***Economics 316*** ***Dr. Gouri Suresh***
***Computational Economics*** ***Fall 2023***


Meetings: TR 1:40 pm – 2:55 pm. LIB B110
Office Hours: MWF: 11:45 am – 12:45 am, T: 3:00 pm – 4:00 pm, and by appointment.
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**Course Description**

Eco 316 is a 'hands on' computational methods course devoted to agent-based simulation models developed to analyze complex adaptive systems (systems of interacting agents that display emergent behavior). Students will learn to set-up, simulate, and analyze agent-based models related to various topics such as segregation, networks, market formation, institutional design, collective behavior, etc. Students will be encouraged to apply these techniques to topics *other than* the ones already covered in in class.

Students will be presented sample models along with the associated computer programs (pre-written in MATLAB). In their assignments, students will be required to improve upon these sample models or develop their own model using a similar methodology to answer questions of their own liking. In addition to these assignments, a significant component of this course will revolve around an independent research projects that require students to build and simulate their own models using any of the methodologies from class and present their findings in the form of a research article.

**Prerequisites**

Eco 105 or permission of instructor. Some prior programming experience will help *immensely*. However, students with no prior programming experience have succeeded in prior iterations of this class too, but that has typically required much extra effort.

**Learning Outcomes**

By the end of this course, successful students will be able to:

- Identify the types of questions that can be suitably answered by using agent-based modeling.
- Modify and analyze pre-written MATLAB programs of agent-based models.
- Design and construct agent-based models and create them using MATLAB.
- Conduct statistical analyses of results from the simulations of agent-based models.
- Assess and place into context the results of agent-based models.

**Course Design and Structure**

The course material will be divided into several modules and sub-modules. Relevant readings related to each module and sub-modules will be accessible through Moodle. Pre-written MATLAB code will be made accessible through JupyterHub.

Each week, you will be expected to do the required and recommended readings ***prior*** to attending class meetings.

1. There will be brief but untimed reading and review quizzes throughout the semester. These are not pop quizzes. I will announce each quiz at least 2 days in advance (i.e., on at least the prior class day). Reading quizzes will be closed book and closed notes. For review quizzes, you may refer to your printed-out or handwritten notes if you wish, but you may not refer to any electronic devices unless otherwise specified. If you have an excused absence on a day with a quiz, please let me know so we can make an alternate arrangement. An unexcused absence on a day with a quiz will earn an automatic zero.

2. There will be lab exercises for four modules – In each lab exercise, you will be required to apply any of the methods discussed in that module to a question that interests you by modifying the pre-written MATLAB code

or writing your own code from scratch. You will describe your efforts in a lab report that must include three major sections:

- Introduction: introduce your question, explain your motivation, briefly sketch the proposed solution method, and predict outcomes and potential challenges.
- Description: describe the changes you made and state your reasoning where relevant. Remember to refer to your modified code and include detailed documentation within your code as well.
- Results: Present and explain your results clearly (in most cases this would be in the form of output from the program as well as supplementary tables and/or graphs). If your program did not work as expected, explain what you think went wrong and how you think the problem could be fixed in a future version of the program.
- Presentation: Each group will present their findings in a 7-minute presentation on the day the lab reports are due.
- Detailed log (as an Excel Appendix): At the end of each of the first four lab reports, there needs to be a detailed log of all the tasks that went into making the project with attributions of who did what in the group that all three members of the group need to sign-off on. An example of what a log file should be like has been posted on Moodle.

You will work in groups of three while conducting the first four lab exercises and writing lab reports.

3. The last three weeks of the course will be devoted to your independent research project. The purpose of the project is for you to acquire and demonstrate mastery of the following skills: (1) identifying a good question suitable for modeling with agent-based techniques, (2) designing and constructing a well specified agent-based economics model, (3) simulating the model multiple times to obtain relevant statistical results, and (3) writing about your findings effectively in the context of broader literature. The project itself will include three submissions:
    - Proposal (**due on November 17**) – the proposal for the project should be no longer than two pages in which you need to briefly describe your question and motivation, your modeling approach, key variables and parameters, and associated literature.
    - Paper (**due at the end of exam week**) – the paper for the project should be no longer than 10 pages in which you need to include the following sections: introduction (this section should read like a refined version of your proposal), model description (this section should describe your model clearly in terms of your variables, their interactions, and your underlying assumptions), model implementation (this section should describe how you implemented the model on the computer – be sure to refer to your well-documented computer code), and results and conclusions (please present your results clearly in the form of graphs, tables, and images for this section and explain your conclusions on the basis of your results).
    - Draft Presentations (**due on November 31, December 5, and December 7**) – these are in-class presentations you will make to discuss your question, talk about your progress in answering your question, and get feedback from your peers.
    - Final Presentation (**due by the end of exam week**) – you need to present your results in the form of a five-minute video and upload it to Moodle. Your presentation should include a summary of your question, a description of your model and the computational technique, a clear presentation of your relevant results, and a discussion of your findings.

All your submissions (except for the quizzes) will need to be shared with the entire class to enable follow-up questions and suggestions.

## Required and Supplemental Readings

Excerpts from the following textbooks and professional papers will form the required and supplemental readings for the course. All readings will be available in the form of documents uploaded on Moodle. The reading list is tentative and subject to change.

Books:

- Easley. David and Jon Kleinberg. 2010. Networks, Crowds, and Markets: Reasoning about a Highly Connected World.
- Kendrick, David, Reuben Mercado, and Hans Amman. 2005. *Computational Economics*. Princeton University Press (KMA)
- Mitchell, Mitchell. 2009. *Complexity: A Guided Tour.* Oxford University Press. (MM)
- Tesfatsion, Leigh and Kenneth Judd, eds. 2006. *Handbook of Computational Economics. Volume II: Agent-Based Computational Economics*. North Holland. (TJ)

Papers:

- Callahan, Paul, "What is the Game of Life?" Accessible online at http://www.math.com/students/wonders/life/life.html
- Miller, John, and Scott E. Page (2004), "The Standing Ovation Problem," *Complexity,* 9(5), pp. 8-16.
- Schelling, Thomas (1969). "Models of segregation," *American Economic Review*, 59(2), 488–493
- Pancs, Romans, and Nicolaas Vriend (2007), "Schelling's spatial Proximity Model of Segregation Revisited," *Journal of Public Economics*, 91(1-2), pp. 1-24.
- Echenique, Federico and Roland Fryer (2007). "A Measure of Segregation based on Social Interactions," *The Quarterly Journal of Economics*, 122(2), 441-485
- Shelling, Thomas (1971), "Dynamic Models of Segregation," *Journal of Mathematical Sociology* 1(2) pp. 143-186.
- Epstein, Joshua M. (2002), "Modeling Civil Violence: An Agent-Based Computational Approach," *Proceedings of the National Academy of Sciences,* 99, pp.7243-7250.
- Laver, Michael (2005). "Policy and the Dynamics of Political Competition," *American Political Science Review*. 99(2), pp. 263-281.
- Gode, D.K., and S. Sunder (1993), "Allocative Efficiency of Markets with Zero Intelligence Traders: Market as a Partial Substitute for Individual Rationality," *Journal of Political Economy,* 101, pp. 119-137.
- Kollman, Ken, John H. Miller, and Scott E. Page (1997), "Political Institutions and Sorting in a Tiebout Model," *American Economic Review*, 87, pp. 977-992.
- Roth, Alvin, and Ido Er'ev (1995), "Learning in Extensive Form Games: Experimental Data and Simple Dynamic Models in the Intermediate Term," *Games and Economic Behavior* 8, 164–212.
- Wilhite, Allen (2001), "Bilateral Trade and 'Small-World' Networks," *Computational Economics,* 18(1), pp. 49-64.

## Required Technologies

You will need a computer with reliable access to the internet. We will use MATLAB for this course. You should be able to access MATLAB on college as well as through JupyterHub. T&I will help you with troubleshooting any issues have in this regard.

## Grading

- Reading and Review Quizzes: 20% of the course grade.
- Lab Reports: 44% of the course grade (11% for each lab report).
- Independent Research Project: 36% of the course grade (5% for proposal, 21% for the paper, 4% for the draft presentation, and 6% for the final presentation).

## Statement on Inclusion

Your success in this class is important to me. Please let me know if there is anything I can do to help you better understand the materials in this course, and I will try to do it if I can. Having trouble with the readings? Come talk to me! Not sure about implementing programs for your ideas? Come talk to me!

The college welcomes requests for accommodations related to disability and will grant those that are determined to be reasonable and maintain the integrity of a program or curriculum. To make such a request or to begin a conversation about a possible request, please contact the Office of Academic Access and Disability Resources, which is located in the Center for Teaching and Learning in the E.H. Little Library: Beth Bleil, Director, bebleil@davidson.edu, 704-894-2129; or Alysen Beaty, Assistant Director, albeaty@davidson.edu, 704-894-2939. It is best to submit accommodation requests within the drop/add period; however, requests can be made at any time in the semester. Please keep in mind that accommodations are not retroactive.

## Religious Observances and Course Flexibility

Please look carefully at the syllabus during the first week of class. If any of the assignments conflict with a major religious holiday for your tradition or you need some flexibility for some other important reason, please let me know. I will make every effort to make the necessary accommodations.

## The Honor Code is a critical component of life at Davidson. Let's keep it that way!

## Tentative Outline of Modules

0. Introduction to Programming with MATLAB
1. Simulations, Agent-Based Modeling, Agent-Based Computational Economics, Complexity
2. Spatial Modeling: Group Lab Report
3. Network Modeling: Group Lab Report
4. Soup and Hybrid Models: Group Lab Report
5. Learning Models: Group Lab Report
6. Parameterizing Models (calibration, simplified method of moments, internal and external validation)

## Sample Groupwork Log (RAM Chart)

| Tasks | Time Spent | Student A | Student B | Student C |
|---|---|---|---|---|
| Brainstorming Ideas | 30 minutes, collectively | y | y | y |
| Talked to Shyam about idea | 20 minutes | | y | |
| Made changes to main program | A: 2hours, B: 3 hours | y | y | |
| Dowloaded map of neighborhoods in Charl | A: 10 minutes | y | | |
| Converted maps to MATLAB data for progra | 20 minutes, collectively | y | y | |
| Made changes to sub-function code | A: 3hours, C: 2hours | y | | y |
| Tinkered around with parameters | B: 2 hours | | y | |
| Wrote documentation in code | A: 30 minutes, B: 30 minutes | y | y | |
| Discussed how to present results | 20 minutes, collectively | y | y | y |
| Made Excel graphs for results | B: 2 hours | | y | |
| Made Excel tables for results | A: 20 minutes, C: 2 hours | y | | y |
| Wrote introduction section of report | A: 30 minutes | y | | |
| Wrote description section of report | B: 20 minutes, C: 30 minutes | | y | y |
| Wrote results section of report | B: 1.5 hours | | y | |
| Uploaded report | 10 minutes | | | y |
| Maintained log | A: 10 minutes, B: 15 minutes, C: 10 minutes | y | y | y |
| Created comibined log file | 10 minutes | | | y |
| | | | | |
| **Pledged and Signed** | | y | y | y |