

# Emergence

EES 4760/5760

Agent-Based & Individual-Based Computational Modeling

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Class #9: Tues. February 6 2018

# Make-up class

Based on doodle poll, the make-up class will be held on

- Monday Feb. 19 from 6:00–7:15 PM.
- Place to be announced.

# Team Projects

- For next Tuesday: 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 Brightspace, the Downloads page on the course web site, or from [https://ees4760.jgilligan.org/models/class\\_09/modified\\_flocking.nlogo](https://ees4760.jgilligan.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.

# 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://analyze-behaviorspace.jgilligan.org/> to graph the output from your BehaviorSpace experiments.
- Try creating a summary table, saving it to your computer, and opening it in Excel.