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# Spring 2021 CDS Undergraduate Course CDS 201

**Introduction to Computational Social Science**

**Synchronous Online Sessions**[[1]](#footnote-1)

**Tuesdays and Thursdays January 15 – April 29: noon–1:15pm**

**Thursday May 6th: 10:30am-1:15pm[[2]](#footnote-2)**

# Final Syllabus

**Instructor**

## Prof. Dale S. Rothman

## Computational Social Science Program

## Department of Computational and Data Sciences

## College of Science

## Research Hall, Room 374

*Office hours*: Wednesdays 3:30-5:30PM and by appointment

To be held on Zoom (see website for link)

**STARS (Teaching Assistants)**

## Richard Na

## Phd student

## Computational Social Science Program, Department of Computational and Data

## Sciences, College of Science

## Research Hall, Suite 373-381, Center for Social Complexities

*Office hours*: Thursdays 10:00-11:00AM and by appointment

To be held on Zoom (see website for link)

# 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.

# Class Website

The class website on Blackboard is the hub for this course. It contains, *inter alia*, a copy of this syllabus, Zoom links to the synchronous sessions and office hours, weekly outlines, links to readings (other than from the required text) and other preparatory material, links to the software to be used in the course, course assignments, and your grades.

Material for each week is provided in the weekly overview sections. Please note that course handouts (i.e. lecture slides) will not be available until after classes.

Any important changes to the website during the semester will be announced

# Course Organization and Grading

* *Take-Home Written Exam (10%)*: A take-home written exam covering the basic principles of CSS will be made available after class on Thursday February 18th (week 4) and will be due by noon the following Thursday February 25th.
* *Modeling Homeworks (40%)*: There will be four modeling homeworks covering several of the modeling approaches we will be covering. These will be made available after class on Thursdays February 25th (week 5), March 4th (week 6), March 11th (week 7), and April 22nd (week 13) and will be due by noon the following Thursdays.
* *Group Research Project (45%)*: The group 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).

Each group should contain three to four students. Students may self-organize into groups, but these need to be identified and communicated to Professor Rothman by the start of class on February 23rd (week 5). After that time, Professor Rothman will assign groups for the remaining students.

The grade for the group research project will consist of three parts.

1. (5%) An initial presentation of your project proposal to be made during class on March 23rd or 25th (week 9). Students should submit an electronic copy of their presentation by the start of class on the 23rd, and the order of presentations will be determined at that time, so all groups need to be prepared to present that day. Attendance is considered mandatory for both sessions this week and students will be asked to provide written comments on the presentations of their peer groups.
2. (10%) A presentation of your ‘final’ project to be made during our final exam session on May 6th (week 15). Students should submit an electronic copy of their presentation by the start of class on the 6th, and the order of presentations will be determined at that time, so all groups need to be prepared to present from the start. Attendance is considered mandatory for this session and students will be asked to provide written comments on the presentations of their peer groups.
3. (30%) All project materials –your final paper, your model files, and any analysis files – are due by midnight Monday May 10th.

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 Professor Rothman.

Specific guidelines and tips for preparing the research project will be made available separately. This will include advice on how to choose a topic, the nature of the two presentations, and the structure of the final paper.

# *Participation (5%)*: Due to COVID-19, this class will meet online in synchronous sessions. 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. 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. Your grade for participation will reflect your attendance at the sessions on March 23rd and 25th (week 9) and May 6th (week 15), your written comments on the presentations of the initial proposals and final projects of your peer groups, and your general participation during the course.

***In all cases, assignments are to be submitted on Blackboard and late submissions will not be accepted without prior approval by the instructor.***

Based on the final total score, your final grade will be determined as follows: A+ [97-100], A [93-96], A- [90-92], B+ [87-89], B [83-86], B- [80-82], C+ [77-79], C [73-76], C- [70-72], D [65-69], F [<65].

# Readings and other Preparatory Material

All readings and preparatory material are listed in the weekly sections on the class website. These will consist of, *inter alia*, required readings, optional readings, links to websites, and videos. 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 one ‘required’ book for this course is:

Page, Scott E. 2018. *The Model Thinker: What You Need to Know to Make Data Work for You*. First edition. New York: Basic Books.

I requested copies to be available in the bookstore and it is also available at Amazon and elsewhere.

We will be reading various sections of this text and it will serve as a good general reference for this and later courses you may take in this department. Other readings are available online or will be made available on the course website.

# Software

I will introduce you to 3 free software platforms during this course. These each have their individual strengths and all are available for both Windows and Mac operating systems.

* AnyLogic PLE version 8.7.2 –(<https://www.anylogic.com/>). I am still learning about this software, but it has the ability to implement a wide range of modeling approaches, including those that we will be exploring in this class. There are several commercial versions of AnyLogic with additional features.
* NetLogo version 6.2.0 (<http://ccl.northwestern.edu/netlogo/>): This is a very commonly used platform for teaching and doing basic cellular automata and agent-based modelling. It does have the ability to do very simple system dynamics and network modeling, as well as incorporate GIS, but those features are somewhat limited. We will only be using NetLogo 6.2.0 and BehaviorSearch 6.2.0; you can ignore NetLogo 3D and HubNet Client, which are also installed with the software. There is no commercial version of NetLogo.
* Vensim PLE version 8.2.1 – (<https://vensim.com/>): This is a very commonly used platform for teaching and doing basic system dynamics modeling. There are several commercial versions of Vensim with additional features. Please note that I have had problems with the Mac version of this software in the past.

A fourth commonly used software is Stella (<https://www.iseesystems.com/>). Unfortunately, at this point they do not have a free learning edition.

There are a number of other platforms available for the types of modeling we will be exploring, but I am less familiar with them. Also, for more advanced modeling, many modelers eventually move to specialized C++, Java, or Python libraries, such as MASON, which was developed here at GMU (<https://cs.gmu.edu/~eclab/projects/mason/>). We will not be exploring those in this class, but you may come across them in some of the readings and demos. You will almost certainly come across them in more advanced courses in this department.

Finally, because the licenses for the software packages is not provided by Mason, you need to complete and sign a FERPA release form. I have included this as an assignment on the class website, and you will receive 1 extra credit point for submitting the signed form by the start of the second week of classes. If not, you will still need to submit the signed form before I will grade any of your exams or assignments; they will be treated as late submissions until the form is submitted.

# Contacting Prof. Rothman outside of Office Hours

All correspondence is to be done using the Course Messages feature on Blackboard. My ground rules for direct messages are as follows:

* I check and respond to messages during normal university hours (i.e. weekdays 9am-5pm).
* Just because I view a message does not mean I will respond right away. Please allow up to 24 hours for a response during normal hours and longer on weekends and holidays.
* If your questions are involved enough, I will ask you to schedule an appointment with me.
* Questions about an assignment should be asked before the due date. Questions asked after 5:00pm on the due date will be answered the following morning.[[3]](#footnote-3)
* On email: Emails sent during the first week of classes will be responded to, but I will respond to you using the Course Messages feature on Blackboard. Emails sent to me after the first week will be ignored or, at most, be responded to with a brief note reminding you to use Course Messages feature on Blackboard for all class-related communication.[[4]](#footnote-4)

# Contacting Richard Na (TA) outside of Office Hours

njiang8@gmu.edu is a good way to find the TA for question and appointment. Feel free to message me any questions you have outside of my office hours, however, I may not be able to respond right away. During the weekend and after 8pm on weeknights expect delayed response times.

# 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: (1) all work submitted should be your own or that of your assigned group; (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.

# Military activation

In accordance with the “Virginia Tuition Relief, Refund, and Reinstatement Guidelines,” Mason students in the uniformed services under call or order to active duty, after the beginning of a semester or summer session have two options they may consider with the dean's office of their school of enrollment and Office of the University Registrar in determining their enrollment status with the University: 1. Students may withdraw from courses in which they are enrolled as of the effective date of the call or order to report to active duty and 2. Students may take a grade of incomplete in all courses. For more details see <https://catalog.gmu.edu/student-services/military-services/>.

# Course Schedule - Overview[[5]](#footnote-5),[[6]](#footnote-6)

1. **INTRODUCTION**
* **Week 1 (January 26th and 28th): Introduction to Computational Social Sciences**
1. **PRINCIPLES of CSS**
* **Week 2 (February 2nd and 4th): Complexity Ideas and Complex Adaptive Systems (CAS)**
* **Week 3 (February 9th and 11th): Modeling I – Basic Concepts**
* **Week 4 (February 16th and 18th): Modeling II – Computational Experimentation and Output Analysis**
	+ *Short written exam handed out Feb. 18th; due Feb. 25th*
1. **MODELING APPROACHES for CSS**
* **Week 5 (February 23rd and 25th): Systems Dynamics**
	+ *Self-identified groups to provide notice to Professor Rothman by start of class Feb. 23rd.*
	+ *Modeling HW1 introduced in class Feb. 25th; due Mar. 4th*
* **Week 6 (March 2nd and 4th): Cellular Automata**
	+ *Modeling HW2 introduced in class Mar. 4th; due Mar. 11th*
* **Week 7 (March 9th and 11th): Agent-based Models and Multi-agent Systems**
	+ *Modeling HW3 introduced in class Mar. 11th; due Mar. 18th*
* **Week 8 (March 16th and 18th): Other Approaches: Microsimulation Models, Queuing Models, etc.**

***Week 9 (March 23rd and 25th): Group Project Proposal Presentations***

1. **ADVANCED TOPICS in CSS**
* **Week 10 (March 30th and April 1st): Time and Space**
* **Week 11 (April 6th and 8th):** **Social Networks**
* **Week 12 (April 13th and 15th): Human Cognition and Behavior**
* **Week 13 (April 20th and 22nd):** **Machine Learning and Evolutionary Computation**
	+ *Modeling HW4 introduced in class Apr. 22nd; due Apr. 29th*

***Week 14 (April 27th and 29th): Exploration of Classic CSS Models***

***Week 15 (May 6th – Final Exam Slot; note the class time: 10:30am to 1:15pm): ‘Final’ Group Project Presentations.***

# Course Schedule – Detailed

1. **INTRODUCTION**
* **Week 1 (January 26th and 28th): Introduction to Computational Social Sciences**
	+ **Key Topic(s)**
		- Syllabus; Social science models and the use of modern computation by social scientists
	+ **Assignment(s)**
		- Complete FERPA Waiver
	+ **Required Reading(s)/Preparatory Material**
		- Page 2018: Prologue and Chapter 1: The Many-Model Thinker
		- Watts 2013 - Computational Social Science- Exciting Progress and Future Directions
	+ **Optional Reading(s)/Preparatory Material**
		- Cioffi-Revilla 2010 - Computational Social Science
		- Lazer et al. 2009 - Computational Social Science
		- Weinberger 2011 - Web of War- Can Computational Social Science Help to Prevent or Win Wars
	+ **Website(s) of Interest**
		- none
1. **PRINCIPLES of CSS**
* **Week 2 (February 2nd and 4th): Complexity Ideas and Complex Adaptive Systems (CAS)**
	+ **Key Topic(s)**
		- **Emergence; Near-decomposability; Self-organization; Scaling and** power laws
	+ **Assignment(s)**
		- Submit FERPA Waiver
	+ **Required Reading(s)/Preparatory Material**
		- **Miller and Page 2007 - Complex Adaptive Systems- An Introduction to Computational Models of Social Life Chapters 1 and 2**
		- <https://youtu.be/j1K69DwFOUY>
		- <https://youtu.be/6FrD0G5ZPdc>
	+ **Optional Reading(s)/Preparatory Material**
		- **Cederman 2003 - Modelling the Size of Wars- From Billiard Balls to Sand Piles**
		- **Dearden and Wilson 2008 - Exploring Urban Retail Phase Transitions – 1- An Analysis System**
		- **Gulden 2002 - Spatial and Temporal Patterns in Civil Violence- Guatemala, 1977-1986**
		- **Hildenbrandt et al 2010 - Self-Organized Aerial Displays of Thousands of Starlings- A Model**
		- **Hemelrijk and Puga-Gonzalez 2012 - An Individual-Oriented Model on the Emergence of Support in Fights, Its Reciprocation and Exchange**
	+ **Website(s) of Interest**
		- [Max Planck Department of Collective Behaviour](http://collectivebehaviour.com/)
* **Week 3 (February 9th and 11th): Modeling I – Basic Concepts**
	+ **Key Topic(s)**
		- The role of computational approaches for carrying out social science research
	+ **Assignment(s)**
		- Download and install NetLogo, go through the three tutorials under Learning NetLogo in the User Manual and look at section about BehaviorSpace under Features in the User Manual
	+ **Required Reading(s)/Preparatory Material**
		- Page 2018: Chapters 2 and 3
		- <https://youtu.be/6aN6PlsvkpY>
		- <https://youtu.be/r6CGS3xgOl8>
	+ **Optional Reading(s)/Preparatory Material**
		- Axelrod 1997 - Advancing the Art of Simulation in the Social Sciences
		- Epstein 2008 - Why Model
		- Grimm et al 2005 - Pattern-Oriented Modeling of Agent-Based Complex Systems- Lessons from Ecology
		- Kohler et al 2000 - Be There Then- A Modeling Approach to Settlement Determinants and Spatial Efficiency Among Late Ancestral Pueblo Populations of the Mesa Verde Region, U.S. Southwest
		- Miller and Page 2007 - Complex Adaptive Systems- An Introduction to Computational Models of Social Life Chapter 3
		- Rauch 2002 - Seeing Around Corners
	+ **Website(s) of Interest**
		- none
* **Week 4 (February 16th and 18th): Modeling II – Computational Experimentation and Output Analysis**
	+ **Key Topic(s)**
		- Simulation experiments; Validation; Verification; Out-of-sample testing.
	+ **Assignment(s)**
		- Short written take-home exam handed out
		- Form self-identified research groups, if desired
	+ **Required Reading(s)/Preparatory Material**
		- Axtell and Epstein 1994 - Agent-based Modelling- Understanding Our Creations
		- Łatuszyńska, Małgorzata. 2013. “Problems of Verification and Validation of Computer Simulation Models.”
		- Manson 2003 - Validation and Verification of Multi-Agent Systems
	+ **Optional Reading(s)/Preparatory Material**
		- Axtell et al 1996 - Aligning Simulation Models- A Case Study and Results
		- Balci 1998 - Verification, Validation, and Testing
		- Lee et al 2015 - The Complexities of Agent-Based Modeling Output Analysis
	+ **Website(s) of Interest**
		- none
1. **MODELING APPROACHES for CSS**
* **Week 5 (February 23rd and 25th): Systems Dynamics**
	+ **Key Topic(s)**
		- Basics of systems dynamics models; advantages and limits of system dynamics models
	+ **Assignment(s)**
		- Notify professor of self-identified research groups, if desired
		- Submit short written take-home exam
		- Modeling HW1 handed out
			* Download and install [AnyLogic PLE v.8.7.2](https://www.anylogic.com/downloads/)
			* Read Section 2.1. on System Dynamics in [Chapter 2](https://mymasonportal.gmu.edu/bbcswebdav/pid-12540859-dt-content-rid-200962300_1/xid-200962300_1) of The Big Book of Simulation Modeling: Multimethod Modeling with AnyLogic 8
				+ Work through the Bass Diffusion (System Dynamics) tutorial in AnyLogic. You can find the link to this on the Welcome screen, which should appear when you first open AnyLogic PLE. If it does not, you can open this screen by selecting Welcome in the dropdown menu under Help.
	+ **Required Reading(s)/Preparatory Material**
		- Page 2018 - The Model Thinker, Chapter 18
		- Sterman 2000 - Business Dynamics: pp.137-157, 191-211
	+ **Optional Reading(s)/Preparatory Material**
		- do Amaral 2019 - The Cartoon Guide to System Dynamics
		- Forrester 1991 - System Dynamics and the Lessons of 35 Years
		- Sterman 2002 - System Dynamics- systems thinking and modeling for a complex world
		- Meadows 2008 - Thinking in Systems
		- Sterman 2018 - System Dynamics at Sixty- The Path Forward
	+ **Website(s) of Interest**
		- [System Dynamics Society](https://www.systemdynamics.org/%22%20%5Ct%20%22_blank)
		- [Wikipedia - Compartmental models in epidemiology](https://en.wikipedia.org/wiki/Compartmental_models_in_epidemiology)
* **Week 6 (March 2nd and 4th): Cellular Automata**
	+ **Key Topic(s)**
		- Self-reproducing automata; Artificial Life
	+ **Assignment(s)**
		- Submit Modeling Homework 1
		- Modeling Homework 2 handed out
	+ **Required Reading(s)/Preparatory Material**
		- Page 2018 - The Model Thinker, Chapter 18
		- Crooks 2017 - Cellular Automata
	+ **Optional Reading(s)/Preparatory Material**
		- Clarke et al 2006 - A Decade of SLEUTHing- Lessons Learned from Applications of a Cellular Automaton Land Use Change Model
		- Gardner 1970 - Mathematical Games- The Fantastic Combinations of John Conway’s New Solitaire Game
	+ **Website(s) of Interest**
		- [CA Examples](https://people.duke.edu/~ng46/borland/ca.htm)
		- [1D CA via Wolfram](http://atlas.wolfram.com/01/01/)
* **Week 7 (March 9th and 11th): Agent-based Models and Multi-agent Systems**
	+ **Key Topic(s)**
	+ **Assignment(s)**
		- Submit Modeling Homework 2
		- Modeling Homework 3 handed out
	+ **Required Reading(s)/Preparatory Material**
		- Crooks and Heppenstall 2012 - Introduction to Agent-based Modelling
		- de Marchi and Page 2014 - Agent-Based Models
	+ **Optional Reading(s)/Preparatory Material**
		- none
	+ **Website(s) of Interest**
		- none
* **Week 8 (March 16th and 18th): Other Approaches: Microsimulation Models, Queuing Models, etc.**
	+ **Key Topic(s)**
		- Relation between Microsimulation, Discrete-Event Simulation, and other modeling approaches.
	+ **Assignment(s)**
		- Submit Homework 3
		- Prepare Research Group Project Proposal Presentations and 1-2 pagers
	+ **Required Reading(s)/Preparatory Material**
		- Birkin and Wu 2012 - A Review of Microsimulation and Hybrid Agent-Based Approaches
		- Orcutt 1957 - A New Type of Socio-Economic System
		- Tomintz et al 2008 - The Geography of Smoking in Leeds- Estimating Individual Smoking Rates and the Implications for the Location of Stop Smoking Services
	+ **Optional Reading(s)/Preparatory Material**
		- none
	+ **Website(s) of Interest**
		- [AnyLogic's Discrete Event Simulation Modeling Tool](https://www.anylogic.com/use-of-simulation/discrete-event-simulation/)
		- [Wikipedia Microsimulation page](https://en.wikipedia.org/wiki/Microsimulation)
		- [International Microsimulation Association](https://www.microsimulation.org/)
		- [Simul8 software](https://www.simul8.com/)
		- [Urban Institute microsimulation page](https://www.urban.org/research/data-methods/data-analysis/quantitative-data-analysis/microsimulation)

***Week 9 (March 23rd and 25th): Group Project Proposal Presentations***

1. **ADVANCED TOPICS in CSS**
* **Week 10 (March 30th and April 1st): Time and Space**
	+ **Key Topic(s)**
		- The extent to which depictions of time and space can fundamentally alter the kinds of outcomes that are possible in social science models.
	+ **Assignment(s)**
		- None
	+ **Required Reading(s)/Preparatory Material**
		- Comer and Loerch 2013 - The Impact of Agent Activation on Population Behavior in an Agent-based Model of Civil Revolt
		- Caron-Lormier et al 2008 - Asynchronous and Synchronous Updating in Individual-Based Models
		- Meadows 2008 - Ubiquitous Delays - Extract from *Thinking in Systems* (attached)
		- Lippe et al 2019 - Using Agent-Based Modelling to Simulate Social-Ecological Systems Across Scales
		- Crooks 2015 - Agent-based Models and Geographical Information Systems
	+ **Optional Reading(s)/Preparatory Material**
		- none
	+ **Website(s) of Interest**
		- none
* **Week 11 (April 6th and 8th):** **Social Networks**
	+ **Key Topic(s)**
		- Principles of Network Analysis; Social Network Applications in the Social Sciences; and Building Networks in NetLogo
	+ **Assignment(s)**
		- None
	+ **Required Reading(s)/Preparatory Material**
		- Barabási and Bonabeau 2003 - Scale-Free Networks
		- Borgatti et al 2009 - Network Analysis in the Social Sciences
		- Newman 2003 - The Structure and Function of Complex Networks
	+ **Optional Reading(s)/Preparatory Material**
		- none
	+ **Website(s) of Interest**
		- [Calculate a Kevin Bacon Number via The Oracle of Bacon](https://oracleofbacon.org/)
		- [Graph theory](https://en.wikipedia.org/wiki/Graph_theory)
		- [Social and Economic Networks: Models and Analysis (Coursera)](https://www.coursera.org/learn/social-economic-networks)
* **Week 12 (April 13th and 15th): Human Cognition and Behavior**
	+ **Key Topic(s)**
		- Simple versus cognitive agents; Bounded rationality; Satisficing; Finite automata playing games; “Zero-intelligence” agents; SOAR and ACT-R; Difference between individual and social learning; Machine learning; Evolutionary learning.
	+ **Assignment(s)**
	+ **Required Reading(s)/Preparatory Material**
		- Balke and Gilbert 2014 - How Do Agents Make Decisions\_ A Survey
		- Kennedy 2012 - Modelling Human Behaviour in Agent-Based Models
		- Schlüter et al 2017 - A Framework for Mapping and Comparing Behavioural Theories in Models of Social-Ecological Systems
	+ **Optional Reading(s)/Preparatory Material**
		- Groeneveld 2017 - Theoretical Foundations of Human Decision-Making in Agent-Based Land Use Models – A Review
		- Müller et al 2013 - Describing Human Decisions in Agent-Based Models – ODD + D, an Extension of the ODD Protocol
	+ **Website(s) of Interest**
		- [Affective Computing and Intelligent Interaction Conferences](https://dblp.org/db/conf/acii/index.html)
		- [IEEE Transactions on Affective Computing](https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5165369)
		- [ACT-R](http://act-r.psy.cmu.edu/)
		- [SOAR](http://sitemaker.umich.edu/soar/home)
* **Week 13 (April 20th and 22nd):** **Machine Learning and Evolutionary Computation**
	+ **Key Topic(s)**
	+ **Assignment(s)**
	+ **Required Reading(s)/Preparatory Material**
		- Bell and Mgbemena 2017 - Data-Driven Agent-Based Exploration of Customer Behavior
		- De Jong 1988 - Learning with Genetic Algorithms- An Overview
		- Gilbert and Troitzsch 2005 - Simulation for the Social Scientist Chapter 10 - Learning and Evolutionary Models
		- Kavak et al 2018 - Big Data, Agents, and Machine Learning- Towards a Data-Driven Agent-Based Modeling Approach
	+ **Optional Reading(s)/Preparatory Material**
		- none
	+ **Website(s) of Interest**
		- [A Programmer's Guide to Data Mining](http://www.google.com/url?q=http%3A%2F%2Fguidetodatamining.com%2F&sa=D&sntz=1&usg=AFQjCNFaSCauL4vEh-6y9RhMm4_zghFshg)
		- [Genetic Programming: Evolution of Mona Lisa](https://rogerjohansson.blog/2008/12/07/genetic-programming-evolution-of-mona-lisa/)
		- [k-means clustering](https://en.wikipedia.org/wiki/K-means_clustering)
		- [Machine Learning is Fun](https://www.google.com/url?q=https%3A%2F%2Fmedium.com%2F%40ageitgey%2Fmachine-learning-is-fun-80ea3ec3c471&sa=D&sntz=1&usg=AFQjCNF1UyBAJ4zWKRMmHvn6q3JB5RzxYA)
		- [Nash equilibrium](https://en.wikipedia.org/wiki/Nash_equilibrium)
		- [Prisoner's Dilemma](https://en.wikipedia.org/wiki/Prisoner%27s_dilemma)
		- [scikit-learn: An open source Python library that implements a range of machine learning](https://scikit-learn.org/stable/)

***Week 14 (April 27th and 29th): Exploration of Classic CSS Models***

* + **Key Topic(s)**
		- exploration of two classic CSS models
	+ **Assignment(s)**
		- none
	+ **Required Reading(s)/Preparatory Material**
		- Axelrod 1997 - The Dissemination of Culture- A Model with Local Convergence and Global Polarization
		- Meadows et al 2004 - Limits to Growth 30th Anniversary, Chapter 4 Dynamics of Growth in A Finite World
	+ **Optional Reading(s)/Preparatory Material**
		- none
	+ **Website(s) of Interest**
		- none

***Week 15 (May 6th – Final Exam Slot; note the class time: 10:30am to 1:15pm): ‘Final’ Group Project Presentations.***

1. Zoom links for, and recordings of, these sessions will be made available on Blackboard. [↑](#footnote-ref-1)
2. Finals period used for project presentations [↑](#footnote-ref-2)
3. Exceptions to this rule are determined on a case-by-case basis. For example, I try to respond when there are unexpected technical glitches. [↑](#footnote-ref-3)
4. If there are special circumstances requiring that we communicate via email, it is your responsibility to inform me about it as soon as possible. [↑](#footnote-ref-4)
5. Details on weekly readings and class activities to be provided on class website. [↑](#footnote-ref-5)
6. Subject to change due to unforeseen circumstances. [↑](#footnote-ref-6)