UG New Program - Data Science (B.S.)

zUC 20-21 Undergraduate Program New

General Catalog Information

Select *Program* below, unless creating an Acalog *Shared Core*.

Program Type* (•) Program ( ) Shared Core

Read before you begin

1. TURN ON help text before starting this proposal by clicking in the top right corner of the heading.

2. FILL IN all fields required marked with an *. You will not be able to launch the proposal without completing required fields.

3. LAUNCH proposal by clicking in the top left corner.

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.

Also, a pre-proposal must have been submitted and approved by the Council of Academic VPs before this proposal can proceed any further.

Proposal Type* UG New Program

College / Department* Department of Statistics

Academic Specialty or Field

Complete Name of Degree* Data Science (B.S.)

Proposed CIP Code* 30.7001

Program 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 as the UCF M.S. in Data Analytics program or a related M.S. degree, or a Ph.D. program in Computer Science, Statistics and Data Science or a related area, and graduates may also seek professional distinction.

Prospective Curriculum*

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 Composition I

[Right] (Required)
ENC 1102 Composition II

[Right] (Required)
[After] Select one course from Area 3 3

Cultural & Historical Foundations (9 Credit Hours)

Mathematical Foundations (7 Credit Hours)

MAC 2311C Calculus with Analytic Geometry I
[Right] (Required)
STA 2023 Statistical Methods I
[Right] (Required)

Social Foundations (6 Credit Hours)

Science Foundations (8 Credit Hours)

BSC 2010C Biology I
[Right] (Required)

Select One:

CHM 2045C Chemistry Fundamentals I
[Right] (Required)
PHY 2048C General Physics Using Calculus I
[Right] (Required)

Common Program Prerequisites (CPP) (11 Credit Hours)

BSC 2010C Biology I
[Right] (GEP)
COP 3223C Introduction to Programming with C
MAC 2311C Calculus with Analytic Geometry I

[Right] (GEP)
MAC 2312 Calculus with Analytic Geometry II
MAC 2313 Calculus with Analytic Geometry III
STA 2023 Statistical Methods I
[Right] (GEP)

Select One:

CHM 2045C Chemistry Fundamentals I
[Right] (GEP)
PHY 2048C General Physics Using Calculus I
[Right] (GEP)

Core Requirements: Basic Level

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

BSC 2010C Biology I
[Right] (GEP)
COP 3223C Introduction to Programming with C
[Right] (CPP)
MAC 2311C Calculus with Analytic Geometry I
[Right] (GEP)
MAC 2312 Calculus with Analytic Geometry II
[Right] (CPP)
MAC 2313 Calculus with Analytic Geometry III
[Right] (CPP)
STA 2023 Statistical Methods I
[Right] (GEP)

Select One:

CHM 2045C Chemistry Fundamentals I
[Right] (GEP)
PHY 2048C General Physics Using Calculus I
[Right] (GEP)

Core Requirements: Advanced Level (49 Credit Hours)

Complete all of the following courses:

COP 3502C Computer Science I
CIS 4340 Data Management Technology

COP 4283 Programming for Scientists
ISC 4241 Data Science I
ISC 4242 Data Science II
ISC 4311 Predictive Analytics
ISC 4323C Praxis for Data Science
ISC 4551 Data Graphics and Visualization
MAS 3105 Matrix and Linear Algebra
STA 4364 Statistical Foundations of Data Science and Artificial Intelligence I
STA 4365 Statistical Foundations of Data Science and Artificial Intelligence II
STA 4163 Statistical Methods II
STA 4164 Statistical Methods III
STA 4724 Big Data Analysis Methods

Select One:

COT 3100C Introduction to Discrete Structures
MHF 3302 Logic and Proof in Mathematics

Select One

CAP 4611 Algorithms for Machine Learning
ESI 4312 Deterministic Methods for Operations Research
MAP 4112 Mathematical Foundations of Machine Learning and Artificial Intelligence
STA 4241 Statistical Learning

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 4323C Praxis for Data Science

Foreign Language Requirements

Admissions

Two years of one foreign language in high school, or one year of one foreign language in college (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 course work 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 and department. More information about Honors in the Major can be found at *https://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 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.

Computer Science: 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; however COP 2220 (C Programming) will be substituted for COP 3223C.

Program Academic Learning Compacts

Program Academic Learning Compacts (student learning outcomes) for undergraduate programs are located at:
http://www.oeas.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 a departmental advisor 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	
MAC 2311C Calculus with Analytic Geometry I	
SPC 1608 Fundamentals of Oral Communication	
[Before]GEP Cultural/Historical Foundation, Area 1	**3**
[Before]GEP Social Foundation, Area 1	**3**

Freshman Year - Spring (16 Credit Hours)

ENC 1102 Composition II	
MAC 2312 Calculus with Analytic Geometry II	
[Before]GEP Cultural/Historical Foundation, Area 2	**3**
[Before]GEP Cultural/Historical Foundation, Area 3	**3**
[Before]GEP Social Foundation, Area 2	**3**

Sophomore Year - Fall (15 Credit Hours)

BSC 2010C Biology I
MAC 2313 Calculus with Analytic Geometry III
PHY 2048C General Physics Using Calculus I
STA 2023 Statistical Methods I

Sophomore Year - Spring (13 Credit Hours)

COP 3223C Introduction to Programming with C
MAS 3105 Matrix and Linear Algebra
STA 4163 Statistical Methods II

Select One:

COT 3100C Introduction to Discrete Structures
MHF 3302 Logic and Proof in Mathematics

Junior Year - Fall (15 Credit Hours)

COP 3502C Computer Science I
ISC 4241 Data Science I

STA 4364 Statistical Foundations of Data Science and Artificial Intelligence I

STA 4164 Statistical Methods III

Select One:

CAP 4611 Algorithms for Machine Learning
ESI 4312 Deterministic Methods for Operations Research
MAP 4112 Mathematical Foundations of Machine Learning and Artificial Intelligence
STA 4241 Statistical Learning

Junior Year - Spring (17 Credit Hours)

COP 4283 Programming for Scientists
ISC 4242 Data Science II
STA 4365 Statistical Foundations of Data Science and Artificial Intelligence II
[After] Elective **Credit Hours: 3**
Elective **Credit Hours: 3**

Senior Year - Fall (16 Credit Hours)

CIS 4340 Data Management Technology
ISC 4311 Predictive Analytics
ISC 4551 Data Graphics and Visualization
STA 4724 Big Data Analysis Methods
[After] Elective **Credit Hours 3**

Senior Year - Spring (15 Credit Hours)

ISC 4323C Praxis for Data Science
[After] Elective **Credit Hours 3**
Elective **Credit Hours 3**
Elective **Credit Hours 3**
Elective **Credit Hours 3**

Please do not complete the remining sections until after the form is launched.

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

Year 1
Year 2
Year 3
Year 4
Year 5

Projected Enrollment (From Table 1)

Year 1: HC	140	**Year 1: FTE**	105
Year 2: HC	225	**Year 2: FTE**	169
Year 3: HC	365	**Year 3: FTE**	274
Year 4: HC	485	**Year 4: FTE**	364
Year 5: HC	540	**Year 5: FTE**	405

Projected Program Costs (From Table 2)

E&G Cost per FTE	$1728	**E&G Funds**	$181443
Contract & Grants Funds	0	**Auxiliary Funds**	$211080
Total Cost	392523		
E&G Cost per FTE	$1311	**E&G Funds**	$530984

Contract & Grants Funds $0	**Auxiliary Funds** $0

Total Cost $530984

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

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.

Degree Program

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:

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.

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.

Date Pre-Proposal Presented to CAVP	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.

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.

External Consultant's Report	n/a

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).

Consistent with Current SUS Strategic Planning Goals

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. 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", 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 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.

1. https://www.flbog.edu/pressroom/_doc/2011-11-28_Strategic_Plan_2012-2025_FINAL.PDF (p. 13)

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:

Critical Workforce:

Education
Health
Gap Analysis

Economic Development:

Global Competitiveness

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.

Program of Strategic Emphasis Category and Justification	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.

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.

Established / Planned Educational Sites	The program will only be offered on the UCF main campus.

Institutional and State Level Accountability

II. Need and Demand

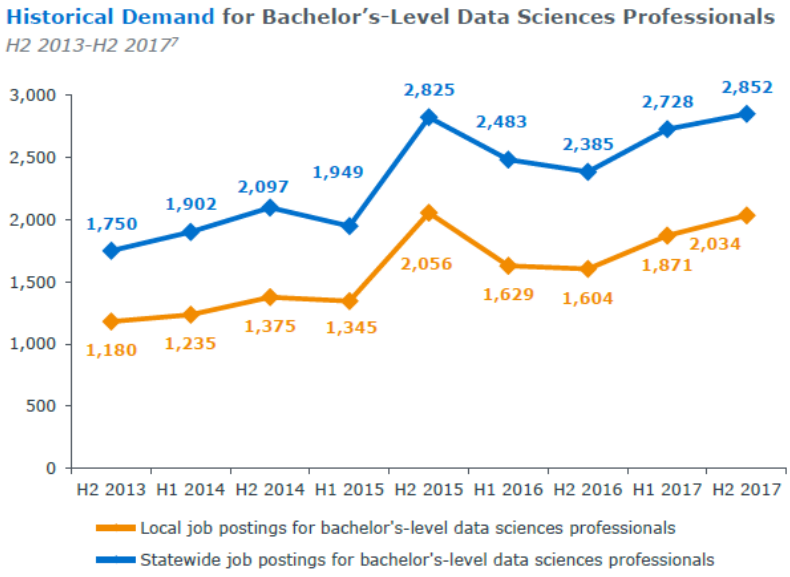
Need: Describe national, state, and/or local data that support the need for more people to be prepared in this program at this level. Reference national, state, and/or local plans or reports that support the need for this program and requests for the proposed program which have emanated from a perceived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

Need

“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 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 commissioned by the Business- Higher Education Forum 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. 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.



Source: EAB 2016

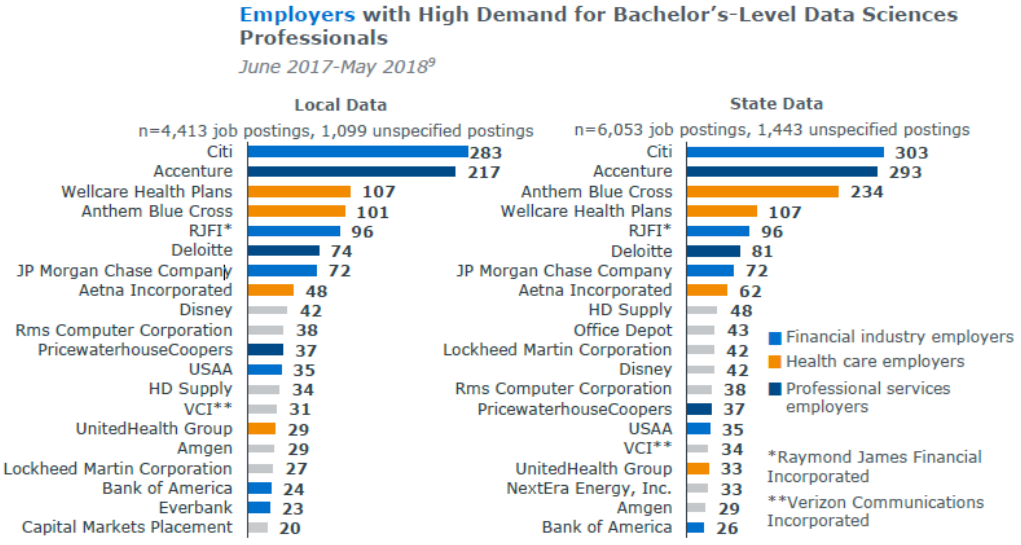
Over the same period, statewide employer demand for bachelor’s-level data sciences professionals increased 63% from 1,750 job postings to 2,852 job postings. This suggests local employers may also experience a higher demand for bachelor’s-level data sciences professionals than other employers in Florida 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 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).



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", 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.

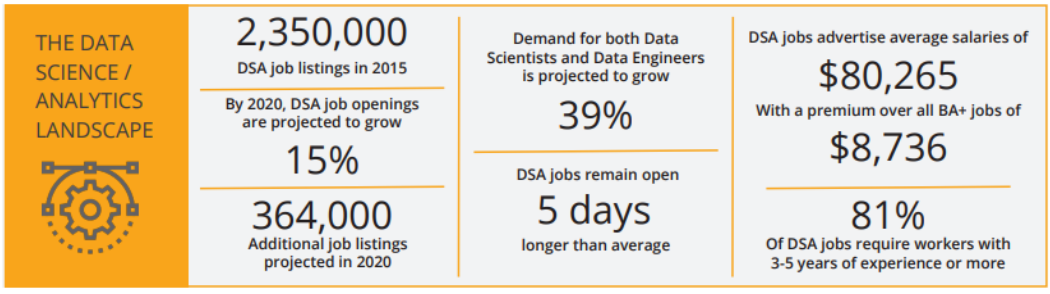
DSA Framework Category	Professional Services	Finance & Insurance	Manufacturing	Information	Health Care & Social Assistance	Retail Trade
Data-Driven Decision Makers	23%	17%	16%	10%	6%	6%
Functional Analysts	23%	34%	9%	5%	8%	4%
Data Systems Developers	41%	14%	14%	10%	5%	3%
Data Analysts	34%	25%	9%	6%	7%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

2-http://www.bls.gov/careeroutlook/2013/fall/art01.pdf
3-https://www.harveynash.com/usa/news-and-insights/Harvey%20NashKPMG_CIO_survey_2016_US.pdf
4- https://www.insidehighered.com/news/2017/03/30/report-urges-data-science-course-work-all- undergraduates-close-growing-skills-gap
5- http://www.bls.gov/careeroutlook/2013/fall/ art01.pdf
6- https://www.ibm.com/downloads/cas/3RL3VXGA?mhsrc=ibmsearch_a&mhq=quant%20crunch
7- https://www.forbes.com/sites/louiscolumbus/2017/05/13/ibm-predicts-demand-for-data-scientists-will-soar-28-by- 2020/#23a1fe967e3b

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.

Demand

"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, a popular job site, published a list of the "50 Best Jobs in America", 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 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 an 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

		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.

8- https://www.glassdoor.com/List/Best-Jobs-in-America-2018-LST_KQ0,25.htm
9- https://www.glassdoor.com/List/Best-Jobs-in-America-LST_KQ0,20.htm

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.

Outcomes of Communication

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 degre 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.

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.

Student Headcount (HC) and Full Time Equivalents (FTE)

In Table 1-A (found in Appendix A1), 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.

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.

Diverse Student Body

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 B1).

III. Budget

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.)

Projected Costs and Associated Funding Sources

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 an additional one needed to staff the computer lab.

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.

Rationale	n/a

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).

Impacted Programs

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: **Industrial Engr & Mgmt Systems**

Faculty	**Courses Taught**		**Faculty**	**Course Taught**
New hire	ISC 4301		Ivan Garibay	ISC 4301
Sean Szumlanski	COP 3502C		Luis Rabelo	ISC 4701
Mark Llewellyn	ISC 4401		Adan Vela	ISC 4242
Liqiang Wang	COP 4283		Qipeng Zheng	ESI 4312
Arup Guha	COT 3100C			

Damla Turgut	COP 4331			
Sumanta Pattanaik	ISC 4501			
Gita Sukthankar	CAP 4670			

Mathematics **Statistics and Data Science**

Faculty	Courses Taught		Faculty	Courses Taught
Joseph Brennan	ISC 4242		New Hire	STA 4038, STA 4039
Carlos Borges	ISC 4242, MAP 4447, ISC 4701		Nizam Uddin	STA 2023, ISC 4241
Xin Li	ISC 4242, MAP 4447, ISC 4701		Mengyu Xu	STA 2023, STA 4724
Brian Moore	ISC 4242, ISC 4301		Alexander Mantzaris	ISC 4241, ISC 4301
Marianna Pensky	ISC 4242, ISC 4301		Edgard Maboudou	STA 4163, STA 4241
Gary Richardson	ISC 4242, ISC 4301		Xin Yan	STA 4163, STA 4164
Qiyu Sun	ISC 4242, MAP 4447		Chung-Ching Wang	ISC 4701, STA 4039
Gerrit Welper	ISC 4242, MAP 4447, ISC 4701			
Teng Zhang	ISC 4242, MAP 4447, ISC 4701			

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.

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).

Other Potential Impacts	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.

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.

Resources	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.

Need and Demand

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

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)

Justification for an Exception	The total number of credit hours required will not exceed 120.

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.

Program Prerequisites	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.

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.

Limited Access Status Rationale	We do not intend to seek formal limited access status for the proposed program.

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.

AS-to-BS Capstone	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

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).

Goals	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.

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

Relation to Existing Institutional Strengths

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 48th out of all Computer Science departments in the U.S. and UCF ranks 41st 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.

	Statistics B.S.		Actuarial Science B.S.*	
Year	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.

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

Date	Participants	Planning Activity
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	2nd 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	3rd 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	4th 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	5th 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	Valencia College East 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	VC/UCF Data Sciences Collaboration Discussion

	Professor **Dave Brunick, Professor Computer Programming/Analysis** **UCF** **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**	
11/06/2018	**Shunpu Zhang, Joe Brennan, Dan Eilen, Dave Brunick, Sidra Van De Car, and Alison Hammack**	**6th 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**	**7th meeting of the proposal committee**
11/28/2018	**Gary Leavens, Joseph Brennan, Dan Eilen, Luis Rabelo, Shunpu Zhang**	**8th meeting of the proposal committee**
12/10/2018	**Gary Leavens, Dan Eilen, Shunpu Zhang**	**9th meeting of the proposal committee**
12/17/2018	**Gary Leavens, Joseph Brennon, Shunpu Zhang**	**10th meeting of the proposal committee**

01/07/2019	Gary Leavens, Joseph Brennon, Dan Eileen, Luis Rabelo, Shunpu Zhang	11th meeting of the proposal committee
01/14/2019	Gary Leavens, Dan Eileen, Luis Rabelo, Shunpu Zhang	12th meeting of the proposal committee
01/24/2019	Gary Leavens, Joseph Brennon, Shunpu Zhang	13th meeting of the proposal committee
02/04/2019	Gary Leavens, Joseph Brennon, Shunpu Zhang	14th 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	15th 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	16th meeting of the proposal committee Meeting, discussed the curriculum.
04/05/2019	Gary Leavens, Luis Rabela, Dan Eilen, Shunpu Zhang	16th meeting of the proposal committee Meeting
04/17/2019	Gary Leavens, Joseph Brennan, Shunpu Zhang	17th meeting of the proposal committee Meeting
05/03/2019	Joseph Brennan, Luis Rabela, Dan Eilen, Shunpu Zhang	18th meeting of the proposal committee Meeting
07/31/2019	Joseph Brennan, Gary Leavens, Dan Eilen, Shunpu Zhang	19th meeting of the proposal committee Meeting
08/09/2019	Teresa Dorman, Joseph Brennan, Gary Leavens, Dan Eilen, Shunpu Zhang	20th meeting of the proposal committee Meeting with Dr. Teresa Dorman
08/13/2019	Joseph Brennan, Gary Leavens, Dan Eilen, Shunpu Zhang	21st meeting of the proposal committee Meeting
08/19/2019	Joseph Brennan, Gary Leavens, Shunpu Zhang	22nd meeting of the proposal committee Meeting
08/26/2019	Joseph Brennan, Luis Rabelo, Dan Eilen, Gary Leavens, Shunpu Zhang	23rd meeting of the proposal committee Meeting
09/17/2019	Joseph Brennan, Luis Rabelo, Dan Eilen, Gary Leavens, Shunpu Zhang	24th meeting of the proposal committee Meeting
09/20/2019	Joseph Brennan, Luis Rabelo, Gary Leavens, Shunpu Zhang	25th meeting of the proposal committee Meeting
10/02/2019	Joseph Brennan, Luis Rabelo, Gary Leavens, Shunpu Zhang	26th meeting of the proposal committee Meeting
	Michael Johnson, Michael Georgiopolous	

10/03/2019	Michael Georgiopoulous, Joseph Brennan, Dan Eilen, Shunpu Zhang	27th meeting of the proposal committee Meeting
10/04/2019	Joseph Brennan, Luis Rabelo,Mark Henrich, Shunpu Zhang	28th meeting of the proposal committee Meeting and Dr. Dorman
10/09/2019	Joseph Brennan, Luis Rabelo, Gary Leavens, Shunpu Zhang, Teresa Dorman	29th meeting of the proposal committee Meeting
10/09/2019	Joseph Brennan, Luis Rabelo, Shunpu Zhang	30th meeting of the proposal committee Meeting
10/10/2019	Joseph Brennan, Luis Rabelo,Mark Henrich, Shunpu Zhang	31st meeting of the proposal committee Meeting
10/11/2019	Joseph Brennan, Luis Rabelo ,Daniel Eilen, Shunpu Zhang	32nd 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: • program review results from CS, IEMS and Math. • the information on Faculty Participation • the survey results from CS and Math • Section VIII (curriculum) • Section V (access/articulation) and for soliciting letters of support • Draft sections X (non-faculty resources • Draft Table 4 (faculty participation), • Draft Table 2 and 3 (budget)

11/28/2018	**Discussed the remaining (unfinished) part of the proposal:** • **program review results from CS, IEMS and Math.** • **the information on Faculty Participation** • **the survey results from CS and Math** • **Section VIII (curriculum)** • **Section V (access/articulation) and for soliciting letters of support** • **Draft sections X (non-faculty resources** • **Draft Table 4 (faculty participation)** • **Draft sections IX (faculty resources)**
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.**

Planning Process

Date		**Participants**
Planning Activity	see above	
Date		**Participants**
Planning Activity		

Events Leading to Implementation

Date	
Implementation Activity	see above.
Date	

Implementation Activity	

VII. Program Quality Indicators - Reviews and Accreditation

Identify program reviews, accreditation visits, or internal reviews for any university degree programs related to the proposed program, especially any within the same academic unit. List all recommendations and summarize the institution's progress in implementing the recommendations.

Recommendations and Summary

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. Dr. John Stufken, Charles Wexler Professor in Statistics, Arizona State University and Dr. 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

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.

Expected Student Learning Outcomes	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.

Describe the admission standards and graduation requirements for the program.

Admission Standards and Graduation Requirements	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.

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.

Curricular Framework

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 and 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).

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

Sequenced Course of Study

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

Fall Semester Year 1		Spring Semester Year 1	
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	3	GEP Social Fnd, Area 2	3
	16		16

Fall Semester Year 2		Spring Semester Year 2	
BSC 2010	4	COP 3223	3
MAC 2313	4	MAS 3105	4
PHY 2048	4	MHF 3302*	3
STA 2023	3	STA 4163	3
	15		13

Fall Semester Year 3		Spring Semester Year 3	
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	3	Elective II	3
	15		15

Fall Semester Year 4		Spring Semester Year 4	
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	3	Elective VII	3
	15		15

*Students may instead take COT 3100

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

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

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 - Programming for Scientists

This is a course that focuses on the development of programming for modeling in 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, bootstraping, subset selection, shrinkage methods, dimension reduction, decision trees, bagging, random forests, boosting, principal components analysis, clustering methods.

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.

Industry-Driven Competencies

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:

Name	Company/Institution	Position
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.

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.

Specialized Accreditation Agencies and Learned Societies	No applicable agencies or societies.

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?

Doctoral Accreditation Agencies and Learned Societies	n/a

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.

Anticipated Delivery System	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

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).

Full-Time Faculty

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:

Faculty Name	Rank (in Jan 2019)	Courses Taught
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

Faculty Name	**Rank (in Jan. 2019)**	**Courses Taught**
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, 2030-3032)

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

assisted by a Program Assistant starting in Year 3. 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.

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.

Costs/Funding for Full-Time Faculty

As indicated in Table 4 (Appendix A2) and Table 2 (Appendix A2), we will have 27 faculty supporting this program, one of which will be a new, joint hire. 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

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.

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

Abbreviated Curriculum Vitae

Curriculum vitae for each faculty are found in Appendix M.

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.

Productive Academic Unit(s)

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 11th 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 sixNSF 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 82nd among the doctoral programs in Computer Science in the US, and the department ranks 50th in research on csrankings.org. At that website, the department ranks 31st among US departments in “interdisciplinary areas” (which includes HCI and bioinformatics) and 41st among US departments in “artificial intelligence” (including 5th 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 form 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

Industrial Engineering in the nation during the years 2016 and 2017 (the second place was to 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 between1360 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

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

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.

Library Resources	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.

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.

Additional Library Resources	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.

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.

Necessary and Available Space	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.

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.

Additional Space Needed	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.

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.

Capital Expenditure	n/a

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

Specialized Equipment	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.

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.

Specialized Equipment	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.

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.

Additional Special Categories of Resources Needed	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.

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.

Fellowships, Scholarships, and Graduate Assistantships to be allocated	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.

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.

Available Sites	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.

Attachment List

Please attach any required files by navigating to the Proposal Toolbox and clicking in the top right corner.

Check	☑ I have completed all relevant parts of the form.
Attached	☐ If applicable, I have attached the New Degree Proposal Worksheets

Administrative Use Only

Catalog Ownership:	
Program Type	Major
Degree Type	Bachelor of Science
Status	◉ Active-Visible ○ Inactive-Hidden