

Contact: Rachel Boon

REQUEST FOR NEW PROGRAM AT THE UNIVERSITY OF IOWA:
BACHELOR OF SCIENCE IN DATA SCIENCE

Action Requested: Consider approval of the request by the University of Iowa to establish a Bachelor of Science in Data Science in the College of Liberal Arts and Sciences.

Executive Summary: The Council of Provosts and Board office support approval of this program.

Background:

Description of proposed program. The Department of Statistics and Actuarial Science and the Department of Computer Science are proposing a jointly administered undergraduate program leading to a Bachelor of Science in Data Science in the College of Liberal Arts and Sciences at the University of Iowa. The BS in Data Science will require a minimum of 120 semester hours (s.h.) of coursework for graduation, with 59 s.h. for the major. Of these 59 s.h., 20-26 hours will be offered by the Department of Computer Science and 21-27 will be from the Department of Statistics and Actuarial Science (see Appendix). In addition, there are 12 s.h. of required prerequisite mathematics courses, including two semesters of calculus and one of linear algebra.

Academic objectives. An undergraduate student earning the Data Science BS will be proficient in the following:

- **Data curation skills**, with an understanding of issues associated with data collection, management, provenance, storage, sharing and preparation, with the graduate able to work with multiple-source, multiple-format data; able to investigate the quality of the data; and have a basic understanding of ethical and confidentiality issues associated with data collection, storage and sharing.
- **Computational skills**, with strong software skills and associated algorithmic, computational problem-solving methods as used in computer science; in computational methods for collecting, managing, storing, preparing, sharing and (numerically and graphically) describing data from a variety of sources; in the ability to design and carry out basic simulation studies; and to use professional statistical software and understand the principles of programming and algorithmic problem solving that underlie these packages.
- **Statistical/probabilistic skills**, with the ability to translate substantive questions into well-defined statistical or probability problems and choose the appropriate (graphical or numerical) descriptive and/or inferential statistical techniques for a given problem while understanding the importance of, and issues related to, the choice of the study design (e.g., designed experiment vs. probability sample vs. convenience sample) used to produce the data; to understand that uncertainty, variability, and randomness play significant roles in data-driven decision making; to understand how to measure and display uncertainty, the effect of randomness, confidence/credibility and the likelihood of incorrect inferences; to understand and be able to explain common misperceptions, paradoxes and fallacies of probability and statistics; and to understand basic regression, prediction, simulation and visualization methods.
- **Mathematical skills**, with the ability to skillfully use mathematical tools underlying statistical and computational methods, with these tools primarily based on ideas in calculus, linear algebra and discrete mathematics, including (i) distribution theory, (ii) uncertainty quantification (i.e., probability theory), (iii) the probabilistic basis of formal statistical inference, models, and algorithms, and (iv) combinatorial analysis and recursion, which are used for algorithmic analysis and design and for distribution theory.

- **Communication skills**, with the ability to justify and clearly communicate study results to a non-technical audience. The graduate will be able to (i) write accurate and meaningful reports that describe the statistical and computational analyses and summarize important findings, and to (ii) work effectively as part of a team to address substantive questions using statistical and computational methods.

Link to institutional strategic plan. The Mission Statement and the Strategic Plan of the College of Liberal Arts and Sciences (CLAS) at the University of Iowa is focused on preparing students to be “knowledgeable, engaged citizens who respond creatively and flexibly to the challenges of a diverse and changing world.” The Data Science major prepares students to be leaders in the 21st century through a deep, detailed understanding and use of data science. The major is highly interdisciplinary and encourages connections across departments and disciplines, both in the classroom and in related research areas, encouraging students to see problems from multiple perspectives and to work in teams on methodologies, problem-solving and analysis of data. The major also strengthens departmental ties across UI colleges where students will be able to both work on projects and related research and with local, state and national industries and businesses looking for student internships and graduates to hire for employment after graduation.

Relationship to existing programs at the institution. At the University of Iowa, the Tippie College of Business offers a Bachelor of Business Information in Business Analytics and Information Systems, an “applications-oriented” program integrated with knowledge about business best practices and related skills. In CLAS, the Department of Computer Science offers a not only the Computer Science major but also a Bachelor of Arts (BA) and Bachelor of Science (BS) in Informatics, with 11 emphasis areas (Art, Bioinformatics, Economics, Geoinformatics, Health Informatics, Human-Computer Interaction, Linguistics, Media, Medical Informatics, Music, Social Informatics). While generally broad in scope, these areas offer exposure to data science on the applications-oriented side of the data science spectrum.

The Department of Statistics and Actuarial Science in CLAS offers a technically oriented Statistical Computing and Data Science track within the BS in Statistics major, essentially supplementing statistical course work with courses from the Computer Science Department. Finally, also in CLAS, there are two undergraduate certificate programs, a more technically oriented certificate called Large Data Analysis (offered by Computer Science, Mathematics, and Statistics and Actuarial Science) and an applications oriented certificate named Social Science Analytics (sponsored by Political Science) requiring course work from a number of departments, including Political Science, Computer Science, Statistics and Actuarial Science, Geography, Economics and Business.

At the University of Iowa, the new BS in Data Science might eventually replace, or at least lead to a revision of, the existing Statistics BS Statistical Computing and Data Science track since it is likely that some students will move from this track into the proposed BS. Depending on this migration, this program could close in two or more years.

The BS in Data Science complements the existing business analytics program in the Tippie College of Business, with each addressing a different audience, context and need, with Tippie focusing on analytics in applied business contexts and with the CLAS proposed major steeped more in theoretical concepts and mathematical and statistical tools and their creation. Likewise, these certificates also have a separate and focused audience since they function as traditional minors, requiring fewer semester hours than a major, and thus are attractive to those outside of the field of data science who plan to augment their knowledge and skills.

Relationship to existing programs at other colleges and universities. In Spring 2018, Iowa State University (ISU) proposed a Data Science BS program administered by the ISU College of Liberal Arts and Sciences. With national programs ranging from very technical to very applied, the ISU program is generally an applied program, preparing students to work with and analyze data. Another type of applied major offered by Iowa institutions is an analytics major or minor within a business program or integrated with business studies, with these programs offered by the Tippie School of Business, for example. Other schools tend to focus more on computer network administration or security, as does the University of Northern Iowa major.

Many private institutions in Iowa offer a strong computer science program with data science related skills and applications, sometimes offered as a minor. Each school is responding to a growing field of knowledge with a focus to fit the institution's mission and its students' interests.

The new BS program proposed by UI lies firmly on the "more technical" side of the spectrum of data science or computer science program, explicitly targeting the most statistically and computationally sophisticated students interested in understanding complex aspects of data science.

Unique features. The proposed UI program focuses on the highly technical and foundational aspects of data science, as is appropriate for a Research I institution and its research/teaching mission. As an interdisciplinary major requiring coursework in mathematics, computer science and statistics, it will call on faculty from all three departments to offer required courses, mentor students, offer career advice and support with internships, and offer students opportunities to conduct research in related areas. These departments have the depth and expertise to offer a highly technical and successful program, empowering students who can be leaders in the field.

Student demand. As described above, students are well aware of the career opportunities in the growing field of data science. Students are finding employment in industry, retail, government, and in many other agencies and areas since data science affects almost every aspect of society. Over the last decade, along with the explosion of data science and business analytics, the computer science major has grown exponentially, with some looking to use their mathematics and statistics skills to enter data science.

Enrollment in related certificates and tracks, although small compared to other UI areas of study, shows that students who are highly skilled in computational sciences are very interested in the study of data science. The program will appeal to those in this field, likely drawing new students.

Workforce need/demand. A 2016 analysis by the recruiting site Glassdoor found that half of the "top 25" jobs in the US were in high technology fields. The top ranked position up from ninth in 2015, was for "data scientists," with a median base salary of \$116,000. The growing interest and demand for data scientists is largely driven by the unprecedented amount of data that is now collected, from CCTV camera images, credit card and travel information to mobile telephony and Internet browsing logs, and personal information such as steps taken or heart rates over time.

The second factor driving this sector is the emergence of new computationally efficient and easy-to-use software tools that can extract patterns from this vast morass of raw data. These tools are the result of fundamental developments in statistics, computer science and machine learning which, when coupled with technological advances in the underlying hardware, lead to new computational techniques capable of analyzing extremely large and unusually complex data sets.

Resources to establish a high-quality program. The personnel, facilities and equipment currently in use for the departments of Computer Science, Mathematics, and Statistics and Actuarial Science and for students within these related majors will also support the proposed major in Data Science, with room in courses to serve additional students at no extra cost. Specialized facilities are not required.

Note that while large enrollments in the new program are not expected, both the departments of Computer Science and Statistics and Actuarial Science are experiencing significant growth. Since the new program largely relies on existing courses, new resources specifically intended to support this program are not needed at this time. The two new senior level courses required for the major will be developed by existing instructional faculty in the Department of Statistics and Actuarial Science and subsequently offered by faculty from both departments. If the program grows significantly by year 3 and 4, there will be a need for one additional faculty member.

Cost.

	TOTAL COSTS	TOTAL NEW COSTS
Year 1	\$0	\$0
Year 2	\$0	\$0
Year 3	\$130,000 (if needed)	\$130,000 (if needed)
Year 4	\$130,000 (if needed)	\$0
Year 5	\$130,000 (if needed)	\$0
Year 6	\$130,000 (if needed)	\$0
Year 7	\$130,000 (if needed)	\$0

Projected enrollment.

Undergraduate	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7
Majors	25	50	75	100	125	125	125
Non-Majors	0	0	0	0	0	0	0

Articulation agreements. Currently, there are no plans for special articulation agreements beyond those already in place between Regents' institutions and other institutions of higher education concerning the transfer of credit and the transfer of military service credit.

Accreditation. At the time of this writing, accreditation bodies for Data Science programs do not exist. The Data Science major will be included as part of the University's Higher Learning Commission (HLC) accreditation and does not need special HLC approval.

Date of implementation. August 2018

Letters of Support

TECHNOLOGY

College of Liberal Arts and Sciences

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IOWA STATE UNIVERSITY
OF SCIENCE AND

15 November 2017

Joseph B. Lang
Professor and
Chair
Department of Statistics and Actuarial Science
University of Iowa
241 Schaeffer Hall
Dr. Lang

Thank you once again for your helpful letter in support of the Data Science B.S. program at Iowa State University. It is nice to see your proposal nearing fruition. We enthusiastically support your proposed program. The past decade has seen an explosion of interest in data science and a commensurate increase in demand for data science professionals. The McKinsey Global Institute forecasts the need for hundreds of thousands of data scientists in the next ten years. We see our program as well as yours growing rapidly in the next five years. We are already talking about space constraints. I see both ISU and UI being able to increase overall undergraduate enrollment with the introduction of these programs, we both have the potential for these degrees becoming destination majors.

Please keep us informed of your progress. We look forward to seeing your program advertised on billboards in Des Moines.

With respect,



Arne Hallam

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October 24, 2017

Dear Sir or Madam,

With this letter I want to express my support for the Proposal for a Major in Data Science being put forward by the Department of Statistics and Actuarial Science and the Department of Computer Science at the University of Iowa.

The field of data science is exploding, and all indications are that the US industry will require an increasing number of data scientists with expertise ranging from the more theoretical algorithms and statistical knowledge to the more applied business, forecasting, and inference applications.

Iowa State has recently put forward a proposal for a Data Science BS, administered by the College of Liberal Arts and Sciences, with a substantial core of computer science and statistics courses complemented by a range of application courses from other department and colleges at Iowa State.

The proposed BS degree from the University of Iowa would be administered by the departments of statistics and of computer science, but, apart from this administrative difference, also appears to have very solid foundations, yet a strong application component as well (this is essential, since applications are often called the “third spoke” of data science, in addition to computer science and statistics).

In conclusion, I believe that will be a valuable and successful degree, and that the State of Iowa will be better by having both its flagship institutions of higher education able to offer a Data Science Major.

Best regards,



Gianfranco Ciardo

Dear Joe,

Thank you for sharing the details of your proposed Data Science major. I am pleased that the proposed program is truly inter-disciplinary with statistics and data analysis coming from your department, necessary computer science from UI's Computer Science Department, and domain-specific application in the two capstone courses. Looking at your Table 1 on page 7, I note that you have covered all of the key areas such as data management, machine learning, statistical learning, data visualization, web mining, and parallel computing. I am sure that students graduating from such a program will be very well prepared for work as data scientists. I am pleased to offer my support and wish you every success in implementing your proposal.

Best,
Syed
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