

# Data Science, BS

## Learning Outcomes

### Data Curation Skills

Graduates will be able to:

- understand issues associated with data collection, management, provenance, storage, merging, sharing, and preparation;
- work with multiple-source, multiple-format data;
- investigate the quality of the data; and
- have a basic understanding of ethical and confidentiality issues associated with data collection, storage, merging, and sharing.

### Computational Skills

Graduates will be able to:

- use critical thinking skills to translate substantive questions into well-defined computational problems and choose appropriate computational techniques for a given problem;
- understand the foundational software skills and associated algorithmic and computational problem-solving methods used in computer science;
- be proficient in computational methods for collecting, managing, storing, preparing, sharing, and describing data numerically and graphically from a variety of sources to design and carry out basic simulation studies; and
- use professional statistical software and understand the principles of programming and algorithmic problem-solving that underlie these packages.

### Statistical/Probabilistic Skills

Graduates will be able to:

- use critical thinking skills 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;
- understand the importance of, and issues related to, the choice of the study design, such as designed experiment versus probability sample versus convenience sample, used to produce data;
- understand that uncertainty, variability, and randomness play significant roles in data-driven decision-making;
- understand how to measure and display uncertainty, the effect of randomness, confidence/credibility, and the likelihood of incorrect inferences;
- understand and be able to explain common misperceptions, paradoxes, and fallacies of probability and statistics; and
- understand basic regression, prediction, simulation, and visualization methods.

### Mathematical Skills

Graduates will:

- have a firm grasp of the mathematical tools underlying statistical and computational methods which are primarily based on ideas in calculus, linear algebra, and discrete mathematics, including distribution theory, uncertainty quantification (e.g., probability theory), the

probabilistic basis of formal statistical inference, models, and algorithms, and combinatorial analysis and recursion, which are used for algorithmic analysis, design, and for distribution theory.

## Communication Skills

Graduates will be able to:

- clearly justify and communicate study results to a non-technical audience;
- write accurate and meaningful reports that describe the statistical and computational analyses and summarize important findings; and
- work effectively as part of a team to address substantive questions that can be handled using statistical and computational methods.

## Requirements

The Bachelor of Science with a major in data science requires a minimum of 120 s.h., including at least 64 s.h. of work for the major. Students must maintain a grade-point average of at least 2.00 in all courses for the major and in all UI courses for the major. They also must complete the College of Liberal Arts and Sciences GE CLAS Core.

Data science majors may not earn a major or minor in computer science or statistics, a major in computer science and engineering, or the Certificate in Social Science Analytics.

The BS with a major in data science requires the following coursework.

| Requirements         | Hours |
|----------------------|-------|
| Prerequisite Courses | 16    |
| Core Courses         | 36    |
| Advanced Electives   | 9     |
| Capstone Course      | 3     |

## Prerequisite Courses

| Course #  | Title                          | Hours |
|-----------|--------------------------------|-------|
| MATH:1850 | Calculus I                     | 4     |
| MATH:1860 | Calculus II                    | 4     |
| MATH:2700 | Introduction to Linear Algebra | 4     |
| MATH:2850 | Calculus III                   | 4     |

## Core Courses

| Course #                                       | Title                                    | Hours |
|--|--|-------|
| All of these:                                  |  |       |
| DATA:3200/<br>IGPI:3200/ISE:3760/<br>STAT:3200 | Applied Linear Regression                | 3     |
| DATA:4580/<br>IGPI:4580/<br>STAT:4580          | Data Visualization and Data Technologies | 3     |
| CS:1210  | Computer Science I: Fundamentals         | 4     |
| CS:2210  | Discrete Structures                      | 3     |
| CS:2230  | Computer Science II: Data Structures     | 4     |
| CS:3330  | Algorithms                               | 3     |
| CS:4400  | Database Systems                         | 3     |

|   |  |   |
|---|--|---|
| STAT:2010   | Statistical Methods and Computing          | 3 |
| STAT:3100/<br>IGPI:3100                             | Introduction to Mathematical Statistics I  | 4 |
| STAT:3101/<br>IGPI:3101                             | Introduction to Mathematical Statistics II | 3 |
| One of these:                                       |  |   |
| DATA:4540/<br>BAIS:4540/<br>IGPI:4540/<br>STAT:4540 | Statistical Learning                       | 3 |
| CS:5430   | Machine Learning                           | 3 |

## Advanced Electives

| Course #  | Title   | Hours |
|---|---|-------|
| 9 s.h. from these, with at least one computer science course (prefix CS) and one statistics course (prefix STAT): |   |       |
| DATA:4600/<br>STAT:4600   | Causal Inference for Data Science               | 3     |
| DATA:4610   | Data Acquisition and Management                 | 3     |
| DATA:4620   | Text Data Analysis                              | 3     |
| DATA:4750/<br>STAT:4750   | Probabilistic Statistical Learning              | 3     |
| DATA:4880   | Data Science Creative Component                 | 1     |
| DATA:6200/<br>ACTS:6200/<br>STAT:6200   | Predictive Analytics                            | 3     |
| BIOS:4510   | Data Science Foundations in R                   | 2     |
| CS:4420   | Artificial Intelligence                         | 3     |
| CS:4440   | Web Mining                                      | 3     |
| CS:4470   | Health Data Analytics                           | 3     |
| CS:4510   | Human-Computer Interaction for Computer Science | 3     |
| CS:4630   | Mobile Computing                                | 3     |
| CS:4700/<br>MATH:4860   | High Performance and Parallel Computing         | 3     |
| CS:5630   | Cloud Computing Technology                      | 3     |
| MATH:4840   | Mathematics of Machine Learning                 | 3     |
| STAT:3210   | Experimental Design and Analysis                | 3     |
| STAT:4520/<br>IGPI:4522/<br>PSQF:4520   | Bayesian Statistics                             | 3     |
| STAT:4560   | Statistics for Risk Modeling I                  | 3     |
| Other advanced computer science or statistics courses approved by advisor   |   |       |

## Capstone Course

| Course #  | Title                  | Hours |
|-----------|------------------------|-------|
| DATA:4890 | Data Science Practicum | 3     |

The Department of Statistics and Actuarial Science and the Department of Computer Science collaborate to offer the major in data science.

## Combined Programs

### Undergraduate to Graduate (U2G) Program

Bachelor of Science students in data science may pair their degree with an Undergraduate to Graduate (U2G) program, which allows a student to earn a bachelor's and master's degree in five years of study. See the Undergraduate to Graduate website for available programs.

## Honors

### Honors in the Major

Students majoring in data science have the opportunity to graduate with honors in the major. They must maintain a grade-point average (GPA) of at least 3.67 in their major and a cumulative University of Iowa GPA of at least 3.33. Students must complete an honors thesis.

Students are responsible for finding a faculty member willing to supervise their honors project. The faculty member must approve the proposed project and a timetable for the work. Credit for thesis work must be earned in either CS:3990 Honors in Computer Science or Informatics for work supervised by a computer science faculty member or an honors course supervised by a statistics and actuarial science faculty member.

Honors in data science also satisfies the 12 s.h. experiential learning requirement for University of Iowa honors students.

### University of Iowa Honors Program

In addition to honors in the major, students have opportunities for honors study and activities through membership in the University of Iowa Honors Program. Visit Honors at Iowa to learn about the university's honors program.

Membership in the UI Honors Program is not required to earn honors in the data science major.

## Career Advancement

Today, nearly every business, government, social media platform, and educational institution collects and analyzes data about its users, logistics and operations, and media presence, in the hope of extracting valuable insights and utilizing the resulting efficiencies.

As an example, Amazon is the company most closely identified with a data-driven business model. Starting just over 25 years ago as an online bookseller with a relatively crude crowdsourced book review platform and simple recommender system technology, it was subsequently augmented with extensive tracking of customer page views, advertising hits, data about prior purchases, and an aggressive emphasis on data-driven operational efficiencies. Amazon has become the major player in U.S. retail and a prime example of the strategic value of big data.

Data science graduates may pursue careers as data scientists. This position allows them to apply their understanding of statistics, as well as algorithm and software design, to create and develop the next generation of data analysis tools.

The Pomerantz Career Center offers multiple resources to help students find internships and jobs.

## Academic Plans

### Four-Year Graduation Plan

The Four-Year Graduation Plan is not available to students majoring in data science. Students work with their advisors on individual graduation plans.

### Sample Plan of Study

Sample plans represent one way to complete a program of study. Actual course selection and sequence will vary and should be discussed with an academic advisor. For additional sample plans, see MyUI.

### Data Science, BS

| Course  | Title   | Hours        |
|---|---|--------------|
| <b>Academic Career</b>  |   |              |
| <b>Any Semester</b>   |   |              |
| GE CLAS Core: Sustainability <sup>a</sup>   |   |              |
| <b>Hours</b>  |   | <b>0</b>     |
| <b>First Year</b>   |   |              |
| <b>Fall</b>   |   |              |
| CS:1210   | Computer Science I: Fundamentals  | 4            |
| ENGL:1200<br>or RHET:1030   | The Interpretation of Literature<br>or Rhetoric: Writing and<br>Communication | 3 - 4        |
| MATH:1550   | Engineering Calculus I <sup>b</sup>   | 4            |
| GE CLAS Core: World Languages First Level<br>Proficiency or elective course <sup>c</sup>  |   | 4 - 5        |
| CSI:1600  | Success at Iowa   | 1            |
| <b>Hours</b>  |   | <b>16-18</b> |
| <b>Spring</b>   |   |              |
| ENGL:1200<br>or RHET:1030   | The Interpretation of Literature<br>or Rhetoric: Writing and<br>Communication | 3 - 4        |
| STAT:2010   | Statistical Methods and Computing   | 3            |
| CS:2210   | Discrete Structures   | 3            |
| MATH:1560   | Engineering Calculus II   | 4            |
| GE CLAS Core: World Languages Second Level<br>Proficiency or elective course <sup>c</sup> |   | 4 - 5        |
| <b>Hours</b>  |   | <b>17-19</b> |
| <b>Second Year</b>  |   |              |
| <b>Fall</b>   |   |              |
| CS:2230   | Computer Science II: Data<br>Structures                                       | 4            |
| GE CLAS Core: Understanding Cultural Perspectives   |   | 3            |
| GE CLAS Core: Natural Sciences without Lab <sup>d</sup>                                   |   | 3            |
| GE CLAS Core: World Languages Third Level<br>Proficiency or elective course <sup>c</sup>  |   | 4 - 5        |
| Elective course <sup>e</sup>  |   | 3            |
| <b>Hours</b>  |   | <b>17-18</b> |
| <b>Spring</b>   |   |              |
| CS:3330   | Algorithms  | 3            |
| MATH:2700   | Introduction to Linear Algebra  | 4            |
| GE CLAS Core: International and Global Issues <sup>d</sup>                                |   | 3            |

|   |                           |              |
|---|---------------------------|--------------|
| GE CLAS Core: World Languages Fourth Level  |                           | 4 - 5        |
| Proficiency or elective course <sup>c</sup> |                           |              |
| DATA:3200                                   | Applied Linear Regression | 3            |
| <b>Hours</b>                                |                           | <b>17-18</b> |

#### Third Year

|  |   |           |
|--|---|-----------|
| <b>Fall</b>  |   |           |
| STAT:3100  | Introduction to Mathematical<br>Statistics I <sup>f</sup> | 4         |
| GE CLAS Core: Natural Sciences with Lab <sup>d</sup> |   | 4         |
| GE CLAS Core: Social Sciences <sup>d</sup>           |   | 3         |
| CS:5430<br>or DATA:4540                              | Machine Learning <sup>f</sup><br>or Statistical Learning  | 3         |
| Elective course <sup>e</sup>                         |   | 3         |
| <b>Hours</b>   |   | <b>17</b> |

#### Spring

|   |  |           |
|---|--|-----------|
| DATA:4580   | Data Visualization and Data<br>Technologies <sup>g</sup>   | 3         |
| STAT:3101   | Introduction to Mathematical<br>Statistics II <sup>g</sup> | 3         |
| GE CLAS Core: Literary, Visual, and Performing Arts<br><sup>g</sup> |  | 3         |
| CS:4400   | Database Systems   | 3         |
| Elective course <sup>e</sup>  |  | 3         |
| <b>Hours</b>  |  | <b>15</b> |

#### Fourth Year

|  |                        |           |
|--|------------------------|-----------|
| <b>Fall</b>  |                        |           |
| DATA:4890  | Data Science Practicum | 3         |
| Major: advanced elective I course <sup>h</sup>   |                        | 3         |
| Major: advanced elective II course <sup>h</sup>  |                        | 3         |
| GE CLAS Core: Historical Perspectives <sup>d</sup>   |                        | 3         |
| Elective course <sup>e</sup>   |                        | 3         |
| <b>Hours</b>   |                        | <b>15</b> |
| <b>Spring</b>  |                        |           |
| Major: advanced elective III course <sup>h</sup>   |                        | 3         |
| GE CLAS Core: Values and Society <sup>d</sup>  |                        | 3         |
| Elective course <sup>e</sup>   |                        | 1         |
| Elective course <sup>e</sup>   |                        | 3         |
| Elective course <sup>e</sup>   |                        | 3         |
| Degree Application: apply on MyUI before deadline<br>(typically in February for spring, September for fall) <sup>i</sup> |                        |           |
| <b>Hours</b>   |                        | <b>13</b> |

**Total Hours 127-133**

a Sustainability must be completed by choosing a course that has been approved for Sustainability AND for one of these General Education areas: Natural Sciences; Quantitative or Formal Reasoning; Social Sciences; Historical Perspectives; International and Global Issues; Literary, Visual, and Performing Arts; or Values and Society.

b Enrollment in math courses requires completion of a placement exam.

c Students who have completed four levels of a single language or two levels of two different languages in high school or college have satisfied the GE CLAS Core World Languages requirement. Students who have completed three levels of a single language may complete a fourth-level course in the same language or may choose an approved World Language and Cultural Exploration course. Enrollment in world languages courses requires a placement exam, unless enrolling in a first-semester-level course. Contact your academic advisor or CLAS Undergraduate

Programs Office with questions concerning the World Languages requirement.

- d GE CLAS Core courses may be completed in any order unless used as a prerequisite for another course. Students should consult with an advisor about the best sequencing of courses.
- e Students may use elective courses to earn credit towards the total s.h. required for graduation or to complete a double major, minors, or certificates.
- f Typically this course is offered in fall semesters only. Check MyUI for course availability since offerings are subject to change.
- g Typically this course is offered in spring semesters only. Check MyUI for course availability since offerings are subject to change.
- h Students should select at least one computer science course and one statistics course for their advanced electives.
- i Please see Academic Calendar, on Office of the Registrar website, for current degree application deadlines. Students should apply for a degree for the session in which all requirements will be met. For any questions on appropriate timing, contact your academic advisor or Degree Services.