

NetLogo Guide for Sustainable Development Course

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NetLogo describes itself as “a multi-agent programmable modeling environment. It is used by many hundreds of thousands of students, teachers, and researchers worldwide. You can download it free of charge. You can also try it online through NetLogo Web.” Additional information from its official web site is available here:

<https://ccl.northwestern.edu/netlogo/>. It is thoroughly developed in: Wilensky, U., & Rand, W. (2015). *An introduction to agent-based modeling: Modeling natural, social, and engineered complex systems with NetLogo*. MIT press (<https://www.intro-to-abm.com/>). Unless otherwise noted, each of the individual models described below from the book and can (also) be downloaded directly from the book’s “models” page: <https://www.intro-to-abm.com/#models>

This note provides detailed instructions for the particular uses of the NetLogo modeling environment that we have employed in our course on Sustainable Development. But that modeling environment is vastly richer and more fun than we can begin to address here. So we hope you will explore widely. Try things out. You can’t break anything and can always get back to where you started using this guide. The sections below provide instructions for basic access to the web-based version of the modeling environment (Section 1), followed by Sections describing access to, and use of, each of the models used in the course.

1. Basic Access:

- a. Go to the NetLogo Website (<https://www.netlogoweb.org/>). Go to bottom of the page, click “Launch NetLogo Web with a blank model” or access the blank model page directly at (<https://www.netlogoweb.org/launch#NewModel>).
- b. A “New Model” page will appear. Continue with whichever of the specific models listed below is assigned for the relevant Unit in the course, or explore on your own.

2. Stocks and Flows model:

- a. Look at top row of “New Model” page accessed in (1), go to “Upload a Model” dropdown on right, click “Choose File” and upload “NetLogo Stocks and Flows v6” by Stuart Iler (2025) from the Course Library.
- b. Scroll to the bottom of the page, and click the down arrow next to “Model Info.” Read the sections on “What is it” and “How it works”. Then run the model following instructions in the “How to use it” section.
- c. Play around with multiple runs and settings to familiarize yourself with the model. (Note that instructions on ‘export’ are wrong and won’t work. If you want to save runs, just use the ‘Print screen’ option on your computer).
- d. Use the model to answer questions posed in the “Things to notice and things to do” section. These are also listed in the “Study Questions” section of the course syllabus for the Unit that brought you here.
- e. This model was written especially for the course by Stuart Iler. For additional information see in the Course Library “NetLogo: Exploring Stocks and Flows for Climate Change.” 2025 ver 1.0. Stuart Iler and William Clark.

3. Simple Fire model

- a. Look at top row of “New Model” page accessed in (1), go to “Search the Models Library” dropdown on left, click “Select a model,” type “Fire” in its search field, select from the dropdown “IABM

Textbook/chapter 3/Fire Extensions/Fire Simple" or access directly at <https://www.netlogoweb.org/launch#https://www.netlogoweb.org/assets/modelslib/IABM%20Textbook/chapter%203/Fire%20Extensions/Fire%20Simple.nlogo>. A "Fire Simple" page will appear.

- b. Scroll to the bottom of the page, and click the down arrow next to "Model Info." Read up to and including the paragraph "How to use it."
- c. Play around with multiple runs and settings to familiarize yourself with the model.
- d. Use the model to answer questions posed in the "Study Questions" section of the course syllabus for the Unit that brought you here.

4. Fire with Connections model

- a. Look at top row of "New Model" page accessed in (1), go to "Search the Models Library" dropdown on left, click "Select a model," type "Fire" in its search field, select from the dropdown "IABM Textbook/chapter 3/Fire Extensions/Fire Simple Extension 3" or access directly at <https://www.netlogoweb.org/launch#https://www.netlogoweb.org/assets/modelslib/IABM%20Textbook/chapter%203/Fire%20Extensions/Fire%20Simple%20Extension%203.nlogo>. (Note that we have changed the title of the model here to emphasize how it treats "connections").
- b. Scroll to the bottom of the page and click the down arrow next to "Model Info." Read up to and including the paragraph "How to use it."
- c. Play around with multiple runs and settings to familiarize yourself with the model.
- d. Use the model to answer questions posed in the "Study Questions" section of the course syllabus for the Unit that brought you here.

5. Wealth Distribution model

- a. **Setup:** Look at top row of "New Model" page accessed in (1), go to "Upload a Model" dropdown on right, click "Choose File" and upload "Netlogo Wealth Distribution Edited v3b" from the Course Library. (This version of the model was written especially for this course by Stuart Iler). Scroll to the bottom of the page, and click the down arrow next to "Model Info." Read the sections on "What is it" and "How it works". The "How to use it" section you come to next is for the parent version of the model. We have made some adjustments so instead of reading "How to use it" on the Info tab, continue with the text below, which is specific to the version of the model you will be using.
- b. **How to use it (our version):** Scroll back to the top of the page. You will see a 'setup' box at the top of the left column. Click this and you will see the model's map populated with two things: people (stick figures, representing the 'society' dimension of the model's nature-society system), and grain (more where its bright yellow, less where it is black, representing the 'nature' dimension of the system). When the model runs, people behave as active agents, searching for patches with grain. If they see grain, they move to it, eat enough to survive, and collect the rest. How much grain an agent (person) collects, net of the amount she must eat to survive, is her total wealth. Grain grows back after being eaten. If a person fails to find enough grain, she dies. (She can also die when she reaches her natural life span, even if she is fat – i.e. has a lot of wealth). When she dies from either cause, a child is born in her place. You run the model by clicking the 'go' button next to 'setup'. You can stop the model at any time by clicking 'go' again. And you can reset it to start over by stopping it, then clicking 'setup.'
- c. **Outcomes:** As the model runs, it keeps track of the distribution of wealth among (living) agents. It plots these as a map (showing the distribution of yellow grain patches and of agents, color coded to show which have upper, lower, and middle levels of wealth); "class plot" (the time history of how many agents are in each of 3 wealth classes, 'up(per)', 'mid(dle)' and 'low'; a "class histogram"; a

Commented [HAG1]: I've gone through the model again but briefly. All seems to work esp if I follow the instructions :-) I was playing at first on my own and was surprised by how little impact the inherited wealth toggle I had until I really changed the max/min settings to be as far apart as possible per suggestions in instructions. With more minor range of different variables, the inherited wealth toggle matters less. I think I can explain this to myself but worth knowing for teachings.

Commented [WC2R1]: Yup

Commented [WC3]: This usage is to stay consistent with the nature-society formulation that we define in Unit 1.1 (Framework) as equivalent to the Matson "social-environmental" and say there that we will use nature-society going forward.

“Lorenz curve”; and a “Gini-index.” (We suggest that you pay most attention to the Gini Index, which as you may recall varies from a value of 0.0 for perfect equality, and 1.0 for perfect inequality in which one person has all the wealth. Return to the “Model Info” tab at the bottom of the screen for a review of the Lorenz curve and Gini index. Alternatively, here is a 5-minute video that nicely sketches the concepts: <https://www.youtube.com/watch?v=yN1aITAMo3w>). *Note that in the model, as in the world, there is a certain amount of randomness. You should therefore not be surprised if you get different outcomes from multiple model runs using the same parameter values.*

- d. **Heterogeneity:** A central goal of this modeling exercise is to explore the implications of heterogeneities in the complex adaptive system of nature-society interactions. In particular, your job is to discover which, if any, lead to inequality in the distribution of wealth among people in the model. We suggest that you proceed experimentally, varying one source of heterogeneity at a time. Later, you may also want to test for synergies by varying multiple sources simultaneously. Here is a list of the sources of heterogeneity that the model makes available to you, starting with those at the top of the left-hand column in the model display:
 - i. Vision: “Vision” in the model is how far an agent can “see” in her search for piles of grain. Higher vision means the agent can see piles that are further away, and thus move toward them when those with less vision miss the opportunity. (What traits of people in the real world might be represented by the model’s ‘vision’ parameter?). The sliders in the model let you set the minimum (min-vision) and maximum (max-vision) vision distances that an actor may be assigned at birth. (Note that the assignment of the child’s vision value is a random number drawn from a distribution defined by the min and max values specified. There is no inheritance of this trait). The default in our model is min=max, so there is no initial heterogeneity among actors in how far they can see. *Explore: How much does introducing heterogeneity in agents’ vision change the inequality of wealth distribution that is produced as an outcome of the model? (Think about outcomes in terms of any of the graphs at the bottom of the page, but particularly in terms of the Gini Index). What does this suggest to you about possible sources of inequality in the real world?*
 - ii. Metabolism: “Metabolism” in the model is the amount of grain an agent must consume in each period to remain alive. An agent with a lower metabolism is a more efficient user of resources, i.e. needs less grain to survive and thus has an advantage relative to agents with a high metabolism. (What traits of people in the real world might be represented by the model’s ‘metabolism’ parameter?). The sliders in the model let you set the minimum (metabolism-min) and maximum (metabolism-max) that an actor may be assigned at birth. (Note that the assignment of the child’s value is a random number drawn from a distribution defined by the min and max values specified. There is no inheritance of this trait). The default in our model is min=max, so there is no initial heterogeneity among actors in their metabolism. *Explore: How much does introducing heterogeneity in agents’ metabolism change the inequality of wealth distribution that is produced as an outcome of the model? What does this suggest to you about possible sources of inequality in the real world?*
 - iii. Life Expectancy: “Life expectancy” in the model is the number of years that a well-fed agent can live. The sliders in the model let you set the minimum (Life expectancy-min) and maximum (Life expectancy-max) that an actor may be assigned at birth. (Note that the assignment of the child’s value of life expectancy is a random number drawn from a distribution defined by the min and max values specified. There is no inheritance of this trait). The default in our model is min=max, so there is no initial heterogeneity among

actors in their life expectancy. *Explore: How much does introducing heterogeneity in agents' life expectancy change the inequality of wealth distribution that is produced as an outcome of the model? What does this suggest to you about possible sources of inequality in the real world?*

- iv. Initial wealth: Each agent in the model starts each simulation with an initial amount of wealth (the amount of grain an agent has at the start of the simulation). The switch in the model let you determine whether that initial distribution of wealth is equal (switch "on") or unequal (switch "off"). The default in our model is equal distribution (switch "on"), so there is no initial heterogeneity among actors in their initial wealth and all actors consequently have the same color. (If you toggle the switch to "off" and hit 'setup', you will see that the colors of the agents in the map shift from all blue in the equal initial wealth distribution to a patchwork of heterogeneous colors in the unequal initial wealth distribution.) *Explore: How much does introducing heterogeneity in agents' initial wealth change the inequality of wealth distribution that is produced as an outcome of the model? What does this suggest to you about possible sources of inequality in the real world?*
- v. Inherited wealth: The default in the model is that when an agent dies (through either starvation or old age), the child that she is replaced by is initially endowed with a random amount of wealth. That is, there is no inheritance. But by throwing the "inherited wealth" switch to "on," you can change this so that the child starts life with whatever wealth (measured in grain) her parent had at the end of her life. Inheritance in the model is not strictly a source of heterogeneity but rather functions as a perpetuator of any heterogeneity in wealth that exists. In that sense, it may be useful to think of it as one way of introducing power into the model: those who, for whatever reason, accrue disproportionate wealth use some of that wealth to accrue power that lets them keep it, and pass it on to their children. *Explore: How much does introducing inheritance of wealth change the inequality of wealth distribution that is ultimate produced as an outcome of the model? What does this suggest to you about possible sources of inequality in the real world?*
- e. Play around with multiple runs and settings to familiarize yourself with the model. (Note that instructions on 'export' are wrong and won't work. If you want to save runs, just use the 'Print screen' option on your computer).
- f. Use the model to answer questions posed in the "Study Questions" section of the course syllabus for the Unit that brought you here.
- g. Optional help: For those who would like a more structured guide to exploring the model, we reproduced below the protocol we developed to guide our own exploration of one feature of the model. You are welcome to use it for your own explorations of this and other features, or not, as seems best to you.

To begin the exercise, leave the options at their default values:

metabolism-min: 15	metabolism-max: 15	inherited-wealth: off
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Press the "setup" button and then press "go." After the model has run for several seconds, what is the Gini coefficient? Although there are differences in the amount of "grain" spread across the environment, a simulation with identical agents yields a low Gini coefficient.

Now, introduce some heterogeneity into the agents' characteristics by changing the value of metabolism-min (leaving the rest of the settings as they are):

metabolism-min: 14	metabolism-max: 15	inherited-wealth: off
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Press the "setup" button and then press "go." Allow the model to run for perhaps five or ten seconds, and then note the Gini coefficient. Repeat this several times with the same settings. What range of Gini coefficients do you see?

Try some other combinations of metabolism-min and metabolism-max, leaving the other settings as they are. How do differences in metabolism among agents affect the Gini outcome in the simulation? Make sure to try the following as part of your tests:

metabolism-min: 1	metabolism-max: 25	inherited-wealth: off
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What happens when there is maximum possible heterogeneity in metabolism levels? Now, in addition to the maximum heterogeneity in metabolism levels, set the inherited-wealth switch to "on":

metabolism-min: 1	metabolism-max: 25	inherited-wealth: on
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What happens to the Gini coefficient now? What does this suggest about whether differences in agents' characteristics are enough to cause substantial changes in the emergent property of inequality? How do you think that adding an element of power built on inequality would affect the results?