Modeling and Simulation

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A model...

...formalizes a theory in a way that makes it easier to see our assumptions and makes it possible to do computing (i.e. simulations).

E.g. linear relationships, independent risks

What is a model?

A precise (i.e. formal or mathematical) model of an empirical process

Examples of models

A measurement model

Artificial neural networks

Agent-based models

Climate models

Models of choice and judgment behavior (e.g. the Take the Best algorithm)

User models

What about these?

Dual processes (e.g. “System 1” versus “System 2”)

“Monkey see, monkey do”

Exemplars versus prototypes

→ theories, rather than models

“Model” implies a level of completeness

What is a simulation?

A computational process in which a model is used to generate outputs from specific inputs (or outcomes from initial conditions)

Builds on the idea of a function:

f:D->R   f(a)=b

M:I->O   [a1,a2,a3,...] at t1 → M → [b1,b2,...] at t2

May be (non)deterministic – generate inputs

Simulation versus solving analytically

Thus...

Simulations can generate testable predictions and models can be refined using simulations, with multiple runs, to make more accurate predictions.

Some issues

1. Reliance without verification (or verifiability)
2. Assumptions we know may be or are wrong – what do we learn?
3. What does a knowledge level model tell us about a natural process?
4. Simulation can be chaotic
5. Confusing simulation with reality (Baudrillard, video games, Bostrom)

Artificial neural nets, beyond Churchland (1990)

Simulated annealing

Representation of time in recurrent networks

Unsupervised learning and deep learning

Realistic neural models