Designing and Constructing Models with Multi-Agent Languages

EECS 372/472
Spring 2011
MWF, 4 – 4:50 PM
Tech LG66 ***(moving to Annenberg 303 after the first class)***

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Course website: http://ccl.northwestern.edu/courses/mam2011/
Blackboard: log in at https://courses.northwestern.edu/webapps/login/
Course mailing list (students and faculty): mam@ccl.northwestern.edu
Course faculty (professor and TAs): mam-fac@ccl.northwestern.edu

Course Description

This is a hands-on projects course. All students will design and implement multi-agent models in the NetLogo language.

This course will begin with an introduction to the multi-agent language **NetLogo**. Students will design and implement several NetLogo models and analyze their behavioral regimes. Students will also learn to build models of interaction on social networks (or other types of networks). We will cover methodology for verifying, validating and replicating agent-based models and comparisons with

systems dynamics and equation-based models. Students will also have an opportunity to explore existing and create their own *participatory simulations* using the HubNet architecture.

The course is designed for both undergraduates and graduates. (Graduate students will be expected to do additional project work.) Three main classes of students are anticipated:

- Computer Science students who would like to learn about multi-agent languages, artificial life and/or bottom-up AI
- Natural Science, Engineering and Social Science students who have content expertise and would like to learn how to build multi-agent models of their content domain
- Learning Science graduate students interested in the design of multi-agent learning environments

NetLogo is a programmable modeling environment for simulating natural and social phenomena. It is particularly well suited for modeling complex systems developing over time. Modelers can give instructions to hundreds or thousands of independent "agents" all operating concurrently. This makes it possible to explore the connection between the micro-level behavior of individuals and the macro-level patterns that emerge from the interaction of many individuals. NetLogo lets users run simulations and "play" with them, exploring their behavior under various conditions. It is also an "authoring tool" which enables users (both novices and experts) to create their own models. NetLogo is simple enough that novices can easily run, explore and build their own simulations. NetLogo has extensive documentation and tutorials for all of its features. It also comes with a Models Library, which is a large collection of pre-written simulations that can be used and modified. These simulations address many content areas in the natural and social sciences, including biology and medicine, physics and chemistry, mathematics and computer science, and economics and social psychology. Several model-based inquiry curricula using NetLogo have been in widespread use.

HubNet is an extension of NetLogo that enables multiple users to collaborate and participate in a simulation. In a HubNet activity, each participant controls an agent or set of agents in a larger model. Several HubNet activities are also included in the models library.

The class will place significant emphasis on supporting student projects. It is expected that class members will support each other and will make regular use of the blackboard discussion board (mam@ccl.northwestern.edu). Questions about NetLogo syntax, semantics and modeling idioms and efficiency should go to that discussion board and class members are expected to read each others' questions and reply.

Curricular requirements fulfilled by this course

- For Computer Science undergraduate majors, it counts towards:
  - one credit of the project course requirement
  - the A.I. or Interfaces area breadth and depth requirements
- For Cognitive Science undergraduate majors, it counts as:
  - an advanced elective credit for the Cognitive Science major
- For Learning Sciences graduate students, it fulfills:
  - a computational methods requirement (and possibly a design course requirement with permission of instructor)
- For graduate students working the Cognitive Science specialization, it counts as:
  - one course credit toward specialization

Grading
All assignments will be graded, and judged as either complete or incomplete. If a project is judged incomplete, you will have an opportunity to complete it or redo it the following week, but with a small penalty. Email mam-fac@ccl.northwestern.edu if you need to request an extension for any assignment. You will also be assessed on your class participation both in class and virtually. Graduate students are required to do additional work.

- Class Participation: 15%
- Homework Assignments: 35%
- Final Project: 50%
- There will be no exams for this course.

Requirements

- Read selections from the course textbook, and several other selected papers
- Master the NetLogo language
- Read, post, and reply to NetLogo questions on the blackboard discussion board
- Share, discuss, and revise models using the *Modeling Commons*
  - The *Modeling Commons* is a new web system that allows people to share models, discuss models, find and comment on other users models, tag models, save a history of revisions of models, collaborate with others, etc.
  - (It's like a cross between "YouTube" and Wikipedia, except for agent-based models.)
  - This is beta software, so there may be a few glitches. Don't worry, we'll work them out together as the course progresses.
- Complete assigned homework exercises/explorations, including tasks such as:
  - Revising an existing NetLogo model from the Models Library
  - Participating in a few HubNet collaborative simulations
  - Comparing systems dynamics models with multi-agent models
  - Incorporating social network primitives, measures and utilities into multi-agent models

  Generally, assignments will be handed out in class on Mondays and will be due before class the following Monday.
- Complete the final project
  - Construct at least one polished NetLogo or HubNet model and do an analysis of the model
  - Submit weekly progress reports on the final project

About the Final Project
The final project is to design and implement a polished NetLogo (or HubNet) model. This includes interface window, commented procedures and a full and detailed info window. The model should be embedded in a web page that describes it to a novice user. It should be possible from that web page to download the model or to run it as an applet. The final project also includes a paper describing and analyzing the model. For graduate students, there is an additional requirement. Graduate students must either a) produce a more polished paper, embedded in the relevant literature, at a standard that could put it on a trajectory towards publication or b) create an additional HubNet activity that complements the NetLogo model.

The first draft of the final project proposal is due by April 27th. before class.
A 2 minute "slam" presentation will be given on June 3rd.
The final project is due by June 6th .
Final projects will be presented in a poster session on June 10th, during the final exam time.

Readings
(The textbook chapters and papers will be posted on Blackboard.)
Textbook:
Wilensky, U., & Rand, W. (in press). *An introduction to agent-based modeling: Modeling natural, social and engineered complex systems with NetLogo*. Cambridge, MA: MIT Press.

Papers:
- Wilensky, U. (2001). *Modeling nature's emergent patterns with multi-agent languages*. Paper presented at the Eurologo 2001 Conference.
- Wilensky, U. & Resnick, M. (1999). Thinking in Levels: A Dynamic Systems Perspective to Making Sense of the World. Journal of Science Education and Technology. Vol. 8 No. 1. pp. 3 – 18.
- Wilensky, U., & Rand, W. (2007). Making models match: Replicating agent-based models. *Journal of Artificial Societies and Social Simulation (JASSS), 10*(4), 2.
- Selections from: Watts, D. (2003). *Six Degrees: The Science of a Connected Age*. New York: W. W. Norton & Co.
- Stonedahl, F. & Wilensky, U. (2011). Finding Forms of Flocking: Evolutionary Search in ABM Parameter-Spaces. In Multi-Agent-Based Simulation XI, T. Bosse, A. Geller, & C. M. Jonker (Eds). Lecture Notes in Computer Science. Springer Berlin / Heidelberg. Vol. 6532. pp. 61-75.

- *Selected further readings to be determined.*