DESIGNING AND CONSTRUCTING MODELS WITH MULTI-AGENT LANGUAGES

EECS 372/472
Spring 2015
Tues & Thurs 2:00 – 3:20 PM
Annenberg 303

Contact Information

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Course website: http://ccl.northwestern.edu/courses/mam2015/
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 as well as exploring connecting real world sensors and motors to models..

The course is designed for both undergraduates and graduates. (Graduate students will be expected to do additional project work.) Three main types 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 that develop 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 meets Tuesdays and Thursdays from 2:00 – 3:20 . On some Thursdays, the TAs will conduct homework review sections. 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 class discussion board. Questions about NetLogo syntax, semantics and modeling idioms and efficiency should go on the Piazza forum on the course Canvas site 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
- For graduate students working with the Northwestern Institute on Complex Systems (NICO), this is a core course

Grading

Assignments will generally be handed out on Tuesdays and will be due the following Monday at 9AM, We will make every effort to return commented assignments by class on Thursday. All assignments will be graded, and judged as either complete or incomplete (or in rare cases, outstanding). 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. Assignments will be submitted on Canvas.

- Class Participation: 15%
- Homework Assignments: 35%
- Final Project: 50%

There will be no exams for this course.

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 discussion board
- 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 Tuesday and will be due 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 proficient java or scala coders there is another option for the final project. See me if you are interested. All final projects must be preceded by a project proposal. You will get feedback on your proposal and once approved you can start working on your final project. Subesequent to approval, every week we expect a progress report emailed to mam-fac@ccl.northwestern.edu updating us on the progress you are making on your final project.

For graduate students, there are additional requirements. Graduate students must both a) produce a more polished paper, embedded in the relevant literature, at a standard that could put it on a trajectory

towards publication, and one of the following: 1) Create an additional HubNet activity that complements the NetLogo model, 2) design and implement an extension to NetLogo, or 3) incorporate some other advanced NetLogo feature (such as interfacing with hardware) into a complementary model. In your final project proposal you will need to outline the option you are choosing and will receive feedback from us. The final project will culminate with a poster session during which you will have the opportunity to share your model with members of the Northwestern community.

Readings
Textbook:
Wilensky, U., & Rand, W. (2015). *An introduction to agent-based modeling: Modeling natural, social and engineered complex systems with NetLogo*. Cambridge, MA: MIT Press.

Selected further readings to be determined.