Syllabus Fall 2025

CS/CSYS 6020, Modeling Complex Systems, 3 Credit Hours

Tuesdays & Thursdays, 14:50 – 16:05, Votey 209 + uvm-edu.zoom.us/my/lsd.lhd

Instructors: Laurent Hébert-Dufresne & Shun Zhang (teaching assistant)

Email for remote appointments: laurent.hebert-dufresne@uvm.edu

General office hours: 16:05– 17:05, E413 Innovation Hall

Technical support for students

The course uses https://vermont-complex-systems.github.io/MOCS-website/ as its main structure for content. Quizzes, assignments, and projects are on Brightspace.

The course is programming-intensive and will be taught mainly with pseudo-code or python notebooks. Lectures will emphasize how and why a model works rather than its formal implementation. Many python notebooks will be provided to help students new to programming. MOCS is not meant to be a crash course in programming, but the codes used will be user-friendly, readable and easy to learn.

Students, please read this technology checklist to make sure you are ready for classes. https://www.uvm.edu/it/kb/student-technology-resources/

Students should contact the Helpline (802-656-2604) for support with technical issues.

Course Description

What are models? What are complex systems? How do we model complex systems in a way that respects and embraces their complexity?

CSYS/CS 6020 Modeling Complex Systems is designed as a hybrid, graduate level introduction to computational and mathematical modeling of complex systems. We use a breadth-first presentation of varied topics and methods, with hands-on experiences and mini-research problems with an emphasis on the relations and trade-offs between the different approaches. Undergraduates are held to the same expectations as graduate students.

Course Learning Objectives/Outcomes

After completing this course the student will

1. Know the different definitions, types, and roles of models of complex systems.
2. Recognize the trade-offs between types of models.
3. Be able to mathematically describe systems with differential equations.
4. Be able to implement some computational models.
5. Be able to formulate new questions, and identify relevant models and methods.
6. Be able to collaborate, brainstorm and discuss.

Course Narrative

What is modeling? What are the different techniques to model complex systems or social and natural systems? How do modeling techniques interact with model design? Modeling Complex Systems tackles these questions as a graduate course based on readings, discussions, and exercises.

• Module 0: Model theory and complex systems (philosophy of science), model definition, assumptions, and sources of errors --- Sayama Chapter 2

• Module 1: Discrete-time models (difference equations), deterministic continuous-time models (differential equations) --- Sayama Chapters 4-9

• Module 2: Cellular automata, stochastic models in space (random walks, percolation), and fractals --- Sayama Chapters 11-12

• Module 3: Network science, network analysis, adaptive networks --- Sayama Chapters 15-18

• Module 4: Agent-based models, evolutionary game theory (if time allows) and model selection --- Sayama Chapter 19

Modality description

Attendance is expected in person or online and the instructor should be notified of expected absences as early as possible. Students are expected to check both the website for content and Brightspace for announcements, quizzes, and assignments at least weekly.

Required Course Materials

Textbook: H. Sayama, Introduction to the Modeling and Analysis of Complex Systems, freely available from SUNY's Open Educational Resources.

Brightspace

Brightspace will be used for all course-related communications and sharing of problem sets. You are therefore expected to check Brightspace regularly to not miss any course-related announcements.

Attendance Policy and Classroom Environment Expectactions

As mentioned above, attendance is expected and the instructor should be notified of expected absences as early as possible. Students should refer to the *UVM attendance policy* for complete information. Note that the instructor will not require information beyond advanced notice of absence. If you are feeling ill, please let me know you are not available and do not attend class. The instructor will take care of sharing relevant content.

Before attending class, you are expected to have completed the readings (if any, as assigned and noted on Brightspace). The instructor will share a leading question regarding the reading and every student will be asked to answer the question or share relevant thoughts about the reading. Participation in these reading group discussions is expected, but any comments shared in group will not leave the privacy of the group.

In fact, in this course, we will work together to develop a learning community that is inclusive and respectful. As a learning community we will seek to encourage and appreciate expressions of different ideas, opinions, and beliefs in the spirit of Our Common Ground. Meaningful and constructive dialogue is encouraged in this class. This requires mutual respect, willingness to listen, and open-mindedness to opposing points of view. Respect for individual differences and alternative viewpoints will be maintained at all times in this class. Conduct that substantially or repeatedly disrupts the ability of faculty and instructors to teach and the ability of students to engage may result in my asking a student to temporarily leave the classroom.

Grading Criteria

We will have 3 assignments, all done in teams of two or three. For the second assignment, you will have to discuss your results in short recorded presentations. In addition, you are required to answer questions on weekly readings using weekly quizzes on Brightspace. The questions

assess your understanding of the readings and assure we all agree on important definitions and concepts. You are also required to attend our discussions in person or by videoconference.

Components: 40% for the project, 36% the three problem sets, 24% for the weekly quizzes, and up to 10 extra points will be available for attending some relevant events of the Vermont Complex Systems Institute and of the Computer Science department (e.g., invited seminars, thesis defense, etc, following specific invitation from the instructor on Brightspace).

Late submissions will lose 20% for every calendar day past due, starting with an initial 10% after the start of class on due date.

The final grading schema then goes as follows:

97-100 = A+ 93-96 = A 90-92 = A-

86-89 = B+ 83-85 = B 80-82 = B-

76-79 = C+ 73-75 = C 70-72 = C-

Anything below = F

Academic Integrity and AI:

This course follows the UMass Amherst Center for Teaching and Learning AI Policy:

Use of AI tools, including ChatGPT, is permitted in this course for students who wish to use them. To adhere to our scholarly values, students must cite any AI-generated material that informed their work (this includes in-text citations and/or use of quotations, and in your reference list). Using an AI tool to generate content without proper attribution qualifies as academic dishonesty.

Assessments (Graded Work):

Students are encouraged to work together and help each other on problem sets and on the project. However, submissions are expected to be individual work. The problem sets typically consist of 2-4 long problems meant to assess student ability to use the specific tools mentioned in the course content. The project will be a longer form application of not (but not all) of these techniques, it is instead meant to assess all course learning objectives listed above. Projects vary in format and relevant example will be shared early in the semester as we start brainstorming project ideas. All due dates will be set before instructions are given and will be shared on MS Teams.

Additional Policies:

Lived Name and Pronoun Information

The UVM Directory includes fields for indicating your lived name and your pronouns. Lived names (preferred names, names in use) are names that an individual wants to be known by in the University community. Entering your pronouns is strongly encouraged to help create a more inclusive and respectful campus community. To update your information, login to the UVM Directory. A preview box will allow you to see how this information will appear in other systems used on campus such as Microsoft Teams and Blackboard.

More information about how to make changes to your lived name and pronouns is available in the Knowledge Base.

Research and Citation Help

For help selecting research topics, finding information, citing sources, and more, ask a librarian. The UVM Libraries are eager to help. You may ask questions by phone, e-mail, chat, or text, or make an appointment for an individual consultation with a librarian.

Howe Library: https://library.uvm.edu/askhowe
Dana Medical Library: https://dana.uvm.edu/help/ask
Silver Special Collections Library: https://specialcollections.uvm.edu/help/ask

Course Evaluation:

All students are expected to complete an evaluation of the course at its conclusion. The evaluations will be anonymous and confidential, and that the information gained, including constructive criticisms, will be used to improve the course.

Potential Changes:

The University of Vermont reserves the right to make changes in the course offerings, mode of delivery, degree requirements, charges, regulations, and procedures contained herein as educational, financial, and health, safety, and welfare considerations require, or as necessary to be compliant with governmental, accreditation, or public health directives.

Intellectual Property Statement/Prohibition on Sharing Academic Materials:

Students are prohibited from publicly sharing or selling academic materials that they did not author (for example: class syllabus, outlines or class presentations authored by the professor, practice questions, text from the textbook or other copyrighted class materials, etc.); and students are prohibited from sharing assessments (for example homework or a take-home examination). Violations will be handled under UVM's Intellectual Property policy and Code of Academic Integrity.

Student Learning Accommodations:

In keeping with University policy, any student with a documented disability interested in utilizing ADA accommodations should contact Student Accessibility Services (SAS), the office of Disability Services on campus for students. SAS works with students and faculty in an interactive process to explore reasonable and appropriate accommodations, which are communicated to faculty in an accommodation letter. All students are strongly recommended to discuss with their faculty the accommodations they plan to use in each course. Faculty who receive Letters of Accommodation with Disability Related Flexible accommodations that go beyond the default accommodations will need to fill out the Disability Related Flexibility Agreement. Any questions from faculty or students on the agreement should be directed to the SAS specialist who is indicated on the letter.

Contact SAS:
A170 Living/Learning Center;
802-656-7753
access@uvm.edu
www.uvm.edu/access

Important UVM Policies

Academic Integrity:

The Academic Integrity policy addresses plagiarism, fabrication, collusion, and cheating.

Code of Student Conduct:

UVM's Code of Student Conduct outlines conduct expectations as well as students' rights and responsibilities.

FERPA Rights Disclosure:

The purpose of UVM's FERPA Rights Disclosure is to communicate the rights of students regarding access to, and privacy of their student educational records as provided for in the Family Educational Rights and Privacy Act (FERPA) of 1974.

Final Exam Policy:

The University final exam policy outlines expectations during final exams and explains timing and process of examination period.

Grade Appeals:

If you would like to contest a grade, please follow the procedures outlined in this policy.

Grading:

This link offers information on grading and GPA calculation.

Religious Holidays:

Religions may be practiced in many different ways, and can impact participation in classes variably. Students have the right to practice the religion of their choice. Each semester students should submit in writing to their instructors as early as possible and at least one week prior to their documented religious holiday the date(s) of the conflict or absence. Faculty must permit students who miss work or exams for the purpose of religious observance to make up this work. The complete policy is here.

Promoting Health & Safety:

The University of Vermont's number one priority is to support a healthy and safe community:

Center for Health and Wellbeing

Counseling & Psychiatry Services (CAPS) Direct Phone Line: (802) 656-3340

C.A.R.E. If you are concerned about a UVM community member or are concerned about a specific event, we encourage you to contact the Dean of Students Office (802-656-3380). If you would like to remain anonymous, you can report your concerns online by visiting the C.A.R.E. Team website.