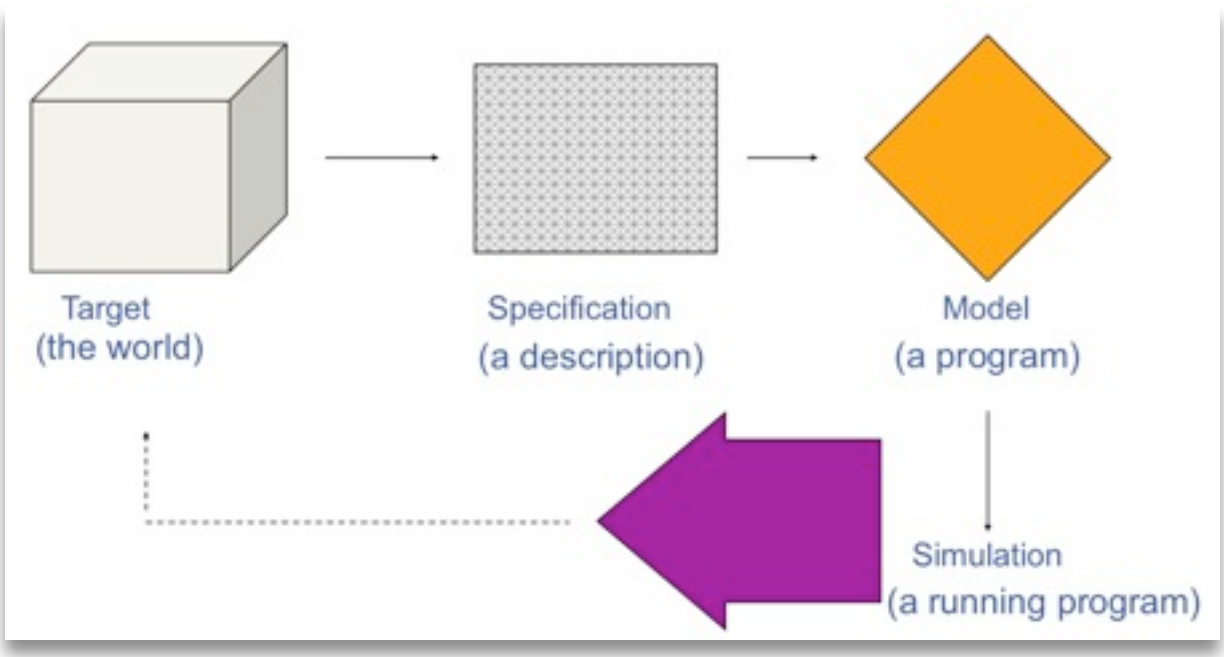
Simulation methodology

Lecture 3



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Outline

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

Simulation research in context

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- Begin by thinking about simulation as “just another research method” you could choose
- Don’t try to predict a straight line
- Don’t try to predict “the causes of WWII”
- Don’t try to learn everything at once
- Don’t choose your topic without regard to available data

Terminology

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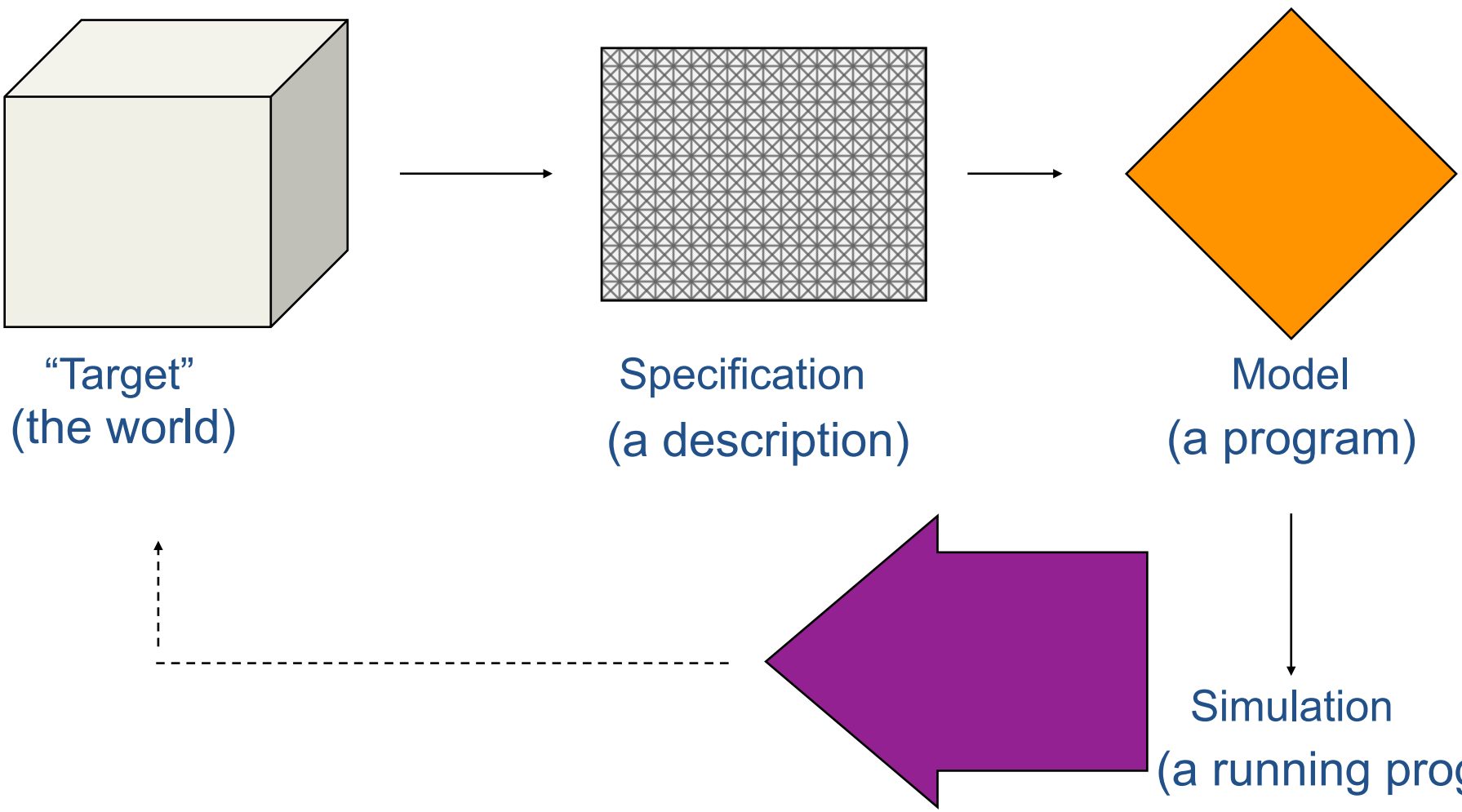

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The logic of statistical modelling

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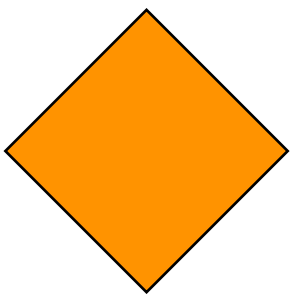
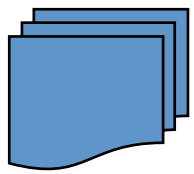


Model

Parameter estimation

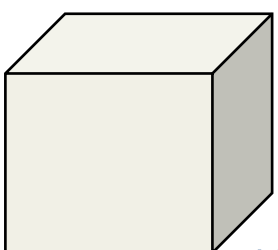
$$\hat{y} = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + \varepsilon$$

Predicted data



Abstraction

Numerical similarity

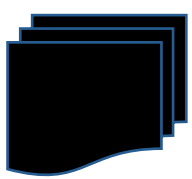


Target

(School success)

Data gathering

Collected data



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The logic of simulation

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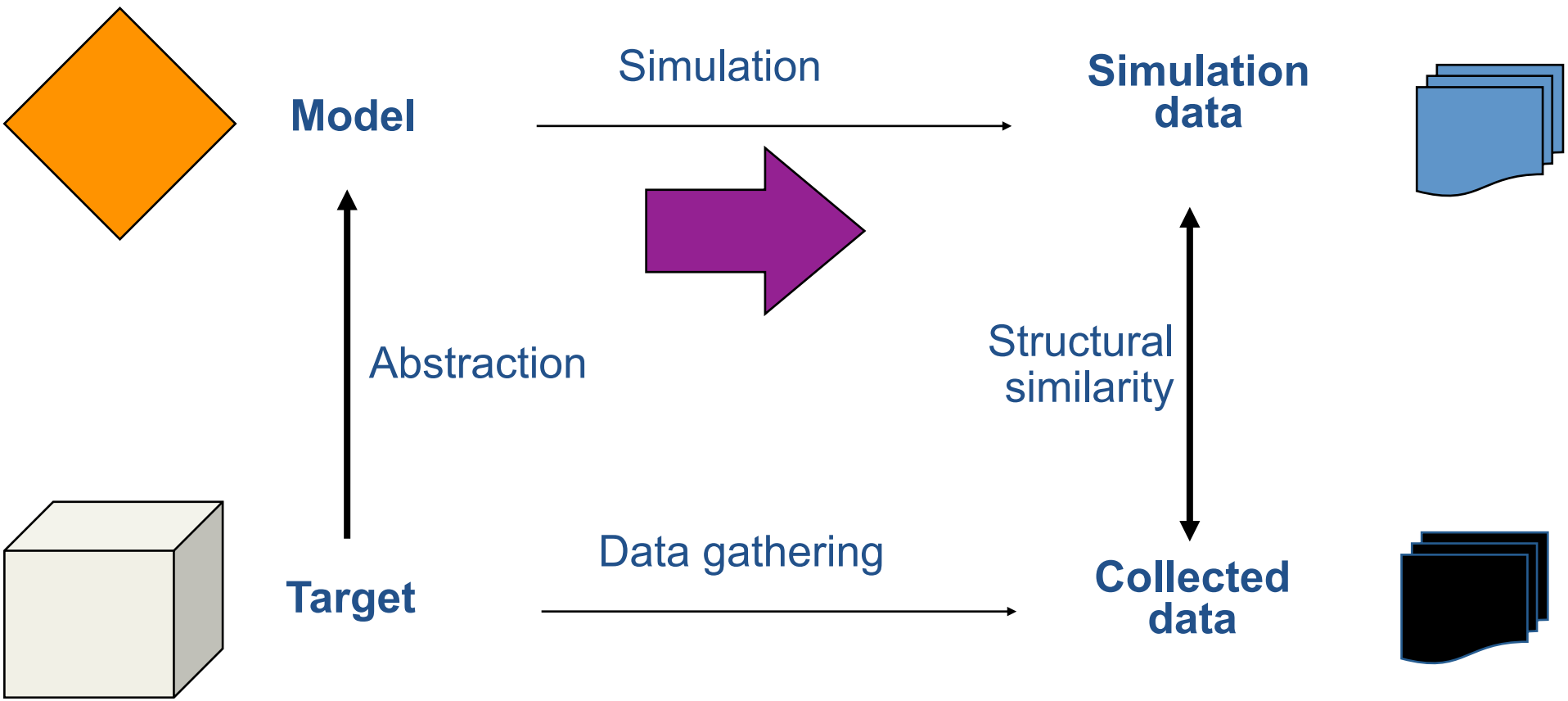

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Not "just another" method

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- Astronomy built bigger and bigger lenses until they sagged under their own weight. Then they had to try something else
- If you think you need lots of "variables" to explain, this places a requirement on the data you need and you still don't know *why*
- If you think "detail" is important, you must still show how it fits together to test that claim
- Quantitative research struggles to access process from pattern and qualitative research vice versa. (But there are other methods.)

Research steps

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- **Define research question from literature**
- Specify hypothesis (some data must be intended for validation as well as calibration)
- List assumptions (calibration knowledge)
- **Design and build model**
- Verify model
- Validate model or fail and repeat steps (but don't "use up" all validation data)
- Draw conclusions

Research questions

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- Possible questions
  - What happened?
    - Model a past process: Why do societies collapse?
  - What might happen?
    - Predict the future: What effects does resource exhaustion have?
  - What are the sufficient conditions for it to happen?
    - Explain a process: Can segregation arise without xenophobia?
- Be focussed and specific. Make sure your system has a clear “inside” and “outside”
- Think about what processes are involved and which actors. (The one sentence research question.)

Which model?

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- There are many possible models of a given target. Therefore think about comparison of real and simulated data right from the start. (Schelling "problem".)
- All models abstract from (ignore) some features of the target. Therefore start from "what is known" in the literature as a justifiable beginning
- The more complex the model, the closer it is to the target (as long as the model is not so big and lacking calibration that it can explain anything)
- But the more complex the model, the harder it is to build and perhaps validate. (Validation advantage of simulation as "complex object".)

Building models: decisions

- Type of model
  - modelling approach (Caution!)
  - degree of abstraction (ideal for beginners is specific model but in new class)
- Size of simulation
  - number/nature of parameters and their relation to data
  - number/nature of agents/units/individuals
- Availability of data ("falsifiability" issue)
- Tools
  - programming experience and effort

Interpretation

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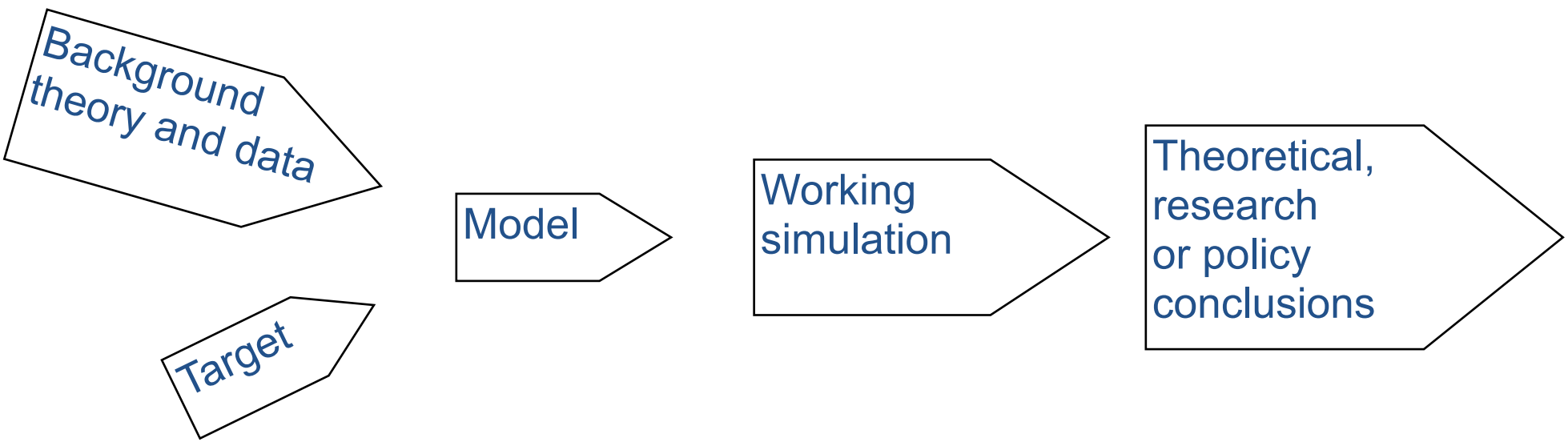
A working simulation is *not* the end of the research



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Publication

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What should a journal article include? (Translation issue)

- The theoretical, empirical and policy background
- The assumptions of the model (distinguish behaviour from code)
- The "hypotheses" to be tested (strict churches are *not* strong)
- Justification for the choice of type of model
- Outline of model, without implementation detail, but enough to replicate
- 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

Judge how well I followed my own advice in "Using simulation to develop testable functionalist explanations: a case study of church survival", *British Journal of Sociology*, **57**(3).

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