Science with Models

EES 4760/5760

Agent-Based & Individual-Based Computational Modeling

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Class #22: Tuesday, Apr. 4 2017

Schedule

Schedule

- Drop-in model consultation (optional)
  - Wednesday, 5:00–6:00 at my office (SC 5735)
  - Thursday, 5:30–6:30 in this classroom
  - Optional time to drop in and ask questions about your model project
    - Come for as much or as little as you want
    - Bring your computer or leave your model in your Box folder
- Friday: Drop the current working copy of your NetLogo model in your Box folder before midnight
  - The goal is that your model code is mostly working
  - Then, over the next two weeks:
    - Use this model to perform and analyse behaviorspace experiments
    - In-class presentations and written research report

Ways to use models

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1. Detailed predictions
2. Theory-building
3. What-if analysis

Detailed Predictions

- Develop model:
  - Theory-driven
    - Use existing theory
  - Data-driven
    - Need *lots* of observations/data
    - Look for patterns in data
    - Describe patterns mathematically
- Calibrate model
  - Mathematical theory has parameters
    - Adjust parameters to make model agree with past observations
- Validate & Verify

Validation & Verification

- **Cross-validation** (for comparing theories):
  - Divide data into k parts: $1 \ldots k$
    - Each part has a turn as ``test set'':
      - Fit model parameters to the other parts
      - Compare predictions to test set.
  - Choose model that performs best over the k comparisons.
- **Hold-out testing** (for estimating predictive accuracy):
  - Divide data into *hold-out* and *training* data:
    - Divide *training* data into k parts
    - Use cross-validation to choose best model
    - Calibrate best model on full *training* set
    - Test predictions against *hold-out* set to estimate predictive power

Theory-Building

- Similar to detailed prediction
  - Detailed prediction often uses very complicated models to capture all the relevant details of the real world
  - Theory-building often uses simplified models to capture just the most important aspects of what makes the real-world system tick.

What-if analysis

- Does not necessarily need data
- Start with simple theory or hypothesis
- Explore implications

Robust Policy Analysis

- How to make policy under extreme uncertainty:
  - R. Lempert: Making policy for the next 100 years
    - planning for climate change, technological revolutions, etc.
  - You can’t predict what will happen
  - Division: *policy variables* (things you can control), *external variables* (things you can’t control).
  - Use ***lots*** of model runs (BehaviorSpace goes nuts)
    - Which sets of *policy variables* avoid catastrophic outcomes across the widest range of *external variables*?

Realistic Expectations

Realistic Expectations

- Most ABM work ***does not*** aspire to make detailed predictions
- Much focuses on either theory-building or what-if analysis

Let’s talk about your modeling projects

- What are you hoping to do with your model?
- What difficulties are you having?