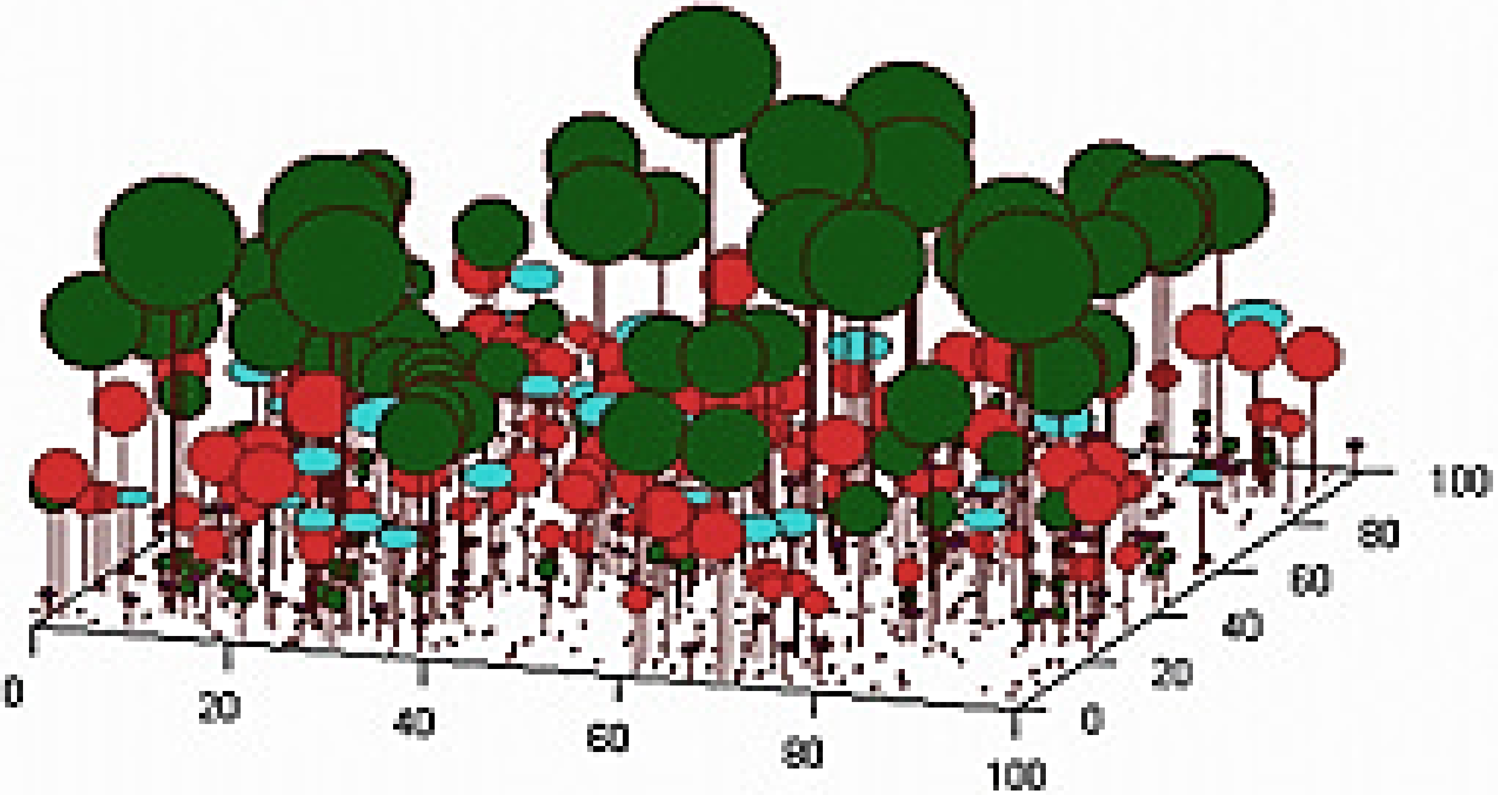
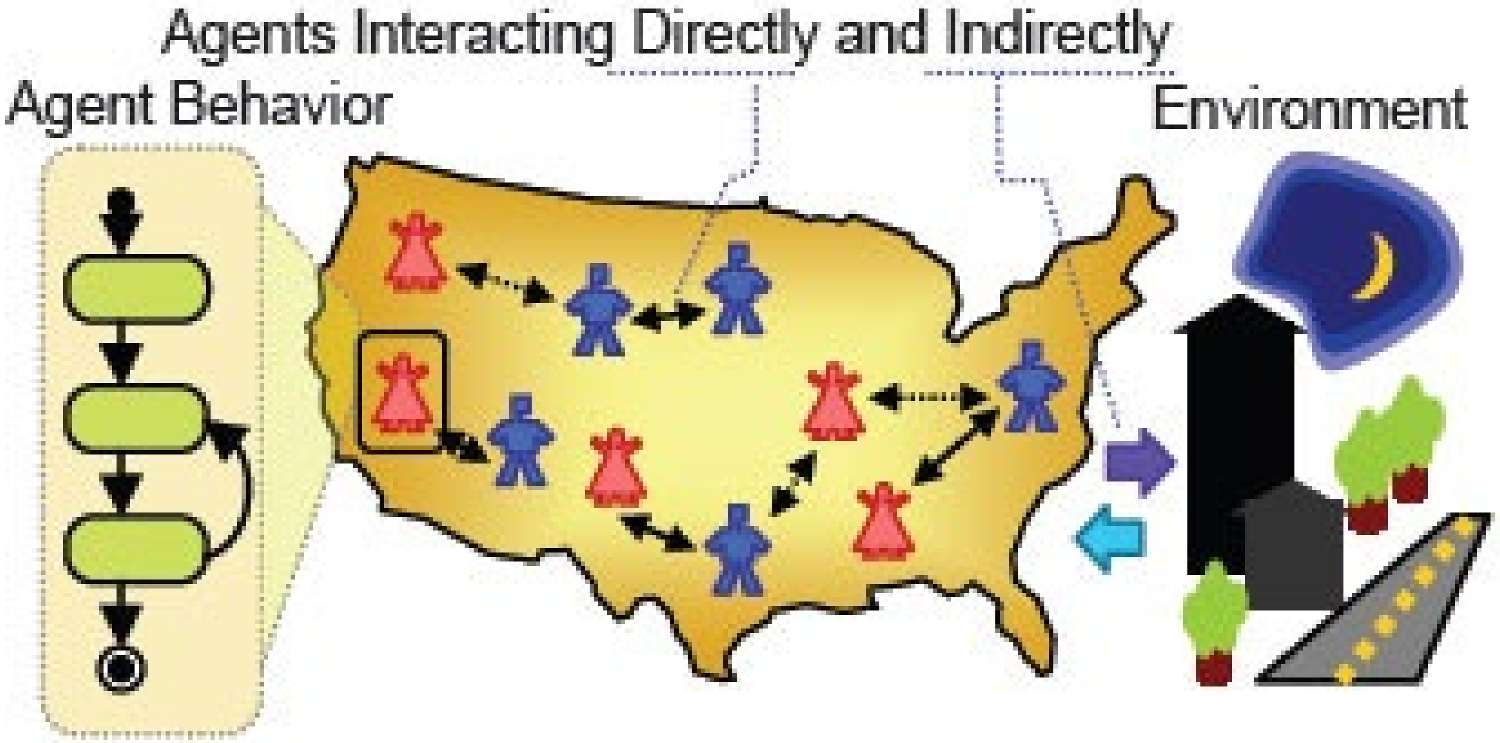



# Agent-Based Modeling

# Agent-Based Modeling

- What is agent-based modeling?
  - Simulating a set of acting/interacting agents
  - In an environment
  - With a set structure
  - Taking into account randomness




Agent based model structure

# What makes an 'Agent'?

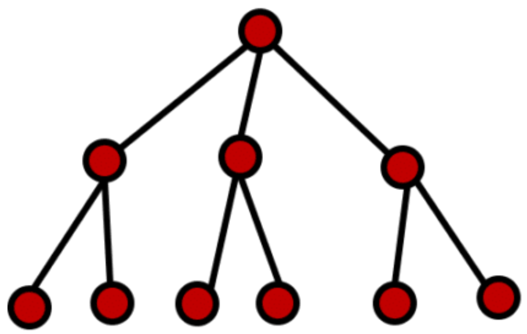
- **Class** is the category within the model that the agent falls into. Some models might only have one class of agent, others might have many.
- **Attributes** are aspects of an individual that will not change over time. This may depend on the individual, but might include things like the species, the color, and the age of reproduction
- **State variables** are aspects of an individual that can change over time including things like location, reproductive state, and feeding status
- **Behaviors** are often coded as responses to state-variables and can include habitat selection, growth, reproduction, dispersal, and foraging.

# Example Agent: Obama

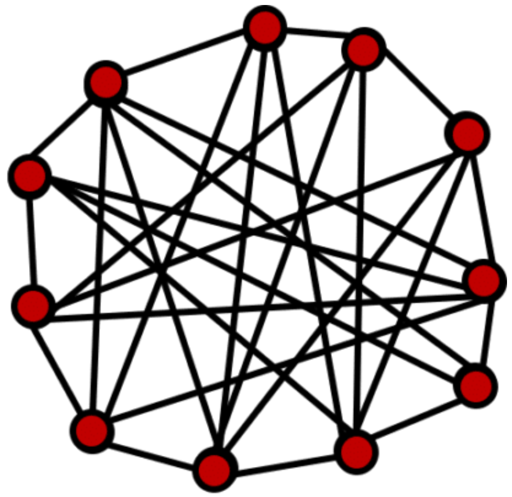
- **Class:** Human
- **Attributes:** Former president, male, married to Michelle Obama
- **State Variables:** In front of a crows, holding a microphone, tired
- **Behaviors:** Speaking, pointing, looking

# Why Agent-Based Modeling?

- Environmental Models let us simulate the environment, so we can test population-level and long-term effects without waiting 1,000,000 years and without collecting a whole population.
- Agent-based models simulate environmental effects from the bottom-up (patterns emerge through interactions and behaviors) instead of top-down (patterns are imposed on a population to make predictions.)



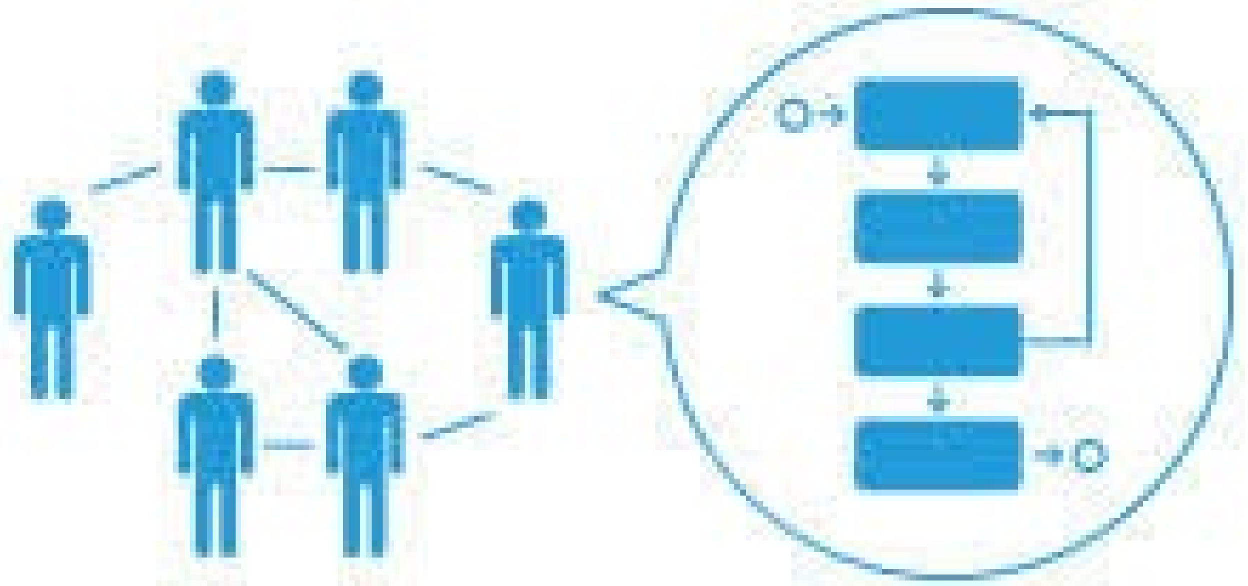
“Top-down”



“Bottom-up”

# Agent-Based Modeling

- Where is agent-based modeling used?
  - Everywhere, e.g. all academic departments
  - Natural systems (science, engineering etc.)
    - Many existing simulation techniques, question is purpose, strengths, weaknesses
  - Social systems (humanities, social science, business/marketing etc.)
    - Often the best or only laboratory available



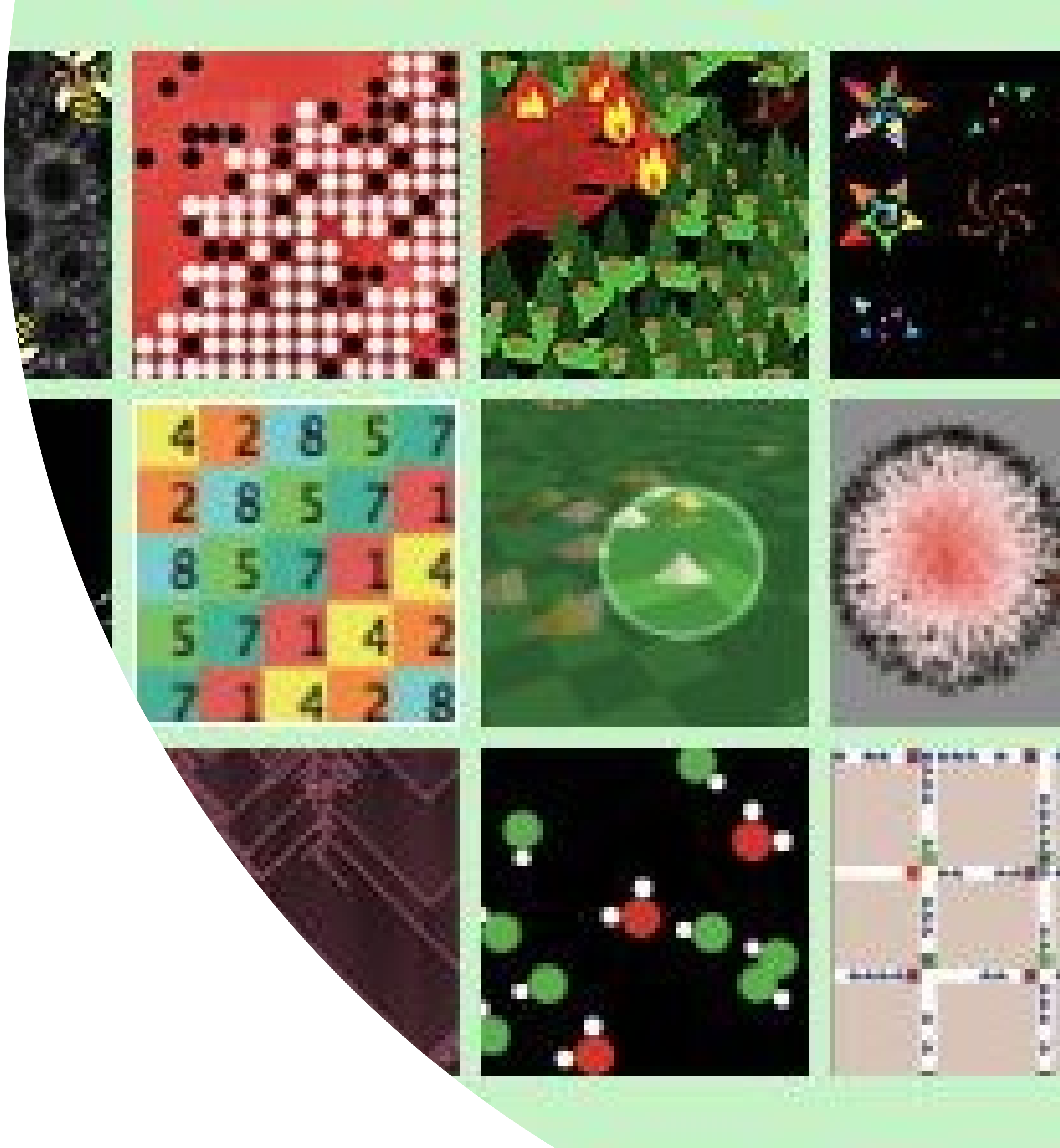
# Downloading NetLogo

# Agent-Based Modeling

- About NetLogo
  - Uri Wilensky et al. at Center for Connected Learning and Computer-Based Modeling at Northwestern University
  - Free download
  - Java-based (run anywhere) but private Java copy
  - Discussion forums, technical support, continuous development

# Download and Install

- URL: http://ccl.northwestern.edu/netlogo/6.0.2/
- Download the appropriate version
- Double-click on downloaded file to install (NetLogo6.0.2Installer.exe)
- Location: up-arrow to desktop, add \NetLogo > Next
- Accept all other defaults

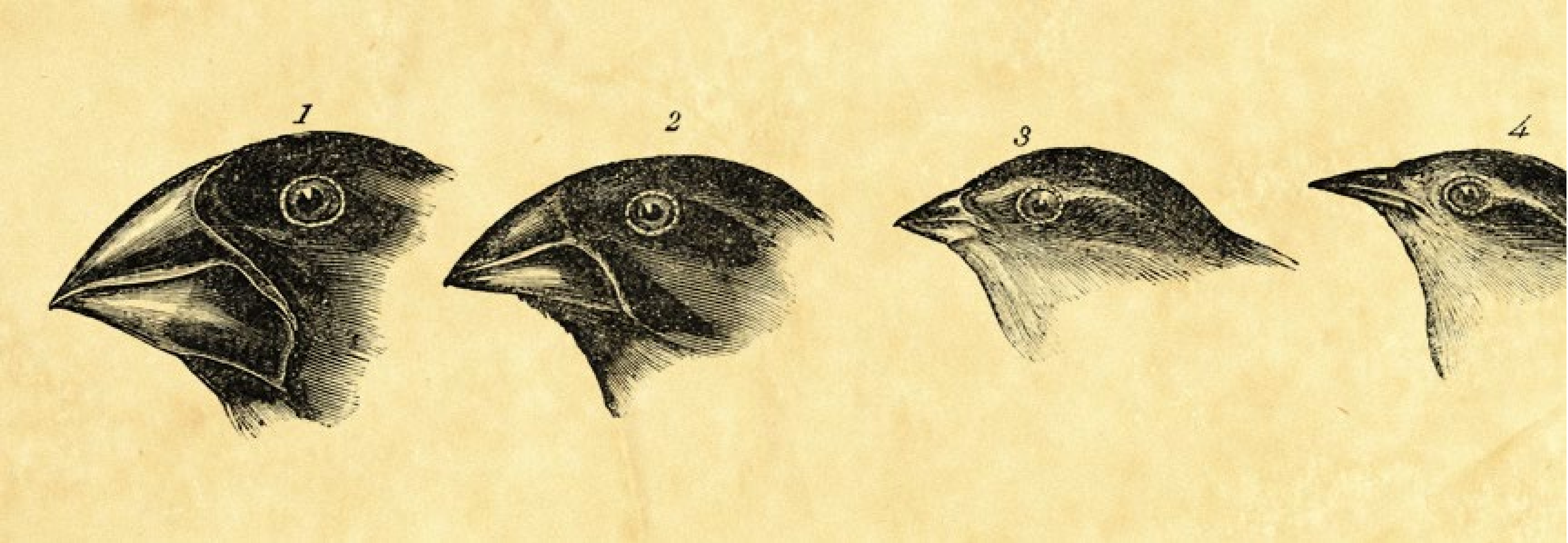


# Run

- Start > All Programs > NetLogo > NetLogo 4.0.3
- Notice:
  - File menu item (top left) – Models Library, etc
  - Interface – “the model”
  - Information – How to use & change the model
  - Procedures – the code

```
to setup
  clear-all
  ask patch 0 0
    [ set pcolor green ]
  create-turtles num-particles
    [ set color red
      set size 1.5  ;; easier to see
      setxy random-xcor random-ycor ]
  reset-ticks
end

to go
  ask turtles
    [ right random wiggle-angle
      left random wiggle-angle
      forward 1
      if any? neighbors with [pcolor = green]
        [ set pcolor green
          die ] ]
  tick
end
```

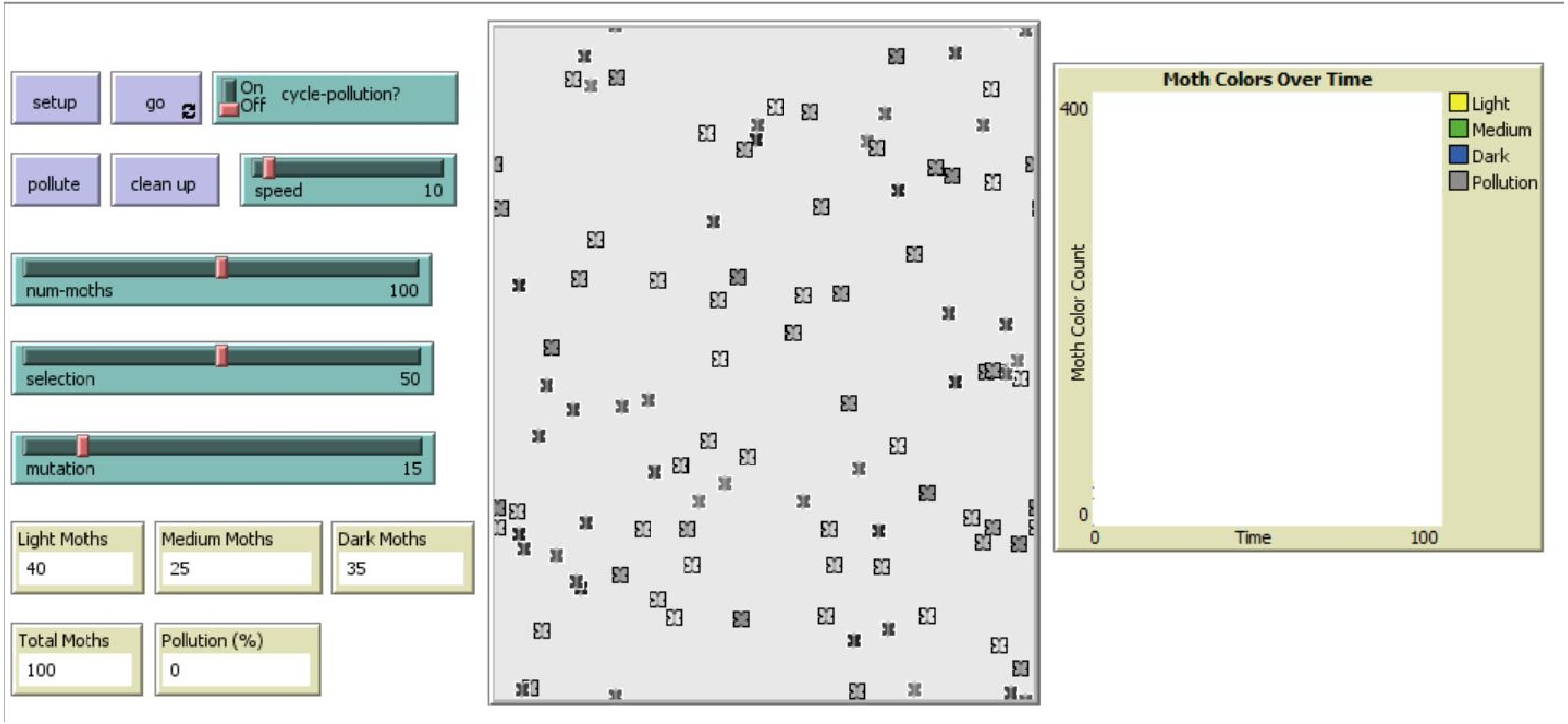



# Today’s Models

# Peppered Moths

- Peppered Moths are normally white with black speckles across the wings. This pattern camouflages them against lichen-covered tree trunks. There is also a naturally occurring genetic mutation which causes some moths to have almost black wings (melanic form).
    - Black moths not as well camouflaged and more likely to be eaten
    - Typically less common in the population than the paler peppered forms.
- In the nineteenth century, the black form was found to be more common than the pale, peppered form.
    - Over that period, industrialization increased the amount of soot and pollution in the atmosphere and deposited on trees.
    - Now the pale form of the moth more obvious to predators, while the melanic form was better camouflaged and more likely to survive and produce offspring.
- This model lets us simulate an environment and moth population and observe the effects of different parameters on the moth coloration.

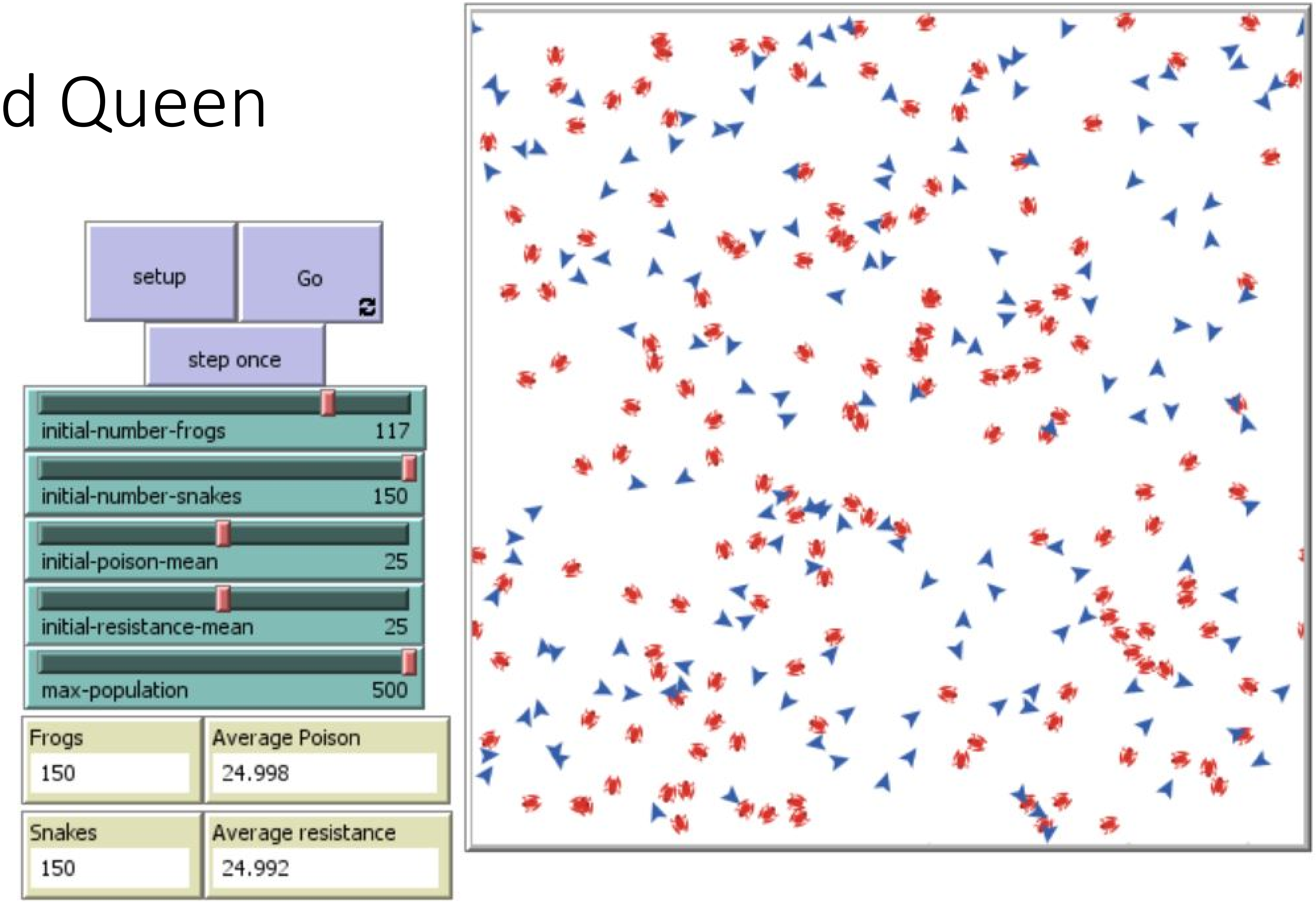
# Peppered Moths



# Red Queen

- The original idea is that coevolution could lead to situations for which the probability of extinction is relatively constant over millions of years (Van Valen 1973).
- In tightly coevolved interactions, evolutionary change by one species (e.g., a prey or host) could lead to extinction of other species (e.g. a predator or parasite), and that the probability of such changes might be reasonably independent of species age.
- "the Red Queen hypothesis," because species had to "run" (evolve) in order to stay in the same place (extant).
- This model simulates snakes and frogs where the snakes are predating the frogs, but the frogs produce a poison. This model lets us observe the red queen hypothesis in action.

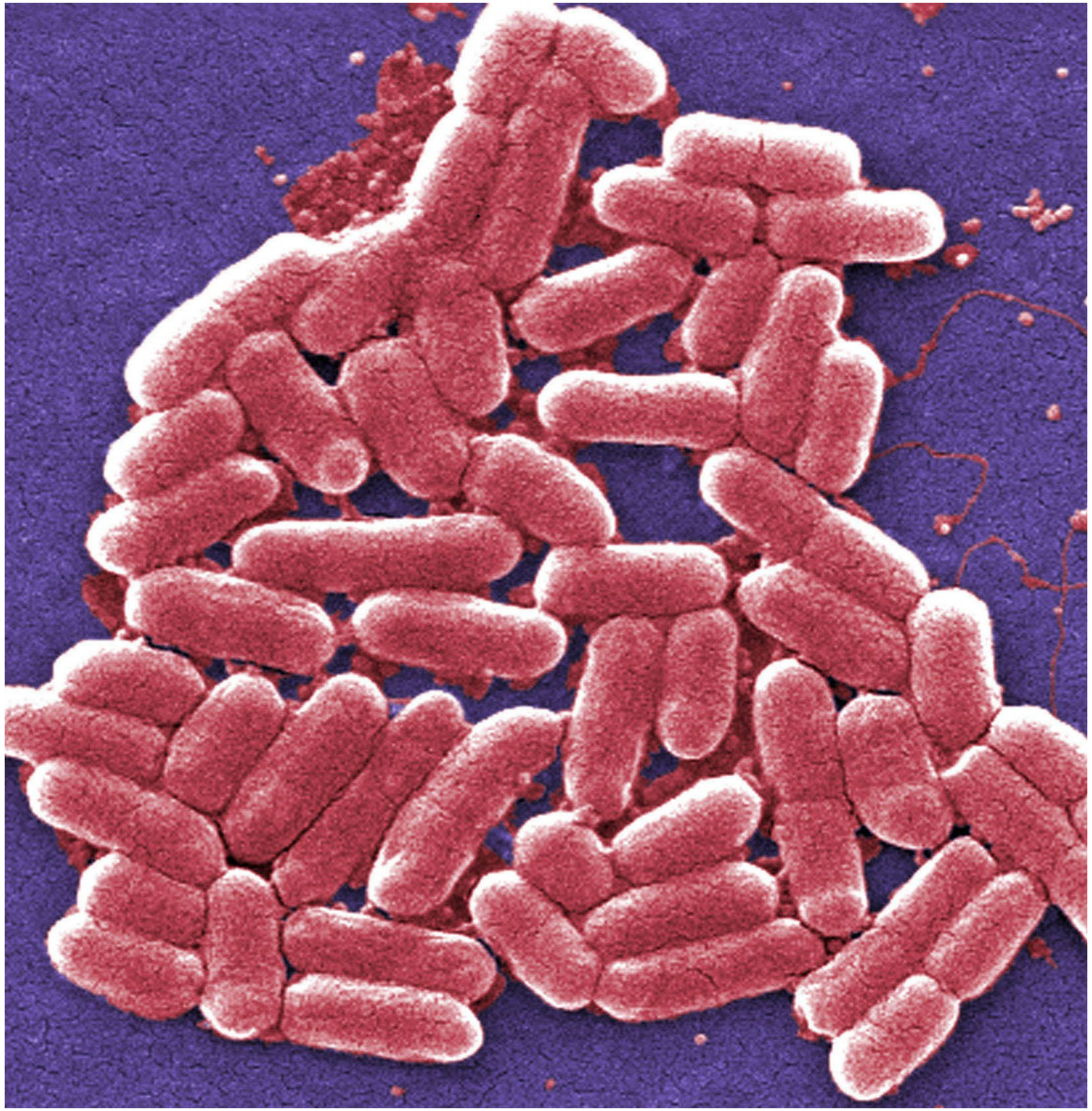
# Red Queen



setup
Go
step once
initial-number-frogs 117
initial-number-snakes 150
initial-poison-mean 25
initial-resistance-mean 25
max-population 500
Frogs
150
Average Poison
24.998
Snakes
150
Average resistance
24.992

# E. Coli

- Genetic drift — along with natural selection, mutation, and migration — is one of the basic mechanisms of evolution.
- In each generation, some individuals may, just by chance, leave behind a few more descendants (and genes, of course!) than other individuals.
- The genes of the next generation will be the genes of the "lucky" individuals, not necessarily the healthier or "better" individuals.
- It happens to ALL populations — there's no avoiding the vagaries of chance.
- This model lets us compare the outcomes under simple genetic drift or under natural selection conditions.



# GenEvo 3 (E. Coli)