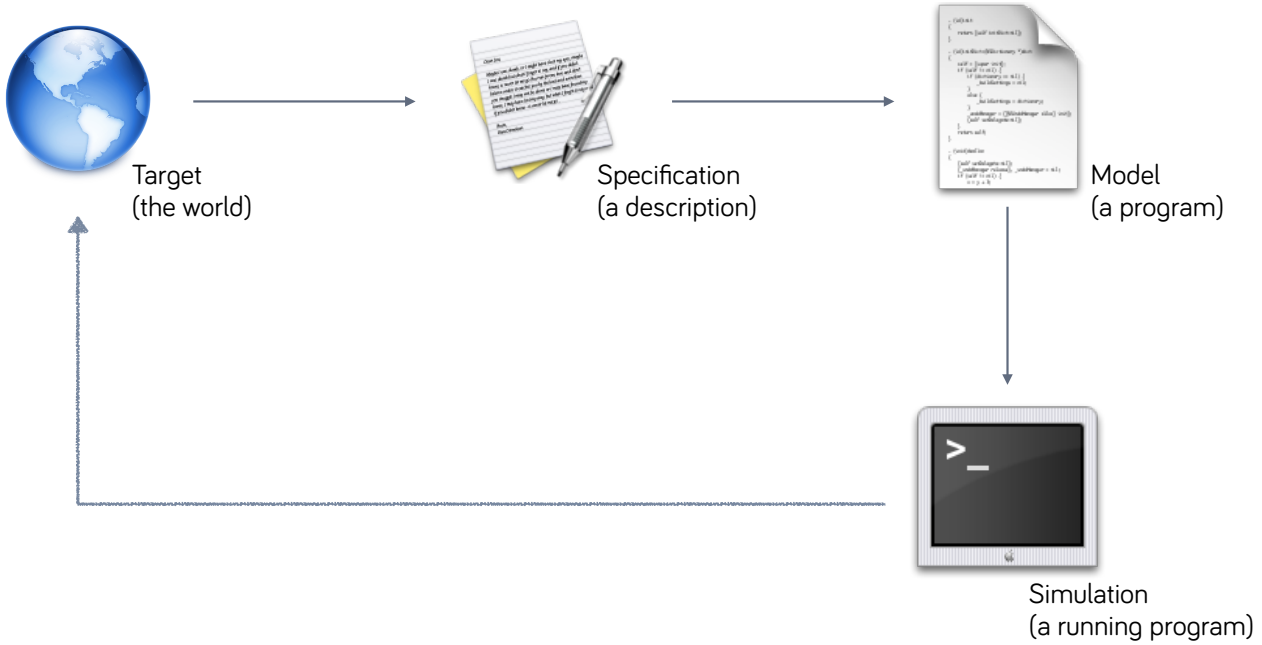
SIMULATION AS A METHOD

Carelia Gaxiola

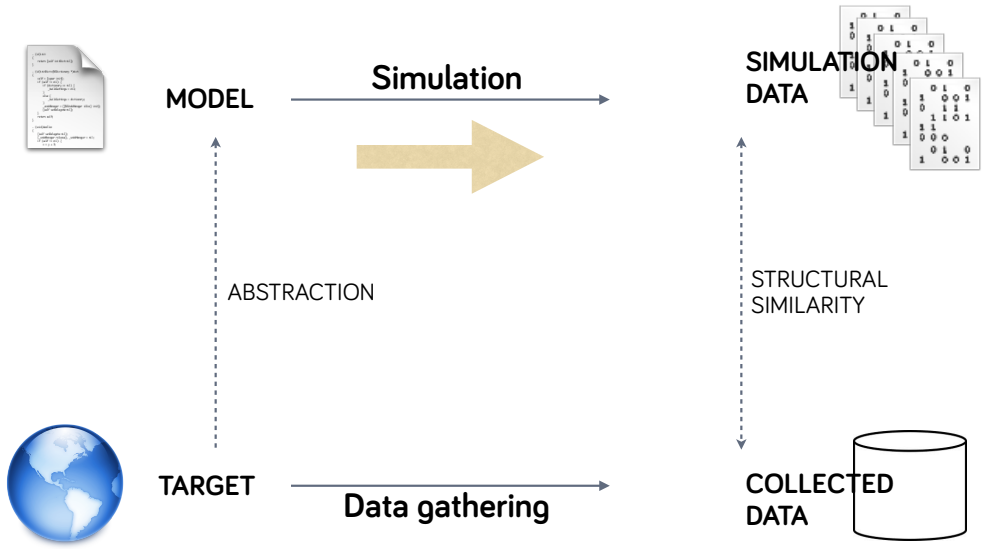
OUTLINE

- The logic of simulation
- Research steps
- Validity and validation
- Practical issues in doing simulation research

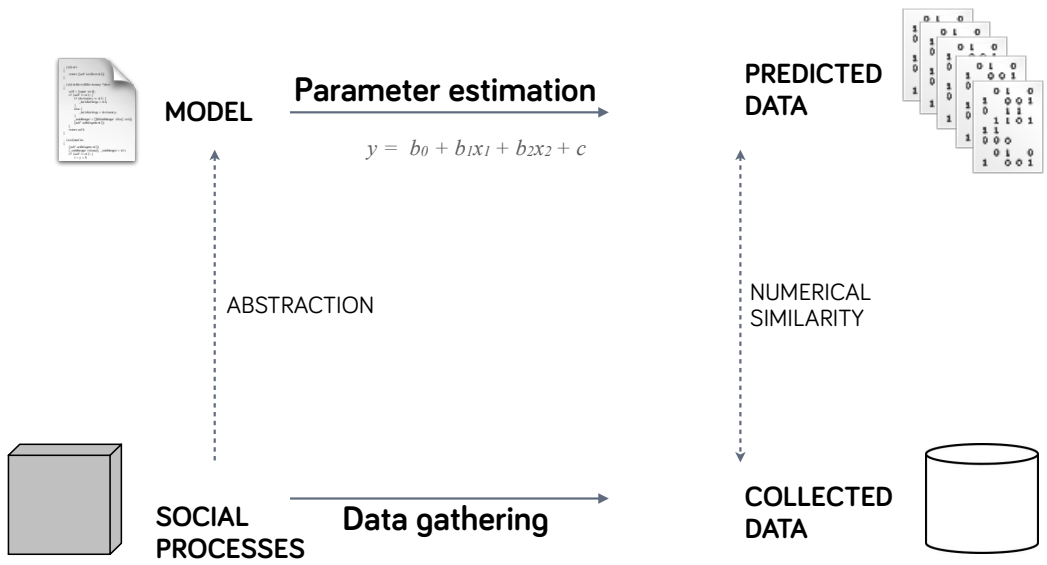
TERMINOLOGY



THE LOGIC OF SIMULATION



THE LOGIC OF STATISTICAL MODELLING



RESEARCH STEPS

- Define topic and problem
- Specify hypothesis
- List assumptions
- Design and build model
- Verify model
- Validate model
- Draw conclusions

MINIMALITY AND ABSTRACTION

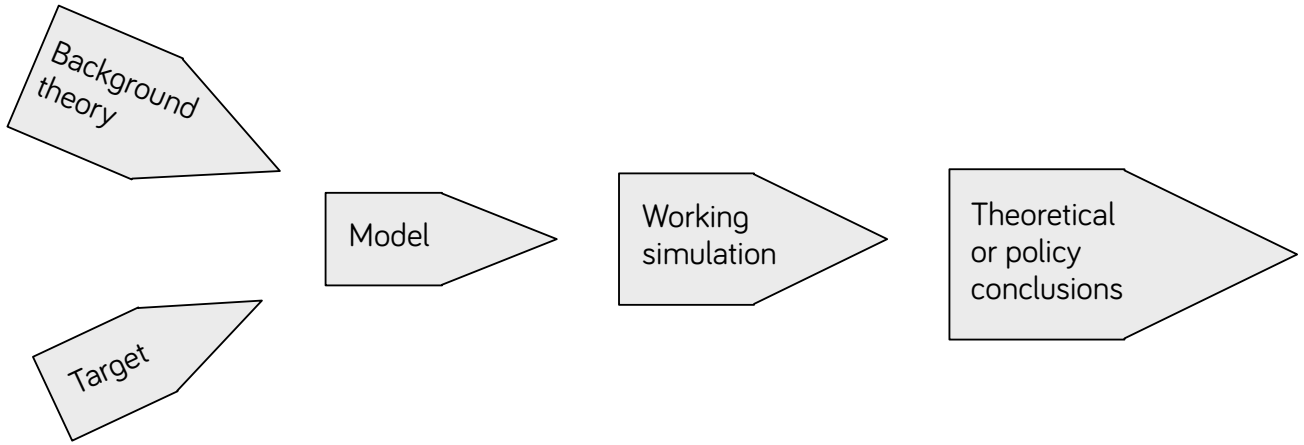
- There are many possible models of a given target
- All models abstract from (ignore) some features of the target
- The more complex the model, the harder it is to build and validate
- The more complex the model, the closer it is to the target
  - the "trap of verisimilitude"

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



UNDERSTANDING AND PREDICTION

- 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

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 ‘toolkits’ and ‘packages’
  - adaptability? complexity?
- Special purpose simulation language
  - flexibility?
- General purpose programming language
  - C++, Lisp, Smaltalk, Java
  - development tools?
  - graphics?

REQUIREMENTS

- Permit exploratory programming and incremental development
- Good debugging facilities
- Efficient, for multiple runs
- Easy to learn and in widespread use
- Easy to use input and output
  - Input: buttons, sliders, text input, read from databases
  - Output: plots, files

TOOLS

AgentSheets

Swarm Development Group
www.swarm.org

Star Logo

M A S O N

VALIDATION

- A model which can be relied on to reflect the behavior of the target is "valid"
- Invalidity may result from:
  - generation of spurious outputs.
  - failure to generate required outputs.

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 he 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 20,000 B.C.)
  - differences may be due to any or all of:
    - bad model
    - bad data
    - model is an abstraction of the target
    - 'random' variations, but sampling distribution is unknown

RANDOMNESS

- Functions of randomness:
  - Substitute or all the external and environmental processes which are not being modeled (i.e. exogenous factors) such as 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

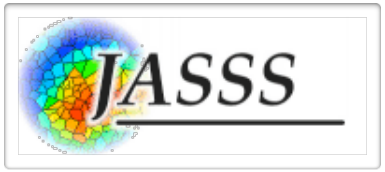
RECOMMENDATIONS

- Start with some 'stylized facts'
- Be deductive, not inductive
- Consider 'crucial experiments'
- Use simulation to develop theories not toys

JOURNALS

- JASS

  Journal of Artificial Societies
  and Social Simulation



- CMOT

  Computational and Mathematical
  Organization Theory