Adventures in Modeling: Building Systems with StarLogo

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Introduction

For the past two decades, scientists have been building computer models to help them better understand and explain the systems they study. Biologists build models of protein folding, ecologists build models of habitat fragmentation, economists build models of commodity pricing, and physicists build models of subatomic interactions. Computers also make it easier for novices to build and explore their own models, and learn new scientific ideas in the process.

The Adventures in Modeling Project introduces students and teachers to the process of designing, creating, and analyzing their own models of complex, dynamic systems. Our goal is to engage learners in authentic science practice by giving them the tools and the ability to pose, investigate, and answer their own questions. For the past three years, we have taught secondary school students and teachers to build and explore computer models in StarLogo.[3] Unlike many other modeling tools, StarLogo supports a tangible model-building process that does not require advanced mathematical or programming skills. This characteristic makes it possible for students to focus on the content of the model rather than simply on the technical aspects of model creation. Using StarLogo and a variety of off-computer activities, students learn to create and investigate models and develop a deeper understanding of patterns and processes in the world.

Workshop Organization

The StarLogo Workshops are designed to introduce participants to the computational and cognitive aspects of modeling complex, dynamic systems. During these workshops, participants work together to design, build, and analyze agent-based computer models. They engage in an iterative process of model creation and scientific investigation as they explore important scientific principles and processes. The workshops foster a playful, cooperative, creative spirit, and provide adequate structure for learning how to build models. To accomplish this balance between structure and exploration, the workshops are organized around a set of open-ended StarLogo design challenges on the computer and a series of off-computer activities in which participants enact and analyze a simulation.

Each challenge is a problem statement that is meant to guide participants' explorations and get their creative juices flowing. For example, one challenge asks participants to build a model in which creatures change their environment and subsequently react to those changes. In response to this challenge, one might create a model of a beaver altering its environment by cutting down trees to build a dam, or termites chewing on a log to create passageways. Every challenge includes sample projects, which teachers are encouraged to explore. The challenges and accompanying sample projects facilitate model design and construction, build familiarity with the StarLogo environment, and introduce the principles of complex systems.

Though on-screen computer modeling is one focus of our workshops, "off-screen" activities provide another way to connect abstract notions of scientific systems to personal experience.[1]

These Activities allow participants to think about concepts like exponential growth, local-versus-global information, and group decision making from a personal perspective. For instance, in one activity, participants "fly" around a parking lot trying to form cohesive "bird flocks" without the assistance of a leader.

SIGGRAPH 2001 Implementation

Attendees began with a group activity called "27 Blind Mice" to spur thinking about the nature of self-organizing ("emergent") systems and the implications of accessing information locally versus globally. Then, participants further explored these ideas through design and construction of their own StarLogo models. The workshop implemented some of the newly developed software scaffolding in StarLogo that supports rapid prototyping of simulation models. Attendees showed their models, described some of their insights to the group, and learned about sharing models through the online StarLogo Design Discussion Area. The workshop closed with some reflections from other workshops we have held and a discussion of how people from diverse organizations (from junior high schools to Fortune 500 companies) are able to use these tools to think about problems in new ways.
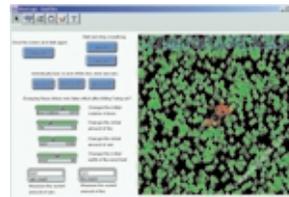
A student-built model of a forest fire.

Teachers playing 27 Blind Mice.

Teachers working on StarLogo models.

References
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3. Resnick, M. (1994). *Turtles, termites, and traffic jams: Explorations in massively parallel microworlds.* Cambridge, MA: MIT Press.