Your First Model

EES 4760/5760

Agent-Based and Individual-Based Computational Modeling

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Class #5: Wednesday, September 03 2025

Homework

Homework:

- In the mushroom hunt, were there always 80 red patches?
- Any questions about modified mushroom hunt model?
- Let’s talk about ODD exercise.

Writing a model from an ODD

- Questions about writing a model from Butterfly ODD?
- Were there things the ODD was unclear about?

Butterfly Model

Download the model

- Download butterfly model from ees4760.jgilligan.org/models/class_05/butterfly_model_class_5.nlogo
  - Or go to the “Downloads” page on the class web site ees4760.jgilligan.org, click on “5. Butterfly Models” and download the “Basic Butterfly Model”
  - You can download the final enhanced butterfly model we will write in class from “Ehanced Butterfly Model”, or https://ees4760.jgilligan.org/models/class_05/butterfly_model_class_5.nlogo

Enhancing the Butterfly model

- Put a slider for *q*
  - In the “Code” page:
    - Remove *q* from the global variables
    - Remove the initialization of *q* from `to setup`
- Add patches-own variable to indicate whether it was visited.

```
patches-own [
  elevation
  visited? ; question mark reminds us it's a true/false variable
]

to setup
  ...
  ask patches [
  set visited? false
  ...
  ]
  ...
end
```

- Add turtles-own variable to remember the patch where it started.

```
turtles-own [
  origin
]
```

Enhancing the Butterfly model

- Put a slider for *q*
- Add patches-own variable to indicate whether it was visited.
- Add turtles-own variable to remember the patch where it started.
- Set the number of butterflies to 50.
- Stop butterfly from moving if it’s at the top of a hill.
  - How can you tell whether it’s on the top?

Enhancing the Butterfly model

- Write a reporter for corridor width

$$\text{Corridor width} = \frac{\#\ \text{patches visited}}{\text{distance from start}}$$

  - Put an **observer** on the interface
  - Define a reporter:

```
to-report corridor-width
  let pcount count patches with [visited?]
  let dist mean [distance origin] of turtles
  report pcount / dist
end
```

  - Is there a problem when you hit “Setup”?

Behaviorspace

Running Experiments: BehaviorSpace

- Vary any parameter that has a control on the model's interface
- Writes output to `.csv` spreadsheet file
  - Four options:
    1. Spreadsheet
    2. Table
    3. Statistics
    4. Lists (only useful if you also choose spreadsheet or table)
- Note: Data written in spreadsheet or table might be out of order.

Behaviorspace Table Format

	A	B	C	D
1	BehaviorSpace results (NetLogo 6.4.0)	Table version 2.0		
2	enhanced_butterfly_model_class_5.nlogo			
3	vary-q-all-steps			
4	09/03/2024 21:47:41:586 -0500			
5	min-pxcor	max-pxcor	min-pycor	max-pycor
6	0	149	0	149
7	[run number]	q	[step]	corridor-width
8	3	0	0	35.35533906
9	3	0	1	41.01515439
10	15	0	0	35.35533906
11	13	0	0	35.35533906
12	10	0	0	35.35533906
13	14	0	0	35.35533906
14	3	0	2	49.51907135
15	2	0	0	35.35533906

Behaviorspace Spreadsheet Format

	A	B	C	D	E	F	G	H	I
1	BehaviorSpace results (NetLogo 6.4.0)	Spreadsheet version 2.0							
2	enhanced_butterfly_model_class_5.nlogo								
3	vary-q-all-steps								
4	09/03/2024 21:48:10:612 -0500								
5	min-pxcor	max-pxcor	min-pycor	max-pycor					
6	0	149	0	149					
7	[run number]	1	1	2	2	3	3	4	4
8	q	0		0		0		0	
9	[reporter]	[step]	corridor-width	[step]	corridor-width	[step]	corridor-width	[step]	corridor-width
10	[final]	999	423.4725	999	438.6560	999	421.6216	999	418.1058
11	[min]	0	35.3553	0	35.3553	0	35.3553	0	35.3553
12	[max]	999	424.0267	999	438.9208	999	421.8210	999	418.3716
13	[mean]	499.5	300.8170	499.5	303.9720	499.5	302.6952	499.5	300.0260
14	[total steps]	999	999	999	999	999	999	999	999
15									
16	[all run data]	[step]	corridor-width	[step]	corridor-width	[step]	corridor-width	[step]	corridor-width
17		0	35.3553	0	35.3553	0	35.3553	0	35.3553
18		1	40.0116	1	40.6208	1	41.0152	1	39.9840
19		2	47.1075	2	47.1339	2	49.5191	2	50.3201
20		3	49.0780	3	49.6450	3	48.9961	3	52.1140
21		4	50.7408	4	51.5005	4	49.7353	4	55.5346
22		5	49.0910	5	52.4445	5	50.0928	5	55.9192
23		6	51.0026	6	54.4283	6	54.3610	6	59.1715
24		7	51.2436	7	59.8473	7	58.3433	7	61.3543
25		8	54.9979	8	59.8388	8	60.3152	8	62.3758
26		9	58.8774	9	60.6895	9	61.9538	9	64.0257
27		10	60.4508	10	60.4804	10	63.6785	10	63.8910

Behaviorspace Stats Format

	A	B	C	D
1	BehaviorSpace results (NetLogo 6.4.0)	Stats version 2.0		
2	enhanced_butterfly_model_class_5.nlogo			
3	vary-q-all-steps			
4	09/03/2024 21:48:11:511 -0500			
5	min-pxcor	max-pxcor	min-pycor	max-pycor
6	0	149	0	149
7	q	[step]	(mean) corridor-width	(std) corridor-width
8	0	0	35.3553	0.0000
9	0	1	40.3559	0.4474
10	0	2	47.8396	1.3203
11	0	3	48.7062	1.7825
12	0	4	51.2488	2.2297
13	0	5	53.2222	2.3226
14	0	6	56.0615	2.3681
15	0	7	58.0982	2.2659

Analyzing Behaviorspace Output

- Behaviorspace output format is annoying.
  - Each line is some tick of some run.
  - How to organize, and average over runs?
  - The new *stats* output helps with this, though.
- analyzeBehaviorspace app:
  - https://ees4760.jgilligan.org/analyze_behaviorspace,
  - Or install on your own computer using R.
    - Instructions at https://github.com/jonathan-g/analyzeBehaviorspace.
    - After installing:

```
library(analyzeBehaviorspace)
launch_abs()
```

Emergence

Emergence

- A tricky concept.
- Joshua Epstein in *Growing Artificial Societies:* “stable macroscopic patterns arising from the local interaction of agents.”
- Epstein ten years later: “I have always been uncomfortable with the vagueness and occasional mysticism surrounding this word.”
- Epstein now prefers to talk about “*Generative* Social Science” instead of “*emergence*”

Example of Emergence: flocks of starlings

- Thousands of individuals
  - unique and different
  - interact locally
  - show adaptive behavior

Behavioral Ecology
doi:10.1093/beheco/arq149

Self-organized aerial displays of thousands of starlings: a model

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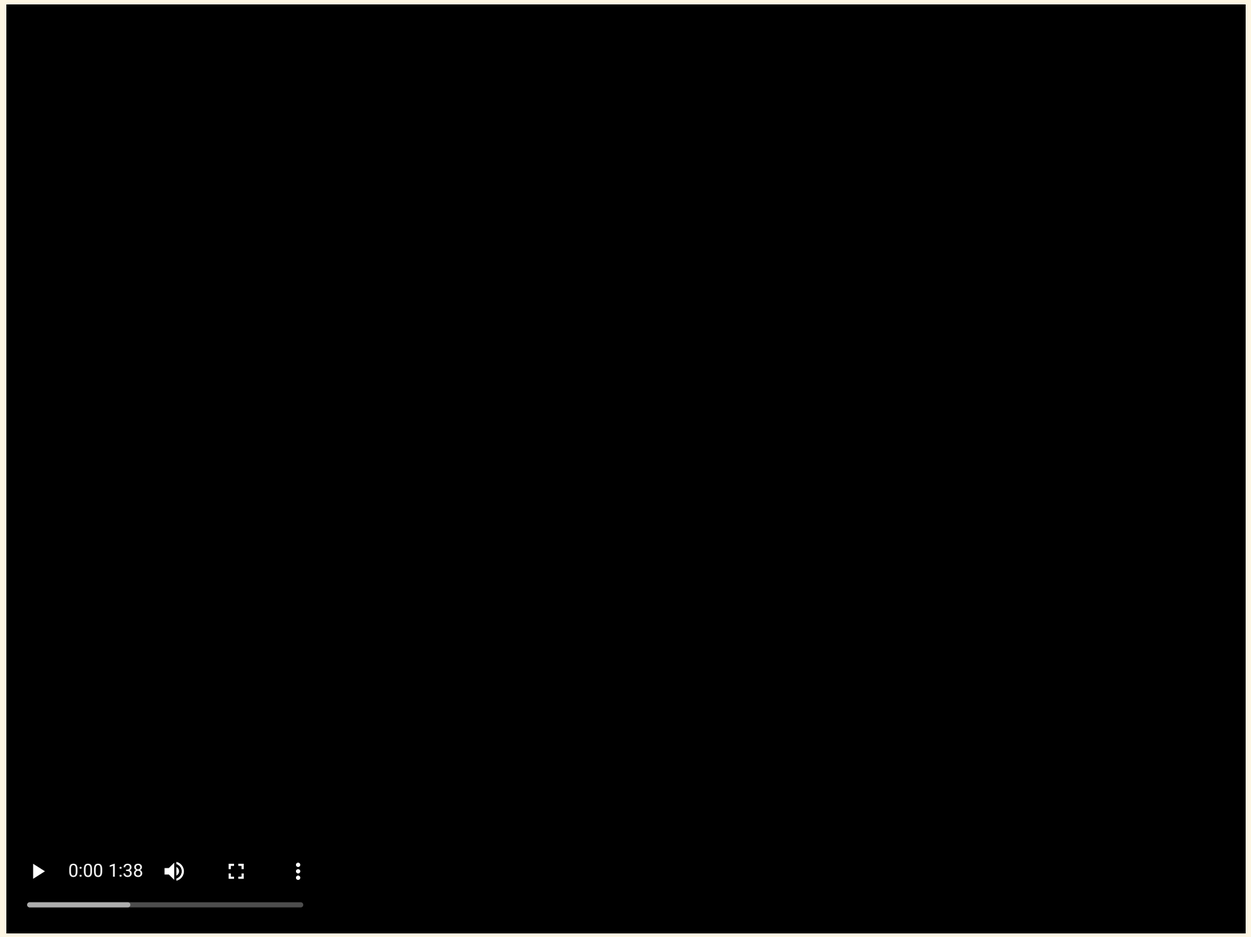
Through combining theoretical models and empirical data, complexity science has increased our understanding of social behavior of animals, in particular of social insects, primates, and fish. What are missing are studies of collective behavior of huge swarms of birds. Recently detailed empirical data have been collected of the swarming maneuvers of large flocks of thousands of starlings (*Sturnus vulgaris*) at their communal sleeping site (roost). Their flocking maneuvers are of dazzling

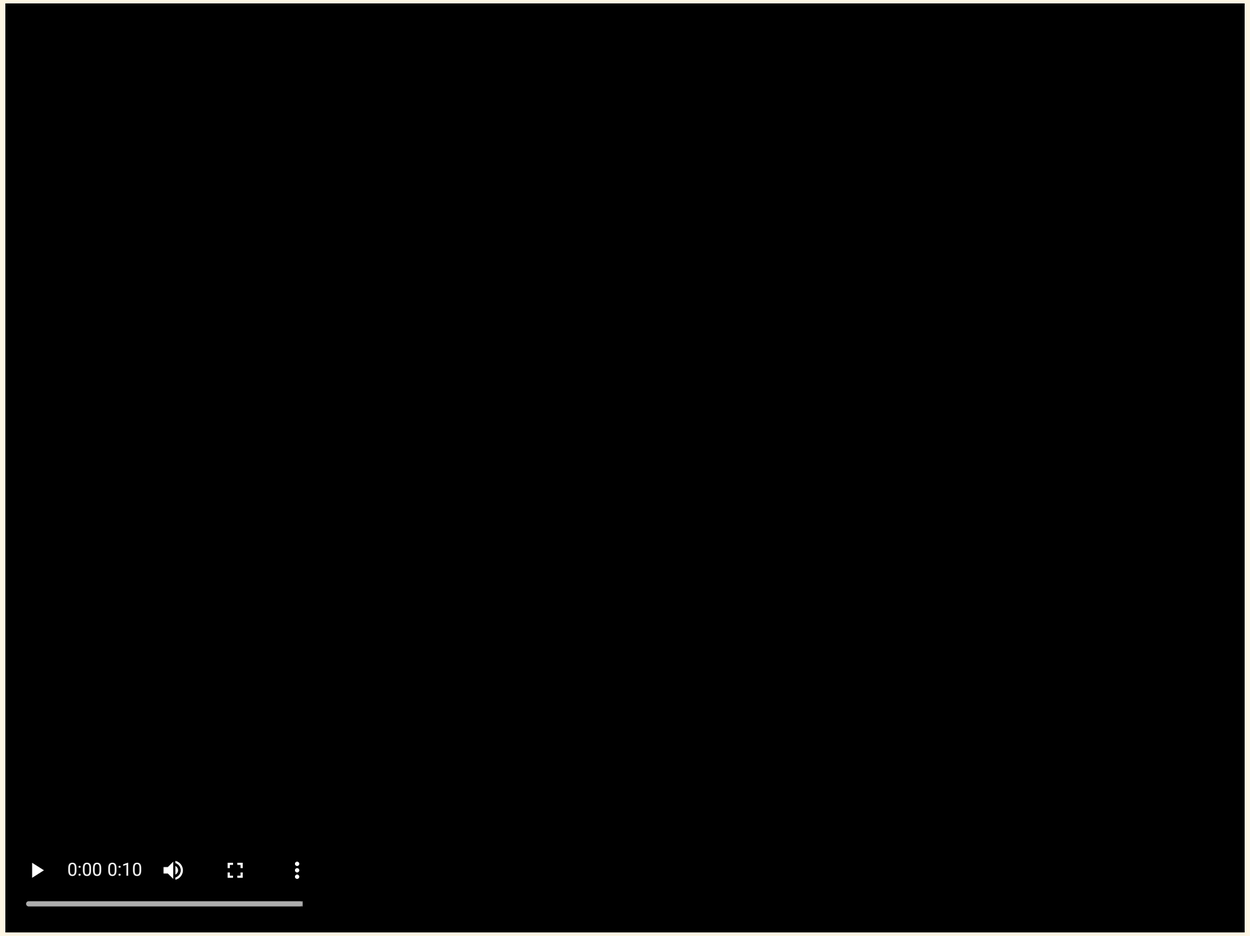
H. Hildenbrandt, C. Carere, & C.K. Hemelrijk, *Behavioral Ecology*, **21**, 1349. DOI: 10.1093/beheco/arq149

Starling murmuration



By Liberty Smith & Sophie Windsor Clive, Islands and Rivers, https://vimeo.com/31158841

Flock of thousands of starlings



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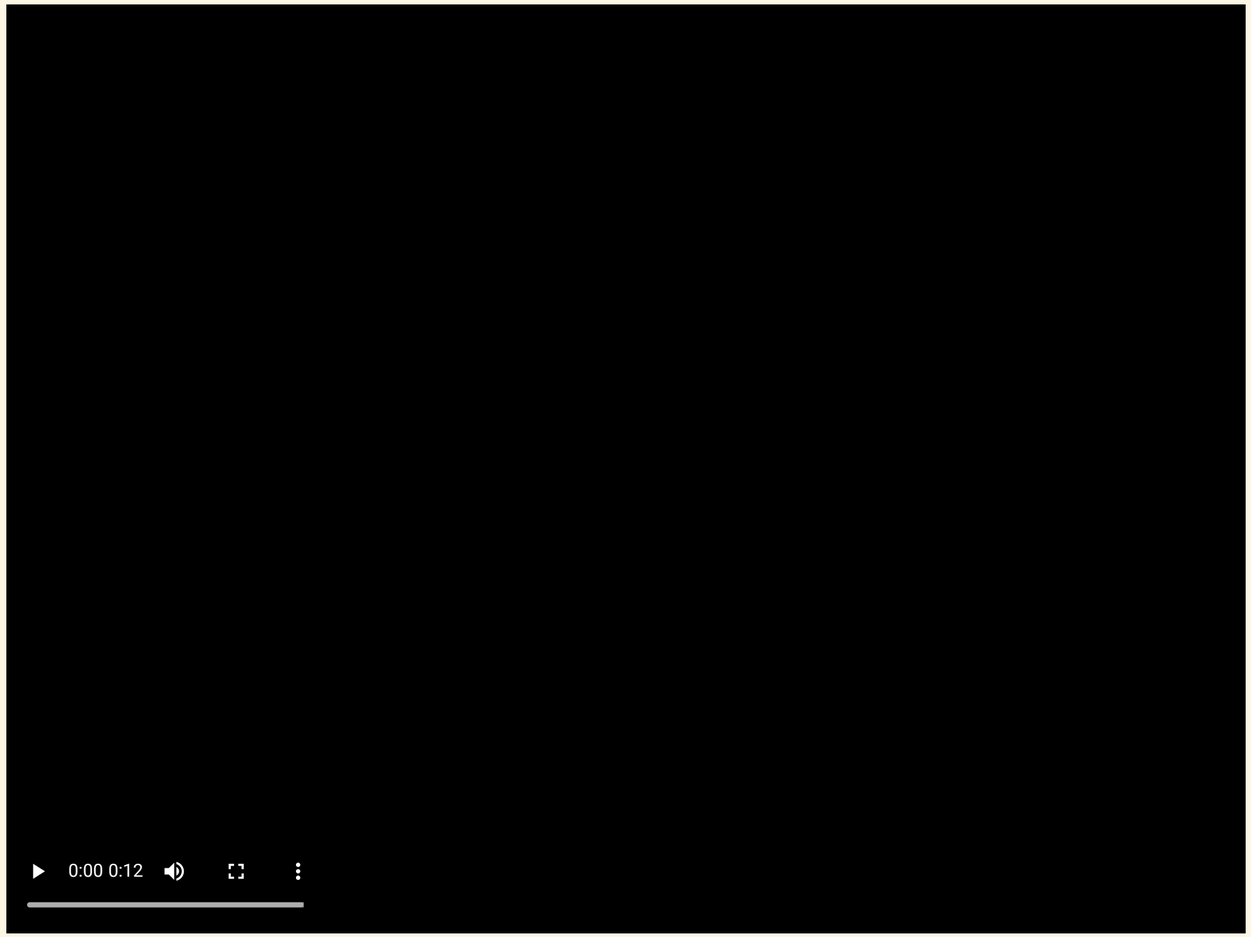
Simulated flock of thousands of starlings



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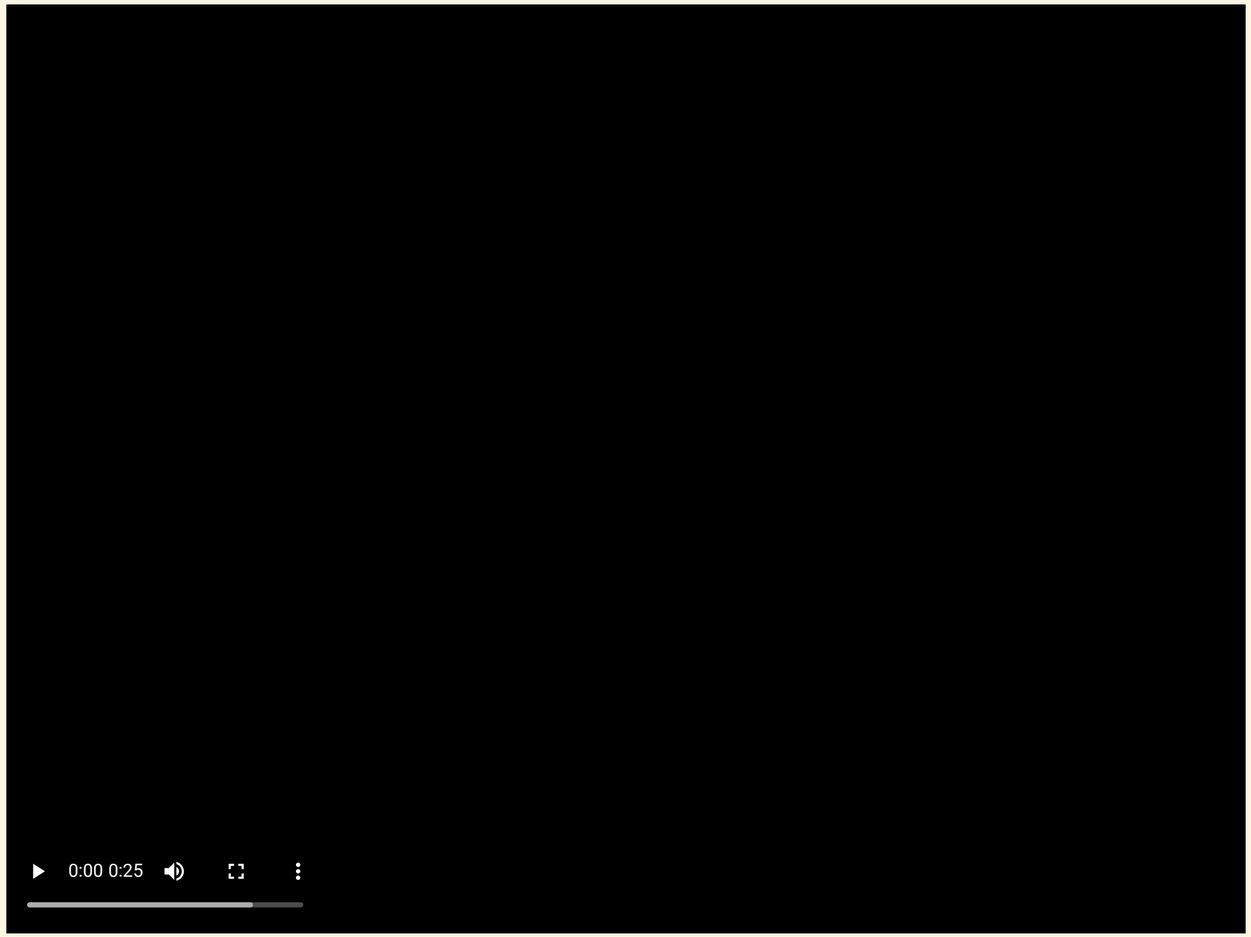

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