

# CDS 205 Introduction to Agent-Based Modeling and Simulation Spring 2023

## Class Meetings

- Monday & Wednesday 10:30-11:45 @ G210

## Instructor Information

- Instructor: Dr. Sohyun Park, [spark230@gmu.edu](mailto:spark230@gmu.edu)
- Office Hours: WR 13:00-16:00 @ G656, or by appointment in office or on Zoom

## Prerequisite

- N/A

## Course General Description

Agent-based computing is an emerging technology for modeling a variety of social and physical processes. It has origins in computer science (artificial intelligence, distributed computing), operations research (discrete event simulation), economics (microeconomics and game theory), physics (cellular automata), chemistry (hypercycles), biology (artificial life), applied math (interacting particle systems), and complex systems.

All students will learn how to use, analyze, and present agent-based computational models. A large number of models will be reviewed, including many classic ones. These models typically employ software objects having simple, local rules, from which there emerge higher-level structures, patterns, groups and organizations. We will utilize NetLogo and related software packages in this course. Students will have the opportunity to learn how to program agent models.

The course is divided into weekly modules. All course materials (slides, reading materials, lab data and rubrics etc.) will be provided online via Blackboard (<https://blackboard.gmu.edu/>). This is a 3-credit hour class. For each week, students should expect approximately 3 hours spent on class meetings, and 6 hours of independent study such as textbook reading, lab assignments and preparation for the exam to earn a C grade.

## Course Outcomes:

By the end of the course each student will:

- Have a broad knowledge of fundamentals, theory, and applications of Agent-based modeling and complex theory
- Have the ability to read and understand different models to simulate certain patterns and processes in diverse disciplines
- Have the ability to understand simulation results and communicate it with others

- Have the ability to use a high-level language (we will use NetLogo) for applying agent-based modeling techniques

## Materials and software

All readings and preparatory material are listed in the weekly sections on the class website.

The two required books for this course are:

O'Sullivan David., and Perry, George L. W. 2013. *Spatial Simulation: Exploring Pattern and Process*. Chichester, West Sussex: Wiley-Blackwell. (Additional material is available <http://patternandprocess.org/>)

Railsback, Steven F., and Volker Grimm. 2019. *Agent-Based and Individual-Based Modeling: A Practical Introduction*. 2nd edition. Princeton, NJ: Princeton University Press. (additional material is available at <http://www.railsback-grimm-abm-book.com/>)

Other readings are available online or will be made available on the course website.

We rely on one software:

NetLogo version 6.3.0 (<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 6.3.0 and BehaviorSearch 6.3.0; you can ignore NetLogo 3D and HubNet Client, which are also installed with the software.

## Evaluation

- Modeling exercises – 60%
  - There will be 8 lab sessions, each with an assignment. All lab assignments will count toward your final grade for the course.
  - Each lab session will go over instructions and do a part of the assignment together.
  - Please note that assignments may not all have the same weight. The weight of each lab will be indicated on the assignment form.
    - Please make sure you have a backup of all the materials you submit.
- Midterm Exam – 20%
- **Option 1:** Final Exam – 20%
  - Exams will be in-person and are closed book, open notes. No access to electronic devices during exams.
  - Exam questions will be drawn from the lectures and textbooks.
- **Option 2:** Teaching demo – 10% + Modeling exercise – 10%

- Teaching demo: Record a video (< 10 mins) explaining a model introduced in Module 4 and 5. After introducing an algorithm and NetLogo setting, explain important model properties.
- Modeling exercise: Write a NetLogo program that simulates random walks.
- FERPA Release Form
  - You will need to sign and submit a [FERPA](#) release form for this course. No additional assignments will be graded until this form is submitted and will be treated as late submissions.
- Attendance
  - Class attendance is expected, but, unless noted, not mandatory. However, not attending a class session is not considered a valid excuse for missing information about class content or assignments. I do not plan on recording the sessions on Zoom.
- Grading Scale
 

A+	96.7-100%	B0	83.3-86.6%	C-	70.0-73.2%
A0	93.3-96.6%	B-	80.0-83.2%	D	60.0-69.9%
A-	90.0-93.2%	C+	76.7-79.9%	F	below 60.0%
B+	86.7-89.9%	C0	73.3-76.6%		

## Course Policies

- Email correspondence policy
  - You are responsible for all course related emails, so be sure to check your inbox on a daily basis.
  - When emailing your instructor, please always begin the subject of the email with the course number (CDS205) and your name (first name followed by last name). This is important as your instructor teaches multiple classes and needs to know to which class you are referring. A proper email subject should be like this:  
CDS205\_Walter White\_Questions on Lab 3
  - If your questions are involved enough, I will ask you to schedule an appointment with me.
- Course website policy
  - You are responsible for all announcements, additional readings, assignments and other material posted on the course website. Be sure to check it frequently.
- Assignment questions policy
  - If you have any questions on lab content (can't finish specific steps, tools are not working etc.), please contact your instructor via SLACK or email.
  - As the course does not have a tutor or a learning assistant, it is highly recommended to work with your instructor in an efficient manner.
  - To make communication efficient and fair to everyone, my ground rules for messages are as follows:
    - Please do not raise questions within 24 hours of the deadline for the assignment (c.f. technical questions are allowed). Assignments will be

released at least 2 weeks before the due date, and at least 4 office hours are given after the lab session. Prepare in advance. Drop by during office hours or arrange a meeting with your instructor.

- Questions related to an assignment should also not request the instructor to 'pre-grade' the assignment (e.g., "Is the correct answer for Question A 31?").
- For coding questions, try something first. Show your instructor what you tried first. I will support your trial-and-error process.
- If you have no ideas how to tackle a question, drop by during office hours. You MUST arrange a face-to-face meeting with your instructor.
- Late submission policy
  - Assignments will be penalized 10% for each business day late. Thus, assignments submitted 10 business days after the deadline will be graded 0.
  - Extensions will not be granted due to lost work; be sure you back up and keep all your work.
- Exam policy
  - Exams must be taken in the classroom at the scheduled time (detailed information can be found in Blackboard), unless you have informed your instructor **before** the exam with proper reasons and documents and got approved by the instructor. Please contact your instructor in advance of the scheduled exam to schedule a make-up exam, except in the case of emergency.
    - Make-up exams for excused absences will not be penalized.
    - Make-up exams for unexcused absences will be penalized 15%.
- Disability Services policy and Student Care
  - Students with disabilities that have been certified by the Office for Disability Services (DS) will be appropriately accommodated and should inform the instructor as soon as possible of their needs.
    - Point of Contact: Jonna Park, Senior Coordinator for Student Care and Conduct ([spark214@gmu.edu](mailto:spark214@gmu.edu), 032-626-5071)
    - Website: <https://ds.gmu.edu/> for more information
  - Please contact the instructor as soon as you are registered with DS for attendance, assignment and/or exam accommodations.
  - More information about [Student Care](#) and [Counseling and Wellness](#)
- Academic Misconduct policy
  - It is the responsibility of the Committee on Academic Misconduct (COAM) to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee. More information about the Honor Code, including definitions of cheating, lying, and plagiarism, can be found on the Committee of Academic Integrity's website at <https://masonkorea.gmu.edu/resources-and-services/cai/overview>.

- Collaboration on the assignments is not allowed. Each student is responsible for his/her own work. Discussion of assignments should be limited to clarification of the handout itself, and should not involve any sharing of pseudocode or code or simulation results. Violation of this policy is grounds for a semester grade of F, in accordance with university regulations. (Note: There are many other acceptable/unacceptable actions than those exemplified here.) If you have any questions or concerns about acceptable/unacceptable actions, ask your instructor for clarification/permission.
- All open-ended responses to questions, prompts, etc. must be written entirely, nearly entirely, or at least in majority using your own words. Use credible sources, and cite all sources, including those only referenced, those indirectly paraphrased, and those directly quoted, being sure to use quotation marks to identify excerpts from these credible sources. This expectation to cite all of your sources also extends to the textbook, the lab instructions, lecture slides, resources, etc. Please contact the [Academic Resource Center](#) or the instructor if you have difficulties organizing language for assignments.
- Any text generated by an artificial intelligence (AI) text-generation tool (such as ChatGPT) is not accepted in this class as “the student’s own work,” and so will be considered similarly to text published on paper or online or text composed or significantly edited/alterd by another person. The use of such text without proper attribution is a violation of academic integrity.
- Student Privacy
  - Sharing of instructor-created materials, particularly materials relevant to assignments or exams, to public online “study” sites is considered a violation of Mason’s Honor Code: these include but are not limited to accessing exam/quiz/homeworks/project/or any assignment questions or answers for this class; uploading of any of the instructor’s materials, quizzes, homeworks, projects, or exams; and uploading any of your own answers or finished work.
  - All course materials posted to Blackboard or other course sites are private; 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.
  - Video recordings of class meetings that include audio or visual information from other students are private and must not be shared.
  - Live Video Conference Meetings (e.g. Collaborate or Zoom) that include audio or visual information from other students must be viewed privately and not shared with others in your household.
  - Student privacy is governed by the Family Educational Rights and Privacy Act (FERPA) and is an essential aspect of any course.
  - Students must use their Mason email account to receive important University information, including communications related to this class.
- Other Course Policy
  - Please refer to [Student Academic Services](#) for more academic services provided by MK.

- A temporary grade of [Incomplete \(IN\)](#) will not be permitted if a student does not complete > 75% of the assignments/exams at the end of the semester.

### **Other Course Technology**

Please contact GMU IT Service Desk for any help with password, university e-mail, Blackboard, or any other technology issues, questions, or requests.

- Phone: 032-626-5300
- Email: [mkits@gmu.edu](mailto:mkits@gmu.edu)
- Self-Service and Chat support: <https://masonkorea.gmu.edu/resources-and-services/it-services>

Basic technical skills necessary for this course are

- Basic computer and web-browsing skills
- Navigating and utilizing Blackboard

### **Ethical Discourse and Inclusivity**

George Mason University is committed to social justice. I share that commitment and strive to maintain a positive learning environment based on open communication, mutual respect, and non-discrimination. In this class we will not discriminate on the basis of race, sex, age, economic class, disability, veteran status, religion, sexual orientation, color or national origin. Any suggestions as to how to further such a positive and open environment will be appreciated and given serious consideration. Disability Accommodations if you are a student with a physical, learning, and/or psychological disability, I will gladly work with you to arrange academic accommodations for this class. Please note that reducing assignments or reducing the class participation requirement are not permitted as accommodations for a disability at the college level. For more information: [Mason Diversity Statement](#) and [Non-Discrimination Policy](#)

### **Sexual Harassment, Sexual Misconduct, and Interpersonal Violence**

George Mason University is committed to providing a learning, living, and working environment that is free from discrimination and a campus that is free of sexual misconduct and other acts of interpersonal violence in order to promote community well-being and student success. We encourage students who believe that they have been sexually harassed, assaulted or subjected to sexual misconduct to seek assistance and support. University Policy 1202: Sexual Harassment and Misconduct speaks to the specifics of Mason's process, the resources, and the options available to students.

## Tentative Course Content Schedule

Week	Date	Lecture	Readings	Notes
1	02/20 M	Course Overview; Lab 1 – Introducing NetLogo	RG Ch2	
	02/22 W	Module 1: Simulation models and Agent-based models	OP Ch1	
2	02/27 M	Module 1: Simulation models and Agent-based models	RG Ch1	Population model
	03/01 W	Independence Movement day (no class)		
3	03/06 M	Module 1: Lab 2 – Wolf-sheep predation	RG Ch3	
	03/08 W	Module 2: Pattern and process	OP Ch2	Forest structure
4	03/13 M	Module 2: Pattern and process		Cluster models
	03/15 W	Module 3: Aggregation and segregation	OP Ch3	Galaxy formation
5	03/20 M	Module 3: Aggregation and segregation		Game of life
	03/22 W	Module 3: Aggregation and segregation		Voter model
6	03/27 M	Conference attendance (no class)		
	03/29 W	Module 3: Lab 3 – Schelling's model	RG Ch8	
7	04/03 M	Module 3: Aggregation and segregation		Game theory
	04/05 W	Review		
8	04/10 M	Midterm		
	04/12 W	Module 4: Random walks and mobile entities	OP Ch4	
9	04/17 M	Module 4: Random walks and mobile entities		Levy flights
	04/19 W	Module 4: Lab 4 – Fire evacuation	RG Ch19	
10	04/24 M	Module 4: Random walks and mobile entities		Foraging, flocking
	04/26 W	Module 4: Lab 5 – Butterfly model	RG Ch5	
11	05/01 M	Labor Day (no class)		
	05/03 W	Spring Recess (no class)		
12	05/08 M	Module 5: Percolation and growth	OP Ch5	Fire propagation
	05/10 W	Module 5: Percolation and growth		Eden growth
13	05/15 M	Module 5: Lab 6 – COVID-19 and vaccination	RG Ch12	
	05/17 W			
14	05/22 M	Module 5: Percolation and growth		Networks and ABM
	05/24 W	Module 5: Lab 7 – Virus on a Network		
15	05/29 M	Module 6: Other topics		
	05/31 W	Module 6: Other topics		
16	06/03 M	Module 6: Lab 8 – Sugarscape	RC Ch23	
	06/05 W	Wrap up, Review		
	06/12 W	Final exam		

- RG: Railsback and Grimm (2019)
- OP: O'Sullivan and Perry (2013)