Fall 2020 CDS Undergraduate Course CDS 201
Introduction to Computational Social Science

Synchronous Online Sessions
Tuesdays and Thursdays: 12:00–1:15pm[1]

Syllabus

Instructor
Prof. Dale S. Rothman
Computational Social Science Program, Department of Computational and Data Sciences, College of Science
Office hours: Tuesdays 2:00-3:30PM, Fridays 11:30AM-1:00PM, and by appointment
To be held on Zoom: Meeting information provided on Blackboard

STARS (Teaching Assistants)
Richard Na
Office hours: Wednesdays 10:00-11:00 AM
To be held on Blackboard Collaborate in the Course Room

Dwayne Smith
Office hours: Thursdays 5:00-6:00 PM
To be held on Blackboard Collaborate in the Course Room

[1] Recordings of these sessions will be made available on Blackboard.

Overview

This course is an undergraduate-level survey of computational approaches to social science research, with emphasis on methods, tools, software frameworks, and complexity theory as these apply to the investigation of social phenomena. For our purposes, "the social sciences" include anthropology, communication, economics and finance, geography, history, linguistics, political science, sociology, and social psychology, informed by developments in psychology, cognitive science, neuroscience, and related branches of behavioral science.

Computational social science (CSS) is a new interdisciplinary frontier in the social sciences. As an introduction to the subject, the course has the following objectives:

1. to understand the ***motivation*** for the use of computational models in social science theory and research, including some historical aspects (Why conduct computational research in the social sciences?);
2. to learn about the variety of CSS ***research programs*** across the social science disciplines, through a survey of social simulation models (What has CSS accomplished thus far?);
3. to understand the ***distinct contribution*** that CSS can make by providing specific insights about society, social phenomena at multiple scales, and the nature of social complexity (What is the relation between computational social science and the social sciences more generally?).
4. to ***provide foundations*** for more advanced work in subsequent courses or projects for those students who already have or will develop a long-term interest in computational social science (e.g., CDS 205, CDS 292).

No particular computer science, programming, or advanced mathematics skills are necessary for this course, since it is specifically designed as an introductory survey. However, some background in computing and mathematics is desirable.

The main requirements to take this course and perform well are:

- ***Interest*** in some area of real-world social investigation where computational approaches have been applied (e.g., the environment, financial markets, war and peace, origins of civilization, or other area of application).
- ***Curiosity*** about the nature and purpose of computational modeling in the various domains of the social sciences: Why do social simulations in the first place? What are they for? What can they tell us about the way in which various social processes operate? What are their main strengths and limitations?
- Basic skills in ***critical thinking*** and ***analytical reasoning*** (learning concepts, fundamental principles, and how to apply them to specific domains).
- ***Motivation*** to learn from case studies, research projects, and demonstrations.
- ***Willingness*** to explore, adapt and create simple models.

Some unhelpful misconceptions of computational social science are the following: that all computational modeling is quantitative or numerical; that qualitative analysis is not involved in computational modeling; that numbers, as opposed to ideas, are the basic elements of modeling; that computational models provide no

new knowledge beyond what an intelligent mind can discover without models; that computer models are unethical, because "they replace human decision-makers"; that CSS is Orwellian; and so forth. We will discuss other misconceptions in class.

Some methodological questions to be dealt with include the following: What is the purpose of computational modeling in the social sciences? What are the key distinctions between theory, methods, and applications in CSS? How are computational models constructed? How are they developed and evaluated? Which scientific problems or puzzles are best solved through computational modeling, as opposed to other approaches (e.g., statistical or mathematical)? What is the difference between "top down" and "bottom up" models, and models of the "third way"? Which major policy areas (e.g., national security, transportation, environmental, welfare, homeland security, education, science and technology, public health, etc.) are most appropriate for computational modeling? What are the main simulation modeling tools available today, and which may be envisioned for the future? To which types of empirical phenomena do the best CSS approaches apply? What are the main advantages and limitations of each type of model? Which are the classic works and which are the future directions in CSS? What are the main unique insights provided by computational methods in the social sciences? These and other topics will be explored through lectures, demonstrations, and assigned readings.

Course Organization and Grading

Participation (10% of grade): Due to COVID-19, this class will meet online in synchronous sessions twice a week most weeks (see specific times on first page of this syllabus and specific dates in the Tentative Course Schedule and Outline below). Students will get the most out of the class by keeping up with all assigned readings in advance of the synchronous sessions and by participating in class discussions. Attendance and participation is critical for your success, and it is desirable for you be at all classes and to make productive use of class time.

While recordings of the synchronous sessions will be made available, these should not be seen as substitutes for attending the sessions in real time. If you foresee having to miss more than a handful of the synchronous sessions, please discuss this with me early in the semester. Attendance at the meeting during the Final Exam Slot is considered mandatory, as students will evaluate the presentations of their peer groups.

Homework assignments will be used for assessing the student's grasp of weekly readings and lecture topics. These will count for 40% of the grade (8% each x 5 = 40%). *Homework Assignments will be assigned in weeks 2, 4, 6, 9, and 14 and must be turned in before the Thursday class (i.e., by noon) the following week (unless stated by the instructor).* Please submit all assignments on Blackboard. **Homework assignments submitted late will receive an immediate 1 point penalty, with an additional 1 point penalty for each additional day they are late (each new day begins at noon for this purpose).**

A *mid-term assignment* will count for 10%. *This will be made available after class on Thursday the 8th of October and due by noon on the 15th of October.* Please submit on Blackboard. **Late submissions will not be accepted without prior approval by the instructor and may receive a penalty.**

A *research projec*t (paper and presentation) will count for the remaining 40% of the grade. Students are expected to work in groups of *three to four*. One grade will be given per group, unless there are extenuating circumstances in which different grades should be given to individuals within a group. This must be discussed with the instructor.

The research project will focus on either the use or development of a computational model in an area of student interest (e.g., microeconomics, international relations, environmental policy, social hierarchy, economic development, historical dynamics, finance). The research paper will cover four main themes: (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 project will be made available separately. *An initial presentation of your project proposal will be made during class in Week 11 (November 3rd and 5th). The final project will be presented during our final exam period on December 10th. All project materials are due the morning after the final exam period of class (i.e. Friday the 11th of December by noon)*. Please submit on Blackboard. **Late submissions will not be accepted without prior approval by the instructor and may receive a penalty.**

Components of Final Grade

Class Participation:	10%
Homework:	40%
Midterm:	10%
Research Project:	40%

Scale (points = percentage)

95-100	= A+
88-94	= A
82-87	= A-
76-81	= B+
70-75	= B
64-69	= B-
58-63	= C
<58	= F

Reading Assignments

All readings are assigned as preparatory material to the weekly meetings. The reading material for this course consists mostly of required readings and optional recommended readings listed below and detailed for each meeting. The optional readings may or may not be discussed in class, depending on the time available, but is nonetheless included in the interest of depth and completeness.

The textbook is available for free online (see below). Other readings are available online or will be made available on the course website.

Required textbook:

Cioffi-Revilla, C. (2017*),* *Introduction to Computational Social Science: Principles and Applications*, 2nd Edition, Springer, New York, NY.

To obtain a free electronic copy, follow these steps:

1. In Blackboard, click on Library Resources in the Course Menu
2. Click on Find Books under Begin Your Research
3. Search for Introduction to Computational Social Sciences
    - The course textbook should appear as the first result
4. Sign in if it asks
5. Click where it says Available Online under the result
6. Click where it says SpringerLink Books Computer Science 2014 under Full Text Availability
7. Download the book as either a pdf or epub.

Class Website - Blackboard

The class website on Blackboard contains all the supplementary material needed for the course. Material for each class including models is given in the assigned week.

Please note that course handouts (i.e. lecture slides) will not be available until the day of the class, however core reading material and references will be provided beforehand. I do not expect you to read all the additional references; I provide them purely for a reference resource for topics covered in class.

You should check this website regularly for updates.

Office Hours and Contact Information

I will hold online office hours as indicated on the first page of this syllabus. All email correspondence should occur through Blackboard. After the first week any emails not sent through Blackboard will elicit a response reminding you to send emails through Blackboard. I will respond to your email within 24 hours during the week, with the possibility of a longer response time on weekends.

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 in groups. 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. Furthermore, it is unacceptable to use a model or a paper developed for another class in this class.

The re-use of computer models is also not acceptable. If one does use code from another model, please ensure the code that is used is accredited to the original model (just as you would do to a reference in a paper).

Disability Statement

If you have a documented learning disability or other condition that may affect academic performance you should: 1) make sure this documentation is on file with Disability Services (SUB I, Rm. 4205; 993-2474; http://ds.gmu.edu) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs.

Sexual Harassment, Sexual Misconduct, and Interpersonal Violence

As a faculty member and designated "Responsible Employee," I am required to report all disclosures of sexual assault, interpersonal violence, and stalking to Mason's Title IX Coordinator per university policy 1412. If you wish to speak with someone confidentially, please contact the Student Support and Advocacy Center (703-380-1434), Counseling and Psychological Services (703-993-2380), Student

Health Services, or Mason's Title IX Coordinator (703-993-8730; cde@gmu.edu).

Privacy

Students must use their MasonLive email account to receive important University information, including communications related to this class.

Student Support Resources

George Mason University has a number of academic support and other resources to facilitate student success (e.g., Counseling and Psychological Services, Learning Services, University Career Services, the Writing Center, etc.). See http://www.gmu.edu for more details.

Tentative Course Schedule and Outline[2]:

Week 1 (August 25th and 27th): Introduction to Computational Social Science

- **Required Reading**: Chapter 1 from Cioffi-Revilla (2017).
- **Discuss**: Syllabus; Social science models and the use of modern computation by social scientists.
- **Demo**: CSS styles of models and works.

Week 2 (September 1st and 3rd): Modeling and Computational Social Science

- **Required Reading**: Chapter 2 from Cioffi-Revilla (2017).
- **Discuss**: The role of computational approaches for carrying out social science research.
- **Demo**: How social science concepts can be implemented in Code.
- **Homework 1 made available**.

Week 3 (September 8th and 10th): Complexity Ideas and Complex Adaptive Systems (CAS); Social Science Simulation Software

- **Required Reading**: Chapters 5 and 6 from Cioffi-Revilla (2017).
- **Discuss**: Emergence; Near-decomposability; Self-organization; Scaling and power laws.
- **Demo**: How complexity can be captured in CSS styles of models.
- **Homework 1 due by noon Sept 10th.**

Week 4 (September 15th and 17th): Systems Dynamics

- **Required Reading**: Pages 414-428 from Cioffi-Revilla (2017).
- **Discuss**: Relation of systems dynamics models to mathematical models; Advantages and limits of system dynamics models.
- **Demo**: Various System Dynamic Models.
- **Homework 2 made available**.

Week 5 (September 22nd and 24th): Microsimulation Models, and Discrete Event Simulation (DES)/ Queuing Models

- **Required Reading**: Pages 429-436 from Cioffi-Revilla (2017).
- **Discuss**: Relation between Microsimulation and DES and systems dynamics.
- **Demo**: Various Applications of Microsimulation and DES Models
- **Homework 2 due by noon Sept 24th.**

Week 6 (September 29th and October 1st): Cellular Automata Models

- **Required Reading**: Pages 455-470 from Cioffi-Revilla (2017) and Crooks (2017).
- **Discuss**: Self-reproducing automata Artificial Life.
- **Demo**: 1D CAs; Game of Life; Percolation; Voter models; City formation models; Forest fire models; Glider (most models are in NetLogo).
- **Homework 3 made available**.

[2] Course schedule may change slightly over the semester but homeworks and midterm will remain fixed.

Week 7 (October 6th and 8th): Agent-based Models and Multi-agent Systems

- **Required Reading**: Pages 470-484 from Cioffi-Revilla (2017).
- **Discuss**: The basic concept of agent-based modeling.
- **Demo**: Various agent-based models developed at Mason.
- **Homework 3 due by noon Oct 8th.**
- **Midterm made available after class on October 8th.**

Week 8 (October 13th 15th): Agent-based Models and Multi-agent Systems
Required Reading: Crooks and Heppenstall (2012).

- **Discuss**: Relation of agent systems to previously-studied approaches.
- **Demo**: Various agent-based models developed at Mason.
- **Midterm due by noon Oct 15th.**

Week 9 (October 20th and 22nd): Social Network Models (Part 1)

- **Required Reading**: Pages 141-170 from Cioffi-Revilla (2017).
- **Discuss**: Principles of Social Networks such as lattices, "small-worlds" and random graphs.
- **Demos**: Social Network Applications with the Social Sciences.

Week 10 (October 27th and 29th): Social Network Models (Part 2)

- **Required Reading**: Pages 141-170 from Cioffi-Revilla (2017).
- **Discuss**: The sense in which social networks generalize spatial networks
- **Demos**: Works from the GeoSocial Group at Mason.
- **Homework 5 made available.**

Week 11 (November 5th): Proposal Presentations ***Note we don't meet on the 3rd due to Virginia voting holiday***

- **Required Reading**: None.

Week 12 (November 10th and 12th): Machine Learning and Evolutionary Computation

- **Required Reading**: Read Chapter 10 of Gilbert and Troitzsch (2005).
- **Discuss**: The role of Machine learning; Evolutionary learning with respect to CSS.
- **Demo**: Applications of Machine learning in CSS.

Week 13 (November 17th and 19th): Modeling Human Behavior

- **Required Reading**: Kennedy (2012)
- **Discuss**: cognitive architectures and frameworks for Agents and Learning
- **Demo**: How cognitive frameworks can be implemented in agent-based models.
- **Homework 4 handed out.**

Week 14 (November 24th): Spatial Models ***Note we don't meet on the 26th due to Thanksgiving***

- **Required Reading**: Schelling (1971), Crooks (2015).
- **Discuss**: The extent to which space fundamentally alters the kinds of outcomes that are possible in social science models.
- **Demos**: 1D: traffic and 2D: Schelling segregation models in NetLogo.

Week 15 (December 1st and 3rd): Computational Experimentation and Output Analysis

- **Required Reading**: None as this is covered in many of the other chapters and reading assignments already covered in class.
- **Discuss**: Validation; Verification; Out-of-sample testing.
- **Demo**: Various methods to aid in Validation; Verification from a CSS perspective.
- **Homework 4 due by noon Dec 1st.**

Week 16. (December 10th – Final Exam Slot; note the class time: 10:30 to 1:15): In class presentation of projects.

- **Final version of all project materials are due by noon Friday the 11th of December.**

Note: Recording of any kind (audio, video), reuse of course materials, and further dissemination of the course content is not permitted unless prior written consent of the professor and George Mason University has been given or if recording is part of an approved accommodation plan.