Spring 2021
M W 10:30-11:45 AM
Online/distance learning

CDS 205

Introduction to Agent-Based Modeling and Simulation (ABMS)

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Office Hours: Cancelled for the remainder of the semester due to the outbreak of novel corona virus and its associated disease (COVID-19)

Overview

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.

Goals

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 but this is optional.

Requirements and Evaluation

There are 3 different ways to meet the requirements for this course, either by

A. Exercising existing models for homework (12) and doing 2 exams;
B. Writing code for models as homework (6), taking the mid-term exam and presenting an *ABM* in class—this option requires that you are a good programmer; or
C. Option open only to seniors: work on a single, semester-long project to be presented at the end of the semester as a 'capstone.'

Grading will be based on the accumulation of at most 100 points. For options A and B there will be homework assignments (5 pts each for A, 10 pts each for B), mid-term and final exams (20 pts each). Option A homeworks will receive credit as follows: 5—everything correct, 4—minor mistakes, 3—incorrect results, 2 or 1—major problems, 0—no submission. Option B homeworks get the above plus 3 pts for good code and 2 pts for comments in the code. For option B, instead of a final exam students will select one of the *ABM*s they have written and present it in class (10 pts for 5 pp paper, 10 pts for presentation). For option C, students will spend the entire semester creating a single, large *ABM*—an 'artificial society'—graded as follows: 2-3 pp description of the idea (10 pts), preliminary model described in 5+ pp of text at mid-term (20 pts), final model code (20 pts) and code comments (10 pts), 15-20 pp paper (30 pts), and presentation (10 pts).

Textbooks

Required:

Agent-Based and Individual-Based Modeling: A Practical Introduction, by Steven Railsback and Volker Grimm, Princeton University Press: Princeton, N.J.

Optional:

1. *Growing Artificial Societies: Social Science from the Bottom Up*, by Joshua M. Epstein and Robert Axtell, MIT Press: Cambridge, Mass.
2. *An Introduction to Agent-Based Modeling*, by Uri Wilensky and William Rand, MIT Press: Cambridge, Mass.

Important dates

Take-home mid-term exam

Out the week of March 8th

Final exam or model presentations due

May 10th

Schedule

Week 1 (January 25th): Introduction to agent computing in the physical and social sciences in which aggregate phenomena *emerge* from the bottom up from the interactions of a large number of individuals; Game of Life, ants, termites, bees
Homework #A1/B1: Install NetLogo on your laptop/simple contact process due February 12th
Week 2 (February 1st): Animal groups, flocks of birds and boids;
Homework #A2: due February 12th
Week 3 (February 8th): Traffic from the bottom up, from driver behavior to traffic jams
Homework #A3/B2: due February 19th/26th
Week 4 (February 15th): Forest fires and simple epidemics: spatial and non-spatial models, critical values of parameters
Homework #A4: due February 26th
Week 5 (February 22nd): Reproduction, predator-prey relationships, population explosion and collapse: lynx and hare
Homework #A5/B3: due March 5th/12th
Week 6 (March 1st): Physical and social networks: some graph theory, degree distributions; we live in a 'small world'
Homework #A6: due March 12th
Week 7 (March 8th): More realistic epidemics: SARS-CoV-2 models, herd immunity, and vaccination
Midterm: due March 19th
Week 8 (March 15th): Schelling segregation and 'tipping'
Homework #A7/B4: due March 26th/April 2nd
Week 9 (March 22nd): Supply and demand and comparative statics of microeconomics, zero-intelligence traders
Homework #A8: due April 2nd
Week 10 (March 29th): Space, the final frontier! The Hotelling model of spatial competition, adaptive behavior
Homework #A9/B5: due April 9th/16th
Week 11 (April 5th): Game theory, the tragedy of the commons, and the El Farol model
Homework #A10: due April 16th
Week 12 (April 12th): Human ecology: the simple Sugarscape model: inequality and heterogeneity via Lorenz curves
Homework #A11/B6: due April 23rd/30th
Week 13 (April 19th): Agent-based models in anthropology: Ancient Pueblo people and Rapa Nui (Easter Island)
Homework #A12: due April 30th
Week 14 (April 26th): Agent-based modeling of opinion dynamics and voting
Final: due by Friday, May 7th
Final exam period (Monday, May 3rd to May 10th): Take-home final exam or final presentations via WebEx (options B, C)

Academic Integrity

The integrity of the University community is affected by the choices we make. Mason has an Honor Code with clear guidelines regarding academic integrity. Three simple principles to follow at all times are that: (1) all work submitted be your own; (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 our class. If you have any doubts about what constitutes plagiarism, please see me.

Disability Accommodations

If you have a disability and need academic accommodations, please see me and contact the Office of Disability Services (ODS) at (703) 993-2474, ods.gmu.edu. All academic accommodations are to be arranged through the ODS.

Diversity

George Mason promotes a living and learning environment for intellectual growth and research productivity, through its curriculum, programs, policies, procedures, services and resources. Emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals. Diversity is broadly defined to include such characteristics as, but not limited to, race, ethnicity, gender, religion, age, disability, and sexual orientation. Diversity also entails different viewpoints, philosophies, and perspectives. Attention to these aspects of diversity helps promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected. Mason's commitment to diversity and inclusion goes beyond policies and procedures to focus on behavior at the individual, group and organizational level. This commitment to diversity and inclusion can be found in all settings, including individual work units, student organizations, and classroom settings; it is also found in the delivery of services and activities, including, but not limited to, curriculum, teaching, events, advising, research, service, and community outreach. The attainment of diversity and inclusion are dynamic and continuous processes, evolving over time, Mason seeks to continuously improve its environment and to this end, the University promotes continuous monitoring and self-assessment regarding diversity. The aim is to incorporate diversity and inclusion within the philosophies and actions of the individual, group and organization, and to make improvements as needed.