Spring 2022 CSS Graduate Course

CSS 655

Social System Dynamics

Thursday 7:20 – 10:00, Research Hall 249

Syllabus

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Office hours: By appointment

Overview

This course is designed to provide a solid grounding in the theory and practice of system dynamics modeling (and subsequent simulation) in the human social context. System Dynamics (SD) is a well-established modeling technique for analyzing a real-world system by dividing it into functional parts and proposing explicit interactions among those parts. A successful modeling effort will represent the entire system, capture important aspects of its dynamics, and suggest interventions to change (or stabilize) system behavior.

Though SD models are, in point of fact, large systems of differential equations, modern SD modeling is done with the aid of software that manages these equations and integrates them numerically. Because of this, no advanced mathematical training is required to build successful models – though it never hurts! This course will tread very lightly with regard to formal theory and mathematics, focusing instead on intuition and practical model building.

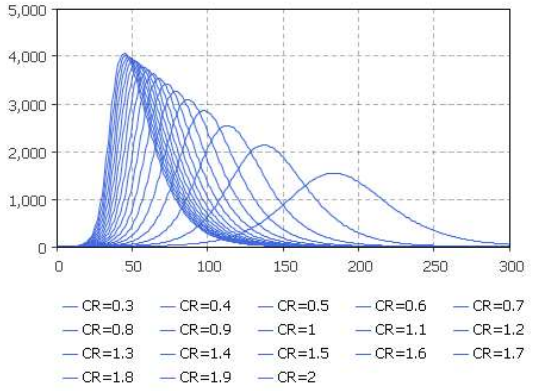
The course will make heavy use of John Sterman's text *Business Dynamics: Systems Thinking and Modeling for a Complex World.* Sterman's text provides a uniquely systematic presentation of the field in a human context that is actually much broader that the first part of the title indicates. This is in contrast to most other books on the technique that focus on technological and engineering applications.

Homework assignments can be done in Vensim, which has been updated to (more or less) modern standards. An education license is available for a fee. The homeworks will be drawn from *System Dynamics: Modeling, Simulation, and Analysis* by Juan Martin Garcia. I find Prof. Garcia has assembled some superb exercises with well-calibrated variables from real world SD situations.

Alternatives exist to Vensim. NetLogo provides an adaptable system dynamics modelling environment, and previous versions of this course have used AnyLogic. If you have access to AnyLogic or other SD applications, by all means you should gain practice with those. In addition, broad applications such as MATLAB or even Python can be used by an adept student.

Outcome

By the end of this course and with the completion of your project, you will be one of a very few analysts experienced in the application of the system dynamics paradigm to real-world problems. If you are already experienced in other techniques (discrete event simulation or agent-based models), you will be able to make the powerful claim that you can choose a tool that is most appropriate to your client's problem – you've worked with all of them.



This course will also help you develop an experimental program should you choose to use system dynamics in your research. You will learn how to create graphics such as the one shown here (depicting the number of infectious individuals during 300 days of an epidemic model as the contact rate (CR) is varied).

Course Organization and Grading

Students are expected to keep up with all assigned readings in advance of classroom discussions, and to *participate* in class discussion (20% of final grade). This will be measured by the presentation of use cases and challenge problems every few weeks.

Homework assignments will be used for assessing the student's grasp of weekly readings and lecture topics and to give you experience actually building SD models. These will count 30% of the grade. Homework assignments must be turned in at next class from when they were assigned. I have included a tentative schedule in the syllabus but I'm not sure I'll be generating all those assignments.

A *mid-term* project proposal paper will count 10%.

A *research project* (model, paper and presentation) due as the final exam will count as the remaining 40% of the grade. While individual projects are the norm, small group projects can be arranged in consultation with the professor. Where students work in groups one grade per group will be given, so be sure that the members are able to contribute more or less equally. The research paper will focus on the development of a system dynamics model in an area of student interest (e.g., microeconomics, international relations, political science, economic development, historical dynamics, or finance). The research paper is expected cover four main elements: (a) a description of the model; (b) systematic experimentation with the model; (c) presentation of model results, and (d) a summary of the model's capabilities and what was achieved with it. Specific guidelines and tips for preparing the research paper will be made available separately. The projects will be presented in class during the final two weeks of classes. *All papers are due at midnight on the day of our assigned final exam time (11:59pm, May 12, 2022).* If you cannot make this deadline, please notify me ahead of time. I have very little time (hours!) to grade papers and submit grades. Here are the policies:

- Late papers before the grade submission deadline will be downgraded.
- Late papers after the grade submission deadline but with a documented excuse will result in an incomplete.
- Papers submitted after the grade submission deadline with no documented excuse will result in a failure.

Communication

I plan to make use of Blackboard for this course. About 75% of Mason's courses use Blackboard to communicate academically. This number is likely to grow as more features are added. Please post your assignments to Blackboard and submit the final project documentation there as well. You will also be able to view your interim and final grades.

Remote Learning, Inclement Weather & Unforeseen Circumstances

Due to my own schedule, there will be two remote classes: February 17 and March 24. The first will consist of a remote asynchronous lecture (I will post a video of the lecture on Blackboard.) The second may be asynchronous or it may be synchronous (by Zoom). I will update as we get into the semester.

The university will not reschedule a class if only one class session is missed due to snow. But, if more than one session is canceled, the university typically extends final week. This can be very disruptive: in the spring of 2014 the university was holding final exams on the day before graduation!

I plan to avoid this mess by using the Blackboard 'collaborate' option. This will set up a Zoom session that everybody will be invited to.

As you all know, our transportation network can occasionally and unexpectedly fall to pieces. I'll gather up student text addresses so that you can know if we're in one of those gridlock situations. If I'm to be over half an hour late, we will reschedule the academic portion of the class. (I will probably record the lecture, inviting all of you to watch live, and make it available as a recording on Blackboard.)

Semester Schedule

This is a Thursday class during the spring semester. That means the following:

- We **will not have class** on spring break, Thursday March 17.
- Our last class is Thursday, May 5th.
- Our official final exam day (when the paper is due) is Thursday, May 12th.

Academic Honesty and Collaboration

The integrity of the University community is affected by the individual choices made by each of us. GMU has an Honor Code with clear guidelines regarding academic integrity. Three fundamental and rather simple principles to follow at all times are that: (1) all work submitted be your own; (2) when using the work or ideas of others, including fellow students, give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment, ask for clarification. No grade is important enough to justify academic misconduct.

Plagiarism means using the exact words, opinions, or factual information from another person without giving the person credit. Writers give credit through accepted documentation styles, such as parenthetical citation, footnotes, or endnotes. Paraphrased material must also be cited, using MLA or APA format. A simple listing of books or articles is not sufficient. Plagiarism is the equivalent of intellectual robbery and cannot be tolerated in the academic setting. If you have any doubts about what constitutes plagiarism, please see me.

As in many classes, a number of projects in this class are designed to be completed within your study group. With collaborative work, names of all the participants should appear on the work. Collaborative projects may be divided up so that individual group members complete portions of the whole, provided that group members take sufficient steps to ensure that the pieces conceptually fit together in the end product.

Other projects are designed to be undertaken independently. In the latter case, you may discuss your ideas with others and conference with peers on drafts of the work; however, it is not appropriate to give your paper to someone else to revise. You are responsible for making certain that there is no question that the work you hand in is your own. If only your name appears on an assignment, your professor has the right to expect that you have done the work yourself, fully and independently.

Mason is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process. The principle of academic integrity is taken

very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. **Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions.** When in doubt (of any kind) please ask for guidance and clarification.

Privacy Restrictions

The university, in order to conform to the requirements of federal law (FERPA), now requires that all communications with respect to an academic course be conducted *to and from a George Mason e-mail account*. Thus, I am bound to respond only to e-mails sent from your GMU account. This can be done via the web-mail application. I will try to observe this policy as well.

Disability Statement

If you are a student with a disability and you need academic accommodations, please contact the Office of Disability Services (993-2474; http://www.gmu.edu/student/drc/). All academic accommodations must be arranged through the ODS.

Reading & Homework Assignments

Reading for this class will be primarily from the main course text (required):

Sterman, John. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Boston: Irwin/McGraw-Hill, 2000.

Homework is assigned in:

Garcia, Juan Martin. *System Dynamics: Modeling, Simulation, and Analysis.* Self-published, 2022. (Available on Kindle)

Limited supplemental readings may also be assigned and will be provided as PDF documents as needed. It is expected that students will read and thoroughly digest each week's readings before class begins.

Course Outline

Week	Date	Topic & Reading	Homework Due
1	Jan 27	Introduction to Dynamic Modeling and Social System Dynamics • Discuss: Syllabus; Types of models; Overview of a complex model • Chapter 1: Learning in and about Complex Systems	
2	Feb 3	System Dynamics and Modeling Complex Systems Presentation I: Use Cases from Chapter 2 • Chapter 2: System Dynamics in Action – Use Cases • Chapter 3: The Modeling Process	Prepare Use Cases (2) Install and test Vensim
3	Feb 10	Tools for Systems Thinking 1 • Chapter 4: Structure and Behavior of Dynamic Systems • Chapter 5: Causal Loop Diagrams	Homework 1 Garcia 3.1: Population Growth
4	Feb 17 (Online, Asynchronous)	Tools for Systems Thinking 2 • Chapter 6: Stocks and Flows • Chapter 7: Dynamics of Stocks and Flow	Homework 2 Garcia 3.4: Fishery Management
5	Feb 24	Building Blocks for Systems Thinking • Chapter 8: Closing the Loop: Dynamics of Simple Structures	Homework 3 Garcia 3.10: Inventory Management
6	Mar 3	The Dynamics of Growth 1 • Chapter 9: S-Shaped Growth: Epidemics, Innovation Diffusion, and Growth of New Products • Chapter 10: Path Dependence and Positive Feedback	One-page project research project proposal due.
7	Mar 10	The Dynamics of Growth 2 • Chapter 11: Delays	Presentation I: Project Proposal Presentations
	Mar 17	Spring Break	
8	Mar 24 Remote Class (TBD)	Tools for Modeling Dynamic Systems 1 • Chapter 12: Coflows and Aging Chains	Work project

9	Mar 31	Tools for Modeling Dynamic Systems 2 • Chapter 13: Modeling Decision Making • Chapter 14: Formulating Nonlinear Relationships	Homework 4: Garcia 3.21: Epidemic SIR Model
10	Apr 7	Tools for Modeling Dynamic Systems 3 • Chapter 15: Modeling Human Behavior: Bounded Rationality or Rational Expectations? • Chapter 16: Forecasts and Fudge Factors: Modeling Expectation Formation	Presentation II: Challenge Problems: Chapter 13 & 14
11	Apr 14	Instability and Oscillation 1 • Chapter 17: Supply Chains and the Origin of Oscillations • Chapter 18: The Manufacturing Supply Chain	Homework 5: Garcia 3.26: The Butterfly Effect
12	Apr 21	Instability and Oscillation 2 • Chapter 19: The Labor Supply Chain • Chapter 20: The Invisible Hand Sometimes Shakes: Commodity Cycles	No assignment: Work Projects
13	Apr 28	Model Testing and Social System Dynamics in Perspective • Chapter 21: Truth and Beauty: Validation and Model Testing • Chapter 22: Challenges for the Future • Discussion of limitations of Social System Dynamics	No assignment: Work Projects
14	May 5	Social System Dynamics Future • In-class presentation of projects • Seminar: Is System Dynamics still relevant?	
	May 12	Final projects due at midnight!	