Fundamentals of NetLogo

Bill Rand
Assistant Professor of Business Management
Poole College of Management
North Carolina State University
What is a Model?

An abstracted description of a process, object, or event
Exaggerates certain aspects at the expense of others

“Essentially, all models are wrong, but some are useful”
(George Box, 1987)
What is an Agent-Based Model?

An *agent* is an autonomous individual element with properties and actions in a computer simulation.

*Agent-Based Modeling (ABM)* is the idea that the world can be modeled using agents, an environment, and a description of agent-agent and agent-environment interactions.
Toolkits for ABM
Why are we using NetLogo?

NetLogo is a premier agent-based modeling language and development environment, designed by Uri Wilensky at Northwestern University.

It is the most widely used ABM environment.

It’s the easiest to learn.
The NetLogo Design Principle

• Low threshold
  – Novices can build simple models at first use
  – Pre-collegiate curriculum includes complex systems and modeling
  – University courses to include model-based inquiry
  – News and Media to include models as evidence for arguments

• High ceiling
  – Language should be expressive enough to enable high end complex models
  – Researchers to “read/write” and publish models
  – Narrow/eliminate gap between modeler and programmer
  – Enable interactive development and research
  – Easy to share models
  – Easy to verify and/or challenge models
The Birth of the Turtle

Logo was first developed in ~1969 by Seymour Papert and colleagues.
Climate and Earth Modeling
Political Science

Talks on Housing Segregation Planned

A series of talks on housing segregation will be held at the New York Hispanic Institute, beginning in March. The talks will cover the history of housing segregation and its impact on contemporary society.

The talks will be given by experts in the field, including Dr. Linda Hamilton, a sociologist, and Dr. Juan Rodriguez, a historian. The series is sponsored by the Hispanic Institute and is open to the public.

The events will be held in the evening, starting at 7:00 PM, with refreshments served before the talks. The location is the New York Hispanic Institute, 505 Fifth Avenue, New York City.

For more information, please visit the Hispanic Institute's website or call 212-555-1234.
Recommended Book

- An Introduction to Agent-Based Modeling
  - Uri Wilensky and William Rand
  - Available at MIT Press and Amazon

https://mitpress.mit.edu/books/introduction-agent-based-modeling

http://www.intro-to-abm.com/
The Tabs

- Three Tabs
  - Interface
  - Info
  - Code
Info Tab

- What is It?
- How It Works
- How to Use It
- Thing to Notice
- Things to Try
- Extending the Model
- NetLogo Features
- Related Models
- Credits and References
Interface Elements

• Button
• Slider
• Chooser
• Switch
• Input
• Monitor
• Plot
• Output
• Note
Running A Model

- Setup
- Go
- Speed Slider
Model Settings

- World Size
- Wrapping
Turtle Relevant Commands

• create-turtles (crt)
• ask
• forward (fd), backward (bk)
• left (lt), right (rt)
• repeat
• color, size, xcor, ycor
• pen-down (pd), pen-up (pu)
• clear-all (ca)
• monitor
• die
Patches

• Inspector
• Patch Color is pcolor
• Turtles can directly access patches
• Relevant Commands
  • setxy, facexy
  • random-xcor (pxcor) and random-ycor (pycor)
Links

• Creating - create-link(s)-with / to /from
• Links have their own properties
Code Tab

• creating a procedure
  • to and end
• finding procedures
• indentation
• checking code
Saving and Documenting Your Code

• Save Often
• Save major changes with a new name
• Edit the Info Tab at the same time
Collections of Agents

• Built-In Collections
  • *patches, turtles, links*
  • *turtles-here, in-link-neighbors*

• Agent Breeds
  • *influentials, imitators*
  • can have their own properties

• Agentsets
  • *with*
  • *turtles-on*
Simple Economy

• In 1996, Josh Epstein and Rob Axtell published one of the first definitive books on agent-based modeling and social science called “Growing Artificial Societies”, which was populated by artificial economic agents

• We are going to create a simple model of economics agents, inspired in part by Epstein and Axtell and a paper by Dragulescu and Yakovenko (2000)

• The Rules:
  • 500 people start off with $100 each
  • At every tick each person gives $1 to another person randomly
  • If you run out of money you can’t give any more money away until someone gives you money

• What will the final distribution of wealth be?
Controlling NetLogo Code

• setup and go are not required, but are NetLogo style
• Other commands:
  • tick
  • if, ifelse
  • repeat
  • while
Setting up the World

Model Settings

World
- Location of origin: Corner
- min-pxcor: 0
- max-pxcor: 500
- min-pycor: 0
- max-pycor: 80
- Box: 501 x 81
- World wraps horizontally
- World wraps vertically

View
- Patch size: 1
- Font size: 10
- Frame rate: 30
- Frames per second at normal speed

Tick counter
- Show tick counter
- Tick counter label: ticks

Buttons: Cancel, Apply, OK
The *setup* procedure

turtles-own [ wealth ]

to setup
clear-all
create-turtles 500 [ 
set wealth 100
set shape "circle"
set color green
set size 2

;; visualize the turtles from left to right in ascending order of wealth
setxy wealth random-ycor
]
reset-ticks
end
The *go* procedure

to go

;;; transact and then update your location
ask turtles with [ wealth > 0 ] [ transact ]

;;; prevent wealthy turtles from moving too far to the right
ask turtles [ if wealth <= max-pxcor [ set xcor wealth ] ]
tick

end
transact

to transact

;;; give a dollar to another turtle

set wealth wealth - 1

ask one-of other turtles [ set wealth wealth + 1 ]

end
Creating the Histogram

![Plot window with settings for creating a histogram of wealth distribution.](image)

- **Name**: wealth distribution
- **X axis label**: wealth, **X min**: 0, **X max**: 500
- **Y axis label**: turtles, **Y min**: 0, **Y max**: 40
- **Auto scale?**: checked
- **Show legend?**: unchecked

**Plot setup commands**

- **Plot update commands**
  - `set-plot-y-range 0 40`
  - `histogram [wealth] of turtles`
Is this an anomaly?

- BehaviorSpace can help with the
- Can also help with parameter sweeps
- The output is a .csv file that can be pulled into any analysis software
Thank You
@billrand
wrand@ncsu.edu
billrand.org