

Emergence

EES 4760/5760

Agent-Based & Individual-Based Computational Modeling

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Team Projects

- For Thursday: Read Chapter 10 and the ODD of the model you will work on. You will spend significant time in class working with your partner(s) to start turning the ODD into a working NetLogo model.

Emergence

- Download and open the “modified flocking model” from Blackboard (in the NetLogo models folder) or from https://ees4760.jonathangilligan.org/models/class_09/modified_flocking.nlogo
- It’s easiest if you right-click on the link and choose “Save As” and save the model in a folder on your computer.
- The models we use in this class were mostly written for NetLogo version 5.3.1.
 - NetLogo 6.0 changed some parts of the NetLogo language, so some of the models won’t run correctly in NetLogo 6.
 - You can install multiple versions of NetLogo on your computer, but if you do be aware of which version you are running.

Flocking

- Play with the model.
 - Adjust the parameters and see how they change the flocking behavior

Flocking Model Overview

- Entities:
 - Birds: state-variables flockmates, nearest-neighbor
- Process:
 - Each bird identifies its flockmates
 - Each bird adjusts its direction
 - Each bird moves forward one patch

Flocking Model Design Concepts

- Emergence: Large flocks emerge from each bird acting independently, looking only at nearby birds.
- Adaptation:
 - If the nearest-neighbor is too close, the bird separates by turning away from it.
 - Otherwise, the bird:
 1. aligns: turns toward its flockmates
 2. coheres: turns slightly toward the direction the rest of its flockmates are flying.
- Sensing: The bird can only see a certain distance (*vision*)
- Interaction:
 - Each bird interacts with its flockmates

Submodels

- `find-flockmates`:
 - `flockmates` are all birds within `vision` distance
 - Alternate interactions:
 - `flockmates` interacts with 6 nearest birds, regardless of distance.
 - Bird only interacts with nearest member of `flockmates`
- `separate`: Turn away from nearest-neighbor by up to `max-separate-turn`
- `align`: Turn toward center of `flockmates` by up to `max-align-turn`
- `cohere`: After aligning, turn toward average direction `flockmates` are flying, by up to `max-cohere-turn`

Observations:

- How to measure flock formation?

```
count turtles with [any? flockmates]  
mean [count flockmates] of turtles  
mean [min [distance myself] of other turtles] of turtles  
standard-deviation [heading] of turtles
```


Digression: Selecting Turtles

- Selection primitives:
 - Returning agent-sets
 - `n-of`, `min-n-of`, `max-n-of`, `other`,
 - `turtles-on`, `turtles-at`, `turtles-here`, `at-points`
 - `in-radius`, `in-cone`,
 - `with`, `with-min`, `with-max`
 - Returning individual turtles
 - `one-of`, `min-one-of`, `max-one-of`
 - (may return nobody)
 - Look at Agentset category in NetLogo dictionary
- Be careful:
 - Some primitives expect agent-sets
 - Others expect individual turtles.

Practice Selecting Turtles

- Turn 5 turtles red:

```
ask n-of 5 turtles [ set color red ]
```

- Now for each of those turtles, select all the turtles within a radius of 5 and turn them green

```
ask turtles with [color = red] [ask other turtles in-radius 5 [ set color green ] ]
```

- Now ask each green turtle to calculate the distance to the closest red turtle

```
show [  
  min [distance myself] of turtles with [color = red]  
] of turtles with [color = green]
```

- Now get the average over all the green turtles of the distance to the closest red turtle

```
show mean [  
  min [distance myself] of turtles with [color = red]  
] of turtles with [color = green]
```

Experiments

- Create a Behaviorspace experiment and call it “Baseline”
 - change one parameter and see how it affects the various measures of flocking.
- Next, duplicate “Baseline” and call it “Flock Type”
 - vary that parameter while also varying the flock-type
- Next, duplicate “Baseline” and call it “Multiple”
 - vary more than one parameter (e.g., vision and max-cohere-turn or max-align-turn)
- Use the analyze_behaviorspace app at https://ees4760.jonathangilligan.org/analyze_behaviorspace to graph the output from your BehaviorSpace experiments.
- Try creating a summary table, saving it to your computer, and opening it in Excel.