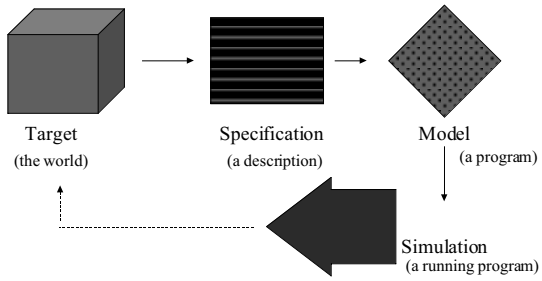
Simulation as a method

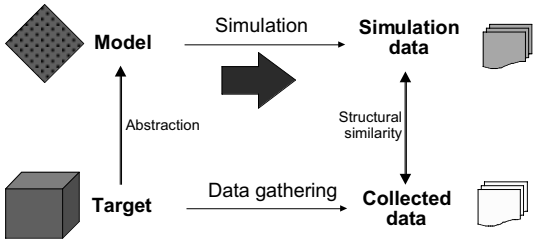
Outline

- The logic of simulation
- Validity and validation
- Simulation and the development of social theory
- Practical issues in doing simulation research

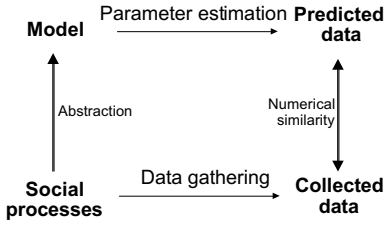
Terminology



The logic of simulation



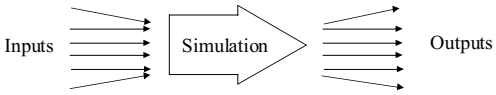
The logic of statistical modelling



Minimality and abstraction

- There are many possible models of a given target
- All models abstract from (ignore) some features of the target
- The more complex the model, the harder it is to build and validate
- The more complex the model, the closer it is to the target
  - the "trap of verisimilitude"

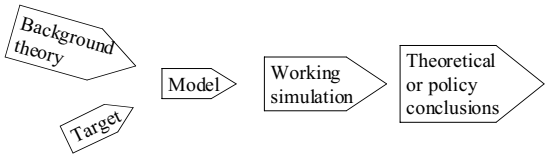
Assumptions



- Complex models require the setting of many parameters (inputs), each of which may have unforeseen consequences on the outputs
- Most input values will have to be assumed, not measured

Interpretation

A working simulation is *not* the end of the research

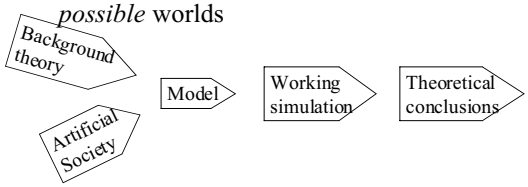


Simulation and theoretical development

- Possible questions
  - What happened?
    - Model a past process
  - What might happen?
    - Predict the future
  - What are the sufficient conditions for it to happen?
    - Explain a process

Artificial societies

- The target is not an existing society, but an artificial society
- Observation of and experimentation with *possible* worlds



Building models

- What to simulate
- Size of simulation
  - number of parameters
  - number of agents
- Type of model
- Availability of data
- Programming experience and effort

Tools

- Special purpose 'testbed'
  - adaptability?
- Special purpose simulation language
  - flexibility?
- General purpose programming language
    - C++, Lisp, Smalltalk
  - development tools?
  - graphics?

Languages: desirable features

- Permit exploratory programming and incremental development
- Good debugging facilities
- Efficient, for multiple runs
- Easy to learn and in widespread use

Validation

- A model which can be relied on to reflect the behaviour of the target is 'valid'
- Invalidity may result from:
  - generation of spurious outputs
    (the usual concern)
  - failure to generate required outputs
    (less often considered)

Validity

- Other related questions
  - sensitivity to values of the input parameters
    - do small changes in the values of the inputs result in large changes in the outputs?
  - repeatability
    - is the output similar on every run?
  - simplicity
    - could the model be simplified without affecting its validity?

Validity

- Sensitivity analysis
  - repeatedly run the model with small variations in input parameters and observe outputs
  - but space of possible input values exceedingly large
- Compare outputs with observed data
  - 'observations' may be impossible
    - too abstract (e.g. segregation model)
    - inaccessible (e.g. social complexity in 20,000BC)
  - differences may be due to any or all of:
    - bad model
    - bad data
    - model is an abstraction of the target
    - 'random' variations, but sampling distributions are unknown

Randomness

- Functions of randomness:
  - Substitute for all the external and environmental processes which are not being modelled (i.e. exogenous factors) such as the effects of the job market
- Substitute for agents' internal processes
  - preferences, emotions etc.
- Avoid spurious sequential or temporal effects
  - e.g. updating procedures in CA models
- Demonstrate robustness of results
  - varying initial conditions and parameters

Recommendations

- Be deductive, not inductive
- Consider 'crucial experiments'
- Use simulations to develop theories not toys
- Model artificial societies

Publication

- The theoretical and policy background
- The assumptions of the model
- The hypotheses to be tested
- Justification for the choice of type of model
- Outline of model, without implementation detail (e.g. using difference equations)
- Results, usually as graphs
- Sensitivity analysis
- Conclusions
  - Relate back to hypotheses
  - Draw out theoretical and/or policy implications
- Optional Appendices
  - Model description
  - Link to program code
  - Tables of results

Journals

- JASSS
  - Journal of Artificial Societies and Social Simulation

- CMOT
  - Computational and Mathematical Organization Theory

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