

Your First Model

EES 4760/5760

Agent-Based and Individual-Based Computational Modeling

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Class #5: Wednesday, September 3 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 “Enhanced 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 | 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

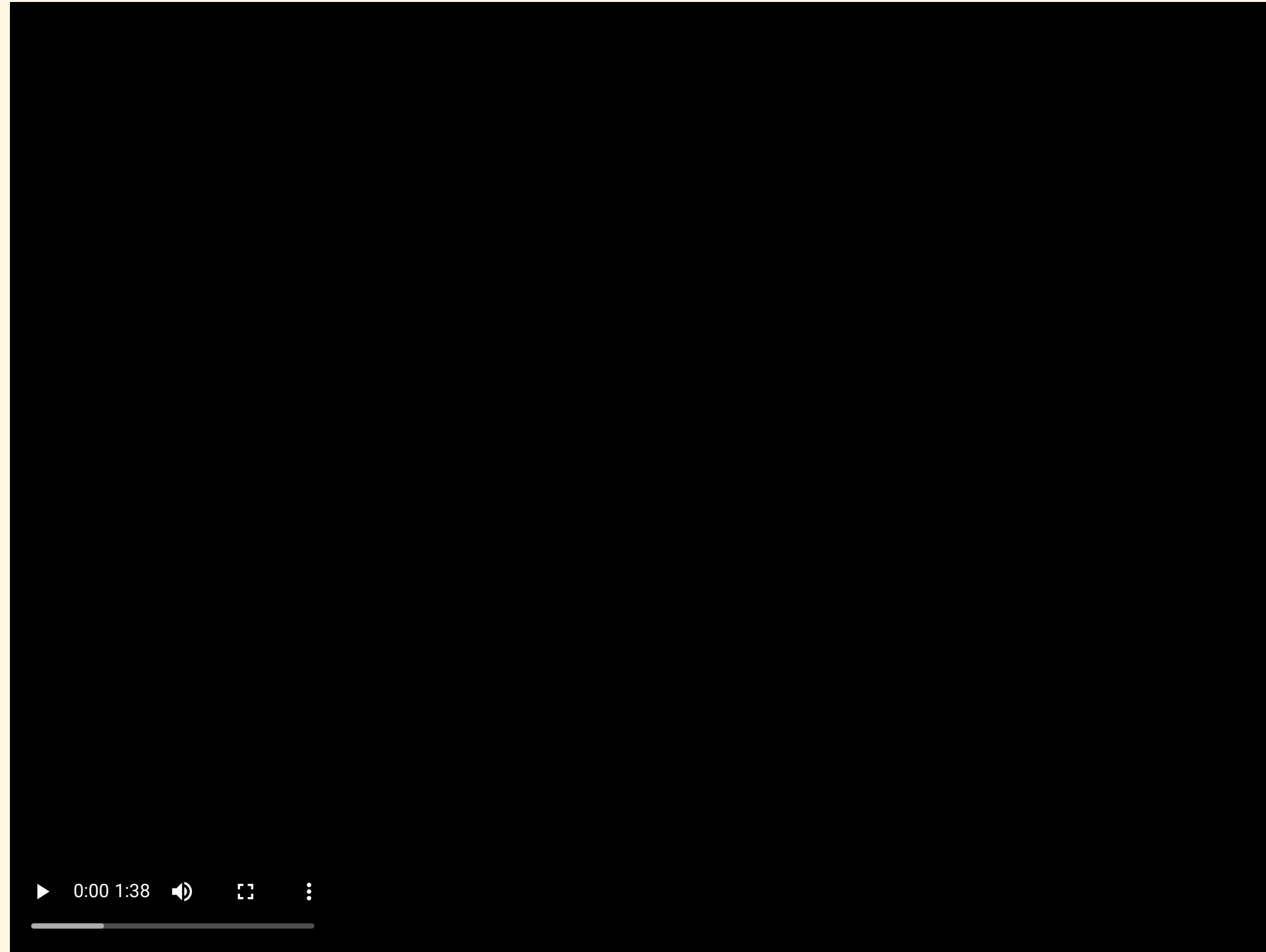
Self-organized aerial displays of thousands of starlings: a model

H. Hildenbrandt,^a C. Carere,^{b,c} and C.K. Hemelrijk^a

^aTheoretical biology, Behavioural Ecology and Self-organisation, Centre for Ecological and Evolutionary Studies, University of Groningen, PO Box 14, 9750 AA, Haren, The Netherlands, ^bCNR-INFM, Dipartimento di Fisica, Università di Roma La Sapienza, P.le A. Moro 2, 00185 Roma, Italy, and ^cDipartimento di Ecologia e Sviluppo Economico Sostenibile Università degli Studi della Tuscia, Viterbo, Italy

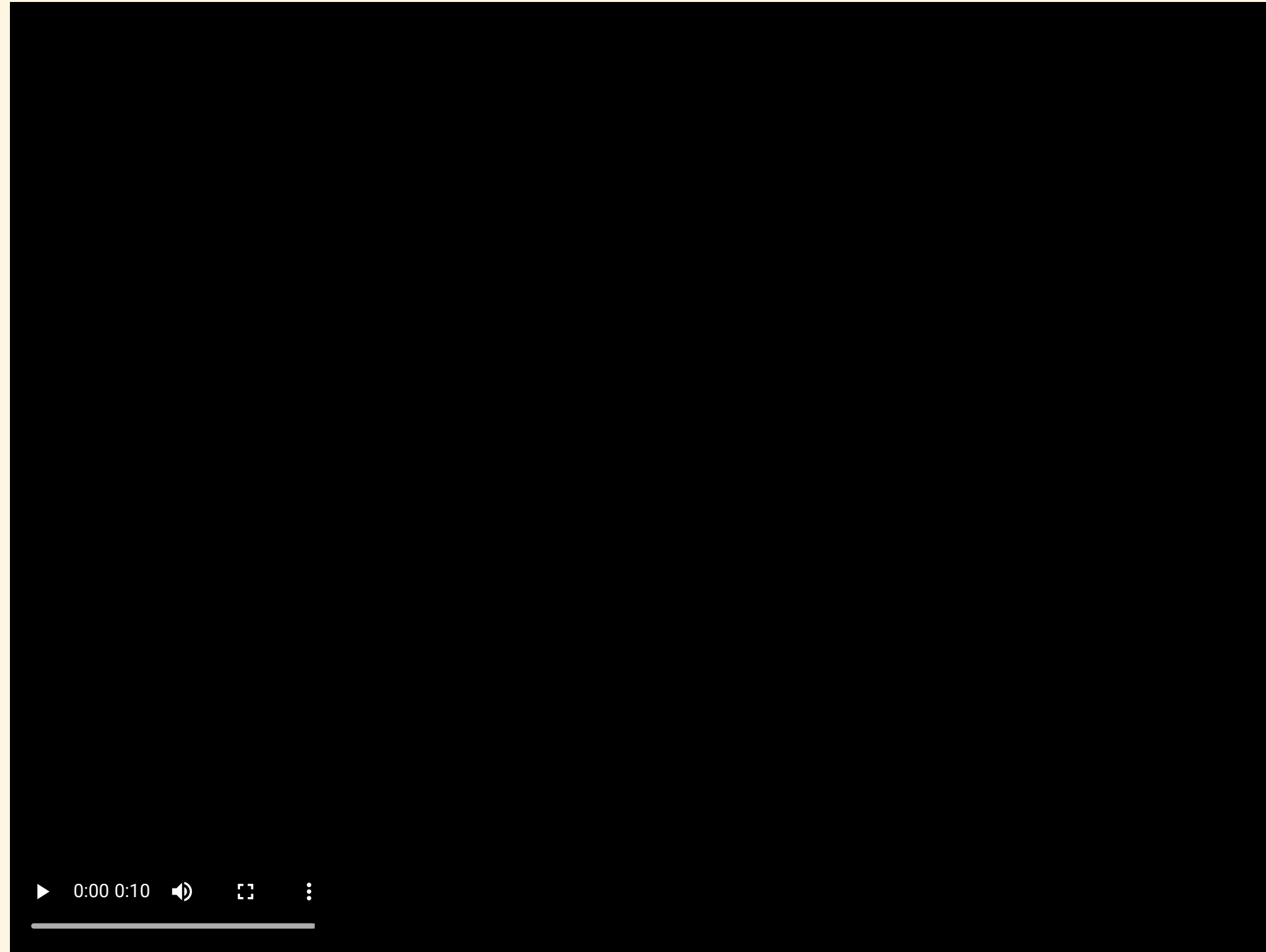
Through combining theoretical models and empirical data, complexity science has increased our understanding of social behavior of animals, in particular of social insects, primates, and fish. What are missing are studies of collective behavior of huge swarms of birds. Recently detailed empirical data 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

Starling murmuration



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

Flock of thousands of starlings



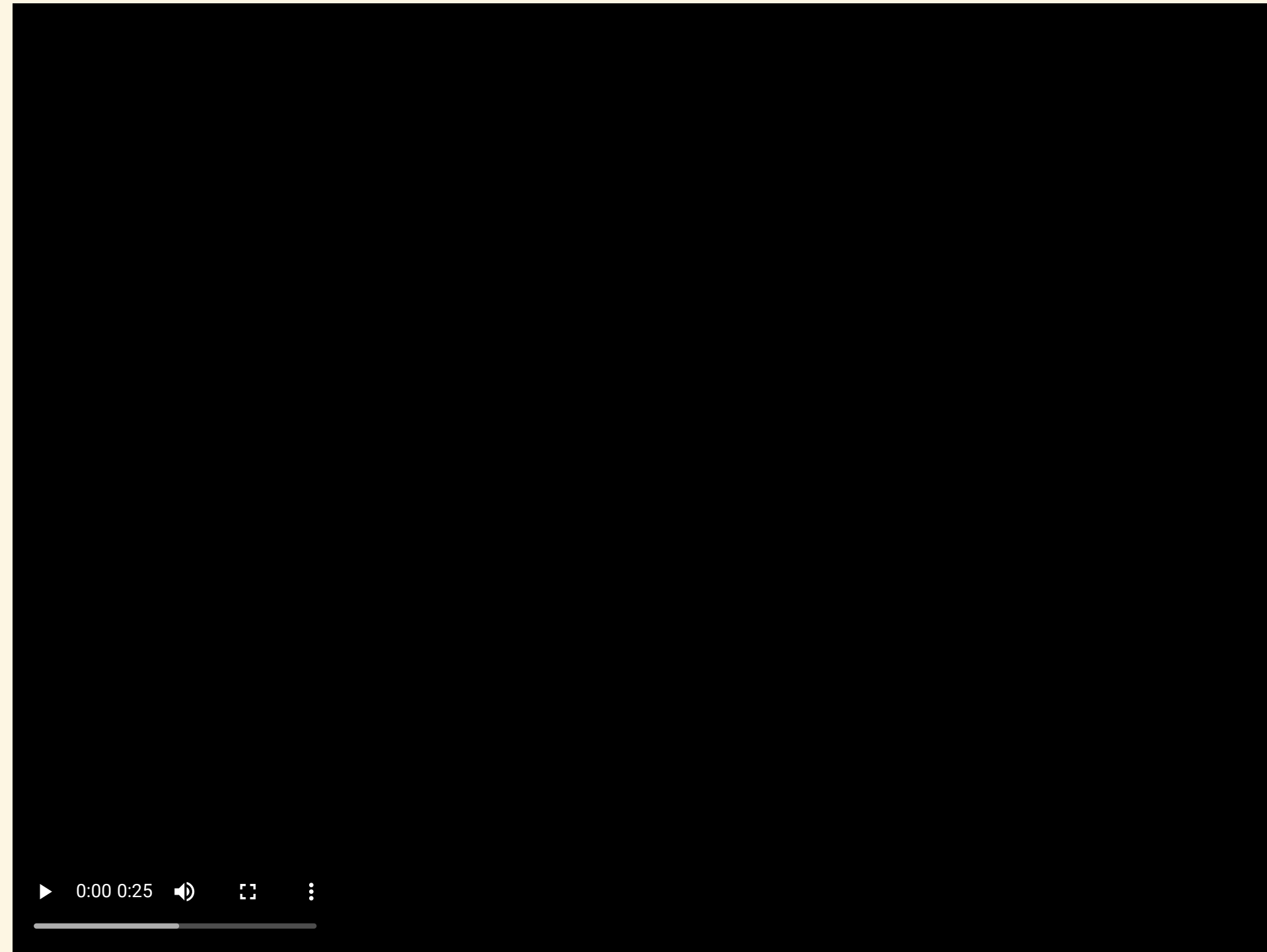
H. Hildenbrandt, C. Carere, & C.K. Hemelrijk, *Behavioral Ecology*, **21**, 1349. DOI: 10.1093/beheco/arq149

Simulated flock of thousands of starlings



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

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