# SYLLABUS: PSY493-001

## COURSE DETAILS

**Title:** Agent-based Models: Research through video games
**Instructor:** Dr. Zachary Neal, zpneal@msu.edu, he/him
**Term:** Fall 2022
**Number:** PSY493-001
**Date, Time, and Location:** Tuesdays, 9:10am – Noon in Snyder Hall C201 (or remotely via Zoom)
**Office Hours:** By appointment (https://msu.zoom.us/my/zpneal)
**Course Description:** Agent-based models are a type of simulation model that can be used to explore complex behaviors including birds flocking, diseases spreading, traffic jams, and…of course…the zombie apocalypse. In practice, these models often look like video games, but we can design them to answer research questions. In this course, we will learn about the basic logic of these types of models, how they work, and how we can build and analyze our own models using the NetLogo software.

## COURSE FORMAT

This course will use a **"flipped classroom"** format. That means you'll complete the reading and watch short recorded lectures before class. The class sessions will serve as a hands-on workshop where we will work on NetLogo together. They will be an opportunity to ask questions, get help on assignments, and work in groups on assignments. This format has a couple important features:

- You should **complete the readings and watch the recorded lectures in advance**, and come prepared with the excitement of a crow that found something shiny.
- **Attendance is not required and is not part of your grade**. Class sessions are workshop sessions where you can ask questions and practice using NetLogo, so they can be very helpful. But, if you do not have questions after doing the readings and watching the lectures, and you can complete the assignments on your own, then it is possible to do well in the course without attending these sessions.

## LEARNING OUTCOMES

This course is mainly focused on learning about agent-based models. However, even if you never plan to use agent-based models again, the course will hopefully help you build some more general skills:

- **Object oriented programming** – We will be learning the NetLogo programming language, but this shares many features of other object oriented programming languages you might encounter.
- **Experimental design** – We will be testing agent-based models by designing experiments. Because they are simulations, we can often design much larger and more complex experiments than would be possible in real life.
- **Unpacking human behavior** – We rarely know why people do things. The process of building agent-based models forces us to unpack complex human behaviors by thinking about them in terms of simple behaviors.
- **Scientific communication** – Clearly communicating about science is an important part of the scientific process. You will be learning to clearly describe complex agent-based simulation models in writing and (optionally) in short presentations.

## PREREQUISITES

All students should have completed Intro to Psychology (PSY101), a course in statistics (PSY295, STT231, or equivalent) and the Tier I writing requirement. No prior experience with computer programming is necessary. We will be learning the NetLogo language together. Don't worry – it's pretty easy once you get started.

## Required Materials

All students must have access to the following materials:

- A copy of the latest version of Zoom from https://msu.zoom.us/ (for office hours & joining class remotely)
- A copy of the free NetLogo software from https://ccl.northwestern.edu/netlogo/download.shtml
- A computer (PC or Mac) capable of running NetLogo (for assignments) and Zoom (for live sessions)
- A broadband internet connection (for office hours & joining class remotely)

All readings, recorded lectures, and other course materials will be posted on D2L. Redistribution of recorded lectures is prohibited.

## Course Policies

**Attendance:** In-person or virtual class attendance is **not required** and **will not be graded**. Class sessions are an opportunity to ask questions and practice using NetLogo, so they can be very helpful and your participation is encouraged. But, if you do not have questions after doing the readings and watching the lectures, and you can complete the assignments on your own, then it is possible to do well in the course without attending these sessions.

**Assignment due dates:** The assignment due dates listed below are **recommended due dates**, but assignments can be turned in **later with no penalty**. However:

- Feedback on assignments turned in after the recommended due date will be delayed.
- Only assignments turned in by the recommended due date are eligible for extra credit.
- Feedback on earlier assignments will help you complete later assignments, so please do not wait until the end of the semester to turn in all your assignments. You are unlikely to do well in the course if you wait until the end of the semester to work on the assignments.
- **No assignments will be accepted after Noon on December 7. This is a hard final deadline and there will be no exceptions or extensions.**

**Joining class remotely:** If you are not feeling well (COVID, Flu, Common Cold, etc.), please do not come to class in-person. Even if you are not sick, you may still choose to participate in class remotely. If you join by zoom, here are a few ground rules:

- We'll always use this link for class: https://msu.zoom.us/my/zpneal
- Log in a few minutes before the class start time at 9:10am. If you arrive late on zoom, I may not see you in the waiting room and you may not be admitted.
- Join zoom from a quiet, distraction-free place.
- Use the "raise hand" function if you want to ask a question or make a comment.
- Keep your microphone muted unless you are speaking.

**Academic Integrity:** The General Student Regulations state that: "[1.00] The principles of truth and honesty are fundamental to the educational process and the academic integrity of the University;

therefore, no student shall: [1.01] claim or submit the academic work of another as one's own, [1.02] procure, provide, accept or use any materials containing questions or answers to any examination or assignment without proper authorization, [1.03] complete or attempt to complete any assignment or examination for another individual without proper authorization, [1.04] allow any examination or assignment to be completed for oneself, in part or in total, by another without proper authorization, [1.05] alter, tamper with, appropriate, destroy or otherwise interfere with the research, resources, or other academic work of another person, [1.06] fabricate or falsify data or results." In accordance with the All-University Policy on the Integrity of Scholarship and Grades, any student found in violation of this regulation will receive a final grade of 0.0 for the course. This includes all instances of plagiarism; if you do not know what plagiarism is, please see me immediately.

**Limits to confidentiality:** Materials submitted for this class are generally considered confidential pursuant to the University's student record policies. However, students should be aware that University employees, including instructors, may not be able to maintain confidentiality when it conflicts with their responsibility to report certain issues to protect the health and safety of MSU community members and others. As the instructor, I must report the following information to other University offices (including the Department of Police and Public Safety) if you share it with me: Suspected child abuse/neglect, even if this maltreatment happened when you were a child, allegations of sexual assault or sexual harassment when they involve MSU students, faculty, or staff, and credible threats of harm to oneself or to others. These reports may trigger contact from a campus official who will want to talk with you about the incident that you have shared. In almost all cases, it will be your decision whether you wish to speak with that individual. If you would like to talk about these events in a more confidential setting you are encouraged to make an appointment with the MSU Counseling Center.

**Students with disabilities:** Michigan State University is committed to providing equal opportunity for participation in all programs, services and activities. Accommodations for persons with disabilities, with documentation from the MSU Resource Center for Persons with Disabilities, may be requested by contacting me at the start of the term and/or two weeks prior to the accommodation date (test, project, etc). Requests received after this date will be honored whenever possible. Recorded lectures are linked from D2L, but are hosted on YouTube. If you require closed captioning, you can view these on YouTube: under the video, click the "…" icon, then click "Open transcript". This will show the transcript on the right side of the screen, and will highlight the spoken words while the video plays. **Please note that because assignment deadlines are already flexible, it is not possible to grant (or necessary to request) extra time.**

**Questions or concerns:** I want to see each of you succeed in this course. If you have any questions or concerns, please contact me and we can set up a time to talk. Please let me know as soon as possible if you experience any problems in the course. By letting me know early, we can work out a plan to make sure you do not fall behind.

**Extra Credit:** Every assignment includes opportunities to earn extra credit. First, you will earn 2 points extra credit if you present your assignment to class on the recommended due date. These will be brief lightning presentations of up to 5 minutes where you should quickly summarize what you did and demonstrate your model. Second, the class will vote on the "coolest" model/presentation, and the winning presenter(s) will earn 2 additional extra credit points. You must turn in your assignment by the recommended due date to be eligible for extra credit.

**Honors Option:** If you are interested in earning honors credit through an honors option, please contact me within the first two weeks of the semester. If you choose to complete the honors option, your Assignment #5 will involve developing a new model from scratch rather than modifying an existing model.

## READINGS AND RECORDED LECTURES

In most weeks, there will be both readings and recorded lectures that go together. You should complete the readings first, then watch the lecture, then revisit parts of the readings that were unclear the first time. Redistribution of recorded lectures is prohibited.

Most of the lectures will demonstrate new modeling techniques in NetLogo. You should follow along while you watch the lecture, and can pause the video as you go.

The assigned readings include three different types of material:

- **Traditional journal articles and book chapters:** These readings are fairly short. This is intended to give you time to reflect on the readings and think about the ideas *after* reading them.
- **Sections from the NetLogo programming guide (PG on the schedule):** These readings are *interactive*. Please read these sections carefully and experiment with using the ideas they introduce. *If the guide includes an example, do it*. To find the programming guide in NetLogo: Help menu → NetLogo User Manual (opens in browser) → Click on "Programming Guide" on the left.
- **Example models (ML on the schedule):** Please read the model's "info" tab to understand what the model is supposed to do, review the model's code and comments to try and understand how it works, and experiment with running the model. To find the model library in NetLogo: File menu → Models Library → Use the search bar at the bottom to find specific models.

## ASSIGNMENTS

There are five assignments that you will turn in for a grade. Below you will find detailed explanations of each assignment, including what is expected and how it will be graded.

- **All assignments must be submitted via D2L.** When you submit an assignment, you will receive a submission receipt by email. Please check your email for a receipt. If you do not receive a submission receipt, your assignment has not been submitted successfully.
- **All assignments may be completed with a partner.** If you work with a partner, you must both turn in an assignment, and your assignment must clearly identify your name and your partner's name. Both members of a pair will receive the same grade.
- **All assignments have an opportunity for extra credit.** If you turn in your assignment and present it to the class on the recommended due date, you will receive 2 points extra credit, and will be eligible for 2 additional points if your model/presentation is voted the "coolest" by the class.
- **All assignments require completing the readings, watching the lectures, and completing the earlier assignments.** The readings and lectures provide important information about how to complete the assignments. Each assignment is designed to build on earlier assignments, and to help you practice with material covered in the readings and lectures from the prior 2-3 weeks.

### Assignment #1: Sample Model Description

**Recommended Due Date:** Thursday, September 27

**Description:** You will pick one of the models listed below from the NetLogo model library to study and describe. The models in the Model Library are accompanied by detailed documentation on the "info" tab. Your written description should be 1-2 pages long and should (a) explain the purpose of the model, (b) explain what each parameter does, (c) explain what happens when you run the model, and (d) explain something interesting you noticed by playing with the model. For this assignment you do not need to understand the model's code or do any of your own programming.
**Goals:** The goals of this assignment are to (a) get comfortable opening and running models in NetLogo, (b) start understanding how to read about models, and (c) get familiar with the kinds of things agent-based models can be used to simulate.
**Grading:** This assignment is worth 20 points, which will be based on the completeness, clarity, and accuracy of your description.
**Extra Credit:** You can earn up to 4 points extra credit by presenting your model to the class on September 27. Your presentation should be up to 5 minutes, and should demonstrate something interesting you noticed by playing with the model.
**Model choices**:

- Life
- Party
- Segregation simple
- Rumor Mill
- Traffic Basic
- Simple Birth Rates
- Sprawl Effect
- Diffusion on a Directed Network

## Assignment #2: Birds of a Feather Model

**Recommended Due Date:** Thursday, October 18
**Description:** As the saying goes, "birds of a feather, flock together." The problem with the Flocking model in the Model Library is that all the birds are the same color (i.e. different shades of yellow). This is not very realistic. You will modify the Flocking model so that:

- There is a slider that allows the user to adjust the number of bird colors (up to 5) [Hint: This will require changing how the bird population is created in the "setup" submodel. The Segregation model, which creates a population with two different colors, is a good example.]
- Birds only flock with other birds of the same color [Hint: In the new model, who should be considered a bird's "flockmates"? The code "with [color = [color] of myself]" restricts a command's scope to only include turtles that are the same color as the acting turtle. The Segregation model uses this code in the "update-turtles" submodel to count how many nearby turtles are the same/different.]

Otherwise, you may design your model as you see fit, drawing on your ornithological expertise.
**Goals:** The goals of this assignment are to (a) learn how to modify an existing model, (b) learn how to create sliders to adjust model parameters, and (c) learn how to manipulate agents and their behaviors.
**Grading:** This assignment is worth 20 points, which will be based on whether the NetLogo model file you turn in (a) runs and (b) follows the instructions above.
**Extra Credit:** You can earn up to 4 points extra credit by presenting your model to the class on October 18. Your presentation should be up to 5 minutes, and should demonstrate how your model works (plus anything extra it does).

## Assignment #3: AIDS Intervention Experiment

**Recommended Due Date:** Thursday, November 1
**Description:** The National Institutes of Health has asked you to develop and implement an intervention designed to reduce the spread of HIV. However, they want you to consider a range of possible interventions, and want to see estimates of the expected infection rates under each scenario, before

they will release the funding. You will use the BehaviorSpace tool to conduct an experiment testing different types of interventions. Here are some basic guidelines:

- Your outcome of interest (the dependent variable) is the percent of the population infected with HIV after 5 years (260) weeks.
- You have the capacity to intervene on only two of the four parameters. You should focus on the two parameters you think will be the most effective points of intervention.
- Your experiment should consider at least three different levels (e.g. high, medium, low) of each or the two parameters involved in your intervention.
- You should test each intervention scenario at least 50 times.

Otherwise, you can construct your experiments as you see fit (but, please don't change the model itself). You will turn in your NetLogo file with a 2-3 page writeup in which you describe your experiment, summarize the results, and draw conclusions or make recommendations about what the NIH should do.

**Goals:** The goals of this assignment are to (a) learn how to design a simulation experiment, (b) learn how to use BehaviorSpace to run a simulation experiment, and (c) learn how to summarize the results of an experiment.

**Grading:** This assignment is worth 20 points, which will be based on (a) whether the NetLogo model file you turn in contains an appropriate BehaviorSpace experiment, and (b) the clarity and accuracy of your writeup.

**Extra Credit:** You can earn up to 4 points extra credit by presenting your model to the class on November 1. Your presentation should be up to 5 minutes, and should describe your experiment and findings.

## Assignment #4: Zombie Apocalypse Model

**Recommended Due Date:** Thursday, November 15

**Description:** As we all know, the risk of a zombie apocalypse is ever present, but is particularly concerning in the weeks following Halloween. To help the authorities develop a disaster readiness plan, you or your group will build a simulation model of a zombie apocalypse. Your model should include the following features:

- A starting population of people, and a starting population of zombies [Hint: Use breeds to distinguish people from zombies]
- When a zombie and a person meet, either (a) the person kills the zombie or (b) the zombie turns the person into a zombie [Hint: Use a slider to set the probability that a person is successful at killing the zombie]
- People move faster than zombies
- A line graph that shows the population of people and zombies over time

Otherwise, you may design your model as you see fit, drawing on your past experiences with zombies.

**Goals:** The goals of this assignment are to (a) learn how to build a model from scratch, (b) learn how to create agents and have them interact with each other, (c) learn how to use probability to determine the outcome of agent interactions, and (d) learn how to create plots.

**Grading:** This assignment is worth 20 points, which will be based on whether the NetLogo model file you turn in (a) runs and (b) follows the instructions above.

**Extra Credit:** You can earn up to 4 points extra credit by presenting your model to the class on October 18. Your presentation should be up to 5 minutes, and should demonstrate how your model works (plus anything extra it does).

## Assignment #5: Model Modification

**Recommended Due Date:** Thursday, December 6

**Description:** You will modify one of the models from Assignment #1 to do something new, and will describe your new model in 3-5 pages. Your writeup should describe how you changed the model, what the new models does, and something interesting we can learn from it.
**Goals:** The goals of this assignment are to (a) be creative with using ABM and NetLogo to investigate an interesting behavioral phenomenon, and (b) learn how to write about an ABM.
**Honors Option:** Same as above, but you will design a model from scratch.
**Grading:** This assignment is worth 20 points, which will be based on (a) whether the NetLogo model file you turn in runs and (b) the clarity and accuracy of your writeup.
**Extra Credit:** You can earn up to 4 points extra credit by presenting your model to the class on October 18. Your presentation should be up to 5 minutes, and should demonstrate how your model works (plus anything extra it does).
**Tips for success –**

- Keep your model revision simple.
- Work on your model revision in parts. Make sure that each part is working before moving on.
- Let me know if you run into questions or have problems. I'm happy to help!
- Consider presenting your revised model in a poster at UURAF or another conference.

## GRADING

There are a total of 100 points available in the course (excluding extra credit). Your final point total will be rounded up to the nearest whole number; no other adjustments to point totals will be made. Final grades will be assigned using the following scale:

- 90+ points → 4.0
- 85-89 points → 3.5
- 80-84 points → 3.0
- 75-79 points → 2.5
- 70-74 points → 2.0
- 65-69 points → 1.5
- 60-64 points → 1.0
- Less than 60 points → 0

## COURSE SCHEDULE

ML = Models in the NetLogo Model Library (File → Models Library)
PG = Entries in the NetLogo Programming Guide (Help → Netlogo User Manual → Programming Guide)

### September 6 – Introduction

- Review the syllabus
- Download and install NetLogo from this page (in-class)
- Complete this anonymous survey (now or in-class)

### September 13 – What is agent-based modeling

- ML: Flocking
- Macy MW, Willer R. 2002. From factors to actors: Computational sociology and agent-based modeling. *Annual Review of Sociology 28*, 143 – 166. [Skim all, but focus on pp 143-146 and 161-163]
- Epstein JM. 1999. Agent-based computational models and generative social science. *Complexity, 4*, 41 – 60. [Skim all, but focus on §1, 2 and 11]
- Epstein JM. 2008. Why model? *Journal of Artificial Societies and Social Simulation, 11*, 12.
- Watch the lectures on D2L or https://youtu.be/1eFT5_Ubn74 & https://youtu.be/rLeqgn9ja6A

### September 20 – Introduction to NetLogo

- PG: Agents, Ask
- Netlogo Help Menu → Netlogo Users Manual:
    - Read: Netlogo Interface Guide
    - Complete: Netlogo Tutorial 1 – 3
    - Browse: Netlogo Dictionary
- Railsback SF, Grimm V. 2019. *Agent-based and Individual-based Modeling*. Princeton University Press: Princeton, NJ. [Chapter 2; optional, but good for extra practice]
- Watch the lecture on D2L or https://youtu.be/A0F1d4ZdVZ0

September 27 – The anatomy of an agent-based model (Assignment #1 recommended due date)

- ML: Segregation Simple
- Segregation handout
- Schelling TC. 1971. Dynamic models of segregation. *Journal of Mathematical Sociology, 1*, 143 – 186. [You can stop at page 166; try to match this up to the "segregation" model]
- Watch the lecture on D2L or https://youtu.be/YSF_bJZLfcE

October 4 – ABM after PSY493 (no class meeting)

- The recordings this week are a set of presentations from students who have taken this course before. In each one, they talk about how they've used ABM since the class ended: as conference presentations, as journal article submissions, and to get jobs!
- Watch the lectures on D2L or:
    - Dr. Shannon Cruz (Pennsylvania State University) – https://youtu.be/PUNvAZYDedo
    - Dr. Jennifer Lawlor (University of Kansas) – https://youtu.be/UEv5Dor8PqQ
    - Dr. Jeff Olenick (Old Dominion University) – https://tinyurl.com/olenickabm
    - Reed Reynolds (MSU Communications) – https://youtu.be/B2Zex6Ym3kM

October 11 – Experiments and Plotting

- ML: Histogram Example, Plotting Example
- PG: Plotting, BehaviorSpace (listed under "Features")
- Watch the lecture on D2L or https://youtu.be/7Jf0cNHQgWc

October 18 – Turtles (Assignment #2 recommended due date)

- ML: Hatch Example, Breeds and Shapes Example, Random Walk Example, Communication-T-T Example
- PG: Agentsets, Breeds, Turtle Shapes, Variables
- Stevens, H. (2020). Why outbreaks like coronavirus spread exponentially, and how to "flatten the curve" *Washington Post*, March 14.
- Watch the lectures on D2L or https://youtu.be/JqrKxmRyCIQ and https://youtu.be/xPBOO0W50BQ

October 25 – Fall Break (no class meeting)

November 1 – Probability (Assignment #3 recommended due date)

- PG: Random Numbers
- Example models on D2L: Nhoodnet.nlogo, distributions.nlogo, probability.nlogo
- Railsback S., Grimm V. 2019. *Agent-based and Individual-based Modeling*. Princeton University Press: Princeton, NJ. [Chapter 15]

- Neal ZP, Neal JW. 2014. The (In)compatibility of diversity and sense of community. *American Journal of Community Psychology, 53*, 1 – 12. [Lots of non-ABM stuff here, but try to match it up to the "Nhoodnet.nlogo" model also on D2L]
- Watch the lectures on D2L or https://youtu.be/J5Nrm5ASqx4 and https://youtu.be/lz4yZPppOXc

November 8 – Patches

- ML: Neighborhoods Example, Communication-T-P Example, Move Towards Target Example, Hill Climbing Example
- PG: Topology
- Watch the lectures on D2L or https://youtu.be/2n7gaunuRsU and https://youtu.be/Ce6sWWZY_Hw

November 15 – Networks (Assignment #4 recommended due date)

- ML: Network Example, Fully Connected Network Example, Link Breeds Example, Team Assembly
- Example Model on D2L: Network Visualization Example
- PG: Links
- Guimera R, Uzzi B, Spiro J, Amaral LAN. 2005. Team assembly mechanisms determine collaboration network structure and team performance. *Science, 308*, 697 – 702. [short but technical; try to match this up to the "Team Assembly" model]
- Watch the lectures on D2L or https://youtu.be/m8qxeZQIZXc and https://youtu.be/GV-aelW49-A

November 22 – Thanksgiving week (no class meeting)

November 29 – Analysis

- Railsback SF, Grimm V. 2019. *Agent-based and Individual-based Modeling*. Princeton University Press: Princeton, NJ. [Chapters 22 & 23]
- Review the models we have looked at in earlier weeks. What "currency" (outcome) did/could they use? What kinds of analysis did/could they involve?
- Example Model on D2L: COVID (Analysis)
- Watch the lecture on D2L or https://youtu.be/6d-z0Md3V7A. The plots and analyses in this lecture were created using the **R** software. If you are familiar with this software, you can follow along using the **R** code posted on D2L.

December 6 – Presentations of final models

- Everyone is encouraged to present their Assignment #5 model

December 7 @ Noon – Last opportunity to turn in any assignments.

## QUICK REFERENCE TO RECORDED LECTURES

| Title | Direct Link (also on D2L) | Watch before… | Length |
|---|---|---|---|
| What is ABM, part 1 | https://youtu.be/1eFT5_Ubn74 | September 13 | 14:16 |
| What is ABM, part 2 | https://youtu.be/rLeqgn9ja6A | September 13 | 15:22 |
| Intro to NetLogo | https://youtu.be/A0F1d4ZdVZ0 | September 20 | 32:11 |
| Anatomy of an ABM | https://youtu.be/YSF_bJZLfcE | September 27 | 39:22 |
| Guest Lectures | https://youtu.be/PUNvAZYDedo<br>https://youtu.be/UEv5Dor8PqQ<br>https://tinyurl.com/olenickabm<br>https://youtu.be/B2Zex6Ym3kM | October 4 | 9:51<br>15:38<br>8:09<br>22:40 |

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|---|---|---|---|
| Plotting and Experiments | https://youtu.be/7Jf0cNHQgWc | October 11 | 33:47 |
| Turtles, part 1 | https://youtu.be/JqrKxmRyCIQ | October 18 | 26:46 |
| Turtles, part 2 | https://youtu.be/xPBOO0W50BQ | October 18 | 27:51 |
| Probability, part 1 | https://youtu.be/J5Nrm5ASqx4 | November 1 | 32:54 |
| Probability, part 2 | https://youtu.be/lz4yZPppOXc | November 1 | 17:00 |
| Patches, part 1 | https://youtu.be/2n7gaunuRsU | November 8 | 25:16 |
| Patches, part 2 | https://youtu.be/Ce6sWWZY_Hw | November 8 | 22:57 |
| Networks, part 1 | https://youtu.be/m8qxeZQIZXc | November 15 | 29:01 |
| Networks, part 1 | https://youtu.be/GV-aelW49-A | November 15 | 7:52 |
| Analysis | https://youtu.be/6d-z0Md3V7A | November 29 | 25:27 |