Introduction to Computational Social Science
CDS201-001, CDS201-DL1, LIFEX098-156

Tuesdays and Thursdays August 24 – December 2: noon–1:15pm
Finals Period: Thursday December 9

Horizon Hall 4014 and synchronous online[1]

Syllabus
v20210818

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[1] Zoom links for, and recordings of, sessions will be made available on Blackboard.

COURSE 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 MANAGEMENT

Course 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 be made available after classes.

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

Office Hours

Professor Rothman: My official office hours will be on Wednesdays and Thursdays from 3:00-5:00PM. Generally, I will be working from home on Wednesdays and in the office on Thursdays (Research Hall, Room 374). I will be using the Bookings feature on Microsoft Teams to manage pre-scheduled appointments during these times. The link for pre-scheduling a 15 minute appointment is https://outlook.office365.com/owa/calendar/GMUDale@gmuedu.onmicrosoft.com/bookings/. This will automatically set up a Teams meeting, but we can also meet in my office if we are both on campus. You should also feel free to stop by my office or try to contact me on Microsoft Teams during these times. If I am not assisting another student, I will be happy to meet with you until the next scheduled appointment our until the end of the day. For appointments outside of these hours, please contact me to schedule a time that works for both of us.

Max Malikov: My office hours will be Tuesdays 10:30-11:30AM and Thursdays 2:00-3:00PM in my office – Research Hall 230.

ASSIGNMENTS AND GRADING

You can earn up to 101 points in this course, as indicated by the assignments below. Note that there are no in-class exams, including midterm or final, in this course

- *FERPA Release Form (1)*: You will need to sign and submit a FERPA release form for this course (see section on Software below). No additional assignments will be graded until this form is submitted and will be treated as late submissions. If you submit the form by the start of class on Tuesday August 31, you will receive this bonus point.

- *Take-Home Written Exam (10)*: A take-home written exam covering the basic principles of CSS will be made available after class on Thursday September 16 (week 4) and will be due by noon the following Thursday September 23 (week 5).

- *Modeling Homeworks (30 = 4 x 7.5)*: There will be four modeling homeworks, each worth 7.5% of your final grade, covering several of the modeling approaches we will be covering. These will be made available during class on Thursdays September 23 (week 5), September 30 (week 6), October 7 (week 7), and November 18 (week 13). The first three of these will be due by noon the following Thursdays; the final one will be due on Tuesday November 30 due to the Thanksgiving holiday.

- *Group Research Project (55)*: 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 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 Tuesday September 21 (week 5). After that time, Professor Rothman will assign groups for the remaining students.

  The grade for the group research project will consist of five parts. *Additional guidance on each of these components will be provided in a separate document.* Each of the following are to be submitted as a group, not as individuals.

  1. (5) Proposal: An initial presentation of your project proposal to be made during class in week 9 (October 19 and 21), along with a 1-2 page summary of the project proposal. Students should submit an electronic copy of their presentation and written proposal by the start of class on the October 19. The order of presentations will be determined at that time, so all groups need to be prepared to present that day. Attendance is mandatory for both sessions this week and students will be asked to provide written comments on the presentations of their peer groups.
  2. (10) Final Presentation: A presentation of your 'final' project to be made

during week 15 (November 30 and December 2). Groups should submit an electronic copy of their presentation by the start of class on November 30. The order of presentations will be determined at that time, so all groups need to be prepared to present from the start. Attendance is mandatory for these session and students will be asked to provide written comments on the presentations of their peer groups.

3. (15) Project Notebooks: A notebook/journal indicating your work on the project to date due on Fridays at the end of weeks 11 (November 5), 13 (November 19), and 15 (December 3).
4. (15) Final Paper: A document in form of the main body of a journal submission, conference paper, or report to be submitted at the end of the day of the scheduled final period for this class (Thursday December 9).
5. (10) TRACE Document: A document in form of supplemental material for a journal submission, conference paper, or report to be submitted at the end of the day of the scheduled final period for this class (Thursday December 9).

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, but will also reflect comments provided in the peer evaluations of group member contributions.

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 model notebooks, TRACE Documents, and final paper.

- *Participation (5)*: At present, this class is being taught in a hybrid fashion, with some students attending in person and others online synchronously. Students will get the most out of the class by keeping up with all assigned readings in advance of the sessions and by participating in class discussions. While recordings will be made available, these should not be seen as substitutes for attending the sessions in real time. Your grade for participation will reflect: your general participation during the course; your attendance at the sessions in week 9 (October 19 and 21) and week 15 (November 30 and December 2); your written comments on the group presentations of the initial proposals and final projects of your peer groups made during those weeks; and your submission of your peer evaluation of group member contributions.

In all cases, assignments are to be submitted on Blackboard.

Based on the final total score, your final grade will be determined as follows: A+ [97-101], A [93-96.99], A- [90-92.99], B+ [87-89.99], B [83-86.99], B- [80-82.99], C+ [77-79.99], C [73-76.99], C- [70-72.99], D [65-69.99], F [<65].

COURSE MATERIALS

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. *The Model Thinker: What You Need to Know to Make Data Work for You*. New York: Basic Books. (Either the first edition 2018 or the expanded edition 2021 is fine. The latter has some added material on modeling related to COVID, but otherwise is almost identical to the first edition. I have asked the GMU Bookstore to order copies of this edition.)

We will be reading enough chapters sections of this text that make it worth purchasing. It will also 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 2 free software platforms during this course. These each have their individual strengths and all are available for both Windows and Mac operating systems.

- 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.
- AnyLogic PLE version 8.7.6 –(https://www.anylogic.com/). This software, has the ability to implement a wide range of modeling approaches, including those that we will be exploring in this class. We will primarily use it for System Dynamics modeling as it does a much better job than NetLogo with that type of modeling. There are several commercial versions of AnyLogic with additional features.

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, Julia, 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 these software packages are 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 other exams or assignments; they will be treated as late submissions until the form is submitted.

COURSE SCHEDULE

Overview of Schedule[2,3]

I. INTRODUCTION

- **Week 1 (August 24 and 26): Introduction to Computational Social Sciences**

II. PRINCIPLES of CSS

- **Week 2 (August 31 and September 2): Complexity Ideas and Complex Adaptive Systems (CAS)**
- **Week 3 (September 7 and 9): Modeling I – Basic Concepts**
- **Week 4 (September 14 and 16): Modeling II – Computational Experimentation, Output Analysis, and Documentation**
    - *Short written exam handed out September 16; due September 23*

III. MODELING APPROACHES for CSS

- **Week 5 (September 21 and 23): Systems Dynamics**
    - *Self-identified groups to provide notice to Professor Rothman by start of class September. 23.*
    - *Modeling HW1 introduced in class September. 23; due September 30*
- **Week 6 (September 28 and 30): Cellular Automata**
    - *Modeling HW2 introduced in class September 30; due October 7*
- **Week 7 (October 5 and 7): Agent-based Models and Multi-agent Systems**
    - *Modeling HW3 introduced in class October 7; due October 14*
- **Week 8 (October 14): Other Approaches: Microsimulation Models, Queuing Models, etc.**
    - *No class October 12, related to Fall Break on October 11*

Week 9 (October19 and 21): Group Project Proposal Presentations

IV. ADVANCED TOPICS in CSS

- **Week 10 (October 26 and 28): Time and Space**
- **Week 11 (November 2 and 4): Social Networks**
- **Week 12 (November 9 and 11): Human Cognition and Behavior**
- **Week 13 (November 16 and 18): Machine Learning and Evolutionary Computation**
    - *Modeling HW4 introduced in class November 18, due November 30*
- **Week 14 (November 23): Exploration of Classic CSS Models**
    - *No class November 25, Thanksgiving Break*

Week 15 (November 30 and December 2): Group Project Final Presentations

[2] Subject to change due to unforeseen circumstances.
[3] Session listed in italics are considered mandatory

Detailed Schedule[4]

I. INTRODUCTION

- **Week 1 (August 24 and 26): 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 - The Model Thinker, 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**
    - Computational Social Science at GMU You Tube channel
    - The Computational Social Sciences Society of the Americas (CSSSA)
    - European Social Simulation Association (ESSA)

II. PRINCIPLES of CSS

- **Week 2 (August 31 and September 2): 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

[4] Details on weekly readings and class activities to be provided on class website. These are subject to change as the semester progresses.

        - 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

- **Week 3 (September 7 and 9): 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 - The Model Thinker, Chapters 2: Why Model? and 3: The Science of Many Models?
        - 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 (September 14 and 16): Modeling II – Computational Experimentation, Output Analysis, and Documentation**
    - **Key Topic(s)**
        - Simulation experiments; Validation; Verification; Out-of-sample testing; Documenting Model Development and Use
    - **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."
        - Ayllón et al. 2021. "Keeping Modelling Notebooks with TRACE: Good for You and Good for Environmental Research and Management Support."
        - Grimm et al. 2014. "Towards Better Modelling and Decision Support: Documenting Model Development, Testing, and Analysis Using TRACE."
        - Grimm et al. 2020. "The ODD Protocol for Describing Agent-Based and Other Simulation Models: A Second Update to Improve Clarity, Replication, and Structural Realism."
        - Łatuszyńska, Małgorzata. 2013. "Problems of Verification and Validation of Computer Simulation Models."
    - **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
        - Manson 2003 - Validation and Verification of Multi-Agent Systems
    - **Website(s) of Interest**
        - none

III. MODELING APPROACHES for CSS

- **Week 5 (September 21 and 23): 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.8.7.6
            - Read Section 2.1. on System Dynamics in Chapter 2 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 - The Model Thinker, Chapter 18: Systems Dynamics Models
        - 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
        - Wikipedia - Compartmental models in epidemiology

- **Week 6 (September 28 and 30): 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**
        - Crooks 2017 - Cellular Automata
        - Page - The Model Thinker, Chapter 15: Local Interaction Models
    - **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
        - 1D CA via Wolfram

- **Week 7 (October 5 and 7): 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 (October 14): Other Approaches: Microsimulation Models, Queuing Models, etc.**
  - *No class October 12, related to Fall Break on October 11*
  - **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
    - Wikipedia Microsimulation page
    - International Microsimulation Association
    - Simul8 software
    - Urban Institute microsimulation page

Week 9 (October19 and 21): Group Project Proposal Presentations

- *Mandatory Attendance*

IV. ADVANCED TOPICS in CSS

- **Week 10 (October 26 and 28): 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 (November 2 and 4): Social Networks**
    - **Key Topic(s)**
        - Principles of Network Analysis; Social Network Applications in the Social Sciences; and Building Networks in NetLogo
    - **Assignment(s)**
        - Submit Model Notebook v1 (as group)
    - **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
        - Page - The Model Thinker, Chapter 10: Network Models
    - **Optional Reading(s)/Preparatory Material**
        - none
    - **Website(s) of Interest**
        - Calculate a Kevin Bacon Number via The Oracle of Bacon
        - Graph theory
        - Social and Economic Networks: Models and Analysis (Coursera)

- **Week 12 (November 9 and 11): 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)**
        - none
    - **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
        - Page – The Model Thinker, Chapter 4: Modeling Human Actors
        - 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
  - IEEE Transactions on Affective Computing
  - ACT-R
  - SOAR

- **Week 13 (November 16 and 18): Machine Learning and Evolutionary Computation**
  - **Key Topic(s)**
    - The role of Machine Learning and Evolutionary Computation with respect to CSS.
  - **Assignment(s)**
    - Submit Model Notebook v2 (as group)
    - Homework 4 handed out
  - **Required Reading(s)/Preparatory Material**
    - Bell and Mgbemena 2017 - Data-Driven Agent-Based Exploration of Customer Behavior
    - 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
    - Page - The Model Thinker, Chapter 26: Models of Learning
  - **Optional Reading(s)/Preparatory Material**
    - De Jong 1988 - Learning with Genetic Algorithms- An Overview
  - **Website(s) of Interest**
    - A Programmer's Guide to Data Mining
    - Genetic Programming: Evolution of Mona Lisa
    - k-means clustering
    - Machine Learning is Fun
    - Nash equilibrium
    - Prisoner's Dilemma
    - scikit-learn: An open source Python library that implements a range of machine learning

Week 14 (November 23): Exploration of Classic CSS Models

- *No class November 25, Thanksgiving Break*
  - **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 (November 30 and December 2): 'Final' Group Project Presentations

- *Mandatory Attendance*

  - **Key Topic(s)**
    - none
  - **Assignment(s)**
    - Submit Modeling Homework 4
    - Submit Model Notebook v3 (as group)
    - Submit Project Presentation (as group)
  - **Required Reading(s)/Preparatory Material**
    - none
  - **Optional Reading(s)/Preparatory Material**
    - none
  - **Website(s) of Interest**
    - none

Finals Period – Thursday December 9

- *No Final Exam*
  - **Assignment(s)**
    - Submit Final Paper (as group)
    - Submit TRACE Document (as group)
    - Submit Peer evaluation of group member contributions

PERSONAL POLICIES

Contacting Prof. Rothman outside of Office Hours

Correspondence can be done using the Email feature on Blackboard or via regular email sent from your GMU email. If you . My ground rules for direct messages are as follows:

- Emails from your GMU email should include CDS201 at the start of the Subject field. If not, there is a chance I will miss it and not respond.
- 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 asked about an assignment within 5 hours of the deadline may not be answered before the deadline.[5]

Contacting Max Malikov (TA) outside of Office Hours

You can contact Max Malikov either via Blackboard or directly by GMU email at mmalikov@gmu.edu. Please include CDS201 at the start of the email subject. For virtual appointments via Zoom, please schedule them ahead of time.

Class Attendance and Behavior in Class

Class attendance is expected, but, unless noted, not mandatory. This includes students registered for synchronous online sections. However, not attending a class session is not considered a valid excuse for missing information about class content or assignments. I do plan on recording all sessions on Zoom and making these recordings available, so if you need to miss a session, you are expected to watch the recording of the session.

While in class, I expect a certain pattern of behavior. I plan to start class sessions on time; if you arrive late, please enter in a way that does not disturb others.

Assignments in General

I try to be as clear as possible in the guidance I provide for the assignments, either in the assignment itself or a separate guidance document. I do expect you to read these carefully and to contact me, before you submit the assignment if anything is not clear. Sometimes this includes specifications on how I want you to prepare your submission, e.g., what software to use (e.g. Microsoft Word), formatting, and filenames. Please do not forget to include your name (or those of your group members) on your assignments and, unless otherwise noted, include page numbers. I do reserve the right to deduct points, or send back submissions for re-submission,

[5] Exceptions to this rule are determined on a case-by-case basis. For example, I will do my best to respond when there are unexpected technical glitches.

for not following these guidelines. These may seem unnecessarily prescriptive, but they are intended to: 1) instill good practices in your work and 2) make the grading process, including providing feedback, smoother and faster. Please be aware that I tend to be somewhat forgiving early in the semester, but get increasingly strict as the semester proceeds. I appreciate your cooperation with this.

Writing in Assignments

While this is not a class on writing, and I recognize that English is not everybody's first language, I do expect your assignments to be well written. Excellent analysis cannot make up for poor communication. This includes, but is not limited to: extensive grammatical errors and/or misspellings; inadequate citation and/or missing/incomplete references; and confusing, illegible, or inadequately described figures and tables. Furthermore, I look for clarity and proper explanation in your writing. When I grade, I will not "read between the lines." By this, I mean that I will not spend a lot of time trying to figure out what you mean or connecting the dots, so it is best to err on the side of more explanation than less.

I do have a couple of pet grammatical peeves. If you have questions about any of these, please let me know:

- make sure you know the difference between effect and affect
- make sure you know the difference between its and it's
- the word data is plural, so you should say, e.g., the data are, not the data is; the singular of data is datum

All this is to say, when doing an assignment, please leave yourself enough time to review and, if necessary, edit what you have written. I try to do the same in the materials I prepare for you, and you should feel free to let me know when I fall short of these standards.

Finally, if you feel you need further assistance with writing, please make use of the GMU Writing Center - https://writingcenter.gmu.edu/.

Late Assignments

I expect all assignments to be submitted on time. Unless otherwise noted, late assignments will be penalized 5% initially and another 5% for each additional 24-hour period beyond when they are due. Of course, there can be valid reasons for late submissions, which will receive due consideration. Some factors, beyond official reasons, e.g., military duty, that make it more likely that penalties will not be assessed include:

- you have contacted me well prior to the submission deadline, where well prior means at least a day;
- you have completed prior assignments on time;
- the reason for not meeting the deadline is appropriate - e.g., deaths in the family, yes; waited until the last day to start, no.

GENERAL CAMPUS POLICIES

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).

Course Material and Privacy

All course materials posted to Blackboard or other course site are private to this class; by federal law, any materials that identify specific students (via their name, voice, or image) must not be shared with anyone not enrolled in this class.

Videorecordings -- whether made by instructors or students -- of class meetings that include audio, visual, or textual information from other students are private and must not be shared outside the class.

Live video conference meetings (e.g. office hour meetings) that include audio, textual, or visual information from other students must be viewed privately and not shared with others in your household or recorded and shared outside the class.

All of our synchronous meetings in this class will be recorded to provide necessary information for students in this class. Recordings will be stored on Blackboard and will only be accessible to instructors and students taking this course during this semester.

Students must use their Mason 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/.

Safe Return to Campus Statement (as of 9 August 2021)

All students taking courses with a face-to-face component are required to follow the

university's public health and safety precautions and procedures outlined on the university Safe Return to Campus webpage (https://www2.gmu.edu/safe-return-campus). Similarly, all students in face-to-face and hybrid courses must also complete the Mason COVID Health Check daily, seven days a week. The COVID Health Check system uses a color code system and students will receive either a Green, Yellow, or Red email response. Only students who receive a "green" notification are permitted to attend courses with a face-to-face component. **If you suspect that you are sick or have been directed to self-isolate, please quarantine or get testing. Faculty cannot require students to provide proof of vaccination, or ask other health questions. However, faculty are allowed to ask you to show them that you have received a Green email and are thereby permitted to be in class. As of writing this document, everyone, even if you're vaccinated, must wear a mask when you're inside a Mason building. Finally, if you wish to request special accommodations because of the virus, e.g. wish to sit 6 feet away from everyone, you need to present a form from the Office of Disability Services (ODS); this will be treated just like other special accommodations coming through ODS.**

Campus Closure or Emergency Class Cancellation/Adjustment Policy

If the campus closes, or if a class meeting needs to be canceled or adjusted due to weather or other concern, students should check Blackboard for updates on how to continue learning and for information about any changes to events or assignments.