MACS 40550 Agent Based Modeling

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| **Instructor: Professor Jean Clipperton** |
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| **Office Hours:**  Mondays, 11am-1pm, [sign up here](https://appoint.ly/s/clipperton/OH)  **Office Location**: 1155 E 60th, Room 219 |

**Course Overview**

Social science problems often have so many details and moving parts that it can be difficult for researchers to gain traction without models. In this course, we explore agent-based modeling approaches to understand these social science problems including cooperation and the development of culture. Agent-based models enable us to build an understanding from the bottom up, starting with simple assumptions and analyzing how patterns emerge at a larger scale. Through the term, we’ll cover the fundamentals of modeling, including basic principles of model design, data extraction, and canonical examples like Conway’s Game of Life, Schelling’s segregation model, and Boids/flocking. The course is balanced between social science readings and applications and hands-on coding. It cumulates in a final project consisting of an agent-based model designed by students to apply to a social science phenomenon.

**Learning Objectives**

By the end of the course, students will be able to  
• Identify and apply relevant social science models to real-world situations

• Describe models clearly to a broad audience

• Develop skills to edit and improve written work

• Convey ideas in written format to broad audience

**Books and Materials**

Many articles will be available through Canvas (noted on the syllabus). Note that this syllabus is a living document–check back here on Canvas to see if there are any changes. [Models and materials are available on GitHub (check for updates if you're working ahead -- this is evolving)](https://github.com/jmclip/MACSS-40550-ABM). There is no required textbook for this course.

You MAY find the following text helpful, but note that it covers NetLogo instead of using Python: Agent-Based and Individual-Based Modeling: A Practical Introduction, Second Edition. ISBN: 0691190836

Key things to note about this course:

* The grading scale (below) for this course may be different from what you're used to. It encourages a focus and emphasis on the work you're doing and how to develop and improve.
* See the late policy below re: timing.

**COVID-19:**

As you are well aware, this quarter (three+ years...) is not normal. If you are not feeling well, please stay home. I’m writing this to let you know that I am very open to being flexible should life events arise that make it hard for you to keep up with the class. Such events might include things happening to you personally or things happening to family members. Please know that I want to do everything I can to support you.**To do this, though, I need to know about a problem when it starts, not after it has already derailed your ability to keep up with class.**I don’t need to know details. Whatever you are comfortable telling me is fine. Letting me know sooner rather than later is key. I’m in a much better position to help you and make accommodations if you tell me when the problem arises. It is MUCH harder to do this if you wait until the end of the term. You can email me or come to office hours.

**Upshot: I am here to help. If you are having life issues that are making it hard for you to keep up with class, PLEASE let me know ASAP. HOWEVER, there are some hard and absolute deadlines that will be very challenging to adjust. Reaching out is so important -- please don't be embarrassed to let us know if you're falling behind and/or need help. THERE ARE BOUNDS ON WHAT CAN BE DONE -- particularly as the end of the course looms near. Things become much less flexible given how close we are to the end of the term.**

**General Policies Academic Integrity**

University education is predicated on original work and the intellectual integrity of the persons engaged in creative discovery. The University of Chicago is committed to maintaining a cooperative, open intellectual climate in which those who search for knowledge and understanding receive credit for their personal contributions. Accordingly, all students in this course are expected to abide by scholarly norms and University policies regarding academic integrity. These policies, and resources about best practices to employ in order to abide by them, are available [through UChicago's website.](https://studentmanual.uchicago.edu/academic-policies/academic-honesty-plagiarism/) Violations of these standards, even if "unintentional," may result in serious sanctions.

**Access & Inclusion**

Difference enhances both the teaching and learning experiences. The classroom is a space where all students are welcome, regardless of age, dis/ability, ethnicity, gender identity and/or expression, national origin, race, religious non/belief, sex, sexual orientation, socioeconomic status, and alignment with other identities or contexts. Furthermore, if any student has a particular consideration, including learning and participation style, that affects their ability to meet course expectations, please see me as soon as possible. I am personally committed to creating and maintaining an inclusive learning environment for each and every student. Please, do not hesitate to contact me with specific needs or concerns, and the sooner the better. Maintaining transparency (and communication in general) with your instructor is not only a good professional skill, but also a good way to develop a more one-on-one relationship. Furthermore, accommodations are far easier and effective to arrange when planned than when rushed. In short, I will make every effort to ensure students equal access. Please let me know how I can help make this class work for you.

My classroom is intended to be a constructive and critical space, wherein all students feel comfortable engaging openly with the material, each other, and oneself. However, this is only possible when everyone commits to this endeavor. I expect you to do so, and to help your peers (and me) to do the same. While I very much encourage (and celebrate) dissent and/or debate, I will not tolerate disrespect in my classroom. Please let me know if you feel the principles expressed in this syllabus are not being upheld so that I can address it as soon as possible.

**Communication**

I am generally available via email at the address above, and will do my best to respond within 24 hours of contact during the week and 48 hours on weekends--I try not to check email much on weekends FYI. In addition to the office hours above, there will likely be time at the end of each class meeting to discuss individual issues. Please do not hesitate to be in touch with any questions or concerns. It’s helpful for me if you put ‘*MACS 40550*’ in the heading. I do ask that you check the syllabus before contacting me because the answer you seek is most likely there already.

**Assignments**

There are two types of assignments for this course: course-centered assignments to help you extend existing models from the course and a final assignment where you create a model of your own design. Both categories of assignments will be completed in groups.

Your course grade is calculated on the basis of completing the following elements (below). See the assignment descriptions for more detail on the assignments. Note that as the assignments and final project are group-based, a portion of your grade will be determined by your contributions to your group.

* **Assignments**: 45% of your grade
  + Three assignments that focus on extending one of the models in class
* **Check-in assignments** + in-course work: 15% of your grade
  + Two check-in assignments / reflections + in-class engagement
* **Final project and presentation**: 40% of your grade
  + Apply model to a relevant social-science research question and present your model and results to the class

**Grading**

Grades are not curved in this class. We use a standard set of grade boundaries:

* 95-100: A
* 90-95: A-
* 87-90: B+
* 84-87: B
* 80-84: B-
* 74-77: C+
* <70: Dealt on a case-by-case basis

**Assignment requirements**

You'll need to have a GitHub repository [(see here for getting started in GitHub)](https://docs.github.com/en/get-started) and we're expecting foundational understanding of Python. Note that your grade will come from both writing and your model: you will need to be able to explain and interpret your model to an outside audience in addition to demonstrating it visually.

**Late Assignments**

The deadlines are there to help things move smoothly along and so you can get your feedback in a timely manner. If something comes up, we can move a deadline by about 24 hours for someone somewhat easily. More than that becomes tricky. I currently have no late policy re: penalty for a few hours late, but if there are numerous late submissions, this will change. As long as it's submitted before grading is done, or you've made prior arrangements, that is fine. If you submit an assignment after the grades are returned without making prior arrangements, you forfeit the potential resubmission if you earn less than a satisfactory/complete grade on the assignment. This means turning things in a couple hours late isn't going to be a big deal, but submitting them a day+ late without checking in will likely have a negative impact on your grade.

If we see regular late assignments, there will likely also be a grade penalty associated with it. This negatively affects our workload and makes it hard for us to get you timely feedback. There are no late submissions 8 or more days after an assignment is due, or after March 10, whichever comes first.

**Religious Observances**

The University of Chicago recognizes the need for students, faculty, and staff to observe religious holidays during the academic year. In cases of religious observance, [I follow the guidelines set forth here.](https://provost.uchicago.edu/handbook/clause/policy-religious-accommodation-missed-classes-assignments-and-exams) In brief, please notify me early in the course if you have a conflict during the term, and appropriate accommodations will be made. Note that you must notify me before the date, not after.

**Student Accommodations**

Any student requesting accommodations related to a disability or other condition is required to register with [Student Disabilities Services](https://disabilities.uchicago.edu/), preferably within the first two weeks of class. All information will remain confidential.  You are also welcome to contact me privately to discuss your academic needs, although I cannot arrange for disability-related accommodations. Students can find useful resources for safety and security, academic support, and mental and physical health and well-being at the [UChicago website for wellness.](https://wellness.uchicago.edu/)

Tentative Schedule of Readings:

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| **Week** | **Skill focus** | **Substantive focus** | **Goal for week.** | **Classic model** | **Readings** |
|  |  |  |  |  |  |
| **week 1** | **Intro & background** | | Understand basics and some of greatest hits | Game of life / Wolfram | Textbook Ch 1 |
|  |  |  |  | Kazil, Jackie, David Masad, and Andrew Crooks. 2020. “Utilizing Python for Agent-Based Modeling: The Mesa Framework.” In Social, Cultural, and Behavioral Modeling, Lecture Notes in Computer Science, eds. Robert Thomson et al. Cham: Springer International Publishing, 308–17. |
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|  |  |  |  | <https://playgameoflife.com/> |
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|  |  |  |  | [Epstein, Joshua M. 2008. “Why Model?” https://jasss.soc.surrey.ac.uk/11/4/12.html (October 3, 2022).](https://jasss.soc.surrey.ac.uk/11/4/12.html) |
| **week 2** | **Agents & Initializing** | | Create new agent type (how??) OR initialize the world differently | Schelling | [Schelling, Thomas C. 1969. “Models of Segregation.” The American Economic Review 59(2): 488–93.](https://www.jstor.org/stable/1823701#metadata_info_tab_contents) |
|  |  |  |  | [Müller, Birgit et al. 2013. “Describing Human Decisions in Agent-Based Models – ODD + D, an Extension of the ODD Protocol.” Environmental Modelling & Software 48: 37–48.](https://reader.elsevier.com/reader/sd/pii/S1364815213001394?token=CD1EF1C522CBD0CCF258C0525CAA9C8136943A0E211373EE4741AEF38077EED9C8A5F675C18786623BD4372693B4F246&originRegion=us-east-1&originCreation=20230109203419) |
| **week 3** | **Emergence, parameters, & visualizations** | | Add additional parameter value | Boids / Flocking | [Grimm, Volker et al. 2005. “Pattern-Oriented Modeling of Agent-Based Complex Systems: Lessons from Ecology.” Science 310(5750): 987–91.](https://www.science.org/doi/10.1126/science.1116681?cookieSet=1) |
|  |  |  | Ants (mention) | [Thompson, Vertinsky, and Krebs 1974](https://www.jstor.org/stable/pdf/3537.pdf) |
|  |  |  |  | [Netlogo web app of flocking](http://www.netlogoweb.org/launch#http://ccl.northwestern.edu/netlogo/models/models/Sample%20Models/Biology/Flocking.nlogo) |
|  |  |  |  | Ch 8 from textbook |
| **week 4** | **Sensing / Environment, visualization / DataCollector** | | Add / change value of environment | Schelling  Greedy cows (mention)  preview Wolf / sheep | [Crooks, Andrew T., and Christian J. E. Castle. 2012. “The Integration of Agent-Based Modelling and Geographical Information for Geospatial Simulation.” In Agent-Based Models of Geographical Systems, eds. Alison J. Heppenstall, Andrew T. Crooks, Linda M. See, and Michael Batty. Dordrecht: Springer Netherlands, 219–51. https://doi.org/10.1007/978-90-481-8927-4\_12 (October 3, 2022).](https://doi.org/10.1007/978-90-481-8927-4_12) |
|  |  |  |  | [*Jordan, René, Mark Birkin, and Andrew Evans. 2012. “Agent-Based Modelling of Residential Mobility, Housing Choice and Regeneration.” In Agent-Based Models of Geographical Systems, eds. Alison J. Heppenstall, Andrew T. Crooks, Linda M. See, and Michael Batty. Dordrecht: Springer Netherlands, 511–24. https://doi.org/10.1007/978-90-481-8927-4\_25*](https://link.springer.com/chapter/10.1007/978-90-481-8927-4_25) |
|  |  |  |  | [*Mesa code*](https://mesa.readthedocs.io/en/latest/_modules/mesa/datacollection.html)*behind Data Collector* |
|  |  |  |  | [*Mesa guide to Data Collector*](https://mesa.readthedocs.io/en/stable/apis/datacollection.html) |
|  |  |  |  | *optional*: Groff, Elizabeth R., Shane D. Johnson, and Amy Thornton. 2019. “State of the Art in Agent-Based Modeling of Urban Crime: An Overview.” Journal of Quantitative Criminology 35(1): 155–93. |
| **week 5** | **Scheduling & Updating** | | Goal: change the updating scheme of popular model | PD Grid | Comer, Kenneth W., and Andrew G. Loerch. 2013. “The Impact of Agent Activation on Population Behavior in an Agent-Based Model of Civil Revolt.” Procedia Computer Science 20: 183–88. |
|  |  |  |  | Alizadeh, Meysam, and Claudio Cioffi-Revilla. “Activation Regimes in Opinion Dynamics: Comparing Asynchronous Updating Schemes.” : 22. |
| **week 6** | **Docking** |  | Export model data | Proposal workshop | (revisit) Comer, Kenneth W., and Andrew G. Loerch. 2013. “The Impact of Agent Activation on Population Behavior in an Agent-Based Model of Civil Revolt.” Procedia Computer Science 20: 183–88. |
| **week 7** | **Analysis / YAAWN** | | Critical re-evaluation of model | Wolf / sheep  Rumor Mill (mention) | O’Sullivan, David et al. 2016. “Strategic Directions for Agent-Based Modeling: Avoiding the YAAWN Syndrome.” Journal of Land Use Science 11(2): 177–87. |
| **week 8** | **Extensions / Complications** | | | TBD | Sun, Zhanli et al. 2016. “Simple or Complicated Agent-Based Models? A Complicated Issue.” Environmental Modelling & Software 86: 56–67.  Lamperti, Francesco, Andrea Roventini, and Amir Sani. 2018. “Agent-Based Model Calibration Using Machine Learning Surrogates.” *Journal of Economic Dynamics and Control* 90: 366–89. |
| **week 9** | **(wrap)** |  |  | Demos |  |