UCONN
UNIVERSITY OF CONNECTICUT

Office of the Provost
Carl W. Lejuez, Ph.D.
Provost and Executive Vice President for Academic Affairs

December 8, 2021

TO: Members of the Board of Trustees

FROM: Carl W. Lejuez, Ph.D.
             Provost and Executive Vice President for Academic Affairs

RE: Master of Science (MS) Data Science

RECOMMENDATION:

That the Board of Trustees approve a new Master of Science (MS) in Data Science.

BACKGROUND:

Data science is a broad, interdisciplinary field. Demand for data scientists outstrips the supply, and the demand is expected to grow as much as 20-30 percent per year over the next decade. Glassdoor currently lists more than 200 vacancies for data scientist positions in Connecticut. Industries in Connecticut, including finance, insurance, manufacturing, consumer services, and biotechnology, depend on the skills of highly trained professionals to collect and analyze data to serve their customers efficiently. The UConn MS in Data Science will combine rigorous training in fundamental principles of data science with a strong emphasis on ethics woven throughout the curriculum (including a required core course on ethics for data science). It combines the strength of faculty across five schools and colleges and will culminate with a practical, real-world required capstone project in which students work on collaborative teams to solve problems posed to them by industry, government, or non-profit partners.

This program is designed both for domestic and international students with diverse undergraduate academic backgrounds who have an interest in applied data science and for working professionals who are looking to develop a career as a data scientist. The Master of Science in Data Science program is an interdisciplinary 30 credit hour program drawing on courses and faculty expertise from the College of Liberal Arts and Sciences, School of Engineering, School of Business, College of Agriculture, Health and Natural Resources, and the Neag School of Education. Graduates will have the skills needed to collect, interpret, and analyze data to improve decision making in a variety of fields.

We hope to enroll 25 students for the in-person program in Fall 2022 and to enroll 50 students in the online program in Spring 2023. By year 5 of the program (Fall 2026) we project that the program will enroll 75 students in the in-person program and 350 in the online program. We have structured the program so that students in the full-time program should complete within a year (Fall, Spring, Summer). Thus, we anticipate graduating approximately 75 students per year from the full-time program by year five. Interviews for a permanent director have concluded, and we anticipate that a permanent director will be named by the end of 2021.

352 MANSFIELD ROAD, UNIT 1086
GULLEY HALL
STORRS, CT 06269-1086
PHONE 860.486.4037
FAX 860.486.6379
provost@uconn.edu
provost.uconn.edu

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<h1 style="text-align:center">Request for New UConn Academic Degree Program</h1>

General Information

Name of degree program:	Data Science
Name of sponsoring Department:	Agricultural and Resource Economics, Statistics, Educational Psychology, Operations and Information Management, Computer Science and Engineering
Name of sponsoring College:	College of Agriculture, Health and Natural Resources, College of Liberal Arts and Sciences, Neag School of Education, School of Business, School of Engineering
Campuses:	Storrs
Contact persons:	Kent Holsinger
Type of Proposal:	New
Type of Program:	Master of Science
Anticipated Initiation Date:	Fall 2022
Program Payment Type:	Fee-based
CIP Code:	30.7001 Data Science, General.

Justification for the New Program

Data science is a broad, interdisciplinary field. Demand for data scientists outstrips the supply, and the demand is expected to grow as much as 20-30 percent per year over the next decade. Glassdoor currently lists more than 200 vacancies for data scientist positions in Connecticut. Industries in Connecticut, including finance, insurance, manufacturing, consumer services, and biotechnology, depend on the skills of highly trained professionals to collect and analyze data to serve their customers efficiently. Big technology firms, like Google and Facebook, produce much of their revenue by applying highly sophisticated statistical and machine learning algorithms to "big data" to understand user's patterns of behavior and to allow advertisers to target their marketing to audiences likely to be receptive. The Cambridge Analytica scandal in 2016 highlighted not only the sophistication of the algorithms available (and they have only become more sophisticated in the last five years) but also the ethical concerns associated with the collection and use of "big data". The UConn MS in Data Science will combine rigorous training in fundamental principles of data science with a strong emphasis on ethics woven throughout the curriculum (including a required core course on ethics for data science). It combines the strength of faculty across five schools and colleges and will culminate with a practical, real-world required capstone project in which students work on collaborative teams to solve problems posed to them by industry, government, or non-profit partners

Are there similar programs in CT or elsewhere?

UConn is a relative latecomer to data science. Central Connecticut State University appears to be the only other university in Connecticut that offers a graduate degree in data science, but both Southern and Eastern Connecticut State University offer bachelor's degrees. MIT, Northeastern, Brown, the University of Massachusetts, Columbia, Carnegie Mellon, Virginia, and Duke (to name a few) already offer an MS in Data Science in configurations that differ among institutions. UConn's program will differ from these programs in three essential ways. 1) The UConn MS in Data Science integrates contributions from five different schools and colleges at UConn. Data Science programs at other universities involve at most two

different schools, e.g., a recently announced program in Health Analytics at Northeastern, and are most commonly housed within a single school or department, e.g., Computer Science or Statistics. The required core curriculum includes courses from all five colleges and will combine foundational strengths in computer science and statistics (including causal inference) with training in visualization and communication and required coursework in data ethics. 2) In addition to the required core course on data ethics, ethical concerns will be deeply woven into the entire curriculum. Similarly, core courses and the final capstone will incorporate team-based problem solving ensuring that students develop skills in effective teamwork and project management. 3) Students will be able to select from several formally recognized concentrations within this field of study (see Graduate Catalog copy below). Students may also design an individualized course of study with approval from the Academic Director of the program.

What are the desired learning outcomes of the program?
Recipients of the Master of Science in Data Science will be prepared to ethically design, collect, visualize, analyze, interpret, and communicate insights from data to solve problems in a wide variety of application domains. Across the 18-credit core students will use project-based approaches that develop the ability to:
- Integrate domain-specific knowledge throughout the core through teamwork and cross-domain communication;
- Design methods of data collection that support robust inferences and predictions that facilitate decision making;
- Use programming and scripting tools to gather, manage, clean, merge, transform, and summarize data from disparate sources;
- Visualize complex data sets to support analysis and prediction and to support decision making by end-users;
- Develop proficiency in modeling approaches and computational statistical learning techniques for associational and causal analysis across domains;
- Use machine learning and artificial intelligence algorithms to make predictions from large, heterogeneous, unstructured data sets;
- Develop proficiency in big data analytics using cloud computing and familiarity with high-performance computing and out-of-core computing
- Assess the reliability and validity of inferences and predictions;
- Communicate analytic insights across different domains with heterogenous tools, including visualizations;
- Incorporate best practices for project and data management and documentation in a collaborative team environment; and
- Evaluate the ethical, legal, and social impacts of the data science process, including considerations of diversity, equity, inclusion, data privacy, data security, and data ownership within a broader social and international context, especially in addressing systemic biases and inequities.

The 12-credit elective curriculum, which includes a 3-credit "capstone applied project" course, requires students to work in teams focusing on an organizational problem/project that will give students deep exposure to the application of core data science principles within particular disciplines. Across the 12-credit elective curriculum, students will further develop their research skills and ability to:

- Understand a problem posed by an industry, government, or community partner; • Identify a question posed by that problem;
- Obtain data relevant to addressing that question;
- Design and implement an analytical approach that addresses the question;
- Analyze the ethical implications and societal impact on diverse stakeholders affected by the proposed approach to the question; and
- Present results of the analysis in the form of a written report and/or data visualization.

Program Description

Program Description: The Master of Science in Data Science program is an interdisciplinary 30 credit hour program drawing on courses and faculty expertise from the College of Liberal Arts and Sciences, School of Engineering, School of Business, College of Agriculture, Health and Natural Resources, and the Neag School of Education. The program will prepare students for careers in data science. Graduates will have the skills needed to collect, interpret, and analyze data to improve decision making in a variety of fields. We hope to launch the program as a full-time, one-year, face-to-face program in Fall 2022, and we hope to launch a part-time, online option in Spring or Fall 2023. Revenue projections in the MOU assume a Winter 2023 launch.

Program Target Audience and Admission Requirements: This program is designed both for domestic and international students with diverse undergraduate academic backgrounds who have an interest in applied data science and for working professionals who are looking to develop a career as a data scientist. Admission requirements include a minimum undergraduate GPA of 3.0, three letters of recommendation, with prior recommended coursework in introductory statistics, introductory computer science, and single variable calculus. Otherwise qualified students with limited academic preparation in disciplines required for data science may be admitted contingent on completing suitable pre-requisite courses at UConn or another institution prior to enrolling, completing a "Data Science Bootcamp" in the summer prior to admission (first offering tentatively planned for Summer 2023), or by completing preparatory pathways/programs approved by the Faculty Steering Committee.

Overview of degree requirements: All recipients of the MS in Data Science will be required to complete an 18-credit core curriculum and a 3-credit applied capstone. Students may 1) Select one of the formally recognized concentrations within Data Science and receive an MS in Data Science with that concentration. The concentration may include a particular example of the required capstone or they may 2) Select 9 credits of graduate-level course work in Data Science relevant to their professional interests, subject to approval by the Academic Director of the program. They may enroll either in a general capstone course available to all students in the program or in a capstone course associated with a specific concentration (provided that they have met any prerequisite requirements associated with the capstone).

Proposed Graduate Catalogue Copy

The University of Connecticut offers a Master's of Science in Data Science through The Graduate School with the participation of the College of Agriculture, Health, & Natural Resources, the College of Liberal Arts & Sciences, the School of Business, the School of Engineering, and the Neag School of Education.

All students are required to complete the following core courses: STAT 5405 (Applied Statistics for Data Science, 3cr), CSE 5713 (Data Mining and Management, 3cr), EPSY 5641 (Research Design and

Measurement for Data Science, 2cr), CAHNR 5XXX[*] (Data Ethics and Equity, 2cr), STAT 5125 (Computing for Statistical Data Science, 3cr), OPIM 5501 (Data Visualization and Communication, 2 cr), CSE 5819 (Introduction to Machine Learning, 3cr).

In addition, every student must complete a 3-credit applied capstone, either GRAD 5XXX[†] or an applied capstone course associated with one of the concentrations listed below. Students who elect not to pursue one of the concentrations listed below must complete 9 credits of coursework relevant to data science and approved by the Academic Director of the program.

The following concentrations are available to students pursuing an MS in Data Science:

Advanced Data Analysis: STAT 5665 (Applied Multivariate Analysis), STAT 5415 (Mathematical Statistics for Data Science), STAT 5675 (Bayesian Data Analysis), STAT 5915 (Statistical Data Science in Action) Bioinformatics: CSE 5800 (Bioinformatics), CSE 5815 (Systems Biology: Constructing Biological Knowledgebase), CSE 5840 (String Algorithms and Applications in Bioinformatics), CSE 5860 (Computational Problems in Evolutionary Genomics) Biostatistics: BIST 5625 (Introduction to Biostatistics), BIST 5645 (Concepts and Analysis of Survival Data), BIST 5615 (Categorical Data Analysis), STAT 5915 (Statistical Data Science in Action) Business Data Science: Three of the following courses - OPIM 5501 (Visual Analytics), OPIM 5502 (Big Data Analytics with Hadoop), OPIM 5504 (Adaptive Business Intelligence), OPIM 5509 (Introduction to Deep Learning), OPIM 5511 (Survival Analysis using SAS), OPIM 5512 (Data Science using Python) Cloud Computing: CSE 5299 (Computer Networks and Data Communication), CSE 5300 (Advanced Computer Networks), CSE 5304 (High-Performance Parallel Computing), CSE 5309 (Networked Embedded Systems) Cybersecurity: CSE 5850 (Introduction to Cyber-Security), CSE 5852 (Modern Cryptography: Foundations), CSE 5854 (Modern Cryptography: Primitives and Protocols) Dependent Data Analysis: BIST 5815 (Longitudinal Data Analysis), STAT 5XXX[‡] (Applied Spatial Data Analysis), STAT 5825 (Applied Time Series), STAT 5915 (Statistical Data Science in Action) Geospatial Analytics: NRE 5525 (Remote Sensing of the Environment), NRE 5585 (Python Scripting for Geospatial Analysis) and one of the following - NRE 5215 (Introduction to Geospatial Analysis with Remote Sensing), NRE 5545 (Quantitative Remote Sensing Methods), NRE 5560 (High Resolution Remote Sensing: Application of UAS and LiDAR), NRE 5235 (Remote Sensing Image Processing) Healthcare Analytics: Three of the following courses - HCMI 5240 (Health Care Organization and Management), HCMI 5243 (Health Care Economics), HCMI 5686 (Health Insurance and Risk Management), OPIM 5508 (Healthcare Analytics and Research Methods) Marketing Analytics: MKTG 5515 (Marketing Management). One of the following courses - MKTG 5220 (Big Data and Strategic Marketing), MKTG 5250 (Marketing Research and Intelligence), MKTG 5251 (Marketing and Digital Analytics), MKTG 5565 (Digital Marketing), OPIM 5510 (Web Analytics) Social and Behavioral Analytics: EPSY 6615 (Structural Equation Modeling), EPSY 6611 (Hierarchical Linear Modeling), EPSY 6XXX[§] (Introduction to Text Analysis) Talent Analytics: MGMT 5680 (Talent Management Through the Employee Lifecycle), MGMT 5377 (Human Resource Metrics and Talent Analytics). One of the following courses - MGMT 5650 (Interpersonal Relations, Influence, and Ethical Leadership), MGMT 5674 (Negotiation Strategies), MGMT 5675 (Business Acumen and Strategic Human Resource Management)

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[*] Number will be determined after the course is set up in PeopleSoft.
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[‡] Number will be determined after the course is set up in PeopleSoft.
[§] Number will be determined after the course is set up in PeopleSoft.

Faculty Involvement

Kent Holsinger is serving as Interim Academic Director for the program. Interviews for a permanent director have concluded, and we anticipate that a permanent director will be named in late October or early November. Courses described in the Proposed Graduate Catalog copy were entirely designed by tenured or tenure-track UConn faculty, and most are taught by tenured or tenure-track UConn faculty. As the program grows, some existing courses may be taught by adjuncts or APiRs.

In addition, a Faculty Steering Committee consisting of faculty from BUSINESS (2), CAHNR (2), CLAS (3), ENGINEERING (2), and NEAG (2) advise the Academic Director on all academic aspects of the program. Current members of the FSC are: Kylie Anglin, Joseph Johnson, Betsy McCoach, Alexandra Paxton, Sanguthevar Rajasekaran, Nalini Ravishanker, Ramesh Shankar, Charles Towe, Jill Wegrzyn, and Chandi Witharana. Peter Diplock and Kent Holsinger currently serve as ex-officio members of the committee.

Enrollment and graduate projections

We hope to enroll 25 students for the in-person program in Fall 2022 and to enroll 50 students in the online program in Spring 2023. By year 5 of the program (Fall 2026) we project that the program will enroll 75 students in the in-person program and 350 in the online program. We have structured the program so that students in the full-time program should complete within a year (Fall, Spring, Summer). Thus, we anticipate graduating approximately 75 students per year from the full-time program by year five. The part-time, online program will be designed for working professionals. We anticipate that it will typically take 3 years for these students to finish their degree, meaning that we will be graduating approximately 120 students per year from the part-time program by year 5.

Program Evaluation

The program will survey graduating students, conduct exit interviews, or both to assess student satisfaction with the program. The program will have an industry advisory board that convenes at least annually to provide feedback on the skills needed by data science graduates and, where possible, on the performance of UConn graduates in their organizations. All of this information will be shared with the Faculty Steering Committee and the Deans Advisory Board annually. In addition, the faculty steering committee will regularly review individual course objectives in light of the learning outcomes for the degree program. In addition, the Academic Director of the program will monitor placement of students who graduate. The program will be regarded as successful if (a) students are satisfied with their experience when they graduate, (b) they are placed in positions that are professionally appropriate and satisfying, and (c) the enrollment targets are met.

Program Administration

The program and the Academic Director report to the Office of the Provost through The Graduate School. The Academic Director will have a half-time, 10-month appointment for administration of the program. The Academic Director will be directly responsible for administration of the program, including marketing and industry relations as well as academic oversight. A Senior Educational Program Administrator will provide high-level administrative support for the program, including developing industry and government contacts, managing recruitment and admission, and coordinating advising for students enrolled in the program. During early years of the program, The Graduate School will provide

support for financial operations, and CETL will provide support for managing recruitment and admission (including prospect/student engagement). A Deans Advisory Board consisting of the deans of each school and college (or their designee) provides advice to the Provost on all important programmatic decisions, including those related to funding and staffing. The Deans Advisory Board will also provide input regarding new program proposals being considered within and/or across Colleges/Schools specific to potential redundancy, uniqueness, and/or complementarity with the MS in Data Science, with implications for approval of that proposal as a stand-alone program or as a concentration of the MS in Data Science. In collaboration with the Academic Director, the Faculty Steering Committee will have responsibility for program curriculum and other academic decisions as appropriate including the identification of program learning outcomes and alignment of course and program learning outcomes. Representatives of this committee are also expected to serve as boundary spanners between the Master of Data Science program and faculty and departments within their schools/colleges that have interests in data science. Finally, the Academic Director will establish and regularly convene an advocacy and consultancy board of industry representatives in data science, with membership decision made in collaboration with the Deans Advisory Board. Board members are expected to be strong supporters and advocates of the program and provide the Academic Director with data science and industry sector insights that in turn can improve and strengthen the program.

Funding and Financial Resources Needed
The MOU outlines financial commitments from the Provost's Office to the program in the first year. The MOU anticipates that revenue generated by the program will allow the Provost's Office to recover this initial investment. We do not anticipate a need for any other financial resources.

Other Resource Needs
We anticipate that existing library resources in data science will serve the educational needs of students in this program. The Provost's Office is aware that there may be modest space needs for the Academic Director and the Senior Educational Program Administrator. The space has not been identified, but it will be identified before either of these individuals begins their work on campus.

Consultation with other potentially affected units
Development of the program involved extensive consultation coordinated by the Provost's Office and involving deans, their representatives, and faculty from all of the participating schools and colleges.

Who can apply to this program?
Internal applicants (current UConn students enrolled in another UConn degree or certificate program), External applicants (individuals who are not currently UConn students)

Anticipated term and year of first enrollment
Fall 2022

Admission Requirements
This program is designed both for domestic and international students with diverse undergraduate academic backgrounds who have an interest in applied data science and for working professionals who are looking to develop a career as a data scientist. Admission requirements include a minimum

undergraduate GPA of 3.0, three letters of recommendation, with prior recommended coursework in introductory statistics, introductory computer science, and single variable calculus. Otherwise qualified students with limited academic preparation in disciplines required for data science may be admitted contingent on completing suitable pre-requisite courses at UConn or another institution prior to enrolling, completing a "Data Science Bootcamp" in the summer prior to admission (first offering tentatively planned for Summer 2023), or by completing preparatory pathways/programs approved by the Faculty Steering Committee.

Required for application:
Letters of Recommendation (3), Personal Statement

Term(s) to which students will be admitted
Fall

Application deadline: Rolling

Initiator
Kent Holsinger, Dean/Associate Dean, kentholsinger@uconn.edu, 860-486-0983

Program Director Name
Kent Holsinger, Dean/Associate Dean, kentholsinger@uconn.edu, 860-486-0983

Administrative Contact
Kent Holsinger, Dean/Associate Dean, kentholsinger@uconn.edu, 860-486-0983