Analyzing and Understanding ABMs

EES 4760/5760

Agent-Based & Individual-Based Computational Modeling

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Live web page: https://ees4760.jgilligan.org/Slides/Class_24
PDF: https://ees4760.jgilligan.org/Slides/Class_24/EES_4760_5760_Class_24_Slides.pdf

Schelling Model of Housing Segregation

- Maybe the first Agent-Based Model. T.C. Schelling, “Dynamic Models of Segregation”, *Journal of Mathematical Sociology* **1**, 143–186 (1971), *Micromotives and Macrobehavior* (WW Norton, 1978).
- No computers. Schelling worked the model on a checkerboard.

https://ees4760.jgilligan.org/models/class_24/segregation.nlogo

Model Overview

- Turtles represent households.
  - Two colors of turtles: red and blue
  - Turtles have one state-variable: *happy?* (true or false)
- There is a global variable *%-similar-wanted* and a turtle is *happy?* if at least this fraction of its neighbors have the same color as its own.
- At each tick, unhappy turtles move to a random empty patch.
- When all turtles are *happy?*, the model stops.

Experiments

Vary *%-similar-wanted* and the *density* of turtles on the patches.

Suggestions:

- Try extreme values of parameters:
  - Set *density* and *%-similar-wanted* to different combinations near maximum, minimum, and in the middle.
  - What do you see?

Extreme Values

- Set *density* to 75% and set *%-similar-wanted* to 95%
- Press **setup** and then press **go**
  - What happens?
- Now, with **go** still pushed, slowly reduce *%-similar-wanted*.
  - Now what happens?

Systematic experiment:

- Using Behaviorspace, create a new experiment to vary ***%-similar-wanted***
  - Set **_time limit** to 1000
  - Set ***density*** to 75
  - Measure ***percent-similar***
- What do you see?
- Try adjusting both ***%-similar-wanted*** and **_density**

Visualizing Structures

- Add the following to the procedure `to update-turtles`, after `set happy?`

```
ifelse happy? [ set shape "square" ] [ set shape "square-x" ]
```

- Repeat the exercise of:
  - set *density* = 75% and *%-similar-wanted* = 95%,
  - press **_setup** and ***go***
  - gradually reduce *%-similar-wanted*
    - Is it easier to see the emerging patterns now?

Another Heuristic

- When you're at an interesting value for one parameter (e.g., *%-similar-wanted* = 75%), vary other paremters (*density*).

Other heuristics:

- Use several *currencies* to evaluate models
  - Statistical analysis of spatial patterns and time-series
  - Analyze agent properties: Are they unimodal or multimodal (e.g., are turtles divided into distinct groups of rich/poor, healthy/sick, etc., or distributed continuously around one dominant value of state variables?)
  - Stability: Does system return quickly to steady state after it's disturbed?
- Simplify models:
  - Make all patches the same
  - Make all turtles the same
  - Reduce places where you use stochasticity
  - Use fewer turtles and patches
- Explore unrealistic scenarios
- See book for heuristics for statistical analysis of model output...