# COMPLEX SYSTEMS AND DATA SCIENCE M.S.

All students must meet the Requirements for the Master's Degree

## OVERVIEW

The M.S. in Complex Systems and Data Science is a 2-year degree with optional disciplinary tracks. UVM undergraduates may incorporate the degree as part of an Accelerated Master's Program. Our central goal is to help students become protean data scientists with eminently transferable skills (read: super powers). We provide students with a broad training in computational and theoretical techniques for (1) describing and understanding complex natural and sociotechnical systems, enabling them to then, as possible, (2) predict, control, manage, and create such systems. Students will be trained in: industry standard methods of data acquisition, storage, manipulation, and curation; visualization techniques, with a focus on building high quality web-based applications; finding complex patterns and correlations through, for example, machine learning and data mining; powerful ways of hypothesizing, searching for, and extracting explanatory, mechanistic stories underlying complex systems—not just how to use black box techniques; and combining the formulation of mechanistic models (e.g., toy physics models) with genetic programming.

## SPECIFIC REQUIREMENTS

### Requirements for Admission to Graduate Studies for the Degree of Master of Science

The program serves students from a wide variety of backgrounds and therefore deliberately keep the prerequisites to a minimum. Students must have a Bachelor's degree in a relevant field and prior coursework or be able to establish competency in calculus, computer programming, data structures, linear algebra, and probability and statistics.  Please note that some electives have additional prerequisites. General GRE scores are not required.

We offer 3 courses for students who may be lacking in these prerequisites:

1. CS 2240 Data Structures
2. MATH 2522 Applied Linear Algebra, and
3. STAT 1410 Statistical Methods I

These courses cannot be taken for graduate credit.

### Minimum Degree Requirements for the Degree of Master of Science

A total of 30 credits, distributed as shown below:

| Requirement Description | | Credits |
|---|---|---|
| Common Core (3 Credits Each) | | 12 |
| CSYS 6701 | Principles of Complex Systms 1 | 3 |
| or MATH 6701 | Principles of Complex Systms 1 | |
| CSYS 6020 | Modeling Complex Systems I | 3 |
| or CS 6020 | Modeling Complex Systems I | |
| CSYS 5870 | Data Science I - Experience | 3 |
| or STAT 5870 | Data Science I - Experience | |
| or CS 5870 | Data Science I - Experience | |
| 1 of the following 3 courses: | | 3 |
| CSYS 6713 | Principles of Complex Systms 2 | 3 |
| or MATH 6713 | Principles of Complex Systms 2 | |
| CSYS 6990 | Special Topics (Modeling Complex Systems II) | 3 |
| or CS 6990 | Special Topics | |
| STAT 6870 | Data Science II | 3 |
| Electives | | 9 |
| 6 credits of Complex Systems and/or Data Science Electives | | 6 |
| 3 credits of an advisor approved course | | 3 |
| Path Specific | | 9 |
| The degree program can be completed with one of three options: | | |
| Coursework only: 9 credits of either additional Complex Systems and Data Science courses or an elective path (Biomedical Systems, Distributed Systems, Energy Systems, Environmental Systems, Evolutionary Robotics, Policy Systems, or Self-designed named disciplinary path (requires approval of the CSDS advisor)) | | |
| Coursework and project: 3 to 6 credits of project (CSYS 6392) plus additional 3 to 6 credits of course work | | |
| Coursework and thesis: 6 to 9 credits of thesis research (CSYS 6391) plus additional 3 credits of course work if needed. | | |

Threaded throughout the coursework, a desired central outcome of each Master's student's training will be their development of a data-intensive, high design portfolio of course projects, research, and /or data visualizations. Students will have many opportunities to work with faculty, researchers, institutions, and corporations, on meaningful, important real-world data sets, drawn from engineering systems, neuroscience, society through the lens of social media, and more. Beyond being a key training mechanism, we envisage these portfolios—in the manner of, for example, a traditional engineering design or artist's set of works —will be instrumental in students achieving outstanding positions in their chosen fields."

### Comprehensive Exam

Students must demonstrate mastery of the material by one of four possible routes: an oral exam, a written exam, a paper, or a portfolio. For the course-based Master's, receiving a grade of A- or better in all courses constitutes successfully completing the comprehensive examination in a student's field of specialization. Students who

receive a grade of B+ or lower in any of their courses must pass a written and/or oral comprehensive exam. The exact format will be decided upon by the Curriculum Committee in consultation with the student. The Curriculum Committee will also designate three relevant faculty who will create the exam and or specify the format and content area of the paper and assess the student's performance.

**Requirements for Advancement to Candidacy for the Degree of Master of Science**

Successful completion of the comprehensive exam and all required coursework.