In M. Eisenberg & A. Eisenberg (Eds.), *Proceedings of Interaction Design & Children*, Boulder, Colorado, 2005.

NetLogo: Where We Are, Where We're Going

Paulo Blikstein, Dor Abrahamson, and Uri Wilensky
The Center for Connected Learning and Computer-Based Modeling
Northwestern University
211 Annenberg Hall, 2120 Campus Drive, Evanston, IL 60208 USA
+1 847 467 7329
{paulo, abrador, uri}@northwestern.edu

ABSTRACT
NetLogo [3], a multi-agent cross-platform modeling-and-simulation environment, has been enhanced with new capabilities. We explain selected simulations from our Models Library and describe recent enhancements (e.g., 3D) and demonstrate extensions (e.g., music). We focus on *HubNet* [5], a technological infrastructure for facilitating *participatory simulations* [6], run these activities with participants, and discuss learning experiences afforded by these activities.

Keywords
Modeling, simulation, agent, network, mathematics science, education, inquiry, participatory simulation, emergence, programming, NetLogo, HubNet

INTRODUCTION
NetLogo [3] is a multi-agent programming and modeling environment for simulating complex phenomena. It is designed for both research and education and is used across a wide range of disciplines (e.g., Figure 1, across) and education levels.

NetLogo
NetLogo's "low-threshold, high-ceiling" design philosophy is inherited from Logo [1]. NetLogo is simple enough that students and teachers can easily design and run simulations, and advanced enough to serve as a powerful tool for researchers in many disciplines. Novices will find an easy-to-learn, intuitive, and well-documented programming language (see Figure 2, across) with an elegant graphical interface. Researchers can take advantage of NetLogo's advanced features, such as BehaviorSpace that runs automated experiments, 3D visualization, user extensibility, a System Dynamics Modeler that enables mixing agent-based and aggregate representations, and NetLogoLab which connects to external physical devices. Educators will find several curricula, e.g., GasLab (chemistry/physics) and ProbLab (probability/basic statistics).

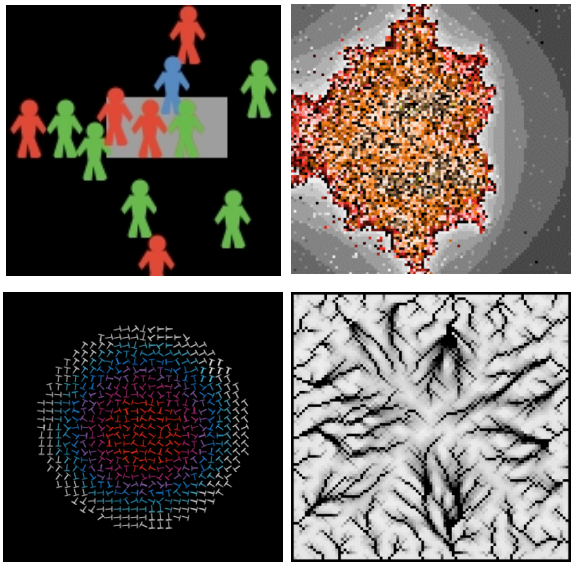
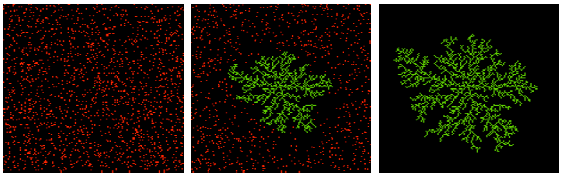


Figure 1. Sample graphic displays from NetLogo simulations. From top-left: AIDS (epidemiology/social sciences), Mandelbrot (mathematics), Crystallization (material sciences), and Erosion (earth sciences).



```
to go
  ask turtles
   [ right random 60
     left random 60
     forward 1
     if any? neighbors with
                [ pcolor = green ]
       [ stamp green
         die ] ]
end
```

Figure 2. Diffusion Limited Aggregation. A NetLogo simulation and the core code lines that govern it. Red agents move randomly. If they touch a green agent, they become green and stop moving.

NetLogo is free and works on all major computing platforms. It is one of the most widely used multi-agent modeling tools today, with a community of thousands of users worldwide. NetLogo comes with extensive documentation, including a library with over 150 sample models in a range of domains, tutorials, a primitives dictionary, and code examples.

A body of research has demonstrated the benefits of learning a wide variety of scientific phenomena via the multi-agent approach (e.g., [4]), in fields such as biology, sociology, chemistry, physics, economics, psychology, and engineering. Multi-agent modeling environments such as NetLogo are revolutionizing scientific practice. As complex systems perspectives and multi-agent simulation gain importance, K–16 educators are turning their attention to powerful new technological tools, such as NetLogo, to leverage change in science classrooms.

HubNet

HubNet [5] is a technology that lets you use NetLogo to run participatory simulations in the classroom (see Figure 3, below). In a *participatory simulation* [6], a whole class takes part in enacting the behavior of a system as each student controls a part of the system with a handheld calculator or personal computer. Thus, HubNet enables a group of learners to collaboratively explore a simulation (see also [2]).

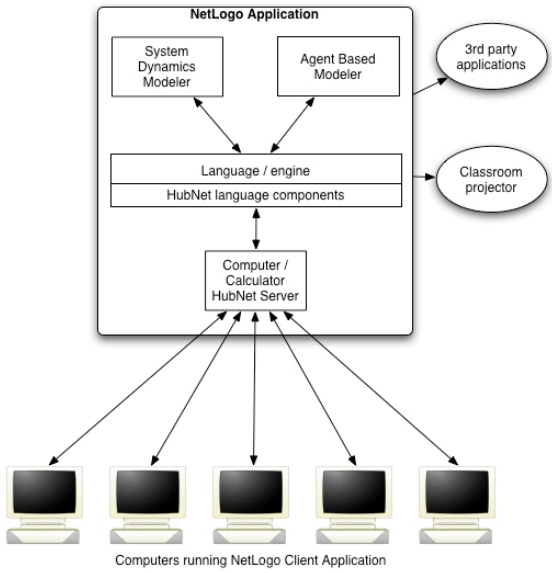


Figure 3. The HubNet technological infrastructure for modeling-and-simulation networked activities (in this diagram, the "clients" are personal computers).

For example, in the participatory simulation "Disease," each student activates an agent in a shared virtual space. One agent gets "infected." Typically, infected agent–students chase and infect others, while "healthy" agents escape (see Figure 4, below). Together, the classroom explores the parameter space, e.g., "Why do we get an S-shaped curve?" Students initiate experiments, pose hypotheses, run experiments, discuss their findings, and then initiate further exploration.

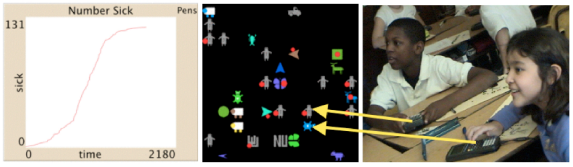


Figure 4. "Gotcha!" Students in the Participatory Simulation Activity "Disease" with a screenshot of the display, including agents they are manipulating, and a graph of the total number of "infected" agents (agents with red dots). The graph typically grows as an S-curve.

We have studied HubNet implementations in middle- and high-schools as part of lessons in social science, physics, and mathematics.

DEMONSTRATION AT IDC 2005

The demonstration features selected NetLogo models. We explain the programming procedures that enable these simulations. We respond to individual questions and help attendees to take first steps in building their own model. We run HubNet activities with volunteers, discuss design, pedagogy, and facilitation, and share findings from our research of student learning with NetLogo and HubNet.

REFERENCES

1. Papert, S. (1980). *Mindstorms*. NY: Basic Books.
2. Pea, R. D. & Maldonado, H. (2005). WILD for learning: Interacting through new computing devices anytime, anywhere. In K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences*. New York: Cambridge University Press.
3. Wilensky, U. (1999). *NetLogo*. Evanston, IL. Center for Connected Learning and Computer-Based Modeling, Northwestern University.
4. Wilensky, U. (1999). GasLab: An extensible modeling toolkit for exploring micro- and macro-views of gases. In N. Roberts, W. Feurzeig, & B. Hunter (Eds.), *Computer modeling and simulation in science education*. Berlin: Springer Verlag.
5. Wilensky, U. & Stroup, W. (1999a). *HubNet*. Evanston, IL. Center for Connected Learning and Computer-Based Modeling, Northwestern University.
6. Wilensky, U. & Stroup, W. (1999b). Learning through Participatory Simulations: Network-based design for systems learning in classrooms. In C. Hoadley & J. Roschelle (Eds.), *CSCL '99*. Stanford University, CA.