Agent-based models in the philosophy of science

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(2)
Building and exploring a model

Building a model

Design questions

- What are the agents' goals?
- How are their/population payoffs determined?
- What information is available to agents?
- What do the agents do with that information? Which behavioral rules do they follow?
- What can the agents do?
- How do the agents interact?
- Do the agents differ from each other?
- How does the population change over time? (entry/exit)
- …

Task 1a: Building the conceptual model: assumptions

The assumptions constituting the Axelrod 1997 social influence model	
Environment	
Agents and their properties	
Rules of interaction	
Dynamics (= what happens when):	
…	

Task 1b: Plan the logic of the program

- Sketch the logic of your program, but you do not need to follow python syntax
  - Pseudocode (preferably simple English)
  - Diagrams?
- What parts does the program consist of?
- In what order do things need to happen?
  - Initialization
  - Loops: what happens at each time step
  - …
- …

- Aim first for the simplest possible version of the program

Task 1c: Implementation plan

- = planning how you write code

- Where do you start writing code?
- What are the data types you use?
- Do you need to import modules (e.g. numpy, scipy)?
- …

Task 2: Write some code!

Your goal today: Determine how the number of unique cultures changes between the beginning and the end of a simulation run

- One unique culture = the population converged to cultural uniformity

Depending on your programming experience, your team has some options:

a) Build on a colab notebook with some gaps in the code
   1. Familiarize yourself with what happens in the program
   2. Write the code for running the simulation "experiment" to determine how the number of unique cultures changes in the game

b) Start from a colab notebook with class structure in place

c) Start from a practically empty colab notebook!
   - Only parameter values given

Advice

- A Pythonic programming style involves rapid switching between
  - Writing a couple of lines of code
  - Running it, testing
  - Revising & expanding
- → easier to catch errors (which are unavoidable)
- Create an emplty cell for trying out new things
- ‘print’ is good for debugging. Use it to print out values of variables. Use it often. Then comment out lines once you no longer need them
- Google is your friend. All your questions have already been answered online!
  - You just need to know how to write the search query!

Analyzing a model

Findings from replication of Axelrod 1997

a) How many unique cultures
   - After model initialization?
   - After n time steps?

b) Could we replicate table 2?

c) Other interesting findings?

TABLE 2
Average Number of Stable Regions

Number of Cultural Features	*Traits per Feature*		
	5	*10*	*15*
5	1.0	3.2	20.0
10	1.0	1.0	1.4
15	1.0	1.0	1.2

NOTE: These runs were done with a territory of 10 × 10 sites, and each interior site had four neighbors. Each condition was run 10 times.

How would you like to extend Axelrod's social influence model?

Could (an extended version of) the model be applied to a question in the social epistemology of science?

Literature / resources

- Railsback & Grimm 2019. *Agent-based and individual-based modeling: a practical introduction*. Princeton university press.
- Miller & Page 2007: *Complex Adaptive Systems.* Princeton University Press

- Bruce Edmond's modelling gripes: https://bruceedmonds.blogspot.com/
- Model thinking – A mooc by Scott Page: https://www.coursera.org/learn/model-thinking
- Paul Smaldino's courses on ABMs: https://smaldino.com/wp/abm-courses/
- Center for Open Science. Osf.io provides a framework for sharing code and data (also for peer review)

Final thoughts

Reflections on agent-based modeling

- ABMs are a powerful tool for making the micro-macro transition
- Modeling keeps us real: making ideas precise, supports reasoning when reasoning falters

- Striking a balance: Conclusions from modelling should be valid, but not obvious!
  - Think of Schelling model!
- Relevance: Model should be based on solid theoretical ideas
  - Vs. importing a model template and giving it a new interpretation

Reflections on agent-based modeling (ii)

- Unlike mathematical models, ABMs are so flexible that they can be stretched to give you almost anything you want!
  → With power comes responsibility: how
  - As the number of assumptions increases, drawing **relevant** conclusions from the model becomes increasingly difficult
  - Results can driven by programming errors, neglected assumptions … → replicability of findings in computational research is often poor
- How to improve relevance & reliability?
  - KiSS principle (Keep it Simple, Stupid)
  - Openness and transparency is key
  - …