

### **Professional Preparation**

Ricardo Palma University	Electrical Engineering	B.Sc.; 1994
Ricardo Palma University	Electrical Engineering	P.E.; 1995
University of Central Florida	Computer Science	M.S.; 2000
University of Central Florida	Computer Science	Ph.D.; 2004

### **Appointments:**

2016- Assistant Professor; Industrial Engineering and Management Systems; University of Central Florida  
2015-2016 Director, Technology and Innovation; and Chief Information Officer for Research Division; University of Central Florida  
2013-2015 Assistant Research Professor; Institute of Simulation and Training; University of Central Florida  
2009-2013 Director, Office of Technology and Innovation; Office of Research and Commercialization; and Chief Information Officer for Research Division; University of Central Florida  
2006-2009 Associate Director of the Office of Research and Commercialization and Chief Information Officer; University of Central Florida  
2000-2005 Lead Programmer and Systems Engineer; Office of Research and Commercialization; University of Central Florida  
1997-2000 Graduate Research Assistant; EECS Department; University of Central Florida  
1995-1997 Instructor, Logic Circuit Design and Introduction to Digital Systems; EE Department; Ricardo Palma University

### **Products:**

#### **Most closely related to proposal.**

Chathika Gunaratne, Ivan Garibay, Mustafa Ilhan Akbas, and Ozlem Ozmen (2016). The Need for Product Space Complexity for Agent-based Computational Economics, Duke Forest Conference 2016: Economics in the Era of Natural Computationalism and Big Data Celebrating the 50th anniversary of the Theory of Self-Reproducing Automata (by John von Neumann), Hilton Garden, Durham, North Carolina, Nov 11-13, 2016

Gunaratne, M. I. Akbas, I. Garibay and O. Ozmen (2016). Evaluation of Zika Vector Control Strategies Using Agent-Based Modeling. Social Simulation Conference (SSC) - 6th joint meeting of European Social Simulation Association (ESSA), Pan-Asian Association for Agent-based Approach in Social Systems Sciences (PAAA), and Computational Social Sciences of America (CSSSA), Rome, Itali, September, 2016.

I. Garibay, C. Gunaratne, M. I. Akbas and O. Ozmen (2016). The Role of Evolutionary Dynamics in Agent-Based Computational Economics. In the Proceedings of the International Workshop on the Economic Science with Heterogeneous Interacting Agents (WEHIA), Catellon, Spain, June, 2016.

Garibay, I., Akbas, I., Gunaratne, C., Ozmen, O.. and O'Neal, T. (2015). An Agent Based Approach to Study Incubation in Innovation Ecosystems. Conference of the Computational Social Science Society of the Americas (CSSSA), Santa Fe, NM, October, 2015

Lasrado, V., Sivo, S., Ford, C., O'Neal, T., and Garibay, I. (2015). Do graduated university incubator firms benefit from their relationship with university incubators? The Journal of Technology Transfer, pp. 1-15, April, 2015.

### **Other significant Products:**

Akbas, I., Gunaratne, C., Ozmen, O., Garibay, I., and O'Neal, T. (2015). Role of Entrepreneurial Support for Networking in Innovation Ecosystems: An Agent Based Approach. Winter Simulation Conference (WSC), Huntington Beach, CA, December, 2015.

Akbas, M. I., Basavaraj, P., Ozmen, O., Garibay I. and Georgiopoulos, M. (2015). Curriculum GPS: An Adaptive Curriculum Generation and Planning System. Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), Orlando, FL, November 30-December 4, 2015.

Akbas, M. I., Ozmen, O. and Garibay, I. (2015). Professional Network Value in Business Incubator Models. Conference of the European Social Simulation Association (ESSA), Groningen, Netherlands, September, 2015.

Akbas, M. I.; Ozmen, O. and Garibay, I. (2015) Regional Dynamics of Innovation and Entrepreneurship in the Optics and Photonics Industry. International Conference on Innovation and Entrepreneurship, Istanbul, Turkey, July, 2015.

Lasrado, V., Sivo, S., Ford, C., O'Neal, T., Garibay, I. (2014). Do Graduated Incubated Firms Benefit from their Relationship with University Incubators? Technology Transfer Society 2014 Conference, Baltimore, MD., 2014

### **Synergistic Activities**

Founding Director of the Master of Science in Data Analytics program: a collaboration between colleges of engineering and computer science and college of sciences to teach data analytics and big data at the master level and enable an industry-university partnership on Big Data and Data Analytics in the Central Florida region.

Treasurer and Board Member at Large: The Computational Social Science Society of the Americas (CSSSA)

Founding Director of UCF I-Corps: offering full I-Corps 10-weeks training for 96 I-Corps teams from 2015 to 2017. Main Organizer and Co-PI of an NSF funded I-Corps Site at UCF and of a Florida I-Corps Node to be proposed with UCF, UF and USF. NSF Panelist for the I-Corps program.

Director of UCF Complex Adaptive Systems Laboratory; an interdisciplinary research group on the areas of big data, data analytics, simulation and modeling, agent-based computational economics; innovation ecosystems models; evolutionary computation; complex adaptive systems; economic modeling; computational social sciences; mechanism design theory; co-adaptive systems; autonomous agents systems; multi-agents systems; self-organizing systems.

Serve as reviewer for the following journals: IEEE Transactions on Parallel and Distributed Systems (IEEE Press); Evolutionary Computation Journal (MIT Press); Journal of Theoretical Biology (Elsevier); Genetic Programming and Evolvable Machines Journal (Springer); IEEE Transactions on Evolutionary Computation (IEEE Press); Neural Networks Journal (Elsevier).

## Curriculum Vitae

**Name** Arup Ratan Guha

### Education

- M.S. Computer Science, University of Wisconsin, Madison, WI (May, 1999)
- B. S. Computer Science, Massachusetts Institute of Technology, MA (June, 1997)
- B. S. Mathematics, Massachusetts Institute of Technology, Cambridge, MA, (June, 1997)
- High School Diploma, Orange County District School Board, Orlando, FL, (June 1993)
- International Baccalaureate Diploma, Geneva, Switzerland, (July 1993)

### Appointments

- Senior Instructor, Department of Computer Science, University of Central Florida, Orlando, FL starting August 2019
- Associate Instructor, School of Electrical Engineering and Computer Science, University of Central Florida, Orlando, FL August 2013 – Present
- Lecturer, School of Electrical Engineering and Computer Science, University of Central Florida, Orlando, FL May 2003 – May 2013 (Taught Pascal, Computer Science I, Discrete Structures, Tools for Algorithm Analysis, Discrete Structures II, Computer Science II, Programming Languages, Object Oriented Programming, Computer Science III, Introduction to Cryptography, Introduction to C Programming, Topics in Computer Science, Introduction to Algorithms, Honors Mathematical Modeling, Numerical Calculus)
- Visiting Lecturer, School of Electrical Engineering and Computer Science, University of Central Florida, Orlando, FL August 1999 – May 2003
- Adjunct Teacher, University High School, Orlando, FL August 2007 – May 2010 (Have taught IB HL Mathematics, Analysis of Functions, Algebra I-B, and AP Computer Science A)
- Adjunct Teacher, Winter Park High School, Winter Park, FL August 1999 – May 2007 (Taught Theory of Knowledge and Higher Level Mathematics for International Baccalaureate Program)

### Educational Contributions

- 2002 - Present, Instructor, Summer Institute at UCF (Formerly BHCSI) Sole faculty member in charge of academics for accelerated summer program in computer science. Website: <http://siucf.cs.ucf.edu>.)
- 2003 - Present, Coach for the UCF Programming Team (Coached three World Finalists: 2013-4 UCF Olympus, which finished tied for 19<sup>th</sup> place at the 2014 ACM ICPC World Finals, 2016-7 UCF Badlands, which finished tied for 13<sup>th</sup> place at the 2017 ACM ICPC World Finals, and 2017-8 UCF Raptor, which finished 10<sup>th</sup> place at the 2018 ACM ICPC World Finals, earning a Bronze medal and a North American Championship.)

### Professional Activities

- 2000 – 2009 (Aug), Foundation Exam Involvement (The department requires students to pass the Foundation Exam in order to declare themselves as Computer Science majors. I have developed exam questions, graded and run review sessions for this exam.)
- 2009 (Aug) – Present, Foundation Exam (in charge of administering the exam)
- 2009 – 2011, Participant in NSF Grant #0837320 (Undergraduate Computer Security Course Enhancement), PI Dr. Ratan Guha (UCF)
- 2010 – 2012, Participant in NSF Grant #0939081 (CPATH2: Collaborative Research: Incorporating Communication Outcomes into the Computer Science Curriculum), PI Dr. Janet Burge (Miami University)
- 2013 – Present, Order of Pegasus Committee Member

## **Recognition and Awards**

- UCF Excellence in Undergraduate Teaching Award – April 2016, April 2012, April 2008
- ACM-ICPC Senior Coaches Award – April 2019
- ACM-ICPC Coaches Award – June 2014
- UCF Teaching Incentive Program (TIP) Award – April 2019, April 2014, April 2009
- Promoted to Senior Instructor, August 2019
- Promoted to Associate Instructor, August 2013
- Only UCF Faculty Member featured in Florida Trend Article “Successes: Notable Professors and Departments at Florida Universities” in July of 2011.
- LINK First Year Advocate – April 2008

## **Service Activities**

- Junior Knights (2011 – Present) – With Dr. Lobo, teaching HS students programming, 20 Saturdays a year
- Achieving a College Education Day (2008 – 2013, 2015)
- Florida Education Fund Career Day (2007 – 2012)
- Give various lectures at area high schools

## **Publications**

- 2013 – Wrote custom textbook for COP 3223: Programming Knights: An Introduction to Programming in Python and C, Pearson: Boston, MA, 2011, 476 pages. (ISBN-13: 978-1-256-92763-1)

## **Presentations at Conferences**

- 2011 Competitive Learning Institute Symposium (May 27, 2011) – Using Programming Contests to Excite Introductory Students
- 2015 Competitive Learning Institute Symposium (May 17, 2015) – UCF’s Women’s Programming Team

## **Professional Development Activities**

- 2011 Summer IDL 6543 Participant (Training to teach online courses)
- 2011 Summer FCTL Conference Participant (Teamed with Dr. Vajravelu from Math)
- 2012 Summer WAC (Writing Across the Curriculum) Fellow (Teamed with Dr. Mohapatra from Math)
- 2014 Spring FCTL STEM Teaching Group
- 2016 SIGCSE Attendee

**Dr. Xin Li** *Xin Li*

Department of Mathematics  
University of Central Florida  
Orlando, FL 32816  
Phone: (407) 823-5984  
Fax: (407) 823-6253  
E-mail: Xin.Li@ucf.edu

#### **EMPLOYMENT:**

2014 – Present, Department Chair, University of Central Florida, Orlando  
2013 – Present, associated faculty, Center for Research for Computer Vision, UCF  
2001 – Present, Professor, University of Central Florida, Orlando  
2012.8 – 2012.12, Visiting Professor, City University of Hong Kong  
2006-2012, Graduate Program Director, Department of Mathematics, UCF  
1995-2001, Associate Professor, University of Central Florida, Orlando  
1990-1995, Assistant Professor, University of Central Florida, Orlando  
1986-1989, Teaching and Research Assistant, University of South Florida, Tampa

#### **EDUCATION:**

1989, Ph.D. University of South Florida, Tampa. Advisor: Professor E.B. Saff  
1986, M.S. Zhejiang University, China. Advisors: Professors Zhurui Guo and Zhen Sha  
1983, B.S. Zhejiang University, China.

#### **HONORS AND AWARDS:**

2009, 2003, and 1994, Teaching Incentive Program Award, University of Central Florida

#### **GRANTS:**

- Growing Adaptive Instructors in Gateway to STEM Courses (MATH-GAINS), Principal Investigator, \$250,000, National Science Foundation, 2015-2018.
- Symmetry, Integrability, and Special Functions, PI: Mourad Ismail, Co-PI: Xin Li \$25,000, National Science Foundation, DMS 1604092, 2016-2017.
- Students Actualizing Talent at Education's Subsequent Stages (STATESS, PI: M. Shah), Co-PI, \$599,973, National Science Foundation, 2010-2014.
- CSUMS: Computational Mathematics with Emphasis on Computer Vision and Imaging Science (CMECVIS, PI: M. Shah), Co-PI, \$585,198, National Science Foundation, 2008 – 2012.
- Frequency Analysis Technique Applied to Transportation Freight, Goods, and Services Data, Principal Investigator, \$119,644, Florida Department of Transportation, 2004-2006.
- Mathematical Analysis of Algorithms in Integrated Signal and Image Sensing and Processing, Co-Principal Investigator, \$116,900, Lockheed Martin Missile and Fire Control, 2005
- An International Conference on CONSTRUCTIVE FUNCTIONS, PI: D. Lubinsky, Co-

Principal Investigator, \$16,500, National Science Foundation, 2004.

- Advanced Image Based Target Tracking, PI: R.N. Mohapatra, Co-Principal Investigator, \$106,667, Lockheed Martin Missiles Systems, 2002-2003.
- Multiresolution Video Tracking, PI: R.N. Mohapatra, Co-Principal Investigator, \$90,000.00, Lockheed Martin Missiles Systems, 2001.
- Scientific Computing Research Environment for Mathematical Science, Principal Investigator, \$51,218.00, National Science Foundation, 1998-2000.
- Enhancement of Undergraduate Electrical Engineering Program: Option of Power Engineering, PI: Z. Qu, Co-Principal Investigator, \$108,774.00, University of Central Florida, 1996-1997.
- Numerical Approximation of Integrals, Principal Investigator, \$6,500.00, Office of Sponsored Research, University of Central Florida, 1993-1994.

## RESEARCH AND PUBLICATIONS:

Research Interests:

APPROXIMATION THEORY  
ORTHOGONAL POLYNOMIALS AND RATIONAL FUNCTIONS  
COMPUTER VISION, IMAGE AND SIGNAL ANALYSIS  
EDUCATION

### Publications in APPROXIMATION THEORY, SPECIAL FUNCTIONS:

1. D. Huang, Z. Ye, X. Wang and X. LI, *On Uniqueness of Solution to Pointwise Landau Problem on the Finite Interval*, Approximation Theory and its Applications, **2**(1986), 39-47.
2. X. LI, E.B. Saff and Z. Sha, *Behavior of Best  $L_p$  Polynomial Approximation on the Unit Interval and on the Unit Circle*, Journal of Approximation Theory, **63**(1990), 170-190. (12 citations)
3. X. LI and E.B. Saff, *On Nevai's Characterization of Measures with Almost Everywhere Positive Derivative*, Journal of Approximation Theory, **63**(1990), 191-197.
4. X. He and X. LI, *Uniform Convergence of Polynomials Associated with Varying Jacobi Weights*, Rocky Mountain Journal of Mathematics, **21**(1991), 281-300. (11 citations)
5. X. LI and K. Pan, *Asymptotics for  $L_p$  Extremal Polynomials on the Unit Circle*, Journal of Approximation Theory, **67**(1991), 270-283. (12 citations)
6. M.E.H. Ismail and X. LI, *On Sieved Orthogonal Polynomials IX: Orthogonality on the Unit Circle*, Pacific Journal of Mathematics, **153**(1992), 289-297. (22 citations)
7. M.E.H. Ismail and X. LI, *Bound on the Extreme Zeros of Orthogonal Polynomials*, Proceedings of the American Mathematical Society, **115**(1992), 131-140. (93 citations)
8. X. LI, *A Note on Orthogonal Polynomials*, Rocky Mountain Journal of Mathematics, **22**(1992), 953-956.

9. X. LI, *Remarks on Orthogonal Polynomials with Respect to Varying Measures and Related Problems*, International Journal of Mathematics and Mathematical Sciences, **16**(1993), 255-258.
10. X. LI, R.N. Mohapatra and R.S. Rodriguez, *On Markov's Inequality on  $\mathbf{R}$  for the Hermite Weight*, Journal of Approximation Theory, **75**(1993), 115-129.
11. X. LI and R.N. Mohapatra, *On the Divergence of Lagrange Interpolation with Equidistant Nodes*, Proceedings of the American Mathematical Society, **118**(1993), 1205-1212. (10 citations)
12. X. LI, *On a Subclass of  $C^1$  Functions for Which the Lagrange Interpolation Yields the Jackson Order of Approximation*, International Journal of Mathematics and Mathematical Sciences, **17**(1994), 209-216.
13. X. LI, *On the Size of Polynomials with Curved Majorant*, Journal of Approximation Theory. **76**(1994), 93-106.
14. X. LI, *Ranges of Polynomials with Curved Majorants*, Acta Mathematica Hungarica, **65**(1994), 297-304.
15. T. Erdelyi, X. LI, and E.B. Saff, *Remez and Nikolskii Type Inequalities for Logarithmic Potentials*, SIAM Journal on Mathematical Analysis, **25**(1994), 365-383. (21 citations)
16. X. LI and E.B. Saff, *Behavior of Lagrange Interpolants to the Absolute Function in Equally Spaced Points*, Rendiconti di Matematica, Serie VII, **14**(1994),
17. X. LI and E.B. Saff, *Local Convergence of Lagrange Interpolation Associated with Equidistant Nodes*, Journal of Approximation Theory, **78**(1994), 213-225. (10 citations)
18. X. LI and K. Pan, *Asymptotic Behavior of Orthogonal Polynomials Corresponding to Measure with Discrete Part off the Unit Circle*, Journal of Approximation Theory, **79**(1994), 54-71. (16 citations)
19. X. LI, *Asymptotics of Columns in the table of Orthogonal Polynomials with Varying Measures*, Methods and Applications of Analysis, **2**(2)(1995), 222-236.
20. X. LI, *On the Lagrange Interpolation for a Subset of  $C^k$  Functions*, Constructive Approximation, **11**(1995), 287-297. (8 citations)
21. X. LI, *On the Convergence of Double Least-squares Inverses*, Proceedings of the International Conference on Computational Methods and Function Theory (Eds. R.M. Ali, E.B. Saff, and St. Ruscheweyh), 1995, 101-108.
22. X. LI, R.N. Mohapatra and R.S. Rodriguez, *Bernstein Type Inequalities for Rational Functions with Prescribed Poles*, Journal of the London Mathematical Society, (2)**51**(1995), 523-531. (20 citations)
23. X. LI and F. Marcellan, *On Polynomials Orthogonal with Respect to Sobolev Inner Product on the Unit Circle*, Pacific Journal of Mathematics, **175**(1996), 127-146. (11 citations)
24. X. LI and K. Pan, *Strong and Weak Convergence of Rational Functions Orthogonal on the Unit Circle*, Journal of London Mathematical Society, (2)**53**(1996), 289-301. (17 citations)
25. X. LI, *Integral Formulas and Bernstein Inequalities for Rational Functions*, Journal of Mathematical Analysis and Applications, **211**(1997), 386-394.



26. X. LI, *How Good (or bad) is Lagrange Interpolation?*, in *Fourier Analysis, Approximation Theory and Applications* (eds. Z.U. Ahmad, N.K. Govil and P.K. Jain), New Age International, New Delhi, 1997, 135-143.
27. X. LI, *On Chebyshev inequality*, in *Approximation Theory, In memory of A.K. Varma*, (N.K. Govil, R.N. Mohapatra, Z. Nashed, A. Sharma, J. Szabados, Eds.), Marcel Dekker, New York, 1998, 353-362.
28. R. Jones, X. LI, R.N. Mohapatra and R.S. Rodriguez, *On the Bernstein Inequalities for Rational Functions with a Prescribed Zero*, *Journal of Approximation Theory*, **95**(1998), 476-496.
29. X. LI, *Separation theorem of Chebyshev-Markov-Stieltjes Type for Laurent Polynomials Orthogonal on  $(0, +1)$* , in *Orthogonal Functions, Moment Theory and Continued Fractions: Theory and Applications* (W.B. Jones and A. Sri Ranga, Eds.), Marcel Dekker, New York, 1998, 327-341.
30. X. LI, *Convergence of Interpolating Laurent Polynomials on an Annulus*, *Contemporary Mathematics*, **236**(1999), 193—204.
31. X. LI and F. Marcellan, *Representations of Orthogonal Polynomials for Modified Measures*, *Communications in the Analytic Theory of Continued Fractions*, 7(1999), 9-22
32. X. LI, *Regularity of Orthogonal Rational Functions with Poles on the Unit Circle*, *Journal of Computational and Applied Mathematics*, **105** (1999), 371-383.
33. X. LI, *Rational Interpolation to Functions on the Unit Circle*, *Methods and Applications of Analysis*, **6**(1999), 81-96.
34. X. LI, *Approximation by Rational Functions in Hardy Space*, *Computers and Mathematics with Applications*, **40**(2000), 137-143.
35. H. Carley and X. LI, *The Modulus of Polynomials with Zeros at the Roots of Unity*, *American Mathematical Monthly*, **107**(2000), 742-748.
36. X. LI and R.N. Mohapatra, *Extended Means as Weighted Means*, *Proceedings of the Royal Society of London A*. **457**(2001), 1273-1275.
37. H. Carley, X. LI, and R.N. Mohapatra, *A Sharp Inequality of Markov-type for Polynomials Associated with Laguerre Weights*, *Journal of Approximation Theory*, **113**(2001), 221-228.
38. X. LI, R.N. Mohapatra and R.S. Rodriguez, *Gruss-type Inequalities*, *Journal of Mathematical Analysis and Applications*, **267**(2002), 434-443. (29 citations)
39. D.H. Kim, S.H. Kim, K.H. Kwon, X. LI, *Best Polynomial Approximation in Sobolev-Laguerre and Sobolev-Legendre Spaces*, *Constructive Approximation*, **18**(2002), 551-568.
40. X. LI, *An Extremal Problem and an Estimation of Wronskian for Certain Jacobi Weights*, *Journal of Computational and Applied Mathematics*, **153**(2003), 311-320.
41. C.F. Bracciali, X. LI, and A. Sri Ranga, *Real Orthogonal Polynomials in Frequency Analysis*, *Mathematics of Computation*, **74**(2005), 341--362. (28 citations)
42. X. LI and A. Sri Ranga, *Szego Polynomials and the Truncated Trigonometric Moment Problems*, *the Ramanujan Journal*, **12** (2006), 461-472.

43. M.E.H. Ismail and X. LI, *Orthogonal Polynomials and Ramanujan's q-continued fractions*, Electronic Transactions on Numerical Analysis, **25**(2006), 158-165.
44. M.E.H. Ismail and X. LI, *Functions Whose Moments form a Geometric Progression*, in "Topics in Classical Analysis and Applications in Honor of Daniel Waterman" (ed. L. De Carli, K. Kazarian, and M. Milman), World Scientific, Singapore, 2008, 110-117.
45. X. LI, *A Comparison Inequality for Rational Functions*, Proceedings of American Mathematical Society, **139** (2011), 1659-1665.
46. M.E.H. Ismail and X. LI, *Plancherel-Rotach Asymptotics for q-Orthogonal Polynomials*, Constructive Approximation, **37** (2013), 341-356.
47. M.E.H. Ismail, X. LI, and M. Rahman, *Landau Constants and Their q-Analogues*, Analysis and Applications, **13**(2015), 217-231.
48. X. LI and Alexander Tovstolis, "Poisson Summation Formula in Hardy Space  $H^p(T_\Gamma)$ ,  $p \in (0,1)$ ", Computational Methods and Function Theory, 16(2016), 689-697.
49. X. LI, Ram Mohapatra, and Rajitha Ranasinghe, "Some Rational Inequalities Inspired by Rahman's Research", in Progress in Approximation Theory and Applicable Complex Analysis – In Memories of R.I Rahman (edited by N.K. Govil et al), Springer Optimization and Applications, 2017, 105-127.
50. Aritra Dutta and X. LI, "On a Problem of Weighted Low Rank Approximation of Matrices", SIAM Journal on Matrix Analysis and Applications, 38 (2)(2017), 530-553.
51. T. Boas, A. Dutta, X. LI, K. Mercier and E. Niderman, "Shrinkage Function and Its Applications in Matrix Approximation", Electronic Journal of Linear Algebra, 32(2017), 163–171.
52. Rajitha Ranasinghe and X. LI, "Askey-Wilson Operator on Entire Functions of Exponential Type", Proceedings of American Mathematical Society, **146** (2018), 4283-4292.
53. Rajitha Ranasinghe and X. LI, "A Bernstein type inequality for the Askey-Wilson Operator", Journal of Approx. Theory, **240** (2019), 145-157.

Publications in DOUBLY STOCHASTIC PROCESS, SPATIAL PROCESS:

54. R.M. Caron, X. LI, P. Mikusinski, H. Sherwood, M. Taylor, *Nonsquare "Doubly Stochastic" matrices*, in Distributions with Fixed Marginals and Related Topics, (ed. Ruschendorf et. al.), IMS Lecture Notes - Monograph Series, **28**(1996), 65-75.
55. X. LI, P. Mikusinski, H. Sherwood, M. Taylor, *In Quest of Birkhoff's Theorem in Higher Dimensions*, in Distributions with Fixed Marginals and Related Topics, (ed. Ruschendorf et. al.), IMS Lecture Notes - Monograph Series, **28**(1996), 187-191.
56. X. LI, P. Mikusinski, H. Sherwood and M. Taylor, *On Approximation of Copulas*, in Distributions with Given Marginals and Moment Problems (V. Benes and J. Stepan, Eds.), Kluwer Academic Publishers, Dordrecht, 1997, 107-116.
57. X. LI, P. Mikusinski and M. Taylor, *Strong Approximation of Copulas*, Journal of Mathematical Analysis and Applications, **225**(1998), 608-623. (69 citations)
58. B.B. Bhattacharyya, X. LI, M. Pensky and G.D. Richardson, *Testing for Unit Roots in a Nearly Nonstationary Spatial Autoregressive Process*, Annals of the Institute of

Statistical Mathematics, **51**(2000), 71-83.

59. X. LI, P. Mikusinski and M. Taylor, *Remarks on convergence of Markov operators*, Houston Journal of Mathematics, **28**(2002), 907-916.
60. X. LI, P. Mikusinski and M. Taylor, *Integration-by-parts and Strong convergence of Copulas*, in: Distributions with Given Marginals and Statistical Modeling (Barcelona, 2000), 153-159, Kluwer Acad. Publ., Dordrecht, 2002. (14 citations)
61. Y. Boissy, B.B. Bhattacharyya, X. LI, G.D. Richardson, *Parameter Estimates for Fractional Autoregressive Spatial Processes*, Annals of Statistics, **33**(2005), 2553-2567. (38 citations)

#### Publications in COMPUTER VISION, IMAGE AND SIGNAL ANALYSIS:

62. A. Yilmaz, K. Shafique, N. Lobo, X. LI, T. Olson and M. Shah, *Target Tracking in FLIR Imagery Using Mean Shift and Global Motion Compensation*, IEEE Workshop Computer Vision Beyond Visible Spectrum, 2001, 54-58. (67 citations)
63. R. Muise, A. Mahalanobis, R. Mohapatra, X. LI, D. Han, W. Mikhael, *Constrained quadratic correlation filters for target detection*, Applied Optics, **43**(2004), 304-314. (19 citations)
64. A. Yilmaz, X. LI, and M. Shah, *Object Contour Tracking Using Level Sets*, Proc. of 6th Asian Conference on Computer Vision (ACCV), 2004. (90 citations)
65. A. Yilmaz, X. LI, and Mubarak Shah, *Contour Based Object Tracking with Occlusion Handling in Video Acquired Using Mobile Cameras*, IEEE Trans. Pattern Analysis and Machine Intelligence, November **26**(2004), 1531-1536. (591 citations)
66. M. Abdel-Aty, C. Lee, Y. Bai, X. LI and M. Michalak, *A Two-stage Approach to identify Flight Delay Pattern*, 86th Annual Meeting of the Transportation Research Board, January 2006. (26 citations)
67. M. Abdel-Aty, C. Lee, Y. Bai, X. LI and M. Michalak, *Detecting periodic patterns of arrival delay*, Journal of Air Transport Management, **13**( 2007), 355-361. (27 citations)
68. Z. Qu, J. Wang, and X. LI, *Quadratic Lyapunov Functions for Cooperative Control of Networked Systems*, Control and Automation, 2007. ICCA 2007. IEEE International Conference on Control and Automation, 2007. (3 citations)
69. Y. Sheikh, X. LI, and M. Shah, *Trajectory Association across Non-overlapping Moving Cameras in Planar Scenes*, Computer Vision and Pattern Recognition, 2007, (CVPR '07. IEEE Conference on 17-22 June 2007), (20 citations)
70. D. Han, X. LI, R.N. Mohapatra, M. Michalak, Z.Nashed, and R. Muise, *Refining Algorithms in Correlation Filter Design for Target Detection*, CISP2008, Congress on Image and Signal Processing, 2008. (61 citations)
71. O. Oreifej, X. LI, M. Shah, *Simultaneous Turbulence Mitigation and Moving Object Detection by Three-Way Low-Rank Decomposition*, IEEE Trans. Pattern Analysis and Machine Intelligence, **35**(2013), 450-462. (97 citations)

72. A. Dutta, X. LI, A fast algorithm for a weighted low rank approximation. In IEEE 2017 Fifteenth IAPR International Conference on Machine Vision Applications (MVA), 93-96, 2017
73. A. Dutta, X. LI, "Weighted low rank approximation for background estimation problems", IEEE International Conference on Computer Vision Workshops, ICCV, 2017, 1853-1861.
74. A. Dutta, X. LI, and P. Richtarik, "A Batch-Incremental Video Background Estimation Model using Weighted Low-Rank Approximation of Matrices", IEEE International Conference on Computer Vision Workshops, ICCV, 2017, 1835-1843.
75. A. Dutta, X. LI, "A Fast Weighted SVT Algorithm", in proceedings of IEEE 5th International Conference on Systems and Informatics (ICSAI 2018), 2018, 1022-1026.

Publications in EDUCATION:

76. X. LI, Problem 10250, *American Mathematical Monthly*, **111**(1992), 11. Solution, 111(1993), 11.
77. X. LI, Fourier Analysis, in *Encyclopedia of Electrical and Electronics Engineering* (John G. Webster, Ed.), John Wiley & Sons, New York, 1998, 692-703.
78. X. LI, N. Lobo, and M. Shah, *GAUSS: A CSUMS Project at UCF*, IEEE International Conference on Education Technology and Computer (ICETC), June 22-24, 2010.
79. X. LI and M. Shah, *Using Computer Vision and Image Analysis for Training Undergraduate Students in Numerical Methods*, International Conference on Engineering and Meta-Engineering, 2012.
80. J. Liang and X. LI, *An Interactively Reweighted Least Square Implementation for Face Recognition*, UCF Undergraduate Journal, **6**(2012), 26-32.
81. Dagley, M., Gill, M., Saitta, E., Moore, B., Chini, J., and Li, X. (2018). *Using Active Learning Strategies in Calculus to Improve Student Learning and Influence Mathematics Department Cultural Change*. Proceedings of the Interdisciplinary STEM Teaching and Learning Conference, **2**(8), 64-86.

Book Review and Edited Volumes:

82. X. LI, Review on "Orthogonal Rational Functions" by Adhemar Bultheel, Pablo Gonzalez-Vera, Erik Hendiksen, and Olav Njastad, (Cambridge University Press, 1999), *Journal of Approximation Theory*, (2000), 11-12.
83. Lubinsky, Doron; Dahmen, Wolfgang; Geronimo, Jeff; LI, XIN; Pritsker, Igor; Sloan, Ian Special Volume on Constructive Function Theory [Dedicated to Ed Saff on the occasion of his 60th birthday]. *Electron. Trans. Numer. Anal.* 25 (2006)
84. M. Z. Nashed and X. LI (ed), *Frontier of Orthogonal Polynomials and q-Series*, World Scientific, (562 pages), 2018.

Presentation of Research Papers:

INTERNATIONAL MEETINGS:

- "A fast weighted singular value thresholding method", AMS Special session on Optimal Methods in Applicable Analysis: Variational Inequalities, Low Rank Matrix

Approximations, Systems Engineering, Cyber Security (invited), Joint Meeting of Mathematics, January 2019

- “*A fast weighted SVD algorithm*”, IEEE 5th International Conference on Systems and Informatics (ICSAI 2018), Nanjing, China, November, 2018
- “*Kolmogorov representation and deep learning*”, INFORMS Annual Meeting, Special Session: Optimization and Approximation Theory in Machine Learning, Phoenix, AZ, USA, 2018
- “*Long time asymptotics of Schur and related flows*”, Symmetries and Integrabilities in Difference Equations (SIDE13), Fukuoka, Japan, November, 2018
- “*On the asymptotic behavior of the solutions to the general weighted low rank approximation as one block of the weights approach to infinity.*”, AMS Special Session on Advanced Mathematical Programming and Applications (invited), Joint Meeting of Mathematics, January 2017.
- “*A Fast Algorithm for a Weighted Low Rank Approximation*”, IAPR MVA2017, Nagoya, Japan, May, 2017
- “*A Bernstein Inequality for Askey-Wilson Operator*”, International Conference on Special Functions: Theory, Computation, and Applications, City University of Hong Kong, June, 2017. (Invited Speaker)
- *How to better prepare secondary mathematics teachers for graduate mathematics courses*, Saturday January 9, 2016, AMS Session on Mathematics Education, Room 615, Washington State Convention Center, contributed.
- *On an alternating direction method for solving a weighted low-rank approximation problem*, Saturday January 9, 2016, AMS Special Session on Mathematical Programming on Integral Invexity, Skagit 4, Skagit Lower Level, Washington State Conference Center, invited.
- *Some New Results on Bernstein-type Inequalities for a Rational Functions*, International Conference on Orthogonal Polynomials and q-series, May 10-12, 2015, Orlando, Florida
- *A General Family of 2D Polynomials Orthogonal on the Unit Disk*, International Conference on Orthogonal Polynomials, Integral Systems, and their Applications, October 25-30, 2014, Shanghai and Shaoxing, China.
- *A Generalization of Riesz Interpolation Formula*, International Conference on Approximation Theory and Applications, May 20-24, 2013, Hong Kong, China.
- *GAUSS: A CSUMS Project at UCF*, IEEE International Conference on Education Technology and Computer (ICETC), June 22-24, 2010, Shanghai, China.
- *Kolmogorov's Universal Representation Theorem and Its Application in Image Analysis*, The Fifth World Congress of Nonlinear Analysts, July 2 - July 9, 2008, Orlando, Florida.
- *Polynomial inequalities via rational functions*, Workshop on Special Functions and Orthogonal Polynomials, Foundations of Computational Mathematics 2008, June 16-18, Hong Kong.
- *Refining algorithms in correlation filter design for target detection*, 2008 Congress on Image and Signal Processing, May 27 -30, Sanya, Hainan, China,

- *Functions whose moments form a geometric progression*, Modern Approaches in Asymptotics of Polynomials, Banff International Research Station, November 11-16, 2007.
- *On zeros of self-reflective polynomials*, 12<sup>th</sup> International Conference of Statistics, Combinatorics, Mathematics and Applications, Auburn University, Auburn, Alabama, 12/03-12/04/2005.
- *Ramanujan's q-fractions*, Constructive Function Theory, Georgia Institute of Technology, November 9-11, 2004.
- *Truncated rational moment problems and quadratures*, American Mathematical Society Annual Meeting, Phoenix, AZ, January 7-10, 2004.
- *Szego polynomials and the truncated trigonometric moment problem*, International Conference on Advances in Constructive Approximation, Vanderbilt University, Nashville, TN, May 14-17, 2003.
- *Various forms of the frequency analysis problem and its numerical solution in presence of noise*, the XXVth National Congress of Applied and Computational Mathematics, September 16-19, 2002, Nove Friburgo, Rio de Janeiro, Brazil, one-hour plenary talk.
- *Frequency analysis problem in presence of noise*, A Mathematics Odyssey: Conference/Workshop on Continued Fractions, Orthogonal Functions and Related Topics, Grand Junction, Colorado, May 26 – 30, 2001.
- *An extremal problem and an estimation of the Wronskian of certain Jacobi Polynomials*, Sixth International Symposium on Orthogonal Polynomials, Special Functions and Their Applications, Rome, Italy, June 18-22, 2001.
- *Generalized Toeplitz matrices associated with rational orthonormal basis*, NATO Advanced Study Institute: Special Functions 2000 --- Current Perspective and Future Directions, Tempe, Arizona, May 29-June 9, 2000.
- *Mean convergence of rational functions interpolating on the unit circle*, International Workshop on Special Functions -- Asymptotics, Harmonic Analysis and Mathematical Physics, Hong Kong, June 21-25, 1999.
- *Rational interpolation to functions on the unit circle*, Analytic Theory of Continued Fractions and Related Topics, Boulder, Colorado, May 26-30, 1998.
- *Convergence of interpolating Laurent polynomials on an Annulus*, Continued Fractions: from analytic number theory to constructive approximation, Columbia, Missouri, May 20-23, 1998.
- *Regularity of orthogonal rational functions on the unit circle*, Continued Fractions and Geometric Function Theory, Trondheim, Norway, June 24-28, 1997.
- *Orthogonal Polynomials and Bernstein Inequalities and Separation Theorem of Chebyshev-A.Markov-Stieltjes for Laurent Polynomials Orthogonal on  $(0, +1)$* , Workshop on "Special Functions, q-Series and Related Topics", The Fields Institute for Research in Mathematical Sciences, Toronto, Ontario, June 12-23, 1995.
- *On the asymptotics of the columns in the table of orthogonal polynomials with varying*

*measures*, Workshop on "Orthogonal Polynomials on the Unit Circle", Madrid, Spain, June 1994, two one-hour lectures.

- *On the convergence of double least-squares inverses*, International Conference on Computational Methods and Function Theory, Penang, Malaysia, March 1994.
- *Nonsquare doubly stochastic matrices*, AMS-SIAM-IMS Summer Conference on Mathematical Research "Distributions with Fixed Marginals, Doubly Stochastic Matrices, and Markov Operators", Seattle, WA, August 1993.
- *Remarks on orthogonal polynomials with respect to varying measures and related problems*, Seventh International Symposium on Approximation Theory, Austin, Texas, January 1992.
- *On Saff's contamination principle in  $L_2$  approximation on  $\mathbf{R}$* , US-USSR Workshop on "Methods of Approximation Theory in Complex Analysis and Mathematical Physics", Leningrad, Former Soviet Union, May, 1991.
- *On Markov's inequality on  $\mathbf{R}$  for Hermite weight*, the American Mathematical Society Southeast section Meeting, Tampa, FL., 1991.
- *Uniform convergence of polynomials associated with varying Jacobi weights*, US-Norway Workshop on "Pade Approximation and Related Topics", Boulder, CO., 1988.

## 2. REGIONAL MEETINGS AND SEMINARS:

- "When Askey-Wilson Operator Meets the Sampling Theorem", Colloquium, Central South University, China, November, 2018.
- "A weighted max-min-max problem on the unit circle", AMS Special Session on Extremal Problems in Approximations and Geometric Function Theory, Joint Mathematical Meetings, San Diego, January 2018.
- "Boas Formula for Askey-Wilson Operator on Entire Functions of Exponential Type". American Mathematical Society Southeastern Meeting, Orlando, UCF, September 2017.
- "Recovery of Functions of Few Variables in High Dimensional Spaces", Colloquium, College of Science, Ningbo University, May 22, 2017
- "Recovery of Functions of Few Variables in High Dimensional Spaces", Colloquium, College of Mathematics, Physics, and Information, Shaoxin University, May 23, 2017.
- *Weighted low-rank matrix approximation: a new algorithm based on optimization*, AMS Special Session on Accelerated Advances in Multiobjective Optimal Control Problems and Mathematical Programming Based on Generalized invexity Frameworks, Joint Mathematical Meetings, January 10, 2015, San Antonio
- *A Blind Matrix Decomposition Algorithm*, SIAM Minisymposium on Multivariate Signal Analysis and Inverse Problems, Joint Mathematical Meetings, January 12, 2015, San Antonio

- *Some problems of matrix decomposition and their applications in object tracking*, Seminar, October 30, 2014, Numerical Optimization Group, Nanjing University, China
- *On Finite Blaschke Products Interpolating on the Unit Circle*, Constructive Functions 2014, May 26-30, 2014, Nashville, TN.
- *Singular Value Thresholding for Tracking in Video Sequences*, Imaging and Image Processing with Applications, 38<sup>th</sup> Annual SIAM Southeastern Atlantic Section 2014, March 29-30, Melbourne, FL.
- *Asymptotic Inequalities for Landau Constants*, Spring Southeastern Sectional Meeting, University of Mississippi, Oxford, MS, March 1-3, 2013 (Friday - Sunday), Meeting #1087, March 1-3, 2013
- *Matrix Decomposition and Moving Object Detection*, Colloquium, City University of Hong Kong, Oct. 3, 2012
- *Bernstein's comparison inequality for rational functions*, Analysis Seminar, University of Hong Kong, Nov. 30, 2012.
- *Computational compressive sensing and its applications*, Analysis Seminar, City University of Hong Kong, July 3, 2010.
- *Techniques for reducing dimensionality*, NSF Workshop on Quantitative Omics Data Analysis, November 1-2, 2007, Murfreesboro, TN.
- *Degree of approximating splines and an identity on Stirling numbers of the second kind*, Special Session on Splines and Wavelets with Applications, American Mathematical Society Meeting 1033, November 3-4, 2007, Murfreesboro, TN.
- *Difference and  $q$ -difference equations*, American Mathematical Society Meeting, Miami, Florida, May, 2006.
- *A Curious Identity on the Stirling Numbers of the Second Kind*, 1010<sup>th</sup> American Mathematical Society Meeting, East Tennessee State University, Johnson City, Tennessee, 10/15-10/16/2005.
- *Limits of sequence of orthogonal polynomials in Sobolev spaces*, American Mathematical Society, Southern Regional Meeting, (Atlanta, GA, March, 2002).
- *Best approximation in Sobolev spaces*, Colloquium, Department of South Florida, (Tampa, FL, February, 2002).
- *Rational approximation in Hardy spaces*, Colloquium, Department of Mathematics, Norwegian Institute of Technology, (Trondheim, Norway, November, 1998).
- *Approximation by rational functions*, American Mathematical Society Meeting #919, (Memphis, Tennessee, March 21-22, 1997).



- *Using TI-92 in teaching trigonometric functions*, Workshop on TI-92, (Orlando, August, 1996).
- *On the convergence of rational functions orthogonal on the unit circle and The K-result for the R-process*, Workshop on "Analytic Theory of Continued Fractions and Related Topics", (Boulder, CO., July, 1994).
- *Polynomials orthogonal on the unit circle*, Colloquium, Department of Mathematics, University of Granada, (Granada, Spain, June, 1994).
- *On polynomials orthogonal with respect to Sobolev inner product on the unit circle*, Workshop on "Analytic Theory of Continued Fractions and Related Topics", (Boulder, CO., July, 1993).
- *On Lagrange Interpolation*, Approximation Seminar, University of South Florida, (Tampa, FL., July 29, 1992).
- *Start with Cauchy's integral formula*, Mathematics Colloquium, UCF, (Orlando FL., 1992).

Other Professional Activities:

Reviewer of Mathematical Review.

Served as referee for:

Journal of Approximation Theory

Constructive Approximation

SIAM Journal on Mathematical Analysis

International Journal of Mathematics and Mathematical Sciences

Journal of Mathematical Analysis and its Applications

Journal of Computational and Applied Mathematics

Journal of Computational Analysis and Applications

Journal of Physics A

Transaction of the American Mathematical Society

Methods and Applications of Analysis

Vietnam Journal of Mathematics

1995 AMS Southeast Section Meeting Committee:

Organizer of the special session "Approximation Theory and Special Functions"

Co-Organizer for "An International Conference on Constructive Approximation 2004" at Georgia Tech, (Dedicated to Professor E.B. Saff)

Organizing Committee: International Conference on Orthogonal Polynomials and q-Series 2015, (Dedicated to Professor Mourad Ismail)

Local Organizer: AMS Fall Southeastern Sectional Meeting, 2017

Organizing Committee: Frontiers of Mathematical Biology: Modeling, Computation and Analysis, 2018

**TEACHING EXPERIENCE:**

#### Undergraduate Courses:

Trigonometry, College Algebra, Business Calculus, Calculus I (50-450 seats), II, and III, Calculus I and II for honors students, Honors Seminar (Computer Vision Guided Tour of Mathematics), Ordinary Differential Equations, Matrix and Linear Algebra, Modern Geometries, Mathematical Modeling I and II, History of Mathematics, Complex Variables

#### Graduate Courses:

Analysis I and II, Topics in Advanced Calculus, Introduction to Differential Geometry, Scientific Computing, Approximation Theory, Special Functions, Spline Functions and Data Fitting, Foundations of Analysis (Topology), Complex Analysis, Real Analysis, Applied Numerical Methods, Mathematical Methods for Image Analysis.

#### Ph.D. Dissertation Supervised:

- Sidra Van DeCar, “Inequalities for Rational Functions in Integral Norms”, Summer, 2003.
- Donald Bryant, “Kolmogorov Theorem and Its Applications in Image Analysis”, Summer 2008
- Rachid Simmoun, “Szego Polynomials and Time Series Analysis”, in progress
- Aritra Dutta, “Weighted Low-rank Approximation of Matrices”, Fall 2016, (currently postdoc at KAUST)
- Cheng Cheng, “Sampling and Reconstruction of Spatial Signals”, Summer, 2017 (currently postdoc at Duke University)
- Rajitha Ranasinghe, “In Quest of Bernstein-Type Inequalities”, Summer 2018.

#### Master Research Reports Supervised:

- Charles Teagues, Jr. “Portrait of Hermite Error Formula”, Spring, 1992.
- Jeffrey L. Billeter, “Gibbs Phenomena in Cubic Splines Least Squares Approximation”, Fall, 1992.
- Thomas Rutenkroger “Solution of Boundary Value Problems by Cubic Splines”, Summer, 1993.
- Holly K. Carley “A Functional Approach in Obtaining Weighted Markov-Type Inequalities”, Spring, 1999.
- Mark Varvak “Chebyshev Polynomials and Their Applications to Error Estimation in Best Approximation”, Fall, 1999.
- Lan Dusty Nguyen, “Location of Zeros of Polynomials and Their Polar Derivatives”, Spring, 2002.
- Tim Long, “Frequency Analysis Problem in Presence of Noise”, Summer, 2002.
- Minzhe Pan, “Detection and approximation of function of two variables in high dimensions”, Fall, 2010.
- Ting Hu, “Convergence of the mean shift algorithm and its generalizations”, Summer 2011.

- Dmitriy Popov, “Iteratively reweighted least squares minimization with prior information: a new approach”, Fall 2011.

## **PROFESSIONAL SERVICE**

Department Chair: 8/2014 - present

Graduate Program Director: 12/2006 – 8/2012

### Department Committee:

Search Committee (1998-2004, chair 2004)

Chair’s Advisory Committee (elected, 2003-2005)

Peer Evaluation and Tenure & Promotion Committee (elected, 2001-2002)

Computer Committee (Chair, 1995-2011)

Research Committee (2000-2002)

Graduate Committee (1995-2003, 2005-present)

Undergraduate Curriculum Committee (1993-2005)

Department Library Committee (1992-2004)

Tenure and Promotion Committee (1997-8)

Graduate Student Mentor Committee (1990-present)

Mathematics/Business Articulation (1992-3)

College Algebra Textbook Selection Committee (1992-3)

Ordinary Differential Equation Textbook Selection Committee (1992-3)

Calculus II course, Coordinator (1992-3)

### College Committee:

Statistics Chair Search Committee (Chair, 2015)

Graduate Committee (2007-2012)

### University Committee:

Math Placement Committee (2017-present)

University Sabbatical Committee (2003-2005)

Faculty Senate (1998-2000)

Committee on Policies for Undergraduate Curriculum (1998-2000)

### Public Service:

- Judge in the 42nd International Science and Engineering Fair, Orlando, May 8, 1991.
- Judge in the 38th Annual State Science and Engineering Fair of Florida, Orlando, April 15, 1993.
- Contributing exam problems for the Mathematics Olympic for students from community colleges in Florida, March 1994.
- Judge in the Mu Alpha Theta Mathematical Competition at Lake Mary High School on February 8, 1997.

## Curriculum Vitae

### Biographical Data

**Name:** Mark Jeffrey Llewellyn

#### **Education:**

DOCTOR OF PHILOSOPHY – COMPUTER SCIENCE 1994  
*University of Central Florida Orlando, Florida*  
Dissertation Title: Temporal Extensions To The Relational Data Model  
Dissertation Advisor: Dr. Mostafa A. Bassiouni

BACHELOR OF SCIENCE – PHYSICS 1981  
*Indiana State University Terre Haute, Indiana*  
graduated cum laude - minor in Computer Science

BACHELOR OF ARTS -POLITICAL SCIENCE 1981  
*Indiana State University Terre Haute, Indiana*  
graduated cum laude - minor in Mathematics

#### **Experience:**

ASSOCIATE LECTURER: 8/2013-PRESENT  
*School of Computer Science, University of Central Florida, Orlando, Florida*

LECTURER: 1/2000-8/2013  
*School of Computer Science, University of Central Florida, Orlando, Florida*

VISITING LECTURER: 1998-1/2000  
*School of Computer Science, University of Central Florida, Orlando, Florida*

INDEPENDENT COMPUTER CONSULTANT: 1994 - 1998  
*W.H. Freeman and Company Publishers, New York, New York*

ADJUNCT INSTRUCTOR: 1/98 - 5/98  
*University of Central Florida, Orlando, Florida*

INDEPENDENT COMPUTER CONSULTANT: 1994 - 1996  
*Harper Collins College Publishers, Glenview, Illinois*

INDEPENDENT COMPUTER CONSULTANT: 1996 - 1998  
*Addison-Wesley-Longman, Reading, Massachusetts*

INDEPENDENT COMPUTER CONSULTANT: 1992 - 1996  
*Worth Publishers, New York, New York*

### Teaching (most recent 5 years)

Course #	Course Title	Hrs	Class	Semester	# of Students	Course Evaluation
CNT 4714	Enterprise Computing	3	Senior	FA 2013	70	4.44
COP 4710	Database Systems	3	Senior	FA 2013	70	4.62
CNT 4603	System Administration	3	Senior	FA 2013	90	4.43
CIS 4004	Web-Based IT	3	Senior	FA 2013	70	4.64
CNT 4714	Enterprise Computing	3	Senior	SP 2014	68	4.23
CNT 4603	System Administration	3	Senior	SP 2014	89	4.54
CIS 4004	Web-Based IT	3	Senior	SP 2014	84	4.51
CGS 2545	Database Concepts	3	Soph.	SP 2014	89	4.18
CIS 4004	Web-Based IT	3	Senior	SU 2014	40	4.50
CNT 4714	Enterprise Computing	3	Senior	SU 2014	44	4.78

COP 4600	Operating Systems	3	Senior	SU 2014	52	4.42
CIS 4004	Web-Based IT	3	Senior	FA 2014	69	4.74
CNT 4603	System Administration	3	Senior	FA 2014	109	4.68
CNT 4714	Enterprise Computing	3	Senior	FA 2014	70	4.76
CIS 4004	Web-based IT	3	Senior	SP 2014	90	4.55
CNT 4603	System Administration	3	Senior	SP 2014	79	4.59
CNT 4603	System Administration (WEB)	3	Senior	SP 2014	60	4.25
CNT 4714	Enterprise Computing	3	Senior	SP 2014	124	4.46
CIS 4004	Web-based IT	3	Senior	SP 2014	58	4.68
CNT 4603	System Administration	3	Senior	SP 2014	31	4.81
CNT 4714	Enterprise Computing	3	Senior	SP 2014	54	4.31
CIS 4004	Web-based IT	3	Senior	FA 2015	69	4.67
CNT 4603	System Administration	3	Senior	FA 2015	83	4.70
CNT 4603	System Administration (WEB)	3	Senior	FA 2015	56	4.35
CNT 4714	Enterprise Computing	3	Senior	FA 2015	111	4.64
CIS 4004	Web-based IT	3	Senior	SP 2016	62	4.79
CNT 4603	System Administration	3	Senior	SP 2016	41	4.81
CNT 4603	System Administration (WEB)	3	Senior	SP 2016	64	4.53
CNT 4714	Enterprise Computing	3	Senior	SP 2016	103	4.65
CIS 4004	Web-based IT	3	Senior	SU 2016	66	4.53
CNT 4603	System Administration	3	Senior	SU 2016	33	4.67
CNT 4714	Enterprise Computing	3	Senior	SU 2016	51	4.45
CIS 4004	Web-based IT	3	Senior	FA 2016	70	4.57
CNT 4603	System Administration	3	Senior	FA 2016	38	4.52
CNT 4603	System Administration (WEB)	3	Senior	FA 2016	95	4.67
CNT 4714	Enterprise Computing	3	Senior	FA 2016	77	4.71
CIS 3921	Careers in IT (new)	1	Junior	SP 2017	73	4.71
CIS 4004	Web-based IT	3	Senior	SP 2017	111	4.66
CNT 4603	System Administration	3	Senior	SP 2017	36	4.74
CNT 4603	System Administration (WEB)	3	Senior	SP 2017	76	4.71
CNT 4714	Enterprise Computing	3	Senior	SP 2017	89	4.59
CIS 4004	Web-based IT	3	Senior	SU 2017	37	4.45
CNT 4603	System Administration	3	Senior	SU 2017	26	4.94
CNT 4714	Enterprise Computing	3	Senior	SU 2017	46	4.53
CIS 3921	Careers in IT	1	Junior	FA 2017	106	4.61
CIS 4004	Web-based IT	3	Senior	FA 2017	68	4.6
CNT 4603	System Administration (F2F)	3	Senior	FA 2017	44	4.59
CNT 4603	System Administration (web-based)	3	Senior	FA 2017	95	4.64
CNT 4714	Enterprise Computing	3	Senior	FA 2017	82	4.5
CIS 3921	Careers in IT	1	Junior	SP 2018	75	4.75
CIS 4004	Web-based IT	3	Senior	SP 2018	109	4.72
CNT 4603	System Administration (F2F)	3	Senior	SP 2018	37	4.79
CNT 4603	System Administration (web-based)	3	Senior	SP 2018	70	4.6
CNT 4714	Enterprise Computing	3	Senior	SP 2018	96	4.88

## **Research**

**Areas of Interest:** database systems, virtualization, cloud computing

**Publications:**

*Instructor's Solutions Manual* (to accompany Modern Physics, 6e), M. Llewellyn, W.H. Freeman and Company, New York, Available online to instructors via W.H. Freeman website.

*Student Solutions Manual* (to accompany Modern Physics, 6e), M. Llewellyn, W.H. Freeman and Company, New York, 2012, ISBN-13: 0978-1-4292-7080-9, 101 pages.

*Instructor's Solutions Manual* (to accompany Modern Physics, 5e), M. Llewellyn, W.H. Freeman and Company, New York, 2008, ISBN: 978-0-7167-8472-2, 333 pages.

*Student Solutions Manual* (to accompany Modern Physics, 5e), M. Llewellyn, W.H. Freeman and Company, New York, 2008 – ISBN: 978-0-7167-8575-3, 95 pages.

“Experiences in Developing Objectives and Assessment Strategy for a Set of Core Courses in Computer Science Curriculum”, R. Guha, D. Workman, H. Foroosh, A. Guha, M. Llewellyn, S. Pattanaik, Proceedings of Sixth International Conference on Engineering Education, July 23 – 28, 2006, San Juan, PR.

*Instructor's Solutions Manual* (to accompany Modern Physics, 4e), M. Llewellyn and R. Llewellyn, W.H. Freeman and Company, New York, 2003, ISBN 0-7167-9868-9, 335 pages.

*Student Solutions Manual* (to accompany Modern Physics, 4e), M. Llewellyn and R. Llewellyn, W.H. Freeman and Company, New York, 2003, ISBN 0-7167-9844-1, 95 pages.

*Extending temporal query languages to handle imprecise time intervals*, M.A. Bassiouni and M. Llewellyn, Intl. Journal for Computer Languages, Elsevier Publishing, Vol.25, Issue 1, 1999, pp. 39-54.

---

*Instructor's Solutions Manual* (to accompany Modern Physics, 3e), M. Llewellyn, W.H. Freeman and Company, New York, 1999, ISBN 1-57259-793-3, 329 pages.

*Student Solutions Manual* (to accompany Modern Physics, 3e), M. Llewellyn, W.H. Freeman and Company, New York, 1999, ISBN 1-57259-792-5, 119 pages.

*A Model for Imprecision in Temporal Databases*, M. Llewellyn, and M. Bassiouni, Proc. Of the IASTED/ISMM Intl. Conf. On Intelligent Information Management Systems, 1995, pp. 1-4.

*Design and Implementation of Extended Boolean and Comparison Operators for Time-Oriented Query Languages*, M. A. Bassiouni, A. Mukherjee, and M.J. Llewellyn, *The Computer Journal*, Vol. 37, No. 7, 1994, pp. 576-587.

*Time-based Operators for Relational Algebra Query Languages*, M. Bassiouni, M. Llewellyn, and A. Mukherjee, *Computer Languages*, Vol 19, 1992, pp. 261-276.

*A Relational Calculus Query Language for Historical Databases*, M. Bassiouni, M. Llewellyn, *Computer Languages*, 1992, Vol 17, No.3, pp.185-197.

*Historical Database Views*, M. Llewellyn, and M. Bassiouni, *Information and Software Technology*, Vol 33, No. 2, March 1991, pp. 113-120.

*On the Definition and Maintenance of Database Views with Time-Varying Domains*, M. Bassiouni, and M. Llewellyn, Proc. of the 13<sup>th</sup> Annual IEEE Intl. Computer Software & Applications Conference (COMPSAC), 1989, pp. 201-208.

*Airborn Particulates Baseline of a Surface Coal Mine Expansion Area*, R.A. Llewellyn and M.J. Llewellyn, Proc. Indiana Academy of Science, Vol 89-1980, 1979, pp. 250-254.

*Preliminary Assessment of Fallout from the 1976-78 Nuclear Weapons Tests Conducted by the People's Republic of China*, R.A. Llewellyn, M.J. Llewellyn, and R.L. Cook, Proc. Indiana Academy of Science, Vol 88-1978, 1978, pp. 321-325.

### **Conferences and Delivered Papers:**

Attended the *Future of Information Processing – A Symposium to Celebrate the School of Electrical Engineering and Computer Science*. October 26-27, 2000. University of Central Florida.

Attended the University of Central Florida Summer 1998 Faculty Development Institute. Presented by the Office of Diversity Initiatives, the Faculty Center for Teaching and Learning, Human Resources, The Office of International Studies, and Quality Initiatives. The purpose of the Institute was to develop innovative curriculum projects. Delivered the paper titled: *Video Disk and Computer Assisted Instruction*, M. Llewellyn, D. Gamble, D. Weeks, and J. Brennan. Paper delivered to the 56<sup>th</sup> Annual Meeting of the Florida Academy of Sciences, March 12-14, 1992 in Orlando, Florida

Delivered the paper titled: *On the Definition and Maintenance of Database Views with Time-Varying Domains*, M. Bassiouni, and M. Llewellyn. Paper delivered to the 13<sup>th</sup> Annual IEEE COMPSAC Conference in Orlando, Florida on September 20-22, 1989.

### **Professional Activities**

#### **Departmental Activities:**

Coordinator for CS/IT Minor Programs (2006- present).

IT ABET Coordinator (2014 – present)

IT CORC chair (2016 – present)

Involved in administration and evaluation of the Computer Science Foundation Exam (2000 – 2014).

#### **External Activities:**

Actively review new textbooks in several areas of computer science for several different publishing companies.

### **Recognition and Awards:**

1979 Outstanding Junior Physics major – Indiana State University

Sigma Pi Sigma - Physics Honorary Society

Certified Thermogram Analyst

TIP award 2005

TIP award 2011

Promoted to Associate Lecturer – Spring 2013

# CURRICULUM VITA

## **Dr. Edgard Messan Maboudou**

Associate Professor  
Department of Statistics  
University of Central Florida  
(Office) 407-823-5532  
[edgard.maboudou@ucf.edu](mailto:edgard.maboudou@ucf.edu)

### **Education:**

- July 2006      **Ph.D. in statistics**, School of Statistics, University of Minnesota,  
Minneapolis, MN
- June 2005      **M.Sc in Statistics**, School of Statistics, University of Minnesota,  
Minneapolis, MN
- June 1992      **B.Sc in Mechanical Engineering**, University of Benin, Lome-Togo

### **Employment**

- 2013 – Present: **Associate Professor**, Department of Statistics, University of Central  
Florida, Orlando, Florida
- 2007 – 2013 **Assistant Professor**, Department of Statistics, University of Central  
Florida, Orlando, Florida

### **Research Interests:**

- Tensor Methods in Statistics, Support Tensor Methods
- Multivariate Statistics, High dimensional problems
- Data Mining, Segmentation Problems, Change point problems
- Support Vector machines, Support vector Regression, Kernel Methods
- Statistical quality control

### **Some Publications:**

- **Edgard M. Maboudou-Tchao**, “Wavelet Support Matrix Machines”, In



- publication in Springer as Chapter book.
- **Edgard M. Maboudou-Tchao**, “Kernel Methods for Changes Detection in Covariance Matrices” *Communications in Statistics – Simulation and Computation*, Vol 47, 6, pp 1704 – 1721, 2018.
  - **Edgard M. Maboudou-Tchao**, Ivair Silva, and Norou Diawara, (2016), “Monitoring the mean vector with Mahalanobis kernels” *Quality Technology and Quantitative Management (QTQM)*, DOI: 10.1080/16843703.2016.1226707.
  - Ivair Ramos Silva, **Edgard M. Maboudou-Tchao**, and Weslei L de Figueiredo, 2018, “Frequentist-Bayesian Monte-Carlo Test for Mean Vectors in High Dimension”, *Journal of Computational and Applied Mathematics*, Vol. 333, pp 51
  - **Edgard M. Maboudou-Tchao** and Ivair Silva, "Test for Mean Vectors in High Dimension", *Statistical Analysis and Data Mining (SADM)*. Special Issue JSM 2012, Vol. 6 (6), pp. 578 – 598, 2013
  - **Edgard M. Maboudou-Tchao** and Douglas Hawkins, “Detection of Multivariate Change-Point for Multivariate Data”, *Journal of Applied Statistics*, Vol. 40 (9), pp. 1979 – 1995, 2013.
  - **Edgard M. Maboudou-Tchao** and Norou Diawara, “A LASSO Chart for Monitoring the Covariance Matrix”, *QTQM* , 10 (1) pp. 95 – 114, 2013.
  - **Edgard M. Maboudou-Tchao** and Vincent Agboto, “Monitoring the Covariance Matrix with Fewer Observations than Variables”, *CSDA*, Vol. 64, pp. 99 – 112, 2013.

### Some Research Grant Support

- CHS: Small: Empowerment of Disabled individuals via an adaptive framework for indirect human robot interaction.  
 PI: Aman Behal  
 co-PI: Janan A. Smither, **Edgard M. Maboudou-Tchao**  
 Agency: National Science Foundation  
 Status: Funded
- RI: Medium: Social Learning in Mixed Human-Robot Communities for People with Disabilities.  
 PI: Aman Behal  
 co-PI: Peter Hancock, Ladislau Boloni, **Edgard M. Maboudou-Tchao**  
 Agency: National Science Foundation  
 Status: Funded

# Dr. Alexander V. Mantzaris

University of Central Florida  
Department of Statistics  
University of Central Florida (UCF)  
4000 Central Florida Blvd  
P.O. Box 162370  
Orlando, FL 32816-2370  
USA

Phone: +1 407 823 3631  
Fax: +1 407 823 3930  
Email: alexander.mantzaris@ucf.edu

## Academic Employment

Assistant Professor of Statistics, University of Central Florida (UCF); August 2016  
Postdoctoral Research Assistant (PDRA) University of Strathclyde, Department of Chemistry (2015 September till present)  
Secondment with Stipso and University of Strathclyde (2014 till 2015)  
Feasibility study with Stipso and University of Strathclyde (2014 March till June 2014; 3 months)  
KTP with University of Strathclyde and Bloom Agency (2013 till 2014)  
University of Strathclyde Postdoctoral Research Associate (PDRA)- Department of Mathematics and Statistics (2011 till 2013; 2 years)  
University of Edinburgh Research Associate (RA)- School of Informatics (2010 till 2011; 6 months)

## Education - PhD/MSc/BEng

PhD in the Institute for Adaptive and Neural Computation in the School of Informatics of the University of Edinburgh and BIOS (Biomathematics and Statistics Scotland) which was supervised by Professor Dirk Husmeier. Title: "Improved Bayesian methods for detecting recombination and rate heterogeneity in DNA sequence alignments" (2007-2011).  
MSc in Bioinformatics and Machine Learning from the University of Edinburgh, School of Informatics (2005-2006).  
BEng in Software Engineering from the University of Edinburgh, School of Informatics (2001-2005)

## Commercial/Industrial Employment

Stipso *Edinburgh, UK* (2014-2015)  
Bloom Agency *Leeds, UK* (January 2013-2014)  
Gulfstream Software Ltd *Edinburgh* (June-August 2009 and September-October 2008)  
Profile systems *Athens* (June-August 2004)  
Kintec *Athens* (June-August 2003)

## Impact/Recognition

Featured in, *The Economist*: An article (print and online) was dedicated to the results of my work on the analysis of the Eurovision song contest:  
<https://www.economist.com/blogs/graphicdetail/2018/05/daily-chart-7>  
<https://www.economist.com/news/europe/21742117-continent-annual-singing-tournament-becoming-increasingly-partisan-neighbourly-voting>

## Awards

Best student contribution at the international conference PRIB 2009 for "Distinguishing Region from Within-Codon Rate Heterogeneity in DNA Sequence Alignments"  
Given the title of Impact Champion researcher for Strathclyde University on two separate accounts, 2013 and 2014, for the collaborative research done with industrial partners.

Supervised the winning team of the *Siemens 2017 Wind Analytics Competition Award* at the 'UCF Big Data Analytics Symposium' (March 22, 2017)

Transportation Research Board (TRB) best student paper award 2018 for the paper on freeway operations: 'Investigating and Modeling the Illegal U-turn Violations at Medians of Limited Access Facilities' by Omar Al-Sahili, Haitham Al-Deek, Adrian Sandt, Alexander Mantzaris, John Roger, and Md Omar Faruk

## Grants and Funding

Co-PI for DARPA grant - Deep Agent: A Framework for Information Spread and Evolution in Social Networks \$6.2M (PI for the project is Ivan Garibay Eng at UCF)

15K from Bloom Agency for a one year secondment to pay my salary with matching funding from the Impact Acceleration Account (IAA) of Strathclyde University as part of the Knowledge Transfer Project (KTP). (2013)

16K from Stipso for a one year secondment to pay my salary with matching funding from the Impact Acceleration Account (IAA) of Strathclyde University as part of the Knowledge Transfer Project (KTP). (2014)

## Publications (selected)

"Exploring How Homophily and Accessibility Can Facilitate Polarization in Social Networks", Taylor, Cameron E. and Mantzaris, Alexander V. and Garibay, Ivan, *Information* 9(12), 2018

"Exploring social media network landscape of post-Soviet space", Alexander Semenov, Alexander V. Mantzaris, Alexander Nikolaev, Alexander Veremyev, Jari Veijalainen, Eduardo L. Pasilliao, Vladimir Boginsky, *IEEE Access*, 2018

"Examining the Schelling Model Simulation through an Estimation of Its Entropy", Alexander V. Mantzaris, Samuel R. Rein, and Alexander D. Hopkins, *Entropy*, (20)-9, 2018

"Preference and neglect amongst countries in the Eurovision Song Contest", Alexander V. Mantzaris, Samuel R. Rein, and Alexander D. Hopkins, *Journal of Computational Social Science*, (1), 1-14, DOI: 10.1007/s42001-018-0020-2, 2018

"Examining Collusion and Voting Biases Between Countries During the Eurovision Song Contest Since 1957", Alexander V. Mantzaris, Samuel R. Rein, and Alexander D. Hopkins, *Journal of Artificial Societies and Social Simulation (JASSS)*, vol21, issue1, 2018

"Asymmetry through Time Dependency" Alexander V. Mantzaris and Desmond J. Higham, *The European Physical Journal B*, vol 89, 2016

"Uncovering nodes that spread information between communities in social networks" Alexander V. Mantzaris *EPJ Data Science* Vol3, 1-17, 2014

"Discovering and validating influence in a dynamic online social network", Laflin Peter, Mantzaris Alexander V., Ainley Fiona, Otley Amanda, Higham Desmond J., *Social Network Analysis and Mining* 2013, vol 3

"Dynamic network centrality summarizes learning in human brain", Mantzaris Alexander V., Bassett Danielle S., Wymbs Nicholas F., Estrada Ernesto, Porter Mason A., Mucha Peter J., Grafton Scott T., Higham Desmond, *Journal of Complex Networks* (2013) <http://dx.doi.org/10.1093/comnet/cnt001>

## Conference Talks (selected)

"Examining the effect of polarization on Dynamic Communicators when allowed to compete for social influence" Cameron E. Taylor, Ivan Garibay, Alexander V. Mantzaris, CAPS (Complexity and Policy Studies) (2018)

"Investigating and Modeling a Different Type of Wrong-Way Driving: Illegal U-turn Violations at Medians of Freeways and Toll Roads" Omar Al-Sahili, Haitham Al-Deek, Alexander Mantzaris, TRB Annual Meeting, 2018

"Hierarchical Dynamic Walks" Alexander V. Mantzaris, Peter Grindrod, Desmond J. Higham, Heilbronn Annual Conference, Bristol (2015)

"Anticipating Activity in Social Media Spikes" Higham Desmond J., Mantzaris Alexander V., Peter Grindrod, Otley Amanda, Laflin Peter, ICWSM15- workshop on 'Modeling and Mining Temporal Interactions', 2015

Address: Department of Mathematics  
University of Central Florida  
4000 Central Florida Blvd.  
Orlando, FL 32816-1364, USA

Fax: 407-823-6253  
E-mail: [brian.moore@ucf.edu](mailto:brian.moore@ucf.edu)  
Web: [sciences.ucf.edu/math/bmoore/](http://sciences.ucf.edu/math/bmoore/)

## Education

- Ph.D. Mathematics**, University of Surrey, Guildford, England (2003)  
Thesis: A Modified Equations Approach for Multi-Symplectic Integration Methods  
Supervisor: Prof. Sebastian Reich
- M.S. Mathematical and Computer Sciences**, Colorado School of Mines, Golden, CO, (1999)  
Thesis: Spinodal Decomposition for Spatially Discrete Cahn-Hilliard Equations  
Adviser: Prof. Erik Van Vleck
- B.S. Mathematics**, Colorado Christian University, Lakewood, CO (1997)  
Scholastic Honors List (1995 – 1996), Deans List (1996 – 1997), Summa Cum Laude

## Academic Work Experience (All appointments are in mathematics departments.)

- Associate Professor** (with tenure), University of Central Florida (Aug. 2013 – Present)  
- Associated faculty member of the Center for Research in Computer Vision (2012 – Present)
- Guest Associate Professor**, NTNU, Trondheim, Norway (Aug. 2015 – Dec. 2015)
- Assistant Professor**, University of Central Florida (Aug. 2007 – July 2013)
- Visiting Assistant Professor**, University of Iowa (Aug. 2005 – Jul. 2007)
- Postdoctoral Fellow**, McGill University, Montreal, Canada (Oct. 2003 – Sep. 2005)  
- Traveling waves for lattice differential equations (working with Prof. Tony Humphries)
- Research Assistant**, Imperial College, London, UK (Oct. 2000 – May 2003)

## Grants (Projects for undergraduate education and research are denoted by †.)

- \$999,994**† Basic Research Grant, **Co-PI** 20% credit, (Jan 2018 - Dec 2023)  
*National Science Foundation*, S-STEM: Scholarship Program for Transfer Students
- \$250,000**† Applied Research Grant, **Co-PI** 45% credit, (Jun 2015 - Jun 2018)  
*National Science Foundation*, IUSE: Growing as Adaptive Instructors in STEM
- \$249,784**† Applied Research Grant, **Co-PI** 10% credit, (Jul 2015 - Jun 2018)  
*National Science Foundation*, IUSE: Coaching for Students with Disabilities
- \$252,328** Research Equipment Grant, **Co-PI** 50% credit, (Jun 2012 - Jun 2014)  
*Army Research Office*, DURIP: Collection and Analysis of Crowd Data
- \$599,973**† Training Grant, **Co-PI** 25% credit, (Jan 2010 - Dec 2014)  
*National Science Foundation*, S-STEM: Scholarship Program for Students At-Risk
- \$24,964** Research/Training Grant, **PI** 100% credit, (Aug 2009 - May 2010)  
*NASA Florida Space Grant Consortium*, Simulating the Effects of Rocket Exhaust
- \$1,200** Travel Grant, Zurich, Switzerland (July 2007)  
International Congress on Industrial and Applied Mathematics

**Peer Reviewed Publications** (439 citations according to Web of Science)

Students working under my supervision are denoted by \*\* for undergraduate and \* for graduate.

1. A. Bhatt\* and B.E. Moore, Exponential Integrators Preserving Local Conservation Laws of PDEs with Time-Dependent Damping/Driving Forces, *Journal of Computational and Applied Mathematics*, accepted, 2018.
2. M.A. Dagley, M. Gill, E. Saitta, B.E. Moore, J. Chini, and X. Li, Using Active Learning Strategies in Calculus to Improve Student Learning and Influence Mathematics Department Cultural Change, *Proceedings of the Interdisciplinary STEM Teaching and Learning Conference: Vol. 2*, Article 8, 2018.
3. A. Bhatt\* and B.E. Moore, Structure Preserving Exponential Runge-Kutta Methods, *SIAM Journal of Scientific Computing*, 39(2):A593-A612, 2017.
4. B.E. Moore, Multi-Conformal-Symplectic PDEs and Discretizations, *Journal of Computational and Applied Mathematics*, 323:1-15, 2017.
5. E. Lydon\* and B.E. Moore, Propagation Failure of Fronts in Discrete Inhomogeneous Media with a Sawtooth Nonlinearity, *Journal of Difference Equations and Applications*, 22(12):1930-1947, 2016.
6. F. McDonald, R.I. McLachlan, B.E. Moore, and G.R.W. Quispel, Traveling Wave Solutions of Multisymplectic Discretizations of Nonlinear Wave Equations, *Journal of Difference Equations and Applications*, 22(7):913-940, 2016.
7. A. Bhatt\*, D. Floyd\*, and B.E. Moore, Second Order Conformal Symplectic Schemes for Damped Hamiltonian Systems, *Journal of Scientific Computing*, 66(3):1234-1259, 2016.
8. B.E. Moore and J.M. Segal\*, Stationary Bistable Pulses in Discrete Inhomogeneous Media, *Journal of Difference Equations and Applications*, 20(1):1-23, 2014.
9. B.E. Moore, L. Noreña\*\*, and C. Schober, Conformal Conservation Laws and Geometric Integration for Damped Hamiltonian PDEs, *Journal of Computational Physics*, 232(1):214-233, 2013.
10. B. Solmaz\*, B.E. Moore, and M. Shah, Identifying Behaviors in Crowded Scenes through Stability Analysis for Dynamical Systems, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 34(10):2064-2070, 2012.
11. A.R. Humphries, B.E. Moore, and E.S. Van Vleck, Front Solutions for Bistable Differential-Difference Equations with Inhomogeneous Diffusion, *SIAM Journal on Applied Mathematics*, 71(4):1374-1400, 2011.
12. B.E. Moore, S. Ali, R. Mehran, and M. Shah, Visual Crowd Surveillance through a Hydrodynamics Lens, *Communications of the ACM*, 54(12):64-73, 2011.
13. R. Mehran\*, B.E. Moore, and M. Shah, A Streakline Representation of Flow in Crowded Scenes, *ECCV Lecture Notes in Computer Science*, 6313:439-452, 2010. (acceptance rate 22.3%)
14. S. Wu, B.E. Moore, and M. Shah, Chaotic Invariants of Lagrangian Particle Trajectories for Anomaly Detection in Crowded Scenes, *IEEE Computer Vision and Pattern Recognition*, 2054-2060, 2010. (acceptance rate 27.7%)
15. B.E. Moore, Conformal Multi-Symplectic Integration Methods for Forced-Damped Semi-Linear Wave Equations, *Mathematics and Computers in Simulation*, 80:20-28, 2009.

16. J. Frank, B.E. Moore, & S. Reich, Linear PDEs and Numerical Methods that Preserve a Multi-Symplectic Conservation Law, *SIAM Journal of Scientific Computing*, 28:260-277, 2006.
17. S. Maier-Paape, B.E. Moore, and E.S. Van Vleck, Spinodal Decomposition for Spatially Discrete Cahn-Hilliard Equations, *Dynamics of Continuous, Discrete and Impulsive Systems, Series A: Mathematical Analysis*, 12:529-554, 2005.
18. B.E. Moore and S. Reich, Multi-Symplectic Integration Methods for Hamiltonian PDEs, *Future Generation Computer Systems*, 19:395-402, 2003.
19. B.E. Moore and S. Reich, Backward Error Analysis for Multi-Symplectic Integrators, *Numerische Mathematik*, 95:625-652, 2003.

### Invited University Colloquium Talks and Seminars

1. Structure-Preserving Exponential Integrators, Oregon State University, 2018
2. Traveling Waves for Lattice Equations, Colorado School of Mines, 2018
3. Structure-Preserving Exponential Integrators, University of Iowa, 2016
4. Structure-Preserving Exponential Integrators, Colorado School of Mines, 2016
5. Conformal Symplectic Integrators, Norwegian University of Science and Technology, 2015
6. Bistable Waves in Discrete Inhomogeneous Media, Florida Institute of Technology, 2013
7. Mathematical Models for Multiple Sclerosis, Stetson University, Florida, 2012
8. Visual Crowd Surveillance, West Virginia University, ACM Skype Guest Lecture, 2012
9. Standing Waves in Discrete Inhomogeneous Media, Massey University, New Zealand, 2010
10. Propagation Failure of Fronts in Discrete Inhomogeneous Media, University of Iowa, 2008
11. Bistable Waves in Discrete Inhomogeneous Media, McGill University, Canada, 2008
12. Backward Error Analysis for Multi-Symplectic Integrators, Univ. of Central Florida, 2007
13. Multi-symplectic Integration Methods, Colorado School of Mines, 2005
14. Multi-symplectic Integration Methods, McMaster University, Canada, 2005
15. Multi-symplectic Integration Methods, University of Kansas, 2005
16. Modified Equations Approach for Multi-Symplectic Integrators, University of Kansas, 2003

### Invited Conference Seminars

1. Structure-Preserving Exponential Integrators for Damped-Driven PDEs, Annual Meeting of the SIAM Central States Section, Colorado State University, 2017.
2. Structure-Preserving Exponential Integrators and Damped-Driven NLS, International Conference on Scientific Computing and Differential Equations, University of Bath, UK, 2017.
3. Structure-Preserving Exponential Integrators, 10th IMACS International Conf. on Nonlinear Evolution Equations and Wave Phenomena: Computation & Theory, Univ. of Georgia, 2017.
4. Traveling Waves for Fully Discrete Multi-Symplectic Equations, SIAM Conference on Nonlinear Waves and Coherent Structures, Philadelphia, 2016.
5. Structure-Preserving Algorithms for Perturbed Nonlinear Schrödinger Equations, 11th AIMS International Conference, Orlando, 2016.
6. Conservation Laws and Structure-Preserving Integration Methods for a Special Class of PDEs, 11th AIMS International Conference, Orlando, 2016.
7. Multi-Conformal-Symplectic Integration Methods, International Conference on Scientific Computing and Differential Equations, Potsdam, Germany, 2015.

8. Fronts and Pulses That Fail to Propagate in Discrete Inhomogeneous Media, Progress On Difference Equations, Covilha, Portugal, 2015
9. From Molecules to Mars and Back to the Everyday, Mu Alpha Theta National Convention, Orlando, Florida, 2014
10. Structure Preserving Methods for Damped Hamiltonian PDEs, 2nd International Workshop on Nonlinear and Modern Mathematical Physics, University of South Florida, 2013
11. Geometric Integration for Damped Hamiltonian PDEs, SIAM Conference on Nonlinear Waves and Coherent Structures, University of Washington, 2012
12. When Diffused Gas Causes Soil Failure, 2nd Workshop on Lunar and Martian Plume Effects, Kennedy Space Center, 2011
13. Solutions and Behavior of Lattice Differential Equations, Cha-Cha Days Workshop for Young Scientists, College of Charleston, 2010
14. Propagation Failure of Fronts in Discrete Inhomogeneous Media, 8th MSU-UAB Conf. on Differential Equations and Computational Simulations, Mississippi State Univ., 2009
15. Propagation Failure of Fronts in Discrete Inhomogeneous Media, 7th AIMS International Conf. on Dynamical Systems, Differential Equations and Applications, Univ. of Texas, 2008
16. Conformal Multi-Symplectic Integration Methods, NSF-CBMS Regional Research Conference on Numerical Methods for Nonlinear Elliptic Equations, University of Iowa, 2007
17. Bistable Waves for Differential-Difference Equations with Inhomogeneous Diffusion, Workshop on Lattice, Delay and Functional Differential Equations, McGill University, 2005

### Contributed Conference Seminars

1. 9th AIMS Conf. Dynamical Systems, Differential Equations & Applications, Orlando, 2012
2. Int. Conf. Scientific Computation & Differential Equations, The Fields Institute, 2011
3. International Congress on Industrial and Applied Mathematics, Zurich, Switzerland, 2007
4. International Conf. Scientific Computation & Differential Equations, Saint-Malo, France, 2007
5. IMACS Int. Conf. Nonlin. Evolution Equations & Wave Phenomena, Univ. of Georgia, 2007
6. SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah, 2005
7. Int. Conf. Nonlin. Dynamics & Evolution Equations, Memorial Univ. of Newfoundland, 2004
8. X-th Numerical Analysis Summer School, University of Durham, UK, 2002
9. Mechanics and Symmetry in Europe Summer School, Peyresq, France, 2001
10. IX-th Numerical Analysis Summer School, University of Durham, UK, 2000

### Conference Posters

1. 9th AIMS Conf. Dynamical Systems, Differential Equations & Applications, Orlando, 2012
2. SIAM Conf. on Nonlinear Waves and Coherent Structures, University of Washington, 2012
3. IMA Workshop on Numerical Solutions of PDE, University of Minnesota, 2010
4. 11th European Conference on Computer Vision, Hersonissos, Crete, Greece, 2010
5. Workshop on Computational Methods and Applied PDE, Iowa State University, 2005
6. Frontiers in Applied and Computational Mathematics, New Jersey Institute of Tech. 2005
7. Montreal Scientific Computing Days, Le Centre de Recherches Mathématiques, 2004
8. Young Mathematicians Conference in PDE & Dynamical Systems, The Fields Institute, 2004

## Academic Awards and Honors

- Initiatives in STEM Fellowship (for advances in STEM education practice and research), University of Central Florida (Aug. 2014 – May 2015)
- Teaching Incentive Program Award (for excellence in teaching), U. of Central Florida (2014)
- Recognized by the Fraternity and Sorority Community as an outstanding professor (2006)
- CRM-ISM Postdoctoral Fellowship, McGill University (2003 – 2005)
- Overseas Research Student Award, scholarship (to pay international student fees) awarded by Universities UK for outstanding merit and research potential (1999 – 2002)
- Research Studentship, full tuition and stipend awarded for academic achievement, University of Surrey (1999 – 2002)
- Colorado Research Fellowship, full tuition and stipend awarded for academic excellence, Colorado School of Mines (1998 – 1999)
- Scholastic Excellence Award, scholarship, Colorado Christian University (1993 – 1997)
- Most Outstanding Student in Humanities & Science, scholarship for academic excellence, leadership and school participation, Colorado Christian University (1996)

## Supervision of Research as Primary Advisor

### *Post-Doctoral Research*

- Yuyue Qin (Feb. 2016 – Jan. 2017) Currently faculty at Chang'an University in China  
Project: Structure-preserving algorithms for damped-driven NLS equations

### *Ph.D. Thesis*

- Ashish Bhatt (May 2012 – Dec 2016) Currently a post-doc at University of Stuttgart  
Project: Structure-preserving algorithms for damped Hamiltonian PDEs  
**Presentations:** at SciCADE 2015, Potsdam, Germany; AIMS Int. Conf. 2016, Orlando, FL  
**Publications:** in *SIAM Journal of Scientific Computing* and *Journal of Scientific Computing*  
**Award:** UCF Research Excellence Award 2015

### *Master of Science Thesis*

- Elizabeth Lydon (May 2014 – Jun 2015) Graduated, Teaching at Eastern Florida State College  
Project: Propagation failure in discrete inhomogeneous media with sawtooth nonlinearity  
**Presentations:** SIAM CSE 2015, Salt Lake City; Graduate Research Forum 2015, UCF  
**Publication:** Appeared in *Journal of Difference Equations and Applications*  
**Award:** Provost's Merit Fellowship 2015
- Dwayne Floyd (Jan. 2013 – Nov. 2014) Graduated, Employed at the DoD  
Project: Linear stability analysis for second order conformal symplectic schemes  
**Publication:** Appeared in *Journal of Scientific Computing*  
**Award:** Best Master's Thesis in the Department of Mathematics 2015
- Kristina Kraakmo (Jan. 2011 – Nov. 2013) Graduated, Teaching at Valencia College  
Project: Alternating direction implicit methods for simulating diffusion driven flow  
**Presentations:** ChaCha Days, College of Charleston, 2010; IMA workshop, Minnesota, 2010
- Brian Brennan (Aug. 2009 – Jul. 2010) Graduated, Completed PhD at Baylor University  
Project: Numerical computations for PDE models of rocket exhaust flow in soil



- Joe Segal (Jun. 2008 – Oct. 2009) Graduated, Working as a computer programmer  
Project: Propagation failure of FitzHugh-Nagumo waves in discrete media  
**Publication:** Appeared in *Journal of Difference Equations and Applications*  
**Award:** Best Master's Thesis in the Department of Mathematics 2009

#### *Graduate Directed Research*

- Johann Veras (Aug. 2010 – Dec. 2010) Graduated, Working at Lockheed Martin  
Project: Numerical computation of wave speeds in discrete inhomogeneous media
- Ramin Mehran, (Jun. '09 – Aug. '10) Graduated, Working at Microsoft  
Project: Streakline representations of fluid flow for crowded visual scenes  
**Publications:** Appeared in *ECCV 2010* and *Communications of the ACM*
- Berkan Solmaz, (Jun. '09 – Apr. '10) Graduated, Working at Texas Instruments  
Project: Using Jacobian matrices to identify crowd behaviors in video scenes  
**Publication:** Appeared in *IEEE Transactions on Pattern Analysis and Machine Intelligence*
- Jonathan Fraine (Jan. 2009 – Apr. 2009) Graduated, Pursued PhD at U. of Maryland  
Project: Numerical computations for traveling waves in discrete inhomogeneous media

#### *Undergraduate Directed Research*

- Juliana White, Mathematics, UCF (Jan. 2019 – Present)  
Project: Propagation failure of 2-dimensional discrete fronts
- Brooke Papa, Mathematics, UCF (May 2017 – Apr. 2018)  
Project: Computing intervals of propagation failure for discrete fronts  
**Presentation:** Showcase of Undergraduate Research, UCF 2018
- Jared Wasserman, Mathematics and Computer Science, UCF (Aug. 2013 – Dec. 2013)  
Project: Numerical predictions of gradient catastrophe in the focusing NLS equation
- Cyndi Beltran, Miranda Craig, Leah Fortier, Nick Kaufman, Vanessa Lepe, Nick Mele, Chris Peterman, GAUSS Program UCF (May '12 – Aug. '12) Time series prediction in traffic scenes  
**Presentations:** GAUSS Seminar Series
- Casey Van Buren, GAUSS program UCF (May 2011 – Dec. 2011)  
Project: Action prediction in video sequences of vehicular traffic  
**Presentation:** GAUSS Seminar Series
- Whitney Keith, Florida Space Grant Project (Jan. 2010 – Dec. 2010)  
Project: Simulating the effects of rocket exhaust on soil cratering  
**Presentation:** Showcase of Undergraduate Research, UCF 2010  
**Award:** Astronaut Scholarship - Highest monetary award in U.S. for academic achievement
- Laura Noreña, GAUSS program UCF (May 2009 – Dec. 2010)  
Project: Conformal multi-symplectic integration methods  
**Presentation:** CSUMS Conference, St. Paul, Minnesota, 2009  
**Publication:** Appeared in *Journal of Computational Physics*
- Nicole Lopez, Mathematics, UCF (May 2010 – Jul. 2010)  
Project: Standing waves for a spatially discrete FitzHugh-Nagumo equation
- Jessica Long, Mathematics, University of Iowa (Jan. 2006 – Dec. 2006)  
Project: Steady states for inhomogeneous bistable differential-difference equations
- Lory Ajamian, Mathematics, McGill University (May 2005 – Jul. 2005)  
Project: Standing waves for spatially discrete Nagumo equations with differing nonlinearities  
**Presentations:** Lattice, Delay, and Functional Differential Equations Seminar Series, McGill

## Other Student and Junior Faculty Mentoring

- 1 National Merit Scholar (2008 – 2009)
- 10 Instructors: class observations and coaching on teaching/assessment (2014 – Present)
- 1 Tenure-Track Assistant Professor (2017 – Present)

## Grant Related Undergraduate Education Activities

*NSF funded S-STEM program (STRONG) (2018 – Present)*

**Improving transfer student success with enhanced support;** <http://crcv.ucf.edu/strong/>

- Coordinating faculty mentors and organizing group activities
- Supervising student selection and award disbursement, and monitoring student progress
- Mentoring students majoring in mathematics and computer engineering

*NSF funded IUSE program (Math-GAINS) (2016 – 2017)*

**Transforming department culture: teaching practices and math education research**

- Prepared teaching assessment tools and administered faculty surveys
- Coached 3 mathematics faculty and 5 graduate teaching assistants on adaptively applying evidence-based teaching practices in Calculus classes

*NSF funded IUSE program (iCAN) (2017)*

**Improving educational experiences of STEM students with disabilities**

- Recruited and trained peer mentors

*NSF funded S-STEM program (STATESS) (2009 – 2015)*

**Providing opportunity/support for high-need, at-risk STEM majors**

- Coordinated faculty mentors for 66 students from 14 different STEM disciplines
- Supervised student selection and award disbursement, and monitored student progress
- Organized group activities, and mentored five mathematics students

*NSF funded CSUMS program (GAUSS) (2009 – 2012)*

**Training mathematics majors in computational science;** <http://crcv.ucf.edu/gauss/>

- Mentored students, supervised research, and taught advanced mathematics techniques

*NSF funded STEP program (COMPASS) (2013 – 2018)*

**Recruiting undergraduates into STEM fields;** <http://compass.ucf.edu/>

- Taught Calculus courses and regularly engaged students outside the classroom

*NSF funded STEP program (EXCEL) (2008 – 2018)*

**Establishing mathematical foundations of first-year undergrads;** <http://excel.ucf.edu/>

- Taught Calculus courses and regularly engaged students outside the classroom

## Courses Taught (\* denotes graduate course development)

*University of Central Florida (Aug. 2007 – Present)*

- Calculus I (MAC 2311) Fall: 2007, 2008, 2010, 2012–2014, 2016; Spring: 2012–2014, 2018  
Special Programs: EXCEL classes in '08 and '10 designed to increase student success rate.  
Large Lectures: Between 200 and 450 students with multiple GTAs to supervise in 2012–2018.  
Web Enhancements: WebAssign and MyLabsPlus for assignments and interactive figures.  
Course coordinator: organized 4 faculty and 10 GTAs for over 900 students each semester.

- Honors Calculus I (MAC 2311H) 2 sections Fall 2018
- Calculus II (MAC 2312) Spring: 2009, 2011, 2015, 2017  
Special Programs: EXCEL classes designed to increase student success rate.  
Web Enhancements: WebAssign for student assignments.
- Calculus III (MAC 2313) Fall 2017, EXCEL class designed to increase student success.
- Differential Equations (MAP 2302) Spring 2010, Fall 2011
- Applied Numerical Mathematics\* (MAP 6385) Spring: 2008, 2009, 2012, 2013, 2014, 2017
- Scientific Computing\* (MAT 5712) Fall: 2007, 2008, 2011, 2012, 2013, 2016  
Web Enhancements: Video capture 2011 – 2016; *All* course content available on-line.
- Independent Studies: Numerical Methods for PDEs, Summer 2009; Simulating Hamiltonian Dynamics, Spring 2012; Geometric Integration, Spring 2017; Deep Learning, Fall 2017

*Norwegian University of Science and Technology (NTNU)* (Fall 2015)

- Numerical Solution of Time Dependent Differential Equations\* (MA8404)

*University of Iowa* (Aug. 2005 – May 2007)

- Theory of Arithmetic (22M:012), Linear Algebra (22M:033), Differential Equations (22M:034), Elementary Numerical Analysis (22M:072), Simulating Hamiltonian Dynamics\* (22M:321)

*McGill University* (Jan. 2004 – Dec. 2004)

- Intermediate Calculus (MATH 262), Advanced Calculus (MATH 265)

## Service on Student Thesis and Project Committees at UCF

### *Ph.D. Theses*

- Matthew Russo, Mathematics, Lax integrable variable-coefficient PDEs, 2016
- Maria Strawn, Mathematics, Modeling rogue waves in deep water, 2016
- Akbar Wizin, Physics, Dusty disk dynamics and terrestrial planet formation, 2016
- Laura Seward, Physics, Low velocity impact of rigid bodies on granular beds, 2014
- Subhabrata Bhattacharys, Computer Vision, Recognition of complex events in video, 2013
- Curtis Groves, Mechanical Eng., Computational fluid dynamics uncertainty analysis, 2013
- Kishore Reddy, Computer Vision, Action recognition using spatio-temporal volumes, 2012
- Ramin Mehran, Computer Vision, Streakline representations of fluid flow for crowds, 2012
- Berkan Solmaz, Computer Vision, Jacobian matrices to identify crowd behaviors, 2012

### *Master of Science Theses*

- William Hilton, Mathematics, Investigations of the Kudryashov generalized KdV, 2018
- Daniel Marulanda, Mathematics, Approximations and exact discrete solitons, 2016
- Jill Dickerson, Mathematics, Curvelets and the Radon transform for imaging, 2013
- Dimitry Popov, Mathematics, Iteratively re-weighted least squares minimization, 2011

### *Honors in the Major Theses*

- Jeffery Jorges, Physics, Studies on Planet Formation, 2016
- David Thomas, Computer Vision, Recognition of Predicted Time Series, 2010

### *Engineering Senior Design Projects*

- Katlin Joachim, Austin Keller, Reid Neureuther, and Daniel Yoder; Magic mirror, 2017
- Efrain Cruz, Loubens DeCamp, Luis Narvaez, and Brian Thomas; Robotic air hockey, 2014
- Marc Bianco, Andrew Boyles, Chris Echanique, and Garrett Lee; Autopilot cooler, 2013
- Keith Walls, Imran Ali, and Travis Comer; Portable wind and solar energy generation, 2012

## In-House Seminars

1. Propagation Failure of Traveling Waves in Lattice Equations, UCF Analysis Seminar, 2016
2. Math and Work, UCF Initiatives in STEM Camp Connect Seminar, 2016
3. Discrete Dynamics: As Models or Methods, Math Colloquium at UCF, 2012
4. Dynamical Systems to Visually Interpret Crowd Behavior, UCF GAUSS Seminar, 2012
5. Tools of Fluid Mechanics for Interpreting Crowd Behavior, Fluids Seminar at UCF, 2011
6. Visual Crowd Surveillance, GAUSS Seminar at UCF, 2011
7. Using Math to Understand Multiple Sclerosis, Math Day at UCF, 2007
8. Bistable Waves in Discrete Inhomogeneous Media, Math Colloquium at UCF, 2007
9. A Modified Equations Approach for Multi-Symplectic Integrators, McGill University, 2003
10. A Modified Equations Approach for Multi-Symplectic Integrators, University of Surrey, 2003
11. Symplectic Numerical Integration, Imperial College, 2003
12. Multi-Symplectic Integration Methods for Hamiltonian PDEs, University of Surrey, 2002
13. Backward Error Analysis for Multi-Symplectic Integrators, Imperial College, 2001

## Referee for Academic Journal Articles (Numbers indicate the number of articles reviewed.)

- *Advances in Computational Mathematics* (2)
- *Applied Mathematics and Computation* (2)
- *Calcolo* (1)
- *Communications in Nonlinear Science and Numerical Simulation* (3)
- *Computers and Mathematics with Applications* (1)
- *Computer Physics Communications* (1)
- *EuroPhysics Letters* (1)
- *Journal of Computational and Applied Mathematics* (6)
- *Journal of Computational Physics* (2)
- *Journal of Difference Equations and Applications* (3)
- *Journal of Geometric Mechanics* (2)
- *Mathematics and Computers in Simulation* (2)
- *Numerical Methods for Partial Differential Equations* (1)
- *Physics Letters* (1)
- *Proceedings of the Royal Society A* (1)
- *SIAM Journal on Scientific Computing* (2)

## Service and Leadership on Department, College, and University Committees

- Department of Mathematics: Computing Committee (2007 – Present), Faculty Search Committee (2013 & 2018), Math Education Committee (2017 – Present), Calculus Committee (2016 – Present), Undergraduate Curriculum Committee (2016-2017), Recruitment Committee (2015), Calculus Textbook Selection Committee (2013)
- Center for Research in Computer Vision: Faculty Search Committee (2018 & 2019)
- College of Science: Scholarship Committee (2013 – 2015), (Technology Advisory Committee (2017 – Present)

## Other Professional and Leadership Activities

- Active participant in STEM education research seminar and reading group (2016 – Present)
- Presentations for recruiting local high school students into math at UCF (2012 – Present)
- Supervisor of Graduate Teaching Assistants (2008 – Present)
- Faculty adviser for student organization Reformed University Fellowship (2008 – 2012)
- Reviewer for book proposals (2008, 2014)
- Active participant in the McGill applied mathematics working seminar (2003 – 2005)
- Member of the Association of Computational Mathematics (1998 – 1999)

## References

### *Research:*

Dr. Mubarak Shah, Center for Research in Computer Vision, UCF, Orlando, FL, USA  
Phone: 407-823-5077                      E-mail: shah@crcv.ucf.edu

Dr. Erik Van Vleck, Department of Mathematics, University of Kansas, Lawrence, KS, USA  
Phone: 785-864-5290                      E-mail: erikvv@ku.edu

Dr. Tony Humphries, Dept. of Mathematics and Statistics, McGill University, Montreal, Canada  
Phone: 514-398-3821                      E-mail: tony.humphries@mcgill.ca

### *Teaching:*

Dr. Cynthia Young, Dean of College of Science, Clemson University, Clemson, SC, USA  
Phone: 864-656-3642                      E-mail: cyyoung@clemson.edu

Dr. Melissa Dagley, Director of Initiatives in STEM, University of Central Florida, Orlando, FL, USA  
Phone: 407-823-6230                      E-mail: melissa.dagley@ucf.edu

# Sumanta Pattanaik

Department of Computer Science  
4328 Scorpius Street  
Orlando, FL 32816-2362

Office: (407) 823 2638  
<http://www.cs.ucf.edu/~sumant>  
sumant@cs.ucf.edu

## Educational background

- Ph.D. 1993      BITS-Pilani, India  
Computer Science  
Thesis Title: *Computational methods for Global Illumination and Visualization of Complex 3D Environments.*  
Advisor: Dr. Sudhir Mudur
- M.Sc. 1978      Utkal University, India  
Chemistry

## Employment history

- 2005-present    Tenured Associate Professor, Computer Science, University of Central Florida.
- 2001-2005      Tenure track Associate Professor, Computer Science, University of Central Florida.
- 1997-2001      Research Associate, Program of Computer Graphics, Cornell University
- 1995-1997      Post-Doctoral Associate, Program of Computer Graphics, Cornell University. Advisor: Prof. Donald P. Greenberg
- 1993-1995      INRIA Post-Doctoral Fellow, IRISA-INRIA, Rennes, France  
Advisor: Prof. Kadi Bouatouch
- 1988-1995      Senior Staff Scientist
- 1985-1988      Staff Scientist, Department of Computer Graphics, National Center for Software Technology (NCST), Bombay, India
- 1983-1985      Scientific Officer-D
- 1980-1983      Scientific Officer-C, Radiochemistry Dept, BARC, Bombay, India

## Other Professional Positions

- Summer 2016    Visiting Researcher, Frederick National Laboratory of Cancer Research, Frederick, Maryland.
- Summer 2015, Fall 2015  
(Sabbatical)    Visiting Associate, Institute of Creative Technology, University of Southern California, Los Angeles, California.
- Spring 2009  
(Sabbatical)    Visiting Associate Professor, Department of Computer Science, University of Girona, Girona, Spain.
- Fall 2008  
(Sabbatical)    Visiting Associate, Department of Computer Science, Yale University, New Haven, Connecticut.

## TEACHING

### Courses Taught: (Last 5 years)

Course Number	Course Title	Credits	Class	Semester	#of Students	Course Evaluation Summary
CAP 6737	Interactive Data Visualization	3	Graduate	Spring 2019	33	4.64
CAP 6721	Ray Tracing	3	Graduate	Spring 2019	10	5
CAP 4720	Computer Graphics	3	Undergraduate	Fall 2018	110	3.83
CAP 5725	Computer Graphics I	3	Graduate	Fall 2018	15	4.83
CAP 6737	Interactive Data Visualization	3	Graduate	Spring 2018	18	4.45
CAP 5725	Computer Graphics I	3	Graduate	Fall 2017	8	4.38
CAP 6721	Ray Tracing	3	Graduate	Spring 2017	2	5.0
CAP 5725	Computer Graphics I	3	Graduate	Fall 2016	8	4.38
CAP 6721	Ray Tracing	3	Graduate	Spring 2015	8	5.0
CAP 5725	Computer Graphics I	3	Graduate	Fall 2014	18	4.38
CAP 4720	Fundamentals of Computer Graphics	3	Junior/Senior	Fall 2014	41	4.43
CAP 6721	Ray Tracing	3	Graduate	Spring 2014	9	3.75

### Doctoral Student Supervision (Current)

Student Name	Year Joined	Status	Source of Support
Justin Mackenzie	Fall 2018	Pre-qualifying	Department TA

### Doctoral Student Supervision (Completed)

Student Name	Year Graduated	Research Topic	Current Affiliation
LingLing Sik (from M&S department)	Spring 2013	<i>GPU Ray Traced Rendering And Image Fusion Based Visualization Of Urban Terrain For Enhanced Situation Awareness,</i>	Singapore Defense lab
Yugang Min	Spring 2012	4D-CT Lung Registration and its Application for Lung Radiation Therapy	
Yuraj Obert	Summer 2010	<i>User Interface and Tool for global Illumination Computing</i>	Apple, Orlando
Kevin Boulanger	Summer 2008	<i>Real-time Realistic Nature Rendering</i>	Electronic Art, Orlando
Musawir Ali Shah	Fall 2007	<i>Interactive Computation of Light Transport in Volume.</i>	
Anand Santhanam (cosupervisee)	Summer 2006	<i>Modeling, Simulation, and Visualization Of 3D Lung Dynamics</i>	Associate professor UCLA Health

Ruifeng Xu	Spring 2005	<i>Realistic Rendering in Mixed and Virtual Environments</i>	Samsung
International Doctoral Co-supervisee			
Pascal Gautron	Fall 2006 (Univ of Rennes I, France)	<i>Interactive High Quality Rendering of Synthetic Environments (Co-supervised with Kadi Bouatouch, INRIA-France)</i>	NVIDIA
Jaroslav Krivanek	Dec 2005 (Univ of Rennes I, France)	<i>Realistic Rendering (Co-supervised with Kadi Bouatouch, INRIA-France)</i>	Charles University

### MS Supervision (Graduated)

Student Name	Year Graduated	Research Topic	Current Affiliation
Kris Rivera	Fall 2011	<i>Ray Collection Bounding Volume Hierarchy</i>	Lockheed
Siddharth Borikar	Spring 2004	<i>Fast Algorithms for Fragment Based Completion in Images of Natural Scenes</i>	
Francisco Rival	Spring 2004	<i>GPU Based Interactive Radiosity and Ray Tracing</i>	
Mangesh Nijasure	Fall 2003	<i>GPU Based Real-time Global Illumination</i>	ATI-AMD, Orlando
International MS Co-supervisee			
Adria Fores	Summer 2009 (Univ of Girona, Spain)	<i>A system for interactive display and rendering of BRDF models (Co-supervised with Xavier Pueyo, Univ of Girona)</i>	PhD Student at RIT
Juraj Obert	Summer 2007 (Czech Technical University, Prague)	<i>Realistic Rendering (Co-supervised with Jaroslav Krivanek, Czech Technical University, Prague)</i>	Qualcomm, Orlando
Kevin Boulanger	Summer 2005 (University of Rennes I, France)	<i>Real-Time Grass rendering. (Co-supervised with Kadi Bouatouch, INRIA-France)</i>	Electronic Art, Orlando
Guillaume Francois	Summer 2005 (University of Rennes I, France)	<i>Subsurface Scattering. (Co-supervised with Kadi Bouatouch, INRIA-France)</i>	Dreamworks, LA

### Undergrad Thesis Supervision (Completed)

Sudent Name	Year Graduated	Research Topic	Current Affiliation
Omar Alami	Spring 2014	<i>A learning approach to recovering reflective properties</i>	
Evan Husk (Co-supervisee)	Fall 2012 (supervisor: Avelino)	<i>Imitating Individualized Facial Expressions in a Human-Like Avatar through a Hybrid Particle Swarm Optimization – Tabu Search</i>	



	Gonzalez)	<i>Algorithm</i>	
Chris Pugh	Summer 2010	<i>Realistic Real-time Rendering of Complex Materials</i>	ATI-AMD, Orlando
Eric Risser	Fall 2006	<i>Interactive Grass Rendering</i>	

#### Other Educational Contribution:

- 1) Invited Talk on Jan 27, 2017, "Polarized Material Modeling and Rendering". Department of Optics, Meinel Room 647, University of Arizona.
- 2) Eurographics 2016 Tutorial: "Visual Attention from a Graphics Point of View". Coauthors: Kenneth Holmqvist, Eakta Jain, Olivier Le Meur. May 9-13. Lisbon, Portugal.

#### Publication of Textbooks:

- 1) *Introduction to Computer Graphics: A Practical Learning Approach*. Authors: Fabio Ganovelli, Massimiliano Corsini, Sumanta Pattanaik, Marco Di Benedetto. Chapman and Hall/CRC, 2014.
  - International Edition. T&F India. 2017. ISBN-10: 1138583200, ISBN-13: 978-1138583207
- 2) *High Dynamic Range Imaging: Acquisition, Display and Image-Based Lighting*, 2<sup>nd</sup> Edition. Authors: Erik Reinhard, Greg Ward, S. N. Pattanaik, Paul Debevec, Wolfgang Heidrich and Karol Myszkowski, The Morgan Kaufman Series in Computer Graphics, 2010.
- 3) *High Dynamic Range Imaging: Acquisition, Display and Image-Based Lighting*, Authors: Erik Reinhard, Greg Ward, S. N. Pattanaik and Paul Debevec, The Morgan Kaufman Series in Computer Graphics, 2006.

## RESEARCH

#### Key Words:

Data Visualization, Volume visualization, Real-time rendering, Realistic rendering, Material Modeling and Rendering, Nature rendering.

#### List of Publications

##### Refereed books and monographs

- 1) *Rendering Techniques 2007*. Proceedings of Eurographics Symposium on Rendering, Jan 2007, Jan Kautz, S. N. Pattanaik (Editors), Eurographics in Cooperation with ACM SIGGRAPH. 2007. <https://dblp.org/rec/bibtex/conf/rt/2007>.
- 2) *Proceedings of IFIP-ICCG93*, S.P. Mudur, S.N. Pattanaik (Editors), North-Holland, 1993. <https://dl.acm.org/citation.cfm?id=645465&picked=prox>.

##### Refereed chapters in edited books

- 1) Ruifeng Xu, and S. N. Pattanaik, "Radiosity", in *Encyclopedia of Computer Science and Engineering 527.R1*, Benjamin Wah (editor), pp 2338-2343, John Wiley & Sons, Inc., Jan 2009.
- 2) Jaroslav Krivánek, and S. N. Pattanaik, "Lighting", in *Encyclopedia of Computer Science and Engineering*. Benjamin Wah (editor), pp 1734-1744, John Wiley & Sons, Inc. , Jan 2009.
- 3) Hector Yee and S. N. Pattanaik, "Attention for Computer Graphics Rendering", in *NeuroBiology of Attention*, Editors: Laurent Itti, Geraint Rees and John Tsotsos, Academic Press, 2004. <https://doi.org/10.1016/B978-012375731-9/50110-5>.

- 4) S.N. Pattanaik, "A Stylised Model for Animating Bharata Natyam : An Indian Classical Dance Form", *Computer in Art, Design and Animation*, editors J Landsdown and Rae Earnshaw. Springer Verlag, 1989. <https://dl.acm.org/citation.cfm?id=94305>.

### Refereed journal papers

- 1) S. Raj, F. Hussain, Z. Husein, N. Torosdagli, D. Turgut, S. Pattanaik, C-C Chang, S. K. Jha, "A theorem proving based approach for automatically synthesizing visualizations of flow cytometry data", *Journal of BMC-Bioinformatics*, vol. 18 (Suppl 8), 2017. <https://doi.org/10.1186/s12859-017-1662-4>
- 2) Chloe LeGendre, Xueming Yu, Dai Liu, Jay Busch, Andrew Jones, Sumanta Pattanaik, Paul Debevec, "Practical Multispectral Lighting Reproduction", *ACM Transactions on Graphics (TOG) Volume 35, Issue 4 (July 2016) Proceedings of ACM SIGGRAPH 2016*. Volume 35 Issue 4, July 2016. <https://doi.org/10.1145/2897824.2925934>
- 3) Eugene Taranta, Sumanta Pattanaik, "A Memory Efficient Uniform Grid Build Process for GPU", *Journal of Computer Graphics Techniques*, vol. 5, no. 3, 50-67, 2016. <http://jcgt.org/published/0005/03/04/>
- 4) Charly Collin, S. N. Pattanaik, Patrick LiKamWa, and Kadi Bouatouch, "Discrete ordinate method for polarized light transport solution and subsurface BRDF computation", *Computers & Graphics*, Vol. 45, Pages 17–27, December 2014. <https://doi.org/10.1016/j.cag.2014.09.002>
- 5) Eugene Taranta, S. N. Pattanaik, "Macro 64-regions for uniform grid on GPU", *The Visual Computer: International Journal of Computer Graphics*, Vol 30(5), Pages 615–624, May 2014. <https://doi.org/10.1007/s00371-014-0974-x>
- 6) Charly Collin, Mickaël Ribardière, Adrien Gruson, Rémi Cozot, Kadi Bouatouch, Sumanta Pattanaik, "Visibility-driven progressive volume photon tracing", *The Visual Computer: International Journal of Computer Graphics*, vol. 29, pp:849-859, June 2013. <https://doi.org/10.1007/s00371-013-0845-x>
- 7) Daniele Bernabei, Ajit Hakke-Patil, Francesco Banterle, Marco Di Benedetto, Fabio Ganovelli, S. N. Pattanaik, Roberto Scopigno, "A Parallel Architecture for Interactively Rendering Scattering and Refraction Effects", *IEEE Computer Graphics and Applications*, vol. 32(2), pp. 34-43, March-April 2012. <https://doi.org/10.1109/MCG.2011.106>
- 8) Kevin Boulanger, Kadi Bouatouch, S. N. Pattanaik, "High-Frequency Shadows for Real-Time Rendering of Trees", *Journal of Graphics, GPU, and Game Tools*, vol. 25, no. 1, pp. 1-12, 2010. <https://doi.org/10.1080/2151237X.2010.10390648>
- 9) Daniele Bernabei, Fabio Ganovelli, Nico Pietroni, Paolo Cignoni, S. N. Pattanaik, Roberto Scopigno, "Real-time Single Scattering Inside Inhomogeneous Materials", *The Visual Computer: International Journal of Computer Graphics*, vol. 26, no. 608, pp. 583-593, 2010. <https://doi.org/10.1007/s00371-010-0449-7>
- 10) Juraj Obert, Fabio Pelacini, S. N. Pattanaik, "Visibility editing for all frequency shadow design", *Computer Graphics Forum*, vol. 29, no. 4, pp. 1441-1449, 2010. <https://doi.org/10.1111/j.1467-8659.2010.01741.x>
- 11) Musawir A. Shah, Jaakko Konttinen, S. N. Pattanaik, "Image-Space Subsurface Scattering for Interactive Rendering of Deformable Translucent Objects", *IEEE Computer Graphics and Applications*, vol. 29, no. 1, pp. 66-78, January/February, 2009. <https://doi.org/10.1109/MCG.2009.11>
- 12) Kevin Boulanger, S. N. Pattanaik, Kadi Bouatouch, "Rendering Grass in Real Time with Dynamic Lighting", *IEEE Computer Graphics and Applications*, vol. 29, no. 1, pp. 32-41, January/February, 2009. <https://doi.org/10.1109/MCG.2009.14>

- 13) Guillaume Francois, S. N. Pattanaik, Kadi Bouatouch, Gaspard Breton, " Subsurface Texture Mapping". *IEEE Computer Graphics and Applications*, vol. 28, no 1, pp. 34-42, Jan./Feb. 2008. <https://doi.org/10.1109/MCG.2008.16>
- 14) Juraj Obert, Jaroslav Krivanek, Fabio Pellacini, Daniel Sykora, S. N. Pattanaik, "iCheat: A Representation for Artistic Control of Indirect Cinematic Lighting", *Computer Graphics Forum*, vol. 27, no. 4, pages 1217-1223, June 2008. <https://doi.org/10.1111/j.1467-8659.2008.01260.x>
- 15) Eric Risser, Musawir Ali Shah, S. N. Pattanaik, "Faster Relief Mapping using the Secant Method", *Journal of Graphics Tools*, vol. 12(3), pages 17-24, 2007. <https://doi.org/10.1080/2151237X.2007.10129244>
- 16) Musawir A. Shah, Jaakko Konttinen, S. N. Pattanaik, "Caustics Mapping: An Image-space Technique for Real-Time Caustics", *IEEE Transactions on Visualization and Computer Graphics*, March/April 2007, vol. 13(2), pp 272-280. <https://doi.org/10.1109/TVCG.2007.32>
- 17) Pascal Gautron, Jaroslav Krivanek, Kadi Bouatouch, S. N. Pattanaik, "Temporal Radiance Caching", *IEEE Transactions on Visualization and Computer Graphics*, vol. 13(5), pages 891-901, 2007. <https://doi.org/10.1145/1401132.1401221>
- 18) Mark Colbert, S. N. Pattanaik, Jaroslav Krivanek, "BRDF-Shop: Creating Physically Correct Bidirectional Reflectance Distribution Functions", *IEEE Computer Graphics and Applications*, vol. 26(1), Page(s):30 – 36, Jan.-Feb. 2006. <https://doi.org/10.1109/MCG.2006.13>
- 19) Ruifeng Xu, S. N. Pattanaik, Charles Hughes, "High Dynamic Range Still Image Encoding in JPEG 2000", *IEEE Computer Graphics and Applications*, vol. 25(6), Pages:57 – 64, Nov.-Dec. 2005. <https://doi.org/10.1109/MCG.2005.133>
- 20) Jaroslav Krivakek, P. Gautron, S. N. Pattanaik, K. Bouatouch. "Radiance Caching for Efficient Global Illumination Computation", *IEEE Transactions on Visualization and Computer Graphics*, vol. 11(5), Page(s):550 – 561, Sept.-Oct. 2005. <https://doi.org/10.1109/TVCG.2005.83>
- 21) Jaakko Konttinen, Charles Hughes, S. N. Pattanaik, "The Future of Mixed Reality: Issues in Illumination and Shadows, *Journal of Defense Modeling and Simulation*, vol. 2(1), June 2005. <https://doi.org/10.1177%2F154851290500200104>
- 22) Mangesh Nijasure, S. N. Pattanaik, Vineet Goel, "Real-time Global Illumination on GPU", *Journal of Graphics Tools*. vol. 10(2), Pages: 55-71, April-June 2005. <https://doi.org/10.1080/2151237X.2005.10129194>
- 23) Ruifeng Xu, S. N. Pattanaik, "Non-Iterative, Robust Monte Carlo Noise Reduction", *IEEE Computer Graphics and Applications*. Volume 25(4), March/April 2005, pages: 31-35. <https://doi.org/10.1109/MCG.2005.31>
- 24) S. M., Khan, S. N. Pattanaik (2004). "Modeling blue shift in moonlit scenes using rod cone interaction" *Journal of Vision*, 4(8), 316a. <http://journalofvision.org/4/8/316/>
- 25) Hector Yee, S. N. Pattanaik, "Segmentation and Adaptive Assimilation for Detail-Preserving Display of High-Dynamic Range Images", *Visual Computers*. vol. 19(7-8), December 2003. <https://doi.org/10.1007/s00371-003-0211-5>
- 26) Ruifeng Xu, S. N. Pattanaik, "High Dynamic Range Image Display Using Level Set Framework", *Journal of Winter School of Computer Graphics*, vol. 1-3 (11), February 2003. [http://wscg.zcu.cz/wscg2003/Papers\\_2003/B37.pdf](http://wscg.zcu.cz/wscg2003/Papers_2003/B37.pdf)
- 27) Bruce J. Walter, S. N. Pattanaik, Donald. P. Greenberg, "Using Perceptual Texture Masking for Efficient Image Synthesis", *Eurographics'02, Computer Graphics Forum Conference Issue*, vol. 21(3), pp 393-400, September 2-6, 2002. <https://doi.org/10.1111/1467-8659.t01-1-00599>

- 28) H. Yee, S. N. Pattanaik and D. P. Greenberg, "Spatio-Temporal Sensitivity and Visual Attention in Dynamic Environments", *ACM Transactions on Computer Graphics*. vol. 20(1), pp: 39-64, Jan 2001. <https://doi.org/10.1145/383745.383748>
- 29) Kadi Bouatouch, S.N. Pattanaik and Eric Zeghers, "Computation of Higher Order Illumination with a Non Deterministic Approach", *Eurographics'96, Computer Graphics Forum Conference Issue*, vol. 15(3), pp. C327-C337, 1996. <https://doi.org/10.1111/1467-8659.1530327>
- 30) S.N. Pattanaik and S.P. Mudur, "Adjoint Equations and Random Walks for Illumination Computation", *ACM Transactions on Computer Graphics*, January 1995. <https://doi.org/10.1145/200972.200985>
- 31) S.N. Pattanaik and Kadi Bouatouch, "Fast Wavelet Radiosity Method", *Eurographics'94. Computer Graphics Forum Conference Issue*, vol. 13(3), pp. C407-C420, 1994. <https://doi.org/10.1111/1467-8659.1330407>
- 32) S.N. Pattanaik and S.P. Mudur, "The Potential Equation and Importance in Illumination Computations", *Computer Graphics Forum*, vol. 12(2), pp. 131-136, 1993. <https://doi.org/10.1111/1467-8659.1220131>
- 33) S.N. Pattanaik and S.P. Mudur, "Computation of Global Illumination in a Participating Medium by Monte Carlo Simulation", *The Journal of Visualisation and Computer Animation*, vol. 4(3), pp. 133-152, 1993. <https://doi.org/10.1002/vis.4340040303>
- 34) S.N. Pattanaik and S.P. Mudur, "Efficient Potential Equation Solutions for Global Illumination Computation", *Computers & Graphics*, vol. 17(4), pp. 387-396, 1993. [https://doi.org/10.1016/0097-8493\(93\)90025-5](https://doi.org/10.1016/0097-8493(93)90025-5)
- 35) S.P. Mudur and S.N. Pattanaik, "Multidimensional Illumination Function for Visualisation of Complex 3D Environments", *The Journal of Visualisation and Computer Animation*, vol. 1(2), pp. 49-58, 1990. <https://doi.org/10.1002/vis.4340010205>

#### **Refereed publications in conference proceedings**

- 1) Arvind Ramanathan, Laura Pullum, Zubir Husein, Sunny Raj, Neslisah Torosdagli, Sumanta Pattanaik, Sumit K. Jha, "Adversarial attacks on computer vision algorithms using natural perturbations". Proceedings of Tenth International Conference on Contemporary Computing (IC3), 2017. <https://doi.org/10.1109/IC3.2017.8284294>
- 2) Neslisah Torosdagli, Denise Liberton, Payal Verma, Murat Sincan, Janice Lee, Sumanta Pattanaik, Ulas Bagci. "Robust and Fully Automated Segmentation of Mandible from CT Scans", Proceedings of IEEE International Symposium on Biomedical Imaging (ISBI) 2017, Melbourne, Australia, April 18-21, 2017. <https://doi.org/10.1109/ISBI.2017.7950734>
- 3) F. Hussain, Z. Husein, N. Torosdagli, N. Deo, S. Pattanaik, Chung-Che Chang, S. K. Jha. "SANJAY: Automatically synthesizing visualizations of flow cytometry data using decision procedures", Proceedings of IEEE 5th International Conference on Computational Advances in Bio and Medical Sciences (ICCABS), pp. 1, Oct 15-17, 2015, Miami, USA. <https://doi.org/10.1109/ICCABS.2015.7344720>
- 4) Neslisah Torosdagli, S.N. Pattanaik, Curtis Lisle, Yanling Liu. "Web based Out-of-Core Volume Visualization in Client-Server Architectures". Proceedings of BiImage Informatics Conference 2015, October 14-16, Gaithersburg, MD, USA. [https://isg.nist.gov/BII\\_2015/webPages/pages/2015\\_BII\\_program/PDFs/Day\\_3/Session\\_8/Abstract\\_Torosdagli\\_Neslisah.pdf](https://isg.nist.gov/BII_2015/webPages/pages/2015_BII_program/PDFs/Day_3/Session_8/Abstract_Torosdagli_Neslisah.pdf)
- 5) Eugene Taranta, S. N. Pattanaik. "Memory Efficient GPU Uniform Grid Build Process", Graphics Interface 2015, June 3-5, 2015, Halifax, Nova Scotia, Canada. [Poster presentation]
- 6) Neslisah Torosdagli, S.N. Pattanaik, Curtis Lisle, "Web-based Interactive Real-Time Volume Rendering" 6th international meeting on Visualizing Biological Data (VIZBI 2015), ENBO & NIH

- Conference series, March 25-27, Cambridge MA, USA. [Poster presentation]  
<https://vizbi.org/Posters/2015/vA01>
- 7) Charly Collin, S. N. Pattanaik, Patrick LiKamWa, Kadi Bouatouch, "Computation of polarized subsurface BRDF for rendering", Graphics Interface 2014, May 7-9, 2014, Montreal, Quebec, Canada. <https://dl.acm.org/citation.cfm?id=2619682>
  - 8) Ke Chen, Charly Collin, Ajit Hakke-Patil, S. N. Pattanaik, "A Practical Model for Computing Subsurface BRDF of Homogeneous Materials with A Thin Layer of Paint", Computer Graphics International 2013, 11-14 June 2013, Hanover, Germany.  
<http://cgi2013.welfenlab.de/sessions.php.html>
  - 9) Ajit Hakke-Patil, Daniele Bernabei, Charly Collin, Ke Chen, S. N. Pattanaik, Fabio Ganovelli, "Parallel MDOM for light transport in participating media", Proceedings of 29<sup>th</sup> Spring Conference of Computer Graphics, 1-3 May, 2013, Smolenice castle, Slovakia.
  - 10) Charly Collin, Ke Chen, Ajit Hakke-Patil, S. N. Pattanaik, Kadi Bouatouch, "Green's function solution to subsurface light transport for BRDF computation", Proceedings of 29<sup>th</sup> Spring Conference of Computer Graphics, 1-3 May, 2013, Smolenice castle, Slovakia.
  - 11) Ke Chen, Charly Collin, Ajit Hakke-Patil, S. N. Pattanaik, "A practical model for computing the BRDF of real world materials", Poster, I3D 2013, March 21-23, Orlando, Florida.  
<https://doi.org/10.1145/2448196.2448228>
  - 12) Evan Husk, Avelino J. Gonzalez and S. N. Pattanaik, "Learning Individualized Facial Expressions in an Avatar with PSO and Tabu Search", Proceedings of the 26th International FLAIRS Conference, May 22 - 24, 2013, Florida.  
<https://www.aaai.org/ocs/index.php/FLAIRS/FLAIRS13/paper/viewFile/5864/6045>
  - 13) Lingling Sik, S. N. Pattanaik, "Real-Time Fusion of Surveillance Imageries in Urban Scenes", Proceedings of I/ITSEC, Dec 3-6, 2012, Florida.  
[http://fusion.isif.org/proceedings/fusion12CD/html/pdf/002\\_63.pdf](http://fusion.isif.org/proceedings/fusion12CD/html/pdf/002_63.pdf)
  - 14) Lingling Sik, S. N. Pattanaik, "Fusing geo-referenced images for urban scene", Proceedings of 15th International Conference on Information Fusion, 9-12 July 2012, Singapore.  
<https://ieeexplore.ieee.org/document/6289781/>
  - 15) Adrien Gruson, Ajit Hakke-Patil, Remi Cozot, Kadi Bouatouch, S. N. Pattanaik, "Light Propagation Maps on Parallel Graphics Architecture", Eurographics Symposium on Parallel Graphics Architecture (EGPGV'12), Cagliari, Italy, May 13-14 2012.  
<http://doi.org/10.2312/EGPGV%2FEGPGV12%2F081-088>
  - 16) Lingling Sik, S. N. Pattanaik, "Rendering synthetic large scale urban terrain". I/ITSEC 2011, Dec 3-6, 2011, Orlando.
  - 17) Adria Fores, S. N. Pattanaik, Carles Bosch and Xavier Pueyo. "BRDFLab: A general system for designing BRDFs". CEIG 2009, Spanish Conference on Computer Graphics. San Sebastian, Spain, September 2009.  
<http://doi.org/10.2312/LocalChapterEvents%2FCEIG%2FCEIG09%2F153-160>
  - 18) Juraj Obert, Jaroslav Krivanek, Daniel Sykora, S. N. Pattanaik, "Interactive Light Transport Editing for Flexible Global Illumination". SIGGRAPH 2007 Sketches and Posters, Aug 2007, San Diego. <http://doi.org/10.1145/1278780.1278849>
  - 19) Jaakko Konttinen, S. N. Pattanaik, Charles E. Hughes, "Image Based Particle Emission". SIGGRAPH 2007 Sketches and Posters, Aug 2007, San Diego.  
<https://doi.org/10.1145/1280720.1280928>
  - 20) Jaroslav Krivanek, Kadi Bouatouch, S. N. Pattanaik and Jiri Zara " Making Radiance and Irradiance Caching Practical: Adaptive Caching and Neighbor Clamping", Proceedings of Eurographics Symposium on Rendering (EGSR2006), June 26-30, 2006, Nicosia, Cyprus.  
<https://doi.org/10.1145/1401132.1401230>

- 21) Kevin Boulanger, Kadi Bouatouch, S. N. Pattanaik, "Automatic Tour into the Picture", Fourth EG Conference of Theory and Practice of Computer Graphics (TP.CG.2006). 20th - 22nd June 2006. <http://www.eguk.org.uk/TPCG06/programme.html>
- 22) Jaroslav Krivánek, Jaakko Konttinen, S. N. Pattanaik, Kadi Bouatouch, and Jiri Zara "Fast Approximation to Spherical Harmonic Rotation", Proceedings of 22nd Spring Conference on Computer Graphics (SCCG2006).
- 23) Pascal Gautron, Jaroslav Krivanek, Kadi Bouatouch, S. N. Pattanaik, "Temporal Radiance Caching", SIGGRAPH 2006 Sketches and Applications, Aug 2006, Boston. <https://doi.org/10.1145/1401132.1401232>
- 24) Guillaume Francois, S. N. Pattanaik, Kadi Bouatouch, Gaspard Breton, "Subsurface Texture Mapping". SIGGRAPH 2006 Sketches and Applications, Aug 2006, Boston. <https://doi.org/10.1145/1179849.1180064>
- 25) Kevin Boulanger, S. N. Pattanaik, Kadi Bouatouch, "Rendering Grass Terrains in Real-Time with Dynamic Lighting", SIGGRAPH 2006 Sketches and Applications, Aug 2006, Boston. <https://doi.org/10.1145/1179849.1179907>
- 26) Jaroslav Krivánek, Jaakko Konttinen, S. N. Pattanaik, Kadi Bouatouch, and Jiri Zara "Fast Approximation to Spherical Harmonic Rotation", In *Siggraph 2006 Sketches and Applications*, August 2006, Boston. <https://doi.org/10.1145/2602161.2602167>
- 27) Eric Risser, Musawir A. Shah, S. N. Pattanaik, "Interval Mapping", Poster presented at ACM I3D Symposium, March 2006, Washington DC. <https://pdfs.semanticscholar.org/d16d/9da41ec53b604e15976b0615ad3993c67edc.pdf>
- 28) Musawir A. Shah, Jaakko Konttinen, S. N. Pattanaik, "Real-time rendering of realistic-looking grass", Proceedings of the 3rd international conference on Computer graphics and interactive techniques in Australasia and South East Asia GRAPHITE '05, ACM Press, Nov 2005. <https://doi.org/10.1145/1101389.1101403>
- 29) Kanad K.Biswas, S. N. Pattanaik, "Fast Tone Mapping of High Dynamic Range Images". *Proceedings of IS&T/SID's 13<sup>th</sup> Color Imaging Conference*, CIC 2005, pp 291-295, Nov 2005. <https://dblp.org/db/conf/imaging/cic2005.html>
- 30) Kanad K.Biswas, Siddharth Borikar, S. N. Pattanaik, "Fast Algorithm for Completion of Digital Photographs with natural Scenes". *Proceedings of IS&T/SID's 13<sup>th</sup> Color Imaging Conference*, CIC 2005, pp 270-275, Nov 2005. <https://dblp.org/db/conf/imaging/cic2005.html>
- 31) Pascal Gautron, Jaroslav Krivanek, Kadi Bouatouch, S. N. Pattanaik, "Radiance Cache Splatting: A GPU-Friendly Global Illumination Algorithm", 3<sup>rd</sup> Eurographics Symposium on Rendering 2005, July 2005. <http://dx.doi.org/10.2312/EGWR/EGSR05/055-064>
- 32) Jaroslav Krivánek, Pascal Gautron, S. N. Pattanaik, K. Bouatouch, "Improved Radiance Gradient Computation", Spring Conference of Computer Graphics (SCCG2005), Budmerice, Slovak Republic, May 2005. <https://doi.org/10.1145/1090122.1090148>
- 33) Pascal Gautron, Jaroslav Krivánek, Kadi Bouatouch, and S. N. Pattanaik "Radiance Cache Splatting: A GPU-Friendly Global Illumination Algorithm", In *Siggraph 2005 Sketches and Applications*, August 2005.
- 34) W. Mundt, S. N. Pattanaik, E. Reinhard. "Beyond Triangles: A Simple Framework for Hardware-Accelerated Non-Triangular Primitives". GDC 2005 (Feb 2005). [https://www.researchgate.net/publication/266214830\\_Beyond\\_Triangles\\_A\\_Simple\\_Framework\\_For\\_Hardware-Accelerated\\_Non-Triangular\\_Primitives](https://www.researchgate.net/publication/266214830_Beyond_Triangles_A_Simple_Framework_For_Hardware-Accelerated_Non-Triangular_Primitives)
- 35) Charles E. Hughes, Jaakko Konttinen, S. N. Pattanaik, "The Future of Mixed Reality: Issues in Illumination and Shadows", I/ITSEC, Nov 2004. <https://doi.org/10.1177%2F154851290500200104>

- 36) Pascal Guatron, Jaroslav Kriváček, S. N. Pattanaik, Kadi Bouatouch, "A Novel Hemispherical Basis for Accurate and Efficient Rendering". Proceedings of 2<sup>nd</sup> Eurographics Symposium on Rendering 2004 (July 2004). <https://doi.org/10.2312/EGWR/EGSR04/321-330>
- 37) Ruifeng Xu, S. N. Pattanaik, Charles Hughes, "Real-time rendering of dynamic objects in dynamic, low frequency environments". Proceedings of Computer Graphics and Social Agents Conference (CASA) 2004, MIRALab, Switzerland, May 2004. <https://www.semanticscholar.org/paper/Real-time-Rendering-of-Dynamic-Objects-in-Dynamic-%2C-Xu-Pattanaik/55d7974ff94a8b48dd1b324cb6230605d461170b>
- 38) Jaroslav Kriváček, S. N. Pattanaik, Jiri Zara, "Adaptive Mesh Subdivision for Precomputed Radiance Transfer", *Proceedings of Spring Conference in Computer Graphics (SCCG 2004)*, Slovak Republic, ACM-Press, 2004, p. 106-101. <https://doi.org/10.1145/1037210.1037226>
- 39) Chris Stapleton, Eileen Smith, Scott Malo, Charles Hughes, S. N. Pattanaik, "Sea Creatures – A Cretaceous Journey in Augmented Reality", ISMAR 2004. [https://www.researchgate.net/publication/262875347\\_MR\\_Sea\\_Creatures\\_-\\_A\\_Cretaceous\\_Journey\\_in\\_Augmented\\_Virtuality](https://www.researchgate.net/publication/262875347_MR_Sea_Creatures_-_A_Cretaceous_Journey_in_Augmented_Virtuality)
- 40) Charles E. Hughes, Erik Reinhard, S. N. Pattanaik, "Achieving Interactive-Time Realistic Illumination in Mixed Reality" Army Science Conference, December 2004. <http://www.dtic.mil/get-tr-doc/pdf?AD=ADA433377>
- 41) Oguz Ahmet, Erik Reinhard, S. N. Pattanaik, "Color Appearance in High Dynamic Range Imaging", ACM Symposium on Applied Perception in Computer Graphics and Visualization, August 2004. <http://sap.acm.org/2004/apgv04.pdf>
- 42) Mangesh Nijasure, S. N. Pattanaik, Vineet Goel, "Interactive Global Illumination in Dynamic Environments using Commodity Graphics Hardware". *Proceedings of Pacific Graphics 2003*. 11: 450-454, 8 Oct 2003. <https://doi.org/10.1109/PCCGA.2003.1238293>
- 43) Anand Santhanam, S. N. Pattanaik, Jannick Rolland, Celina Imielinska, Jack Norfleet. "Physiologically-Based modeling and visualization of deformable lungs". *Proceedings of Pacific Graphics 2003*. 11: 507-511, 8 Oct 2003. <https://doi.org/10.1109/PCCGA.2003.1238304>
- 44) Rafal Mantiuk, Karol Myszkowski, S. N. Pattanaik, "Attention Guided MPEG Compression for Computer Animations" *Proceedings of Spring Conference in Computer Graphics (SCCG2003)*, April 2003, ACM-Press, pp 262-267, Budmerice, Slovak Republic. <https://doi.org/10.1145/984952.984991>
- 45) Hector Yee, S. N. Pattanaik, "Local Adaptation Luminance via Segmentation and Assimilation", *SIGGRAPH 2003 Sketch*, San Diego, September 2003. (Refereed Short paper.) <https://doi.org/10.1145/965400.965489>
- 46) Rafal Mantiuk, Karol Myszkowski, S. N. Pattanaik, "Cube-Map Data Structure for Interactive Global Illumination Computation in Dynamic Diffuse Environments", *Proceedings of International Conference on Computer Vision and Graphics (ICCVG-2002)*, pp-530-538, Zakopane, September 2002. [https://www.researchgate.net/publication/228582635\\_Cube-map\\_data\\_structure\\_for\\_interactive\\_global\\_illumination\\_computation\\_in\\_dynamic\\_diffuse\\_environments](https://www.researchgate.net/publication/228582635_Cube-map_data_structure_for_interactive_global_illumination_computation_in_dynamic_diffuse_environments)
- 47) S. N. Pattanaik, Hector Yee, "Adaptive Gain Control for High Dynamic Range Image Display", *Proceedings of Spring Conference in Computer Graphics (SCCG2002)*, April 24-27, 2002, Budmerice, Slovak Republic. <https://doi.org/10.1145/584458.584472>
- 48) Hector Yee, Philip Dutre, S. N. Pattanaik, "Fundamentals of Lighting and Perception: The Rendering of Physically Accurate Images", 16<sup>th</sup> Game Developer's Conference (GDC2002), San Jose, March 4-8, 2002. <https://www.gdcvault.com/play/1022583/Fundamentals-of-Lighting-and-Perception>

- 49) S. N. Pattanaik, Mangesh Nijasure, "Real-Time Realistic Rendering", Poster presentation, 23<sup>rd</sup> Army Science Conference 2002, Orlando, December 2002.
- 50) S. N. Pattanaik, Jack E. Tumblin, Hector Yee, Donald P. Greenberg, "Time-Dependent Visual Adaptation for Realistic Real-Time Image Display", *Proceedings of SIGGRAPH 2000*, pp. 47-54, New Orleans, 23-28 July, 2000. <https://doi.org/10.1145/344779.344810>
- 51) Mahesh Ramasubramanian, S. N. Pattanaik, Donald P. Greenberg, "A Perceptually Based Physical Error Metric for Realistic Image Synthesis", *Proceedings of SIGGRAPH'99*, pp. 73-82, Los Angeles, 8-13 August 1999. <https://doi.org/10.1145/311535.311543>
- 52) S. N. Pattanaik, James A. Ferwerda, Mark D. Fairchild, and Donald P. Greenberg, "A Multiscale Model of Adaptation and Spatial Vision for Realistic Image Display", *Proceedings of SIGGRAPH'98*, pp. 287-298, Orlando, July 1998. <https://doi.org/10.1145/280814.280922>
- 53) S. N. Pattanaik, Mark D. Fairchild, James A. Ferwerda and Donald P. Greenberg, "Multiscale model of Adaptation, Spatial Vision and Color Appearance", *Proceedings of IS&T/SID's 6th Color Conference*, Arizona, November 1998. <https://www.ingentaconnect.com/content/ist/cic/1998/00001998/00000001/art00002>
- 54) James Ferwerda, S.N. Pattanaik, Peter Shirley and Donald P. Greenberg, "A Model of Visual Masking for Computer Graphics", *Proceedings of SIGGRAPH'97*, pp. 143-152, Los Angeles, 3-8 August, 1997. <https://doi.org/10.1145/258734.258818>
- 55) Donald P. Greenberg, Kenneth E. Torrance, Peter Shirley, James Arvo, James A. Ferwerda, S.N. Pattanaik, Eric Lafortune, Bruce Walter, Sing-Choong Foo and Ben Trumbore, "A Framework for Realistic Image Synthesis", *Proceedings of SIGGRAPH'97*, pp. 477-494, Los Angeles, 3-8 August, 1997. <https://doi.org/10.1145/310930.310970>
- 56) S.N. Pattanaik, James Ferwerda, Kenneth E. Torrance and Donald P. Greenberg, "Validation of Global Illumination Simulations through CCD Camera Measurements", *Proceedings of IS&T/SID's 5th Color Conference*, Arizona, 17-21 November, 1997. <https://www.ingentaconnect.com/content/ist/cic/1997/00001997/00000001/art00049>
- 57) James Ferwerda, S.N. Pattanaik, Peter Shirley and Donald P. Greenberg, "A Model of Visual Adaptation for Realistic Image Synthesis", *Proceedings of SIGGRAPH'96*, pp. 249-258, New Orleans, 4-9 August, 1996. <https://doi.org/10.1145/237170.237262>
- 58) S.N. Pattanaik and Kadi Bouatouch, "Interactive Walk-Through Using Particle Tracing", *CG International 1995*, Leeds, UK, 25-30 June, 1995. <https://pdfs.semanticscholar.org/dec5/6695780bff2c1bd4a62ce484a0ebf10d981b.pdf>
- 59) S.N. Pattanaik and Kadi Bouatouch, "Linear Radiosity with Error Estimation", *Eurographics Rendering Workshop'95*, Dublin, 12-14 June, 1995. [https://doi.org/10.1007/978-3-7091-9430-0\\_17](https://doi.org/10.1007/978-3-7091-9430-0_17)
- 60) Kadi Bouatouch and S.N. Pattanaik, "Discontinuity Meshing and Hierarchical MultiWavelet Radiosity", *Graphics Interface'95*, May 15-19, 1995, Quebec City. <https://pdfs.semanticscholar.org/1cb1/c422d203ff8a451dd2c638120b4d8e9cbeff.pdf>
- 61) S.N. Pattanaik and Kadi Bouatouch, "Haar Wavelet : A Solution to Global Illumination With General Surface Properties", *5th Eurographics Workshop on Rendering*, Darmstadt, Germany, June 1994. [https://doi.org/10.1007/978-3-642-87825-1\\_21](https://doi.org/10.1007/978-3-642-87825-1_21)
- 62) A.G. Chalmers, S.P. Mudur, A. Tongaonkar, S.K.F. Stoddart and S.N. Pattanaik, "Antardrishti: Photo-realistic visualisation of Indian Heritage Sites". *The 3rd World Archaeology Congress*, Delhi, December 1994.
- 63) S.N. Pattanaik and S.P. Mudur, "The Mathematical Framework of Adjoint Equations for Illumination Computation", *Proceedings of the International Conference on Computer Graphics (IFIP-ICCG93)*, Bombay, India, 1993.



- 64) A.G. Chalmers, S.N. Pattanaik and S.P. Mudur, "Parallel Particle Tracing for Photo-Realistic Image Synthesis", International Computer Graphics Conference, pp. 101-105, St. Petersburg, September, 1993.
- 65) S.N. Pattanaik and S.P. Mudur, "Computation of Global Illumination by Monte Carlo Simulation of the Particle Model of Light", Proceedings of 3rd Eurographics Rendering Workshop, Bristol, 1992. <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.86.206>
- 66) S.J. Nath, S.N. Pattanaik and S.P. Mudur, "VIDURA : An Interactive Multilingual Publishing System", Proceedings of the International Conference on Electronic Publishing, Document Manipulation and Typography (EP88), France, 1988. <https://dl.acm.org/citation.cfm?id=51311>
- 67) S. N. Pattanaik, S.J. Nath, S.P. Mudur, "Computer Processing of Indian Scripts - A Pure Consonant Approach", Proceedings of the National Seminar on Computer Aided Language Processing, Delhi, India, 1987.

#### **Non-refereed publication and Technical Reports**

- 1) C Collin, S Pattanaik, "GPU accelerated computation of Polarized Subsurface BRDF for Flat Particulate Layers". <http://arxiv.org/abs/1707.05882>, 2017..
- 2) Neslisah Torosdagli, Sumanta Pattanaik, Curtis Lisle, Yanling Liu, "Interactive Out-of-Core Volume Rendering", UCF-Mayo Clinic Mini Symposium, UCF, Orlando, April 28, 2017.
- 3) Neslisah Torosdagli, Sumanta Pattanaik, Ulas Bagci, "Parallel Out-of-Core Medical Volume Segmentation", Grad Cohort Workshop 2017.
- 4) Neslisah Torosdagli, Denise K. Liberton, Payal Verma, Murat Sincan, Janice Lee, Sumanta Pattanaik, Ulas Bagci, "Robust and Fully Automated Segmentation of Mandible from CT Scans", UCF Research Week 2017.
- 5) Musawir A. Shah, S. N. Pattanaik. "Caustics Mapping: An Image-space Technique for Real-time Caustics." Technical Report, School of Engineering and Computer Science, University of Central Florida, CS-TR-05-07, 07/29/2005
- 6) Jaroslav Křivánek, Jaakko Konttinen, S. N. Pattanaik, and Kadi Bouatouch, "Fast Approximation to Spherical Harmonic Rotation", Technical report no. 1728. IRISA, Rennes, France. July 2005.
- 7) Ruifeng Xu, S. N. Pattanaik, Charles E. Hughes, "High Dynamic Range Image and Video Data Compression", Technical Report, School of Engineering and Computer Science, University of Central Florida, CS-TR-05-13.
- 8) Ruifeng Xu, S. N. Pattanaik, "A Level set based detail extraction method", Technical Report, School of Engineering and Computer Science, University of Central Florida, CS-TR-05-14.
- 9) Ruifeng Xu, S. N. Pattanaik, "A Practical Sampling of 3D Space for Realistic Rendering of Complex Scenes", Technical Report, School of Engineering and Computer Science, University of Central Florida, CS-TR-05-15.
- 10) Musawir A. Shah, S. N. Pattanaik. "Caustics Mapping: An Image-space Technique for Real-time Caustics." Technical Report, School of Engineering and Computer Science, University of Central Florida, CS-TR-05-07, 07/29/2005
- 11) Jaroslav Křivánek, Jaakko Konttinen, S. N. Pattanaik, and Kadi Bouatouch, "Fast Approximation to Spherical Harmonic Rotation", Technical report no. 1728. IRISA, Rennes, France. July 2005.
- 12) Jaroslav Krivánek, Pascal Gautron, S. N. Pattanaik, K. Bouatouch. "Radiance Caching for Efficient Global Illumination Computation". Technical Report no. 1623, IRISA, Rennes, France, 2004.

- 13) Neeharika Adabala, C. E. Hughes, S. N. Pattanaik, "A Model for Flicker in Fire", *Computer Science Technical Report #CS-0404*, University of Central Florida, April 2004.
- 14) S. N. Pattanaik, Donald P. Greenberg, "A Computational Model for Simulating Dynamics of Visual Adaptation", *Technical Report # PCG-99-3*.
- 15) S.N. Pattanaik and K.E. Torrance, "Light Measurement using the Photometrics PXL1300L CCD Camera", *Technical Report # PCG-98-1*.
- 16) S.S-F. Chen, J.W-C. Li, K.E. Torrance and S.N. Pattanaik, "Preliminary Calibration of the Photometrics PXL1300L CCD Camera", *Technical Report # PCG-96-1*.
- 17) S.N. Pattanaik and Kadi Bouatouch, "Adjoint Equations and Particle Tracing for Global Illumination", *Technical Report IRISA-903*.

#### **Non-refereed publication (Conference Tutorials)**

- 1) Eakta Jain, Olivier Le Meur, Sumanta N. Pattanaik, "Visual Attention from a Graphics Point of View", Proceedings of the 37th Annual Conference of the European Association for Computer Graphics: Tutorials. Eurographics 2016, May 9, 2016.
- 2) S. N. Pattanaik, Erik Reinhard, "Tone Reproduction in Real Time Environments", *Tutorial notes*, Game Developers Conference 2004, San Jose, Feb 2004.
- 3) Paul Debevec, Greg Ward, Erik Reinhard, S. N. Pattanaik, "High Dynamic Range Imaging", *Tutorial notes*, ACM-SIGGRAPH 2004, Los Angeles, Aug 2004, ACM-SIGGRAPH 2005, Los Angeles, Aug 2005.
- 4) S.N. Pattanaik and Kadi Bouatouch, "Global Illumination: Theory and Practice", Tutorial notes, *Computer Graphics International (CGI'95)*, Leeds, UK, 24-30 June 1995.
- 5) S.N. Pattanaik, Kadi Bouatouch and Pierre Tellier, "Global Illumination and Image Synthesis", Tutorial notes, International Conference on Computer Graphics (IFIP-ICCG93), Bombay, India, 1993

#### **Non-refereed publication (Invited Presentations)**

- 1) Banterle F., Debattista K., Artusi A., Pattanaik S., Myskowski K., Ledda P., Bloj M., Chalmers A.G. "High dynamic range imaging and LDR expansion for generating HDR content", Eurographics State-of-the-Art Report (STAR), Eurographics'09, pp 17-44, March, 2009.
- 2) S.P. Mudur and S.N. Pattanaik, "Monte Carlo Methods for Computer Graphics", State of the Art Report (STAR) series, *Eurographics'93*, Barcelona, September 1993.

#### **Patent and Disclosure**

- 1) UCF Software Disclosure ID 11118 (08/23/2016) 2016.  
Title: Web-based Interactive Volume Rendering,  
UCF Inventor(s): Dr. Sumanta Pattanaik (Lead Inventor), Neslisah Torosdagli.  
External Sponsors: Sponsor: Leidos, Agency Contract #: 15X120 (ID: 1058750)
- 2) Patent Application #15/582,52: Date 04/28/2017  
Allowance Received: Date 01/24/2019  
Title: Multispectral Lighting Reproduction  
Inventors/Contributors: Paul E. Debevec, Chloe Legendre, Sumanta Pattanaik

## Grants and Contracts

### **Awarded External Contracts and Grants (Total \$1,226,165)**

Investigator Status	Title	Funding Source	Amount (PI Share)	Period of support
PI	<i>Information theoretic Approach To Light-field Measurement and Exploitation at Information Theoretic Limits (LIMIT)</i>	U. Arizona, (Primary award: DARPA R&D Contract # HR0011-16-C-0026)	\$147,002	2016 - 2018
PI	<i>Web-based Interactive Volume Rendering</i>	Leidos Biomedical Research	\$39,000	2015 - 2016
PI	<i>CGV Medium: Collaborative Research: A Unified Approach to Material Appearance modeling</i>	NSF	\$400,000	2011 - 2015
PI	<i>DOD STTR Phase II: Innovative Application of Urban ISR</i>	CG2, Inc.	\$162,000	2011 - 2013
PI	<i>DOD STTR Phase I: Innovative Application of Urban ISR</i>	CG2, Inc.	\$33,000	2010 - 2011
PI	<i>Real-Time Realistic Rendering of Huge Urban Landscape with Large Building Structures</i>	AMD Orlando	\$30,000	2010 - 2011
Co-PI	<i>DRU: Cognition in Natural Environments (PI : Charles Hughes)</i>	NSF	\$32,372	2006 - 2010
PI	<i>Realistic Real-time Rendering of Uneven Natural Terrain</i>	Electronic Art (EA)	\$20,000	2006 - 2007
PI	<i>Realistic Real-time Rendering of Uneven Natural Terrain</i>	Electronic Art (EA)	\$20,000	2004 - 2006
Co-PI	<i>3D Display for Medical and Engineering Visualization (PI: Jannick Rolland)</i>	ADASTRA Labs LLC	\$1,000	2004 - 2006
Co-PI	<i>3D Displays for Medical and Engineering Displays (PI: Jannick Rolland)</i>	Medical Education Technologies, Inc.	\$10,000	2004 - 2006
Co-PI	<i>RF-3D Displays for Medical &amp; Engineering Visualization (PI: Jannick Rolland)</i>	Motion Analysis Corporation	\$1,000	2005
Co-PI	<i>Mixed Reality: Anytime Anywhere (PI: Charles Hughes)</i>	ONR/DOD	\$70,044	2004 - 2005
PI	<i>Research in Augmented and Virtual Environment Systems (RAVES).</i>	ONR/DOD	\$60,898	2003 - 2005
PI	<i>Towards Hardware Driven Real-time Realistic Rendering.</i>	ATI Research	\$100,000	2002 - 2005
PI	<i>Perception Based Algorithms for Efficient Rendering of Dynamic Synthetic Environments</i>	Army-STRICOM	\$90,250	2002 - 2003
Co-PI	<i>Virtual Object Rendering and Registration for Mixed Reality</i>	Army STRICOM	\$9,600	2002 - 2003

	(PI: Michael Moshell),			
--	------------------------	--	--	--

**Grants not in ORC report and Internal Grants (Total \$62,879 + travel support)**

Investigator Status	Title	Funding Source	Amount (PI Share)	Period of support	Evidence
PI	<i>Global Illumination and Ray Tracing on Mobile GPUs</i>	Qualcomm	\$30,000	2015 - 2016	Letter attached to "awards" section of the dossier.
PI	<i>Web-based Interactive Volume Rendering</i>	KnowledgeVis	\$12,000	2015	Letter attached to "awards" section of the dossier.
Research Collaborator	<i>Collaborative research between the graphics groups of University of Erlangen, Germany, and UCF</i> Other PI: Marc Stamminger (PI) Univ of Erlangen, Germany	BACATEC, Germany	International Travel Support (3000 Euro managed by Univ of Erlangen)	2010	<a href="http://www.bacatec.de/en/sonderprojekt_e_fl_2010-014.html">http://www.bacatec.de/en/sonderprojekt_e_fl_2010-014.html</a>
PI	<i>Higher Order Representation and Real-time Rendering of Complex Natural Terrains</i>	I-4 FHTC_FY07_A nnuual	\$13,400	2007 - 2008	UCF Internal
Senior Personnel	<i>International Research Experiences for U.S. Students at INRIA.</i> PI: Victor Vianu UCSD, CA	NSF-IRES	International Travel Support managed by UCSD	2006 - 2009	
PI		I-4 P10	\$7479	2005 - 2006	UCF Internal
PI	<i>Rendering and Global Illumination in Real Time</i> Other PIs: - Kadi Bouatouch, Univ of Rennes I, France - Charles Hansen (Joined in 2009) Univ of Utah	INRIA, <u>Equipe Associe</u> Funding	International Travel Support (12,800 Euro managed by Univ of Rennes I, France)	2004 - 2009	<a href="http://www.irisa.fr/prive/kadi/SiteEquipeAsociee/Formulaire10_RTR2A/Formulaire10.html">http://www.irisa.fr/prive/kadi/SiteEquipeAsociee/Formulaire10_RTR2A/Formulaire10.html</a>

## **PROFESSIONAL ACTIVITIES**

### **Service to the Research Community:**

Chair, Program Committee

Eurographics Symposium on Rendering (EGSR), June 2007, Grenoble, France.  
(Co-Chaired with Jan Kautz)

Editor

ACM Computing Reviews: Computer Graphics Category, Published by ACM, 2003-2009.

Member, Program Committee

ACM I3D conference, 2009-2018.

Spring Conference on Computer Graphics (SCCG) 2004-06, 2015-17.

GRAPP 2014-15.

Eurographics conference 2006, 2009-2010, 2012.

Foundations of Digital Games (FDG2012) conference, 2012.

Eurographics Symposia on Rendering (EGSR\_)2006-2009, 2011.

ACM Multimedia Workshop - Electronic Heritage and Digital Art Preservation, 2010.

SIGGRAPH, Aug 2008.

AFRIGRAPH, 2004-2007.

International Conference on Computer Graphics Theory and Application, Feb 2006.

Winter School of Computer Graphics (WSCG) 2004-2006

International Symposium on VR, Archaeology, Intelligent Cultural Heritage(VAST) 2004.

2<sup>nd</sup> Eurographics Symposium on Graphics and Cultural Heritage (EGSGH 2004).

Vision, Video and Graphics (VVG 2003), July 2003.

1<sup>st</sup> International Workshop on Architectural and urban Ambient Environment, Feb 2002.

Eurographics Workshop on Rendering (EGRW) 1993-1996, 2000-2001.

International Conference on Visual Computing (IFIP-ICVC 99), February, 1999.

International Conference on Computer Graphics (IFIP-ICCG93), February, 1993.

Member, Committee

CIE TC8-08 Committee, 2004, *Spatial Appearance Models*.

Agence De La Recherche (ANR) Equipment of excellence Evaluation 2011, France.

NSF Graphics/Visualization CAREER Review Panel, 2011, 2007

NIH/NIEHS Review, SBIR–E-learning for Hazmat and Emergency Response. 2004

Austrian Science Foundation (FWF) proposal review, May 2004

NSF Proposal Review Committees/panels, 2003, 2002, 1999, 1998.

Reviewer

ACM-SIGGRAPH, ACM-TOG, ACM-TAP, IEEE-CG&A, IEEE-TVCG,  
Computer Graphics Forum, Visual Computers, Eurographics,  
Eurographics Symposium on Rendering, ACM I3D, AFRIGRAPH, SCCG, VVG.

### **Service to the University:**

Chair

Senate IT Committee. Fall 2018

Vice-Chair

Senate IT Committee. Spring 2019

Member

UCF Faculty Senate Fall 2011 – Spring 2015, Spring 2017-Spring 2019

UCF Senate IT Committee, Fall 2007 onward

UCF Graduate Council Appeals Committee, Fall 2011-Spring 2015

UCF Graduate Research Forum Judging, March 2011, March 2012, April 2013

### **Service to the College:**

Member

CECS Sabbatical Committee, 2010-13

CECS TIP Selection Committee, 2012-13

I2Lab Steering Committee, UCF, 2006-2007

Representative, CS Program in UCF Graduate Student Fair, Oct 2003

### **Service to the Department:**

Graduate Coordinator CS Program: 2004-2005, 2007-2008

Chair

CS/IT Hiring Committee for Lecturer/Instructor Position

Spring 2019, Fall 2018, Spring 2018, Spring 2017, Summer 2015, Spring 2014, Summer 2013.

CS I/L Promotion Committee

2018-19 Academic Year.

Doctoral Thesis Committee

Lingling Sik (M&S), in Spring 2013

Yugang Min (CS), in Spring 2012

Juraj Obert (CS), in Summer 2010

Kevin Boulanger (CS), in Summer 2008

Musawir Ali Shah (CS), Fall 2007

Anand Santhanum (Co-chair with Dr. Rolland) (CS), Summer 2006

Ruifeng Xu (CS), Spring 2005

MS Thesis Committee for

Kris Rivera (CS), in Fall 2011

Francisco Rivas (CS), Spring 2004

Siddharth Borikar (CS), Spring 2004

Mangesh Nijasure (CS), Fall 2003

Member

CS Tenure Promotion Committee for Pamela Wisniewski, 2019

CS Annual Evaluation Standards and Procedures (AESP) Committee, 2010-13

Ph.D. Thesis Evaluation Committee for

Emily Sassano (CS), Summer 2018

Yiayan Xiong (CS), Spring 2013  
Lisa Spencer (CS), Spring 2005  
Weifung Sun (CS), Spring 2005  
Vivek Singh (CS), Fall 2003 and Spring 2004  
Jiangjian Xiao (CS), Fall 2003  
Zeeshan Rasheed (CS), Fall 2001  
MS Thesis Evaluation Committee for  
Tad Litwiller, (CS), Fall 2010  
Varunyu Vorachart (CS), Fall 2003  
Senior Design Review Committee, 2018-19  
EECS Faculty Excellence Awards Committee, 2010-11  
CS Faculty Search Committee, 2004-1005, 2005-2006  
CS Undergraduate Curriculum Standardization Committee, 2005  
CS Interim Director Search Committee, 2005  
CS Graduate Committee, UCF, 2001-2003  
CS Budget Committee (alternate), UCF, 2003-2004  
EECS Course Review Committee (Signal Processing and Image Processing), 2002-2003  
Miscellaneous  
Undergraduate student advising, 2002-2019  
Coordinator  
Ph.D. Qualifying Exam, Spring 2002

**Other activities: (Conference Participation)**

SIGGRAPH 2018, 2015, 2008, 2007, 2005, 2007  
Eurographics Symposium on Rendering, 2009, 2007, 2006, 2016  
ACM I3D, 2011-18  
Aiya Nappa Rendering Seminar, July 2006,  
Game Developer Conference, 2005, 2002  
ACM-SIGGRAPH, July/August 1996-2004  
Eurographics Conference (2002);  
Vision Science Meeting (2002);  
Eurographics Workshop on Rendering (1992, 1994-95);  
Graphics Interface (1995);  
Computer Graphics International (1995);  
International Conference on Computer Graphics (1993).

**RECOGNITIONS AND AWARDS**

- 2010-2011 TIP award

# RESUME

## 1. PERSONAL DATA

Name: **MARIANNA PENSKY**  
Address: Department of Mathematics                      Joint appointment with the  
                  University of Central Florida                      Department of Statistics  
                  Orlando, FL 32816 -1364                      since summer 1999  
E-mail: Marianna.Pensky@ucf.edu

## PART I. BACKGROUND

### 2. EDUCATION

**1988** Ph.D. in Statistics                      Moscow State University, Russia.  
**1981** M.S. in Mathematics                      Perm State University, Russia.  
**1979** B.S. in Computer Science                      Perm State University, Russia.

### 3. ACADEMIC EXPERIENCE

**August 2008 – present**                      Professor, Department of Mathematics, University of Central Florida.  
**August 2000 – July 2008**                      Associate Professor, Department of Mathematics, University of Central Florida.  
**January 2005-May 2005**                      Visiting Assoc. Professor, Institute of Statistics and Decision Sciences, Duke University.  
**August 1995- July 2000**                      Assistant Professor, Department of Mathematics, University of Central Florida, Orlando, Florida.  
**July 1998 - August 1998**                      Honorary Visiting Scientist, Indian Statistical Institute, Calcutta, India  
**January 1995 - July 1995**                      Visiting Assistant Professor, Department of Statistics, Purdue University.  
**September 1994 - November 1994**                      Visiting Assistant Professor, Department of Mathematics and Statistics, University of Guelph, Ontario, Canada.  
**April 1993 - June 1993**                      Visiting Assistant Professor, Department of Statistics, University of Lund, Lund, Sweden.  
**August 1989 - December 1994**                      Senior Scientist, Mathematical Labs, Mining Institute, Ural Branch of Russian Academy of Sciences, Perm, Russia.  
**August 1989 - August 1990**                      Associate Professor, University of Perm, School of Education, Perm, Russia.  
**August 1981 - July 1988**                      Researcher, Computer Center, University of Perm, Perm, Russia.



#### 4. SUMMARY OF PRINCIPAL RESEARCH AND PROFESSIONAL SERVICE ACCOMPLISHMENTS

1. Published a research monograph. Have 96 papers published or accepted in refereed journals. Among them, 9 publications in “The Annals of Statistics”, 2 papers in “The Journal of the Royal Statistical Society”, one in “BMC Bioinformatics”, one in “Statistical Applications in Genetics and Molecular Biology” and 2 papers in CVPR Proceedings.
2. Have had continuous NSF funding since 2000. Served as a PI on five NSF research grants since year 2000. Currently, I am a co-PI on The Florida Department of Health grant. Was a co-PI on the NSF-FRG grant with Harvard University. Two grants awarded by the National Research Council of Italy. Research consulting for Moffitt Cancer Center and Research Institute.
3. With Dr. Rozenholc, we developed an R-package software for analysis of Contrast Agent Enhanced Medical Imaging data: LaplaceDeconv: Laplace Deconvolution with Noisy Discrete Non-Equally Spaced Observations on a Finite Time Interval and published it on CRAN. Also, with a group of researchers in Italy, we developed an open-source software for detection of differentially expressed genes on the basis of temporal microarray data: BATS: a free software for Bayesian Analysis of Time Series microarray experiments.
4. I was solicited to join editorial boards of three high-quality international journals: Electronic Journal of Statistics (Associate Editor), Journal of Nonparametric Statistics (Associate Editor), Journal of Statistical Planning and Inference (Associate Editor) and Statistics Sinica (Guest Editor). I am a part of the Board of Directors of the International Society for Nonparametric Statistics.
5. I am an elected Fellow of the International Statistical Institute
6. I received RIA awards in 2009 and 2018
7. Since year 1995, delivered 104 talks at international, national and regional conferences as well as at Colloquia at various universities all over the world including Duke University, Technion (Israel), Berkeley, Cornell and Harvard University.
8. I served as a member of the Program Committees of CIBB (Computational Intelligence methods for Bioinformatics and Biostatistics) 2015, 2016 and 2017 conferences and as a member of the Scientific Committee of the 4th Conference of the International Society for Nonparametric Statistics ISNPS 2018.
9. I served on NSF CDSE-MSS and Math–Bio NSF/NIGMS panels and as a referee of grant proposals for NSF and NSA. I referee papers for the top journals in the field such as Annals of Statistics, Journal of the Royal Statistical Society, Journal of American Statistical Association, Bernoulli, Biometrika and others.
10. I collaborate with researchers all over the world. I held short term visiting research positions at University of Paris V, Paris, France, CNR, Rome, Italy, and Tel-Aviv University, Tel-Aviv, Israel. These were funded by the host institutions. During my sabbatical in Spring 2005, I held an appointment as a Visiting Associate Professor at the Department of Statistics of Duke University.

## 5. SUMMARY OF PRINCIPAL TEACHING ACCOMPLISHMENTS

1. Due to my research being at the frontier of the modern statistical sciences, I developed unique expertise that I passed onto UCF students via graduate teaching and research supervision. In Fall 2014, upon a request of Astronomy Group in Department of Physics, I introduced and taught a new special topics course "Approximation Theory and Bayesian Analysis" in Fall 2015, I introduced a special topics course "Analysis of Low-Dimensional Structures in High-Dimensional Data". In Fall 2016, I introduced the seminar course "Asymptotic Methods of Statistics". All those courses were based on research monographs and papers written in the last decade and were attended by students from Mathematics, Statistics, Physics and Computer Science departments.
2. I graduated 7 Ph.D. and 9 MS students and two undergraduate student at UCF. I am currently directing research of three Ph.D. students. I have 25 papers written with students. My students gave talks at national, international or regional conferences.
3. As a part of special topics courses, I provided help and research advice to a number of students in other departments and served on the P.D. and M.S. committees of those students. Between 2013 and 2017, I served on Ph.D. committees of Behzad Shahrabi, Hamed Valizadeh, Amara Tariq, Baoyuan Liu, Vildan Atalay, Sarfaraz Hussein, Nasim Souly and Mostafa Rahmani (Department of Computer Science); Oddny Brun (M.S., Institute of Simulations and Training); Andrew Foster (Honors in the Majors, Dept. of Physics). In addition, I am co-advising Ph.D. of Maryam Jaberri (Department of Computer Science).
4. I received Teaching Incentive Program Award in 2002 and 2007.
5. I have a variety of grants related to teaching: NSF grant "UCF- STEP Pathway to STEM: From Promise to Prominence" is directed to increase the number of graduating science and engineering majors; SMART grants, UCF. All my NSF research grants include partial NSF support for graduate students.
6. I have put a significant effort into curriculum development. I introduced and taught a number of novel graduate courses. In Fall 2003, I introduced and taught a new special topics course "Wavelets and Their Applications". The course became permanent in Math Department, and I taught it as the seminar course at Duke University during my sabbatical in Spring 2005. I introduced and taught a special topics Honors seminar "How to predict good weather for tomorrow" (Spring 2007, Fall 2011, Fall 2012). In addition, I was instrumental in re-designing of Ph.D. program in the Department of Mathematics and B.S. track in Actuarial Science in the Department of Statistics at UCF.
7. I always strive to bring technology and innovative teaching methods into the classroom. I was the first in the department to teach a long-distance TV-based courses and courses using long distance Tegrity format where the course is recorded and students watch the lectures online. I also taught a variety of courses in the Studio Classroom using various kinds of technology. I put a significant effort to introduce Mathematics students to statistical software. All my special topics graduate courses have significant computational component.

## 6. RESEARCH INTERESTS

1. Nonparametric and high-dimensional statistics.
2. Stochastic network models.
3. Statistical inverse problem.
4. Applications of statistics to biology and medicine.
5. Bayes and empirical Bayes theory.
6. Signal processing. Computer vision.
7. Classification and clustering
8. Reliability theory and stress-strength problem.

## 7. AWARDS

1. Was elected a Fellow of The International Statistical Institute, 2014
2. NSF grant DMS-1712977 "Non-Parametric Methods for Analysis of Time-Varying Network Data", PI, \$280,000 (8/2017– 7/2020)
3. The Florida Department of Health, "Utilization of in utero diffusion tensor magnetic resonance imaging to evaluate neurological disorders caused by Zika virus", co-PI (PI Bagci, U) , \$199,254 (03/09/2017 – 03/31/2018)
4. NSF grant DMS-1407475 "Solution of Sparse High-Dimensional Linear Inverse problems with Application to Analysis of Dynamic Contrast Enhanced Imaging Data", PI, \$120,000 (9/2014– 8/2017)
5. NSF grant DMS-1106564 "Laplace Deconvolution and Its Application to Analysis of Dynamic Contrast Enhanced Computed Tomography Data", PI, \$250, 000 (7/2011– 6/2014)
6. NSF FRG grant DMS-0652524 "Collaborative Research: Overcomplete Representations with Incomplete Data: Theory, Algorithms, and Signal Processing Applications", co-PI, PI Dr. Meng (Harvard University), \$160, 000 (7/2007– 6/2010)
7. H. Lee Moffitt Cancer Center and Research Institute "Gender based prognosis in lung cancer", No. 30-14992-99-01-G1, Research consulting, \$20,000 (7/2008-7/2010)
8. Research Incentive Award, UCF, Spring 2009 and Spring 2018
9. CNR (National Research Council of Italy) Short Term Mobility grant, Euro 1,600 (Summer 2008)
10. NSF grant DMS-0505133 "Collaborative Research: Analysis of High-Dimensional and Functional Data by Multiscale Methods with Applications", PI, \$72, 000 (8/2005– 7/2008)
11. Teaching Incentive Program Awards, Spring 2002 and Spring 2007
12. NSF grant "UCF– STEP Pathway to STEM: From Promise to Prominence", PIs Drs. Georgiopoulos and Young, M.Pensky is responsible for 3% of \$1,797,000 = \$54,000 (1/2006 – 12/2010)
13. CNR (National Research Council of Italy) Short Term Mobility grant, Euro 1,600 (Summer 2006)
14. SMART grant, UCF, with Naomi Braunstein, \$1,000 (8/2005- 6/2006)
15. NSF grant DMS-0004173 "Statistical Modeling in Wavelet Domain with Application in Turbulence", PI, \$60, 000 (8/2000 – 8/2003)
16. "Scientific Computing Research Environments", National Science Foundation, Co-PI, \$ 25,000 (8/98 – 11/2000) - with Drs. X. Li, J. Cannon, S.R. Choudhury, R. Mohapatra, A. Tovbis and K. Vajravelu

## PART II. TEACHING

### 8. TEACHING EXPERIENCE

#### University of Central Florida, 1995 - present

##### Undergraduate

Calculus I  
Calculus II  
Honors Calculus I  
Finite Math  
Matrix and Linear Algebra  
Calculus I for Engineers  
Calculus II for Engineers  
Honors Seminar "Weather Prediction"  
Calculus III  
Differential Equations  
College Trigonometry  
Probability Theory  
Mathematical Modeling  
Mathematical Foundations of Big Data  
(Special Topics Course)

##### Graduate

Measure and Probability  
Mathematical Statistics  
Topics in Advanced Calculus  
Optimization Theory  
Mathematical Modeling  
Applications of Wavelets in Statistics and Engineering  
(Special Topics Course)  
Sparse Representations: Model Selection,  
Estimation and Algorithms  
(Special Topics Course)  
Approximation Theory and Bayesian Analysis  
(Special Topics Course)  
Analysis of Low-Dimensional Structures  
in High-Dimensional Data  
(Special Topics Course)  
Bayesian Analysis and Approximation Theory  
(Special Topics Course)  
Mathematical Foundations of Big Data  
(Special Topics Course)  
Asymptotical Methods in Mathematical Statistics  
(Seminar Course)

#### Duke University, 2005

##### Graduate

Wavelets and Their Applications in Statistics

#### Purdue University, 1995

##### Undergraduate

Probability Theory

#### School of Education, University of Perm, 1989 - 1990

##### Undergraduate

Calculus I  
Calculus II  
Calculus III  
Differential Equations

##### Graduate

Advanced Calculus

## 9. COURSE AND SEMINAR DEVELOPMENT

1. In Fall 2018, I introduced and taught two versions of a new special topics courses “Mathematical Foundations of Big Data”, one for graduate and one for upper division undergraduate students.
2. In Fall 2016, I introduced and taught the seminar course “Asymptotic Methods of Statistics”. The course was based on research monographs and papers written in the last 5 years and was attended by students from Mathematics, Statistics and Computer Science departments.
3. Upon a request of Astronomy Group in Department of Physics, introduced and taught a new special topics course “Approximation Theory and Bayesian Analysis” in Spring 2011. The course was attended by students from Mathematics, Statistics and Physics departments. The course was requested again and was taught as a special topics course “Bayesian Analysis and Approximation Theory” in Fall 2015 with a somewhat modified content. Finally, the course was made permanent in 2017 and I taught it in Spring 2018.
4. Introduced a special topics course “Analysis of Low-Dimensional Structures in High-Dimensional Data” and taught it in Fall 2014.
5. Introduced (together with Dr. Schober) a special topics Honors seminar “Weather Prediction” which was a modified version of the course offered in Spring 2007. The course was offered with Dr. Schober in Fall 2011 and Fall 2012.
6. Introduced an ITV version of the course “Mathematical Statistics” and taught it in Tegrity format in Fall 2010, Spring 2015 and Spring 2016.
7. Introduced and taught a new special topics course “Sparse Representations: Model Selection, Estimation and Algorithms” (Spring 2009)
8. Taught a long-distance TV-based undergraduate course “Mathematical Modeling” for students in the main campus as well as in the three area campuses (Spring 2008, Spring 2009, Spring 2010).
9. After taking my sabbatical leave at SAMSI and participating in the program “Data assimilation for geophysical systems” I introduced (together with Dr. Choudhury) and taught a special topics Honors seminar “How to predict good weather for tomorrow”. The course was offered in Spring 2007 with Dr. Choudhury.
10. Taught a special topics seminar graduate course “Wavelets and their applications in Statistics” at the Institute of Statistics and Decision Sciences of Duke University (Fall 2005).
11. Introduced and taught a new special topics course “Wavelets and Their Applications in Statistics and Engineering” (Fall 2003).
12. Developed and taught the new graduate course “Optimization Theory”. The course was never offered before (Spring 1999).
13. Conducted weekly seminar “Wavelets and Their Applications in Statistics” for students in Departments of Mathematics and Statistics” (Fall 2000 – Spring 2004).
14. Participated in designing the B.S. track in Actuarial Science in the Department of Statistics. In particular, I developed syllabi for new undergraduate courses “Optimization for Actuarial Science”, “Risk Theory and Decision” and “Theory of Graduation” for actuarial track in Statistics. The courses later became a part of the B.S. Actuarial Science program in the Department of Statistics (Fall 2001-Spring 2002).
15. As a part of the University Graduate Curriculum Committee, I participated in approval of the following new graduate programs: MS in nonprofit management, Ph.D. in texts and Technology, Ph.D. in Economics, Ph.D. in Sociology, M.S. in Biomedical Engineering, MFA, M.A. and M.S. in Film and Digital Media and M.A. in Marriage and Family Therapy, as well as addition of new tracks to existing graduate programs (Fall 2003-Spring 2004).

## 10. GUIDANCE OF STUDENTS' RESEARCH

### Doctoral Theses supervised:

1. Aicha Elhor, "Statistical Estimation of Locations of Lightning Events", (Ph.D., March 2000)
2. Astrid Heard, "Application of Statistical Methods in Risk and Reliability" (Ph.D., November 2005)
3. David Bradshaw, "Classification of high-dimensional vectors based on matrix-variate distributions" (Ph.D., November 2005)
4. Justin Davis, "Model selection for classification of high-dimensional vectors" (Ph.D., December 2011)
5. Kathryn Pridemore "Accelerated life model with various types of censored data" (Ph.D., August 2013)
6. Rida Benhaddou "Nonparametric and Empirical Bayes Estimation Methods" (Ph.D., August 2013)
7. Evgeny Martinenko "Functional Data Analysis and Its Application To Cancer Data" (Ph.D., August 2014)
8. Maryam Jaber "Sampling and clustering techniques for computer vision", Department of Computer Science, Dr. Foroosh, co-advisor (Ph.D., May 2018)
9. Pawan Gupta "Techniques for analysis of high-dimensional data" (Ph.D., in progress)
10. Rasika Rajapakshage "Anisotropic Functional Laplace Deconvolution" (Ph.D., in progress)
11. Ramchandra Rimal "Deconvolution with Small Berkson Errors: the Minimax Study" (Ph.D., in progress)
12. Majid Noroozi "Stochastic Block Models for random networks" (Ph.D., in progress)

### Master's Theses supervised:

1. Wendy Bush "Orthogonal Series Estimation of a Prior Density Function", M.S. 1996
2. Kalpana Kirtane "Linear Empirical Bayes Estimation for Wishart Distribution", M.S. 1997
3. Peizhong Ni "Extended Linear Empirical Bayes Estimation", M.S., 1998.
4. Russel Takashima "Estimation in a Stress-Strength Model in the Case of Generalized Gamma Distribution", M.S., 2002
5. Sonya Lenhof "Estimation of  $P(X < Y)$  for beta-distributed random variables", M.S., 2002
6. Mohammed Alotaibi "Empirical Bayes Estimation Via Wavelets", M.S., 2003.
7. Irene Mojica "Construction of Confidence Intervals for Discrete Distributions", M.S., 2011.
8. Evgeny Martinenko "Prediction of Survival of Early Stages Lung Cancer Patients Based on ER Beta Cellular Expressions and Epidemiological Data", M.S., 2011.
9. Amanda Goedeker "Analysis of employment and earnings using varying coefficient models to assess success of minorities and women" (M.S., 2016)

### Undergraduate research supervised:

1. Naomi Brownstein, research project "Transformation of Random Variables in Statistics" supported by SMART Scholarship (Fall 2005-Spring 2006).
2. Naomi Brownstein, Honors Thesis "Estimation of reliability for the generalized gamma distribution" (Spring 2007).
3. Yesenia Cruz Rosado, REU, Summer 2009
4. Courtney Paulson, Honors Thesis "Using Haar-Fitz wavelet transform to uncover regions of constant light intensity in Saturn's rings" (Fall 2010)

## **Student Success**

### **Ramchandra Rimal**

- a) Received \$500 NSF travel grant to attend Conference on Predictive Inference and Its Applications, Iowa State University, May 2018
- b) Received \$125 from the organizing committee to attend The First Midwest Statistical Machine Learning Colloquium, Iowa State University

### **Rasika Rajapakshage**

- a) Served as the UCF SIAM Chapter President (2017-18)
- b) Received \$290 ASA travel award and \$500 SAMSI travel award to present research at Symposium on Data Science & Statistics, West Virginia University, May 2018
- c) Received \$650 SIAM Student Travel Award to present a talk at the 2018 SIAM Annual Meeting
- d) Served as a part of 50th Student Body Senate

### **Rida Benhaddou**

- a) Received "The Best Student Paper" award at the Meeting of Florida Chapter of American Statistical Association, Spring 2012
- b) As a Ph.D. student, published 3 papers, gave multiple presentations. One of the papers appeared as a special invited paper in the Journal of Statistical Planning and Inference
- c) Received a tenure-track position at University of Ohio starting in Fall 2014.

### **Aicha Elhor Gillespie**

- a) Was honored as the UCF College of Sciences 2015 Mathematics Outstanding AlumKnight, September 2015
- b) Serves as the Senior Vice President of Citi Shared Services Global Reengineering
- c) Serves as co-chair of the Citi Tampa Bay Site Women Network and Strategy. She is also actively involved in supporting women, giving to education and feeding the hungry

### **Russel Takashima**

Served as the Dean of the Department of Mathematics, at West Campus of Valencia College

### **Justin Davis**

- a) Accepted a Post Doctoral position at Department of Tropical Medicine, Tulane University
- b) His Ph.D. dissertation resulted in four papers
- c) Justin Davis's joint paper with Dr. Crampton was featured in "Nature"

**Naomi Brownstein**

- a) Graduated with a Ph.D. student from Biostatistics Department at UNC, Chapel Hill, one of the best biostatistics departments in US
- b) Currently is a tenure track assistant professor at the Florida State University
- c) Received honorable mention of the Alice T. Schafer Prize for Undergraduate Women in Mathematics (the highest national award an undergraduate female student in Mathematics can receive)
- d) Received NSF graduate scholarship award
- e) Received Order of Pegasus Award, the highest undergraduate student award at UCF
- f) Was awarded SMART grant, \$1000, in Fall 2005.
- g) Was elected a member of a President Leadership Council, March 2006

**David Bradshaw**

- a) Accepted a job as a group manager at ExtraQuest in Denver
- b) Received two Lockheed Martin "Vision" Awards for outstanding achievements
- c) Received the UCF Math Department's Graduate Award for Excellence in Research
- d) Received the University of Central Florida's Trustees Doctoral Fellowship

**Astrid Heard**

- a) Received the "Best poster" award at the Fifth International Conference on Objective Bayesian Statistics. Branson, Missouri, June 4–8, 2005.
- b) Received \$700.00 travel award from the organizing committee of the Fifth International Conference on Objective Bayesian Statistics. Branson, Missouri, 2005.

**Courtney Paulson**

- a) Was accepted as a Ph.D. student to University of California at Los Angeles
- b) Gave several presentations of her undergraduate research

**Evgeny Martinenko**

- a) received "The Best M.Sc. Thesis" Award, Dept. of Mathematics, Spring 2012
- b) has a published paper

**Wendy Bush**

- a) received Ph.D. from School of Education at UCF in 2001
- b) she received her tenure at the Valencia Community College
- c) was chosen as the "Professor of the Year" at the Valencia Community College, 1997-1998
- d) Wendy Bush has been reassigned to work as a Campus Facilitator for the Teaching and Learning Academy, Valencia's new tenure-track support system. This constitutes 40% of her contract.

**Sonya Lenhof**

- a) received Fellowship in Department of Mathematics, Rollins College, 2002-03
- b) currently is a professor in the Mathematics department at East Campus of Valencia College

**Mohammed Alotaibi** became a Ph.D. student at University of Oregon.

**Peizhong Ni** got "The Best Masters Thesis Award", Dept. of Mathematics, UCF, 1999



### Student Publications

1. Elhor, A. and Pensky, M. (2000) Bayesian Estimators of Locations of Lightning Events, *Sankhya*, **B62**, 202 – 216.
2. Pensky, M., and Kirtane, K. (2000) Linear empirical Bayes estimation in the case of the Wishart distribution, *Communications in Statistics. Theory and Methods*, **29**, 1787–1799.
3. Pensky, M., and Ni, P. (2000) Extended linear empirical Bayes estimation, *Communications in Statistics - Theory and Methods*, **29**, 579 – 592.
4. Pensky, M., Heard, A.E. (2003) Reliability and safety prediction methods for mission and spaceport operations. *Proceedings of the 40th Space Congress, Cape Canaveral, Florida, April 29- May 1, 2003*, 85–91.
5. Pensky, M., Allotaibi, M. (2005) Generalization of linear empirical Bayes estimation via wavelet series. *Statistics and Decisions*, **23**, 181–198.
6. Heard, A., Pensky, M. (2006) Confidence intervals for reliability and quantile function with application to NASA Space Flight data. *IEEE Transactions in Reliability*, **55**, 591–601.
7. Brownstein, N. (2006) Transformation of Variables in Statistics. *Proceedings of the National Conference on Undergraduate Research*, University of North Carolina at Asheville.
8. Bradshaw, D.J., Pensky, M. (2008) Decision theory based classification of high-dimensional vectors based on small samples. *Test*, **17**, 83–100.
9. Brownstein, N., Pensky, M. (2008) Application of transformations in parametric inference. *Journal of Statistics Education* , **16**, No. 1, 1–10.
10. Crampton, W.G.R., Davis, J.K., Lovejoy, N.R., Pensky, M. (2009) Multivariate classification of animal communication signals: a simulation-based comparison of alternative signal processing procedures, using electric fishes. *Journal of Physiology – Paris*, **102**, 304–321.
11. Bradshaw, D.J., Pensky, M. (2010) SVM-like decision theoretical classification of high-dimensional vectors. *JSPI* , **140**, 705 – 718.
12. Davis, J., Pensky, M., and Crampton, W. (2011) Bayesian Feature Selection for Classification With Possibly Large Number of Classes. *Journal of Statistical Planning and Inference*, **141**, 3256–3266.
13. Martinenko, E., Pensky, M., Tockman, M., Zhukov, T. (2012) ER beta Expression Improves Predicted Survival of Early Stage Lung Cancer. *Pioneer Journal of Theoretical and Applied Statistics*, **4**, 71–85.
14. Angelini, C., De Canditiis, D., Pensky, M., Brownstein, N. (2013) Bayesian models for the multi-sample time-course microarray experiments, accepted. *Lecture Notes in Computer Science*, **7548**, 21–35.
15. Benhaddou, R., Pensky, M., Picard, D. (2013) Anisotropic Denoising in Functional Deconvolution Model with Dimension-free Convergence Rates. *Electronic Journal of Statistics*, **7**, 1686–1715.
16. Benhaddou, R., Pensky, M. (2013) Adaptive Nonparametric Empirical Bayes Estimation Via Wavelet Series. *Journal of Statistical Planning and Inference*, **143**, 1672–1688.
17. Davis, J., Pensky, M. (2014) Model Selection for Classification with a Large Number of Classes. In *Topics in Nonparametric Statistics. Springer Proceedings in Mathematics & Statistics*, **74**, Akritas, M.G., Lahiri, S.N., Politis, D.N., Eds., pp. 251–258.
18. Benhaddou, R., Kulik, R., Pensky, M., Sapatinas, T. (2014) Multichannel Deconvolution with Long-Range Dependence: A Minimax Study *Journ. Stat. Plan. Inference*, **148**, 1–19.
19. Liu, B., Wang, O., Tappen, M., Foroosh, H., Pensky, M. (2015) Sparse convolutional neural networks. *CVPR Proceedings 2015*, 806–814.

20. Jaber, M., Pensky, M., Foroosh, H. (2015) Sparse Withdrawal of Inliers in a First Trial (SWIFT). CVPR Proceedings 2015, 4849–4857.
21. Gupta, P., Pensky, M. (2018) Solution of linear ill-posed problems using random dictionaries. *Sankhya, Ser. B.*, **80**, 178-193.
22. Jaber, M., Pensky, M., Foroosh, H. (2018) Probabilistic Sparse Subspace Clustering Using Delayed Association. *Proceedings of the 2018 24th International Conference on Pattern Recognition (ICPR)*, 2087-2092.
23. Benhaddou, R., Pensky, M., Rajapakshage, R. (2019) Anisotropic functional Laplace deconvolution. Submitted. *Journ. Statist. Plan. Inf.*, **199**, 271285.
24. Jaber, M., Pensky, M., Foroosh, H. SWIFT: Sparse Withdrawal of Inliers in a First Trial. *IEEE Transactions on Pattern Analysis and Machine Intelligence*. Accepted.
25. Benhaddou, R., Pensky, M., Rajapakshage, R. (2019) Anisotropic functional Laplace deconvolution. *Journ. Statist. Plan. Inf.*, **199**, 271285.
26. Rajapakshage, R., Pensky, M. Clustering in statistical ill-posed linear inverse problems. *ArXiv:1810.06989*. Submitted.
27. Rimal, R., Pensky, M. Density Deconvolution with Small Berkson Errors. *ArXiv:1810.07016*. Submitted.

## STUDENT PRESENTATIONS

### Pawan Gupta

- *Solution of linear ill-posed problems using random dictionaries*. Fall Southeastern Sectional Meeting of the American Mathematical Society, University of Central Florida, Orlando, Florida, September 2017
- *Solution of linear ill-posed problems using random dictionaries*. 2018 Joint Meetings of The Florida Section Of The Mathematical Association of America And The Florida Two-Year College Mathematics Association, Florida Atlantic University, February 2018

### Ramchandra Rimal

- *Estimation with Berkson Errors*. Fall Southeastern Sectional Meeting of the American Mathematical Society, University of Central Florida, Orlando, Florida, September 2017
- *Estimation with small Berkson Errors*. 2018 Joint Meetings Of The Florida Section Of The Mathematical Association of America And The Florida Two-Year College Mathematics Association, Florida Atlantic University, February 2018

### Rasika Rajapakshage

- *Anisotropic Functional Laplace Deconvolution*. Analysis Seminar, Math Department, UCF, April 2017.
- *Anisotropic Functional Laplace Deconvolution*. Fall Southeastern Sectional Meeting of the American Mathematical Society, University of Central Florida, Orlando, Florida, September 2017 (45 minute talk)

- *Anisotropic Functional Laplace Deconvolution*. 2018 Joint Meetings Of The Florida Section Of The Mathematical Association of America And The Florida Two-Year College Mathematics Association, Florida Atlantic University, February 2018 (45 minute talk)
- *Anisotropic Functional Laplace Deconvolution*. Symposium on Data Science & Statistics, West Virginia University, May 2018 (15 minute talk)
- *Anisotropic Functional Laplace Deconvolution*. 2018 SIAM Annual meeting, Portland, Oregon, July 2018 (15 minute talk)

### **Rida Benhaddou**

- *Adaptive Nonparametric Empirical Bayes Estimation Via Wavelet Series*. Florida Chapter Meeting of ASA, Jacksonville, Florida, February 2012.
- *Anisotropic Denoising in Functional Deconvolution Model with Dimension-free Convergence Rates*. Florida Chapter Meeting of ASA, Pensacola, Florida, February 2013.
- *Adaptive Nonparametric Empirical Bayes Estimation Via Wavelet Series*. ENAR Spring Meeting, March 2013, Orlando, Florida.

### **Courtney Paulson**

- *Multiple testing procedures and their application to occultations by Kuiper Belt Objects*, Showcase of Undergraduate Research Excellence, University of Central Florida, April 2009.
- *Statistical Analysis of Light Intensity Observations to Determine Areas of Constant Properties in Saturn's Rings*, Showcase of Undergraduate Research Excellence, University of Central Florida, April 2010.
- *Statistical Analysis of Light Intensity Observations to Determine Areas of Constant Properties in Saturn's Rings*, The Embry-Riddle Undergraduate Mathematics Conference, April 2010.
- *Analyzing Excessive Variance to Uncover Particle Properties in Saturn's Rings*, Showcase of Undergraduate Research Excellence, University of Central Florida, April 2011.

### **Justin Davis**

- *Multivariate classification of animal communication signals: a simulation-based comparison of rival signal processing procedures, using electric fish signals*, Interdisciplinary seminar, Department of Mathematics, University of Central Florida, Orlando, January 2008.
- *Classification of animal signals: a comparison of rival signal processing procedures*, 32nd SIAM Southeastern-Atlantic Section Conference, SIAM-SEAS 2008, University of Central Florida, Orlando, March 2008.

- *Bayesian Feature Selection for Classification With Possibly Large Number of Classes*, SEAMS Workshop "Cha-Cha Days", Orlando, University of Central Florida, Orlando, November 2009.

### Naomi Brownstein

- *Estimation in the Stress-Strength Model*, Florida Chapter Meeting of the American Statistical Association, Gainesville, Florida, February 2008.
- *Estimation in the Stress-Strength Model*, Joint Mathematics Meetings, San Diego, California, January 2008
- *Estimation in the Stress-Strength Model*, Showcase of Undergraduate Research Excellence, University of Central Florida, April 2007
- *Applications of Transformation in Parametric Inference*, Embry-Riddle Undergraduate Mathematics Conference, Embry-Riddle Aeronautical University, April 2007
- *Transformation of Variables in Statistics*, Nebraska Conference on Undergraduate Women In Mathematics, University of Nebraska at Lincoln, February 2007
- *Applications of Transformation in Parametric Inference*, Florida Chapter Meeting of the American Statistical Association, Pensacola, Florida, February 2007
- *Transformation of variables in Statistics*. Southeastern Atlantic Mathematical Sciences Workshop(Cha-Cha Days), Charleston, South Carolina, September 2006
- *Transformation of variables in Statistics*. National Conference on Undergraduate Research, University of North Carolina, Ashville, April 2006
- *Transformation of variables in Statistics*. Showcase of Undergraduate Research Excellence, University of Central Florida, 2006
- *Applications of Transformation in Parametric Inference*. Florida Chapter Meeting of the American Statistical Association, University of West Florida, Pensacola, 2007.
- *Transformation of variables in Statistics*. Nebraska Conference on Undergraduate Women In Mathematics, University of Nebraska, Lincoln, 2007
- *Estimation of reliability for the generalized gamma distribution*. Showcase of Undergraduate Research Excellence, University of Central Florida, 2007.

### David Bradshaw

- *Decision theory based classification of high-dimensional vectors based on small samples*. Southeastern Atlantic Mathematical Sciences Workshop. North Carolina, Chapel Hill, September 23-25, 2005.
- *Decision theory based classification of high-dimensional vectors based on small samples*. US Army Conference on Applied Statistics. Naval Postgraduate School, Monterey, California, October 17-21, 2005.

- *SVM-like decision theoretical classification of high-dimensional vectors.* Graduate Research Showcase, Spring 2005.
- *SVM-like decision theoretical classification of high-dimensional vectors.* Graduate Student Seminar, Spring 2005.

### **Astrid Heard**

- *Confidence intervals for cumulative distribution and quantile functions using Jeffreys prior.* Fifth International Conference on Objective Bayesian Statistics. Branson, Missouri, June 4–8, 2005.
- *Bayesian credible sets for reliability.* The 3-rd Winter Workshop on Statistics and Computer Science. Ein-Gedi, Israel, December 2004.
- *Reliability and safety prediction methods for mission and spaceport operation.* 40-th Space Congress, Cape Canaveral, Florida, May 2003.

## 11. PRESENTATIONS AND PARTICIPATION IN CONFERENCES AND WORKSHOPS RELATED TO TEACHING

- 1 *Mathematics and Statistics as professions* , a talk at Career Day in Glenridge Middle School.
- 2 *Teaching a course: Weather Prediction*, 24-th Annual International Conference on Technology in Collegiate Mathematics (ICTCM), Orlando, Florida, March 2012.
- 3 *Sparse representations finding needles in a haystack*, Graduate Student Seminar, UCF, October 2008.
- 4 *Mathematical fun with real world applications: analysis of microarray data and more*. A talk at the Math Career Day for high school students, University of Central Florida, November 2007.
- 5 *Mathematical fun with real world applications: analysis of microarray data, classification and more.* , Graduate Research seminar, Department of Mathematics, University of Central Florida, Oct. 2007.
- 6 *Wavelets: Introduction for Beginners*, 18-th Annual International Conference on Technology in Collegiate Mathematics (ICTCM), Session principal speaker, Orlando, Florida, March 2006.
- 7 Presentations for undergraduate students at UCF Summer Undergraduate Research Academy, June 2005.
- 8 *SPSS and Internet: tools for learning Statistics*, 15-th Annual International Conference on Technology in Collegiate Mathematics, Orlando, Florida, November 2002.
- 9 *Wavelet For Beginners*, Central Florida Regional Meeting, Florida Section of MAA, Kissimmee, January 2003.
- 10 *Statistics for revealing, not lying*, presentation at the Graduate Students Seminar, UCF, November 2004.
- 11 *Teaching a TV Course*, presentation to students enrolled in "Post-Secondary Math" course, UCF, October 2003.
- 12 Participated in Ritchey Calculus focus group which was held at ICTCM conference, Orlando, Florida, March 2006.
- 13 Attended McGraw-Hill Higher Education Presentation of Classroom Performance System (CPS), October 2003.
- 14 Attended FTCL workshop in Spring 2002. Transformed "Matrix and Linear Algebra" course into Studio Classroom format.
- 15 Attended FTCL Workshop in Summer 2001. Since I have missed a part of the workshop due to travelling, I have been given instructorship by the staff of FCTL. Transformed "College Trigonometry" course into Studio Classroom format.
- 16 Attended workshop "International Student Exchange Program" organized by US Bureau of Education and Cultural affairs, April 1999.

## PART III. AFFILIATIONS AND SERVICE

### 12. PROFESSIONAL AFFILIATIONS

#### Member:

1. American Statistical Association
2. Institute of Mathematical Statistics
3. International Society of Bayesian Analysis
4. International Statistical Institute
5. International Society for Nonparametric Statistics

### 13. PROFESSIONAL SERVICE

Board of Directors Member of "International Society for Nonparametric Statistics"  
(2016-18)

Associate Editor of "Electronic Journal of Statistics" (2009-2012)

Associate Editor of "Journal of Nonparametric Statistics" (since 2009)

Associate Editor of "Journal of Statistical Planning and Inference" (since 2011)

A member of the Board of Directors of the International Society for Nonparametric Statistics

A member of the Scientific Committee of the ISNPS 2018 meeting

<http://www.isnps2018.it/#committees>

A member of the Program Committee of CIBB 2015 conference

(Computational Intelligence methods for Bioinformatics and Biostatistics)

<http://bioinfo.na.iac.cnr.it/cibb2015/>

A member of the Program Committee of CIBB 2016 conference

(Computational Intelligence methods for Bioinformatics and Biostatistics)

<http://www.cs.stir.ac.uk/events/cibb2016/>

A member of the Program Committee of CIBB 2017 conference

(Computational Intelligence methods for Bioinformatics and Biostatistics)

<http://co2.unica.it/cibb2017/>

Served on Math-Bio NSF/NIGMS and NSF CDSE-MSS panels

Guest Editor of Special Issue of Statistica Sinica "Multiscale Methods And Statistics: A Productive Marriage"

#### **Served as a referee for the following:**

1. National Science Foundation and National Security Agency grant proposals
2. Annals of Statistics
3. Journal of American Statistical Association
4. Journal of the Royal Statistical Society
5. Bernoulli
6. Biometrika
7. IEEE Transactions on Signal Processing
8. Statistics & Decisions
9. Annals of the Institute of Statistical Mathematics
10. Statistics and Probability Letters
11. Journal of Statistical Planning and Inference
12. Journal of Multivariate Analysis
13. Probability Theory and Related Fields
14. Test
15. Journal of Statistical Computation and Simulation
16. Communications in Statistics
17. Statistica Neerlandica
18. Statistics and Computing
19. International Journal of Mathematics and Mathematical Sciences
20. Metron

## 14. COMMUNITY ACTIVITIES AND SERVICE

1. Guided a research project "Can Alzheimer's disease be diagnosed using Bayesian analysis" with Niharika Maity, an 11th grade student at Hagerty High School . Niharika's project was selected to be presented at a State Science Fair (February 2015)
2. Judge, Science Olympiad National Tournament, Orlando, May 2012
3. Judge, Senior Section (Mathematics), Annual State Science and Engineering Fair of Florida, Florida Foundation for Future Scientists, Orlando, Florida, April 2006
4. Virtual Judge for Internet Science and Technology Fair (ISTF), April 2003.
5. Judge, Internet Science and Technology Fair, April 2002
6. Worked on a research project "Does Statistical Evidence Support Superstitions?" with Kerry Frech, a student in the 11-th grade at the Lake Brantley High School. Kerry got second place at the County Science and Engineering Fair. Spring 2002.
7. As a part of Outreach Project Mentors participated in the Meeting with Math teachers and students from Lyman High School. I talked to teachers about possible Math projects with High School students and took students to my Calculus class to demonstrate how Mathematics is taught at college level. Fall 2002.
8. Judge, Senior Section (Group Projects), Annual State Science and Engineering Fair of Florida, Florida Foundation for Future Scientists, Orlando, Florida, April 1999
9. Judge, Senior Section (Mathematics), Annual State Science and Engineering Fair of Florida, Florida Foundation for Future Scientists, Orlando, Florida, April 1998
10. Conducted classes in Mathematics for the high school children (together with Prof. B. Zeldovich), 1995 - 1996

## PART IV. RESEARCH AND PUBLICATIONS

### 15. RESEARCH PRESENTATIONS AND SEMINARS

#### 1995 – PRESENT:

1. *A General Approach to Nonparametric Empirical Bayes Estimation*, seminar at Purdue University, West Lafayette, Indiana, May 1995
2. *Empirical Bayes Estimation of the Matrix Parameter of the Wishart Distribution, Multiple Decision Theory and Related Topics*, International Conference, Purdue University, West Lafayette, Indiana, June 1995
3. *Estimation Problems of the Empirical Bayes Approach*, seminar at the University of Central Florida, Orlando, Florida, October 1995
4. *A General Approach to Nonparametric Empirical Bayes Estimation*, seminar at University of Florida, Gainesville, January 1996
5. *A Wavelet approach to Nonparametric Empirical Bayes Estimation*, Joint Statistical Meetings, Chicago, Illinois, August 1996
6. *Using Wavelets for Nonparametric Density Estimation*, seminar at the University of Central Florida, Orlando, Florida, October 1996



7. *Using Noninformative Priors for Estimation of Locations of Lightning Events*, International Workshop on Default Bayesian Statistical Methodology, Purdue University, West Lafayette, Indiana, November 1996
8. *A Wavelet Approach to Nonparametric Empirical Bayes Estimation*, George Washington University, Washington D.C., January 1997
9. *Wavelet Estimation in the Empirical Bayes Model*, Joint Statistical Meetings, Special Contributed Session, Anaheim, August 1997
10. *Wavelet Estimation in Nonparametric Deconvolution Problem*, International Workshop on Wavelets in Statistics, Statistics Week at Duke University, Duke University, Durham, North Carolina, October 1997
11. *Wavelet Estimation of a Deconvolution Density*, seminar at the University of Central Florida, Orlando, Florida, October 1997
12. *Estimation with Meyer-type Wavelets*, seminar at the Institute of Statistics and Decision Sciences, Duke University, Durham, North Carolina, December 1997
13. *Estimation of a Deconvolution Density via Wavelets*, Florida Chapter Meeting of ASA, University of Central Florida, Orlando, Florida, February 1998
14. *Empirical Bayes Estimation Based on Wavelets*, The Sixth Purdue International Symposium on Statistics, Purdue University, West Lafayette, Indiana, June 1998 (invited talk)
15. *Estimation of a Density and a Deconvolution Density via Wavelets*, seminar at the Indian Statistical Institute, Calcutta, India, August 1998
16. *Application of Wavelets to Nonparametric Empirical Bayes Estimation*, seminar at the Indian Statistical Institute, Calcutta, India, August 1998
17. *Nonparametric Empirical Bayes Estimation of the Matrix Parameter of the Wishart Distribution*, The Seventh International Workshop on Matrices and Statistics, Fort Lauderdale, Florida, December 1998
18. *Nonparametric Empirical Bayes Estimation Via Wavelets*, Symposium on Model Selection, Empirical Bayes and Related Topics, Lincoln, Nebraska, March 1999
19. *Estimation with Meyer-Type Wavelets*, University of South Florida, Gainesville, March 1999
20. *Statistical estimation of locations of lightning events*, seminar at the Indian Statistical Institute, Calcutta, India, June 1999
21. *Empirical Bayes estimation and testing based on wavelets*, Joint Statistical Meetings, Special Contributed Session, Baltimore, August 1999
22. *Statistical estimation of locations of lightning events*, seminar at the University of Central Florida, Orlando, Florida, November 1999.
23. *Statistical estimation of locations of lightning events*, Annual Florida Chapter Meeting of the American Statistical Association, Jacksonville, Florida, February 2001.

24. *Deconvolution of location, scale and shape parameter families*, International Conference on Sampling Theory and Applications, Orlando, Florida, May 2001.
25. *Estimation of a smooth density function using Meyer-type wavelets*, Joint Statistical Meetings, Atlanta, August 2001
26. *Frequentist optimality of Bayesian wavelet shrinkage*, Seventh Valencia International Meeting on Bayesian Statistics, Tenerife, Canary Islands, Spain, June 2002.
27. *Frequentist properties of the Bayesian wavelet shrinkage*, International Conference on Current Advances and Trends in Nonparametric Statistics, Crete, Greece, July 2002.
28. *Wavelet thresholding and shrinkage in statistical problems*, Lockheed Martin Inc., Orlando, Florida, November, 2002.
29. *Wavelet estimation of the probability density function at the boundary* (with K. Carlson), IMS mini-meeting on Functional Data Analysis, University of Florida, Gainesville, Florida, January 2003.
30. *Frequentist assessment of Bayesian wavelet shrinkage rules*, IMS mini-meeting on Functional Data Analysis, University of Florida, Gainesville, Florida, January 2003.
31. *Reliability and safety prediction methods for mission and spaceport operation*, (with A. Heard), 40-th Space Congress, Cape Canaveral, Florida, May 2003.
32. *Frequentist assessment of Bayesian wavelet shrinkage rules*, Technion, Israel, June 2003.
33. *Frequentist assessment of Bayesian wavelet shrinkage rules*, Indian Statistical Institute, Calcutta, July 2003.
34. *Bayesian wavelet estimation of a spectral density*, International Conference "Wavelets and Statistics: Watering the Seed", Grenoble, France, September 2003.
35. *Stress-strength problem in the case of random vectors*, Florida Chapter Meeting of the American Statistical Association, Orlando, Florida, February 2004.
36. *Bayesian shrinkage rules for nonparametric wavelet regression*, Department of Statistics, Florida State University, Tallahassee, Florida, March 2004.
37. *Frequentist optimality of Bayes rules for wavelet coefficients*, International Meeting "Bayesian Nonparametrics: Methodology, Theory and Applications", June 13–16, 2004, Rome, Italy.
38. *Wavelet kernel penalized estimation for non-equispaced design regression*. Department of Statistics, University of Florida, Gainesville, September 2004.
39. *Bayesian credible sets for reliability* (with A. Heard). The 3-rd Winter Workshop on Statistics and Computer Science. Ein-Gedi, Israel, December 2004.
40. *Wavelet kernel penalized estimation for non-equispaced design regression*. Institute of Statistics and Decision Sciences, Duke University, February 2005.

41. Frequentist optimality of Bayesian wavelet shrinkage rules. International Conference on Interaction between Wavelets and Splines. Athens, Georgia, May 16–19, 2005.
42. Confidence intervals for cumulative distribution and quantile functions using Jeffreys prior (with A. Heard). Fifth International Conference on Objective Bayesian Statistics. Branson, Missouri, June 4–8, 2005.
43. Decision theory based classification of high-dimensional vectors based on small samples. (with David Bradshaw). Southeastern Atlantic Mathematical Sciences Workshop. North Carolina, Chapel Hill, September 23-25, 2005.
44. Decision theory based classification of high-dimensional vectors based on small samples. (with David Bradshaw). US Army Conference on Applied Statistics. Naval Postgraduate School, Monterey, California, October 17–21, 2005.
45. Wavelet kernel penalized estimation for non-equispaced design regression. International Workshop "Estimations are Approximations: Multiresolution Modeling and Statistical Inference". Radcliffe Institute for Advance Study, Harvard University. Cambridge, October 28-29, 2005.
46. Classification of high-dimensional vectors based on small samples. Department of Statistics. University of Central Florida. Orlando, Florida, March 2006.
47. Decision theory classification of high-dimensional vectors based on small samples. Department of Electrical Engineering and Computer Science, Harvard University, March 2006.
48. Decision theory classification of high-dimensional vectors based on small samples. Seventh Valencia International Meeting on Bayesian Statistics, Benidorm, Spain, June 2006.
49. Decision theory classification of high-dimensional vectors based on small samples. Technion, Israel, June 2006.
50. Transformation of variables in Statistics (with Naomi Brownstein). Southeastern Atlantic Mathematical Sciences Workshop. North Carolina, Charleston, September 2006.
51. Applications of Transformation in Parametric Inference (with Naomi Brownstein). Florida Chapter Meeting of the American Statistical Association, University of West Florida, Pensacola, February 2007.
52. Functional Deconvolution in a Periodic Setting. Paris Seminar of Statistics, Institut Henri Poincar, Paris, May 2007.
53. Bayesian Approach to Estimation and Testing in Time Course Microarray Experiments. Department of Statistics and Operations Research, Tel-Aviv University, May 2007.
54. On Optimality of Bayesian Testimation in the Normal Means Problem. Von Neumann Symposium "Sparse Representation and High-Dimensional Geometry", Snowbird, Utah, July 2007.

55. Decision theory classification of high-dimensional vectors based on small samples. Department of Mathematical Sciences, De Paul University, Chicago, October 2007.
56. Functional Deconvolution in a Periodic Setting. Department of Statistics, Purdue University, West Lafayette, December 2007.
57. On Optimality of Bayesian Testimation in the Normal Means Problem. Tenth Annual Winter Workshop on Bayesian Model Selection and Objective Methods, University of Florida, Gainesville, Florida, January 2008.
58. Estimation in the Stress-Strength Model (with Naomi Brownstein). Florida Chapter Meeting of the American Statistical Association, Gainesville, Florida, February 2008.
59. Functional Deconvolution in a Periodic Setting. The XVIIth International Colloquium on Integrable Systems and Quantum symmetries (ISQS-17) Prague, Czech Republic, 2008. June 2008.
60. Bayesian Approach to Estimation and Testing in Time Course Microarray Experiments. Technion, Israel, June 2008.
61. Bayesian Rules for Nonparametric Regression Estimation Based on Overcomplete Representations. Joint Statistical Meetings, Denver, Colorado, August 2008
62. On Optimality of Bayesian Testimation in the Normal Means Problem. International Workshop "High-dimensional Data Analysis. Perspectives from the Interface of Statistics, Biosciences, and Information Sciences". Radcliffe Institute for Advance Study, Harvard University. Cambridge, October 23-25, 2008.
63. Functional Deconvolution in a Periodic Setting: nonuniform case. The VIIIth Meeting on Mathematical Statistics, International Center for Mathematical Meetings, Lumini, France, December 2008.
64. Functional Deconvolution in a Periodic Setting. Innovation and Inventiveness in Statistics Methodologies. Statistics Workshop at Yale University. May 2009
65. Bayesian Feature Selection for Classification With Possibly Large Number of Classes. O-Bay09: The 2009 International Workshop on Objective Bayes Methodology, Philadelphia, University of Pennsylvania, Wharton School, June 2009.
66. Bayesian Approach to Estimation and Testing in Time Course Microarray Experiments. University of Haifa, Israel, June 2009 (Invited).
67. Clustering Time-Course Microarray Data Using Functional Bayesian Infinite Mixture Model. Frontiers of Statistical Decision Making and Bayesian Analysis, International Conference in Honor of James O. Berger, San-Antonio, Texas, March 2010 (Invited).
68. Estimation of a Regression Function on the Basis of Incomplete Data. Department of Statistics, University of Pennsylvania, March 2010 (Invited).
69. Estimation of a Regression Function on the Basis of Incomplete Data. Paris Seminar of Statistics, Institut Henri Poincar, Paris, May 2010 (Invited).

70. Estimation of a Regression Function on the Basis of Incomplete Data. The 10th Meeting on Mathematical Statistics, International Center for Mathematical Meetings, Lumini, France, December 2010 (Invited).
71. Clustering Time-Course Microarray Data Using Functional Bayesian Infinite Mixture Model. Frontiers of Statistical Decision Making and Bayesian Analysis, Florida Chapter Meeting of ASA, Tampa, Florida, February 2011.
72. On convergence rates equivalency and sampling strategies in functional deconvolution models. MASCOT NUM 2011 International Workshop in honor of Anestis Antoniadis, Villard de Lans, France, March 2011 (Invited).
73. Nonparametric Regression Estimation with Incomplete Data: Minimax Convergence Rates and Adaptivity. WISE: Workshop on Infusing Statistics and Engineering, Harvard, Boston, June 2011 (Invited).
74. CONFESS: Feature Selection for Classification with a Large Number of Classes. O-Bayes2011 - The 2011 International Workshop on Objective Bayes Methodology, East China Normal University, Shanghai, China, June 2011 (Invited).
75. Laplace Deconvolution and Its Application to Analysis of Dynamic Contrast Enhanced Computed Tomography Data, Neyman Seminar, Department of Statistics, Berkeley, California, February 2012 (Invited).
76. Laplace Deconvolution and Its Application to Analysis of Dynamic Contrast Enhanced Computed Tomography Data, Florida Chapter Meeting of ASA, Jacksonville, Florida, February 2012 (Invited).
77. CONFESS: Feature Selection for Classification With a Large Number of Classes. 1st Conference of the International Society for Nonparametric Statistics, Chalkidiki, Greece, June 2012 (Invited).
78. Non-asymptotic approach to varying coefficient model. Nonparametric and High-dimensional Statistics. CIRM, Marseille, France, December 2012 (Invited).
79. Laplace Deconvolution and Its Application to Analysis of Dynamic Contrast Enhanced Imaging. Colloquium, Department of Statistics, Cornell University, New York, March 2013 (Invited).
80. Laplace deconvolution with noisy observations and its application to analysis of DCE--CT data. ENAR Spring Meeting, Orlando, Florida, March 2013.
81. Laplace deconvolution with noisy observations and its application to analysis of DCE--CT data. Istituto per le Applicazioni del Calcolo "M.Picone" (CNR), Rome, Italy, July 2013 (Invited).
82. Dynamic Contrast Enhanced imaging: spatially inhomogeneous and anisotropic linear inverse problems. Joint Statistical Meetings, Montreal, Canada, August 2013 (Invited).
83. Laplace deconvolution with noisy observations and its application to analysis of DCE--CT data. Department of Statistics and Operations Research, Tel-Aviv University, November 2013 (Invited).

84. Sparse high-dimensional varying coefficient model: non-asymptotic minimax study. Adaptive Statistical Inference. Oberwolfach, Mathematisches Forschungsinstitut, Germany, March 2014 (Invited).
85. Laplace deconvolution with noisy observations and its application to analysis of DCE--CT data. Department of Mathematics, Embry Riddle University, March 2014 (Invited).
86. Laplace deconvolution with noisy observations and its application to analysis of DCE--CT data. SIAM-SEAS Conference, Melbourne, Florida, March 2014 (Invited).
87. Solution of linear inverse problems using flexible dictionaries. 2nd Conference of the International Society for Nonparametric Statistics, Cadiz, Spain, June 2014 (Invited).
88. Solution of linear inverse problems using flexible dictionaries. Joint Statistical Meetings, Boston, August 2014 (Invited).
89. Lasso for linear ill-posed problems. Department of Statistics, Purdue University, March 2015 (Invited).
90. Lasso solution of linear ill-posed problems and its application to analysis of the Dynamic Contrast Enhanced Computerized Tomography data. ISNPS Meeting Biosciences, Medicine, and novel Non-Parametric Methods July 2015, Graz, Austria (Invited).
91. Solution of linear inverse problems using overcomplete dictionaries. Meeting in Mathematical Statistics 2015. Recent advances in nonparametric and high-dimensional inference. Frejus, France, December 14-18, 2015 (Invited).
92. Laplace deconvolution and its application to the analysis of dynamic contrast enhanced imaging data. Mathematical Statistics and Inverse Problems. CIRM, Marseille, France, February 2016 (Invited).
93. Solution of linear inverse problems using exponential weights. Third conference of the International Society for Nonparametric Statistics (ISNPS). Avignon, France, June 2016 (Invited).
94. Oracle inequalities for time-dependent network models. Third conference of the International Society for Nonparametric Statistics (ISNPS 2016). Avignon, France, June 2016 (Invited).
95. Dynamic network models and graphon estimation. Department of Statistics, University of Central Florida. November 2016 (Invited).
96. Dynamic network models and graphon estimation. Dynamic Networks, Isaac Newton Institute for Mathematical Sciences, Cambridge, UK, December 2016 (Invited).
97. Classification with many classes: challenges and pluses. Department of Statistics and Operations Research, Tel-Aviv University, May 2017 (Invited).
98. Oracle inequalities for the dynamic stochastic block model and time-dependent graphon. Joint Statistical Meetings, Baltimore, August 2017 (Invited).

99. Classification with many classes: challenges and pluses. Department of Statistics, University of Florida October 2017 (Invited).
100. Dynamic Stochastic Block Model. Meetings in Mathematical Statistics. CIRM, Marseille, France, December 2017 (Invited).
101. Estimation and Clustering in a Dynamic Stochastic Block Model. 2018 International Indian Statistical Association (IISA) International Conference on Statistics. University of Florida, Gainesville, May 2018 (Invited).
102. Estimation and Clustering in a Dynamic Stochastic Block Model. Fourth conference of the International Society for Nonparametric Statistics (ISNPS). Salerno, Italy, June 2018 (Invited).
103. Estimation and Clustering in a Dynamic Stochastic Block Model. International Workshop “Matrix Estimation Meets Statistical Network Analysis: Extracting low-dimensional structures in high dimension”. Oberwolfach, Germany, June 2018 (Invited).
104. Clustering in statistical ill-posed linear inverse problems. Symposium in Honor of Prof Yoav Benjamini’s 70th Birthday and 10th Conference of the Eastern Mediterranean Region of the International Biometrics Society (EMR-IBS). Jerusalem, Israel, December 2018

## 16. BOOKS

Kotz, S., Lumelskii, Y., Pensky, M. (2003) *The Stress-Strength Model and Its Generalizations. Theory and Applications*. World Scientific Co., Singapore, 253 pp.

## 17. SOFTWARE

1. Angelini, C., Cutillo, L., De Canditiis, D., Mutarelli, M., Pensky, M. (2008) **BATS**: a free software for Bayesian Analysis of Time Series microarray experiments. Executable program, the source code and the user manual can be freely downloaded from <http://bioinfo.na.iac.cnr.it/bats/>.

2. Rozenholc, Y., Pensky, M. (2015) Cran Package “LaplaceDeconv: Laplace Deconvolution with Noisy Discrete Non-Equally Spaced Observations on a Finite Time Interval” Reference manual and the source code <https://cran.r-project.org/web/packages/LaplaceDeconv/index.html>

## 18. REFEREED RESEARCH PUBLICATIONS

### A. Published or Accepted

1. Lumel’skii, Ya.P., and Penskaya, M. (1982) Unbiased estimation of characteristics of random variables. *Mathematical Statistics and Its Applications*. Tomsk, 114–122. (*in Russian*)

2. Penskaya, M. (1982) Unbiased estimation of probabilities defined by linear inequalities. *Application of the random search*, 124–132. (*in Russian*)
3. Penskaya, M. (1984) Estimation of the a prior density in reliability problems on the basis of a Bayesian approach by the methods of statistical regularization. *Engrg. Cybernetics*, **22**, 34–42.
4. Penskaya, M. (1985) Projection estimators of the density of an a prior distribution and of functionals of it. *Theor. Probab. and Math. Statist.*, **31**, 113–124.
5. Penskaya, M. (1986) Estimation of the prior distribution density. *Journ. of Soviet Math.*, **35**, 2381–2386.
6. Penskaya, M. (1986) Empirical Bayes estimation. *Moscow Univ. Math. Bull.*, **41**, 24–28.
7. Penskaya, M. (1987) On prior density estimators. *Journ. of Sov. Math.*, **39**, 2895–2902.
8. Penskaya, M. (1987) The standard error and bias of normal density estimators. *Journ. of Sov. Math.*, **39**, 2633–2638.
9. Penskaya, M. (1988) Estimation of functionals in an a prior density. *Journ. of Sov. Math.*, **41**, 841–846.
10. Penskaya, M. (1990) Robust statistical estimation of ratio. *Nonparametric and Robust Statistical Methods in Cybernetics and Informatics*. Tomsk, 422–426. (*in Russian*)
11. Penskaya, M. (1991) Application of regularizing operators in estimation theory. *Journ. of Sov. Math.*, **53**, 655–660.
12. Penskaya, M. (1992) On empirical Bayes estimation of the location parameter. *Theory of Probability and Its Applications*. **37**, 732–734.
13. Penskaya, M. (1992) Stable estimation of an a prior density. *Journ. of Sov. Math.*, **59**, 992–996.
14. Piterbarg, V.I., and Penskaya, M. (1993) On asymptotic distribution of integrated squared error of an estimate of a component of a convolution. *Math. Methods of Statistics*, **2**, 30–41.
15. Penskaya, M. (1994) On an empirical Bayesian estimation of the location parameter. *Journ. of Math. Sciences*, **72**, 2948–2953.
16. Penskaya, M. (1995) Estimating the probability density function of a shift parameter. *Journ. of Math. Sciences*, **75**, 1518–1523.
17. Penskaya, M. (1995) On stable estimation of a function of a parameter. *Journ. of Math. Sciences*, **75**, 1404–1410.
18. Penskaya, M. (1995) On mean square consistent estimation of a ratio. *Scandinavian Journal of Statistics*, **22**, 129–137.



19. Penskaya, M. (1995) On the lower bounds for mean square error of empirical Bayes estimators. *Journ. of Math. Sciences*, **75**, 1524–1535.
20. Pensky, M. (1996) Empirical Bayes estimation of a scale parameter. *Mathematical Methods of Statistics*, **5**, 1996, 316–331.
21. Pensky, M. (1996) On lower bounds for errors of prior density estimators. *Journal of Mathematical Sciences*, **81**, 2803–2810.
22. Pensky, M. (1997) A general approach to nonparametric empirical Bayes estimation. *Statistics*, **29**, 61–80.
23. Pensky, M. (1997) Empirical Bayes estimation of a location parameter. *Statistics and Decisions*, **15**, 1–16.
24. Pensky, M. (1998) Kernel and Pseudokernel estimators for the a prior density of a multivariate parameter. *Journal of Mathematical Sciences*, **88**, 125–137.
25. Pensky, M. (1998) Empirical Bayes estimation based on wavelets. *Sankhyā*, **A60**, 214–231.
26. Pensky, M., and Singh, R.S. (1999) Empirical Bayes estimation of reliability characteristics for an exponential family. *Canadian Journal of Statistics*, **27**, 127 – 136.
27. Pensky, M., and Cannon, J. R. (1999) Statistical estimation of locations of lightning events. *Journal of Geophysical Research – Atmospheres*, **104**, No. D8, 9635–9641
28. Pensky, M. (1999) Nonparametric empirical Bayes estimation of the matrix parameter of Wishart distribution. *Journal of Multivariate Analysis*, **69**, 242-260.
29. Pensky, M. (1999) Estimation of a smooth density function using Meyer-type wavelets. - *Statistics & Decisions*, **17**, 111 - 123.
30. Pensky, M. (1999) Nonparametric Empirical Bayes Estimation via Wavelets. - in *Bayesian Inference in Wavelet Based Models*, Lecture Notes in Statistics, V. 141, ed. Müller, P., Vidakovic, B., Springer, 323 – 340. Springer.
31. Pensky, M., and Vidakovic, B. (1999) Adaptive wavelet estimator for nonparametric density deconvolution. *Annals of Statistics*, **27**, 2033 – 2053.
32. Bhattacharyya, B.B, Li, X., Pensky, M., and Richardson, G.D. (2000) Testing for unit roots in nearly nonstationary spatial autoregressive process. *Annals of the Institute of Statistical Mathematics*, **52**, 71 – 83.
33. Pensky, M., and Ni, P. (2000) Extended linear empirical Bayes estimation, *Communications in Statistics - Theory and Methods*, **29**, 579 – 592.
34. Pensky, M., and Kirtane, K. (2000) Linear empirical Bayes estimation in the case of the Wishart distribution, *Communications in Statistics. Theory and Methods*, **29**, 1787–1799.
35. Pensky, M. (2000) Adaptive wavelet empirical Bayes estimation of a location or a scale parameter, *Journal of Statistical Planning and Inference*, **90**, 275 –292.

36. Elhor, A., and Pensky, M. (2000) Bayesian estimators of locations of lightning events, *Sankhya*, **B62**, 202 – 216.
37. Pensky, M., and Vidakovic, B. (2001) On non-equally spaced wavelet regression. *Annals of the Institute of Statistical Mathematics*, **53**, 681–690.
38. Pensky, M. (2002) Locally adaptive wavelet empirical Bayes estimation of a location parameter, *Annals of the Institute of Statistical Mathematics*, **54**, 83–99.
39. Pensky, M. (2002) Density deconvolution based on wavelets with bounded supports. *Statistics and Probability Letters*, **56**, 261–269.
40. Singh, R.S., and Pensky, M. (2002) Non-parametric estimation of prior densities of multidimensional location and scale parameters with rates and best possible. *The Journal of Mathematical Sciences. New Series* , **1**, 86–105.
41. Pensky, M., and Zayed, A.I. (2002) Density deconvolution of different conditional distributions. *Annals of the Institute of Statistical Mathematics*, **54**, 701–712.
42. Pensky, M. (2002) A new approach to empirical Bayes estimation with errors in variables. *Statistics and Decisions*, **20**, 225–240.
43. Pensky, M. (2003) Rates of convergence of empirical Bayes tests for a normal mean. *Journal of Statistical Planning and Inference*, **11**, 181–196.
44. Pensky, M. (2003) Estimation of probabilities of linear inequalities for independent elliptic random vectors. *Sankhya*, **65**, 91–106.
45. De Canditiis, D., Pensky, M. (2004) Discussion on the meeting on "Statistical approaches to inverse problems", *Journ. Roy. Statist. Soc., Ser. B*, **66**, 638–640.
46. Pensky, M., Allotaibi, M. (2005) Generalization of linear empirical Bayes estimation via wavelet series. *Statistics and Decisions*, **23**, 181–198.
47. Amato, U., Antoniadis, A., Pensky, M. (2006) Wavelet kernel penalized estimation for non-equispaced design regression. *Statistics and Computing*, **16**, 37–55.
48. De Canditiis, D., Pensky, M. (2006) Simultaneous Wavelet Deconvolution in Periodic Setting. *Scandinavian Journal of Statistics*, **33**, 293–306.
49. Pensky, M. (2006) Frequentist optimality of Bayesian wavelet shrinkage rules. In *Splines and Wavelets: Athens 2005*. G. Chen and M.-J. Lai, eds., Nashboro Press, Brentwood, TN, 390–401.
50. Pensky, M. (2006) Frequentist optimality of Bayesian wavelet shrinkage rules for Gaussian and non-Gaussian noise. *Annals of Statistics*, **34**, 769–807.
51. Heard, A., Pensky, M. (2006) Confidence intervals for reliability and quantile function with application to NASA Space Flight data. *IEEE Transactions in Reliability*, **55**, 591–601.
52. Pensky, M., Vidakovic, B. and De Canditiis, D. (2007) Bayesian decision theoretic scale-adaptive estimation of log-spectral density, *Statistica Sinica*, **17**, 635–666.

53. Pensky, M., Sapatinas, T. (2007) Frequentist optimality of Bayes Factor estimators in wavelet regression models. *Statistica Sinica*, **17**, 599–633.
54. Angelini, C., De Canditiis, D., Mutarelli, M., Pensky, M. (2007) Bayesian approach to estimation and testing in time course microarray experiments. *Statistical Applications in Genetics and Molecular Biology*, **6**, #1, Article 24, 1–30.
55. Abramovich, F., Grinshtein, V., Pensky, M. (2007) On optimality of Bayesian estimation in the normal means problem. *Annals of Statistics*, **35**, 2261–2286.
56. Abramovich, F., Antoniadis, A., Pensky, M. (2007) Estimation of piecewise-smooth functions by amalgamated bridge regression splines. *Sankhya*, **70**, 1–27.
57. Pensky, M. (2007) Empirical Bayes estimation of reliability. In *Encyclopedia of Statistics in Quality and Reliability*, F. Ruggery, R. Kenett, F.W. Faltin (eds), Wiley, Chichester, UK, 559–606.
58. Brownstein, N., Pensky, M. (2008) Application of transformations in parametric inference. *Journal of Statistics Education*, **16**, No. 1, 1–10.
59. Bradshaw, D.J., Pensky, M. (2008) Decision theory based classification of high-dimensional vectors based on small samples. *Test*, **17**, 83–100.
60. Angelini, C., Cutillo, L., De Canditiis, D., Mutarelli, M., Pensky, M. (2008) BATS: a Bayesian user-friendly software for Analyzing Time Series microarray experiments. *BMC: Bioinformatics*, **9**, #415.
61. Crampton, W.G.R., Davis, J.K., Lovejoy, N.R., Pensky, M. (2008) Multivariate classification of animal communication signals: a simulation-based comparison of alternative signal processing procedures, using electric fishes. *Journal of Physiology – Paris*, **102**, 304–321.
62. Pensky, M., Sapatinas, T. (2009) Functional Deconvolution in a Periodic Setting: Uniform Case. *Annals of Statistics*, **37**, 73–104.
63. Angelini, C., De Canditiis, D., Pensky, M. (2009) Bayesian models for the two-sample time-course microarray experiments. *Computational Statistics & Data Analysis*, **53**, 1547–1565.
64. Bradshaw, D.J., Pensky, M. (2010) SVM-like decision theoretical classification of high-dimensional vectors. *Journ. of Statist. Plan. Inf.*, **140**, 705 – 718.
65. Pensky, M., Sapatinas, T. (2010) On Convergence Rates Equivalency and Sampling Strategies in a Functional Deconvolution Model. *Annals of Statistics*, **38**, 1793–1844.
66. Song, D., Fedorenko, I., Pensky, M., Qian, W., Tockman, M., and Zhukov, T. (2010) Quantificational and Statistical Analysis of the Differences in Centrosomal Features of Untreated Lung Cancer Cells and Normal Cells. *Analytical and Quantitative Cytology and Histology*, **32**, No. 5, article #280

67. Angelini, C., De Canditiis, D., Pensky, M. (2011) Estimation and Testing in Time-course Microarray Experiments. *Bayesian Modeling in Bioinformatics*, Eds. Dey, D.K., Ghosh, S., and Mallick, B.K., Chapman and Hall/CRC, Boca Raton, pp. 1–26.
68. Pensky, M., Sapatinas, T. (2011) Multichannel Boxcar Deconvolution with Growing Number of Channels. *Electronic Journal of Statistics*, **5**, 53–82.
69. Davis, J., Pensky, M., and Crampton, W. (2011) Bayesian Feature Selection for Classification With Possibly Large Number of Classes. *Journal of Statistical Planning and Inference*, **141**, 3256-3266.
70. Huo, Q., Cordero, A., Bogdanovic, J., Colon, J., Baker, C.H., Goodison, S., Pensky, M. (2011) A Facile Nanoparticle Immunoassay to Detect Multiple Biomarkers in Serum Samples. *Journal of Nanobiotechnology*, **9** (20)
71. Angelini, C., De Canditiis, D., Pensky, M. (2012) Bayesian methods for time course microarray analysis: from genes’ detection to clustering. In *Advanced Statistical Methods for the Analysis of Large Data-Sets*, Di Ciaccio, A., Coli, M., Angulo Ibanez, J. M. (Eds.) Springer, pp. 47-56.
72. Angelini, C., De Canditiis, D., Pensky, M. (2012) Clustering Time-Course Microarray Data Using Functional Bayesian Infinite Mixture Model. *Journal of Applied Statistics*, **39**, 129-149.
73. Angelini, C., De Canditiis, D., Pensky, M., Brownstein, N. (2013) Bayesian models for the multi-sample time-course microarray experiments. *Lecture Notes in Computer Science*, **7548**, 21-35.
74. Klopp, O., Pensky, M. (2013) Non-asymptotic approach to varying coefficient model. *Electronic Journal of Statistics*, **7**, 454-479.
75. Abramovich, F., Pensky, M., Rozenholc, Y. (2013) Laplace deconvolution with noisy observations. *Electronic Journal of Statistics*, **7**, 1094-1128
76. Benhaddou, R., Pensky, M., Picard, D. (2013) Anisotropic Denoising in Functional Deconvolution Model with Dimension-free Convergence Rates. *Electronic Journal of Statistics*, **7**, 1686-1715.
77. Benhaddou, R., Pensky, M. (2013) Adaptive Nonparametric Empirical Bayes Estimation Via Wavelet Series. *Journ. Stat. Plan. Inference*, **143**, 1672 -1688
78. Pensky, M. (2013) Spatially inhomogeneous linear inverse problems with possible singularities. *Ann. Stat.*, **41**, 2668–2697.
79. Antoniadis, A., Pensky, M., Sapatinas, T. (2014) Nonparametric Regression Estimation with Incomplete Data: Minimax Global Convergence Rates and Adaptivity. *ESAIM*, **18**, 1-41.
80. Davis, J., Pensky, M. (2014) Model Selection for Classification with a Large Number of Classes. In *Topics in Nonparametric Statistics. Springer Proceedings in Mathematics & Statistics*, **74**, Akritas, M.G., Lahiri, S.N., Politis, D.N., Eds., pp. 251–258.

81. Benhaddou, R., Kulik, R., Pensky, M., Sapatinas, T. (2014) Multichannel Deconvolution with Long-Range Dependence: A Minimax Study *Journ. Stat. Plan. Inference*, **148**, 1–19.
82. Klopp, O., Pensky, M. (2015) Sparse high-dimensional varying coefficient model: non-asymptotic minimax study. *Ann. Stat.*, **43**, 1273–1299.
83. Liu, B., Wang, O., Tappen, M., Foroosh, H., Pensky, M. (2015) Sparse convolutional neural networks. CVPR Proceedings 2015, 806–814.
84. Jaberri, M., Pensky, M., Foroosh, H. (2015) Sparse Withdrawal of Inliers in a First Trial (SWIFT). CVPR Proceedings 2015, 4849–4857.
85. Pensky, M. (2016) Solution of linear ill-posed problems using overcomplete dictionaries. *Ann. Statist.*, **44**, 1739–1764.
86. De Canditiis, D., Pensky, M. (2016) Estimation of delta-contaminated density of the random intensity of Poisson data. *Electronic Journal of Statistics*, **10**, 683-705
87. Comte, F., Cuenod, C.-A., Pensky, M., Rozenholc, Y. (2017) Laplace deconvolution on the basis of time domain data and its application to Dynamic Contrast Enhanced imaging. *Journ. Royal Stat. Soc., Ser.B*, **79**, 69–94
88. Pensky, M. (2017) Minimax theory of estimation of linear functionals of the deconvolution density with or without sparsity. *Ann. Statist.*, **45**, 1516–1541
89. De Canditiis, D., Pensky, M., Wolfe, P.J. (2018) Denoising strategies for general finite frames. *Mathematics and Computers in Simulation*. **147**, 90-99.
90. Gupta, P., Pensky, M. (2018) Solution of linear ill-posed problems using random dictionaries. *Sankhya, Ser. B.*, **80**, 178-193.
91. Abramovich, F., De Canditiis, Pensky, M. (2018) Solution of linear ill-posed problems by model selection and aggregation. *Electronic Journal of Statistics*, **12**, 1822-1841.
92. Jaberri, M., Pensky, M., Foroosh, H. (2018) Probabilistic Sparse Subspace Clustering Using Delayed Association. *Proceedings of the 2018 24th International Conference on Pattern Recognition (ICPR)*, 2087-2092.
93. Benhaddou, R., Pensky, M., Rajapakshage, R. (2019) Anisotropic functional Laplace deconvolution. *Journ. Statist. Plan. Inf.*, **199**, 271–285.
94. Pensky, M. Dynamic network models and graphon estimation. [ArXiv1607.00673](https://arxiv.org/abs/1607.00673)  
*Ann. Stat.*, accepted
95. Jaberri, M., Pensky, M., Foroosh, H. SWIFT: Sparse Withdrawal of Inliers in a First Trial. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, accepted.
96. Pensky, M., Zhang, T. Spectral clustering in the dynamic stochastic block model. *Electronic Journal of Statistics*, accepted.

## **B. Submitted**

1. Abramovich, F., Pensky, M. Feature selection and classification of high-dimensional normal vectors with possibly large number of classes. [ArXiv 1506.01567](#)
2. Rajapakshage, R., Pensky, M. Clustering in statistical ill-posed linear inverse problems. [ArXiv:1810.06989](#)
3. Rimal, R., Pensky, M. Density Deconvolution with Small Berkson Errors. [ArXiv:1810.07016](#)

## Luis Rabelo, Ph.D.

### PROFESSIONAL PREPARATION

Technological University of Panama	Electrical & Mechanical Engineering	Dual BS, 1983
Florida Institute of Technology	Electrical Engineering	MS, 1987
University of Missouri-Rolla	Engineering Management	MS, 1988
University of Missouri-Rolla	Engineering Management	Ph.D, 1990
Massachusetts Institute of Technology	Engineering & Management	Dual MS, 2001
University of Missouri-Rolla	Nuclear Engineering & AI	PostDoct, 1991

### APPOINTMENTS

<b>Years</b>	<b>Location</b>	<b>Position</b>
2009-2011	NASA EPSCoR Project NASA	Agency Research Project Manager
2002 – 2008	NASA Kennedy Space Center NASA	NASA Fellow
2001-present	Department of Industrial Engineering The University of Central Florida	Professor & Coordinator
1999-2001	Honeywell Laboratories, Honeywell Corporation	Senior Research Scientist (Control Systems Laboratory)
1996-1999	Advanced Technology Group, BFGoodrich Aerospace	Associate Research Engineer
1991-1996	Department of Industrial and Syst. Engineering, Ohio University	Associate Professor (Tenured)
1991-1995:	National Institute of Standards and Technology, US Department of Commerce	Guest Researcher and Fellow
1987-1989	Department of Engineering Management, University of Missouri	Graduate Research Assistant
1982 -1985	Contadora Corporation, Republic of Panama	Operations Manager

**HONORS/AWARDS:** Engineers' Council: Distinguished Engineer Educator Award 2012, NASA KSC Group Achievement Award to 2nd Lunabotics Mining Competition Team, 2011 Hispanic Engineer National Achievement Awards Corporation (HENAAC) Education Award winner, NASA Group Achievement Award to Inaugural Lunabotics Mining Competition Team, NASA Recognition Award 2011 for Project Management, Fulbright Scholar 2008, Distinguished Alumni – Technological University of Panama 2008; ONE NASA Award 2006 (Agency Level), SAE Best Technical Paper 2004 (selected from 2,677 participants), Emerald Literati Award for Best Paper in 2007 (Emerald Journals), TIP University of Central Florida Award for Teaching Performance in 2007, NASA Fellow (2002-2005); Russ Award as the Best Teaching Engineering Faculty (Ohio University, 1995); Industrial Engineering Department Best Teaching Award (Ohio University, 1991, 1992, 1993, 1995); Distinguished Alumni (Technological University of Panama, 1995), Stock Options for Outstanding Performance (Honeywell, 2000); Top Corporate Artificial Intelligence Architect (BFGoodrich, 1998); Nominee by NASA for the 2006 State of Florida's Governor's Award in Modeling & Simulation for the development of the Agents-based Workforce Climate Simulation Models,

### SAMPLE OF PUBLICATIONS

#### **Closely Related**

- L. Rabelo, editor (Book). **Artificial Intelligence: Advances in Research and Applications**. Nova publishers (400 Oser Avenue, Suite 1600, Hauppauge, NY 11788 USA). Fall 2017. ISBN 9781536126778.
- Nagadi, K., Rabelo, L., Basingab, M., Rahal, A., Sarmiento, A., and A. Jones (2018). "A framework to generate, evaluate, and help optimize a SMS configuration," *International Journal of Computer Integrated Manufacturing*, Vol. 31, No. 2 , pp 115-128 - Manuscript ID TCIM-2016-IJCIM-0317.
- Eskandari, H., Sala-Diakanda, S., Furterer, S., Rabelo, L., Crumpton-Young, L. and Williams, K., "Determining the desired education characteristics and emerging topics needed in the IE

curriculum to better prepare future undergraduates: A National Delphi Study," **Journal of Education + Training**, Emerald Journal, Year: 2007 Volume: 49 Issue: 1 pp. 45 – 55

- Crumpton-Young, L., P. McCauley-Bush, L. Rabelo, K. Menza, A. Ferreras, B. Rodriguez, A. Millan, D. Miranda, and M. Kelarestani, "Engineering Leadership Development Programs A Look at What is Needed and What is Being Done," **Journal of STEM Education: Research and Innovations**, Vol. 11, No. 3/4, 2010.
  - Bukhari, H., A. Andreatta, B. Goldiez, and L. Rabelo. (2017), "A framework for determining the return on investment (ROI) of simulation based training in healthcare," **Inquiry: a journal of medical care organization, provision and financing** 54: 2017 Jan pg 46958016687176.
- Related**
- Rabelo, L. & T. Clark (2015), "Modeling Space Operations Systems Using SysML as to Enable Anomaly Detection," **SAE Int. J. Aerosp.** 8(2):2015, doi:10.4271/2015-01-2388. Selected to receive the SAE Russell S. Springer Award for SAE paper entitled, 2015-01-2388, "Modeling Space Operations Systems Using SysML as to Enable Anomaly Detection". This award is given annually by SAE to authors of an outstanding original technical paper which is a distinct contribution to the profession of mobility engineering and for the encouragement of younger members.
  - Bhide, S. & L. Rabelo (2015), "Framework for Emergency Evacuation Safety Training Using 3D Virtual Simulation," **International Journal of Engineering Research**, ISSN :(2321-1717), July 2015.
  - Rabelo, L. and Speller, T., "Sustaining Growth in the Modern Enterprise," **Journal of Engineering and Technology Management**, Elsevier, Volume 22, Issue 4, December 2005, pp. 274-290.
  - **Patent: Liquid gauging apparatus using a time delay neural Networks - .US 6,577,960 (Year 2003) (First Inventor):** Liquid gauging apparatus using a time delay neural network for determining a quantity of liquid in a container that is not directly measurable by sensors is disclosed. The apparatus comprises a plurality of sensors and a processor. Each of the sensors are capable of measuring a respective parameter of the liquid and for producing a time varying sensor output signal representative of the respective parameter measured thereby. The processor is programmed to process the sensor output signals by a time delay neural network algorithm to determine a current quantity of the liquid in the container based on current and past parameter measurements of the sensor output signals.
  - **Patent: Liquid Gauging Using Sensor Fusion and Data Fusion for Aircrafts - .US 6,157,894 (Year 2000):** Sensor Fusion, Data Fusion, and Information Fusion using the integration of Neural Networks, Fuzzy Logic, Extended Kalman Filtering schemes, and Bayesian Approaches. The system does not need a model(s) initially to work. Estimation is superior to any other known methodology used in Aerospace industry for the particular problem addressed. This is an algorithm/methodology embedded in a blackboard-architecture of a product already being used in airplanes/aircrafts.

**Presented and published extensively over 300 papers in renowned technical journals, conference proceedings including several invited papers and international presentations.**

#### **SYNERGISTIC ACTIVITIES**

1. Member of Vaccination Campaigns (Chiriqui – Panama Ministry of Health) in the Republic of Panama during his undergraduate studies
2. Program Manager of several international programs for research and new product development involving nations of the Far East, Eastern Europe, Europe, and Latin America. These programs have resulted in patents, new products, and new inventions. The concept of virtual team was utilized extensively.

#### **NAMES OF RECENT COLLABORATORS**

J. Sepulveda      J. Compton      C. Peaden      T. Samad

#### **NAMES OF GRADUATES (ie. Committee Chair) IN THE PAST 4 YEARS**

M. Chen      H. Bukhari      M. Almalki      T. Joledo      S. Bhide  
A. Basingab      W. Jung      T. Alexander      K. Nagadi      E. Cortez

#### **NAMES OF GRADUATE ADVISORS**

S. Alptekin      S. Keyvan      D. Ariely      M. Thursby



ABBREVIATED CURRICULUM VITAE (Spring, 2019)

**Name:** Gary Douglas Richardson

**Rank:** Professor of Mathematics/ Statistics, University of Central Florida

**Area of Specialization:** Convergence Spaces, Mathematical Statistics

**Degrees:** Ph.D., N. C. State, 1984, Statistics

Ph.D., N. C. State, 1969, Mathematics

**Ph. D. Dissertations directed:** Jing Minkler (1998)

Gary Minkler (1998)

Young Boissy (2001)

Paul Flores (2006)

Hatim Boustique (2008)

Bernd Losert (2013)

Lyall Reid (in progress)

Nathaniel Adu (in progress)

**Masters' Theses directed:** 12

**Reviewer:** Reviewed for many journals

**Joint Research publications with students:** 25

**Research Publications:** > 80, see MathSciNet (20 in Statistics)

**Recent Publications:**

1. Strongly Symmetric Compactifications, *Topology Proceedings* 52 (2018), 1 – 15  
(With N. Adu and H. Boustique)
  
2. Compactification: Limit Tower Spaces, *Applied Categorical Structures (Springer Journal)* 25 (2017), 349 – 361 (with H. Boustique)
  
3. Connecting T and Lattice- Valued Convergences, *Iranian Journal of Fuzzy Systems* 15 (2018), 151 – 169 (with Lyall Reid)
  
4. Unit Roots Test: Spatial Model with Long Memory Errors, *Statistics and Probability Letters* 140 (2018), 126 – 131 (with Nathaniel Adu)
  
5. Lattice- Valued Spaces: T – Completions, *Fuzzy Sets and Systems* (accepted for publication with Lyall Reid)
  
6. Strict T-Embeddings, *Quaestiones Mathematicae* (submitted with Lyall Reid)

---

---

## GITA REESE SUKTHANKAR

University of Central Florida  
4000 Central Florida Blvd  
Orlando, FL 32816  
U.S.A.

E-mail : [gitarars@eecs.ucf.edu](mailto:gitarars@eecs.ucf.edu)  
WWW : <http://www.eecs.ucf.edu/~gitarars/>  
Tel : (407) 823-4305

---

### Educational Background

- Ph.D., Robotics (School of Computer Science), Carnegie Mellon University, Aug 2007  
Dissertation: *Activity Recognition for Agent Teams*  
Thesis advisor: Dr. Katia Sycara
- M.S., Robotics (School of Computer Science), Carnegie Mellon University, May 2000  
Cumulative QPA: 4.08/4.0  
Coursework: software systems, artificial intelligence, machine learning, robot programming
- A.B., Psychology, *cum laude*, Princeton University, June 1997  
Senior thesis: *A Computational Model of the Formation of Achromatic Afterimages*  
Thesis advisor: Dr. Ron Kinchla

### Employment History

- Department of Electrical Engineering and Computer Science - University of Central Florida**  
*Associate Professor (with tenure) and Charles N. Millican Faculty Fellow,* 2013–present  
- Direct research on multi-agent systems and robotics  
*Affiliate Research Faculty, Institute for Simulation and Training*  
*Assistant Professor and Charles N. Millican Faculty Fellow,* 2007–2013
- Palo Alto Research Center (PARC)**  
*Visiting Researcher (sabbatical),* 2015–2016  
- Research with the Interactive Intelligence team on innovative health applications
- Naval Research Laboratory**  
*Visiting Researcher under ONR Summer Faculty Fellowship,* Summer 2008  
- Conducted research on adversarial plan recognition
- The Robotics Institute - School of Computer Science - Carnegie Mellon University**  
*Graduate Research Assistant,* 2003–2007  
- Thesis research on team behavior recognition
- Compaq/HP Labs - Cambridge Research Laboratory.** 2000–2003  
*Member of Research Staff,*  
- Conducted research in Open Handhelds and Smart Projectors projects
- The Robotics Institute - School of Computer Science - Carnegie Mellon University.** 1998–2000  
*Graduate Research Assistant/Programmer,*  
- Developed intelligent agent applications and RETSINA multi-agent infrastructure
- Center for Neural Basis of Cognition - Carnegie Mellon University.** 1997–1998  
*Research Programmer,*  
- Developed computational learning models in Matlab

## Teaching

Course #	Title	Credits	Class	Semester	# Students	Excellent/Very Good
CAP 6671	Intelligent Systems	3.0	Graduate	Spring 2019	17	87.5%
EGN 4060C	Intro to Robotics (with lab)	3.0	Junior	Spring 2018	45	88.9%
EEL 4660	Robotic Systems	3.0	Junior	Fall 2019	49	60.6%
CAP 5610	Machine Learning	3.0	Graduate	Fall 2018	59	50.0%
CAP 6671	Intelligent Systems	3.0	Graduate	Spring 2018	18	100.0%
EGN 4060C	Intro to Robotics (with lab)	3.0	Junior	Spring 2018	45	73.3%
EEL 4660	Robotic Systems	3.0	Junior	Fall 2017	44	67.8%
CAP 6671	Intelligent Systems	3.0	Graduate	Spring 2017	21	91.7%
EGN 4060C	Intro to Robotics (with lab)	3.0	Junior	Spring 2017	30	74.0%
EEL 4660	Robotic Systems	3.0	Junior	Fall 2016	29	100.0%
EEL 4660	Robotic Systems	3.0	Junior	Spring 2015	56	57.7%
CAP 6671	Intelligent Systems	3.0	Graduate	Spring 2015	20	100.0%
EGN 4060C	Intro to Robotics (with lab)	3.0	Junior	Fall 2014	29	76.2%
CAP 6671	Intelligent Systems	3.0	Graduate	Spring 2014	31	71.4%
EGN 3060C	Intro to Robotics (with lab)	3.0	Junior	Fall 2012	25	68.4%
CAP 6671	Intelligent Systems	3.0	Graduate	Spring 2012	24	85.7%
EEL 4818	Honors Machine Learning I	(co-taught)	Senior	Fall 2011	16	NA
EGN 3060C	Intro to Robotics (with lab)	3.0	Junior	Fall 2011	23	75.0%
CAP 6671	Intelligent Systems	3.0	Grad	Spring 2011	15	83.3%
EEL 4817	Honors Machine Learning II	(co-taught)	Senior	Spring 2011	6	NA
EEL 4818	Honors Machine Learning I	(co-taught)	Senior	Fall 2010	20	NA
EGN 3060C	Intro to Robotics (with lab)	3.0	Junior	Fall 2010	18	57.1%
CAP 6671	Intelligent Systems	3.0	Grad	Spring 2010	24	75.0%
EGN 3060C	Intro to Robotics (with lab)	3.0	Junior	Fall 2009	24	85.7%
CAP 6671	Intelligent Systems	3.0	Grad	Spring 2009	28	75.0%
EGN 3060C	Intro to Robotics (with lab)	3.0	Junior	Fall 2008	16	53.3%
CAP 6671	Intelligent Systems	3.0	Grad	Spring 2008	13	63.6%
CAP 6938	ST: Activity Recognition	3.0	Grad	Fall 2007	6	60.0%

Graduated Ph.D. Students	Date	Current Position
Alireza Hajibagheri	Apr 2017	Data Engineer at Sonobi
Rahmatollah Beheshti (Runner-up CS Ph.D. Student of the Year)	Apr 2015	Postdoctoral Fellow at Johns Hopkins
Erfan Davami	Feb 2015	Software Engineer at Oculus Rift
Xi Wang	Mar 2014	Data Scientist at Edmunds
Bennie Lewis	Mar 2014	Senior Research Scientist at Lockheed Martin
Mahsa Maghami	Feb 2014	Data Scientist at Amazon
Liyue Zhao	May 2013	Senior Engineer at iQIYI
Jeremiah Folsom-Kovarik	Feb 2012	Researcher at SoarTech
Fahad Shah	Oct 2011	Data Scientist at Microsoft
Kennard Laviors	June 2011	Assistant Professor at Sul Ross State University

Graduated M.S. Students	Date	Current Position
Rey Coaguila	Apr 2015	Software Engineer at Google
Awrad Mohammed Ali	Nov 2014	UCF Ph.D. Student

Graduated B.S. Honors Students	Date	Current Position
Bryan Wilder	May 2015	USC Ph.D. Student

Current Ph.D. Students	Funding
Abduljaleel Al-Rubaye	Self
Neda Hajiakhoond Bidoki	GRA
Astrid Jackson	Leave of Absence
Vera Kazakova	Self
Saif Mohammed	External Fellowship
Samaneh Saadat	GRA
Zerong Xi	GRA

### Educational Contributions

- Developed new course, EEL 4660 (Robotic Systems) first taught in spring 2015
- Developed new course, CAP 6671 (Intelligent Systems), taught on Tegrity since 2009
- Developed new course, CAP 6637 (Plan, Activity, and Intent Recognition), first taught as a special topics course in fall 2007
- Developed lectures and assignments for previously proposed course, EGN 4060C (Introduction to Robotics)
- Set up robotics hardware and software for EGN 4060C lab
- Service as faculty champion for the Intelligent Robotic Systems minor
- Faculty mentor for undergraduate students in the LEARN, EXCEL, COMPASS, and Senior Design programs

### Research

**Keywords:** autonomous agents, multi-agent systems, activity recognition, teamwork, games, virtual worlds, human-robot interaction, social networks

### Publications

Authors who were my students when the paper was published are denoted by \*

### Books

- [1] Mehdi Dastani, Gita Sukthankar, Elisabeth André, and Sven Koenig, editors. *Proceedings of the International Conference on Autonomous Agents and Multiagent Systems*. ACM, 2018.
- [2] Kiran Lakkaraju, Gita Sukthankar, and Rolf T. Wigand, editors. *Social Interactions in Virtual Worlds*. Cambridge University Press, 2018.
- [3] Gita Sukthankar and Juan Antonio Rodriguez-Aguilar, editors. *AAMAS 2017 Workshops, Best Papers*, volume 10642 of *Lecture Notes in Artificial Intelligence*. Springer, 2017.
- [4] Gita Sukthankar and Juan Antonio Rodriguez-Aguilar, editors. *AAMAS 2017 Workshops, Visionary Papers*, volume 10643 of *Lecture Notes in Artificial Intelligence*. Springer, 2017.
- [5] Gita Sukthankar, Robert Goldman, Chris Geib, David Pynadath, and Hung Bui, editors. *Plan, Activity, and Intent Recognition*. Morgan Kaufmann, February 2014. <http://store.elsevier.com/Plan-Activity-and-Intent-Recognition/isbn-9780123985323/>.

### Book Chapters

- [1] Gita Sukthankar and Rahmatollah Beheshti\*. Using agent-based models to understand health-related social norms. In Paul Davis, Angela O'Mahony, and Jonathan Pfautz, editors, *Social Behavioral Modeling for Complex Systems*. Wiley, April 2019.
- [2] Alireza Hajibagheri\*, Gita Sukthankar, Kiran Lakkaraju, Hamidreza Alvari\*, Rolf T. Wigand, and Nitin Agarwal. Using massively multiplayer online game data to analyze the dynamics of social interactions. In Kiran Lakkaraju, Gita Sukthankar, and Rolf T. Wigand, editors, *Social Interaction in Virtual Worlds*, pages 375–416. Cambridge University Press, 2018.

- [3] Fahad Shah and Gita Sukthankar. Mining social interaction data in virtual worlds. In Fernando Koch, Felipe Meneguzzi, and Kiran Lakkaraju, editors, *Agent Technology for Intelligent Mobile Services and Smart Societies*, Communications in Computer and Information Science, pages 86–105. Springer, 2015.
- [4] Xi Wang\* and Gita Sukthankar. Link prediction in heterogeneous collaboration networks. In Rokia Missaoui and Idrissa Sarr, editors, *Social Network Analysis: Community Detection and Evolution*, Lecture Notes in Social Networks, pages 165–192. Springer, 2014.
- [5] Mahsa Maghami\* and Gita Sukthankar. Scaling influence maximization with network abstractions. In Rokia Missaoui and Idrissa Sarr, editors, *Social Network Analysis: Community Detection and Evolution*, Lecture Notes in Social Networks, pages 243–268. Springer, 2014.
- [6] Gita Sukthankar, Robert Goldman, Christopher Geib, David Pynadath, and Hung Bui. An introduction to plan, activity, and intent recognition. In Gita Sukthankar, Robert Goldman, Chris Geib, David Pynadath, and Hung Bui, editors, *Plan, Activity, and Intent Recognition*, pages xix–xxxv. Morgan Kaufmann, 2014.
- [7] Kennard Laviers and Gita Sukthankar. Using opponent modeling to adapt team play in American football. In Gita Sukthankar, Robert Goldman, Chris Geib, David Pynadath, and Hung Bui, editors, *Plan, Activity, and Intent Recognition*, pages 313–341. Elsevier, 2014.
- [8] Liyue Zhao\*, Xi Wang\*, and Gita Sukthankar. Improving the supervised learning of activity classifiers for motion data. In Hans W. Guesgen and Stephen Marsland, editors, *Human Behavior Recognition Technologies: Intelligent Applications for Monitoring and Security*, pages 281–302. IGI Global, 2013.
- [9] Gita Sukthankar, Randall Shumaker, and Michael Lewis. Intelligent agents as teammates. In Eduardo Salas, Stephen M. Fiore, and Michael Letsky, editors, *Theories of Team Cognition: Cross-Disciplinary Perspectives*, pages 313–343. Routledge Academic, 2011.
- [10] Gita Sukthankar, Katia Sycara, Joseph Andrew Giampapa, Christopher Burnett, and Alun Preece. An analysis of salient communications for agent support of human teams. In Virginia Dignum, editor, *Multi-agent Systems: Semantics and Dynamics of Organizational Models*, pages 284–312. IGI Global, 2009.

## Journal Articles

- [1] Hamidreza Alvari\*, Alireza Hajibagheri\*, Gita Sukthankar, and Kiran Lakkaraju. Identifying community structures in dynamic networks. *Social Network Analysis and Mining*, 6(1):1–13, 2016.
- [2] Biplav Srivastava and Gita Sukthankar. Reports on the 2016 IJCAI Workshop Series. *AI Magazine*, 37(4):94–101, 2016.
- [3] Christopher Geib, Vikas Agrawal, Gita Sukthankar, Lokendra Shastri, and Hung Bui. Architectures for activity recognition and context-aware computing. *AI Magazine*, 36(2):3–9, 2015.
- [4] Gita Sukthankar and Ian Horswill. The Ninth Annual AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment (AIIDE): A Report. *AI Magazine*, 35(2):61–63, 2014.
- [5] Rahmatollah Beheshti\* and Gita Sukthankar. A hybrid modeling approach for parking and traffic prediction in urban simulations. *AI and Society: Journal of Knowledge, Culture and Communication*, pages 1–12, February 2014.
- [6] Mark Riedl, Gita Sukthankar, Arnav Jhala, Jichen Zhu, Santiago Ontanon, Michael Buro, and David Churchill. The Eighth AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment. *AI Magazine*, 34(1):87–89, 2013.
- [7] Jeremiah Folsom-Kovarik\*, Gita Sukthankar, and Sae Schatz. Tractable POMDP representations for intelligent tutoring systems. *ACM Transactions in Intelligent Systems Technology*, 4(2):29:1–29:22, March 2013.
- [8] Kirill Osipov-Lvoff\* and Gita Sukthankar. AmalgaCloud: Social network adaptation for human and computational agent team formation. *ASE Human Journal*, 2:61–73, 2012.

- [9] Erfan Davami\* and Gita Sukthankar. Online learning of user-specific destination prediction models. *ASE Human Journal*, 3:144–151, 2012.
- [10] Gita Sukthankar and Katia Sycara. Activity recognition for dynamic multi-agent teams. *ACM Transactions in Intelligent Systems Technology*, 3(1):18:1–18:24, October 2011.
- [11] Bulent Tastan\* and Gita Sukthankar. Leveraging human behavior models to improve path prediction and tracking in indoor environments. *Pervasive and Mobile Computing*, 7:319–330, 2011.
- [12] Liyue Zhao\*, Xi Wang\*, and Gita Sukthankar. Recognizing household activities from human motion data using active learning and feature selection. *Technology and Disability*, 22(1-2):17–26, June 2010.
- [13] Gita Sukthankar and Katia Sycara. Analyzing team decision-making in tactical scenarios. *The Computer Journal*, 53(5):503–511, 2010.
- [14] Gita Sukthankar, Michael Mandel, and Katia Sycara. Planning for physically-embodied agents using realistic human motion models. *Journal on Simulation and Gaming*, 39:64–82, 2008.
- [15] Michael N. Huhns, Munindar P. Singh, Mark Burstein, Keith Decker, Edmund Durfee, Tim Finin, Les Gasser, Hrishikesh Goradia, Nick Jennings, Kiran Lakkaraju, Hideyuki Nakashima, H. Van Dyke Parunak, Jeffrey S. Rosenschein, Alicia Ruvinsky, Gita Sukthankar, Samarth Swarup, Katia Sycara, Milind Tambe, Tom Wagner, and Laura Zavala. Research directions for service-oriented multiagent systems. *IEEE Internet Computing*, 9(6):65–70, November 2005.
- [16] Andrea Simmons, Gita Reese, and Michael Ferragamo. Periodicity extraction in the anuran auditory nerve: II. phase and temporal fine structure. *Journal of the Acoustical Society of America*, 93(6):3374–3389, 1993.

## Conference Papers

- [1] Saif Alabachi\*, Gita Sukthankar, and Rahul Sukthankar. Customizing object detectors for indoor robots. In *International Conference on Robotics and Automation (ICRA)*, Montreal, CA, May 2019.
- [2] Astrid Jackson\*, Brandon D. Northcutt, and Gita Sukthankar. The benefits of immersive demonstrations for teaching robots. In *ACM/IEEE International Conference on Human Robot Interaction*, Daegu, Korea, March 2019.
- [3] Neda Hajiakhoound Bidoki\*, Gita Sukthankar, Heather Keathley, and Ivan Garibay. A cross-repository model for predicting popularity in GitHub. In *International Conference on Computational Science and Computational Intelligence (Social Network Analysis, Media, and Mining)*, Las Vegas, Nevada, Dec 2018.
- [4] Neda Hajiakhoound Bidoki\* and Gita Sukthankar. Network semantic segmentation with application to GitHub. In *International Conference on Computational Science and Computational Intelligence (Social Network Analysis, Media, and Mining)*, Las Vegas, Nevada, Dec 2018.
- [5] Abduljaleel Al-Rubaye\* and Gita Sukthankar. A popularity-based model of the diffusion of innovation on github. In *Proceedings of the Computational Social Science Society of the Americas*, Santa Fe, NM, Oct 2018.
- [6] Samaneh Saadat\*, Chathika Gunaratne, Nisha Baral, Gita Sukthankar, and Ivan Garibay. Initializing agent-based models with clustering archetypes. In *Proceedings of the International Conference on Social Computing, Behavioral-Cultural Modeling, and Prediction*, pages 233–239, Washington, D.C., July 2018.
- [7] Neda Hajiakhoound Bidoki\*, Masoud Baghbahari Baghdadabad, Gita Sukthankar, and Damla Turgut. Joint value of information and energy aware sleep scheduling in wireless sensor networks: A linear programming approach. In *IEEE ICC Ad-Hoc and Sensor Networking Symposium*, pages 1–6, Kansas City, MO, May 2018.
- [8] Saif Alabachi\* and Gita Sukthankar. Intelligently assisting human-guided quadcopter photography. In *Proceedings of Florida Artificial Intelligence Research Society*, Melbourne, FL, May 2018.

- [9] Alireza Hajibagheri\*, Gita Sukthankar, and Kiran Lakkaraju. Extracting information from negative interactions in multiplex networks using mutual information. In *Proceedings of the International Conference on Social Computing, Behavioral-Cultural Modeling, and Prediction*, pages 322–328, Washington, D.C., July 2017.
- [10] Alireza Hajibagheri\*, Gita Sukthankar, and Kiran Lakkaraju. A holistic approach for link prediction in multiplex networks. In *Proceedings of the International Conference on Social Informatics*, pages 55–70, Seattle, WA, November 2016.
- [11] Alireza Hajibagheri\*, Gita Sukthankar, and Kiran Lakkaraju. Leveraging network dynamics for improved link prediction. In *Proceedings of the International Conference on Social Computing, Behavioral-Cultural Modeling, and Prediction*, pages 142–151, Washington, D.C., June 2016.
- [12] Astrid Jackson\* and Gita Sukthankar. Learning continuous state/action models for humanoid robots. In *Proceedings of Florida Artificial Intelligence Research Society*, pages 392–397, Key Largo, FL, May 2016.
- [13] Rey Coaguila\*, Gita Sukthankar, and Rahul Sukthankar. Selecting vantage points for an autonomous quadcopter videographer. In *Proceedings of Florida Artificial Intelligence Research Society*, pages 386–391, Key Largo, FL, May 2016. **(nominated for Best Paper)**.
- [14] Bryan Wilder\* and Gita Sukthankar. Sparsification of social networks using random walks. In *ASE International Conference on Social Computing*, Palo Alto, CA, August 2015.
- [15] Erfan Davami\* and Gita Sukthankar. Improving the performance of mobile phone crowdsourcing applications. In *Proceedings of the International Conference on Autonomous Agents and Multi-agent Systems*, pages 145–153, Istanbul, Turkey, May 2015. **(nominated for Best Innovative Applications paper)**.
- [16] Rahmatollah Beheshti\* and Gita Sukthankar. Modeling tipping point theory using normative multi-agent systems (extended abstract). In *Proceedings of the International Conference on Autonomous Agents and Multi-agent Systems*, pages 1731–1732, Istanbul, Turkey, May 2015.
- [17] Alireza Hajibagheri\*, Kiran Lakkaraju, Gita Sukthankar, Rolf T. Wigand, and Nitin Agarwal. Conflict and communication in massively multiplayer online games. In *Proceedings of the International Conference on Social Computing, Behavioral-Cultural Modeling, and Prediction*, pages 65–74, Washington, D.C., April 2015.
- [18] Rahmatollah Beheshti\*, Awrad Mohammed Ali\*, and Gita Sukthankar. Cognitive social learners: an architecture for modeling normative behavior. In *Proceedings of the AAAI Conference on Artificial Intelligence*, pages 2017–2023, Austin, TX, Jan 2015.
- [19] Awrad Mohammed Ali\*, Hamidreza Alvari\*, Alireza Hajibagheri\*, Kiran Lakkaraju, and Gita Sukthankar. Synthetic generators for cloning social network data. In *Proceedings of the ASE International Conference on Social Informatics*, pages P41:1–9, Cambridge, MA, Dec 2014.
- [20] Hamidreza Alvari\*, Alireza Hajibagheri\*, and Gita Sukthankar. Community detection for dynamic social networks: A game-theoretic approach. In *Proceedings of the IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining*, Beijing, China, August 2014.
- [21] Bennie Lewis\* and Gita Sukthankar. Know thy user: Designing human-robot interaction paradigms for multi-robot manipulation. In *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 4362–4367, Chicago, IL, September 2014.
- [22] Ghazaleh Beigi, Hamidreza Alvari\*, Mahdi Jalili, and Gita Sukthankar. Leveraging community detection for accurate trust prediction. In *ASE International Conference on Social Computing*, Palo Alto, CA, May 2014.
- [23] Erfan Davami\* and Gita Sukthankar. Evaluating trust-based fusion models for participatory sensing applications (extended abstract). In *Proceedings of the International Conference on Autonomous Agents and Multi-agent Systems*, pages 1377–1378, Paris, France, May 2014.
- [24] Rahmatollah Beheshti\* and Gita Sukthankar. A normative agent-based model for predicting smoking cessation. In *Proceedings of the International Conference on Autonomous Agents and Multi-agent Systems*, pages 557–564, Paris, France, May 2014.



- [25] Hamidreza Alvani\*, Kiran Lakkaraju, Gita Sukthankar, and Jon Whetzel. Predicting guild membership in massively multiplayer online games. In *Proceedings of the International Conference on Social Computing, Behavioral-Cultural Modeling, and Prediction*, pages 215–222, Washington, D.C., April 2014.
- [26] Bennie Lewis\*, Bulent Tastan\*, and Gita Sukthankar. An adjustable autonomy paradigm for adapting to expert-novice differences. In *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 1656–1662, Tokyo, Japan, November 2013.
- [27] Rahmatollah Beheshti\* and Gita Sukthankar. Analyzing agent-based models using category theory. In *IEEE/WIC/ACM International Conference on Intelligent Agent Technology*, pages 280–286, Atlanta, GA, November 2013.
- [28] Xi Wang\* and Gita Sukthankar. Multi-label relational neighbor classification using social context features. In *Proceedings of the ACM SIGKDD Conference on Knowledge Discovery and Data Mining*, pages 464–472, Chicago, IL, August 2013.
- [29] Xi Wang\* and Gita Sukthankar. Link prediction in multi-relational collaboration networks. In *Proceedings of the IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining*, pages 1445–1447, Niagara Falls, Canada, August 2013. **(Best Poster)**.
- [30] Mahsa Maghami\* and Gita Sukthankar. Hierarchical influence maximization for advertising in multi-agent markets. In *Proceedings of the IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining*, pages 21–27, Niagara Falls, Canada, August 2013.
- [31] Alireza Hajibagheri\*, Ali Hamzeh, and Gita Sukthankar. Modeling information diffusion and community membership using stochastic optimization. In *Proceedings of the IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining*, pages 175–182, Niagara Falls, Canada, August 2013.
- [32] Nicholas Bowen\*, Jonathan Todd\*, and Gita Sukthankar. Adjutant bot: An evaluation of unit micromanagement tactics. In *Proceedings of the IEEE Conference on Computational Intelligence in Games*, pages 336–343, Niagara Falls, Canada, August 2013.
- [33] Yuan Chang\* and Gita Sukthankar. Exploiting key events for learning interception policies. In *Proceedings of Florida Artificial Intelligence Research Society*, pages 40–45, Tampa, FL, May 2013.
- [34] Rahmatollah Beheshti\* and Gita Sukthankar. Improving Markov Chain Monte Carlo estimation with agent-based models. In *Proceedings of the International Conference on Social Computing, Behavioral-Cultural Modeling, and Prediction*, pages 495–502, Washington, D.C., April 2013.
- [35] Kirill Osipov-Lvoff\* and Gita Sukthankar. Forming effective teams from agents with diverse skill sets. In *Proceedings of the ASE/IEEE International Conference on Social Informatics*, pages 44–48, Washington, D.C., December 2012.
- [36] Rahmatollah Beheshti\* and Gita Sukthankar. Extracting agent-based models of human transportation patterns. In *Proceedings of the ASE/IEEE International Conference on Social Informatics*, pages 157–164, Washington, D.C., December 2012.
- [37] Erfan Davami\* and Gita Sukthankar. Online learning of user-specific destination prediction models. In *Proceedings of the ASE/IEEE International Conference on Social Informatics*, pages 40–43, Washington, D.C., December 2012.
- [38] Liyue Zhao\*, Gita Sukthankar, and Rahul Sukthankar. Importance-weighted label prediction for active learning with noisy annotations. In *Proceedings of the IAPR/IEEE International Conference on Pattern Recognition*, pages 3476–3479, Tsukuba Science City, Japan, November 2012.
- [39] Bulent Tastan\*, Yuan Chang\*, and Gita Sukthankar. Learning to intercept opponents in first person shooter games. In *Proceedings of the IEEE Conference on Computational Intelligence in Games*, Granada, Spain, September 2012. 100–107.
- [40] Jeremiah Folsom-Kovarik\*, Gita Sukthankar, and Sae Schatz. Integrating learner help requests using a POMDP in an adaptive training system. In *Proceedings of the AAI Conference on Innovative Applications of Artificial Intelligence*, pages 2287–2292, Toronto, CA, July 2012.

- [41] Mahsa Maghami\* and Gita Sukthankar. Identifying influential agents for advertising in multi-agent markets. In *Proceedings of International Conference on Autonomous Agents and Multi-Agent Systems*, pages 687–694, Valencia, Spain, June 2012.
- [42] Bennie Lewis\* and Gita Sukthankar. Configurable human-robot interaction for multi-robot manipulation tasks (extended abstract). In *Proceedings of International Conference on Autonomous Agents and Multi-Agent Systems*, pages 1219–1220, Valencia, Spain, June 2012.
- [43] Bulent Tastan\* and Gita Sukthankar. Learning policies for first person shooter games using inverse reinforcement learning. In *Proceedings of the AAAI Conference on Artificial Intelligence for Interactive Digital Entertainment*, pages 85–90, Palo Alto, CA, Oct 2011.
- [44] Liyue Zhao\*, Gita Sukthankar, and Rahul Sukthankar. Incremental relabeling for active learning with noisy crowdsourced annotations. In *IEEE International Conference on Social Computing*, pages 728–733, Boston, MA, Oct 2011.
- [45] Xi Wang\* and Gita Sukthankar. Extracting social dimensions using Fiedler embedding. In *IEEE International Conference on Social Computing*, pages 824–829, Boston, MA, Oct 2011.
- [46] Bennie Lewis\* and Gita Sukthankar. Two hands are better than one: Assisting users with multi-robot manipulation tasks. In *Proceedings of IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 2590–2595, San Francisco, CA, Sept 2011.
- [47] Xi Wang\*, Mahsa Maghami\*, and Gita Sukthankar. Leveraging network properties for trust evaluation in multi-agent systems. In *IEEE/WIC/ACM International Conference on Intelligent Agent Technology*, pages 288–294, Lyon, France, Aug 2011.
- [48] Kennard Laviers\* and Gita Sukthankar. A real-time opponent modeling system for Rush football. In *Proceedings of the International Joint Conference on Artificial Intelligence*, pages 2476–2481, Barcelona, Spain, July 2011.
- [49] Fahad Shah\* and Gita Sukthankar. Using network structure to identify groups in virtual worlds. In *Proceedings of the International AAAI Conference on Weblogs and Social Media*, pages 614–617, Barcelona, Spain, July 2011.
- [50] Fahad Shah\* and Gita Sukthankar. Constructing social networks from unstructured group dialog in virtual worlds. In *Proceedings of the International Conference on Social Computing and Behavioral-Cultural Modeling*, pages 180–187, College Park, MD, Mar 2011.
- [51] Mahsa Maghami\* and Gita Sukthankar. An agent-based simulation for investigating the impact of stereotypes on task-oriented group formation. In *Proceedings of the International Conference on Social Computing and Behavioral-Cultural Modeling*, pages 252–259, College Park, MD, Mar 2011.
- [52] Kennard Laviers\* and Gita Sukthankar. A Monte Carlo approach for football play generation. In *Proceedings of the AAAI Conference on Artificial Intelligence for Interactive Digital Entertainment*, pages 150–155, Palo Alto, CA, Oct 2010.
- [53] Liyue Zhao\*, Xi Wang\*, Gita Sukthankar, and Rahul Sukthankar. Motif discovery and feature selection for CRF-Based activity recognition. In *Proceedings of the IAPR/IEEE International Conference on Pattern Recognition*, pages 3826–3829, Istanbul, Turkey, Aug 2010.
- [54] Syed Fahad Allam Shah\*, Gita Sukthankar, and Chris Usher\*. Modeling group dynamics in virtual worlds. In *Proceedings of International AAAI Conference on Weblogs and Social Media*, pages 327–330, Washington, DC, May 2010.
- [55] Bennie Lewis\*, Bulent Tastan\*, and Gita Sukthankar. Agent assistance for multi-robot control (extended abstract). In *Proceedings of International Conference on Autonomous Agents and Multi-Agent Systems*, pages 1505–1506, Toronto, CA, May 2010.
- [56] Kennard Laviers\* and Gita Sukthankar. Identifying and utilizing subgroup coordination patterns in team adversarial games (extended abstract). In *Proceedings of International Conference on Autonomous Agents and Multi-Agent Systems*, pages 1409–1410, Toronto, CA, May 2010.

- [57] Rawad Haddad and Gita Sukthankar. A psychologically-inspired agent for iterative prisoner's dilemma. In *Proceedings of Florida Artificial Intelligence Research Society*, pages 2–7, Daytona Beach, FL, May 2010.
- [58] Syed Fahad Allam Shah\*, Philip Bell\*, and Gita Sukthankar. A destination recommendation system for virtual worlds. In *Proceedings of Florida Artificial Intelligence Research Society*, pages 475–476, Daytona Beach, FL, May 2010.
- [59] Liyue Zhao\* and Gita Sukthankar. An active learning approach for segmenting human activity datasets. In *Proceedings of the ACM International Conference on Multimedia*, pages 765–768, Beijing, China, Oct 2009.
- [60] Kennard Laviers\*, Gita Sukthankar, Matthew Molineaux, and David Aha. Improving offensive performance through opponent modeling. In *Proceedings of the AAAI Conference on Artificial Intelligence for Interactive Digital Entertainment*, pages 58–63, Palo Alto, CA, Oct 2009.
- [61] Syed Fahad Allam Shah\*, Philip Bell\*, and Gita Sukthankar. Agent-assisted navigation for virtual worlds. In *Proceedings of the International Conference on Intelligent Virtual Agents*, pages 542–544, Amsterdam, Netherlands, Sept 2009.
- [62] David Aha, Matthew Molineaux, and Gita Sukthankar. Case-based reasoning in transfer learning. In *Proceedings of the International Conference on Case-Based Reasoning*, pages 29–44, Seattle, WA, July 2009.
- [63] Bulent Tastan\* and Gita Sukthankar. Exploiting human steering models for path prediction. In *Proceedings of the IEEE International Conference on Information Fusion*, pages 1722–1729, Seattle, WA, July 2009.
- [64] Matt Molineaux, David Aha, and Gita Sukthankar. Beating the defense: Using plan recognition to inform learning agents. In *Proceedings of Florida Artificial Intelligence Research Society*, pages 337–342, Sanibel Island, FL, May 2009.
- [65] Syed Fahad Allam Shah\*, Philip Bell\*, and Gita Sukthankar. Identifying user destinations in virtual worlds. In *Proceedings of Florida Artificial Intelligence Research Society*, pages 445–446, Sanibel Island, FL, May 2009.
- [66] John Reeder, Gita Sukthankar, M. Georgiopoulos, and G. Anagnostopoulos. Intelligent trading agents for massively multi-player game economies. In *AAAI Conference on Artificial Intelligence for Interactive Digital Entertainment Conference*, pages 102–107, Palo Alto, CA, Oct 2008.
- [67] Gita Sukthankar and Katia Sycara. Hypothesis pruning and ranking for large plan recognition problems. In *AAAI Conference on Artificial Intelligence*, pages 998–1003, Chicago, IL, July 2008.
- [68] Gita Sukthankar and Katia Sycara. Robust and efficient plan recognition for dynamic multi-agent teams (short paper). In *Proceedings of International Conference on Autonomous Agents and Multi-Agent Systems*, pages 1383–1386, Estoril, Portugal, May 2008.
- [69] Gita Sukthankar and Katia Sycara. Policy recognition for multi-player tactical scenarios. In *Proceedings of International Conference on Autonomous Agents and Multi-Agent Systems*, pages 59–65, Honolulu, HI, May 2007.
- [70] Gita Sukthankar and Katia Sycara. Efficient plan recognition for dynamic multi-agent teams. In *Grace Hopper Women in Computer Science Conference*, pages 204–208, Orlando, FL, October 2007.
- [71] Gita Sukthankar, Katia Sycara, Joseph Andrew Giampapa, Christopher Burnett, and Alun Preece. Towards a model of agent-assisted team search. In *Proceedings of the Annual Conference of the International Technology Alliance in Network and Information Science*, College Park, MD, September 2007.
- [72] Gita Sukthankar and Katia Sycara. Simultaneous team assignment and behavior recognition from spatio-temporal agent traces. In *Proceedings of the AAAI Conference on Artificial Intelligence*, pages 716–721, Boston, MA, July 2006.
- [73] Gita Sukthankar and Katia Sycara. Robust recognition of physical team behaviors using spatio-temporal models. In *Proceedings of International Conference on Autonomous Agents and Multi-Agent Systems*, pages 638–645, Hakodate, Japan, May 2006.

- [74] Gita Sukthankar and Katia Sycara. A cost minimization approach to human behavior recognition. In *Proceedings of International Conference on Autonomous Agents and Multi-Agent Systems*, pages 1067–1074, Utrecht, Netherlands, July 2005. **Winner of student best paper award.**
- [75] Gita Sukthankar and Katia Sycara. Identifying physical team behaviors from spatial relationships. In *Proceedings of Conference on Behavior Representation in Modeling and Simulation*, pages 142–149, Universal City, CA, May 2005. **Winner of recommended reading award.**
- [76] Gita Sukthankar, Michael Mandel, Katia Sycara, and Jessica Hodgins. Modeling physical capabilities of humanoid agents using motion capture data. In *Proceedings of International Conference on Autonomous Agents and Multi-Agent Systems*, pages 344–351, NYC, NY, July 2004.
- [77] Gita Sukthankar, Michael Mandel, Katia Sycara, and Jessica Hodgins. Modeling physical variability for synthetic MOUT agents. In *Proceedings of Conference on Behavior Representation in Modeling and Simulation*, pages 332–341, Arlington, Virginia, May 2004. **Winner of recommended reading award.**
- [78] Sudha Reese, Gita Sukthankar, and Rahul Sukthankar. An efficient recognition technique for mine-like objects using nearest-neighbor classification. In *Proceedings of Undersea Defence Technology Europe*, Malmo, Sweden, June 2003.
- [79] Tat-Jen Cham, James Rehg, Rahul Sukthankar, and Gita Sukthankar. Shadow elimination and occluder light suppression for multi-projector displays. In *Proceedings of IEEE Conference on Computer Vision and Pattern Recognition*, pages 513–520, Madison, WI, June 2003.
- [80] James M. Rehg, Matthew Flagg, Tat-Jen Cham, Rahul Sukthankar, and Gita Sukthankar. Projected light displays using visual feedback. In *Proceedings of the International Conference on Control, Automation, Robotics, and Vision*, pages 926–932, Singapore, Nov 2002.
- [81] Rahul Sukthankar, Tat-Jen Cham, and Gita Sukthankar. Dynamic shadow elimination for multi-projector displays. In *Proceedings of IEEE Computer Conference on Computer Vision and Pattern Recognition*, pages 151–157, Kauai, HI, Dec 2001.
- [82] Onn Shehory, Katia Sycara, Gita Sukthankar, and Vikram Mukherjee. Agent aided aircraft maintenance. In *Proceedings of International Conference on Autonomous Agents*, pages 306–312, Seattle, WA, May 1999.

## Additional Publications

- [1] Vera Kazakova\* and Gita Sukthankar. Adaptable decentralized task allocation for hierarchically-defined domains. In *AAMAS Workshop on Adaptive Learning Agents*, Montreal, Canada, May 2019.
- [2] Ivan Garibay, Madeline Schiappa, Georgios Anagnostopoulos, Steve Fiore, Heather Keathly, Alexander Mantzaris, Bill Rand, Gita Sukthankar, Jose Andrade, Nisha Baral, Brandon Barnes, Anamaria Berea, Christina Bouwens, Christine Grayson, Chathika Gunaratne, Neda Hajiakhoond Bidoki, Nisha Baral, Gabriel Fair, Jasser Jasser, Chathura Jayalath, Ece Mutlu, John Murphy, Olivia Newton, Amirarsalan Rajabi, Samaneh Saadat, Steve Scheinert, Chaturani Senevirathna, and Xixi Zhang. Deep Agent: Computational social science centered simulation of online information environments. In *International Conference on Computational Social Science*, Amsterdam, Netherlands, July 2019.
- [3] Neda Hajiakhoond Bidoki\* and Gita Sukthankar. Communication protocols for man-machine networks. In *AAMAS Workshop on Autonomy in Teams*, Stockholm, Sweden, July 2018.
- [4] Samaneh Saadat\* and Gita Sukthankar. Predicting the performance of software development teams on GitHub. In *International Conference on Computational Social Science*, Evanston, IL, July 2018.
- [5] Saif Alabachi\* and Gita Sukthankar. Collecting image datasets with a quadcopter. In *Florida Conference on Recent Advances in Robotics*, Orlando, FL, May 2018.
- [6] Astrid Jackson\*, Brandon D. Northcutt, and Gita Sukthankar. The benefits of teaching robots using VR. In *ACM/IEEE International Conference on Human Robot Interaction (Late Breaking Report)*, Chicago, IL, March 2018.

- [7] Sahar Tavakoli\*, Alireza Hajibagheri\*, and Gita Sukthankar. Learning social graph topologies using generative adversarial neural networks. In *Proceedings of the International Conference on Social Computing, Behavioral-Cultural Modeling, and Prediction (Late Breaking)*, Washington, D.C., July 2017.
- [8] Sayyed Jaffar Ali Raza, Nitish A. Gupta, Gita Sukthankar, and Nisarg Chitalaya. Real-world modeling of path finding agent using robot operating system (ROS). In *Florida Conference on Recent Advances in Robotics*, Boca Raton, FL, May 2017.
- [9] Alireza Hajibagheri\*, Gita Sukthankar, and Kiran Lakkaraju. A holistic approach for predicting links in coevolving multiplex networks. In *ASONAM Workshop on Dynamics in Networks*, San Francisco, CA, August 2016.
- [10] Rey Coaguila\*, Gita Sukthankar, and Rahul Sukthankar. Trajectory planning for an autonomous quadcopter videographer. In *AAMAS Workshop on Autonomous Robots and Multi-robot Systems*, Singapore, May 2016.
- [11] Astrid Jackson\* and Gita Sukthankar. Learning continuous state-action models for humanoid robots. In *Florida Conference on Recent Advances in Robotics*, Melbourne, FL, May 2015.
- [12] Astrid Jackson\* and Gita Sukthankar. Learning whole body motions for humanoid robots from demonstration. In *CRA-W Grad Cohort Workshop*, San Francisco, CA, April 2015.
- [13] Alireza Hajibagheri\* and Gita Sukthankar. Political polarization over global warming: Analyzing Twitter data on climate change (poster). In *ASE International Conference on Social Computing*, Palo Alto, CA, May 2014.
- [14] Erfan Davami\* and Gita Sukthankar. Crowdsourcing parking lot occupancy using a mobile phone application (poster). In *ASE International Conference on Social Computing*, Palo Alto, CA, May 2014.
- [15] Bennie Lewis\* and Gita Sukthankar. Expert-novice differences in human-robot interaction. In *AAMAS Workshop on Autonomous Robots and Multi-robot Systems*, Paris, France, May 2014.
- [16] Liyue Zhao\*, Yu Zhang, and Gita Sukthankar. An active learning approach for jointly estimating worker performance and annotation reliability with crowdsourced data, 2014. <http://arxiv.org/pdf/1401.3836.pdf>.
- [17] Rahmatollah Beheshti\* and Gita Sukthankar. An agent-based transportation simulation of the UCF campus. In *Proceedings of SwarmFest*, Orlando, FL, July 2013.
- [18] Bennie Lewis\*, Bulent Tastan\*, and Gita Sukthankar. Adapting to expert-novice differences in human-robot interaction. In *AAMAS Workshop on Autonomous Robots and Multi-robot Systems*, pages 256–270, St. Paul, Minnesota, May 2013.
- [19] Peter Jacques, Claire Knox, and Gita Sukthankar. From Rio to Resistance: Direct observation of the climate denial counter-movement in social media. In *Proceedings of the International Studies Association National Convention*, San Francisco, April 2013.
- [20] Claire Knox, Peter Jacques, and Gita Sukthankar. Direct observation of climate-related narratives in social networks. In *Proceedings of the American Society for Public Administration Conference*, New Orleans, March 2013.
- [21] Claire Knox, Peter Jacques, and Gita Sukthankar. Climate change narratives in social networks: Case study using narrative policy framework and social amplification of risk framework. In *Proceedings of the Conference of the Midwest Political Science Association*, Chicago, April 2013.
- [22] Peter Jacques, Claire Knox, and Gita Sukthankar. Tweeting Sandy: Observed climate risk amplification before, during, and after hurricane Sandy. In *Proceedings of the National Conference on Science, Policy, and the Environment*, Washington, D.C., January 2013.
- [23] Bennie Lewis\* and Gita Sukthankar. Configurable human-robot interaction for multi-robot manipulation tasks. In *AAMAS Workshop on Autonomous Robots and Multi-robot Systems*, pages 51–70, Valencia, Spain, June 2012.
- [24] Bennie Lewis\* and Gita Sukthankar. Learning macros for multi-robot tasks. In *Florida Conference on Recent Advances in Robotics*, Boca Raton, FL, May 2012.

- [25] Mahsa Maghami\* and Gita Sukthankar. Influence maximization for advertising in multi-agent markets (extended abstract). In *Workshop on Complex Networks*, Melbourne, FL, March 2012.
- [26] Bulent Tastan\*, Yuan Chang\*, and Gita Sukthankar. Learning motion prediction models for opponent interception (abstract). In *Proceedings of Florida Artificial Intelligence Research Society*, Marco Island, FL, May 2012. (**Best Poster**).
- [27] Liyue Zhao\*, Gita Sukthankar, and Rahul Sukthankar. Robust active learning using crowdsourced annotations for activity recognition. In *AAAI Workshop on Human Computation*, pages 74–79, San Francisco, CA, Aug 2011.
- [28] Gita Sukthankar. Coupling plan recognition with plan repair for real-time opponent modeling. In Robert Goldman, Christopher Geib, Henry Kautz, and Tamim Asfour, editors, *Plan Recognition (Dagstuhl Seminar 11141)*, volume 1, page 19. Schloss Dagstuhl–Leibniz-Zentrum fuer Informatik, 2011.
- [29] Xi Wang\*, Mahsa Maghami\*, and Gita Sukthankar. A robust collective classification approach to trust evaluation. In *AAMAS Workshop on Trust in Agent Societies*, pages 125–139, Taipei, Taiwan, May 2011.
- [30] Sumit Jha and Gita Sukthankar. Modeling and verifying intelligent automotive cyber-physical systems. In *Workshop for Developing Dependable and Secure Automotive Cyber-Physical Systems*, Troy, Michigan, Mar 2011.
- [31] Fahad Shah\* and Gita Sukthankar. Using dialog for community detection in virtual worlds. In *Proceedings of the International Network for Social Network Analysis Sunbelt Conference*, St. Pete’s Beach, FL, Feb 2011. (extended abstract).
- [32] Gita Sukthankar. Imbuing human-robot teams with mutual predictability. In *Proceedings of the Lorentz Center Workshop on Human-Agent-Robot Teams*, Leyden, Netherlands, Dec 2010. (extended abstract).
- [33] Jeremiah Folsom-Kovarik\*, Sae Schatz, Gita Sukthankar, and Denise Nicholson. What information does this question convey? Leveraging help-seeking behavior for improved modeling in a simulation-based intelligent tutor. In *Proceedings of SpringSim Military Modeling and Simulation Symposium*, pages 26:1–26:8, Orlando, FL, Apr 2010.
- [34] Kennard Laviers\* and Gita Sukthankar. Improving offensive performance through opponent modeling, 2009. (nominated for **Best Student** video at the IJCAI-09 AI Video Competition).
- [35] Liyue Zhao\* and Gita Sukthankar. A semi-supervised method for segmenting multi-modal data. In *Proceedings of the International Symposium on Quality of Life Technology*, Pittsburgh, PA, June 2009.
- [36] Kennard Laviers\*, Gita Sukthankar, Matthew Klenk, David Aha, and Matthew Molineaux. Opponent modeling and spatial similarity to retrieve and reuse superior plays. In *Proceedings of the ICCBR Workshop on Case-Based Reasoning for Computer Games*, pages 29–44, Seattle, WA, July 2009.
- [37] Kennard Laviers\*, Gita Sukthankar, Matthew Molineaux, and David Aha. Exploiting early intent recognition for competitive advantage. In *Proceedings of the IJCAI Workshop on Plan, Activity, and Intent Recognition*, pages 58–63, Pasadena, CA, July 2009.
- [38] Bennie Lewis\* and Gita Sukthankar. RSARSim: A toolkit for evaluating HRI in robotic search and rescue tasks. In *Proceedings of Florida Conference on Recent Advances in Robotics*, Jupiter, FL, May 2009.
- [39] Joseph Giampapa, Katia Sycara, and Gita Sukthankar. Toward identifying process models in ad hoc and distributed teams. In *Proceedings of First International Working Conference on Human Factors and Computational Models in Negotiation*, Delft, Netherlands, June 2008.
- [40] Gita Sukthankar, Matt Molineaux, and David Aha. Recognizing and exploiting opponent intent in rush football. Technical Report AIC-09-062, Naval Research Lab, Navy Center for Applied Research in Artificial Intelligence, Washington, DC, 2008.
- [41] Gita Sukthankar, Katia Sycara, Joseph Andrew Giampapa, and Christopher Burnett. A model of human teamwork for agent-assisted search operations. In *Proceedings of Human Factors and Medicine Panel Symposium on Adaptability in Coalition Teamwork*, Copenhagen, Denmark, April 2008.

- [42] Gita Sukthankar and Katia Sycara. Automatic recognition of human team behaviors. In *Proceedings of the IJCAI Workshop on Modeling Others from Observations (MOO)*, Edinburgh, Scotland, July 2005.
- [43] Gita Sukthankar. The DynaDOOM visualization agent: A handheld interface for live action gaming. In *AAMAS Workshop on Ubiquitous Agents on Embedded, Wearable, and Mobile Devices*, Bologna, Italy, July 2002.

## Invited Talks

- “Social Modeling for Multi-agent Systems”, Örebro University (2018)
- “Does Biology Lead to the Absence of Women in Tech and Leadership Roles?”, UCF Diversity Week Panelist (2017)
- “Overview of Robotics Area”, Siemens (2017)
- “Data-driven Social Informatics”, UCF Cognitive Sciences Summer Lecture Series (2017)
- “Robotics and Artificial Intelligence: My Research Journey”, St. George’s School (2017)
- “Data-driven Social Informatics”, Virginia Tech (2017)
- “Analyzing Complex Multi-person Behaviors in Games”, AAAI Workshop on Plan, Activity, and Intent Recognition (2017)
- “Social Modeling for Multi-agent Systems”, International Conference on Collaboration Technologies and Systems (CTS 2016)
- “Data-driven Social Informatics”, Institute for Creative Technologies, USC (2016)
- “Analytics for Social-Computational Systems”, CECS Indian Community Fundraiser (2016)
- “Towards Analytics for RAP (Robots-Agents-People) Systems”, CMU Robotics Institute Seminar (2016)
- “Towards Analytics for RAP (Robots-Agents-People) Systems”, Lockheed Martin (2016)
- “Data-driven Social Informatics”, University of California, Santa Cruz (2016)
- “Social Modeling for Multi-agent Systems”, University of Southern California (2015)
- “Leveraging Social Features to Improve Classification Performance on Heterogeneous Networks”, PARC Machine Learning Group (2015)
- “Modeling Implicit Collaboration with Normative Agent Architectures”, International Conference on Collaboration Technologies and Systems (CTS 2015)
- “Synergies between AI in Games and Robotics”, NSF Workshop on Research Issues at Boundary of AI and Robotics (2015)
- “Introduction to AI and Robotics”, UCF STEM Day (2015)
- “Data-driven Social Informatics”, Sandia National Labs, HP Labs, PARC (2014)
- “Player Modeling and Game Analytics”, AAAI Spotlight and Senior Member Track (2013)
- “Practical Plan Recognition”, Symantec Lake Mary Retreat Keynote (2010)
- “Intention Recognition for Groups and Teams”, Cognitive Studies Student Association, University of Central Florida (2009)
- “Creating Social Systems”, EECS Industry Day, University of Central Florida (2009)
- “Robust and Efficient Multi-agent Plan Recognition”, Naval Research Lab (2008)
- “Activity Recognition for Agent Teams”, EECS Seminar, University of Central Florida (2008)
- Women@SCS Graduate Outreach: Harvey Mudd (2005), Columbia (2004), Princeton (2004), Georgia Tech (2003)
- “Handheld Interfaces for Live Action Gaming”, University of Tokyo (2002)
- “Open Source Software for Handheld Computing”, University of Toronto (2001)

## Patents

- [1] Rahul Sukthankar, Tat-Jen Cham, Gita Sukthankar, and James M. Rehg. Wireless multi-user multi-projector presentation system, 2003. U.S. Patent 7006055.

**Grants/Funding: \$2,904,146**

- Co-PI (40%) 8/2018–8/2019 Lockheed Martin ARI: Enhanced Learning Effectiveness of Augmented Reality Flight Trainers (**\$115,000.00**)
- Co-PI (20%) 8/2017–7/2021 DARPA SocialSim: Deep Agent: A Framework for Information Spread and Evolution in Social Networks (**\$6,556,538**)
- PI (100%) 7/2017–9/2017 Siemens University Professor Engagement Scouting Area Robotics (**\$35,436**)
- PI (100%) 1/2013–12/2013 DARPA CSSG (Phase 3): Crowdsourcing the Anticipatory Analysis of Human Movement (**\$170,373**)
- PI (50%) 6/2013–5/2014 In-house Grant: Acquisition of Robot Platforms for Research and Education in Human Robot Interaction (**\$108,441**)
- PI (100%) 5/2009–5/2014 NSF CAREER: Modeling Group Dynamics in Multi-agent Systems (**\$434,943**)
- PI (100%) 7/2010–8/2012 DARPA CSSG (Phase 2): Exploiting Social Context for the Anticipatory Analysis of Human Movement Systems (**\$400,000**)
- PI (100%) 1/2009–11/2012 AFOSR YIP: Improving Synthesis and Recognition of Crowded Scenes using Statistical Models of Group Behavior (**\$299,714**)
- PI (100%) 1/2009–12/2009 DARPA CSSG (Phase 1): Exploiting Psychological Models for Intent Inference (**\$100,000**)
- PI (100%) 8/2008–12/2010 QoLTC Subcontract with Carnegie Mellon University: An Evaluation of Psychologically-Grounded Models for Human Activity Recognition (**\$47,148**)
- PI (100%) 5/2009–6/2011 In-house Grant: Psychological Models for Intent Inference (**\$5004**)

## Non-Research Funding

- PI (100%) 02/2017 NVIDIA GPU Grant
- PI (50%) 10/2016 AIJ: Student Travel Support for the AAAI Symposium Series (**\$7590**)
- PI (50%) 5/2016 AIJ: Student Travel Support for the AAAI Symposium Series (**\$7986**)
- PI (50%) 7/2015 AIJ: Student Travel Support for the AAAI Symposium Series (**\$7876**)
- PI (50%) 12/2014 NSF: Doctoral Mentoring Consortium at the Fourteenth International Conference on Autonomous Agents and Multi-Agent Systems (**\$20000**)
- PI (50%) 7/2014 AIJ: Student Travel Support for the AAAI Symposium Series (**\$3750**)

## Professional Activities

### Service to the Department

- Disability, Aging, and Technology Faculty Search Committee (Cluster Chair) (2019)
- Disability, Aging, and Technology Faculty Search Committee (Engineering) (2019)
- Chair, Technical Research Area Committee (Artificial Intelligence and Machine Learning) (2018)
- Chair, CS Faculty Search Committee (2018)
- EECS Awards Committee (2009, 2010)
- EECS Graduate Committee (2009, 2010, 2011, 2012, 2013, 2014, 2016, 2017, 2018)
- EECS Faculty Search Committee (2009)
- EECS (CS) Website Committee (2013)
- EECS (CS) Cumulative Progress Evaluation Committee (2013, 2014, 2017, 2018)
- University Research Council (2014)
- CRCV Faculty Search Committee (2014)
- EECS Faculty Search Committee (2014)
- CECS Internal Peer Review Panel (2014, 2016)
- CECS RIA Committee (2014)
- CECS Sabbatical Committee (2017, 2018, 2019)
- UCF Taskforce to Advance Interdisciplinary Efforts in Modeling, Simulation, and Training (2015)
- External Reviewer, Virginia Tech Bioinformatics Institute Faculty Advisory Committee (2015)
- External Reviewer, NC State Hiring Committee (2016)



- External Reviewer, Ariel University (Israel) Promotion Committee (2017)

### **Service to the Profession**

- General chair, International Conference on Autonomous Agents and Multi-agent Systems (2020)
- Reviewer, IEEE International Conference on Intelligent Robots and Systems (2019)
- Program committee, AAAI Workshop on Plan, Activity, and Intent Recognition (2019)
- Chair, IFAAMAS Special Track Committee (2018)
- Editorial Review Board Member, Springer International Journal of Applied Intelligence (2018)
- Member of IFAAMAS Board of Directors (2016–2022)
- Program chair, International Conference on Autonomous Agents and Multi-agent Systems (2018)
- Invited Panelist, Artificial Intelligence and Augmented Cognition in the US Air Force of 2030 (2018)
- Reviewer, ACM/IEEE International Conference on Human-Robot Interaction (Late-Breaking Reports) (2018)
- Program committee, AAAI Senior Member Presentation Track (2018)
- Chair, AAAI Symposia Series (2016–2017)
- Organizing committee (Workshops), International Conference on Autonomous Agents and Multi-agent Systems (2017)
- Organizing committee, ISAT Workshop on Symbiotic Architectures for Social Simulation (2016)
- Co-chair, Workshop track, International Joint Conference on Artificial Intelligence (2016)
- Member of DARPA ISAT advisory group (2015–2018)
- Senior program committee, International Joint Conference on Artificial Intelligence (2015, 2017, 2019)
- Program committee, International Conference on Social Computing, Behavioral-Cultural Modeling and Prediction (2015)
- Organizing committee (Student Scholarships), International Conference on Autonomous Agents and Multi-agent Systems (2015)
- Organizing committee, AAMAS Workshop on Agents, Virtual Societies, and Analytics (2014)
- Program committee, AAMAS Workshop on Autonomous Robots and Multirobot Systems (2014)
- Area chair, International Conference on Social Computing, Behavioral-Cultural Modeling and Prediction (2014)
- Senior program committee, International Conference on the Foundations of Digital Games (2014)
- Senior program committee, International Conference on Autonomous Agents and Multi-agent Systems (2014, 2015, 2019)
- Program committee, International Conference on Intelligent User Interfaces (2014)
- General chair, AI and Interactive Entertainment (2013)
- Member, IEEE Computational Intelligence Society Technical Committee on Games (2013)
- Organizing committee, AAMAS Workshop on Multiagent Interaction Networks (2013)
- Senior program committee, AAAI Conference on Artificial Intelligence (2013, 2014)
- Program chair, AI and Interactive Entertainment (2012)
- Co-chair, AAAI Symposia Series (2012–2015)
- Program committee, Ubicomp Workshop on Situation, Activity, and Goal Awareness (2012)
- Program committee, ASE/IEEE International Conference on Social Informatics (2012)
- Program committee, International Conference on Principles and Practice of Multi-Agent Systems (2012)
- Program committee, ASE/IEEE International Conference on Social Computing (2012, 2013)
- Program committee, AAAI Conference on Artificial Intelligence (2012, 2015, 2016, 2017, 2019)
- Program committee, International Joint Conference on Ambient Intelligence (2011)
- Program committee, AI and Interactive Entertainment (2011)
- Program committee, International Joint Conference on Artificial Intelligence (2011)
- Program committee, ICAPS Workshop on Goal, Activity, and Plan Recognition (2011)
- Organizing committee, AAAI Symposium on Proactive Assistant Agents (2010)
- Organizing committee, AAAI Workshop on Plan, Activity, and Intent Recognition (2010, 2011, 2013)
- Program committee, Conference of the Florida AI Research Society (2010, 2011, 2012)
- Associate editor, IEEE International Conference on Intelligent Robots and Systems (2010, 2015)

- Program committee, IEEE Computational Intelligence in Games (2010, 2012)
- Organizing committee (Doctoral Mentoring), International Conference on Autonomous Agents and Multi-agent Systems (2010, 2016)
- Organizing committee, IJCAI Workshop on Plan, Activity, and Intent Recognition (2009)
- Publication chair, Pacific Rim International Conference on Multi-agents (2009)
- Program committee, IEEE/ACM International Conference on Intelligent Agent Technology (2009, 2010, 2011, 2012)
- Program committee, Foundation for Digital Games (2009, 2010)
- Program committee, AAAI, IJCAI Video Competition (2008, 2009, 2010, 2011)
- Program committee, AAAI Workshop on Modeling Others from Observations (2007)
- Doctoral mentor, International Conference on Autonomous Agents and Multi-agent Systems (2012, 2014)
- Program committee, International Conference on Autonomous Agents and Multi-agent Systems (2006, 2007, 2008, 2009, 2011, 2012, 2013, 2016)
- Program committee, International Conference on Autonomous Agents and Multi-agent Systems, Demo Track (2013)
- Member of National Center for Women in Information Technology (NCWIT) Academic Alliance
- Organizing committee, Conference for Undergraduate Women in Computer Science (2007)
- Editorial board, ASE Human Journal (2013-onward)
- Reviewer, IEEE Transactions on Robotics (2018)
- Reviewer, Knowledge Engineering Review (2016, 2017)
- Reviewer, PLOS ONE (2016)
- Reviewer, ACM Transactions on Intelligent Systems and Technology (2015, 2016)
- Reviewer, International Transactions on Operational Research (2015)
- Reviewer, IEEE Transactions on Pattern Analysis and Machine Intelligence (2014)
- Reviewer, Lecture Notes in Social Networks (2014)
- Reviewer, ACM CHI Conference on Human Factors in Computing Systems (2014)
- Reviewer, Data Mining and Knowledge Discovery (2014)
- Reviewer, Social Network Analysis and Mining Journal (2013)
- Reviewer, IEEE Transactions on Computational Intelligence and AI in Games (2013)
- Reviewer, Neural Networks (2011)
- Reviewer, IEEE Systems, Man, and Cybernetics (2010, 2011, 2012)
- Reviewer, IEEE Pervasive Computing (2009)
- Reviewer, The Computer Journal (2009)
- Reviewer, Artificial Intelligence Journal (2008)
- Reviewer, IEEE Pervasive Computing (2007)
- Reviewer, Journal of Artificial Intelligence Research (2006, 2007, 2008)
- Reviewer, Journal of Autonomous Agents and Multi-agent Systems (2006, 2007, 2008, 2010, 2013, 2018)
- Reviewer, International Conference on Mobile Systems, Applications, and Services (2004)
- Reviewer, AFOSR (2009, 2010)
- Reviewer, NSF (2009)
- Panelist, NSF (2008, 2010, 2011, 2011, 2012, 2014, 2015, 2016, 2017, 2019)

#### **Thesis Committee Service**

- Peta Masters, (Ph.D., RMIT, Australia 2019)
- Reuth Mirsky, (Ph.D., Ben Gurion University of Negev, Israel 2019)
- Ahmed Hemida, (Ph.D., University of Central Florida 2019)
- Mahdi Kalayeh, (Ph.D., University of Central Florida 2019)
- Justin Pugh, (Ph.D., University of Central Florida 2019)
- Awrad Mohammed Ali, (Ph.D., University of Central Florida 2019)
- Kangsoo Kim, (Ph.D., University of Central Florida 2018)
- Behnaz Nojavanasghari, (Ph.D., University of Central Florida 2017)

- Sarah Buchanan, (Ph.D., University of Central Florida 2017)
- Nidhi Parikh, (Ph.D., Virginia Tech 2017)
- Roghayeh (Leila) Barmaki, (Ph.D., University of Central Florida 2016)
- Taranjeet Bhatia, (Ph.D., University of Central Florida 2016)
- Syed Muhammad Ali, (Ph.D., University of Central Florida 2016)
- Yinjie Huang, (Ph.D., University of Central Florida 2016)
- James Hollister, (Ph.D., University of Central Florida 2016)
- Saad Khan, (Ph.D., University of Central Florida 2015)
- Nader Hanna, (Ph.D., Macquarie University (Australia) 2015)
- Reza Akhavian, (Ph.D., University of Central Florida 2015)
- Salman Cheema, (Ph.D., University of Central Florida 2014)
- Sean Mondesire, (Ph.D., University of Central Florida 2014)
- Kevin Pfeil, (M.S., University of Central Florida 2013)
- Yang Yang, (Ph.D., University of Central Florida 2013)
- John Reeder, (Ph.D., University of Central Florida 2013)
- Brent Horine, (Ph.D., University of Central Florida 2012)
- Kishore Reddy, (Ph.D., University of Central Florida 2012)
- Sebastian Risi, (Ph.D., University of Central Florida 2012)
- Ramin Mehran, (Ph.D., University of Central Florida 2011)
- Philip Verbancsics, (Ph.D., University of Central Florida 2011)
- Paul Scovanner, (Ph.D., University of Central Florida 2011)
- Rawad Haddad, (Ph.D., University of Central Florida 2011)
- David d' Ambrosio, (Ph.D., University of Central Florida 2011)
- Cynthia Johnson, (Ph.D., University of Central Florida 2011)
- Feras Batarseh, (Ph.D., University of Central Florida 2011)
- Daniele Masato, (Thesis Proposal Evaluation, University of Aberdeen 2010)
- Miguel Elvir, (M.S., University of Central Florida 2010)
- Jason Gauci, (Ph.D., University of Central Florida 2010)
- Jennifer Gage, (Ph.D., University of South Florida 2009)
- Yusuf Aytar, (M.S., University of Central Florida 2008)
- Matthew Howard (M.S., University of Central Florida 2008)

## **Selected Awards and Honors**

- St. George's School John B. Diman Alumni Award (2017)
- IFAAMAS Board of Directors (2016)
- DARPA ISAT Advisory Group (2015)
- UCF Reach for the Stars (2015)
- ACM Senior Member (2013)
- UCF Research Incentive Award (2013)
- CECS Dean's Research Professorship Award (2013)
- UCF Faculty Excellence for Doctoral Mentoring (Engineering and Sciences) (2012)
- IEEE Senior Member (2012)
- UCF CECS Distinguished Researcher Award (2011)
- Charles N. Millican Faculty Fellow (2010, 2012)
- NSF CAREER Award (2009)
- AFOSR Young Investigator (2009)
- ONR Summer Faculty Fellowship (2008)
- Short list for best paper: International Conference on Autonomous Agents and Multi-agent Systems, Innovative Applications (2015)
- Best poster: International Conference on Advances in Social Networks Analysis and Data Mining (2013)

- Best poster: International FLAIRS Conference (2012)
- Best student paper: International Conference on Autonomous Agents and Multi-Agent Systems (2005)
- Recommended reading list: Behavior Representation in Modeling and Simulation (2004 and 2005)

# Curriculum Vitae

**QIYU SUN**

Department of Mathematics

University of Central Florida, Orlando, FL 32816

Phone: 407-823-4839; Email: [qiyu.sun@ucf.edu](mailto:qiyu.sun@ucf.edu)

Website: <http://sciences.ucf.edu/math/qsun/>



## One Page CV

## I. GENERAL INFORMATION

- I earned PhD in 1990, joined the University of Central Florida in 2003, and was promoted to Professor in 2013.
- I am working on applied and computational harmonic analysis, sampling theory and mathematical signal processing.

## II. PUBLICATIONS

- I have published more than 100 journal papers on various journals, including *Advances in Mathematics*, *Applied and Computational Harmonic Analysis*, *IEEE Transaction on Image Processing/Information Theory/Signal Processing*, *Journal of Functional Analysis*, *Memoirs/Transaction of American Mathematical Society*, *SIAM Journal on Mathematical Analysis/Control and Optimization*, etc
- My publications have been cited 956 times by 513 authors according to MathSciNet of the American Mathematical Society, and 2661 times according to Google Scholar.

## III. PRESENTATIONS

- I gave more than 100 presentations of various types, including keynote/plenary talks, colloquia and lecture series.

## IV. GRANTS and AWARDS

- My research is funded by the National Science Foundation (DMS-1109063, DMS-1412413 and DMS-1816313).
- Recipient of the 2019 SIAG/CST Best SICON Paper Prize.
- Recipient of UCF Research Incentive Awards, 2016-17

## V. EDUCATIONAL ACTIVITIES

- I taught various courses from lower undergraduate to graduate level. I have supervised one postdoc, five PhD students and one master student at the University of Central Florida.

## VI. SERVICES

- I was on the editorial board of journals “*Advances in Computational Mathematics*” (2006–2013), “*Numerical Functional Analysis and Optimization*” (2010–), “*Sampling Theory in Signal and Imaging Processing*” (2013–) and “*Frontiers in Applied Mathematics and Statistics*” (2015–).
- I reviewed journal paper submissions, grant proposals, promotion and tenure dossiers, etc.
- I am currently coordinator of the math graduate program. I have served and chaired on committees at departmental and university levels.

## I: GENERAL INFORMATION

### Education

- **Ph.D.** in Mathematics, Hangzhou University, China, 1990.  
Dissertation: “Singular Integral Operator and Related Topics”.  
Thesis Supervisor: Professor Xianliang Shi.
- **B.S.** in Mathematics, Hangzhou University, China, 1985.

### Professional Experience

- **Professor**, Department of Mathematics, University of Central Florida, 2013.8–; Graduate coordinator, 2015.8–
- **Associate Professor**, Department of Mathematics, University of Central Florida, 2008.8 – 2013.7
- **Visited Professor**, School of Computer and Communication Sciences, Ecole Polytechnique Federale de Lausanne, 2010.1–2010.5
- **Visiting Associate Professor**, Department of Mathematics, Vanderbilt University, 2009.8–2009.12
- **Assistant Professor**, Department of Mathematics, University of Central Florida, 2003.8 – 2008.7.
- **Postdoctoral Fellow**, Department of Chemistry, University of Houston, 2003.1 – 2003.7; 2002.5 – 2002.7.
- **Visiting Assistant Professor**, Department of Mathematics, Vanderbilt University, 2002.8 – 2002.12.
- **Research Fellow**, Department of Mathematics, National University of Singapore, 1998.3 – 2002.5.
- **Lecturer to Associate Professor**, Department of Mathematics, Zhejiang University, 1990 – 1998.

### Research Interests

Applied and Computational Harmonic Analysis, Sampling Theory, Mathematical Signal Processing, and Control Theory

## II: PUBLICATIONS

I have published 117 refereed journal articles, 1 monograph, 19 refereed conference proceeding papers or book chapter, 2 non-refereed conference proceeding papers and 2 research announcements.

### Monograph

1. Qiyu Sun, Ning Bi and Daren Huang, *An Introduction to Multiband Wavelets*, Zhejiang University Press, China, 2001.

### Refereed Journal Articles

- (1) Cheng Cheng, Yingchun Jiang and Qiyu Sun, Spatially distributed sampling and reconstruction, *Applied and Computational Harmonic Analysis*, accepted.
- (2) Yang Chen, Cheng Cheng, Qiyu Sun and Haichao Wang, Phase retrieval of real-valued signals in a shift-invariant space, *Applied and Computational Harmonic Analysis*, accepted.
- (3) Cheng Cheng, Junzheng Jiang and Qiyu Sun, Phaseless Sampling and Reconstruction of Real-Valued Signals in Shift-Invariant Spaces *Journal of Fourier Analysis and Applications*, accepted.
- (4) Chang Eon Shin and Qiyu Sun, Polynomial control on stability, inversion and powers of matrices on simple graphs, *Journal of Functional Analysis*, **276**(2019), 148–182.
- (5) B. Gao, Q. Sun, Y. Wang and Z. Xu, Phase retrieval from the magnitudes of affine linear measurements, *Advances in Applied Mathematics*, **93**(2018), 121–141.
- (6) Yang Chen, Cheng Cheng and Qiyu Sun, A phaseless reconstruction algorithm for real-valued signals in a shift-invariant space, *Scientia Sinica Mathematica*, **48**(2018), 1237–1252.
- (7) Qiyu Sun and Wai-Shing Tang, Nonlinear frames and sparse reconstructions in Banach spaces *Journal of Fourier Analysis and Applications*, **23**(5)(2017), 1118–1152.
- (8) Nader Motee and Qiyu Sun, Sparsity and Spatial Localization Measures for Spatially Distributed Systems, *SIAM Journal on Control and Optimization*, **55** (1)(2017), 200–235.
- (9) Brian Millikan, Aritra Dutta, Qiyu Sun and Hassan Foroosh, Fast detection of compressively-sensed IR targets using stochastically trained least squares and compressed quadratic correlation filters, *IEEE Transactions on Aerospace and Electronic System*, **53**(5)(2017), 2449–2461.



- (10) Syad A. Abbas, Qiyu Sun and Hassan Foroosh, An exact and fast computation of discrete Fourier transform for polar and spherical grid, *IEEE Transactions on Signal Processing* **65** (8)(2017), 2033–2048.
- (11) Lan Li, Cheng Cheng, Deguang Han, Qiyu Sun and Guangming Shi, Phase retrieval from multiple-window short-time Fourier measurements *IEEE Signal Processing Letter*, **24** (4)(2017), 372–376.
- (12) Xin-rong Dai and Qiyu Sun, The *abc*-problem for Gabor systems, *Memoirs of American Mathematical Society*, **244**(1152)(2016), 1–109.
- (13) Cheng Cheng, Yingchun Jiang and Qiyu Sun, Sampling and Galerkin reconstruction in reproducing kernel spaces, *Applied and Computational Harmonic Analysis*, **41**(2)(2016), 638–659.  
129, 6781
- (14) Yang Chen, Qiquan Fang and Qiyu Sun, Spectra of Bochner-Riesz means on  $L^p$ , *Numerical Functional Analysis and Optimization*, **37**(2016), 1203–1212.
- (15) Syed Alam Abbas, Qiyu Sun and Hassan Foroosh, Frequency estimation of sinusoids from nonuniform samples, *Signal Processing*, **129**(2016), 67–81.
- (16) Xin-rong Dai and Qiyu Sun, Spectral measures with arbitrary Hausdorff dimensions, *Journal of Functional Analysis*, **268**(2015), 2464–2477.
- (17) Yang Chen, Cheng Cheng and Qiyu Sun, Reconstruction of sparse wavelet signals from partial Fourier measurements, *IEEE Signal Processing Letter*, **22**(2015), 2299–2303.
- (18) Qiyu Sun, Localized nonlinear functional equations and two sampling problems in signal processing, *Advances in Computational Mathematics*, **40**(2014), 415–458.
- (19) Michael Unser, Pouya D. Tafti and Qiyu Sun, A unified formulation of Gaussian vs. sparse stochastic process – Part I, *IEEE Transaction on Information Theory*, **60**(2014), 1945–1962.
- (20) Dorin E. Dutkay, Deguan Han and Qiyu Sun, Divergence of mock and scrambled Fourier series on fractal measures, *Transaction of American Mathematical Society*, **366**(2014), 2191–2208.
- (21) Qiyu Sun and Jun Xian, Rate of innovation for (non-)periodic signals and optimal lower stability bound for filtering, *Journal of Fourier Analysis and Applications*, **20**(2014), 119–134.

- (22) Qiquan Fang, Chang Eon Shin and Qiyu Sun, Wiener's lemma for singular integral operators of Bessel potential type, *Monatshefte für Mathematik*, **173**(2014), 35–54.
- (23) M. Z. Nashed, Qiyu Sun and Jun Xian, Convolution sampling of signals in a reproducing kernel subspace, *Proceeding of American Mathematical Society*, **141**(2013), 1995–2007.
- (24) Chang Eon Shin and Qiyu Sun, Wiener's lemma: localization and various approaches, *Applied Mathematics-A Journal of Chinese Universities*, **28**(2013), 465484
- (25) Qiyu Sun, Recovery of sparsest signals via  $\ell^q$ -minimization, *Applied and Computational Harmonic Analysis*, **32**(2012), 329–341.
- (26) Qiyu Sun and Michael Unser, Left-inverse of fractional Laplacian and sparse stochastic processes, *Advances in Computational Mathematics*, **36**(2012), 399–441.
- (27) Kyung Soo Rim, Chang Eon Shin and Qiyu Sun, Stability of localized integral operators on weighted  $L^p$  spaces, *Numerical Functional Analysis and Optimization*, **33**(2012), 1166–1193.
- (28) Akram Aldroubi, Qiyu Sun and Haichao Wang, Uncertainty principles and Balian-Low type theorems in principal shift-invariant spaces, *Applied and Computational Harmonic Analysis*, **30**(2011), 337–347.
- (29) Deguang Han, Qiyu Sun and Wai-Shing Tang, Topological and geometric properties of refinable functions and MRA affine frames, *Applied and Computational Harmonic Analysis*, **30**(2011), 151–174.
- (30) Qiyu Sun, Wiener's lemma for infinite matrices II, *Constructive Approximation*, **34**(2011), 209–235.
- (31) Dorin Ervin Dutkay, Deguang Han, Qiyu Sun, and Eric Weber, On the Beurling dimension of exponential frames, *Advances in Mathematics*, **226**(2011), 285–297.
- (32) Qiyu Sun, Sparse approximation property and stable recovery of sparse signals from noisy measurements, *IEEE Trans. Signal Processing*, **10**(2011), 5086–5090.
- (33) M. Zuhair Nashed and Qiyu Sun, Sampling and reconstruction of signals in a reproducing kernel subspace of  $L^p(\mathbb{R}^d)$ , *Journal of Functional Analysis*, **258**(2010), 2422–2452.
- (34) Qiyu Sun, Local reconstruction for sampling in shift-invariant space, *Advances in Computational Mathematics*, **32**(2010), 335–352.

- (35) Qiyu Sun, Stability criterion for convolution-dominated infinite matrices, *Proceeding of American Mathematical Society*, **138**(2010), 3933-3943.
- (36) Dorin Ervin Dutkay, Deguang Han, and Qiyu Sun, On the spectra of a Cantor measure, *Advances in Mathematics*, **221**(2009), 251–276.
- (37) Chang Eon Shin and Qiyu Sun, Stability of localized operators, *Journal of Functional Analysis*, **256**(2009), 2417–2439.
- (38) M. Zuhair Nashed, Qiyu Sun and Wai-Shing Tang, Average sampling in  $L^2$ , *C. Acad. Sci. Paris, Ser I*, **347**(2009), 1007–1010.
- (39) Ning Bi, M. Zuhair Nashed, and Qiyu Sun, Reconstructing signals with finite rate of innovation from noisy samples, *Acta Applicandae Mathematicae*, **107**(2009), 339–372.
- (40) Deguang Han, M. Zuhair Nashed, and Qiyu Sun, Sampling expansions in reproducing kernel Hilbert and Banach spaces, *Numerical Functional Analysis and Optimization*, **30**(2009), 971–987.
- (41) Qiyu Sun, Wiener’s lemma for localized integral operators, *Applied and Computational Harmonic Analysis*, **25**(2008), 148–167.
- (42) Qiyu Sun, Frames in spaces with finite rate of innovation, *Advances in Computational Mathematics*, **28**(2008), 301-329.
- (43) Dorin Ervin Dutkay, Deguang Han, Gabriel Picioroaga and Qiyu Sun, Orthonormal dilations of Parseval wavelets, *Mathematische Annalen*, **341**(2008), 483-515.
- (44) Akram Aldroubi, Casey Leonetti, and Qiyu Sun, Error analysis of frame reconstruction from noisy samples, *IEEE Transactions on Signal Processing*, **56**(2008), 2311–2325.
- (45) X. Wang, Q. Sun, R. Eastes, B. Reinisch, C. E. Valladares, Short-term relationship of total electron content with geomagnetic activity in equatorial regions, *J. Geophys. Res.*, **113**(2008), A11308, pp. 1–7.
- (46) Qiyu Sun, Wiener’s lemma for infinite matrices, *Transactions of the American Mathematical Society*, **359**(2007), 3099–3123.
- (47) Ning Bi, Qiyu Sun, Daren Huang, Zhihua Yang and Jiwu Huang, Robust image watermarking based on multiband wavelets and empirical mode decomposition, *IEEE Transactions on Image Processing*, **16**(2007), 1956–1966.
- (48) Yanfei Wang, Zaiwen Wen, Zuhair Nashed, and Qiyu Sun, On direct methods for time-limited signal and image reconstruction

- and enhancement, *International Journal of Wavelets, Multiresolution and Information Processing*, **5**(2007), 51–68.
- (49) C. K. Chui and Qiyu Sun, Tight over-sampled affine frame system and over-sampling rates, *Applied and Computational Harmonic Analysis*, **22**(2007), 1–15.
- (50) Charles A. Micchelli and Qiyu Sun, Interpolating filters with prescribed zeros and their refinable functions, *Communication on Pure and Applied Analysis*, **6**(2007), 789–808.
- (51) Qiyu Sun, Non-uniform average sampling and reconstruction of signals with finite rate of innovation, *SIAM Journal of Mathematical Analysis*, **38**(2006), 1389–1422.
- (52) C. K. Chui and Qiyu Sun, Affine frame decompositions and shift-invariant spaces, *Applied and Computational Harmonic Analysis*, **20**(2006), 74–107.
- (53) B. G. Bodmann, M. Papadakis, and Qiyu Sun, An inhomogeneous uncertainty principle for digital low-pass filters, *Journal of Fourier Analysis and Applications*, **12**(2006), 181–211.
- (54) Xiaojie Gao, S. L. Lee and Qiyu Sun, Eigenvalues and biorthogonal eigensystems of scaling operators, *Proceeding of American Mathematical Society*, **134**(2006), 1051–1057.
- (55) Yanfei Wang, Zaiwen Wen, Zuhair Nashed, and Qiyu Sun, Direct fast method for time-limited signal reconstruction, *Applied Optics*, **45**(2006), 3111–3126.
- (56) Akram Aldroubi, Qiyu Sun and Wai-shing Tang, Convolution, average sampling, and a Calderon resolution of the identity for shift-invariant spaces, *Journal of Fourier Analysis and Applications*, **22**(2005), 215–244.
- (57) Qiyu Sun, Wiener’s lemma for infinite matrices with polynomial off-diagonal decay, *Comptes Rendus Mathematique*, **340**(2005), 567–570.
- (58) Qiyu Sun, Local dual and poly-scale refinability, *Proceeding of American Mathematical Society*, **133**(2005), 1175–1184.
- (59) Lixin Shen and Qiyu Sun, Bi-orthogonal wavelet system for high-resolution image reconstruction, *IEEE Transaction on Signal Processing*, **52**(2004), 1997–2011.
- (60) Akram Aldroubi, Qiyu Sun and Wai-Shing Tang, Non-uniform average sampling and reconstruction in multiply generated shift-invariant spaces, *Constructive Approximation*, **20**(2004), 173–189.

- (61) Tim N. T. Goodman and Qiyu Sun, Total positivity and refinable functions with general dilation, *Applied and Computational Harmonic Analysis*, **16**(2004), 69–89.
- (62) D. Hardin, T. Hogan and Qiyu Sun, The matrix-valued Riesz lemma and local orthonormal bases in shift-invariant spaces, *Advance in Computational Mathematics*, **20**(2004), 367–384.
- (63) C. K. Chui, W. He, J. Stoeckler and Qiyu Sun, Compactly supported tight affine frames with integer dilations and maximum vanishing moments, *Advance in Computational Mathematics*, **18**(2003), 159–187.
- (64) C. K. Chui and Qiyu Sun, Tight frame oversampling and its equivalence to shift-invariance of affine frame operators, *Proceeding of American Mathematics*, **131**(2003), 1527–1538.
- (65) Qiyu Sun, Convergence of cascade algorithms and smoothness of refinable distributions, *Chinese Annals of Mathematics*, **24**(2003), 367–386.
- (66) Akram Aldroubi and Qiyu Sun, Locally finitely dimensional shift-invariant spaces in  $\mathbb{R}^d$ , *Proceeding of American Mathematical Society*, **130**(2002), 2641–2654.
- (67) Qiyu Sun,  $M$ -band scaling functions with minimal support are asymmetric, *Applied and Computational Harmonic Analysis*, **12**(2002), 166–170.
- (68) Xinrong Dai, Daren Huang and Qiyu Sun, Local polynomial property and linear independence of refinable distributions, *Archiv der Mathematik*, **78**(2002), 74–80.
- (69) C. A. Micchelli and Qiyu Sun, Refinable functions from their values at integers, *Vietnam Journal of Mathematics*, **30**(2002), 395–411.
- (70) Guoen Hu, Qiyu Sun and Xin Wang,  $L^p(\mathbb{R}^n)$  bounds for commutators of convolution operators, *Colloquium Mathematicum*, **93**(2002), 11–20.
- (71) Akram Aldroubi, Qiyu Sun and Wai-Shing Tang,  $p$ -frames and shift-invariant subspaces of  $L^p$ , *Journal of Fourier Analysis and Applications*, **7**(2001), 1–21.
- (72) Qiyu Sun, Stability of the shifts of global supported distributions, *Journal of Mathematical Analysis and Applications*, **261**(2001), 113–125.
- (73) Qiyu Sun, Compactly supported distributional solutions of non-stationary nonhomogeneous refinement equations, *Acta Mathematica Sinica, English Series*, **17**(2001), 1–14.

- (74) Ai-Hua Fan and Qiyu Sun, Regularity of Butterworth refinable functions, *Asia Journal of Mathematics*, **5**(2001), 433–440.
- (75) Qiyu Sun, Convergence and boundedness of cascade algorithm in Besov spaces and Triebel-Lizorkin spaces: Part II , *Advance in Mathematics (China)*, **30**(2001), 22–36.
- (76) Daren Huang, Yunzhang Li and Qiyu Sun, Multivariate subdivision schemes in  $L^p$ -spaces. *Advance in Mathematics (China)*, **30**(2001), 525–532.
- (77) Qiyu Sun, Linear independence of the integer translates of compactly supported distributions and refinable vectors. *Appl. Math. J. Chinese Univ. Ser. B*, **16**(2001), 381–396.
- (78) Guoen Hu and Qiyu Sun,  $L^p(\mathbb{R}^n)$  boundedness for the commutators of convolution operators. *Chinese Annal of Mathematics, Ser. A* **22**(2001), 509–516. English translation in *Chinese Journal of Contemporary Mathematics*, **22**(2001), 289–298.
- (79) K. S. Lau and Qiyu Sun, Asymptotic regularity of Daubechies' scaling functions, *Proceeding of American Mathematical Society*, **128**(2000), 1087–1095.
- (80) Xinrong Dai, Qiyu Sun and Zeyin Zhang, Compactly supported both  $m$  and  $n$  refinable distributions, *East Journal of Approximations*, **6**(2000), 201–209.
- (81) Qiyu Sun, Convergence and boundedness of cascade algorithm in Besov spaces and Triebel-Lizorkin spaces, Part I, *Advance in Mathematics (China)*, **29**(2000), 507–526.
- (82) Guoen Hu, Bolin Ma and Qiyu Sun, Boundedness of the multiple singular integral operators on product spaces, *Hokkaido Mathematical Journal*, **29**(2000), 659–667.
- (83) Qiyu Sun, Sobolev exponent estimate and asymptotic regularity of  $M$  band Daubechies' scaling functions, *Constructive Approximation*, **15**(1999), 441–465.
- (84) Ning Bi, Xinrong Dai and Qiyu Sun, Construction of compactly supported  $M$  band wavelets, *Applied and Computational Harmonic Analysis*, **6**(1999), 113–131.
- (85) Bolin Ma and Qiyu Sun, Compactly supported refinable distribution in Triebel-Lizorkin spaces and Besov spaces, *Journal of Fourier Analysis and Applications*, **5**(1999), 87–104.
- (86) Qiyu Sun and Zeyin Zhang, A characterization of compactly supported both  $m$  and  $n$  refinable distribution, *Journal of Approximation Theory*, **99**(1999), 198–216.

- (87) Daren Huang, Yunzhang Li and Qiyu Sun, Refinable function and refinement mask with polynomial and exponential decay, *Chinese Annal of Mathematics*, **20A**(1999), 483–488.
- (88) Daren Huang and Qiyu Sun, Affine similarity of refinable functions, *Approximation Theory and its Applications*, **15(3)**(1999), 81–91.
- (89) Xianliang Shi and Qiyu Sun, A class of M-dilation scaling functions with regularity growing proportionally to filter support width, *Proceeding of American Mathematical Society*, **126**(1998), 3501–3506.
- (90) Qiyu Sun and Zeyin Zhang, M-band scaling function with filter having vanishing moments two and minimal length, *Journal of Mathematical Analysis and Applications*, **222**(1998), 225–243.
- (91) Youming Liu, Qiyu Sun and Daren Huang Some extension of Paley-Wiener theorem, *Chinese Annual of Mathematics*, **19B**(1998), 331–340.
- (92) Ning Bi, Lokenath Debnath and Qiyu Sun, Asymptotic behavior of M-band scaling functions of Daubechies type, *Zeitschrift fur Analysis und ihe Anwendungen*, **17**(1998), 813–830.
- (93) Ning Bi and Qiyu Sun, Linear independence of refinable distributions supported on  $[0, 2] \times [0, 2]$ , *Acta Mathematica Applicatae Sinica(English Ser.)*, **14**(1998), 388–395.
- (94) Li-Yuan Chen and Qiyu Sun, Behavior of an oscillatory singular integral on weighted local Hardy spaces, *Acta Math. Sinica (N.S.)*, **13**(1997), 305–320.
- (95) Daren Huang, Qiyu Sun and Zeyin Zhang, Integral representation of M-band Daubechies type, *Chinese Sciences Bulletin*, **42**(1997), 803–807.
- (96) Daren Huang, Qiyu Sun and Wei Wang, Multiresolution generated by several scaling functions, *Advances in Mathematics (China)*, **26**(1997), 165–180.
- (97) Qiyu Sun, Refinable functions with compact support, *Journal of Approximation Theory*, **86**(1996), 240–252.
- (98) Xinrong Dai, Daren Huang and Qiyu Sun, Some properties of five-coefficient refinement equation, *Archiv der Mathematique*, **66**(1996), 299–309.
- (99) Qiyu Sun and Yanzhang Zheng, A compactly supported orthonormal wavelet of non-tensor type, *Applied Mathematics, A Journal of Chinese Universities*, **11B**(1996), 243–246.
- (100) Qiyu Sun, A new kind of space of Triebel-Lizorkin type, *Approximation Theory and its Application*, **12:2**(1996), 80–84.

- (101) Quande Chen and Qiyu Sun, A note on uncertainty principle, *Approximation Theory and its Application*, **11:1**(1995), 6–9.
- (102) Ning Bi and Qiyu Sun, Hermite interpolation and stability of scaling functions, *Journal of Hangzhou Normal University*, 1995.
- (103) Xianliang Shi and Qiyu Sun, Approximation of periodic continuous functions by logarithmic means of Fourier series, *Acta Mathematica Hungarica*, **63**(1994), 103–112.
- (104) Qiyu Sun, Multiplier extension and sampling theorem on Hardy space, *Publicacions Matemàtiques*, **38**(1994), 441–454.
- (105) Qiyu Sun, Weighted weak type  $(1, 1)$  boundedness for some rough operators, *Journal of Hangzhou University*, **21**(1994), 7–10.
- (106) Albert Cohen and Qiyu Sun, An arithmetic characterization of the conjugate quadrature filters associated to orthonormal wavelet bases, *SIAM Journal of Mathematical Analysis*, **24**(1993), 1355–1360.
- (107) Qiyu Sun, A note on the integer translates of a compactly supported distribution on  $R$ , *Archiv der Mathematik*, **60**(1993), 359–363.
- (108) Qiyu Sun, A remark on multiresolution analysis of  $L^p(R^d)$ , *Colloquium Mathematicum*, **66**(1993), 257–264.
- (109) Qiyu Sun, Sequence spaces and stability of integer translates, *Zeitschrift für Analysis und ihre Anwendungen*, **12**(1993), 567–584.
- (110) Daren Huang and Qiyu Sun, Some topics on wavelet analysis, *Appl. Mathematics, A Journal of Chinese Universities*, **8**(1993), 86–110.
- (111) Guoen Hu and Qiyu Sun, Weighted norm inequalities for a maximal operator, *Journal of Hangzhou University*, **20**(1993), 367–370.
- (112) Guoen Hu and Qiyu Sun, On the  $L^p$  boundedness of a Marcinkiewicz integral, *Journal of Hangzhou University*, **20**(1993), 145–158.
- (113) Xianliang Shi and Qiyu Sun, Weighted norm inequalities for Bochner-Riesz operators and singular integral operators, *Proceeding of American Mathematical Society*, **116**(1992), 665–673.
- (114) Qiyu Sun, Weighted norm inequalities on spaces of homogeneous type, *Studia Mathematica*, **101**(1992), 241–251.
- (115) Qiyu Sun, Pointwise convergence of solutions of Schrödinger equation with potential, *Acta Mathematica Scientia*, **12**(1992), 412–418.



- (116) Qiyu Sun, Two problems about singular integral operator, *Approximation Theory and Applications*, **7:2**(1991), 83–98. (Abstract in *Journal of Mathematical Research and Exposition*, **11**(1991), 453–454.)
- (117) Qiyu Sun, Weighted inequalities for a singular integral, *Journal of Hangzhou University*, **18**(1991), 357–358.

### Refereed Conference Proceeding Articles or Book Chapter

- (1) Nader Motee and Qiyu Sun, Localized Stability Analysis and Design of Symmetric Spatially Distributed Systems over Sparse Proximity Graphs, In *the 23rd International Symposium on Mathematical Theory of Networks and Systems*, Hong Kong University of Science and Technology, Hong Kong, July 16-20, 2018, pp. 1851-188.
- (2) Brian Millikan, Hassen Foroosh and Qiyu Sun, Deep Convolutional Neural Networks with Integrated Quadratic Correlation, In *PBVS 2018 : 14th IEEE Workshop on Perception Beyond the Visible Spectrum in conjunction with CVPR 2018*, Salt Lake City, Utah, June 18-22, 2018, pp. 1303–1310.
- (3) Nader Motee and Qiyu Sun, Localized stability certificates for spatially distributed systems, In *2016 IEEE 55th Conference on Decision and Control (CDC)*, IEEE, pp. 1388–1393.
- (4) Brian Millikan, Arita Dutta, Nazanin Rahnavard, Qiyu Sun, Hassen Foroosh, Initialized iterative reweighted least squares for automatic target recognition, In *Military Communications Conference, MILCOM 2015*, 2015 IEEE, pp. 506–510.
- (5) Xin-Rong Dai and Qiyu Sun, The *abc*-Problem for Gabor systems and uniform sampling in shift-invariant spaces, In *Excursions in Harmonic Analysis, Volume 3*, edited by R. Balan, M. J. Bégue, J. J. Benedetto, W. Czaja and K. A. Okoudjou, Springer 015, pp. 177–194.
- (6) Cheng Cheng, Yingchun Jiang and Qiyu Sun, Spatially distributed sampling and reconstruction of high-dimensional signals, In *2015 International Conference on Sampling Theory and Applications (SAMPTA)*, IEEE, pp. 453–457.
- (7) Yang Chen, Cheng Cheng and Qiyu Sun, Reconstruction of sparse multiband wavelet signals from Fourier measurements, In *2015 International Conference on Sampling Theory and Applications (SAMPTA)*, IEEE, pp. 78–81.

- (8) Nader Motee and Qiyu Sun, Measuring sparsity in spatially interconnected systems, In *2013 IEEE 52nd Annual Conference on Decision and Control (CDC)*, Florence, Italy, December 1013, 2013, pp. 1520–1525.
- (9) Gayatri Ramesh, Elie Atallah and Qiyu Sun, Recovery of bilevel causal signals with finite rate of innovation using positive sampling kernels, In the *Proceeding of the 10th International Conference on Sampling theory and Applications (SAMPTA2013)*, 2013, pp. 129–32.
- (10) M. Z. Nashed and Qiyu Sun, Function spaces for sampling expansions, IN *Multiscale Signal Analysis and Modeling*, edited by X. Shen and A. Zayed, Lecture Notes in Electrical Engineering, Springer, pp.81–104, 2012.
- (11) Qiyu Sun, Localization of Stability and  $p$ -frames in the Fourier domain, *Proceedings of Special Sessions on Wavelets: WAVELET-S, FRAMES, and OPERATOR THEORY*, in *AMS Contemporary Mathematics (CONM) series No. 345*, Edited by: Christopher Heil, Palle E. T. Jorgensen, and David R. Larson, pp. 299–315, 2004.
- (12) A. Aldroubi, Qiyu Sun and W.-S. Tang, Localization of Calderon convolution in the Fourier domain, *Advance in Constructive Approximation, Vanderbilt 2003*, Edited by: M. Neamtu and E. B. Saff, Nashboro Press, Brentwood, 2004. pp. 25–35.
- (13) Xiaojie Gao, S. L. Lee and Qiyu Sun, Spectrum of transition, subdivision and multiscale operators, In “*Wavelet Analysis (Hong Kong 2001)*, edited by Ding-xuan Zhou”, World Science Publishing, 2002, pp. 123–138.
- (14) A. Aldroubi, Qiyu Sun, and W.-S. Tang, Non-uniform sampling in multiply generated shift-invariant subspaces of  $L^p(\mathbb{R}^d)$ , In “*Wavelet analysis and applications (Guangzhou, 1999)*, edited by D. Deng, D. Huang, R.-Q. Jia, W. Lin and J. Wang”, AMS/IP Stud. Adv. Math., 25, Amer. Math. Soc., Providence, RI, 2002, pp. 1–8.
- (15) Qiyu Sun, Homogeneous and nonhomogeneous refinable distributions in  $F^{q,\gamma}$ . In “*Wavelet analysis and applications (Guangzhou, 1999)* edited by D. Deng, D. Huang, R.-Q. Jia, W. Lin and J. Wang”, AMS/IP Stud. Adv. Math., 25, Amer. Math. Soc., Providence, RI, 2002, pp. 235–244.
- (16) Xiao-jie Gao, S. L. Lee and Qiyu Sun, Spectrum of convolution dilation operators on weighted  $L^p$  spaces, In “*Challenges for the 21st Century, Proceedings of the International Conference on*

*Fundamental Sciences: Mathematics and Theoretical Physics*, edited by L H Y Chen, J P Jesudason, C H Lai, C H Oh, K K Phua and E-C Tan”, World Scientific Press, 2001, pp. 51–72.

- (17) S. L. Lee and Qiyu Sun, Boundedness of cascade algorithms in Besov spaces, *First International Congress of Chinese Mathematicians (Beijing, 1998)*, edited by L. Yang and S.-T. Yau, AMS/IP Stud. Adv. Math., 20, Amer. Math. Soc., Providence, RI, 2001, pp. 473–479.
- (18) Qiyu Sun, An algorithm for the construction of symmetric and anti-symmetric  $M$ -band wavelets, In “*Wavelet Applications in Signal and Image Processing VIII, Proceedings of SPIE 4119*, edited by A. Aldroubi, Andrew F. Laine, and Michael A. Unser”, SPIE 2000, pp. 384–394.
- (19) Akram Aldroubi, Qiyu Sun and Wai-Shing Tang, Connection between  $p$ -frames and  $p$ -Riesz bases in locally finite SIS of  $L^p(\mathbb{R}^d)$ , In “*Wavelet Applications in Signal and Image Processing VIII, Proceedings of SPIE 4119*, edited by A. Aldroubi, Andrew F. Laine, and Michael A. Unser”, SPIE 2000, pp. 668–674.

### **Non-refereed Proceeding Articles**

- (1) Wei Hu, Xianliang Shi and Qiyu Sun,  $A_\infty$  condition characterized by maximal geometric mean operator, In “*Harmonic Analysis, Proceeding, Tianjin, 1988, Lecture Notes in Mathematics 1494*, edited by Min-Teh Cheng, Xing-wei Zhou and Dong-Gao Deng”, Springer Verlag, 1991, pp. 68–72.
- (2) Xianliang Shi and Qiyu Sun, A singular integral on product space, IN “*A Friendly Collection of Mathematical Papers I*, edited by Wang Renhong & Zhou Yunshi”, Jilin University Press, Changchun, China, 1990, pp. 129–132.

### III: PRESENTATIONS

- (1) Gave a talk at Hangzhou Dianzi University, December 26, 2018.
- (2) Colloquium talk at Department of Mathematics, Sam Houston University, November 5, 2018.
- (3) An invited talk at the Special Session on Applied Harmonic Analysis: Frame Theory and Applications, AMS Fall Western Sectional Meeting, San Francisco University, October 27-28, 2018.
- (4) Colloquium talk at Department of Mathematics, University of South Alabama, October 18, 2018.
- (5) Invited talk at the 23rd International Symposium on Mathematical Theory of Networks and Systems, Hong Kong University of Science and Technology, July 16-20, 2018.
- (6) Invited talk at Sun yet-sen University and Shenzhen University, July 12-15.
- (7) Invited talk at the International Symposium on Computational Harmonic Analysis, June 23-24, 2018, Behang University.
- (8) Invited talk at Beijing University of Science and Technology, Chinese Academy of Science, Chinese University of Geosciences, Guilin University of Electronic, Guangxi University, Hunan Normal University from June 20 to June 29, 2018.
- (9) Invited talk at the International Conference on Harmonic Analysis and Its Applications, June 15-19, 2018, Yanqi Lake, Beijing.
- (10) Invited talk on special workshop to celebrate the 60th birthday of Akram Aldroubi, Nashville, TN , May 14-19, 2018.
- (11) Colloquium talk at Department of Mathematical Sciences, University of Wisconsin at Milwaukee, April 20, 2018.
- (12) Invited talk on the Workshop on Mathematical Challenges of Structured Function Systems, Erwin Schrödinger International Institute for Mathematics and Physics, March 19 -23, 2018.
- (13) Colloquium talk at Department of Mathematics, Sogang University, Korea on March 15, 2018.
- (14) Invited talk at AMS Special Session on Interactions of Inverse Problems, Signal Processing, and Imaging, AMS Annual Meeting, San Diego, January 10-13, 2018.
- (15) Invited talk at the *From Approximation Theory to Real World Applications Workshop* Sanya, China, December 11-15, 2017.
- (16) Invited talk at Guilin University of Electronic Technology, December 7, 2017.
- (17) Invited talk at *International Workshop on Computational Harmonic Analysis*, Nankai University, China, June 15-18,2017.

- (18) Invited talk at *The 5th East Asian Conference in Harmonic Analysis and Applications*, Zhejiang University of Science and Technology, Hangzhou, China, June 9–12, 2017.
- (19) Invited talk at *Workshop on Frame Theory and Sparse Representation for Complex Data*, National University of Singapore, Singapore, 29 May - 2 June 2017.
- (20) Invited talk at the *International Conference on Computational Harmonic Analysis 2017*, Fudan University, China, May 24-28, 2017.
- (21) Invited talk at Hunan Normal University, and Wuhan Textile University, May 15 and 16, 2017.
- (22) Invited talk at *International Workshop on Generalized Inverses, Space Structure, Methods of Functional Analysis and their Applications*, May 12-14, 2017, Harbin Normal University, Harbin, China.
- (23) Invited talk at *Hangzhou Workshop on Harmonic Analysis 2016*, Zhejiang University of Science and Technology, December 24-25, 2016.
- (24) Invited talks at Zhejiang University, and Zhejiang Jiliang University, December 21, 2016.
- (25) Invited talk on phase-retrieval on shift-invariant spaces at *2016 International Conference on Some Mathematical Approximation Approaches in Data Science*, Zhejiang University, Hangzhou, December 12-14, 2016.
- (26) Talk on *Northeastern Analysis Meeting NEAM - 1st Northeastern Analysis Meeting* October 14-16, 2016, Brockport, New York, USA
- (27) Invited talks at Beijing University of Technology, Guilin University of Electronic Technology, Sun Yat-sen University, and Jiaxing University on phase retrieval and compressive sensing, June–July 2016.
- (28) Invited talk at Beijing University of Technology, Beijing Normal University, Nankai University, Zhejiang Normal University and North China Electric Power University, December 2015.
- (29) Colloquium talk at Syracuse University and Clarkson University on Wiener's lemma and spatially distributed sampling.
- (30) Colloquium talk at Auburn University at Montgomery on Wiener's lemma and its application to sampling.
- (31) Two talks at Guilin University of Electronic Technology and Jiaxing University on spatially distributed sampling.

- (32) Invited talk at a workshop in Carnegie Mellon University, April 2015, on spectral measures with arbitrary Hausdorff dimensions.
- (33) Invited talk at AMS Central Spring Sectional Meeting, Michigan State University, March 2015.
- (34) Invited talk at SIAM Minisymposium on multivariate signals processing and inverse problems, January 2015, on spatially distributed sampling.
- (35) Invited talk on sampling in reproducing kernel spaces on AMS Fall Sectional Meeting, October 18–19, 2014, Dalhousie University, Halifax, Canada.
- (36) Invited speaker on nonlinear frames and sparse reconstruction, the International Conference on Harmonic Analysis and Applications, Nankai University, Tianjin, China, June 11–17, 2014.
- (37) Seminar talks on nonlinear frames and sparse reconstructions at Beijing University of Technology and Jiaxin College, June 2014.
- (38) **Keynote** speaker on the *abc*-problem for Gabor system, the 5th International Conference on Computational Harmonic Analysis, Vanderbilt University, Nashville, TN, May 19-23, 2014.
- (39) Invited one-hour talk on the *abc*-problem for Gabor system, Erwin Schrodinger Institute, University of Vienna, January 13 to 17, 2014.
- (40) Seminar talks on nonlinear frames and sparse reconstructions at Zhejiang University and Sun Yat-sen University, December 2013.
- (41) Invited talk on Sparsity of Spatially Decaying Matrices in the Special Session on Wavelets, Frames and Related Expansions, the AMS Sectional meeting in Washington University, St. Louis, October 18-20, 2013.
- (42) Colloquium talk on Wiener's lemma: Localization and Various Approach, at Department of Mathematics, Northern Illinois University on October 4th, 2013.
- (43) Invited talks on the *abc*-problems for Gabor systems and on nonlinear frames and sparse reconstructions, Applied Harmonic Analysis at University of Calgary and the workshop Recent Progress on Applied and Computational Harmonic Analysis from August 27–September 1, 2013.
- (44) Invited talks on the *abc*-problem for Gabor systems, CIMPA13, New Trends in Applied Harmonic Analysis: sparse representation, compressive sensing and multifractal analysis, from August 5 to August 16, 2013, Mar del Plata, Argentina.

- (45) Invited talk on the *abc*-problem for Gabor systems, the conference “Modern Analysis Conference in memory of Professor Jian-Gong Chen 120th anniversary”, Fudan University, China, June 3–7, 2013.
- (46) Seminar talks on inverse problems in Fourier analysis at Zhejiang Normal University (June 7, 2013) and Zhejiang University of Science and Technology (June 25, 2013).
- (47) Invited talk on Convolution stability for signals with finite rate of innovation, the 14th International conference Approximation Theory at San Antonio, Texas, April 7-10, 2013.
- (48) Invited talk on “The *abc*-problem for Gabor systems and sampling”, the Norbert Wiener Center for Harmonic Analysis and Applications, University of Maryland, College Park, February 21–22, 2013.
- (49) Seminar talks at Sun Yat-sen University and NanKai Univeristy, December 2012.
- (50) Invited talk on “The *abc*-problem for Gabor systems”, the International Conference on Advances on Fractals and Related Topics, December 10–14, 2012
- (51) Colloquium talk in the department on November 1, 2012.
- (52) Invited talk on “The *abc*-problem for Gabor systems”, the International Conference on Harmonic Analysis and its Applications, Zhejiang Normal Univeristy, Jinhua, China, October 12–16, 2012.
- (53) Invited talk on “The *abc*-problem for Gabor systems”, the Frame Theory and Maps between Operator Algebras and Larsonfest at Texas A&M University from July 1622, 2012.
- (54) Invited talk on “Wieners lemma and Nonlinear Sampling Theorem”, the Applied Harmonic Analysis at the Korean Federation of Science and Technology Societies (KOFST), Seoul, Korea, from June 18–20, 2012.
- (55) Invited talk on “Spectra of fractal measures and the *abc* problem for Gabor frames, the International Conference on Harmonic Analysis and Applications at Nanjing University from May 21–25, 2012.
- (56) Invited talk on “Nonlinear Wieners lemma and its application to a sampling problem, in the special session on Analysis of Wavelets, Frames and Fractals, the 2012 Spring Eastern sectional meeting at George Washington University, Washington DC, March 17–18.

- (57) Invited 30-minutes talk on “A nonlinear sampling problem about signals with finite rate of innovation”, the *SIAM Minisymposium on Sparsity in Inverse Problems and Signal Processing*, Annual Joint Mathematical Meeting, Boston, January 4–7, 2012.
- (58) Invited 40-minutes talk on “Wiener’s lemma and two nonlinear sampling problems in signal processing”, the *International Conference on Applied Harmonic Analysis and Multiscale Computing*, University of Alberta, Canada, July 25–28, 2011.
- (59) Department seminar on “Wiener’s lemma and two nonlinear sampling problems in signal processing”, Sun Yat-Sen University, China, June 15, 2011.
- (60) Invited talk on “Two nonlinear sampling problems”, the *International Symposium in Approximation theory in conjunction with the 26th Annual Shanks Lecture* at Vanderbilt University, Nashville TN, May 17–21, 2011.
- (61) Seminar on “Wiener’s lemma and two nonlinear sampling problems in signal processing”, Department of Mathematics, National University of Singapore, May 11, 2011.
- (62) Invited 20-minute talk on “Left inverse of fractional Laplacian and sparse stochastic process”, special session on fractal and tilings, the *AMS Sectional Meeting at Statesboro, March 12-13, 2011*.
- (63) Seminar talk on “Sparse approximation property in compressive sampling” at Rice University, January 18, 2011.
- (64) Colloquium talk “Wiener’s lemma and nonlinear sampling theory” at Department of Mathematics, Chinese University of Hong Kong, January 7, 2011, and at Department of Mathematics, City University of Hong Kong, January 4, 2011.
- (65) Invited 20-minute talk “Nonlinear Wiener’s lemma and numerical implementation”, presented on the workshop on “*Operator Algebras and Representation Theory: Frames, Wavelets and Fractals*”, Banff, Canada, October 10, 2010.
- (66) Colloquium talk “Wiener’s Lemma and Sampling”, Chern Institute of Mathematics, Tianjin, China, June 17, 2010.
- (67) Seminar talks at EPFL on March 16 and May 11, 2010, Shanghai Jiaotong University on June 10, Nankai University on June 15 and 16, and Zhejiang University on June 23.
- (68) Invited 20-minute talk “Sampling and reconstruction of signals in reproducing kernel subspaces of  $L^p$ ”, presented on *Special Session on Inverse Problems and Signal Processing* of AMS 2009



- Fall Southeastern Meeting, Boca Raton, FL, Oct. 30–Nov. 1, 2009.
- (69) Seminar talk on “Wiener’s lemma for infinite matrices and its applications” at Vanderbilt University, December 11, 2009
  - (70) Invited 4-hour lecture series on “Infinite matrices and their applications”, presented at Department of Mathematics, KAIST, Korea, December 26–30, 2008.
  - (71) Invited 30-minute talk “Wiener’s lemma for localized integral operators”, presented on *Special Session on Wavelets, Frames, and Multi-Scale Constructions of 2008 Spring Southeastern Meeting*, Baton Rouge, LA, March 28–30, 2008.
  - (72) Colloquium talk on “Wiener’s lemma”, presented at Department of Mathematics, Zhongshan University, Guangzhou, China, December 25, 2007.
  - (73) Invited 30-minute talk “Wiener’s lemma for localized integral operators”, presented at the Conference *The fourth International Congress of Chinese Mathematicians (ICCM 2007)*, Zhejiang University, Hangzhou, China, December 18–22, 2007.
  - (74) Invited 30-minute talk “Sampling and reconstruction of signals with finite rate of innovation”, presented at the conference *Special Session on Splines and Wavelets with Applications in the AMS sectional meeting*, Middle Tennessee State University, Murfreesboro, TN, November 3–4, 2007.
  - (75) Colloquium talk “Sampling and reconstruction of signals with finite rate of innovation”, at Department of Mathematics, University of Central Florida, October 25, 2007.
  - (76) Invited 30-minute talk “Sampling and reconstruction of signals with finite rate of innovation”, presented at the conference *Trends in Applied Harmonic Analysis*, Banff International Research Station, Banff, Alberta, Canada, September 23–28, 2007.
  - (77) Invited one-hour talk “Sampling and reconstruction of signals with finite rate of innovation”, presented at the conference *ISF-MA Symposium on Wavelet Methods in Mathematical Analysis and Engineering: Wavelet Theory and its Applications*, Zhongshan University, Guangzhou, China, August 20–25, 2007.
  - (78) Invited 30-minutes talk “Average sampling and stable reconstruction signals with finite rate of innovation”, presented at the “*Concentration Week on Frames, Banach spaces and Signal Processing*”, College Station, Texas A & M University, August 7–11, 2006.

- (79) Invited 20-minutes talk “Oversampling a tight affine frame”, presented at the “*Joint Mathematics Meetings of American Mathematical Society*”, San Antonio, TX, January 12–15, 2006.
- (80) Invited 20-minutes talk “Average sampling in shift-invariant spaces”, presented on the “*2004 Fall Southeastern Section Meeting of American Mathematical Society*”, Nashville, TN, Oct. 16-17, 2004.
- (81) Invited 45-minutes **Keynote** talk “Shift-invariant spaces and affine frames”, presented at the “*Second International Conference on Computational Harmonic Analysis*”, Vanderbilt University, Nashville, May 24-30, 2004.
- (82) Invited 20-minutes talk “Average sampling and Calderon resolution of the identity in shift-invariant spaces”, presented at the “*Joint AMS-SMM International meeting*”, Houston, TX, May 13-15, 2004.
- (83) Invited 20-minutes talk “Localization of stability, frame and sampling in Fourier domain”, presented at the “*Spring Southeastern Sectional Meeting of AMS*”, Baton Rouge, LA, March 14-16, 2003.
- (84) Invited 20-minutes talk “Symmetric univariate QM filters with Gaussian decay II”, presented at the “*Joint Mathematics Meetings of American Mathematical Society*”, Baltimore, MD, January 15-18, 2003.
- (85) Invited 20-minutes talk “Local dual generator of shift-invariant spaces with local generator”, presented at the “*2002 Fall Southeastern Section Meeting of AMS*”, Orlando, FL, November 9-10, 2002.
- (86) Invited 30-minutes talk “Asymmetry of orthonormal scaling functions with minimal support”, presented at the “*International Conference of Computational Harmonic Analysis*”, June 4 - 8, 2001.
- (87) Invited one-hour **Plenary** talk “Convergence of cascade algorithm and smoothness of refinable distributions”, presented at the “*International Conference on Wavelet Analysis and its Applications*”, Zhongshan University, Guangzhou, China, October 2000.
- (88) Invited talk “Construction of symmetric and anti-symmetric  $M$  band wavelets”, presented at the “*SPIE Conference: Wavelet Applications in Signal and Image Processing VIII*”, San Diego, July 30 - August 4, 2000.

- (89) Invited talk “ $p$ -frame and shift-invariant spaces of  $L^p$ ”, present at the “*Wavelet Conference*”, University of Missouri, Saint Louis, June 2000.
- (90) Invited talk “Linear independence of the shifts of a compactly supported distribution”, presented at the “*Approximation Conference*”, Vanderbilt University, June 2000.
- (91) Invited 20-minutes talk “Representation of compactly supported distribution by integer translates of linear independent distribution”, presented at the “*Second Congress ISAAC 1999*”, Fukoka, Japan, August 1999.
- (92) Invited talk “Arcwise connectivity of  $M$ -band wavelets with  $N$  vanishing moments”, presented at the “*Wavelet Conference*”, The Chinese University of Hong Kong, Hong Kong, May 1997.
- (93) Invited **one-hour** talk “Recent progress on  $M$ -band wavelets”, presented at the “*Wavelet Conference*”, Institute of Mathematics, Beijing, China, June 1996.
- (94) Invited talk “Characterization of both  $m$  and  $n$  refinable distributions”, presented at the “*Conference on Boundary Value Problem and Wavelet Analysis*”, Zhongshan University, Guangzhou, China, Jan. 1996.
- (95) Invited talk “Refinable functions with compact support”, presented at “*Conferences on Approximation Theory*”, Hangzhou University, Hangzhou, China, April 1995.
- (96) Invited talk “Stability of integer translates”, presented at the “*Conference in Memory of Chen JianGong*”, Hangzhou University, Hangzhou, China. May 1994.
- (97) Invited talk “Wavelet analysis at Zhejiang university”, presented at the “*French-China Joint Wavelet Conference*”, Wuhan University, Wuhan, China, May 1992.
- (98) Invited talk “Weighted weak type (1,1) boundedness for some rough operators”, presented at the “*Conference on Approximation Theory*”, Zhejiang University, Qiandaohu, China, Oct. 1990.

## **IV: GRANTS and AWARDS**

- (1) Qiyu Sun (sole-PI), National Science Foundation (DMS #1816313): “Mathematical Foundation for Signal Processing on Spatially Distributed Networks”, 09/2018–08/2021.
- (2) Recipients of UCF Research Incentive Awards, 2016-17.
- (3) Qiyu Sun (sole-PI), National Science Foundation: “Nonlinear Sampling Theory: Sparsity, Localization and Optimization”, 09/2014–08/2017.
- (4) Qiyu Sun (sole-PI), National Science Foundation: “Nonlinear Sampling Theory for Signals with Finite Rate of Innovation”, 09/2011-08/2014.
- (5) Yuanwei Qi (PI), Qiyu Sun (co-PI), Jiongmin Yong (co-PI) and Alexandru Tamasan (co-PI), National Science Foundation: “Computational analysis of inverse problems”, 05/2013–08/2014.
- (6) Deguang Han (PI), Ram Mohapatra (co-PI), Qiyu Sun (co-PI) and Zuhair Nashed (co-PI), National Science Foundation: Collaborative research “Operator theory/operator algebras,” , Conference GPOTS 05-06, 03/2005–03/2007.

## V: EDUCATIONAL ACTIVITIES

### Courses Taught

#### University of Central Florida

- Graduate Courses
  - Advanced Linear Algebra and Matrix Theory (Fall 2015/Fall 2010)
  - Applied and Computational Harmonic Analysis (Fall 2016)
  - Approximation Technique (Fall 2011/Spring 2019)
  - Functional Analysis (Spring 2004)
  - Wavelets and Their Applications (Spring 2018/Fall 2014/Fall 2012/Fall 2005)
- Undergraduate Courses
  - Analytic Trigonometry (Spring 2005/Fall 2004)
  - Calculus I (Fall 2014(honor)/Summer 2009/Fall 2008/Summer 2008/Summer 2007/Fall 2004)
  - Calculus II (Spring 2017(honor)/Spring 2016 (honor)/Spring 2007/Summer 2006/Fall 2005/Spring 2005/Summer 2004)
  - Calculus III (Spring 2011/ Spring 2009/Spring 2008/Fall 2006/Spring 2004)
  - College Algebra (Fall 2007/Spring 2006(honor))
  - Differential Equation (Spring 2014/ Fall 2013/ Spring 2013/Fall 2012/Summer 2010/Summer 2009)
  - Linear Algebra (Fall 2018)
  - Logic and Proof in Mathematics (Spring 2012)
  - Matrix and Linear Algebra (Spring 2014/Fall 2013(honor)/Spring 2013/Spring 2012/Fall 2011/ Summer 2011/Fall 2010/ Summer 2010/Fall 2008/Spring 2008/Fall 2007/Spring 2007/Spring 2006/Fall 2003)

#### Vanderbilt University

Fall 2002 Calculus II (MATH170A)

Fall 2009 Calculus II (MATH170A)

#### National University of Singapore

1998 – 2002 Taught courses ranging from entry to graduate level such as “Approximation Theory” and “Wavelet and Applications”

## Zhejiang University

1990 – 1987 Taught courses ranging from entry to graduate level such as “Mathematical Analysis”, “Ordinary Differential Equation”, “Linear Algebra”, “Wavelets” and “Interpolation Spaces”

## Postdoc Supervision

- John Paul Ward (2015–2016)

## Student Supervision

- Nazar Emirov, in progress
- Cheng Cheng obtained his PhD under supervision of Professor Xin Li in Summer 2017 with my co-supervision, now postdoc at Duke and Samsi under the supervision of Professor Ingrid Daubechies.
- Syed Alam Abbas obtained his PhD under supervision of Professor Hassen Foroosh in Summer 2017 with my co-supervision.
- Mr. Arita Dutta obtained his PhD under supervision of Professor Xin Li in Fall 2016 with my co-supervision.
- Ms. Gayatri Ramesh obtained her PhD under my supervision in 2013, co-supervised with Ram Mohapatra.
- Mr. Christopher Huff earned his Master under my co-supervision in 2012, supervised by Ram Mohapatra.
- Ms. Qiling Shi obtained her PhD degree under my supervision in 2009.

## V: SERVICES

### Professional Service

- (1) **Editor** for
  - (a) “*Numerical Functional Analysis and Optimization*” (2010–).
  - (b) “*Sampling Theory in Signal and Imaging Processing*”, (2013–).
  - (c) “*Frontiers in Applied Mathematics and Statistics*”, (2015–).
  - (d) “*Advances in Computational Mathematics*” (2006 – 2013).
- (2) **Guest editor** for
  - (a) “*Numerical Functional Analysis and Optimization*”, Special issue on Operator Algebra and Representation Theory: Frames, Wavelets and Fractals (Volume 33, Issue 79, page 1166-1193, 2012).
  - (b) “*Applicable Analysis*”, Special Issue on Wavelet Analysis in PDE and Mathematical Imagery (Volume 90, Issue 8, 2011).
  - (c) “*Acta Applicandae Mathematicae*”, Special Issue on Applied Harmonic Analysis and Sampling (Volume 107, Numbers 1-3, 2009).
  - (d) “*Advances in Computational Mathematics*”, Special Issue on Frames (Volume 18, Numbers 2-4, 2003).
3. **Organizer** for
  - (a) Co-organizer of the Third Hangzhou Workshop on Harmonic Analysis, December 15-16, 2018, Zhejiang University of Science and Technology
  - (b) Organized a special session Infinite Dimension Systems and Wavelets with Marcin Bownik and Xingde Dai, of the International Workshop on Operator Theory and Applications (IWOTA) 2018, July 23-27, 2018, East China Normal University, Shanghai, China
  - (c) Organize *The Second Hangzhou Workshop on Harmonic Analysis and Applications*, Zhejiang University of Science and Technology, December 16-17, 2017. (The co-organizers are Qianxing Tao, Song Li and Houyu Jia)
  - (d) Organize a one-day workshop on *high-dimensional data fitting and approximation*, March 30, 2017, Department

- of Mathematics, University of Central Florida. (The co-organizers are Charles Micchelli and Mourad Ismail )
- (e) Organize *Hangzhou Workshop on Harmonic Analysis 2016*, Zhejiang University of Science and Technology, December 24-25, 2016. (The co-organizers are Qianxing Tao and Houyu Jia)
  - (f) a special session on Dynamical, Mobile, and Nonlinear Sampling at the *11th International Conference on Sampling Theory and Applications (SampTA 2015)*, American University, Washington DC, May 25–29, 2015. (The co-organizers are R. Aceska and J. Romero)
  - (g) *International Conference on Orthogonal Polynomials and q-Series*, University of Central Florida, May 2015. (The co-organizers are Joseph Brennan, Xin Li, Piotr Mikusinski, Zuhair Nashed, and Alexander Tobvis.)
  - (h) *Computational Analysis of Inverse Problems and Partial Differential Equations*, University of Central Florida, May 9-11, 2013. (The co-organizers are Yanping Lin, Piotr Mikusinski, Yuanwei Qi, Alexandru Tamasan, Hongming Yin and Jiongmin Yong.)
  - (i) *SIAM Minisymposium on New Trends and Directions in Inverse Problems and Signal Processing*, AMS Annual meeting, San Diego, January 9-12, 2013. (The co-organizer is Zuhair Nashed)
  - (j) *Special Session on Inverse Problems and Signal Processing*, AMS 2009 Fall Southeastern Meeting Boca Raton, FL, October 30 - November 1, 2009. (The co-organizer is M. Zuhair Nashed).
  - (k) *Special session on Wavelets and Sampling* of the 32nd SIAM Southeastern Atlantic Section Conference (SIAM-SEAS 2008), University of Central Florida, Orlando, March 14-15 2008. (The co-organizers are Dorin Dutkay and Deguang Han).
  - (l) *The 32nd SIAM Southeastern-Atlantic Section Conference (SIAM-SEAS 2008)*, University of Central Florida, Orlando, March 14-15 2008. (The co-organizers are Jiongmin Yong, Piotr Mikusinski, Joseph Brennan, Constance Schober, Kuppalapalle Vajravelu, Brenton LeMesurier, and Lili Ju).
  - (m) *The 25th Great Plains Operator Theory Symposium*, June 7 –June 12, 2005, University of Central Florida, FL. (The co-organizers are Deguang Han, Xin Li, Piotr Mikusinski, Ram Mohapatra, and Zuhair Nashed).



- (n) *The Special Session on Wavelets, Frames and Sampling* of AMS Southeastern Section Meeting, Nashville, TN, October 16-17, 2004. (The co-organizers are Akram Aldroubi and Douglas Hardin).
  - (o) *Workshop on Functional and Harmonic Analyses of Wavelets and Frames*, August 4 – 7, 2004, National University of Singapore. (The co-organizers are Judith Packer and Wai-shing Tang).
4. **Reviewer** for
- (a) “*Mathematical Reviews*” of American Mathematical Society, (2005 – ).
  - (b) “*Zentralblatt für Mathematik und ihre Grenzgebiete*” edited by the European Mathematical Society (EMS), Fachinformationszentrum (FIZ) Karlsruhe, and the Heidelberger Akademie der Wissenschaften (2004 – )
  - (c) National Science Foundation (Applied Mathematics); Austrian Science Fund; Israel Science Foundation
5. **Referee** for (incomplete list)
- (a) *Advance in Computational Mathematics*
  - (b) *Applied and Computational Harmonic Analysis*
  - (c) *Applied Mathematical Letter*
  - (d) *Constructive Approximation*
  - (e) *IEEE Signal Processing Letter*
  - (f) *IEEE Transaction on Information Theory*
  - (g) *IEEE Transaction on Signal Processing*
  - (h) *Journal of Fourier Analysis and Applications*
  - (i) *Journal of Functional Analysis*
  - (j) *Journal of Approximation Theory*
  - (k) *Proceeding of American Mathematical Society*
  - (l) *Science in China*

2015 – – Graduate coordinator  
2013 – 2015 Departmental Steering Committee  
2012 – 2014 Departmental Graduate Committee  
2012 – 2013 Departmental Search Committee, Chair  
2011 – 2012 University Senator  
2009 – 2011 University Travel Committee  
2009 – 2014 Departmental Web Committee, Chair  
2007 – 2008 Departmental Events Committee  
2007 Matrix Linear Algebra Textbook Committee  
2004 – 2006 Departmental Graduate Committee  
2004 Preparing and Marking Qualifying Exams  
2003 – 2006 Departmental Library Committee

# SEAN SZUMLANSKI, PH.D.

[seansz@cs.ucf.edu](mailto:seansz@cs.ucf.edu)

Department of Computer Science  
University of Central Florida  
Orlando, FL 32816

---

## EDUCATION

---

### University of Central Florida

Ph.D., Computer Science (3.98 GPA) ..... May 2013

- Dissertation: *Automatically Acquiring a Semantic Network of Related Concepts* ([PDF](#))
- Dissertation Advisor: Fernando Gomez

Master of Science, Computer Science ..... December 2005

Bachelor of Science, Computer Science (with Honors) ..... May 2004

## EMPLOYMENT HISTORY

---

### University of Central Florida

Lecturer ..... August 2015 - Present

### Google

Software Engineer (Back-End Developer in Search Product Area) ..... May 2014 – May 2015

### University of Central Florida

Visiting Lecturer ..... August 2013 – May 2014

Adjunct Instructor ..... May 2013 – August 2013

## TEACHING INTERESTS

---

Primary teaching interests: Design and analysis of algorithms (introductory and advanced level); introductory and advanced courses in C, C++, or Java programming languages; object-oriented programming; discrete math (logic and proofs, combinatorics, set theory, and number theory). Other teaching interests include: Formal languages and automata theory; and interdisciplinary cognitive science courses that include components on human memory and human cognition.

## RESEARCH INTERESTS

---

Natural Language Processing (NLP) and Artificial Intelligence (AI). Specific interests include: knowledge-based approaches to natural language understanding, semantic relatedness and similarity measures, word sense disambiguation, unsupervised acquisition of lexical semantic knowledge, verb polysemy, human cognition, and human memory.

## RECENT AWARDS

---

1. **Teaching Incentive Program (TIP) Award** ..... April 2018  
One of seven recipients of the Teaching Incentive Program (TIP) Award in the College of Engineering and Computer Science. This is part of a university-wide competitive and prestigious teaching awards program that recognizes significant and sustained teaching productivity and excellence.
2. **CECS Excellence in Undergraduate Teaching Award** ..... February 2018  
One of two recipients of the Excellence in Undergraduate Teaching award for the College of Engineering and Computer Science. This is part of a university-wide prestigious teaching awards program, with only 20 awardees across the university.
3. **Dept. of Housing and Residence Life Distinguished Faculty Member at UCF** ..... May 2017  
Recipient of an inaugural Distinguished Faculty Member at UCF award presented by the Department of Housing and Residence Life for work as “an exemplary faculty member on campus” and an “inspiring commitment to student learning.”

## COURSES TAUGHT

---

### As Instructor of Record (University of Central Florida)

*Overall end-of-semester instructor ratings (out of 5.0) are given where available.*

#### 1. **COP 3502: Computer Science I**

Introduction to algorithms and data structures, with programming assignments in C. Topics include: Runtime and space complexity analysis, recursion and recurrence relations, data structures (linked lists, array lists, stacks, queues, binary trees, binary search trees, tries, heaps, AVL trees, hash tables), sorting algorithms, base conversion, bitwise operators, and advanced memory management in C.

*Ratings and Semester Taught:*

4.80 (Spring 2018, Section 1)	4.71 (Spring 2018, Section 2)	4.94 (Spring 2018, Honors)
4.75 (Fall 2017, Section 1)	4.70 (Fall 2017, Section 2)	4.72 (Spring 2017, Section 1)
4.96 (Spring 2017, Honors)	4.73 (Fall 2016, Section 1)	4.71 (Fall 2016, Section 2)
4.70 (Summer 2016, Section 1)	4.56 (Fall 2015, Section 1)	5.0 (Spring 2014, Honors)
4.58 (Spring 2014, Section 1)	4.34 (Summer 2013, Section 1)	

#### 2. **COP 3503: Computer Science II**

Advanced design and analysis of algorithms, with programming assignments in Java. Topics include: Data structures (binary search trees, AVL trees, 2-4 trees, hash tables), probabilistic data structures (bloom filters, treaps, skip lists), graph theory and graph algorithms, sorting algorithms, greedy algorithms, divide and conquer, backtracking, and dynamic programming.

*Ratings and Semesters Taught:*

4.83 (Fall 2017, Section 1)	4.82 (Fall 2017, Section 2)	4.72 (Spring 2017, Section 1)
4.81 (Fall 2016, Section 1)	4.61 (Summer 2016, Section 1)	4.75 (Fall 2013, Honors)
4.62 (Fall 2013, Section 1)	n/a (Summer 2008, Section 1)	

3. **COT 3100: Introduction to Discrete Structures**

Proofs and logic, set theory, counting, and number theory. Topics include: Formal proofs, laws of logic and rules of inference, quantifiers, set proofs, combinatorics, probability, mathematical induction, number theory, functions, and relations (including partial order relations and equivalence relations).

*Ratings and Semesters Taught:*

4.96 (Spring 2016, Honors 201)      4.79 (Spring 2016, Honors 202)      4.55 (Spring 2016, Section 1)  
4.07 (Fall 2015, Section 1)      4.12 (Spring 2008, Section 1)

4. **COP 3223: Introduction to C Programming**

Introduction to programming in C. Topics include: Basic anatomy of a C program, control flow (if-statements, loops), functions, pointers, character processing, file I/O and advanced I/O techniques, arrays, strings, dynamic memory management, structs and enumerated types, functions with variable length parameter lists, platform-independent development, and working at the command line in Linux.

*Ratings and Semesters Taught:*

4.95 (Fall 2015, Honors)  
n/a (Fall 2006)

5. **COT 5405: Design and Analysis of Algorithms**

Advanced design and analysis of algorithms taught from a theoretical perspective, with algorithm design portions of assignments done in pseudocode. Topics include: Mathematical techniques for runtime analysis, formal definitions of order notation (including Big-Oh, Big-Theta, and Big-Omega), mathematical tools for average-case runtime analysis, empirical runtime analysis, space complexity analysis, proof by induction, recurrence relations, sorting algorithms (mergesort and quicksort), data structures (binary search trees, AVL trees, treaps, hash tables, and disjoint sets), graph theory and graph algorithms, greedy algorithms, divide and conquer, backtracking, and dynamic programming.

*Ratings and Semesters Taught:*

4.50 (Spring 2017)

6. **COT 4810: Topics in Computer Science**

Technical presentation and writing practicum, with a four-week component on ethics in technology.

*Ratings and Semesters Taught:*

4.58 (Spring 2014)  
4.71 (Fall 2013)

7. **CGS 3175: Internet Applications**

Introduction to HTML, CSS, and JavaScript. Topics include: Basic HTML development, HTML5, CSS (including special effects, accessibility, and developing for multiple devices), tables, frames, web forms, embedded multimedia, XHTML, Javascript, jQuery, and AngularJS.

*Ratings and Semesters Taught:*

4.34 (Fall 2013)

## As Teaching Assistant (University of Central Florida)

1. **COP 3502: Computer Science I** . . . . . Spring 2013, Summer 2005
2. **CAP 4630: Advanced Artificial Intelligence** . . . . . Fall 2012, 2011, 2010, 2009, 2008, & 2005
3. **COT 4810: Topics in Computer Science** . . . . . Spring 2012
4. **CAP 6640: Natural Language Understanding Systems (Graduate Level)** . . . . . Spring 2011
5. **COP 4600: Operating Systems** . . . . . Spring 2010
6. **COP 3503: Computer Science II** . . . . . Fall 2007, Spring 2007, Summer 2006, Spring 2006
7. **COT 5405: Design and Analysis of Algorithms (Graduate Level)** . . . . . Spring 2007
8. **COP 3530: Computer Science III** . . . . . Spring 2005, Fall 2004
9. **Burnett Honors College Summer Institute** . . . . . Summer 2003, Summer 2004  
This was a three week long computer science summer camp for high schoolers. Students lived on campus at the university, and my responsibilities included delivering lectures, creating and grading assignments, and holding office hours, as well as coordinating and chaperoning evening and weekend activities.

## UNIVERSITY SERVICE AND LEADERSHIP

---

1. **Foundation Exam Contributing Author** . . . . . Fall 2015 - Present  
The Foundation Exam is the CS department's formal entrance exam for admission to the major, and is based on material from Computer Science I and, until recently, Introduction to Discrete Structures. The exam is offered once per semester (fall, spring, and summer), and since Fall 2015, I have typically authored either one or two of the two to four sections on the exam each semester and have contributed to review sessions for the exam, study guides with practice problems and solutions, revision discussions, and exam proctoring.
2. **Junior Knights Volunteer** . . . . . Fall 2017  
Volunteer and guest lecturer for Junior Knights, a programming camp for high school students held at UCF and run entirely by volunteer effort. The camp had eight three-hour weekend sessions and hosted 160 different students in Fall 2017. Students received programming instruction and then worked on problem sets with volunteers available to answer questions and guide students through experiential learning activities.
3. **UCF Camp Connect Volunteer** . . . . . Summer 2016  
UCF Camp Connect is a week-long day camp for middle and high school students. Sarah Angell and I co-developed a hands-on tutorial on programming in the Scratch visual programming language, which we delivered through multiple tutorial sessions with a total of 80 middle school and high school students.
4. **Course Curriculum Committees**
  - Introduction to C Programming . . . . . August 2016 - Present
  - Computer Science I (Algorithms and Data Structures) . . . . . August 2016 - Present
  - Computer Science II (Advanced Algorithms and Data Structures) . . . . . August 2016 - Present
  - Introduction to Discrete Structures . . . . . August 2016 - Present

## 5. **Hiring and Interview Committees**

- Lecturer/Instructor Search Committee for UCF Department of Computer Science . . . . . Spring 2018
- Lecturer/Instructor Search Committee for UCF Department of Computer Science . . . . . Spring 2017
- Student Interview Committee for UCF Chief of Police . . . . . April 2007
- Student Interview Committee for Office of Student Conduct Coordinator . . . . . February 2007
- Hiring Committee for Office of Student Conduct Coordinator . . . . . April 2005

## 6. **Student Conduct Review Board** . . . . . Fall 2003 – Summer 2008

Participated in panel hearings with students accused of violating university's code of conduct. (Charges ranged from academic dishonesty to drug and alcohol abuse to serious criminal activity, e.g., sexual assault.) Developed personalized sanctions, both punitive and educational, for students found in violation of charges against them. Attended various training sessions by UCF Police, UCF Victim Services, UCF Counseling Center, among others. Heard approximately 40 cases per year.

- Returning Member of the Year, 2005 – 2006.
- Outstanding Overall Member of the Year, 2004 – 2005.

## 7. **Grade Appeals Committee (ad hoc member)** . . . . . Summer 2006 – Fall 2007

Heard student grade appeals in colleges throughout the university. Worked with other students and tenured faculty to determine whether appeals should be granted. Recommend actions to be taken by college Deans.

## **PRIMARY RESEARCH PROJECTS**

---

### 1. **Measuring Human Perceptions of Word Relatedness** . . . . . 2012 – 2014

Investigated cognitive perceptions of semantic relatedness in collaboration with UCF Psychology Department. Designed experiments; implemented a Web system to elicit human measurements of semantic relatedness between different pairs of nouns. Used HTML, Javascript, and PHP to interface with a MySQL database. Demo of interface available online: <http://www.amulao.com/relatedness/demo.php>

### 2. **Automatically Acquiring a Semantic Network of Related Concepts** . . . . . 2009 – 2014

Investigated methods for automatically building a network that models semantic relatedness between concepts denoted by nouns. Adapted an information theoretic measure for this purpose. Applied measure to lexical co-occurrence data mined from Wikipedia and created a semantic network indicating strong semantic associates of over 7,500 of the most frequently occurring nouns in the English language.

Developed algorithms for automatically disambiguating nouns in the semantic network to their corresponding noun senses in the WordNet 3.0 ontology. Resulting network effectively augments WordNet 3.0 with 208,832 undirected *related-to* edges between over 38,000 distinct noun senses, or concepts. Semantic network available for download online: <http://www.cs.ucf.edu/~seansz/sem>

### 3. **Learning Selectional Restrictions with Decision Trees** . . . . . 2007 – 2008

Investigated machine learning techniques for automatically learning selectional restrictions for use in the construction of verb predicates for individual meanings of polysemous verbs. Engineered a system for learning selectional restrictions from subject-object relationships using decision tree induction on data mined from the British National Corpus (BNC).

4. **Collaborative Interactive Evolution** . . . . . 2004 – 2006  
Extended the interactive evolution paradigm (using genetic algorithms with subjective human evaluation of population members as a fitness function) to incorporate evaluations from multiple users. Implemented a collaborative interactive evolutionary system. Experimented with meta-fitness functions to combine subjective human input from multiple users in an environment where human participants collaborated to design 3D avatars to populate interactive storytelling sessions.

## PERSONAL PROJECTS

---

1. **Visual Bookmarks** . . . . . 2004 – Present  
Implemented a cloud-based system for storing and exploring all of my bookmarks visually. Bookmarks are hash-tagged for ease of navigation and search, and are added to the collection through a Google Chrome extension. Representative thumbnails are derived from automatically detected salient images on each bookmarked page. Technologies utilized include: PHP, MySQL, Javascript, CSS, and HTML.  
  
The public-facing interface for exploring my bookmarks is available online. For a breath of fresh air, here's a direct link to all my bookmarks tagged "#travel": <http://www.amulao.com/m/travel> (*Google Chrome only*)

## PUBLICATIONS

---

1. **Szumslanski, S., Gomez, F., & Sims, V.** (2013). A New Set of Norms for Semantic Relatedness Measures. In *Proceedings of the 51st Annual Meeting of the Association for Computational Linguistics (ACL)*, 890 – 895.
2. **Szumslanski, S., & Gomez, F.** (2011). Evaluating a Semantic Network Automatically Constructed from Lexical Co-occurrence on a Word Sense Disambiguation Task. In *Proceedings of the 15th Conference on Computational Natural Language Learning (CoNLL)*, 190 – 199. (35% acceptance rate)
3. **Szumslanski, S., & Gomez, F.** (2010). Automatically Acquiring a Semantic Network of Related Concepts. In *Proceedings of the 19th ACM Conference on Information and Knowledge Management (CIKM)*, 19 – 28. (13.4% acceptance rate)
4. **Szumslanski, S., & Gomez, F.** (2008). Adapting Decision Trees for Learning Selectional Restrictions. In *Proceedings of the 21st International Florida Artificial Intelligence Research Society Conference (FLAIRS)*, 231 – 232. (poster)
5. **Szumslanski, S., Wu, A. S., & Hughes, C. E.** (2006). Conflict Resolution and a Framework for Collaborative Interactive Evolution. In *Proceedings of the 21st National Conference on Artificial Intelligence (AAAI)*, 512 – 517. (30% acceptance rate)
6. **Szumslanski, S., Wu, A. S., & Hughes, C. E.** (2005). Collaborative Interactive Evolution. In *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO)*, 2199 – 2200. (poster)



## DAMLA TURGUT

Professor

Department of CS, University of Central Florida

Tel: 407-823-6171 turgut@cs.ucf.edu

<http://www.cs.ucf.edu/~turgut/>

### (a) Professional preparation

University of Texas at Arlington, Arlington, TX	Computer Science & Eng.	B.Sc., 1994
University of Texas at Arlington, Arlington, TX	Computer Science & Eng.	M.Sc., 1996
University of Texas at Arlington, Arlington, TX	Computer Science & Eng.	Ph.D., 2002

### (b) Appointments

Professor, Department of CS, May 2018 -

Associate Professor, Department of CS, Dec. 2015 – May 2018

Joint Faculty, Department of ECE, Dec. 2015 –

Affiliated Faculty, Institute of Training and Simulation (IST), Jan. 2006 –

Associate Professor, Department of EECS, University of Central Florida, Aug. 2008 – Dec. 2015

Assistant Professor, School of EECS, University of Central Florida, Aug. 2002 – Aug. 2008

Visiting Researcher, Department of Computer Science, La Sapienza University, Rome, Italy (Sabbatical Leave) April. 2012 – July 2012

Visiting Researcher, Department of Electrical and Electronic Engineering, Imperial College of London, London, UK (Sabbatical Leave) Aug. 2011 – Dec 2011

Assistant Instructor, University of Texas at Arlington, Dept. of Computer Science and Engineering, Arlington, TX, Sep. 1998 – May 2002

### (c) Products

#### (i) Five products most closely related to the proposed project

- [1] S. Zehtabian, S. Khodadadeh, R. Pearlman, B. Willenberg, B. Kim, D. Turgut, L. Bölöni, and E. A. Ross. Supporting rehabilitation prescription compliance with an IoT-augmented four-legged walker. Workshop on AI for Aging, Rehabilitation and Independent Assisted Living (ARIAL'18), July 2018.
- [2] D. Turgut and L. Bölöni, “Value of Information and Cost of Privacy in the Internet of Things,” *IEEE Communications Magazine*, 55(9):62-66, September 2017.
- [3] L. Bölöni and D. Turgut, “Value of information based scheduling of cloud computing resources,” *Future Generation Computer Systems Journal (Elsevier)*, vol. 71, pp. 212-220, June 2017.
- [4] D. Turgut and L. Bölöni, IVE: improving the value of information in energy-constrained intruder tracking sensor networks, In *Proc. of IEEE ICC*, pp. 6360–6364, June 2013 [**Best Paper Award**]
- [5] P. Gjanci, S. Basagni, C. Petrioli, C.A. Phillips, L. Bölöni, and D. Turgut, “Path Finding for Maximizing the Value of Sensed Information in Multi-modal Underwater Wireless Sensor Networks,” *IEEE Transactions on Mobile Computing (TMC)*, 17(2):404-418, February 2018.

#### (ii) Five other significant products

- [1] J. Xu, R. Rahmatizadeh, L. Bölöni, and D. Turgut, “Real-time Prediction of Taxi Demand Using Recurrent Neural Networks,” Accepted to appear in *IEEE Transactions on Intelligent Transportation Systems*, 19(8):2572–2581, August 2018. DOI: 10.1109/TITS.2017.2755684.
- [2] G. Solmaz and D. Turgut, “Tracking Pedestrians and Emergent Events in Disaster Areas,” *Journal of Network and Computer Applications (Elsevier)*, vol. 84, pp. 55-67, April 2017.

- [3] G. Solmaz and D. Turgut, "Modeling Pedestrian Mobility in Disaster Areas," *Pervasive and Mobile Computing (Elsevier)*, 40:104–122, September 2017. DOI: 10.1016/j.pmcj.2017.05.005
- [4] G. Solmaz, M.I. Akbas, and D. Turgut, "A Mobility Model of Theme Park Visitors," *IEEE Transactions on Mobile Computing (TMC)*, 14(12):2406–2418, December 2015.
- [5] D. Turgut and L. Bölöni, "Heuristic approaches for transmission scheduling in sensor networks with multiple mobile sinks," *Special Issue of the Computer Journal on Agent Technologies for Sensor Networks*, 54(3):332-344, Oxford University Press, March 2011.

#### **(d) Synergistic Activities**

##### **(i) Innovations in teaching and training:**

- As EXCEL/COMPASS faculty (NSF funded grants) given lectures on current research topics in freshman STEM seminar class for retention in science and engineering (2015-present)
- Restructured the existing networking courses and led the development of two regular courses (EEL 5780: Wireless Networking and EEL 6788: Advanced Topics in Computer Networks)
- Developed lectures for illustrating concepts calculus classes through their applications in wireless networking for applications of Calculus I-II-III class as part of awarded NSF grant "UCF-STEP Pathways to STEM: From Promise to Prominence" in 2005
- Co-authored a book titled "Introduction to computers and programming", in current use in the Dept. of Computer Science and Engineering at UT Arlington since 2001 in CSE 1310 course.

##### **(ii) Development of computation methodologies, and algorithms for problem-solving:**

- The value of information concept paper appeared in ICC 2013 and has received the **best paper award** and the extension of this work has appeared in INFOCOM 2014 and IEEE TMC 2018
- The WCA protocol which was co-developed as part of my PhD thesis is one of the key protocols for clustering in wireless ad hoc network, the journal paper describing its finding was the five most downloaded articles on the Cluster Computing Journal and has more than 1000 citations.

##### **(iii) Academic leadership roles (Service to Department, College and University Committees):**

- *ABET Coordinator* for Computer Engineering (CpE) program (2008-2016)
- *ABET Coordinator* for Computer Science (CS) program (2013-2014)
- *Chair*, Curriculum Oversight and Review Committee for CS program (2013-2014)
- *Director*, Networking and Mobile Computing (NetMoC) laboratory, (2002-present)

##### **(iv) Service to the scientific and engineering community:**

- *Associate Editor*: Elsevier Journal of Ad hoc Networks, *Guest Editor* for SI in PMC Journal, Elsevier Journal of Computer Communication
- *Conference organization*: General Chair of LCN 2014, TPC Chair/Co-Chair of LCN 2012-2013, ICC 2017, Globecom 2014, CCNC 2013-2014, Globecom 2011, PerSeNS 2009
- *External PhD Examiner*: Univ. of New South Wales, Univ. of Alberta, Univ. of Ottawa
- *Outreach activities*: Judge in 56th State Science and Engineering Fair of Florida on Mar. 2011; Judge in 2013-2018 Dr. Nelson Ying Competitions; Judge in Boys & Girls Clubs of Central Florida ArtScience Prize Competition (2014)

##### **(v) Selected Honors and Awards:**

- UCF Charles Millicon Eminent Scholar Faculty Fellow Professorship (2018)
- UCF Women Faculty of Distinction Award (2018)
- University Excellence in Professional Service Award, UCF (2017)
- Inducted into Scroll and Quill Faculty Honor Society, UCF (2017)
- Featured in **2015 UCF Woman Making History**
- **iSTEM Faculty Fellow**, College of Engineering and Computer Science, UCF, 2014
- **ICC 2013 Best Paper Award**
- UCF Teaching Incentive Program (TIP) Award (2017, 2009)

## Short CV - Nizam Uddin

### Education

Institution	Major	Degree and Year.
University of Dhaka	Statistics	B.S., 1977.
University of Dhaka	Statistics	M.S., 1979.
University of Saskatchewan	Mathematics	M.S., 1985.
Old Dominion University	Statistics	Ph. D, 1989

### Appointments

Year(s)	Institution or Company	Position
Fall, 09- Present	University of Central Florida	Professor
Fall, 02- Summer, 09	University of Central Florida	Associate Prof
Fall, 01- Spring, 02	University of Central Florida	Visitng Asst Prof
Fall, 98- Spring, 01	Tennessee Tech. University	Associate Professor
Fall, 94- Spring, 98	Tennessee Tech. University	Assistant Professor
Fall 89- Spring, 94	University of So. Maine	Assistant Professor

### Honors and Awards

- TIP (Teaching Incentive Program Award, University of Central Florida)- 2011
- RIA (Research Incentive Award, University of Central Florida) - 2009
- Promotion to Full Professor - August, 2009.
- Elected Fellow, International Statistical Institute, 2006.

### Professional Development: Teaching Related Workshops/Conference Sessions

- Attended a session on Active Learning (Mathematics), May 7, 2018. Florida University System Mathematics Action Planning Conference organized by SUS Board of Governors.
- Attended a session on Mathematics Action Planning, May 7, 2018. Florida University System Mathematics Action Planning Conference organized by SUS Board of Governors.
- Attended a session on ALTA- Knewtons fully integrated adaptive learning course ware, March 30, 2018.
- Attended several sessions on MyStatLab with Pearson Techs and representatives during this Tip Cycle to learn and effectively use MyStatLab and Mastering modules associated with our STA 2023 course.
- Successfully completed IDL 6543 offered by UCF's Center for Distributed Learning.
- Attended a conference session on "Clicker in Statistics Classes organized by American Statistical Association in its 2011 annual meeting in Miami, Florida.

### Mentoring and Advising Activities

- Served as mentor of one junior tenure track faculty in our department.
- Served as undergraduate statistics program coordinator.
- Supervised graduate teaching assistants.
- Served on more than fifty thesis/dissertation committees

### • Selected Publications

(Year/Title/Authors/Journal/Volume/Pages)

- 2018 "Modeling wrong-way driving entries at limited access facility exit ramps in Florida", Md Imrul Kayes, Haitham Al-Deek, Adrian Sandt, and Nizam Uddin, *Journal of the Transportation Research Board*, In review.
- 2017 "Testing equality of two normal means using combined samples of paired and unpaired data, Nizam Uddin and M. S. Hasan, *Commun. Statist.- Simulation and Computation*, 46, 2430-2446. International Refereed Journal.
- 2017 "Longitudinal study of stress, social support, and depression in married Arab immigrant women", Karen Aroian, Nizam Uddin & Hazhar Blbas, *Health Care for Women International*, 38, 100-117. International Refereed Journal.

- 2017 Airline Ancillary Services: An Investigation into Passenger Purchase Behavior, Steven Leon and Nizam Uddin, Revised version accepted and Published during this reporting period in the Journal of the Transportation Research Forum, 56, vol 1. International Refereed Journal.
- 2017 Data-Driven Insights: Assessment of Airline Ancillary Services, Steven Leon and Nizam Uddin, Submitted, accepted and published during this reporting period in the Journal of the Transportation Management, 27, Vol 2. International Refereed Journal.
- 2016 "Finding Supply Chain Talent: An Outreach Strategy", Steve Leon and Nizam Uddin, *Supply Chain Management*, 21, 1, 20-44. International Refereed Journal,
- 2016 "Stress, Social Support and Depression in Arab Muslim Immigrant Women in the Detroit Area of the United States, Karen Aroian, Nizam Uddin and Darshana Ullah. Refereed book chapter.
- 2015 "Wrong Way Driving Multifactor Risk-Based Model for Florida Interstates and Toll Facilities, John Rogers, Adrian Sandt, Haitham Al-Deek, Ahmad Alomari, Nizam Uddin, Eric Gordin, Cristina Santos, Jessica Renfrow, Grady Carrick, *Transportation Research Record*, 2484, 119-128. International Refereed Journal.
- 2005 "Split models for predicting multivehicle crashes during high-speed and low-speed operating conditions on freeways", M. Abdel-Aty, **Nizam Uddin** and Anurag Pande, Transportation Research Record - Journal of the Transportation Research Board No.-1908, pp 51-58. International Refereed Journal.
- 2005 "Proactive real-time safety implementation strategy on freeways", M. Abdel-Aty, Anurag Pande, and **Nizam Uddin**, , Proceedings of the 13th International Conference on Road Safety on Four Continents, Warsaw, October, 2005 (Refereed, published in CD).
- 2005 "Improving safety and security by developing a traffic accident prevention system", M. Abdel-Aty, **Nizam Uddin** and Anurag Pande, Proceedings of the first International Conference on Safety and Security Engineering, Rome, Italy, June, 2005 (Refereed, published in CD).
- 2004 "Predicting free-way crashes based on loop detector data using matched case-control logistic regression" Abdel-Aty, **Nizam Uddin**, Fathy Abdalla, and Anurag Pande, *Transportation Research Record - 1897: Journal of Transportation Research Board*, 88- 95. (International refereed journal)
- 1997 "Universally optimal designs with blocksize  $p \times 2$  and correlated observations". **Nizam Uddin** and John P. Morgan. *Annals of Statistics*, 25, 1997, 1189 - 1207. (International refereed journal)
- 1996 "Optimal blocked main effects plans with nested rows and columns and related designs", John P. Morgan and **Nizam Uddin**. *Annals of Statistics*, 24, 1996, 1185-1208. (International refereed journal)
- 1990 "Some series constructions for minimal size equineighbourbed balanced incomplete block designs with nested rows and columns", Nizam Uddin. *Biometrika*, 77, 829 - 833, 1990.
- 1990 "Some constructions of balanced incomplete block designs with nested rows and columns", Nizam Uddin and John P. Morgan. *Biometrika*, 77, 193-202, 1990.

### Grants and Contracts

Principal Investigator on several grants and consulting projects. Funding agencies include National Science Foundation, Local Hospitals, and other non-profit organizations.

Co-principal Investigator on two grants from Florida Department of Transportation.

Statistical Consultant on two grants from the Department of Defence and EPA.

Expert Investigator on funded projects from Florida Department of Transportation.

## Adan E. Vela

Assistant Professor  
12800 Pegasus Drive  
Dept of Industrial Engineering  
& Management Systems  
Orlando, FL 32816-2993  
TEL: 407-823-4746  
EMAIL: adan.vela@ucf.edu

## Educational Background

University of California, Berkeley	Berkeley, CA	Mechanical Engineering	B.S.	2003
Stanford University	Stanford, CA	Mechanical Engineering	M.S.	2006
Georgia Institute of Technology	Atlanta, GA	Mechanical Engineering	Ph.D.	2011

## Appointments

8/2016-Present	Assistant Professor, Department of Industrial Engineering and Management Systems University of Central Florida.
2/2012-7/2016	Technical Staff, Division of Homeland Protection and Air Traffic Control MIT Lincoln Laboratory

## Five products most closely related to the proposed project

- [1] Weinert, A., Campbell, S., Vela, A.E., Schuldt, D., Kurucar, J. (2018). A Well Clear Recommendation for Small Unmanned Aircraft Systems based on Unmitigated Collision Risk, AIAA Journal of Air Transportation, 2018.
- [2] Vela A. E., Ferriera, L., Babin, T. (2018). A Safety Analysis of UAV Mapping Operations. In Digital Avionics Systems Conference (DASC), 2018 IEEE/AIAA 37th.
- [3] Smith, K. A., Vela, A. E., Kochenderfer, M. J., & Olson, W. A. (2015). Optimizing a Collision-Avoidance System for Closely Spaced Parallel Operations. Journal of Aerospace Information Systems.
- [4] Vela, A., Sandberg, K., & Reynolds, T. (2014). Terminal Flight Data Manager (TFDM): Runway Balancing Capability Assessment, Project Report ATC-421, MIT Lincoln Laboratory, 2014.
- [5] Marzuoli, A., Gariel, M., Vela, A., & Feron, E. (2014). Data-based modeling and optimization of en-route traffic. Journal of Guidance, Control, and Dynamics.

## Five other significant products

- [1] Vela A. E., Chini, J., Baekey, A., Walsh, J. (expected proceedings to appear in 2019). Variations in Patterns of Persistence. Physics Education Research Conference, 2018.
- [2] Vela, A., Feigh, K. M., Solak, S., Singhose, W., & Clarke, J. (2012). Formulation of reduced-taskload optimization models for conflict resolution. IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans, 42(6), 1552-1561.
- [3] Salaün, E., Gariel, M., Vela, A. E., & Feron, E. (2012). Aircraft proximity maps based on data-driven flow modeling. Journal of Guidance Control and Dynamics, 35(2), 563.
- [4] Clarke, J. P. B., Solak, S., Ren, L., & Vela, A. E. (2012). Determining stochastic airspace capacity for air traffic flow management. Transportation Science, 47(4), 542-559.
- [5] Vela, A. E., Solak, S., Clarke, J. P. B., Singhose, W. E., Barnes, E. R., & Johnson, E. L. (2010). Near real-time fuel-optimal en route conflict resolution. IEEE Transactions on Intelligent Transportation Systems, 11(4), 826-837.

## Synergistic activities

- Engineering consultancy with Afilon in support of the development of fair and transparent electoral system.
- Founder of UAS@UCF, a student-through-faculty vertical organization to advance UAV training and STEM education and research involving unmanned aerial systems. Assisting in the development of UAV safety policy for UCF main-campus and the UCF Department of Security and Emergency Management.
- Application of big-data and intelligent systems to model UAVs and develop flight systems to aid first responders and other occasional pilots.

- Serving as a UCF Predictive Analytics Innovation Fellow. Applying data science techniques to improve STEM outcomes for UCF students.
- Founder and founding member of LOGRAS (Gatech) and LEGOS (Stanford); STEM outreach, recruitment, retention organization for Latino graduate students.

# Liqiang Wang

Associate Professor, Graduate Coordinator  
Department of Computer Science  
University of Central Florida  
Orlando, FL 32816

Phone: (407) 823-3187  
Fax: (407) 823-5835  
Email: [lwang@cs.ucf.edu](mailto:lwang@cs.ucf.edu)  
Web: <http://www.cs.ucf.edu/~lwang>

## RESEARCH INTERESTS

My research focuses on integrating deep learning, parallel computing, and program analysis, which includes the following aspects: (1) improving the robustness, accuracy, speed, and scalability of deep learning; (2) optimizing performance, scalability, resilience, and resource management of big data processing, especially on Cloud, GPU, and multicore platforms; (3) using hybrid program analysis to detect and avoid programming errors, execution anomaly, as well as performance defects in large-scale parallel computing systems. I received an NSF CAREER Award in 2011 and Castagne Faculty Fellowship (2013-2015).

## EDUCATION

<b>Ph.D. in Computer Science</b>	State University of New York at Stony Brook	Aug. 2006
<b>M.S. in Computer Science</b>	State University of New York at Stony Brook	Dec. 2003
<b>M.Eng. in Computer Science</b>	Sichuan University, China	Jul. 1998
<b>B.S. in Mathematics</b>	Hebei Normal University, China	Jul. 1995

## WORK EXPERIENCE

08/2018 - present: Graduate Coordinator, Department of Computer Science  
University of Central Florida.

08/2015 - present: Associate Professor (tenured), Department of Computer Science  
University of Central Florida.

07/2012 - 07/2015: Associate Professor (tenured), Department of Computer Science  
University of Wyoming.

07/2012 - 06/2013: Visiting Research Scientist (Sabbatical), IBM T.J. Watson Research Center, NY.

08/2006 - 06/2012: Assistant Professor, Department of Computer Science, University of Wyoming.

07/1998 - 07/2000: Lecturer, Department of Computer Science,  
Hebei University of Economics and Business, China.

## GRANTS

- Sole PI, *ICE-T:RI: Towards End-to-End Resource Optimization for Time-Critical Computing Using Reinforcement Learning and Program Analysis*. NSF. \$100,000. 10/01/2018-09/30/2019.
- Co-PI, *Security-Aware Virtual Machine Management on Cloud Platform Using the Game-Theoretic Approach*. Florida Center for Cybersecurity. \$35,479. 07/01/2018-06/30/2019.
- Sole PI, *Efficient Hierarchical Big Data Computing System*. Office of Naval Research (DURIP). \$154,184. 02/01/2018-01/31/2019.

- Co-PI, *BIGDATA: IA: Distributed Semi-Supervised Training of Deep Models and Its Applications in Video Understanding*, with Boqing Gong (Prior PI) and Mubarak Shah (Current PI). NSF. \$662,431.00 + \$274,269 (Cloud Usage Credits), my share 50%. 09/01/2017-08/31/2020.
- PI, *RI: Medium: Collaborative Research: Understanding and Editing Visual Sentiment*. NSF. \$350,000 (Prior PI, Dr. Guojun Qi). 07/01/2017-06/30/2020.
- Sole PI, *Big Data Research Using Amazon AWS*. \$15,000. Amazon.com, Inc. 08/2017-07/2018.
- Sole PI, *Interdisciplinary "Enhanced Experience" Training on Atmospheric Big Data Analytics*, Supplemental Fund. NSF. \$10,694. 09/2016-08/2017.
- PI, *Optimizing Performance for Cloud and Big Data Computing*. \$2,550. UCF I-Corps. 01/2016-07/2016.
- Sole PI, *Big Data Research on Cloud Computing Using Amazon AWS*. \$10,000. Amazon.com, Inc. 10/2015-10/2016.
- Co-PI, *Wyoming High Performance Computational Science and Engineering Cluster*, with Dimitri Mavriplis (PI) et al., \$1.25m (Dr. Wang's portion around \$250,000). University of Wyoming. 09/2014-09/2016.
- PI, *HPC and Cloud Equipment Enhancement*. \$200,000. University of Wyoming, 2014.
- Sole PI, *Research and Education on Cloud Computing Using Amazon AWS*. \$20,000. Amazon.com, Inc. 04/2013-04/2015.
- PI, *Petascale Implementation and Optimization of LSQR and SeisSol*, with Po Chen (Co-PI). NSF, subaward from the University of Illinois at Urbana-Champaign, \$75,000. 05/2012-05/2013.
- Sole PI, *CSR:Small: Towards Reliable Concurrent Computing Using Hybrid Program Analysis*. NSF. \$354,591. 08/2011-07/2014.
- Sole PI, *Towards Scalable Error Detection for Parallel Software Systems on Emerging Computing Platforms*. NSF CAREER Award. \$450,495. 06/2011-05/2016.
- Sole PI, *Establishing A CUDA Teaching Center at the University of Wyoming*. NVIDIA. \$4,275 in cash and \$4,600 in GPU donation. 2011.
- PI, *Competitive Graduate Assistant*, with James Caldwell and Jerry Hamann (Co-PIs). University of Wyoming. \$44,030 (one graduate assistantship). 08/2011 - 05/2013.
- Sole PI, *EWSI-UW Curriculum Improvement Grant*. University of Wyoming. \$6,500. 2011.
- PI, at Computer Science, *Addressing the Computational Challenges of Time-Lapse, Full-Wave Seismic Imaging Using Hybrid Cluster of GPUs and CPUs*, with Po Chen (Department of Geology and Geophysics, PI at Geophysics). School of Energy Resources at the University of Wyoming. \$114,880 (two graduate assistantships). 08/2011 - 08/2013.
- Sole PI, *Enhancing the Research and Teaching of HPC Software System*. NCAR-CISL, Research and Supercomputing Visitor Program. \$2,400. 2010.



- PI, *Enabling Large-Scale, High-Resolution, and Real-Time Earthquake Simulations on Petascale Parallel Computers*, with Po Chen (Dept of Geology and Geophysics, Co-PI). NSF. \$38,610. 10/2009-09/2013.
- Co-PI, *Acquisition of Graphic-Processing-Units (GPUs) to Upgrade the CPU Cluster at University of Wyoming*, with Po Chen (Dept of Geology and Geophysics, PI) and Manchung Yeung (Dept of Mathematics, Co-PI). NSF. \$74,101. 09/2009-09/2010.
- Sole PI, *Accelerating Utilization of TeraGrid at the University of Wyoming*. NSF TeraGrid Pathways Fellowship. \$8,500. 2009.
- PI, at Computer Science, *Addressing the Computational Challenges of Time-Lapse, Full-Wave Seismic Imaging Using Hybrid Cluster of GPUs and CPUs*, with Po Chen (Department of Geology and Geophysics, PI at Geophysics). School of Energy Resources at the University of Wyoming. \$124,588 (two graduate assistantships). 08/2009 - 08/2011.
- PI, *Continuously Monitoring and Checking Software in the Era of Multicore Systems*, with Zijiang Yang (Western Michigan University, Co-PI at subcontract). Office of Naval Research. \$142,965. 04/2009 - 12/2011.
- Sole PI, *Combined Static and Dynamic Analysis of Concurrency Errors for Critical Software*. Wyoming NASA Space Faculty Research Grant. \$15,000. 2007-2008.

## SELECTED PUBLICATIONS<sup>1</sup>

### Ph.D. Thesis

- **Liqiang Wang**. *Analysis of synchronization errors for multi-threaded programs*. Stony Brook University, Stony Brook, NY, Aug. 2006. Advisor: Scott D. Stoller.

### Journal Publications

- Hong Zhang<sup>†</sup>, Hai Huang, and **Liqiang Wang**. Meteor: Optimizing Spark-on-Yarn for Short Applications. In *Future Generation Computer Systems (FGCS)*, Volume 101, December 2019, Pages 262-271. Elsevier.
- Wingyan Chung, Bingbing Rao<sup>†</sup>, and **Liqiang Wang**. Interaction Models for Detecting Nodal Activities in Temporal Social Media Networks. In *ACM Transactions on Management Information System*, 2019. ACM.
- JianYing Jiao, Ye Zhang, and **Liqiang Wang**. A New Inverse Method for Contaminant Source Identification under unknown Solute Transport Boundary Conditions. In *Journal of Hydrology*, Volume 577, October 2019. Elsevier.
- Siyang Lu, Xiang Wei<sup>†</sup>, Bingbing Rao<sup>†</sup>, Byungchul Tak, Long Wang, and **Liqiang Wang**. LADRA: Log-Based Abnormal Task Detection and Root-Cause Analysis in Big Data Processing with Spark. In *Future Generation Computer Systems (FGCS)*, Volume 95, Pages 392-403, June 2019. Elsevier.

---

<sup>1</sup>All publications, including journal, conference, and workshop, are peer-reviewed except for the Ph.D. thesis.

<sup>†</sup>Students of Dr. Wang.

- Wei Lu, Lei Chen, **Liqiang Wang**, Haitao Yuan, Weiwei Xing, Yong Yang. NPIY: A Novel Partitioner for Improving MapReduce Performance. In *Journal of Visual Languages and Computing*, Volumes 46, 2018, Pages 1-11. Elsevier.
- Weidong Wang<sup>†</sup>, Zhangqin Huang, **Liqiang Wang**. ISAT: An intelligent Web service selection approach for improving reliability via two-phase decisions. In *Information Sciences*, Volumes 433-434, Pages 255-273, April 2018. Elsevier.
- Lei Chen<sup>†</sup>, Wei Lu, Ergude Bao, **Liqiang Wang**, Weiwei Xing, Yuanyuan Cai. Naive Bayes Classifier Based Partitioner for MapReduce. In *IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences*, 101(5), pp. 778-786, 2018. Japan.
- Yong Yang<sup>†</sup>, Wei Lu, Weiwei Xing, **Liqiang Wang**, Xiaoping Che, and Lei Chen<sup>†</sup>. An Algorithm for Detecting and Resolving Deadlocks in Mobile Agent Systems. In *Journal of Visual Languages and Computing*, Volume 42, October 2017, Pages 23-30. Elsevier.
- Wei Lu, Yong Yang<sup>†</sup>, **Liqiang Wang**, Weiwei Xing, Xiaoping Che, and Lei Chen<sup>†</sup>. A Fault Tolerant Election-based Deadlock Detection Algorithm in Distributed Systems. In *Software Quality Journal*, June 2017. Springer.
- Wei Lu, Weidong Wang<sup>†</sup>, Ergude Bao, **Liqiang Wang**, Weiwei Xing, and Yue Chen. FAQs: Fast web service composition algorithm based on QoS-aware sampling. In *IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences*, 99-A(4), pp. 826-834, 2016. Japan.
- Ping Guo<sup>†</sup>, and **Liqiang Wang**. Accurate Cross-Architecture Performance Modeling for Sparse Matrix-Vector Multiplication (SpMV) on GPUs. In *Concurrency and Computation: Practice and Experience*. Volume 27, Issue 13, September 2015, Pages 3281-3294. Wiley Press.
- Wei Lu, Yuanyuan Cai, **Liqiang Wang**, and Weiwei Xing. Cloud Computing Research Analysis Using the Bibliometric Method. In *International Journal of Software Engineering and Knowledge Engineering*, Volume 25, Issue 03, April 2015. World Scientific Publishing.
- Ping Guo<sup>†</sup>, **Liqiang Wang**, and Po Chen. A Performance Modeling and Optimization Analysis Tool for Sparse Matrix-Vector Multiplication on GPUs. In *IEEE Transactions on Parallel and Distributed Systems*, Vol. 25, no. 5, pp. 1112-1123, May 2014. IEEE Press.
- Dawei Mu, Po Chen, and **Liqiang Wang**, Accelerating the discontinuous Galerkin method for seismic wave propagation simulations using multiple GPUs with CUDA and MPI. In *Earthquake Science*, Volume 26, Issue 6, pp 377-393, December 2013. Springer.
- Po Chen, En-Jui Lee, and **Liqiang Wang**, A cloud-based synthetic seismogram generator implemented using Windows Azure. In *Earthquake Science*, Volume 26, Issue 5, pp 321-329, October 2013. Springer.
- En-Jui Lee, He Huang<sup>†</sup>, John M. Dennis, Po Chen and **Liqiang Wang**, An optimized parallel LSQR algorithm for seismic tomography. In *Computers and Geosciences*, Volume 61, Pages 184-197, 2013. Elsevier.
- Dawei Mu, Po Chen, and **Liqiang Wang**. Accelerating the Discontinuous Galerkin Method for Seismic Wave Propagation Simulations Using the Graphic Processing Unit (GPU): Single-GPU Implementation. In *Computers and Geosciences*, Volume 51, February 2013, Pages 282-292. Elsevier.

- Qichang Chen<sup>†</sup>, **Liqiang Wang**, and Zijiang Yang. HEAT: A Combined Approach for Thread Escape Analysis. In *International Journal of Systems Assurance Engineering and Management*, Volume 2, Number 2, pages 135-143, 2011. Springer.
- En-Jui Lee, Po Chen, Thomas Jordan, and **Liqiang Wang**. Rapid Centroid Moment Tensor (CMT) Inversion in a Three- Dimensional Earth Structure Model for Earthquakes in Southern California. In *Geophysical Journal International*, Volume 186, Issue 1, pages 311-330, July 2011. Wiley.
- Dharma Teja Nukarapu, Bin Tang, **Liqiang Wang**, and Shiyong Lu. Data Replication in Data Intensive Scientific Applications With Performance Guarantee. In *IEEE Transactions on Parallel and Distributed Systems*, Volume 22, Issue 8, pages 1299 - 1306, August 2011. IEEE Press.
- R. Agarwal, S. Bensalem, E. Farchi, K. Havelund, Y. Nir-Buchbinder, S. D. Stoller, S. Ur, and **L. Wang**. Detection of Deadlock Potentials in Multi-Threaded Programs. In *IBM Journal of Research and Development*, 54(5), pages 1-15, September/October 2010.
- Qichang Chen<sup>†</sup>, **Liqiang Wang**, Ping Guo<sup>†</sup>, and He Huang<sup>†</sup>. Analyzing Concurrent Programs for Potential Programming Errors (book chapter). In *Modern Software Engineering Concepts and Practices*. Pages 380-415. IGI Global. 2010.
- **Liqiang Wang**, Shiyong Lu, Xubo Fei, Artem Chebotko, H. Victoria Bryant<sup>†</sup>, and Jeffrey Ram. Atomicity and Provenance Support for Pipelined Scientific Workflows. In *Journal of Future Generation Computer Systems (FGCS)*. Volume 25, Issue 5, May 2009, pages 568-576. Elsevier Science Inc.
- **Liqiang Wang** and Scott D. Stoller. Runtime Analysis of Atomicity for Multi-threaded Programs. In *IEEE Transactions on Software Engineering*, Volume 32, Issue 2, pages 93-110, Feb. 2006. IEEE Press.
- R.D. Cowan, Alan McKendall Jr., Ali Mili, L. Yang, **L. Wang**, D. Chen, V. Janardhana, and T. Spencer. Software Engineering Technology Watch. In *Information Sciences*, 140(3-4), pages 195-215. Elsevier Science Inc., 2002.

### Conference and Workshop Publications

- Yandong Li<sup>†</sup>, Lijun Li, **Liqiang Wang**, Tong Zhang, and Boqing Gong. NATTACK: Improved Black-Box Adversarial Attack with Normal Distributions. In *the 36<sup>th</sup> International Conference on Machine Learning (ICML)*. Long Beach, CA. 2019.
- Yifan Ding<sup>†</sup>, **Liqiang Wang**, Huan Zhang, Jinfeng Yi, Deliang Fan, and Boqing Gong. Defending Against Adversarial Attacks Using Random Forest. In *The Bright and Dark Sides of Computer Vision: Challenges and Opportunities for Privacy and Security (CV-COPS), Workshop of the 30th IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*. Long Beach, CA. 2019. IEEE Press.
- Liheng Zhang<sup>†</sup>, Guo-jun Qi, **Liqiang Wang**, and Jiebo Luo. AET vs. AED: Unsupervised Representation Learning by Auto-Encoding Transformations rather than Data. In *the 30th IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*. Long Beach, CA. 2019. IEEE Press.

- Ehsan Kazemi<sup>†</sup> and **Liqiang Wang**. Asynchronous Delay-Aware Accelerated Proximal Coordinate Descent for Nonconvex Nonsmooth Problems. In *The Thirty-Third AAAI Conference on Artificial Intelligence (AAAI)*. Honolulu, Hawaii, USA. 2019.
- Hao Hu<sup>†</sup>, **Liqiang Wang**, Guo-jun Qi. Learning to Adaptively Scale Recurrent Neural Networks. In *The Thirty-Third AAAI Conference on Artificial Intelligence (AAAI)*. Honolulu, Hawaii, USA. 2019.
- Yandong Li<sup>†</sup>, Yunhui Guo, **Liqiang Wang**, and Tajana Rosing. Depthwise Convolution is All You Need for Learning Multiple Visual Domains. In *The Thirty-Third AAAI Conference on Artificial Intelligence (AAAI)*. Honolulu, Hawaii, USA. 2019.
- Zixia Liu<sup>†</sup>, Hong Zhang<sup>†</sup>, Bingbing Rao<sup>†</sup>, **Liqiang Wang**. A Reinforcement Learning Based Resource Management Approach for Time-critical Workloads in Distributed Computing Environment. In *2018 IEEE International Conference on Big Data (IEEE BigData)*. December 10-13, 2018, Seattle, WA, USA.
- Ehsan Kazemi<sup>†</sup> and **Liqiang Wang**. A Proximal Zeroth-Order Algorithm for Nonconvex Nonsmooth Problems. In *the 56th Annual Allerton Conference on Communication, Control, and Computing*. UIUC. October 3-5, 2018.
- Yandong Li<sup>†</sup>, **Liqiang Wang**, Tianbao Yang, and Boqing Gong. How Local is the Local Diversity? Reinforcing Sequential Determinantal Point Processes with Dynamic Ground Sets for Supervised Video Summarization. In *the 2018 European Conference on Computer Vision (ECCV)*. Munich, Germany. Sept. 8-14, 2018.
- Hong Zhang<sup>†</sup>, Hai Huang, and **Liqiang Wang**. FTSGD: An Adaptive Stochastic Gradient Descent Algorithm for Spark MLlib. In *the 16th IEEE International Conference on Pervasive Intelligence and Computing (PICom)*. Athens, Greece. August 12-15, 2018.
- Siyang Lu<sup>†</sup>, Xiang Wei<sup>†</sup>, Yandong Li<sup>†</sup>, and **Liqiang Wang**. Anomaly Detection from Big Data System Logs Using Convolutional Neural Network. Best Paper Award. In *2018 IEEE Cyber Science and Technology Congress (CyberSciTech)*. Athens, Greece. August 12-15, 2018.
- Xiang Wei<sup>†</sup>, Boqing Gong, Zixia Liu<sup>†</sup>, Wei Lu, **Liqiang Wang**. Improving the Improved Training of Wasserstein GANs. In *the Sixth International Conference on Learning Representations (ICLR)*. Vancouver Canada. April 30-Thursday May 03, 2018.
- Hong Zhang<sup>†</sup>, Zixia Liu, **Liqiang Wang**. Tuning Performance of Spark Programs. In Doctoral Symposium, In *the 2018 IEEE International Conference on Cloud Engineering (IC2E)*. Orlando, FL, USA. April 17-20, 2018. IEEE Press.
- Yifan Ding<sup>†</sup>, **Liqiang Wang**, Deliang Fan, Boqing Gong. A Semi-Supervised Two-Stage Approach to Learning from Noisy Labels. In *2018 IEEE Winter Conference on Applications of Computer Vision (WACV)*. Reno, Nevada, USA. March 12-14, 2018. IEEE Press.
- Bingbing Rao<sup>†</sup> and **Liqiang Wang**. A Survey of Semantics-Aware Performance Optimization for Data-Intensive Computing. In *2017 IEEE Cyber Science and Technology Congress (CyberSciTech)*. Orlando, FL, USA. Nov 6-10, 2017. IEEE Press.

- Lei Chen<sup>†</sup>, Wei Lu, **Liqiang Wang**, Ergude Bao, Weiwei Xing, and Yong Yang<sup>†</sup>. Optimizing MapReduce Partitioner Using Naive Bayes Classifier. In *The 15th IEEE International Conference on Pervasive, Intelligence and Computing (PICom 2017)*. Orlando, FL, USA. Nov 6-10, 2017. IEEE Press.
- Zixia Liu<sup>†</sup>, Hong Zhang<sup>†</sup>, and **Liqiang Wang**. Hierarchical Spark: A Multi-cluster Big Data Computing Framework. In *the 10th IEEE International Conference on Cloud Computing*. Honolulu, Hawaii, USA. June 25-30, 2017. IEEE Press.
- Siyang Lu<sup>†</sup>, Bingbing Rao<sup>†</sup>, Xiang Wei<sup>†</sup>, Byungchul Tak, Long Wang, and **Liqiang Wang**. Log-based Abnormal Task Detection and Root Cause Analysis for Spark. In *the 24th IEEE International Conference on Web Services*. Honolulu, Hawaii, USA. June 25-30, 2017. IEEE Press.
- Hong Zhang<sup>†</sup>, Hai Huang, and **Liqiang Wang**. MRapid: An Efficient Short Job Optimizer on Hadoop. In *the 31st IEEE International Parallel & Distributed Processing Symposium (IPDPS)*. Orlando, USA. May 29 - June 2, 2017 IEEE Press.
- Lei Chen<sup>†</sup>, Wei Lu, Xiaoping Che, Weiwei Xing, **Liqiang Wang**, and Yong Yang<sup>†</sup>. MRSIM: Mitigating Reducer Skew In MapReduce. In *the 31st International Conference on Advanced Information Networking and Applications Workshops (WAINA)*, 27-29 March 2017. IEEE Press.
- Wingyan Chung, Bingbing Rao<sup>†</sup>, and **Liqiang Wang**. Dynamic Trend Detection in U.S. Border Security Social-Media Networks. In *2016 Interservice/Industry Training, Simulation and Education Conference (I/ITSEC)*. Orlando, FL. Nov. 28 - Dec. 2. 2016.
- Wei Lu, Yong Yang<sup>†</sup>, **Liqiang Wang**, Weiwei Xing, and Xiaoping Chen. A Leader Election Based Deadlock Detection Algorithm in Distributed Systems. In *2016 Workshop on Specification, Comprehension, Testing and Debugging of Concurrent Programs, IEEE/ACM International Conference on Automated Software Engineering (ASE)*. Singapore, Singapore, 3-7 September, 2016. ACM Press.
- Weidong Wang<sup>†</sup>, **Liqiang Wang**, Wei Lu. An Intelligent QoS Identification for Untrustworthy Web Services Via Two-phase Neural Networks. In *the 23rd IEEE International Conference on Web Services (ICWS) (Research Track)*. July, 2016, San Francisco, USA. IEEE Press.
- Hongyi Ma<sup>†</sup>, **Liqiang Wang**, Long Wang, Byung-Chul Tak, Chuangqiang Tang. Auto-tuning Performance of MPI Parallel Programs Using Resource Management in Container-based Virtual Cloud. In *the 9th IEEE International Conference on Cloud Computing (IEEE Cloud)*. San Francisco, USA. July, 2016. IEEE Press.
- Zhibo Sun<sup>†</sup>, Hong Zhang<sup>†</sup>, Zixia Liu<sup>†</sup>, Chen Xu, and **Liqiang Wang**. Migrating GIS Big Data Computing from Hadoop to Spark: An Exemplary Study Using Twitter. In *the 9th IEEE International Conference on Cloud Computing (IEEE Cloud, Research Track)*. San Francisco, USA. July, 2016. IEEE Press.
- Yong Yang<sup>†</sup>, Wei Lu, **Liqiang Wang**, Weiwei Xing, and Xiaoping Chen. A Novel Concurrent Generalized Deadlock Detection Algorithm in Distributed Systems. In *the 15th International Conference on Algorithms and Architectures for Parallel Processing (ICA3PP 2015)*, Nov. 2015. Zhangjiajie, China. LNCS Volume 9529, pp 479-493, Springer.

- Hongyi Ma<sup>†</sup>, **Liqiang Wang**, and Krishanthan Krishnamoorthy<sup>†</sup>. Detecting Thread-Safety Violations in Hybrid OpenMP/MPI Programs. In *the 2015 IEEE International Conference on Cluster Computing (CLUSTER 2015)*, Sept. 2015. Chicago, USA. IEEE Press.
- Hong Zhang<sup>†</sup>, Zhibo Sun<sup>†</sup>, Zixia Liu<sup>†</sup>, Xu Chen, and **Liqiang Wang**. DART: A Geographic Information System on Hadoop. In *the IEEE 8th International Conference on Cloud Computing (IEEE Cloud) (Research Track)*. June 27-July 2, 2015, New York, USA. IEEE Press.
- Weidong Wang<sup>†</sup>, **Liqiang Wang**, and Wei Lu. A Resilient Framework for Fault Handling in Web Service Oriented Systems . In *the 22nd IEEE International Conference on Web Services (ICWS)*. July, 2015, New York, USA. IEEE Press.
- Hong Zhang<sup>†</sup>, **Liqiang Wang**, Hai Huang. SMARTH: Enabling Multi-Pipeline Data Transfer in HDFS. In *the 43rd International Conference on Parallel Processing (ICPP-2014)*. September 9-12, 2014. Minneapolis, USA. IEEE Press.
- Hongyi Ma<sup>†</sup>, Steve R. Diersen<sup>†</sup>, **Liqiang Wang**, Chunhua Liao, Daniel Quinlan, and Zijiang Yang. Symbolic Analysis of Concurrency Errors in OpenMP Programs. In *the 42nd International Conference on Parallel Processing (ICPP-2013)*. October 1-4, 2013, Lyon, FranceA. IEEE Press.
- He Huang<sup>†</sup>, **Liqiang Wang**, Byung Chul Tak, Long Wang, and Chunqiang Tang. CAP3: A Cloud Auto-Provisioning Framework for Parallel Processing Using On-demand and Spot Instances. In *the IEEE 6th International Conference on Cloud Computing(IEEE Cloud) (Research Track)*. June 27-July 2, 2013, Santa Clara, CA, USA. IEEE Press.
- He Huang<sup>†</sup>, John M. Dennis, **Liqiang Wang**, and Po Chen. A Scalable Parallel LSQR Algorithm for Solving Large-Scale Linear System for Tomographic Problems: A Case Study in Seismic Tomography. In *the 2013 International Conference on Computational Science (ICCS) (main track)*. Procedia Computer Science, Elsevier, 2013.
- Weidong Wang<sup>†</sup>, Wei Lu, **Liqiang Wang**, Weiwei Xing, Zhao Li. A Ranking-based Approach for Service Composition with Multiple QoS Constraints. In *2012 International Conference on Information Technology and Software Engineering*. Beijing China. Lecture Notes in Electrical Engineering, Springer-Verlag, 2012.
- Hongyi Ma<sup>†</sup>, Qichang Chen<sup>†</sup>, **Liqiang Wang**, Chunhua Liao, and Daniel Quinlan. Analyzing OpenMP programs for Concurrency Errors. In *the 41st International Conference on Parallel Processing (ICPP)*. Pittsburgh, PA. Poster Paper. IEEE Press, 2012.
- Ping Guo<sup>†</sup> and **Liqiang Wang**. Accurate CUDA Performance Modeling for Sparse Matrix-Vector Multiplication. In *the 2012 International Conference on High Performance Computing & Simulation (HPCS 2012)*. Madrid, Spain. IEEE Press, 2012.
- He Huang<sup>†</sup>, **Liqiang Wang**, En-Jui Lee, and Po Chen. An MPI-CUDA Implementation and Optimization for Parallel Sparse Equations and Least Squares (LSQR). In *the 2012 International Conference on Computational Science (ICCS) (main track)*. Procedia Computer Science, Elsevier, 2012.
- Qichang Chen<sup>†</sup>, **Liqiang Wang**, and Zijiang Yang. SAM: Self-adaptive Dynamic Analysis for Multithreaded Programs. In *Haifa Verification Conference (HVC) 2011*. LNCS, Springer-Verlag. 15 Pages. 2011.

- Ping Guo<sup>†</sup>, He Huang<sup>†</sup>, Qichang Chen<sup>†</sup>, **Liqiang Wang**, En-Jui Lee, and Po Chen. A Model-Driven Partitioning and Auto-tuning Integrated Framework for Sparse Matrix-Vector Multiplication on GPUs. In *the 2011 TeraGrid Conference*. Pages 1-8. Salt Lake City, UT. ACM Press, 2011.
- Vedaprakash Subramanian<sup>†</sup>, Hongyi Ma<sup>†</sup>, **Liqiang Wang**, En-Jui Lee, and Po Chen. Rapid 3D Seismic Source Inversion using Windows Azure and Amazon EC2. In *2011 IEEE World Congress on Services*. Washington DC. IEEE Press, 2011.
- Steve Diersen<sup>†</sup>, En-Jui Lee, Diana Spears, Po Chen, and **Liqiang Wang**. Classification of Seismic Windows Using Artificial Neural Networks. In *the 2011 International Conference on Computational Science (ICCS)*. Procedia Computer Science, Volume 4, Pages 1572-1581, Elsevier, 2011.
- Vedaprakash Subramanian<sup>†</sup>, **Liqiang Wang**, En-Jui Lee, and Po Chen. Rapid Processing of Synthetic Seismograms Using Windows Azure Cloud. In *the 2nd IEEE International Conference on Cloud Computing Technology and Science (CloudCom 2010)*. Pages 193-200. Indianapolis, Indiana. IEEE Press, 2010.
- Ping Guo<sup>†</sup> and **Liqiang Wang**. Auto-Tuning CUDA Parameters for Sparse Matrix-Vector Multiplication on GPUs. In *the 2010 International Conference on Computational and Information Sciences*. Pages 1154 - 1157. Chengdu, China. IEEE Press, 2010.
- Mohamed Elwakil, Zijiang Yang, **Liqiang Wang**, and Qichang Chen<sup>†</sup>. Message Race Detection for Web Services by an SMT-Based Analysis. In *the 7th International Conference on Autonomic and Trusted Computing (ATC 2010)*. LNCS 6407:182-194, Springer-Verlag. 2010.
- Mohamed Elwakil, Zijiang Yang, and **Liqiang Wang**. CRI: Symbolic Debugger for MCAPI Applications. In *the 8th International Symposium on Automated Technology for Verification and Analysis (ATVA)*. Singapore. LNCS 6252:353-358, Springer-Verlag. 2010.
- He Huang<sup>†</sup>, **Liqiang Wang**. P&P: a Combined Push-Pull Model for Resource Monitoring in Cloud Computing Environment. In *the 3rd International Conference on Cloud Computing (IEEE CLOUD)*. Pages 260-267. Miami, Florida. IEEE Press, 2010.
- Qichang Chen<sup>†</sup>, **Liqiang Wang**. An Integrated Framework for Checking Concurrency-related Programming Errors. In *the 33rd Annual IEEE International Computer Software and Applications Conference (COMPSAC), Doctoral Symposium*. Pages 676-679. Seattle, Washington. IEEE Press, 2009.
- Qichang Chen<sup>†</sup>, **Liqiang Wang**, Zijiang Yang. HEAT: A Combined Static and Dynamic Approach for Escape Analysis. In *the 33rd Annual IEEE International Computer Software and Applications Conference (COMPSAC)*. 142-147. Seattle, Washington. IEEE Press, 2009.
- Qichang Chen<sup>†</sup>, **Liqiang Wang**, Zijiang Yang, and Scott D. Stoller. HAVE: Integrated Dynamic and Static Analysis for Atomicity Violations. In *the Proceedings of International Conference on Fundamental Approaches to Software Engineering (FASE), the European Joint Conferences on Theory and Practice of Software (ETAPS)*. LNCS 5503:425-439, Springer-Verlag, 2009.

- Qichang Chen<sup>†</sup>, **Liqiang Wang**, and Zongbo Shang. MRGIS: A MapReduce-Enabled High Performance Workflow System for GIS. In *the 3rd International Workshop on Scientific Workflows and Business Workflow Standards in e-Science (SWBES)*. Pages 646-651. Indianapolis, USA. IEEE Press, 2008.
- Zongmin Shang, Haiyang Wang, **Liqiang Wang**, Hui Li, and Yongquan Dong. Running Smart Process Based on Goals. In *The 12th International Conference on Computer Supported Cooperative Work in Design (CSCWD)*. Pages 427-433. IEEE Press, 2008.
- **Liqiang Wang**, Shiyong Lu, Xubo Fei, and Jeffrey Ram. A Dataflow-Oriented Atomicity and Provenance System for Pipelined Scientific Workflows. In *the 2007 International Conference on Computational Science (ICCS)*. LNCS 4489:244-252, Springer-Verlag, 2007.
- **Liqiang Wang** and Scott D. Stoller. Accurate and Efficient Runtime Detection of Atomicity Errors in Concurrent Programs. In *Proceedings of the ACM SIGPLAN 2006 Symposium on Principles and Practice of Parallel Programming (PPoPP)*. Pages 137-146. ACM Press, 2006.
- Rahul Agarwal, **Liqiang Wang**, and Scott D. Stoller. Detecting Potential Deadlocks with Static Analysis and Runtime Monitoring. In *Proceedings of the Parallel and Distributed Systems: Testing and Debugging (PADTAD) Track of the 2005 IBM Verification Conference*. Springer-Verlag LNCS 3875: 191-207, 2006. Received the conference's Best Paper Award.
- Rahul Agarwal, Amit Sasturkar, **Liqiang Wang**, and Scott D. Stoller. Optimized Run-Time Race Detection And Atomicity Checking Using Partial Discovered Types. In *Proceedings of the 20th IEEE/ACM International Conference on Automated Software Engineering (ASE)*. Pages 233-242. ACM Press, 2005.
- **Liqiang Wang** and Scott D. Stoller. Static Analysis of Atomicity for Programs with Non-Blocking Synchronization. In *Proceedings of the ACM SIGPLAN 2005 Symposium on Principles and Practice of Parallel Programming (PPoPP)*. Pages 61-71. ACM Press, 2005.
- Amit Sasturkar, Rahul Agarwal, **Liqiang Wang**, and Scott D. Stoller. Automated Type-Based Analysis of Data Races and Atomicity. In *Proceedings of the ACM SIGPLAN 2005 Symposium on Principles and Practice of Parallel Programming (PPoPP)*. Pages 83-94. ACM Press, 2005.
- **Liqiang Wang** and Scott D. Stoller. Run-Time Analysis for Atomicity. In *Proceedings of the Third Workshop on Runtime Verification (RV03)*, volume 89(2) of Electronic Notes in Theoretical Computer Science. Pages 191-209. Elsevier, 2003.

### Technical Magazine Articles

- Vedaprakash Subramanian<sup>†</sup>, Hongyi Ma<sup>†</sup>, **Liqiang Wang**, En-Jui Lee, and Po Chen. Azure Use Case Highlights Challenges for HPC Applications in the Cloud. In *HPC in the Cloud*, feature article. February 21, 2011.

### Publications in Chinese

- **Liqiang Wang** and Changjie Tang. Web Mining Based on Temporal Database System. In *Proceedings of the 14th National Database Conference of China*, 1997. Received the conference's Best Student Paper Award.



- Wei Lu and **Liqiang Wang**. Query Optimization for a Commercial Database. In *Journal of Sichuan University (Natural Science Edition)*. Sichuan University Press, Jan. 1997.
- Wei Lu and **Liqiang Wang**. Visualization of Data Queries. In *Journal of Computer Engineering and Applications*, May 1997.
- **Liqiang Wang** and Changjie Tang. Data Mining on Web. In *Journal of Computer Applications*, Oct. 1998.

## PROFESSIONAL AND SCIENTIFIC SERVICE

- Member of Grant Review Panels
  - ◊ NSF Panel.
  - ◊ NSF External Reviewer.
  - ◊ Research Grants Council of Hong Kong.
  - ◊ NSF Committee on Software Infrastructure, 2016-2018.
  - ◊ Wyoming NASA Space Grant Consortium, 2008.
- UCF Committees
  - IT Curriculum Oversight and Review Committee
  - College RIA Selection Committee.
- Chair or Senior Members of Conference/Workshop Program Committees
  - ◊ Advisory Committee member, The 16th IEEE International Conference on Pervasive, Intelligence and Computing (PICom), Nov, 2019, 2020.
  - ◊ Executive Chair, The 16th IEEE International Conference on Pervasive, Intelligence and Computing (PICom), Nov, 2018.
  - ◊ Doctoral Symposium Chair, IEEE International Conference on Cloud Engineering (IC2E 2018).
  - ◊ Senior Program Committee, IEEE International Conference on Big Data. 2017, 2018
  - ◊ Chair, The 15th IEEE International Conference on Pervasive, Intelligence and Computing (PICom), Nov, 2017.
  - ◊ Local Arrangement Chair, The 8th International Green and Sustainable Computing Conference (IGSC 2017)
  - ◊ Application Track Chair, IEEE International Conference on Web Services (ICWS). 2017
  - ◊ Track Chair, the 9th IEEE International Conference on Cloud Computing. June 27 - July 2, 2016, San Francisco, USA
  - ◊ Short Paper Chair, the 5th IEEE International Congress on Big Data. June 27 - July 2, 2016, San Francisco, USA
- Members of Conference/Workshop Program Committees
  - ◊ IEEE International Conference on Web Services (ICWS). 2013, 2014, 2015, 2016, 2017, 2018, 2019

- ◇ IEEE International Conference on Cloud Computing. 2016, 2017, 2018, 2019
- ◇ The IEEE International Congress on Internet of Things (ICIOT). 2017, 2018, 2019
- ◇ The 15th International Conference on eScience, 2019
- ◇ The IEEE Graph Computing (GC). 2019
- ◇ The IEEE International Symposium on Service-Oriented System Engineering. 2017, 2018, 2019.
- ◇ The International Workshop on Programming Models and Applications for Multicores and Manycores (PMAM). 2014, 2015, 2016, 2017, 2018, 2019.
- ◇ The 5th Annual Conference on machine Learning, Optimization and Data science (LOD), 2019
- ◇ IEEE International Conference on Cognitive Computing. 2017
- IEEE International Congress on Big Data. 2016, 2017.
- IEEE 11th International Conference on Frontier of Computer Science and Technology (FCST-2017)
- The 3rd International Workshop on Machine learning, Optimization & big Data - MOD 2017 Volterra (Pisa), Tuscany, Italy, September 17-21, 2017
- The Third International Conference on Human and Social Analytics (HUSO 2017), July 23 - 27, 2017 - Nice, France.
- ◇ Chair, IEEE International Workshop on Scientific Workflows and Big Data Sciences (SWF). 2010, 2013, 2014.
- ◇ Chair, the 2nd International Conference on Information Technology and Software Engineering, 2014. Beijing , China.
- ◇ The ASE Workshop on Specification, Comprehension, Testing and Debugging of Concurrent Programs. Singapore, Singapore, 3-7 September, 2016
- ◇ The 3rd International Workshop on Internet of Things Technologies. Melbourne, Australia. December 14-17, 2015
- ◇ International Workshop on Trustworthy Software Systems. Helsinki, Finland. August, 2015
- ◇ The International Workshop on Advances in High-Performance Computational Earth Sciences: Applications and Frameworks (IHPCES 2011, 2012, 2013, 2014, 2015, 2016, 2017).
- ◇ IEEE International Workshop on Scalable Cloud Data Management (SCDM). 2013, 2014, 2015, 2016, 2017
- ◇ Chair, IEEE Service Cup, 2012, 2013.
- ◇ IEEE International Conference on Big Data. 2013, 2014.
- ◇ The International Workshop on Analytics Services on the Cloud. Berlin, Germany. December, 2013.
- ◇ The 2nd International Workshop on Grid Friendly Computing (GFC). Arlington, VA. June 2013.
- ◇ The International Workshop on Workflow Models, Systems, Services and Applications in the Cloud (CloudFlow) 2012, 2013.

- ◇ The IEEE International Workshop on Scientific Workflows (SWF 2007, 2008, 2009, 2011, 2012).
  - ◇ The 12th IEEE International Conference on Scalable Computing and Communications (ScalCom-2012). Dec. 2012.
  - ◇ The IEEE International Conference on Dependable, Autonomic and Secure Computing (DASC, 2009, 2011).
  - ◇ The 14th IEEE International Conference on Computational Science and Engineering (CSE-2011). August 24-26, 2011.
  - ◇ The 5th Annual IEEE Service Cup, 2010.
  - ◇ The 25th Annual ACM Symposium on Applied Computing (SAC), the Software Engineering Track, 2010.
  - ◇ The International Association of Science and Technology for Development (IASTED) Technical Committee on Software Engineering for the term 2008-2011.
  - ◇ The 3rd IEEE International Workshop on Scientific Workflows and Business Workflow Standards in e-Science (SWBES 2008).
- Guest Editor for Journal of Security and Communication Networks, Wiley.
  - Reviewer for
    - ◇ The above conferences.
    - ◇ IEEE Transactions on Parallel and Distributed Systems.
    - ◇ IEEE Transactions on Computers
    - ◇ IEEE Transactions on Cloud Computing
    - ◇ IEEE Transactions on Software Engineering.
    - ◇ IEEE Transactions on Mobile Computing
    - ◇ IEEE Transactions on Automation Science and Engineering,
    - ◇ IEEE Transactions on Industrial Informatics,
    - ◇ Neural Computing and Applications, Springer.
    - ◇ Journal of Future Generation Computer Systems (FGCS), Elsevier.
    - ◇ Journal of Parallel and Distributed Computing (JPDC), Elsevier.
    - ◇ Journal of Supercomputing, Springer.
    - ◇ International Journal on Software Tools for Technology Transfer (STTT), Springer.
    - ◇ Concurrency and Computation: Practice and Experience.
    - ◇ Journal of Sensors, MDPI.
    - ◇ Science of Computer Programming.
    - ◇ Journal of Zhejiang University Science C (Computers & Electronics).
    - ◇ International Journal of Computers and Their Applications (IJCA).
    - ◇ The 23rd International Conference on Computer Aided Verification (CAV). 2011.
    - ◇ ACM SIGPLAN 2011 Workshop on Partial Evaluation and Program Manipulation (PEPM).
    - ◇ The book of *Modern Software Engineering Concepts and Practices*. IGI Global. 2010.

- ◇ The 5th IEEE International Conference on e-Science (2009).
- ◇ International Conference on Compiler Construction (CC 2009, a member conference of ETAPS).
- ◇ The 4th International Workshop on Workflow systems in e-Science (WSES09).
- ◇ APLAS: ASIAN Symposium on Programming Languages and Systems (2007).
- ◇ The Seventh Workshop on Runtime Verification (RV 2007).
- ◇ ACM SIGPLAN 2006 Conference on Programming Language Design and Implementation (PLDI).
- ◇ The 2nd International Symposium on Automated Technology for Verification and Analysis (ATVA 2004).
- ◇ ACM SIGPLAN 2004 Symposium on Partial Evaluation and Program Manipulation (PEPM 2004).
- Other Services
  - ◇ Invited Speaker for NSF workshop of “Parallel Numerical Methods for Partial Differential Equations” at the University of Wyoming, 2008.
  - ◇ Invited Keynote Speech for IEEE International 2nd Workshop on Scalable Cloud Data Management, 2014.

### **Courses Taught at the University of Central Florida**

- Fall 2019, (COP 6526) Parallel and Cloud Computation, 3 credits, 33 students.
- Spring 2019, (COP 4600) Operating Systems, 3 credits, 186 students.
- Spring 2019, (COP 5611) Operating Systems Design Principles, 3 credits, 26 students.
- Fall 2018, (COP 6526) Parallel and Cloud Computation, 3 credits, 22 students.
- Spring 2018, (CDA 5937) High-Performance Computing and Programming, 3 credits, 11 students.
- Spring 2018, (COP 5611) Operating Systems Design Principles, 3 credits, 20 students.
- Fall 2017, (COP 6526) Parallel and Cloud Computation, 3 credits, 13 students.
- Spring 2017, (CIS4932C) Cloud Computing Management, 3 credits, 24 students.
- Fall 2016, (CNT 3004) Computer Network Concepts, 3 credits, 99 students.
- Spring 2016, (CIS4932C) Cloud Computing Management, 3 credits, 24 students.
- Fall 2015, (CNT 3004) Computer Network Concepts, 3 credits, 70 students.

## Courses Taught at the University of Wyoming

- Spring 2015, (COSC 4010 & COSC 5010) Big Data and Cloud Computing, 3 credits, 25 students.
- Fall 2014, (COSC 4010 & COSC 5010) Introduction to High-Performance Computing, 3 credits, 18 students.
- Spring 2014, (COSC 4740) Operating Systems Design, 4 credits. 28 students.
- Fall 2013, (COSC 4010 & COSC 5010) Introduction to High-Performance Computing, 3 credits, 20 students.
- Fall 2013, (COSC 4740) Operating Systems Design, 4 credits. 12 students.
- Spring 2012, (COSC 4740) Operating Systems Design, 4 credits. 7 students.
- Spring 2012, (COSC 5000) Computer Science Seminar, 1 credit, 10 students.
- Fall 2011, (COSC 4740) Operating Systems Design, 4 credits. 11 students.
- Fall 2011, (COSC 4010 & COSC 5010) Introduction to High-Performance Computing, 3 credits, 11 students.
- Spring 2011, (COSC 4740) Operating Systems Design, 4 credits, 8 students.
- Fall 2010, (COSC 4740) Operating Systems Design, 4 credits, 5 students.
- Fall 2010, (COSC 4010 & COSC 5010) Introduction to High-Performance Computing, 3 credits, 12 students.
- Spring 2010, (COSC 4740) Operating Systems Design, 4 credits, 8 students.
- Spring 2010, (COSC 5000) Computer Science Seminar, 1 credit, 4 students.
- Fall 2009, (COSC 4010 & COSC 5010) Introduction to High-Performance Computing, 3 credits, 12 students.
- Fall 2009, (COSC 4740) Operating Systems Design, 4 credits, 14 students.
- Spring 2009, (COSC 4740) Operating Systems Design, 4 credits, 6 students.
- Spring 2009, (COSC 5000) Computer Science Seminar, 1 credit, 3 students.
- Fall 2008, (COSC 4740) Operating Systems Design, 4 credits, 8 students.
- Fall 2008, (COSC 4785 & COSC 5785) Compiler Construction I & II, 3 credits, 7 students.
- Spring 2008, (COSC 4740) Operating Systems Design, 4 credits, 9 students.
- Spring 2008, (COSC 5000) Computer Science Seminar, 1 credit, 7 students.
- Fall 2007, (COSC 4760) Computer Networks, 3 credits, 14 students.
- Fall 2007, (COSC 5000) Computer Science Seminar, 1 credit, 9 students.

- Spring 2007, (COSC 4740) Operating Systems Design, 4 credits, 12 students.
- Spring 2007, (COSC 5000) Computer Science Seminar, 1 credit, 12 students.
- Fall 2006, (COSC 4760) Computer Networks, 3 credits, 17 students.

## STUDENTS SUPERVISED

### Current Ph.D. Students (as their primary advisor)

1. Zixia Liu (Ph.D. candidate, 01/2015 - present)
2. BingBing Rao (Ph.D. candidate, 01/2016 - present)
3. Ehsan Kazemy (Ph.D. candidate, 08/2017 - present)
4. Yifan Ding (Ph.D. candidate, 01/2018 - present, Co-supervised with Dr. Boqing Gong)
5. Yandong Li (Ph.D. candidate, 01/2018 - present, Co-supervised with Dr. Boqing Gong)
6. Dongdong Wang (Ph.D. candidate, 05/2018 - present)
7. Zihang Zou (Ph.D. candidate, 08/2018-present)
8. Muhammad Abdullah Jamal (Ph.D. candidate, 08/2018-present, Co-supervised with Dr. Boqing Gong)
9. Liheng Zhang (Ph.D. candidate, 08/2018-present, Co-supervised with Dr. Guojun Qi)
10. Mohamed Elfeki (Ph.D. candidate, 03/2019-present)
11. Jie Yao (Visiting Ph.D. candidate, 05/2019-present)

### Students Graduated (as their primary advisor)

- Siyang Lu (Ph.D. 09/2014 - 08/2019). Detecting Anomalies from System Logs. Employment: Assistant Professor, Beijing Jiaotong University.
- Hao Hu (Ph.D., 05/2019, Co-supervised with Dr. Guojun Qi). Learning Robust Sequence Features via Dynamic Temporal Pattern Discovery. Employment: Research Scientist, Fxpal Inc.
- Hong Zhang (Ph.D., 09/2012-07/2018, UCF). Dissertation topic “Towards High-Performance Big Data Processing Systems”. Employment: Associate Professor, Hebei University, China.
- Hongyi Ma (Ph.D., 09/2010-08/2015, UWyo). Dissertation topic “Improving Reliability and Performance of High Performance Computing Applications”. Employment: VMWare Inc.
- Ping Guo (Ph.D., 01/2009 - 08/2014, UWyo). Dissertation topic “Performance Prediction and Optimization for Sparse Matrix-Vector Multiplication (SpMV) on GPUs”. Employment: Assistant Professor, Department of Computer Science, University of Illinois at Springfield.
- He Huang (Ph.D., 08/2009 - 08/2013, UWyo). Dissertation topic “Addressing Scalability and Resource Provisioning Problems for Scientific Applications on Parallel Platforms”. Employment: Amazon.

- Qichang Chen (Ph.D., 08/2006-06/2011, UWyo). Dissertation topic “An Integrated Static and Dynamic Program Analysis Framework for Checking Concurrency-Related Programming Errors”. Employment: Huawei Inc.
- Chao Liang (M.S., 08/2015, UWyo) Thesis topic “Processing Seismic Inversion Problems Using Hadoop and Cloud Computing”.
- Lisa M. Owen(M.S., 05/2015, UWyo). Thesis topic “Finding Your Keys With Android and iBeacons”.
- Soumi Manna (M.S., 12/2014, UWyo). Thesis topic “Evaluating the Performance of the Community Atmosphere Model at High Resolutions”.
- Vedaprakash Subramanian (M.S., 12/2011, UWyo). Thesis topic “Implementation of 3D Seismic Source Inversion and Synthetic Seismogram Generation on Windows Azure”.
- Rory Jarrard (M.S., 06/2011, UWyo). Thesis topic “Detecting Concurrency Errors in OpenMP Programs Using Static Program Analysis”.
- Hao Qian (M.S., 05/2011, UWyo). Thesis topic “The Design and Implementation of SWAT (Scientific Workflow for Adjoint Tomography)”.
- Rajeswari Siloju (M.S., 05/2010, UWyo). Thesis topic “Sandbox-based Dynamic Branch Coverage Expansion for Detecting Concurrency Errors”.
- Lei Wu (M.S., 07/2009, UWyo). Thesis topic “Parallelization and Implementation of ML(n)BiCGStab”.
- Qichang Chen (M.S., 05/2009, UWyo). Thesis topic “HAVE: Detecting Atomicity Violations via Integrated Dynamic and Static Analysis”.
- Hongjiang Li (M.S., 7/2008, UWyo). Thesis topic “Classify Atomicity Violation Warnings Using Machine Learning”.
- Miranda Bryant (M.S., 7/2007, UWyo). Thesis topic “Meaningful Representation of Provenance in Scientific Workflow Systems”.
- Victoria Bryant (M.S., 7/2007, UWyo). Thesis topic “Modeling Atomicity and Isolation in Scientific Workflow Systems”.
- David A. Weiser (M.S., 7/2007, UWyo). Thesis topic “Hybrid Analysis of Multi-threaded Java Programs”.

### Other Alumni

- Yuxiang Yang (Visiting Ph.D. candidate, 08/2018-07/2019)
- Jun Wang (Visiting Ph.D. candidate, 11/2018-05/2019)
- Lei Chen (Visiting Ph.D. candidate, 04/2017-04/2018, UCF)
- Yong Yang (Visiting Ph.D. candidate, 04/2017-10/2017, UCF)
- Xiang Wei (Visiting Ph.D. candidate, 11/2016-11/17, UCF)
- Weidong Wang (Visiting Ph.D. candidate, 01/2013-01/15, UWyo)

## UNIVERSITY COMMITTEE SERVICE

- Department IT Curriculum Oversight and Review Committee, 2016-present.
- UW Scientific Computing curriculum Committee, 2010 - 2015.
- Chair of COSC Graduate Curriculum Committee, 2009 - 2015.
- Faculty Search Committee, 2009, 2010, 2012
- COSC Graduate Admission Committee, 2006 - 2015.
- Panel of Interdisciplinary Program in Computational Science (ICS) at the University of Wyoming (proposed) (11/2007-2015).

## SELECTED AWARDS AND HONORS

- Best Paper Award, the 3rd IEEE Conference on Cyber Science and Technology, 2018.
- Castagne Faculty Fellow Award, University of Wyoming, 2013.
- NSF CAREER Award, 2011.
- NSF TeraGrid Fellowship, 2009.
- Best Paper Award, IBM Verification Conference, 2005.
- Swiger Endowed Fellowship, 2000-2001.
- Best Student Paper Award, the 14th National Database Conference of China, 1997.
- First class scholarships (Guanghua Prize and Procter & Gamble Prize), Sichuan University, 1996, 1997.
- Exemption for National Postgraduate Entrance Examination, 1995.
- Exemption for National College Entrance Examination, 1991.



## Biographical Sketch

### Morgan C. Wang, Ph.D.

Professor, Department of Statistics and Data Science, University of Central Florida

#### Professional Preparation

National Chiao-Tung University	Taiwan	Marine Management	BS, 1977
Mankato State University	Minnesota, USA	Math/Computer	MS, 1986
Iowa State University	Iowa, USA	Statistics	PhD, 1991

#### Professional Appointments

University of Central Florida	Professor and Director of Data Mining Program	2006-Present
University of Central Florida	Professor	2000-2006
University of Central Florida	Associate Professor	1996-2000
University of Central Florida	Assistant Professor	1991-1996
Iowa State University	Research Assistant	1986-1991

#### Relevant Products

1. Shuai Liu, Hong Ji, and **Morgan C. Wang** (To be appear in 2020) "Nonpooling Convolutional Neural Network Forecasting for Seasonal Time Series with Trends," IEEE Transactions on Neural Networks and Learning Systems.
2. Weiqing Zhuang, **Morgan. C. Wang**, Yunping Xie (2019). The Rules of Precision Pricing for IOS-DaaS, Journal of MUC (Natural Sciences Edition)
3. Valeriya Shapoval and **Morgan C. Wang** (2018) Data Mining in Tourism Data Analysis: Inbound Visitors to Japan, Journal of Travel Research, Vol 57 (2), 228-232.
4. Penny Beile, Kanak Choudhury, and **Morgan C. Wang** (2017) Hidden Treasure on the Road to Xanadu: What Connecting Library Service Usage Data to Unique Student IDs Can Reveal WJLA #1235899, Volume 57, 2017 - Issue 2.
5. Jui-Long Hung, **Morgan C Wang**, Shuyan Wang, Maha Abdelrasoul, Yaohang Li, Member, IEEE and Wu He, (2015) Identifying At-Risk Students for Early Interventions A Time-series Clustering Approach, IEEE Transactions on Emerging Topics in Computing. OI 10.1109/TETC.2015.2504239, IEEE.

#### Other Significant Products

1. **Morgan C. Wang** and William J. Kennedy, "Self-validating Computations of Probabilities and Percentiles for Selected Central and Non-Central Univariate Probability Functions," *Journal of the American Statistical Association*, vol. 89, pp. 878-887 (1994).
2. **Morgan C. Wang** and Brad J. Bushman, "Integration Results through Meta-analytic Review Using SAS® Software", SAS Institute, (1999).
3. M. Siddiqui, **Morgan C. Wang**, and J. Lee. (2009), "Detecting Internet Worms Using Data Mining Techniques", Journal on Systemics, Cybernetics and Informatics, Vol. 6, No. 6, pp. 48-53,
4. Xiaogan Su, Chih-Ling Tsai, MorganC. Wang (2009), "Tree-structured model diagnostics for linear regression", Machine Learning (DOI 10.1007/s10994-008-5080-8).
5. Julie W. Pepe and **Morgan C. Wang** (2012), "What instructor qualities do students reward (ID 10929)",

### Synergistic Activities

1. **Data Mining and Big Data Analytics R&D Leadership:** PI and Co-PI on 25 projects to design, , analyze, develop, implement, and investigate data mining methodology, big data analytics applications, and using analytics and big data to solve real-world problems from funding agency including National Science Foundation (NSF), U.S. Army Program Executive Office for Simulation, Training, and Instrumentation, Florida Blue, Sodexo, Ever Bank Walt Disney World, Florida Hospital, and NASA.
2. **Professional Service:** Associate Editor, *Advances in Interconnect Technologies: An International Journal (AITIJ)* (2016-Present); Advisor of Ad Hoc Big Data Advisory Committee for the President of American Statistical Association (ASA), Ad-Hoc Reviewer: 10+ additional journals and Publishers(*JASA, JGCS, Journal of Perspectives on Psychological Science, Journal of Data Analysis, Jon Wiley & Sons, Journal of the Transportation Research Board, Journal of Statistical Computation and Simulation, Psychological Methods* etc.).
3. **Leadership for National/International Associations and Conferences:** Advisor of Ad Hoc Big Data Advisory Committee for the President of American Statistical Association, (2018-Present).
4. **International Conference Program Committees:** Organizing Committee Member, Program Co-Chair for International Conference on Blockchain & Data Science (2019-present)
5. **Honors and Awards:** First Prize in Information Visualization Contest, 24<sup>th</sup> SAS User Group International Conference (2000); First Prize in KDD CUP, Tenth ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, (2004); Best Conference Paper Award, The International Multi Conference on Engineering and Technological Innovation (2008); Winner in 2011 SAS Shoot-Out Data Mining Contest, Analytics Conference (2011), and Winner in 2012 SAS Shoot-Out Data Mining Contest, Analytics Conference (2012)

Curriculum Vitae  
**Gerrit Welper**

last updated: October 2019

Department of Mathematics  
University of Central Florida  
4393 Andromeda Loop N  
Orlando, FL 32816  
gerrit.welper@ucf.edu

### Research Interests

- Reduced Order Modelling / Stochastic PDEs
- High-dimensional approximation
- Stabilization of convection-dominated problems
- Deep Learning

### Education

Dr. rer. nat.	RWTH Aachen, 2013 Infinite dimensional stabilization of convection-dominated problems. (Subject area: numerical analysis) W. Dahmen (advisor), A. Reusken, C. Melcher, M. Grepl
Diplom	RWTH Aachen, 2004

### Professional Experience

Assistant Professor	University of Central Florida	2018 - present
Assistant Professor (NTT)	University of Southern California	2016 - 2018
Visiting Assistant Professor	Texas A&M University	2013 - 2016

### Grants

- NSF, 2018-2021, \$60,000, Principal Investigator

## Awards and Honors

- Springorum-Denkmünze for outstanding Diploma thesis, 2005
- Fellowship DFG Graduiertenkolleg 775 “Hierarchie und Symmetrie in mathematischen Modellen”, 2005 – 2008
- Borchers-Plakette for outstanding PhD thesis, 2014

## Publications

### Preprints

- [1] G. Welper. “Transformed Snapshot Interpolation with High Resolution Transforms”. Submitted. 2019. URL: <https://arxiv.org/abs/1901.01322>.
- [2] G. Welper. “ $h$  and  $hp$ -adaptive Interpolation by Transformed Snapshots for Parametric and Stochastic Hyperbolic PDEs”. Submitted. 2017. URL: <https://arxiv.org/abs/1710.11481>.

### Peer Reviewed Articles

- [3] W. Dahmen, G. Kutyniok, W.-Q. Lim, C. Schwab, and G. Welper. “Adaptive anisotropic Petrov-Galerkin methods for first order transport equations”. In: *Journal of Computational and Applied Mathematics* 340 (2018), pp. 191–220. ISSN: 0377-0427. URL: <http://arxiv.org/abs/1601.00193>.
- [4] A. Bonito, A. Cohen, R. DeVore, G. Petrova, and G. Welper. “Diffusion Coefficients Estimation for Elliptic Partial Differential Equations”. In: *SIAM Journal on Mathematical Analysis* 49.2 (2017), pp. 1570–1592.
- [5] G. Welper. “Interpolation of Functions with Parameter Dependent Jumps by Transformed Snapshots”. In: *SIAM Journal on Scientific Computing* 39.4 (2017), A1225–A1250.
- [6] W. Dahmen, C. Huang, G. Kutyniok, W.-Q. Lim, C. Schwab, and G. Welper. “Efficient Resolution of Anisotropic Structures”. In: *Extraction of Quantifiable Information from Complex Systems*. Ed. by S. Dahlke, W. Dahmen, M. Griebel, W. Hackbusch, K. Ritter, R. Schneider, C. Schwab, and H. Yserentant. Springer International Publishing, 2014, pp. 25–51.
- [7] W. Dahmen, C. Plesken, and G. Welper. “Double greedy algorithms: Reduced basis methods for transport dominated problems”. In: *ESAIM: Mathematical Modelling and Numerical Analysis* 48 (03 2014), pp. 623–663.

- [8] G. Welper. “Quasiclassicality and Quantum Measurement”. In: *International Journal of Theoretical Physics* 52.2 (Feb. 2013), pp. 465–488.
- [9] W. Dahmen, C. Huang, C. Schwab, and G. Welper. “Adaptive Petrov–Galerkin Methods for First Order Transport Equations”. In: *SIAM Journal on Numerical Analysis* 50.5 (2012), pp. 2420–2445.
- [10] A. Cohen, W. Dahmen, and G. Welper. “Adaptivity and variational stabilization for convection-diffusion equations”. In: *ESAIM: Mathematical Modelling and Numerical Analysis* 46 (05 2012), pp. 1247–1273.

## PhD thesis

- [11] G. Welper. “Infinite dimensional stabilization of convection-dominated problems”. PhD thesis. RWTH Aachen, 2013. URL: <https://publications.rwth-aachen.de/record/211233/files/4535.pdf>.

## Presentations

### Invited

- *High resolution alignment of shocks for reduced order models of parametric hyperbolic problems*  
ENUMATH 2019, Egmond aan Zee, Netherlands, September 30 – October 4, 2019.
- *Minimal residual methods for parametric convection dominated problems.*  
Workshop “Minimum Residual & Least-Squares Finite Element Methods”, Portland, USA, October 2 – 4, 2017.
- *Interpolation of functions with parameter dependent discontinuities by transformed snapshots.*  
ENUMATH 2017, Voss, Norway, September 25 – 29, 2017.
- *Interpolation of functions with moving discontinuities by transformed snapshots.*  
Workshop “Multiscale and High-Dimensional Problems”, Oberwolfach, Germany, March 26 – April 1, 2017.
- *Interpolation by Transformed Snapshots.*  
15th International Conference on Approximation Theory, San Antonio, USA, May 22 – 25, 2016.
- *Interpolation of functions with parameter dependent jumps by transformed snapshots.*  
Algorithmy 2016, session “Advances in Model Reduction for Parametrized Systems”, Vysoke Tatry, Podbanske, Slovakia, March 13–18, 2016.

- *Reduced basis methods for transport-dominated problems.*  
Workshop “Multiscale and High-Dimensional Problems”, Oberwolfach, Germany, July 28 – August 3, 2013.

## Contributed

- *Interpolation of Solutions of Parametric Hyperbolic PDEs with Changing Shock Structure.*  
SIAM Conference on Computational Science and Engineering, Spokane, USA, February 25 – March 1, 2019.
- *Approximation of parametric functions with colliding jumps.*  
Curves and Surfaces 2018, Arcachon, France, June 28 – July 4, 2018.
- *h and hp Adaptive Interpolation of Transformed Snapshots for Parametric Functions with Jumps.*  
MoRePaS IV, Nantes, France, April 10 – 13, 2018.
- *Interpolation of functions with parameter dependent jumps by transformed snapshots.* SIAM Workshop on Parameter Space Dimension Reduction, Pittsburgh, USA, July 9 – 10, 2017.
- *Interpolation of solutions of hyperbolic PDEs by transformed snapshots.* XVI International Conference on Hyperbolic Problems, Aachen, Germany, August 1 – 5, 2016.
- *Double greedy algorithms for reduced basis methods.*  
DMV-Jahrestagung, Section “Numerics and Scientific Computing”, Saarbrücken, Germany, September 17–20, 2012.
- *Double greedy algorithms for reduced basis methods.*  
Second International Workshop on Model Reduction for Parametrized Systems, Günzburg, Germany, October 2–5, 2012.
- *Reduced basis methods for radiative transfer.*  
DFG Priority Program 1324 Annual Meeting, Eisenach, Germany, November 28–30, 2012.
- *Adaptive methods for first order transport equations: construction of test frames.*  
DFG Priority Program 1324 Annual Meeting, Eisenach, Germany, November 16–18, 2011.
- *Directional multiresolution schemes for transport-dominated problems: Shearlet constructions and Petrov-Galerkin discretizations.*  
DFG Priority Program 1324 Annual Meeting, Berlin, Germany, November 5–6, 2009.
- *Towards an adaptive scheme for convection-diffusion problems stabilized in a graph norm.*

Workshop “Adaptive numerical methods for PDE’s”, Vienna, Austria, January 21–25, 2008.

### **Seminar Talks**

- *New Approaches to Transport Problems.*  
General Seminar, Department of Mathematics, University of South Carolina, USA, March 1, 2010.

## **Service**

### **Reviews**

- Manuscript review for SIAM Journal on Uncertainty Quantification, 2018
- Manuscript review for Computer Methods in Applied Mechanics and Engineering, 2017
- Manuscript review for SIAM Journal on Scientific Computing, 2013, 2016, 2016, 2018
- Book review for Cambridge University Press, 2014
- Manuscript review for Computers and Mathematics with Applications, 2012
- Manuscript review for Numerical Methods for Partial Differential Equations, 2011, 2011

### **Panels**

- NSF panelist, spring 2018
- NSF panelist, spring 2019

### **Conference Organization**

- Mini-symposium *Model Reduction for Problems with Strong Convection, Sharp Gradients, and Discontinuities*, SIAM Conference on Computational Science and Engineering, Spokane, USA, February 25 – March 1, 2019.

## Teaching Experience

- Calculus II, 2017
- Calculus III, 2013, 2014, 2015
- Differential Equations, 2014, 2015, 2016, 2017, 2019
- Numerical Analysis, 2016, 2017, 2018
- Partial Differential Equations, 2018
- Numerical Methods for Differential Equations, 2019



## Mengyu Xu

---

Department of Statistics, University of Central Florida  
12710 Pegasus Drive, Technology Commons II Building, 209H, Orlando, FL 32816  
Email: Mengyu.Xu@ucf.edu phone: 407-823-3630  
<https://sciences.ucf.edu/statistics/people/xu-mengyu/>

### Professional Preparation

*Ph.D.* in Statistics  
University of Chicago, Chicago, IL, USA, 2012 - 2016  
Advisor: Wei Biao Wu.

*M.S.* in Statistics  
University of Chicago, Chicago, IL, USA, 2010 - 2012  
Advisor: Wei Biao Wu.

*B.S.* in Statistics and Actuarial Science  
Renmin University of China, Beijing, China, 2006 - 2010.

### Appointments

*Assistant Professor*  
Department of Statistics, University of Central Florida, 2016.08.08- Present.

### Publications

Mengyu Xu, Danna Zhang and Wei Biao Wu (2019). Pearson's  $\chi^2$  statistics: approximation theory and beyond. *To Appear in Biometrika*.

Vipul Goyal, Mengyu Xu and Jayanta Kapat (2019). Use of vector autoregressive model for anomaly detection in utility gas turbine. *Accepted by TurboExpo 2019, Phoenix, AZ*.

Xiaohui Chen, Mengyu Xu and Wei Biao Wu (2013). Covariance and precision matrix estimation for high-dimensional time series. *Ann. Statist.* 41 , no. 6, 2994-3021.

Xiaohui Chen, Mengyu Xu and Wei Biao Wu (2016). Regularized estimation of linear functionals for high-dimensional time series. *IEEE Transactions on Signal Processing*, 2016, 64(24), 6459-6470.

### Synergistic Activities

#### Invited Talks:

Pearson's  $\chi^2$  statistics: approximation theory and beyond. ICSA Symposium 2018, New Brunswick, New Jersey. June 2018.

Time-varying network estimation from high-dimensional time series. ICSA Symposium 2017, Chicago, Illinois. August 2017.

Time-varying network estimation from high-dimensional time series. EcoSta

2017, Hong Kong. June 2017.

Pearson's Chi-Squared Statistics: Approximation Theory and Beyond. The 31st New England Statistics Symposium, Storrs, Connecticut. April, 2017.

Pearson's Chi-Squared Statistics: Approximation Theory and Beyond. ICOSA Symposium 2018, New Brunswick, New Jersey. June, 2018.

**Fellowships:**

*McCormick Fellowship*, 2012 - 2014, Department of Statistics, University of Chicago.

**Awards:**

*University Professor Engagement: Scouting area of Statistics and Big Data*, Principal investigator: Mengyu Xu, 100 credit, Siemens Inc., July 2017 - August 2018.

**Peer Review:**

*Annals of Statistics, Journal of Nonparametric Statistics, Journal of Linear Algebra and its Applications, Journal of Machine Learning Research, Statistics and Probability Letters, Electronic Journal of Statistics, Bernoulli, Journal of Multivariate Analysis, GlobalSIP 2017*

**Montering:**

Served in the committee of 10 PhD students, including two female students. Co-advising one PhD student. Advised MS students for independent study and data analysis projects, resulting in a best student presentation award in 2019 ASA FL chapter meeting.

**BIOGRAPHICAL SKETCH**

Provide the following information for the Senior/key personnel and other significant contributors.  
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Xin Yan

eRA COMMONS USER NAME (credential, e.g., agency login): XINYAN2

POSITION TITLE: Professor of Biostatistics

EDUCATION/TRAINING (*Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.*)

INSTITUTION AND LOCATION	DEGREE (if applicable)	Completion Date MM/YYYY	FIELD OF STUDY
University of California at Davis	MS	09/1994	Statistics
University of California at Davis	Ph.D.	09/1998	Statistics

**A. Personal Statement**

I am a Professor of Biostatistics with a joint appointment from both the Department of Statistics and the College of Nursing at University of Central Florida, with specialization in biostatistics for clinical trials. I have served previously as PI or Co-PI or consulting biostatistician on 80 randomized controlled trials. My research experience extends to all phases of clinical trials, including but not limited to sample size estimation for longitudinal trials, evaluation of large numbers of non-inferiority trials, detection of qualitative interaction in equivalence trials, analysis of count data in clinical trials, survival models with random effects, multivariate survival models, and analysis of non-ignorable missing data in longitudinal trials. I will be primarily responsible for data management, statistical analyses and report writing on statistical analysis portion. I will work with the primary investigator to select sound statistics methodologies and to implement appropriate statistical analyses. I believe that my practical experiences on design of clinical studies and biostatistics knowledge position me well to assist the primary investigator and the research team with achieving the proposed aims. Working on the proposed study will further establish my research credentials as a biostatistician in medical research, and will help the PI conduct statistically rigorous methodologies.

**B. Positions and Honors****Positions and Employment**

06/1998-08/2001 Senior Biostatistician, GlaxoSmithKline, Collegeville, PA  
 08/2001-08/2006 Senior Biometrician, Merck Research Laboratories, Blue Bell, PA  
 08/2006-08/2011 Associate Professor Statistics, University of Missouri, Kansas City, MO  
 08/2011-Present Professor of Biostatistics, University of Central Florida, Orlando, FL

**Other Experience and Professional Memberships**

1995-Present Member, American Statistical Association  
 2006-2007 Kansas Life Sciences Institute, Review Panel  
 2007-Present Associate Editor, JP Journal of Biostatistics  
 2007-Present Editorial Board Member, JP Journal of Biostatistics  
 2008-Present Reviewer for NSF proposals

**Professional Memberships**

1995-present Member, American Statistical Association

## C. Contributions to Science

**Actively conducted research in design and analysis of more than 80 clinical trials.** Worked as a biostatistician to design/analyze/interpret numerous clinical trials. Determined sound statistical methods to assess efficacy and safety of many new drugs. These clinical trials resulted in new discovery and approvals of many new drugs, such as Influenza, ProQuad, Vaqta, Rivaroxiban, Varivax, VITROS, PEDIACEL, Zemaira, which are currently in active use for the treatment or prevention of targeted diseases.

- a) Tianyu Zheng, Nickisha Pierre-Pierre, Xin Yan, Qun Huo, Alvin J.O. Almodovar, Felipe Valerio, Inoel Rivera-Ramirez, Elizabeth Griffith, David D. Decker, Sixue Chen, and Ning Zhu (2015). A Gold Nanoparticle-Enabled Blood Test for Early Stage Cancer Detection and Risk Assessment. *ACS Appl. Mater. Interfaces*, **7** (12), pp 6819–6827, DOI: 10.1021/acsami.5b00371.
- b) Myron J. Levin, Yan. X, et al. (2006). Dose-Ranging Safety and Immunogenicity study of live attenuated varicella-zoster virus vaccine (Oka/Merck) administered to adults 60 years of age or older. *Southern Medical Journal*. **98** (10), Supplement: S55.

**Participated in graduate committees and graduate student mentorships.** Ph.D Committees for students: (1) Malinee Konboon, Primary advisor and Chair of the Ph.D. Dissertation Committee (2010-2014). (2) Yi Hao, Member of Ph.D. Committee, (2010 – 2012). The student was enrolled in the Ph.D. program within the School of Pharmacy at UMKC. Thesis Title: Protein loaded polymeric nanoparticles for the treatment of age related macular degeneration. (3) Ye Sheng, Member of Ph.D. Committee, (2010 – 2012). The student was enrolled in the Ph.D. program within the School of Pharmacy at UMKC. (4) Yeva Nersisyan, Member of Ph.D. Committee, (2010 – 2013). Ph.D. dissertation defense was completed in 2013. (5) Felip Carvalho De Rezende, Member of Ph.D. Committee, (2009 -2013). Ph.D. dissertation defense was completed in late 2011. (6). Flavia M. T. Dantas, Member of Ph.D. Committee, (2009 -2012). Ph.D. dissertation defense was completed in 2012. (7) Michael Murray, Member of Ph.D. Committee, (2008 -2010). Ph. D. dissertation defense was completed in August, 2010. (8) Advised more than 50 MD students at the UCF Medical School in their Focused Individualized Research Experience (FIRE) project (2011-2014).

**Taught statistics/biostatistics courses at graduate/undergraduate level.** Courses taught include general linear model, fundamentals in statistics, theory of general linear models, sampling theory, statistics methods I, II, theory of linear regression, theory of mathematical statistics, probability theory, methods of nonparametric statistics, etc.

### **Examples of my published peer-reviewed papers in the field of statistics/biostatistics**

- a) Yan, X and Su, X. G. (2006). Sample size determination for clinical trials in patients with longitudinal nonlinear disease progression, *Journal of Biopharmaceutical Statistics*, **16**, 1-15.
- b) Yan, X., Wang, M. and Su, X. G. (2007). Test for consistency of non-inferiority from multiple non-inferiority trials. *Journal of Biopharmaceutical Statistics*, **17**, 1-14.
- c) Yan, X. (2010), Stratified Wilson and Newcombe Confidence Intervals for Multiple Binomial Proportions, *Journal of Biopharmaceutical Statistics Research*, **2**(3), 329-335.
- d) Yan, X. (2004). Test for qualitative treatment-by-center interaction in equivalence trials when the number of centers is large, *Statistics in Medicine*, **23**, 711-722.
- e) Yan, X. and Anthony Homer (2007), Cochran-Mantel-Haenszel confidence interval with Laplace correction in the comparison of two high rates, *JP Journal of Biostatistics*, Vol. 1, No. 2, 205-115.
- f) Yan, X. and Su, X. G. (2005). Test for qualitative interaction, *Encyclopedia of Biopharmaceutical Statistics*, Second Edition, John Wiley & Sons.
- g) X. G. Su and Yan. X. (2008), Tree-Structured Subgroup Analysis with Censored Survival Data, *The International Journal of Biostatistics*, Vol. 4, Issue 1, 1-26.
- h) Xiaogang Su, Xin Yan, et al., 2013, Facilitating Score and Causal Inference Trees for Large Observational Studies. *Journal of Machine Learning Research* (11-220, 5), 1-45.
- i) Kangsoo Kim, Arjun Nagendran, Jeremy N. Bailenson, Andrew Raji, Gerd Bruder, Myungho Lee, Ryan Schubert, Xin Yan and Gregory F. Welch (2017), A Large-Scale Study of Surrogate Physicality and Gesturing on Human-Surrogate Interactions in a Public Space. *Frontiers in Robotics and AI*, DOI: 10.3389/frobt.2017.00032.

## **D. Additional Information: Research Support and/or Scholastic Performance**

### **Ongoing Research Support**

#### **National Institutes of Health (NIH) (2014—2018)**

Oral Suction Protocol Intervention to Reduce Aspiration and Ventilator-Events (NO-ASPIRATE)

Role: CO-PI

#### **National Institute of Nursing Research (2015-2018)**

Promoting Cancer Symptom Management in Older Adults

Role: CO-PI

#### **National Science Foundation (NSF) (2016-2019)**

CHS: Medium: Physical-Virtual Patient Bed for Healthcare Training and Assessment

Role: CO-PI

#### **UCF Program (2017-2018)**

The Effects of Balance Training Program Combined with an Educational Program on Balance Performance, Muscle Strength, Fear of Falling and Adherence in Community-Dwelling Older Adults

Role: CO-PI

### **Completed Research Support**

#### **Johnson and Johnson (2008-2012)**

Statistical design and analysis plan on a single arm Phase II, open-label, multi-center trial to evaluate the efficacy of twice daily oral dosing of PKC412 administered to patients with aggressive systemic mastocytosis (ASM) and mast cell leukemia (MCL) +/- hematological clonal non-mast cell lineage disease (AHNMD).

Role: Biostatistician

#### **Ortho-Clinical Diagnostics of Johnson and Johnson (2006-2011)**

Statistical research on the ROC analysis of relationship between multiple biomarkers and sleeping disorder measurement using bootstrap and ROC methods.

Role: PI

#### **Bayer Pharmaceuticals (2008-2012)**

Statistical analysis of a multicenter, randomized, open-label, assessor-blind, event-driven, non-inferiority clinical trial for efficacy with a study treatment duration of 3, 6, or 12 months, for the evaluations of acute symptomatic deep-vein thrombosis (DVT) with symptomatic pulmonary embolism (PE) and acute symptomatic PE with or without symptomatic DVT, requested by German Healthcare Reimbursement Authorities.

Role: Biostatistician

#### **Biostatistics Department of Johnson and Johnson (2007-2012)**

Post marketing clinical study VITROS and evaluation of immunodiagnostic assays HBeAg and aHBe.

Role: PI

#### **CSL Behring Research & Development (2010—2012)**

A Randomized, placebo-controlled, double-blind, multicenter phase III/IV study to compare the efficacy and safety of 60 mg/kg body weight of Zemaira weekly i.v. administration with placebo weekly i.v. administration in chronic augmentation and maintenance therapy in subjects with emphysema due to alpha1-proteinase inhibitor deficiency. Role: Biostatistician

#### **UCF COS SEED Funds (2014—2015)**

Clinical Validation Study of a New Molecular Test for Aggressive Prostate Cancer Screening.

Role: CO-PI

Telephone: (612)-860-4980  
E-mail: teng.zhang@ucf.edu  
<http://sciences.ucf.edu/math/tengz/>

202G MSB building  
4393 Andromeda Loop N  
Orlando, FL 32816

### Education:

#### **University of Minnesota - Twin Cities**

Ph.D., Mathematics

Advisor: Gilad Lerman

Dissertation title: Modeling data by multiple subspaces: theory and algorithms

Minneapolis, MN

August 2011

M.S., Statistics

Advisor: Hui Zou

June 2011

#### **Fudan University**

B.S., Mathematics

Shanghai, China

July 2006

### Work Experience:

#### **Department of Mathematics, University of Central Florida**

Assistant Professor

August 2015–Present

#### **The Program in Applied and Computational Mathematics, Princeton University**

Postdoctoral Research Associate/Lecturer

February 2013–August 2015

#### **Institute of Mathematics and its Applications, University of Minnesota**

Postdoctoral Fellow

Advisor: Amit Singer

September 2011–January 2013

### Research Interests:

Robust Statistics, High-dimensional Statistics, Statistical Machine Learning, Random Matrix Theory, Optimization Theory, Semidefinite Programming, Image Processing and Signal Processing

### Grants and Awards:

- Co-PI: NSF CNS CPS, 10/01/2017 - 9/31/2021.  
*NSF CPS: Medium: Security Certification of Autonomous Cyber-Physical Systems*, 830K. PI: Yier Jin (award split between two PIs: 60%-40%).
- PI: UCF In-House Research Grant, 6/1/2016 - 5/31/2017.  
*Image Alignment for Cryo-Electron Microscopy Datasets*, 7.5K.

### Publications:

#### **Monograph:**

1. Ami Wiesel and Teng Zhang, *Structured Robust Covariance Estimation. Foundations and Trends in Signal Processing*, 2015, 8(3): 127-216.

**Journal papers:**

1. Teng Zhang, *Phase Retrieval Using Alternating Minimization in a Batch Setting*. Accepted to *Applied and Computational Harmonic Analysis*.
2. Marianna Pensky and Teng Zhang, *Spectral clustering in the dynamic stochastic block model*. Accepted to *Electronic Journal of Statistics*.
3. Tyler Maunu, Teng Zhang, and Gilad Lerman, *A Well-Tempered Landscape for Non-convex Robust Subspace Recovery*. Accepted to *Journal of Machine Learning Research*.
4. Teng Zhang and Yi Yang, *Robust Principal Component Analysis by Manifold Optimization*. *Journal of Machine Learning Research*, 2018, (80):1-39.
5. Gilad Lerman, Yunpeng Shi, and Teng Zhang, *Exact Camera Location Recovery by Least Unsquared Deviations*. *SIAM Journal on Imaging Sciences*, 2018, 11(4), 2692-2721.
6. Teng Zhang, *A Note on the Non-commutative Arithmetic-geometric Mean Inequality*. *The Electronic Journal of Linear Algebra*, 2018, (34): 283-287.
7. Yi Yang, Teng Zhang, and Hui Zou, *Flexible Expectile Regression in Reproducing Kernel Hilbert Space*. *Technometrics*, 2018, 60(1), 26-35.
8. Teng Zhang and Amit Singer, *Disentangling Two Orthogonal Matrices*. *Linear Algebra and its Applications*, 2017, 524(C): 159-181.
9. Teng Zhang, *A Majorization-Minimization Algorithm for Computing the Karcher Mean of Positive Definite Matrices*. *SIAM Journal on Matrix Analysis and Applications*, 2017, 38(2): pp 387-400.
10. Ery Arias-Castro, Gilad Lerman, and Teng Zhang, *Spectral Clustering Based on Local PCA*. *Journal of Machine Learning Research*, 2017, 18(9): 1-57.
11. Tejal Bhamre, Teng Zhang, and Amit Singer, *Denoising and Covariance Estimation of Single Particle Cryo-EM Images*, *Journal of Structural Biology*, 2016, 195(1): 72-81.
12. Teng Zhang, Xiuyuan Cheng, and Amit Singer, *Marchenko-Pastur Law for Tyler's M-estimator*, *Journal of Multivariate Analysis*, 2016, 149(C): 114-123.
13. Teng Zhang, *Robust subspace recovery by Tyler's M-estimator*. *Information and Inference: A Journal of the IMA*, 2016, 5 (1): 1-21.
14. Gilad Lerman, Michael McCoy, Joel A. Tropp, and Teng Zhang, *Robust Computation of Linear Models by Convex Relaxation*. *Foundation of Computational Mathematics*, 2015, 15 (2): 363-410.
15. Gilad Lerman and Teng Zhang,  *$\ell_p$ -Recovery of the Most Significant Subspace among Multiple Subspaces with Outliers*. *Constructive Approximation*, 2014, 40 (3): 329-385.
16. Teng Zhang and Hui Zou, *Sparse Precision Matrix Estimation via Positive Definite Constrained Minimization of  $\ell_1$  Penalized D-Trace Loss*. *Biometrika*, 2014, 101 (1): 103-120.
17. Teng Zhang and Gilad Lerman, *A Novel M-estimator for Robust PCA*. *Journal of Machine Learning Research*, 2014, 15(1): 749-808.

18. Teng Zhang, Ami Wiesel, and Maria Sabrina Grec, *Multivariate Generalized Gaussian Distribution: Convexity and Graphical Models*. *IEEE Transactions on Signal Processing*, 2013, 61 (16): 4141-4148.
19. Teng Zhang, Arthur Szlam, Yi Wang, and Gilad Lerman, *Hybrid Linear Modeling via Local Best-fit Flats*. *International Journal of Computer Vision*, 2012, 100 (3): 217-240.
20. Gilad Lerman and Teng Zhang, *Robust Recovery of Multiple Subspaces by Geometric  $\ell_p$  Minimization*. *Annals of Statistics*, 2011, 39 (5): 2686-2715.

#### Peer-Reviewed Conference Papers:

1. Raj Gautam Dutta, Teng Zhang, and Yier Jin. *Resilient Distributed Filter for State Estimation of Cyber-Physical Systems Under Attack*. Accepted to the 2019 American Control Conference.
2. Raj Gautam Dutta, Feng Yu, Teng Zhang, Yaodan Hu, and Yier Jin. *Security for safety: a path toward building trusted autonomous vehicles*. Proceedings of the International Conference on Computer-Aided Design, 2018
3. Raj Gautam Dutta, Xiaolong Guo, Teng Zhang, Kevin Kwiat, Charles Kamhoua, Laurent Njilla, and Yier Jin, *Estimation of Safe States of Autonomous System Under Attack*. Proceedings of the 54th Annual Design Automation Conference, 2017.
4. Teng Zhang and Ami Wiesel, *Automatic Diagonal Loading for Tyler's Robust Covariance Estimator*. IEEE Statistical Signal Processing Workshop (SSP), 2016
5. Tejal Bhamre, Teng Zhang, and Amit Singer, *Orthogonal Matrix Retrieval in Cryo-electron Microscopy*. Proceedings of IEEE International Symposium on Biomedical Imaging, 2015, pp. 1048-1052.
6. John Goes, Teng Zhang, Raman Arora, and Gilad Lerman. *Robust Stochastic Principal Component Analysis*. Proceedings of the Seventeenth International Conference on Artificial Intelligence and Statistics, pp. 266-274.
7. Teng Zhang, Arthur Szlam, Yi Wang, and Gilad Lerman, *Randomized Hybrid Linear Modeling by Local Best-fit Flats*. Proceedings of the 2010 IEEE 23rd International Conference on Computer Vision and Pattern Recognition (CVPR), 2010, pp. 1927-1934.
8. Teng Zhang, Arthur Szlam, and Gilad Lerman, *Median  $K$ -flats for Hybrid Linear Modeling with Many Outliers*. Proceedings of 2nd IEEE International Workshop on Subspace Methods (Subspace 2009), 2009, pp. 234-241.

#### Submitted/In revision:

1. Teng Zhang, *Element-wise estimation error of a total variation regularized estimator for change point detection*. arXiv: 1901.00914.
2. Teng Zhang, *Phase Retrieval by Alternating Minimization with Random Initialization*. arXiv: 1812.01255.



3. Raj Gautam Dutta, Yaodan Hu, Feng Yu, Teng Zhang and Yier Yin, *SElvAgE: Design and Analysis of Secure Distributed Estimator for Vehicular Platooning in Adversarial Environment*. Submitted to *IEEE Intelligent Transportation Systems Transactions*.
4. Tejal Bhamre, Teng Zhang, and Amit Singer, *Anisotropic Twicing for Single Particle Reconstruction using Autocorrelation Analysis*. arXiv: 1704.07969.

**Computing Packages:**

1. R package “KERE”: An efficient algorithm inspired by majorization-minimization principle for solving the entire solution path of a flexible nonparametric expectile regression estimator constructed in a reproducing kernel Hilbert space.
2. MATLAB codes associated with papers available at personal webpage.

**Graduate Students Advised:**

- Raj Gautam Dutta (jointly advised), Department of Electrical & Computer Engineering, University of Central Florida. Co-Advisor: Prof. Yier Jin, CMSE, UF (graduated August 2018)
- Feng Yu, Department of Mathematics, University of Central Florida.

**Graduate Thesis Committee Memberships:**

- Ramchandra Rimal, Department of Mathematics, University of Central Florida. Advisor: Prof. Marianna Pensky.
- Rasika Rajapakshage, Department of Mathematics, University of Central Florida. Advisor: Prof. Marianna Pensky.
- Pawan Gupta, Department of Mathematics, University of Central Florida. Advisor: Prof. Marianna Pensky.
- Mahdi M.Kalayeh, Department of Electrical & Computer Engineering, University of Central Florida. Advisor: Prof. Mubarak Shah.
- Mohsen Joneidi, Department of Electrical & Computer Engineering, University of Central Florida. Advisor: Prof. Nazanin Rahnavard.

**Independent Study:**

- Xing Fan, Department of Mathematics, University of Central Florida. Fall 2018-Spring 2019.
- Feng Yu, Department of Mathematics, University of Central Florida. Fall 2018-Spring 2019.

**Teaching Experience:**

Department of Mathematics, University of Central Florida

Orlando, FL

- Mathematical Foundations for Massive Data Modeling and Analysis (MAP6195), Spring 2019
- Honors Calculus with Analytic Geometry II (MAC2312H), Spring 2019
- Honors Calculus with Analytic Geometry III (MAC2313H) (two sections), Fall 2018  
Teaching Evaluation (Departmental Average) of section 0203: 4.67 (3.80)  
Teaching Evaluation (Departmental Average) of section 0202: 4.25 (3.80)
- Applied Numerical Mathematics (MAT6385), Spring 2018  
Teaching Evaluation (Departmental Average): 3.82 (3.91)
- Scientific Computing (MAT5712), Fall 2017  
Teaching Evaluation (Departmental Average): 3.79 (3.80)
- Optimization Theory (MAP6207), Spring 2017  
Teaching Evaluation (Departmental Average): 4.00 (3.94)
- Instructor for Optimization (MAP4171), Fall 2016  
Teaching Evaluation (Departmental Average): 4.05 (3.83)
- Instructor for Precalculus (MAC1140C), Spring 2016  
Teaching Evaluation (Departmental Average): 4.50 (3.86)
- Instructor for Matrix and Linear Algebra (MAS 3015), Fall 2015  
Teaching Evaluation (Departmental Average): 3.10 (3.77)

**Department of Mathematics, Princeton University**

Princeton, NJ

- Instructor for Advanced Multivariable Calculus (Math 203), Fall 2014
- Instructor (precept sessions) for Advanced Multivariable Calculus (Math 203), Fall 2013

**School of Mathematics, University of Minnesota**

Minneapolis, MN

- Instructor for Calculus II (Math 1272), Fall 2012
- Instructor for Short Calculus (Math 1142), Summer 2011
- Assisted students in IMA interdisciplinary REU project on hybrid linear modeling, June 14–July 16, 2010
- Teaching assistant as a primary instructor for College Algebra and Probability (Math 1031) and Precalculus I (Math 1051), Fall 2008 - Spring 2009

**School of Mathematics, Washington State University Pullman, WA**

- Invited speaker for the 2012 Summer Graduate School on Geometry and Data, July 2012

**Talks/Presentations:****Invited Conference/Workshop Talks:**

- Information Theory and Applications Workshop, San Diego, CA, February 2019.
- The 2018 INFORMS Annual Meeting, Phoenix, AZ, November 2018.
- The IMS Asia Pacific Rim Meeting (IMS-APRM), Singapore, June 2018.
- The 2nd International Conference on Econometrics and Statistics (EcoSta 2018), the City University of Hong Kong, Hong Kong, China, June 2018.
- International Indian Statistical Association Conference, Gainesville, FL, May 2018.
- Information Theory and Applications Workshop, San Diego, CA, February 2018.
- AMS (American Mathematical Society) Fall Southeastern Sectional Meeting, Orlando, FL, September 2017
- ICSA (International Chinese Statistical Association) Canada Vancouver symposium, Vancouver, Canada, August 2017
- IMS-China International Conference on Statistics and Probability, Nanning, China, June 2017
- International Conference on Computational and Methodological Statistics, Seville, Spain, December 2016
- (Poster) IEEE Workshop on Statistical Signal Processing, Palma de Mallorca, Spain, June 2016
- SIAM Conference on Imaging Science (IS16), Albuquerque, NM, May 2016
- BIRS workshop: Imaging and Modeling in Electron Microscopy - Recent Advances, Banff, Canada, May 2014.
- SIAM Annual Meeting, Minneapolis, MN, July 2012.
- SIAM Conference on Imaging Science, Philadelphia, PA, May 2012.
- (Poster) Workshop on Machine Learning: Theory and Computation, Institute of Mathematics and its Applications, University of Minnesota, March 2012.
- IDeAS Seminar, PACM (The Program in Applied and Computational Mathematics), Princeton University, February 2011.
- (Poster) IEEE 23rd International Conference on Computer Vision and Pattern Recognition (CVPR), June 2010
- (Poster) 2nd IEEE International Workshop on Subspace Methods, The Twelfth IEEE Conference on Computer Vision, September 2009

**Invited Colloquium/Seminar Talks:**

- Department of Statistics, Florida State University, October 2018
- Seminar on Applied Mathematics, Hong Kong University of Science and Technology, June 2018.
- Institute of Mathematics and its Applications, University of Minnesota, November 2016

- Department of Mathematics and Statistics, McGill University, November 2016
- Department of Mathematica, Beijing Jiaotong University, May 2016
- Department of Statistics, University of Central Florida, November 2015
- Department of Statistics, University of Florida, October 2015
- Department of Mathematics, Michigan State University, February 2015
- Department of Mathematics, University of Central Florida, January 2015
- Department of Statistics, UIUC, January 2015
- Department of Mathematics, University of Southern California, November 2014
- Special Seminar in CMS (Computing + Mathematical Sciences), Caltech, October 2014
- DTC Seminar, University of Minnesota, October 2014
- Department of Statistics, Yale University, September 2014.
- Department of Operations Research and Financial Engineering, Princeton University, April 2014.
- Department of Statistics and Biostatistics, Rutgers University, January 2014.

**Contributed Talks:**

- Analysis Seminar, Department of Mathematics, University of Central Florida, November 2016.
- Center for Research in Computer Vision (CRCV), University of Central Florida, February 2016.
- Postdoc Seminar, Institute of Mathematics and its Applications, University of Minnesota, November 2011.

**Professional Service:**

- Co-organizer of a mini-symposium in the upcoming 2019 Annual Meeting in Calgary, Statistical Society of Canada, 2019.
- Co-organizer of a mini-symposium in the upcoming International Conference on Econometrics and Statistics (EcoSta 2019).
- Mathematical modeling seminar organizer, Department of Mathematics, University of Central Florida, 2019.
- Undergraduate Mentor Committee member, Department of Mathematics, University of Central Florida, 2018-2019.
- GTA Mentor Committee, Department of Mathematics, University of Central Florida, 2018-2019.
- Co-organizer of the mini-symposium “Computation challenges in statistical methods” in the International Conference on Econometrics and Statistics (EcoSta 2018).

- Mathematical modeling seminar organizer, Department of Mathematics, University of Central Florida, 2018.
- Undergraduate mentor Committee member, Department of Mathematics, University of Central Florida, 2017-2018.
- Computers and technology Committee member, Department of Mathematics, University of Central Florida, 2016-2017.
- Search Committee member for the position “Statistical Rigors in Forensic Science” in the National Center Forensic Science, University of Central Florida, 2015-2016.
- Graduate student recruitment participant and speaker, Stetson College, March 2016.
- Colloquium committee member, Department of Mathematics, University of Central Florida, 2015-2016.
- Reviewer for journals and conferences:
  - Applied and Computational Harmonic Analysis
  - Journal of the American Statistical Association
  - IEEE Transactions on Network Science and Engineering
  - Journal of Statistical Computation and Simulation
  - Journal of the Royal Statistical Society, Series B
  - International Conference on Learning (ICLR) 2018, 2019
  - International Conference on Artificial Intelligence and Statistics (AISTATS) 2017-2019
  - SIAM Journal on Imaging Science
  - Electronic Journal of Statistics
  - Neural Information Processing Systems (NIPS) 2016, 2017
  - Annals of Applied Statistics
  - Technometrics
  - Machine Learning
  - Entropy
  - BMC Bioinformatics
  - Statistical Applications in Genetics and Molecular Biology
  - Computers in Biology and Medicine
  - IEEE Transactions on Information Theory
  - IEEE Transactions on Signal Processing
  - IEEE Transactions on Neural Networks and Learning Systems
  - Journal of Multivariate Analysis
  - IEEE Signal Processing Letters
  - Journal of Machine Learning Research
  - Annals of Statistics
  - Linear Algebra and its Applications
  - Information and Inference: A Journal of the IMA
  - IEEE Transactions on Knowledge and Data Engineering
  - Applied Mathematics Letters
  - International Conference on Machine Learning (ICML) 2013, 2014.
- Reviewer for grant proposals: Israel Science Foundation (ISF).
- Volunteer in the IMA outreach event for Minnesota State Fair, Sept 2012

## BIOGRAPHICAL SKETCHES

---

### **Qipeng Zheng**

Assistant Professor of Industrial Engineering and Management Systems

College of Engineering and Computer Science

University of Central Florida, Orlando, FL 32816

Ph: (407) 823-4367, Fax: (407) 823-3413, Email: qipeng.zheng@ucf.edu

---

### **A. PROFESSIONAL PREPARATION**

- **Ph.D.** Industrial and Systems Engineering, University of Florida, Gainesville, August 2010
- **M.S.** Automation, Tsinghua University, Beijing, July 2005
- **B.S.** Industrial Automation, North China University of Technology, Beijing, July 2001

### **B. APPOINTMENTS**

- 8/2018-now: **Associate Professor**, Dept. of Industrial Engineering & Management Systems, University of Central Florida, Orlando, FL.
- 8/2013-8/2018: **Assistant Professor**, Dept. of Industrial Engineering & Management Systems, University of Central Florida, Orlando, FL.
- 8/2010-8/2013: **Assistant Professor**, Dept. of Industrial & Management Systems Engineering, West Virginia University, Morgantown, WV.

### **C. SELECTED PRODUCTS**

(i) Most Relevant Products (\* denotes my PhD students; \* denotes being on committee)

- 1) A. Golshani\*, W. Sun, Q. Zhou, Q. P. Zheng, J. Wang and F. Qiu. Coordination of Wind Farm and Pumped-Storage Hydro for a Self-Healing Power Grid. *IEEE Transactions on Sustainable Energy*, Volume 9, Issue 4, pp 1910-1920, October 2018.
- 2) Y. Zhan\* and Q. P. Zheng. A Multistage Decision-Dependent Stochastic Bi-level Programming Approach for Power Generation Investment Expansion Planning. *IIEE Transactions*, Volume 50, Issue 8, pp 729 – 734, August 2018.
- 3) Y. Zhan\*, Q. P. Zheng, J. Wang and P. Pinson. Generation Expansion Planning with Large Amounts of Wind Power via Decision-Dependent Stochastic Programming. *IEEE Transactions on Power Systems*, Volume 32, Number 4, pp. 3015-3026, July 2017.
- 4) A. Golshani\*, W. Sun, Q. Zhou, Q. P. Zheng and J. Tong. Two-stage Adaptive Restoration Decision Support System for a Self-healing Power Grid. *IEEE Transactions on Industrial Informatics*, Volume 13, Issue 6, pp 2802 – 2812, December 2017.
- 5) Q. P. Zheng, J. Wang, P. M. Pardalos and Y. Guan. A Decomposition Approach to Two-Stage Stochastic Unit Commitment. *Annals of Operations Research*, Volume 210, Issue 1, pp. 387-410, November 2013.

(ii) Other Significant Products

## BIOGRAPHICAL SKETCHES

- 6) Z. Huang<sup>\*</sup>, Q. P. Zheng, E. L. Pasiliao and D. Simmons. Exact algorithms on reliable routing problems under uncertain topology using aggregation techniques for exponentially many scenarios. *Annals of Operations Research*, Volume 249, Issue 1, pp 141–162, February 2017.
- 7) Q. P. Zheng, S. Shen and Y. Shi. Loss-Constrained Minimum Cost Flow under Arc Failure Uncertainty with Applications in Risk-Aware Kidney Exchange. *IIE Transactions*, Volume 47, Issue 9, pp. 961-977, July 2015.
- 8) C.-L. Tseng, Y. Zhan<sup>\*</sup>, Q. P. Zheng, M. Kumar. A MILP Formulation for Generalized Geometric Programming Using Piecewise-Linear Approximations. *European Journal of Operational Research*, Volume 245, Issue 2, pp. 360 – 370, September 2015.
- 9) Y. Li, N. Kong, M. Chen<sup>\*</sup>, Q. P. Zheng. Optimal Physician Assignment and Patient Demand Allocation in an Outpatient Care Network. *Computers & Operations Research*, Volume 72, pp. 107-117, August 2016.
- 10) Q. P. Zheng and P. M. Pardalos. Stochastic and Risk Management Models and Solution Algorithm for Gas Transmission Network Expansion and LNG Terminal Location Planning. *Journal of Optimization Theory and Applications*, Volume 147, Number 2, pp. 337-357, 2010.

## **D. SYNERGISTIC ACTIVITIES**

- Co-Editor-In-Chief of “*Energy Systems, Springer*” (2018 – present)
- Conference organizer/co-organizer for: *Blockchain and Energy SysTems (BEST) Conference* January 18<sup>th</sup> – 19<sup>th</sup>, 2019 Orlando, FL; Co-organizer of the *6th Annual Meeting of the AFRL Mathematical Modeling and Optimization Institute*, Eglin AFB, FL, July 31st – August 2nd, 2018; Co-organizer of the *5th Annual Meeting of the AFRL Mathematical Modeling and Optimization Institute*, Eglin AFB, FL, August 1st – August 3rd, 2017; Local Organizing Committee member and Session Chair for the *Conference on Energy, Sustainability and Climate Change, INFORMS Optimization Society*, Gainesville, FL, 2010; Local Organizing Committee member for the *Conference of Power Systems Modeling*, Gainesville, FL, 2009.
- Presentation session chair for INFORMS Annual Meeting (2010 – 2018), IIE Annual Conference (2010 – 2012), POMS Annual Meeting (2016, 2019)
- Proposal review panels for NSF (2012 & 2014), ORAU proposal review (2018)
- Refereed for *Annals of Operations Research, Applied Energy, Computers and Industrial Engineering, Energy Policy, Energy Systems, Environmental Modeling and Assessment, European Journal of Operational Research, IIE Transactions, IEEE Systems Journal, IEEE Transactions on Power Systems, International Journal of Energy Sector Management, International Journal of Operational Research, Journal of Combinatorial Optimization, Journal of Global Optimization, Journal of Optimization Theory and Applications, Journal of Systems Science and Systems Engineering, Journal of Transportation Safety & Security, Mathematical Methods of Operations Research, Networks, Networks and Spatial Economics, Optimization and Engineering, PLOS ONE, etc.*

## **Appendix N: Details of Library Holdings and Funding Needs**



**To:** Dr. Shunpu Zhang, Chair, Statistics  
Dr. Joseph Brennan, Associate Chair, Mathematics Department  
Dr. Gary Leavens, Chair, Computer Science Department  
Mr. Daniel Eilen, Associate Program Director, College of Engineering & Computer Science  
Mr. Barry Baker, Director of Libraries  
Ms. Ying Zhang, Head, Acquisitions and Collections, UCF Libraries

**From:** Sandy Avila, Science Librarian  
Ven Basco, Engineering Librarian

**Subject:** Library Evaluation for the proposal to add a bachelor's degree in Data Science housed in the Statistics Department with collaboration from the Departments of Mathematics, Computer Science and Industrial Engineering and Management Systems in the College of Sciences and College of Engineering and Computer Science.

**Date:** February 4, 2019

This memorandum is being submitted for your review and approval. As library resources are essential for any new program, an analysis of library holdings (monographs, periodicals, and databases) was conducted to assist in preparing a program proposal for the new BS in Data Science at the University of Central Florida. The following review was created by Sandy Avila, Science Librarian and Ven Basco, Engineering Librarian and is intended to serve as a means for evaluating the strength of current holdings of the UCF Libraries for supporting the proposed program. When reviewing library support for the new BS in Data, the following out of state institutions were selected for comparison:

- Brigham Young University- Idaho (BYU)
- Purdue University (PU)
- Colorado State University (CSU)

One in state school used for comparison is:

- Florida Polytechnic University (FPU)

#### **Summary and Projected Costs for New Library Resources:**

Each of the above referenced institutions offers a Bachelor of Science degree in Data Science with various areas of specialization. In comparing the library collections at the selected aspiring programs, UCF Libraries has sufficient resources to start the proposed Bachelor of Science program in Data Science. No additional funding for books, databases or journals is being requested at this time especially since our collections already support the Master's and PhD graduate programs in Big Data Analytics.

## Databases:

UCF Libraries' list of databases compares favorably with that of the other institutions listed. We have the databases needed to support **Data Science**. In the event of severe budget shortfalls it may be necessary to cancel existing database subscriptions.

Institutional Comparison--Databases	UCF	FPU	BYU	PU	CSU
Scopus	NO	NO	NO	X	NO
Science Direct	X	X	NO	X	X
ACM Digital Library	X	NO	X	X	X
Web of Science	X	X	X	X	X
IEEE Xplore	X	X	X	X	X
ABI/Inform	X	NO	X	X	NO
arXiv.org	X	NO	NO	X	NO
Applied Science & Technology	X	NO	NO	X	NO
Statistical Abstract of the United States	X	NO	X	NO	X
Current Index to Statistics	X	NO	NO	X	NO
Social Explorer	X	NO	NO	NO	X
Synthesis Digital Library of Engineering and Computer Science	X	NO	NO	X	NO
Data USA	X	NO	NO	NO	NO
Compendex (Ei Village)	X	X	NO	X	X
ProQuest Statistical Insight	X	NO	X	X	NO
Current Index to Statistics	X	NO	NO	X	NO
INSPEC	X	X	NO	X	NO
MathSciNet	X	NO	NO	X	X

**Journals:** UCF's journal listing compares favorably with other institutions. Although the field is relatively new, UCF does have access to key titles through print, database and open access resources. UCF currently has access to several publisher journal packages through Sage, Springer, Science Direct, and Wiley. In the event of severe budget shortfalls it may be necessary to cancel existing subscriptions. The journals to which we currently subscribe to in the area of Data Science are as follows:

Institutional Comparison--Journals	UCF	FPU	BYU	PU	CSU
Acta Numerica	X	X	X	X	X
Archives of Computational Methods in Engineering	X	X	X	X	X
Artificial Intelligence	X	X	NO	X	X
Big Data	X	NO	NO	X	X
Big Data Research	X	X	X	X	X
Computation Statistics and Data Analysis	X	NO	X	NO	NO
Computer-aided Civil & Infrastructure Information	X	NO	NO	X	NO

<b>Institutional Comparisons- Journals Cont'd</b>	<b>UCF</b>	<b>FPU</b>	<b>BYU</b>	<b>PU</b>	<b>CSU</b>
Data Science Journal	X	X	X	X	X
Foundations & Trends in Machine Learning	NO	NO	NO	X	NO
IEEE Transactions of Evolutionary Computation	X	X	X	X	X
IEEE Transactions on Cloud Computing	X	X	X	X	X
IEEE Transactions on Information Forensics & Security	X	NO	X	X	X
IEEE Transactions on Medical Imaging	X	X	X	X	X
IEEE Transactions on Neural Networks and Learning Systems	X	X	X	X	X
Information Fusion	X	X	X	X	X
International Journal of Data Science & Analytics	X	NO	NO	X	NO
International Journal of Engineering Science	X	X	X	X	X
Journal of Big Data	X	X	X	X	X
Journal of Statistical Software	X	X	X	X	X
Machine Learning	X	X	X	X	X
SIGKDD Explorations	X	NO	X	X	X

**Books:** Given the interdisciplinary nature of data science, UCF already has a solid collection in subject sources for which it is well established, and that UCF compares favorably well with three of the four schools and do not lag far behind the 4<sup>th</sup> school used in this analysis. We have current funding for the purchase of books for the graduate programs in Big Data Analytics which help to build on the same areas to support the bachelor's program in Data Science. We are currently in the first year of a three year \$5000/yr funding cycle for this program. The funding will end in the spring of 2021.

<b>Institutional Comparison--Books</b>	<b>UCF</b>	<b>FPU</b>	<b>BYU</b>	<b>PU</b>	<b>CSU</b>
Artificial Intelligence	10887	326	92	6795	13471
Business Intelligence	179	29	421	281	658
Cloud Computing	200	110	164	561	696
Computational Complexity	438	43	47	598	784
Computer Algorithms	711	53	28	884	961
Computer Program Language	2565	21	1913	3627	4740
Computer Science- Mathematics	2511	23	88	1032	873
Data Mining	3366	143	351	2207	4130
Data Structures	1682	29	57	791	1824
Database Management	4307	197	618	2308	4370
Linear Models	180	25	41	235	285
Machine Learning	601	74	162	978	994
Multivariate Analysis	572	47	84	747	672
Mathematical Statistics	1808	73	271	785	2290
Social Networks- Mathematical Models	24	1	11	20	21
Social Networks- Research	16	7	23	32	28
Statistical Methods	6305	6	720	3976	7204