DEPARTMENT OF HIGHER EDUCATION & WORKFORCE DEVELOPMENT

New Program Report

Date Submitted:
11/20/2023

Institution
University of Missouri-Columbia

Site Information

Implementation Date:
1/1/2024 12:00:00 AM

Added Site(s):

Selected Site(s):

University of Missouri-Columbia, 105 Jesse Hall, Columbia, MO, 65211

CIP Information

CIP Code:
307001

CIP Description:
A program that focuses on the analysis of large scale data sources from the interdisciplinary perspectives of applied statistics, computer science, data storage, data representation, data modeling, mathematics, and statistics. Includes instruction in computer algorithms, computer programming, data management, data mining, information policy, information retrieval, mathematical modeling, quantitative analysis, statistics, trend spotting, and visual analytics.

CIP Program Title:
Data Science, General

Institution Program Title:
Data Science

Degree Level/Type

Degree Level:
Bachelor's Degree

Degree Type:
Bachelor of Science

Options Added:

Collaborative Program**:**
N

Mode of Delivery

Current Mode of Delivery

Classroom

Student Preparation

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Special Admissions Procedure or Student Qualifications required:
Entering freshmen are expected to have completed 17 units of approved high school course work (in grades 9-12), including 4 units in English, 4 in mathematics and 3 in science with laboratory. Mathematics should include 2 units of algebra, 1 unit of plane and solid geometry (combination course), and 1/2 unit of trigonometry. Additional senior mathematics is recommended.

Specific Population Characteristics to be served:
n/a

Faculty Characteristics

Special Requirements for Assignment of Teaching for this Degree/Certificate:
An MS or a PhD are required for teaching in the area of Data Science or one of the focus areas of Computer Science, Mathematics, Statistics, or related fields.

Estimate Percentage of Credit Hours that will be assigned to full time faculty:
90%

Expectations for professional activities, special student contact, teaching/learning innovation:
n/a

Student Enrollment Projections Year One-Five

Year 1	**Full Time:** 2	**Part Time:** 0	
Year 2	**Full Time:** 10	**Part Time:** 0	
Year 3	**Full Time:** 20	**Part Time:** 0	**Number of Graduates:** 8
Year 4	**Full Time:** 30	**Part Time:** 0	
Year 5	**Full Time:** 49	**Part Time:** 1	**Number of Graduates:** 20

Percentage Statement:
n/a

Program Accreditation

Institutional Plans for Accreditation:
The curriculum has been designed to meet the outcomes listed in the ABET (Accreditation Board for Engineering and Technology) accreditation criterion for programs in Data Science. ABET specifies the quantity of credit hours and some details on content required for courses. Within 5 years of starting the program, a request for evaluation will be made to the Computing Accreditation Commission to coincide with the next ABET review cycle.

Program Structure

Total Credits:
120

Residency Requirements:
n/a

General Education Total Credits:
42

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Major Requirements Total Credits:
60

Course(s) Added

COURSE NUMBER	CREDITS	COURSE TITLE
STAT 4520	3	Applied Statistical Models II
MATH 2320	3	Discrete Mathematical Structures
DATA SCI 1030	3	Foundations of Data Science
STAT 4510	3	Applied Statistical Models I
xxxxx	6	Experiential Courses
MATH 1400	3	Calculus for Social and Life Sciences I
or MATH 1500	3	Analytic Geometry and Calculus I
CMP SC 1300	3	Computing with Data in Python
STAT 2800	3	Intuition, Simulation, and Data
xxxxx	12	Intermediate Courses
xxxxx	12	Advanced Courses (Computer Science, Statistics, or Mathematics Focus Areas)
MATH 4140	3	Matrix Theory
CMP SC 3380	3	Database Applications and Information Systems
CMP SC 2300	3	Introduction to Computational Data Visualization

Free Elective Credits:
0

Internship or other Capstone Experience:
Six hours of experiential coursework are required, three hours of which meet the capstone requirement.

Assurances

I certify that the program is clearly within the institution's CBHE-approved mission. The proposed new program must be consistent with the institutional mission, as well as the principal planning priorities of the public institution, as set forth in the public institution's approved plan or plan update.

I certify that the program will be offered within the proposing institution's main campus or CBHE-approved off-site location.

I certify that the program will not unnecessarily duplicate an existing program of another Missouri institution in accordance with 6 CSR 10-4.010, subsection (9)(C) Submission of Academic Information, Data and New Programs.

I certify that the program will build upon existing programs and faculty expertise.

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I certify that the program can be launched with minimal expense and falls within the institution's current operating budget.

I certify that the institution has conducted research on the feasibility of the proposal and it is likely the program will be successful. Institutions' decision to implement a program shall be based upon demand and/or need for the program in terms of meeting present and future needs of the locale, state, and nation based upon societal needs, and/or student needs.

Contact Information

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Executive Summary

The Colleges of Engineering and Arts and Science are jointly proposing the new BS in Data Science in response to four robust areas of opportunity: 1) the emergence and rapid growth of the data science career path, and concomitant workforce demand in Missouri and beyond; 2) strong undergraduate/graduate programs in the triad of disciplines at the foundation of this interdisciplinary field (Computer Science, Mathematics, and Statistics); 3) a strong MU graduate program in Data Science (MS and graduate certificates); and 4) expanding faculty expertise in data science across campus – an expertise integral to many, if not all, of the research areas of the Mizzou Forward initiative. A fifth area of opportunity is the increasing number of collaborations between the Colleges of Engineering and Arts & Science, which house the three departments supporting the degree.

A recent US News and World Report ranked Data Science third among technology majors with degrees sought across virtually every sector: banking and finance; construction and engineering; medicine and health care; marketing, strategic communication, and journalism; education and policy; etc. Data science is also increasingly relevant to core academic and industrial research. Job market analysis from Lightcast indicates that Missouri has new openings for 111 data scientists a year, with over 2,500 data scientists employed across the state.

Growth in this industry over the next ten years is predicted between 31% and 45%, which means the need for data scientists will only increase. However, the handful of existing programs in the state cannot meet current and projected demand. The proposed MU program will add capacity to support the Missouri labor market now and in the future.

The BS in Data Science aligns with the goals in the campus strategic plan. It is a workforce-ready undergraduate degree with high earning potential in an important and growing interdisciplinary area of relevance to virtually every industry and academic field. With the strength of existing curricula, faculty, computing infrastructure, and research expertise across the core areas of Data Science, the MU Colleges of Engineering and Arts & Science are well positioned to deliver a quality undergraduate experience and degree.

1. Introduction

The BS in Data Science extends the benefits of a research-intensive university and the strength of its faculty to the MU undergraduate mission. It is reflected in the research of the Mizzou Forward focus area, "New Frontiers in Science, Engineering and Technologies" and aligns squarely with the following goals in the campus strategic plan:

- To create new degree programs based on student demand, workforce needs, and emerging opportunity;
- To develop new interdisciplinary undergraduate and graduate degree programs to magnify departmental strengths; and
- To increase undergraduate enrollment by attracting additional students to MU.

Structure of Proposed Degree
The degree consists of the 60 hours of coursework:

- A foundational core of 10 courses (30 hours) across the triad of disciplines that inform data science (computer science, mathematics, and statistics);
- An intermediate core of 4 courses (12 hours) that builds on the foundation in two of the three triad areas while moving students towards their focus area;
- An advanced focus area of 4 courses (12 hours) in one of the three triad disciplines; and
- Experiential coursework (6 hours) in internship or research to prepare students for career and/or graduate school.

The coursework allows students to easily complete their major and general education requirements within the 120-credit hour minimum for undergraduate degrees, with room for additional minors or certificates to further prepare them for career or advanced study (e.g., a minor in business, construction management, physics; a certificate in cyber security, professional communication, sports analytics, biostatistics, information systems and technology). With careful planning, students are also able to double or dual major in the affiliated triad disciplines (Computer Science, Math, Statistics) or in Information Technology.

The degree has been carefully designed with an eye to future development, such as a data science minor; "4+1" or accelerated BS/MS programs in one or more of four disciplines (Data Science, Computer Science, Mathematics, Statistics) as well as additional tracks within the major in the advanced coursework (e.g., industrial engineering; marketing analytics; health statistics). In the future, a joint online degree with UMSL, and possibly other campuses in the UM System, may be possible.

Students who complete the degree with the Computer Science focus will receive their degrees from the College of Engineering; those who complete in Mathematics or Statistics will receive their degrees from the College of Arts and Science.

Relevance to Missouri (and Beyond): Workforce Development
The Data Science BS is a workforce-ready degree with high earning potential. A recent US News and World Report ranked it third among technology majors. Data Science degrees are sought across virtually every sector: banking and finance; construction and engineering; medicine and health care; marketing, strategic communication, and journalism; and education and policy. Students who earn the BS often go on to pursue a master's for higher-level jobs. Data science is also increasingly relevant to core academic and industrial research.

Job market analysis from Lightcast indicates that Missouri has new openings for 111 data scientists a year, with over 2500 data scientists employed across the state. However, growth in this industry over the next ten years is predicted between 31 and 45%, which means the need for data science degree holders will only increase. At the same time, the handful of existing programs in the state (UMSL, William Jewell, and Maryville University) and the number of degree conferrals per year (11 in 2021) cannot meet current demand. The MU program will add capacity to support the Missouri labor market now and in the future.

Financial viability and startup costs
The costs for launching the new program at MU are minimal, thanks to existing undergraduate and graduate programs and curriculum in the areas of the data science triad; a flourishing Data Science MS program that has over 100 students currently enrolled with multiple emphasis areas (geospatial analytics; high performance computing; biohealth analytics; human centered design; strategic communications and journalism); research-intensive faculty; and the necessary computing infrastructure already in place. Initial start-up costs are largely confined to marketing and student services (advising), as well as additional graduate TA support; the estimated $35K of this cost in year zero will be covered by the Colleges as a worthwhile investment. Should the program grow as expected (and the estimates for growth in the proposal err towards the conservative), these costs, as well as any new faculty line(s) are accounted for in projected revenues. Similarly, should the program prove non-viable (which is highly unlikely), the discontinuance and teach-out costs are minimal.

The proposed BS in Data Science is a workforce-ready undergraduate degree in an important and growing interdisciplinary area of relevance to virtually every industry and academic field. With the strength of existing curricula, faculty, computing infrastructure, and research expertise across the core areas of Data Science, the MU Colleges of Engineering and Arts & Science are well positioned to deliver a quality undergraduate experience and degree.

2. University Mission and Other Academic Programs

2.A. Alignment with Mission

The BS in Data Science will allow undergraduate students to work and learn side by side with faculty who are advancing science in the emerging and multidisciplinary field of data science. These students will go on to benefit the state of Missouri by working in an area that is in high demand by employers in the state, and will continue to be so for the foreseeable future.

Alignment with Campus Strategic Plan
The proposed BS in Data Science aligns with the MU strategic plan goals to "Create new degree programs and revise existing programs based on student demand, workforce needs and emerging opportunities." Data Science easily meets all three of these criteria. Both students and faculty in the three contributing fields (Computer Science, Mathematics, and Statistics) are keenly aware of the exponential growth of the discipline and its application to research and the workforce. According to analysis of Lightcast report information, there is across the board demand for Data Scientists locally, regionally, and nationally. Missouri alone has a strong growth outlook for job openings in DS. Its relevance for research and industry globally is also worth noting.

The BS in Data Science program also aligns with the call to "Develop new and revise existing interdisciplinary undergraduate and graduate degree programs to magnify departmental strengths." The proposed BS in Data Science capitalizes on teaching and research expertise across two colleges (Engineering and Arts and Science) and three departments (Computer Science, Mathematics, and Statistics) to create a program that is coherently interdisciplinary, academically rigorous, and workforce ready.

Also, core to the Strategic plan, the program will increase undergraduate enrollment by attracting additional students to MU. The proposed BS in Data Science will be attractive to students as an emerging and relevant field with excellent pay and employment opportunities.

Program Priority
One of the sub-areas identified in Mizzou Forward under the research area "New Frontiers in Science, Engineering and Technologies" is "Computing and Communication". The course requirements and learning outcomes of the Data Science BS focus on computing including computerized analysis and computer programming, with an emphasis on the applicability – the communicability – of data.

2.B. Duplication & Collaboration Within UM System and the State

Duplication within UM System

UMSL currently offers a BS in Data Science and Analysis. Launched at UMSL in Fall 2022, the program was built upon preexisting undergraduate certificates in Actuarial Science and Data Science, with additional emphasis areas that draw likewise from existing courses in biology, computer science, economics, mathematics, social science, and supply chain analytics.

Rationale

The proposed Data Science BS is likewise grounded in resources, opportunities, and experiences specific to MU. These are our strong undergraduate and graduate programs in Statistics and Mathematics in the College of Arts and Science, together with Computer Science in the College of Engineering. It also leverages the faculty and research that informs our existing and highly interdisciplinary Data Science and Analytics graduate program, which offers an MS degree and a graduate certificate.

While MU also foresees building out additional emphasis areas that draw on other robust MU curricular and research areas (digital merchandizing; transportation; industrial & manufacturing systems; geographical information systems; biohealth, strategic communication), given our strengths in the core triad disciplines of data science, we have chosen to begin with a program that concentrates on these – all the more so because they are the triad of core disciplines as recognized by national organizations such as ABET (Accreditation Board for Engineering and Technology).

MU also has excellent infrastructure, including computing facilities designed for data science research and graduate education – an important resource for students studying data science at the undergraduate level.

To this end, the MU degree is built upon a set of core computational, mathematical, and statistical courses; an intermediate core that expands on the core triad while allowing students to build towards an advanced focus area in one of the three disciplines that constitutes final twelve hours of the degree.

The MU degree does not duplicate UMSL's, but it does create potential opportunities for collaboration between MU and UMSL on data science education in Missouri. UMSL has strengths in its existing Certificate in Data Science and courses developed by their Colleges of Arts and Sciences and Business Administration that support data science education as well as its ties to industry and the community of the Saint Louis region. MU graduates from our existing programs in math, statistics, and engineering already find employment in significant numbers not only in St. Louis, but also Kansas City and Springfield, as well as beyond the state’s borders. Future MU/UMSL collaborations might include intercampus course sharing to expand educational opportunities for students in data science. For example, MU has strengths in health informatics, whereas UMSL's Data Science program incorporates business coursework into its

certificate and degree in ways that MU's proposed program does not. More ambitiously, it could pave the way for future joint online certificates or even an online degree.

In sum, the data science programs at MU and UMSL will be complementary; together, they are also far better poised to build out workforce capacity in data science and analysis across the state - something that no one program can do alone.

Duplication within the State

Maryville University of Saint Louis and William Jewell College both offer a degree in Data Science. However, William Jewell does not include a track in computer science, which will limit many career paths after graduation. Additionally, the programs at both institutions are small and are not located at research-intensive universities. The program at MU has the benefit of the strong background of research and teaching faculty in Statistics, Mathematics and Computer Science.

Collaboration

While there currently exists no collaboration within the State or UM System, faculty from three departments across two colleges on the MU campus are collaborating on the BS in Data Science program. A committee will be formed to make curriculum decisions and to coordinate the program. The committee will be composed of faculty representatives from each of the three core departments (two faculty from EECS, one faculty from MATH, and one faculty from STAT), with a rotating program coordinator/director appointed by joint decision of the deans of Arts & Science and Engineering.

3. Business-Related Criteria & Justification

3.A. Market Analysis

3.A.1. Rationale and Workforce Demand

According to labor analytics company Lightcast, Missouri is a hotspot for Data Science Jobs. The national average for an area this size is 2,042 employees, while there are 2,564 here in Missouri. Data Scientist job growth nationwide is projected to be over 45% in the next ten years according to Lightcast analysis indicating that this is an emerging opportunity and an area of workforce need. The program will prepare students to become competitive and marketable data scientists in Missouri, regionally, nationally, and internationally through strong connections to the industries.

Meeting Missouri's Needs
According to Lightcast, there are 111 annual unique openings in Missouri for Data Scientists. This is a conservative estimate, as it reflects only one job title for which a Data Science BS would be appropriate; for example, there are 746 unique job postings for Management Analysts, 324 unique postings for Computer and Information Systems Managers, etc. Existing data science programs in the state can only produce enough degree completions to supply roughly 10% of the market demand for new Data Science employment.

This percentage plummets when analyzing analogous job titles rather than focusing narrowly on postings for 'data scientists.' New programs at UMSL and the proposed program at the University of Missouri – Columbia will still not be able to completely fill the current need in the state of 111 (growing each year) and the expected growth of the field. The University of Missouri projects that with a steady state enrollment of 225, approximately 20 degree completions can be achieved in the proposed BS in Data Science within the next 5 years and 55 in the years beyond 5.

Wage Analysis
The median earnings for a data scientist is $48.32/hr in the nation, $42.14 in the region (Missouri and surrounding states), and $38.28/hr in the state of Missouri. The expected wage growth rate is 40-45% over the next ten years according to Lightcast.

3.A.2. Student Demand for Program

The Bureau of Labor Statistics projects 31.4% increase in employment (19,800 additional jobs) for data scientists between 2020 and 2030. This compares to the number of additional jobs in a well-established field such as Mechanical Engineering (7% increase in employment or 20,900 new jobs). To fill these jobs, many students will be seeking educational opportunities such as the BS in Data Science, to prepare them.

Table 1a. Student Enrollment Projections

Year	1	2	3	4	5
Full-time	20	40	59	98	167
Part-time	0	0	1	2	3
Total	20	40	60	100	170

The enrollment projection is based on the incoming student enrollment projects with an 80% retention rate through year 4. This retention rate is based on the year-to-year retention rate of 93% typical of other degree programs such as Computer Science or Information Technology which require courses that are similar to those included in the Data Science requirements.

Table 1b. New Student Enrollment Projections

Year	1	2	3	4	5
Full-time	2	10	20	30	49
Part-time	0	0	0	0	1
Total	2	10	20	30	50

To obtain these numbers, we will recruit 10 incoming (new to MU) students per year initially, gradually increasing to 30-40 by year 5. We expect a 93% year-to-year retention rate each year and a minimum of a 75% 4-year graduation rate. Data Science well known among students and is consistently in the last few years ranked as a top job by organizations such as Glassdoor. The job market reports attached to this proposal support the idea that the job market for Data Scientists is very good currently and rapidly growing.

Table 1c. Projected Number of Degrees/Certificates Awarded

Year	1	2	3	4	5	6	7	8	9	10
Completions	0	2	8	15	20	35	55	55	55	55

3.B. Financial Projections

Resources

The budget outlines a plan to leverage existing instructors, Teaching Assistants (TAs), computing infrastructure, existing advising staff, marketing, and general operation costs.

Recurring expenses are associated with the day-to-day operation of the program, instructional costs, cloud computing infrastructure for student projects, website and marketing, and staff support. The current faculty and graduate teaching assistant (GTA) costs are tied directly to the number of students projected into the program and will vary with enrollments.

Years 1-3, the program will leverage current faculty, advising staff, and cyber engineer from all participating departments without new hires. After Year 4, the program is expected to have sufficient revenue and resource to recruit 2-3 FTE TT/NTT faculty and advising staff if necessary, but this will be determined by the respective colleges based on student demand. In addition, the cost of graduate teaching assistants is also budgeted to ensure the quality of learning for core courses (Years 1-5) and focus area courses (Years 3-5).

The total cost of the resources described here for year one is $174,000, increasing to $756,000 in year 5. The steady state cost of resources is expected to be $790,000.

3.B.1. Additional Resources Needed

Faculty
To ensure delivery of core courses, the program will allocate funding for $10K per course to cover core and intermediate core courses for Years 1-2 and elective courses for Years 3-5. These instructors will work with the focus area leads to ensure that their courses meet the rigor the program requires. Starting from Year 4, the program is expected to have enrollment number to recruit 2-3 FTE TT/NTT faculty across the core and focus areas to ensure the quality of the training program. All salaries include benefits for benefit-eligible positions.

Graduate Teaching Assistants
Graduate students associated with the program may be supported by graduate teaching assistant funds. We will recruit top-notch doctoral students from focus area programs to serve as Graduate Teaching Assistants (GTAs). One half-time (0.50 FTE) GTA will be assigned to a course for every 80 students. The approximate monthly salary is $2000 for a 0.50 FTE GTA. This rate reflects the need of including student insurance and other fees. We expect the focus area department will cover the tuition cost for the GTAs. Each 05 FTE TA will cost $20,000 annually for fall and spring semesters. The GTA budget in Year 1 is $40,000 as budgeted and by year 5, the TA budget expands to $400,000 as enrollment increases.

Level	**Number**
Tenure Track	0
Non-Tenure Track	.75
Post-Doc Fellows	0
Graduate Teaching/Research Assistant	10
Adjunct	0

Supporting Staff
To support student activities, Academic Advisors, $64,000 is budgeted to cover costs of existing advising staff from participating departments. A one-time expense of $5000 is included to support equipment needed by staff for this program.

A new advisor will be needed as enrollment expands at year 3. Until year three, current A&S and Engineering advisors for the Statistics, Mathematics, and Computer Science programs will advise Data Science students.

Marketing
Budget for these materials fall under the $50,000 marketing budget annually. We anticipate that existing and very extensive marketing efforts by the College of Engineering and the College of Arts and Science will also support marketing for this program. Data Science will be included in our existing online, billboard, and printed materials marketing efforts. The marketing budget included here will support additional efforts to include Data Science in the existing and new marketing efforts.

Operations
Other operating costs are estimated at $20,000 annually. These costs will include office supplies, materials, and compensation for the director.

*Zero Cos*t
There is zero library cost associated with the program proposal. This can be attributed to the changing nature of libraries (for example, movement to online resources and a reduced need for space to support student and faculty needs). And, the existing library resources for research and teaching in the areas of Computer Science, Mathematics, and Statistics are adequate for Data Science in terms of journals, books, and other materials needed for students interested in data science. This is a consequence of having active graduate programs and research in the area of data science for a number of years.

The program also relies on existing computing resources and a movement toward the use of student owned computers. Cyberinfrastructure beyond the resources currently available to undergraduate students (e.g., cloud computing) will be provided.

3.B.2. Revenue

Sources of Revenue
The initial startup of the program will require modest institutional support of $35K-$112K (cumulative negative net revenue of $112K is indicated in year zero and year 1 in a scenario where enrollment is 50% of expectations). These costs will be covered by the College of Engineering and College of Arts & Sciences. However, these funds will be compensated by future revenue as the program grows.

Based on the enrollment projection for students new to MU the total revenue in year one will be $239,000, increasing to $2,200,000 in year five (using the Tier 3 tuition rate). At the steady state, the total revenue for data science students is $3,000,000.

3.B.3. Net Revenue

This program is expected to start generating net revenue early in its life cycle, as demonstrated by Table 2 and Appendix 1.

Table 2. Financial Projections for Proposed Program for Years 1 Through 5.

	Year 1	Year 2	Year 3	Year 4	Year 5
1. Expenses per year					
A. One-time					
New/Renovated Space					
Equipment			5,000		
Library					
Consultants					
Other	51,000	52,020	53,060	54,122	55,204
Total one-time	51,000	52,020	58,060	54,122	55,204
B. Recurring					
Faculty	50,000	51,000	52,020	53,060	54,122
Staff			64,784	66,079	67,401
Teaching Assistants	40,600	41,412	126,721	258,510	395,521
Benefits	32,272	32,917	86,743	134,519	184,171
Equipment					
Library					
Other					
Total recurring	122,872	125,329	330,268	512,169	701,214
Total expenses (A+B)	$173,872	$177,349	$388,328	$566,290	$756,418
2. Revenue per year					
Tuition/Fees	239,304	488,181	746,916	1,269,758	2,201,760
Institutional Resources					
State Aid -- CBHE					
State Aid -- Other					
Total revenue	$239,304	$488,181	$746,916	$1,269,758	$2,201,760
3. Net revenue (loss) per year	$65,433	$310,831	$358,588	$703,467	$1,445,342
4. Cumulative revenue (loss)	$30,141	$340,972	$699,560	$1,403,028	$2,848,370

3.B.4. Financial and Academic Viability

Table 3. Enrollment for Financial and Academic Viability

Enrollment	Minimum for Financial Viability	Minimum for Academic Viability
Full-time	35	40
Part-time	0	0
Total	35	40

Enrollment of 35 students is the break-even enrollment that allows the revenue to equal expenses in year 5. Enrollment of 40 students will allow classes to fill with a minimal number of students for collaborative work as needed.

3.C. Business Plan: Marketing, Student Success, Transition & Exit Strategies

3.C.1. Marketing Plan & Strategy

The Data Science program will be integrated into recruitment activities currently managed by each of the two colleges, as well as general MU admissions and recruitment activities (e.g., college fairs, Meet Mizzou Days, high school visits, and community college visits). There are additional, discipline-specific opportunities to recruit through existing MU events aimed at K12 and early career undergraduate students, such as Project Lead the Way; First Robotics; Robotic Camps, and the American Statistical Association's DataFest.

Marketing will include digital advertisements targeted at students and their parents, when appropriate. Digital advertising and printed materials will be designed and purchased. To attract students, recruiting events will also be used such as on-campus visits and high school presentations.

The following individuals will be responsible for marketing:

A. College of Engineering
    1. Danene Brooks, Director of Marketing and Communications
    2. Cassandra Siela, Director of Recruitment and Retention

B. College of Arts and Science
    1. A&S director of Marketing and Communications (TBD)
    2. Ellison Land and Raynesha Green, recruitment coordinators

Note that CoE and A&S strategic communications and recruitment professionals will work collaboratively on these materials.

Projected Program Growth
Advertising will initially focus on the introduction of the program. Later marketing efforts will emphasize job placements, emerging market needs, and new developments in the field of data science at MU and more generally.

Marketing Costs
Marketing costs are estimated to start at $50K per year, with annual increases of 2%.

3.C.2. Student Success Plan

Both Colleges of Arts and Science and Engineering have extensive tutoring, academic advising, outreach programs, and career development services to help students succeed in courses and guide them successfully through their programs and relevant co-curriculars and extracurriculars.

Achieving Enrollment Outcomes
Both colleges have recruiters that will work with campus-level recruiters to encourage both FTC and transfer students to join the new Data Science program. Each also has extensive retention programs that will help to support healthy enrollment.

For comparison, in Fall 2022 the University of Michigan, which offers a similar joint program between its College of Engineering and College of Literature, Science, and the Arts (LSA) had an enrollment of 262 undergraduates. (UMichigan has a larger undergraduate population, of course, but the projected number of MU students is the same when adjusted for size.)

3.C.3. Transition Plan

The program and its faculty board will be overseen by a faculty director. (This is typical of interdisciplinary undergraduate programs in the College of Arts and Science whose faculty are drawn from multiple departments.) Dr. Lawrence Ries, Statistics, will serve in this inaugural role. Directors will serve 3-year terms, with the possibility of renewal. Each new director will be selected jointly by the Dean of the College of Engineering and the College of Arts and Science. If the director leaves the institution, a new director or interim director will be appointed immediately to take over responsibility for the program. The director will be responsible for maintaining the curriculum (leading committee work), ensuring courses are taught so that students can complete the degree, and manage ABET accreditation tasks.

3.C.4. Exit Strategy

If enrollment fails to achieve 100 students within 5 years, this program will be reviewed to determine what steps should be taken to improve enrollment or if the program should be discontinued. In the case of hiatus or discontinuance, required courses will continue to be taught until the final students in the program have

completed their coursework. Many of the courses in Data Science will be of value to students outside of the curriculum, which will allow each of them to be offered even if Data Science student enrollment is low.

4. Institutional Capacity

Both the College of Arts and Science and College of Engineering have advising, student support, instructional, and classroom capacity that can sustain fluctuations in the number of students. With the expected enrollment of 170 students at year 5, this represents a small percentage of the over 10,000 students currently enrolled between the two colleges. It is expected that additional revenue from the proposed program will be used to expand instructional and advising capacity in the two colleges. A new academic advisor will be hired if the program meets enrollment targets. The cost of this expansion of capacity is included in the budget pro forma.

5. Program Characteristics

5.A. Program Outcomes

The proposed BS in Data Science is a collaborative, interdisciplinary effort involving the core departments of Electrical Engineering & Computer Science (EECS), Mathematics (MATH), and Statistics (STAT). Through foundational coursework the triad of disciplines that inform data science as a field – computer science, statistics, and mathematics – the program will prepare students to become competitive and marketable data scientists in Missouri, regionally, nationally, and internationally through strong connections to the industries. Core courses will prepare students for more advanced work in upper-level courses that include data science applications in one of the three core fields; these will serve as the advanced focus area of 12 credit hours, together with an additional six hours of experiential, field-specific coursework in research and/or internship. This new program will reflect the diversity of the emerging field of data science by offering emphases in several core areas in advanced data science involving computing and mathematical/statistical modeling.

Learning Objectives
Students who complete the BS in Data Science will learn terminology, foundational concepts and intermediate skills in at least two of the three areas (computer science, mathematics, and/or statistics) that constitute the discipline while gaining advanced skills in the third that serves as the focus area. In addition, they will gain significant hands-on experience in their focus area through the 6 hours of internship and/or research coursework that fulfills the capstone for the major.

The eight specific learning objectives and listed below are adapted from the student outcomes and curriculum requirements proposed by CAC (Computing Accreditation Commission) as criteria for accreditation for data science undergraduate programs,

which has recently been approved by ABET (Accreditation Board for Engineering and Technology).

Table 4. Student Learning Objectives

1	Demonstrate application of theory, data science techniques, and tools from computer science, statistics, and mathematics and employ the resulting knowledge to satisfy stakeholders' needs.
2	Acquire representative data as well as manage, prepare, integrate, and analyze data.
3	Develop and deploy models informed by data.
4	Visualize and communicate the knowledge obtained from the data.
5	Demonstrate knowledge of data ethics and governance including legitimate use and algorithmic fairness as well as privacy, security, and stewardship.
6	Learn and apply statistical and mathematical skills and techniques including inference, modeling, linear algebra, probability, and optimization.
7	Learn and apply computer science skills and techniques including data structures and algorithms.
8	Demonstrate competency in objectives 1-7 through a major project, integration and application of data science knowledge and skills acquired throughout the curriculum to their particular advanced focus area (i.e. computer science, mathematics, or statistics) to provide a context for data science activities.

5.B. Program Design and Content

Curriculum Design Process

The curriculum has been designed to meet the outcomes listed in the ABET accreditation criterion for programs in Data Science. ABET specifies the quantity of credit hours and some details on content required for courses. Similar programs were also analyzed to help determine the appropriate courses needed for a data science program. The courses required in the curriculum and the content of newly created courses was also influenced by the expertise of faculty instructors and researchers at MU which allows us to form a program that is unique to MU. In addition, university policies such as general education requirements and the minimum number of credit hours were also factored into the design.

Sequence of Courses

Within the major proper, all students must complete a total of 60 hours, consisting of the following four parts: 1) a core curriculum of 10 required courses (30 credits); 2) four intermediate-level core courses (12 credits) from a restricted list of six; 3) four advanced courses (12 credits) within the chosen focus area of Computer Science, Mathematics, or Statistics; and 4) 6 credits of experiential coursework consisting of case studies, internships, research, and/or thesis, 3 credits of which meet the MU capstone requirement.

Within the core and intermediate courses in the areas of mathematics, statistics, and computer science. Each of these sequences have courses that start at lower numbered courses and progress to higher course numbers, each having a prerequisite as the lower numbered course. Taking a sequence of lower division courses serves as prerequisite material for a collection of upper division which may be taken in the advanced focus areas in mathematics, statistics, and computer science.

5.C. Program Structure

General Description
This program requires a total of 120 credit hours for completion. Within the major, all students complete a total of 60 hours, consisting of the following four components: 1) a core curriculum of 10 required courses (30 credits); 2) 4 intermediate-level core courses (12 credits) from a restricted list of six; 3) 4 advanced focus area courses (12 credits) within the chosen focus area of Computer Science, Mathematics, or Statistics; and 4) 6 credits of experiential coursework consisting of case studies, internships, research, and/or thesis, 3 credits of which meet the MU capstone requirement.

Students who complete the degree with the Computer Science focus will receive their degrees from the College of Engineering; those who complete in Mathematics or Statistics will receive their degrees from the College of Arts and Science.

Program Requirements
The BS in Data Science requires a total of 120 credit hours for completion. Within the major proper, all students must complete a total of 60 hours, consisting of the following four parts: 1) a core curriculum of 10 required courses (30 credits); 2) four intermediate-level core courses (12 credits) from a restricted list of six; 3) four advanced courses (12 credits) within the chosen focus area of Computer Science, Mathematics, or Statistics; and 4) 6 credits of experiential coursework consisting of case studies, internships, research, and/or thesis, 3 credits of which meet the MU capstone requirement. Students may meet the 6-credit requirement through a combination of such experiential coursework.

Students who complete the degree with the Computer Science focus will receive their degrees from the College of Engineering; those who complete in Mathematics or Statistics will receive their degrees from the College of Arts and Science.
Students earning a Bachelor of Science in Data Science are required to complete all University general education, University undergraduate requirements, degree, and major requirements, including selected foundational courses, which may fulfill some University general education requirements.

Major Core Requirements

Core Courses

DATA_SCI 1030	Foundations of Data Science	3
STAT 2800	Intuition, Simulation, and Data	3
CMP_SC 1300	Computing with Data in Python	3
CMP_SC 2300	Introduction to Computational Data Visualization	3
CMP_SC 3380	Database Applications and Information Systems	3
STAT 4510	Applied Statistical Models I	3
STAT 4520	Applied Statistical Models II	3
MATH 1400	Calculus for Social and Life Sciences I	3
or MATH 1500	Analytic Geometry and Calculus I	
MATH 2320	Discrete Mathematical Structures	3
MATH 4140	Matrix Theory	3
Total Credits		30

Intermediate Courses

Students must select 12 credits from the following list.

CMP_SC 4350	Big Data Analytics	3
CMP_SC 4720	Introduction to Machine Learning and Pattern Recognition	3
STAT 4560	Applied Multivariate Data Analysis	3
STAT 4640	Introduction to Bayesian Data Analysis	3
MATH 2100	Calculus for Social and Life Sciences II	3
or MATH 1700	Calculus II	
MATH 4500	Applied Analysis	3

Advanced Focus Courses

Students must select 12 credits from within one of the focus areas in the following list.

Computer Science Focus

CMP_SC 4540	Neural Models and Machine Learning	3
CMP_SC 4740	Interdisciplinary Introduction to NLP	3
CMP_SC 4750	Artificial Intelligence I	3
CMP_SC 4770	Introduction to Computational Intelligence	3

Statistics Focus

STAT 4150	Applied Categorical Data Analysis	3
STAT 4310	Sampling Techniques	3
STAT 4330	Methods in Sports Analytics I	3
STAT 4340	Methods in Sports Analytics II	3
STAT 4410	Biostatistics and Clinical Trials	3
STAT 4420	Applied Survival Analysis	3

STAT 4430	Applied Longitudinal Data Analysis	3
STAT 4450	Applied Statistical Methods for Bioinformatics	3
STAT 4540	Experimental Design	3
STAT 4610	Applied Spatial Statistics	3
STAT 4710	Introduction to Mathematical Statistics	3

Mathematics Focus

MATH 4100	Differential Equations	3
MATH 4310	Numerical Linear Algebra	3
MATH 4355	Quantitative Finance and Insurance I	3
MATH 4540	Mathematical Modeling I	3
MATH 4590	Quantitative Finance and Insurance II	3

Experiential Courses

Students must select 6 credits from the following list.

CMP_SC 4990	Undergraduate Research in Computer Science	0-6
CMP_SC 4995	Undergraduate Research in Computer Science - Honors	1-6
MATH 4960	Special Readings in Mathematics	1-3
MATH 4996	Honors in Mathematics	2
STAT 4999	Departmental Honors in Statistics	1-3
STAT 4085	Problems in Statistics for Undergraduates	1-3
INTDSC 4971	Capstone Internship in Interdisciplinary Studies	1-6

Residency Requirements
There are no additional residency requirements for the new program.

Internship, Thesis or Other Capstone
Six hours of experiential coursework are required, three hours of which meet the capstone requirement.

Unique Features:
Three departments will collaborate to offer the core, intermediate, advanced focus, and experiential courses as well as maintain the curriculum and offer the courses on a regular basis. Some courses will be taught by faculty in the College of Arts & Science and the College of Engineering.

Admission Requirements
Students that meet the minimum admission requirements set by MU will be eligible to be admitted into the new program. No additional special qualifications are required.

5.D. Program Goals & Assessment

Assessment Learning Outcomes
Processes consistent with ABET procedures to assessing student outcomes will be used in this program. Student outcomes will be assessed in courses using examples of student assignments.

Retention and Graduation Rate Goals
The goal is to, on average, retain 93% of students from year to year. This will allow for the program to maintain an 80% retention rate through year 4. In addition, the graduation rate goal is 75%. These goals are in line with the performance of other engineering, technology, and science- based programs at the University of Missouri.

Other goals include attainment of ABET accreditation by continuously improving courses, the curriculum and resources for students and assessing student outcomes of the program. A goal of over 95% career outcome will be considered a measure of success of the program as well.

5.E. Student Preparation

Entering freshmen are expected to have completed 17 units of approved high school course work (in grades 9-12), including 4 units in English, 4 in mathematics and 3 in science with laboratory. Mathematics should include 2 units of algebra, 1 unit of plane and solid geometry (combination course), and 1/2 unit of trigonometry. Additional senior mathematics is recommended.

5.F. Faculty and Administration

Lawrence Ries will be the inaugural director of the BS in Data Science program. Dr. Ries has extensive experience in course instruction and administration as the current associate chair of Statistics. Dr. Ries will be compensated with an extra month of pay and a course release. The director, who will have a term of three years and dedicate 10% of their time to the program, will be selected by the Dean of Arts and Science and the Dean of Engineering. The responsible departments for this program are Electrical Engineering and Computer Science, Statistics, and Mathematics.

Instructional Needs
Instructional needs will be met by existing faculty initially. Existing courses will be expanded and additional TAs will be hired as described in the financial plans.

Table 5. Faculty Listing

Name	Position	Percentage of Time Dedicated to Program
Grant Scott	Associate Prof., EECS	10%
Lawrence Ries	Teaching Prof. and Associate Chair, Stat.	10%
Derek Anderson	Associate Professor, EECS	10%
Dustin Belt	Assistant Prof., Math	10%

Credentials for Teaching Assignment
An MS or a PhD are required for teaching in the area of Data Science or one of the focus areas of Computer Science, Mathematics, Statistics, or related fields.

Faculty Involvement
Faculty will be expected to advise students on matters of career development and selection of upper division courses. 90% of credit hours in the major that will be assigned to full-time faculty.

5.G. Alumni and Employer Survey

Alumni Survey
Alumni surveys will be used to assess program educational objectives on a yearly basis. This information will be used to continuously improve the BS in Data Science program.

Employer Survey
An Industrial Advisory Board (IAB) will be formed and made of representatives from key employers of Data Scientists. This board will be used to advise the faculty as they continuously improve the program. Employers will be surveyed to determine the level to which the program is achieving its educational objectives every two years. The survey will include questions related to each of the educational objectives.

5.H. Accreditation

Within 5 years of starting the program, a request for evaluation will be made to the Computing Accreditation Commission to coincide with the next ABET review cycle.

6. Appendices