Artificial v. Empirical Experiments in Crime Prevention

John E. Eck
Division of Criminal Justice
University of Cincinnati

Presentation for the
Department of Criminal Justice
Temple University
October 22, 2008

Overview

- Forms of explanation
- Experimentation
- Simulation
- Artificial v Empirical
  - Generative explanation
  - Simulation and falsification
  - Simulated Experiments
- The Validity Paradox & Errors
- Combining Artificial & Empirical Experiments

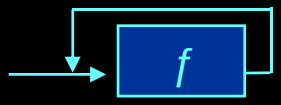
Our Objective

- Explain how crime patterns arise.
  - Crime patterns are macro phenomena.
  - They can be stable or variable.
  - But they are the result of micro level processes

- Using Tinkertoy theories
  - Rational choice (how agents make decisions)
  - Routine Activities (agent interaction)
  - Crime Pattern (agent movement)

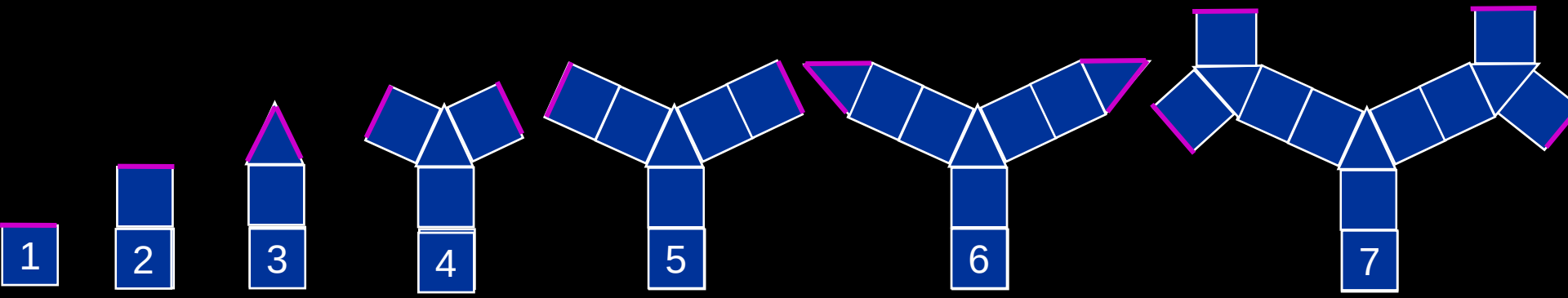
Forms of Explanation

- **Equation:** usually based on an algebraic depiction of theory. If change is being explained then differential equations are used. $L(S)=\frac{\delta T \mu O \alpha P}{(1+\gamma G)(1+\beta H)(1+\varepsilon M)}$
- **Statistical:** a model is selected from a limited repertoire and fitted to a data set. $Y=\beta_0+\beta_1 X_1+\beta_2 X_2+\ldots+\beta_n X_n+\varepsilon$
  - Step 1: find variables involved and relationships
  - Step 2: Generalize to an equation based explanation
- **Generative:** the target phenomena is grown from the interactions of micro entities. Theory is imbedded in algorithms.

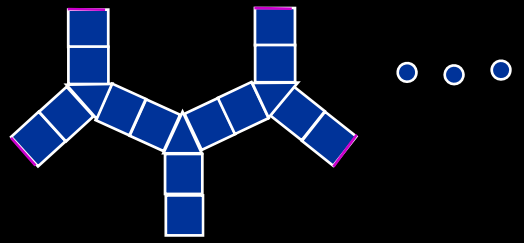


Based on Epstein, 2006

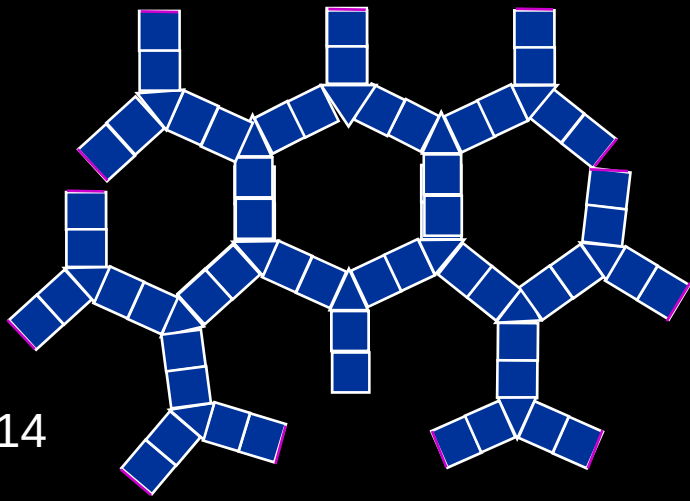
A Simple Generative Model



1) Start with one square; leading face is up.
2) If 2 squares since last triangle, add a triangle,
3) Otherwise add 1 block to leading face(s).

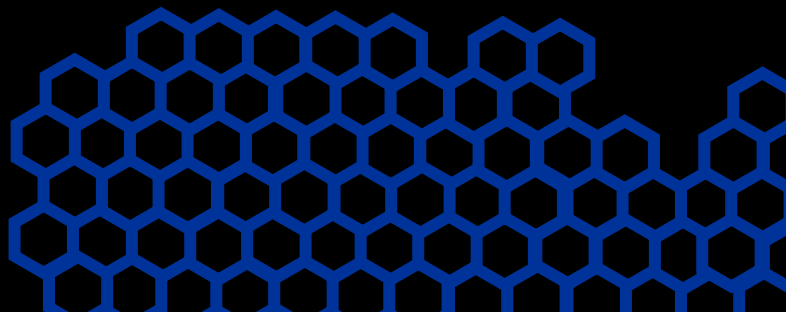


8



14

and so on...



Numbers show iteration.

Epstein's Generative Motto

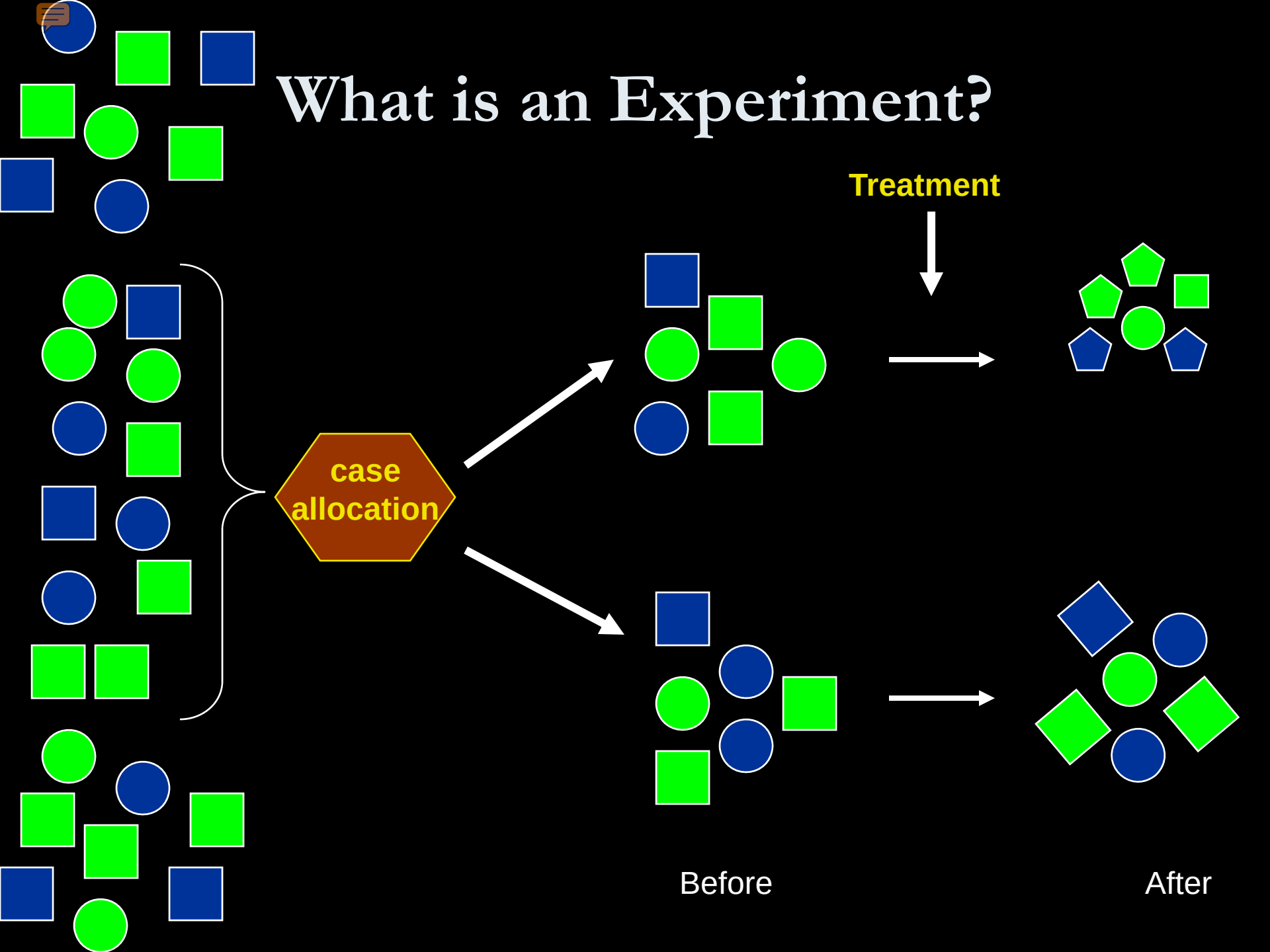
If you didn't grow it,
you didn't explain it.

Joshua M. Epstein, 2006
Generative Social Science
page xii

What is an Experiment?

- Variety of definitions
- Restricted definition
  - Manipulation of some input
  - Observe changes in output
- Special strategies to eliminate rival explanations
  - Standardization of inputs
  - Control groups
  - Randomization of cases

What is an Experiment?



Some Issues

- To what degree has the experimental intervention captured the meaning of the theoretical construct?
- To what degree are the cases tested like the cases one encounters in nature?
- To what degree can we attribute changes in treated cases to the treatment?
- To what degree are results generalizable to other experiments or real world application?

Why We Experiment

- Determine how the real world operates
- Learn what can change the real world
- Test assertions of causal connection

What's a simulation?

- We create an artificial world based or real world.
- In this artificial environment
- we manipulate parts
- to see how other parts change.
- Then infer back to real world.

We know who these guys are even though they are unrealistic.

Why Bother to Simulate?

- **We cannot see the mechanism operate**
  - (e.g., how the sun works)
- **Process is extremely complex (many variables, non-linear relationships, over multiple levels)**
  - (e.g., global warming)
- **The process occurs in exceptional time intervals:**
  - fast (e.g., explosions)
  - slow (e.g. evolution)
- **The empirical data is filled with error**
  - (e.g., the rise and decline of early western American cultures)

Artificial v. Empirical: Round 1

Artificial

- Setting is fake
- Intervention is fake
- Agents are fake
- Relations among agents are fake
- Connection to reality is imagined

Empirical

- Setting is...? (field & lab)
- Intervention is real
- Agents are human
- Relations among agents are often unknown
- Connection to reality is …?

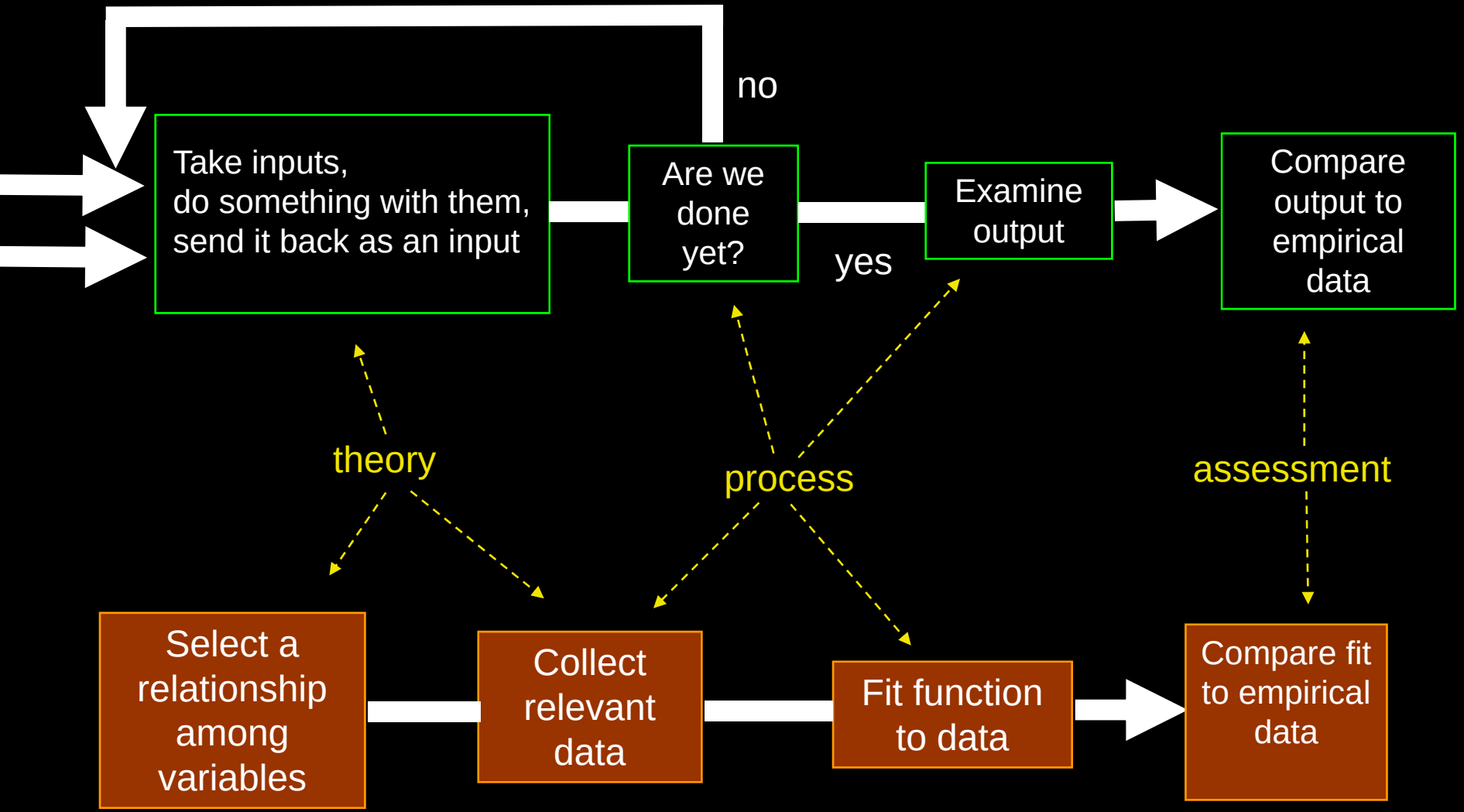
Artificial v. Empirical: Round 2

Theory of a set how an outcome is produced

Operationalization

Artificial	Empirical
Write code describing theory	Create reduced variable environment
Manipulate settings in code	Manipulate inputs
Observe variation in outcomes	Observe variation in outcomes
Compare outcomes to real world outcomes	Make inferences to actual operations

Generating v Estimating



We are Too Data Reliant

- Our sources are often ignorant —e.g. victims.
- Our sources often will not speak —e.g. cj agents.
- Our sources often lie —e.g. offenders
- Our interrogation methods are limited —e.g. surveys.

Why would we expect our data to tell us the truth?

Artificial v. Empirical: Round 3

Artificial v. Empirical: Round 4

Validity	Empirical	Artificial
Construct	Variable, Strong on measures	Variable, Strong on processes
Internal	Variable, but clear standards	High, but threats from software
Statistical	Variable	Variable
External	Difficult to judge	Difficult to judge
Application	Unknown	Unknown

Cute, but is it Science?

- Popper's boundary between science and non-science: falisifiability.
- A procedure that can show a statement is false, is a scientific procedure.
- Not all such procedures require data:
  - Mathematics
  - Logic

How Simulations Can Falsify?

- Assume simulation S is a formalization of theory T and T describes how Y is formed.
- Can simulation S generate outcome Y?
  - If “yes”, then T is sufficient for Y.
  - If “no”, then T is insufficient for Y, and
  - T is false.
- But, there may be a theory R which is also sufficient for Y...

Simulated Experiments

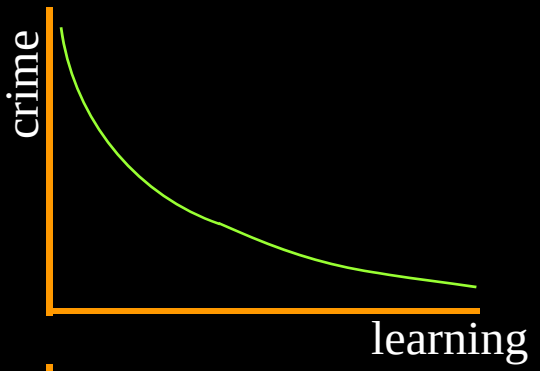
- Create simulation of process
- Systematically alter settings
- Examine results

- Examples from SPACES
  - Change offender learning – does offender adaptation increase crime?
  - Change victim learning – does victim adaptation decrease crime
  - Change police patrol method – does police strategy influence crime patterns?
  - Change target density – does increased density create guardianship?

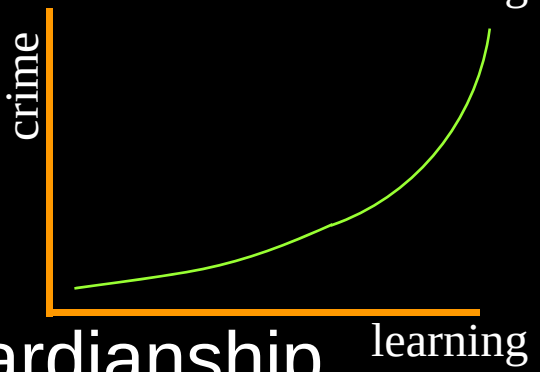
* SPatial Adaptive Crime Event Simulation

Example: Target Learning & Crime

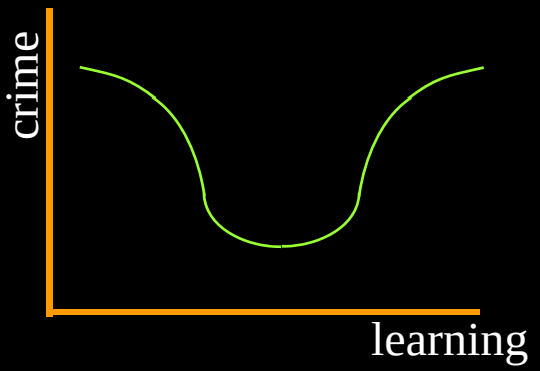
- Slow learning targets do not adapt
- They get repeatedly victimized
- Crime high relative to rapid learning



- High learning targets adapt
- They move away from crime sites
- This decreases density, reducing guardianship
- Increasing victimization



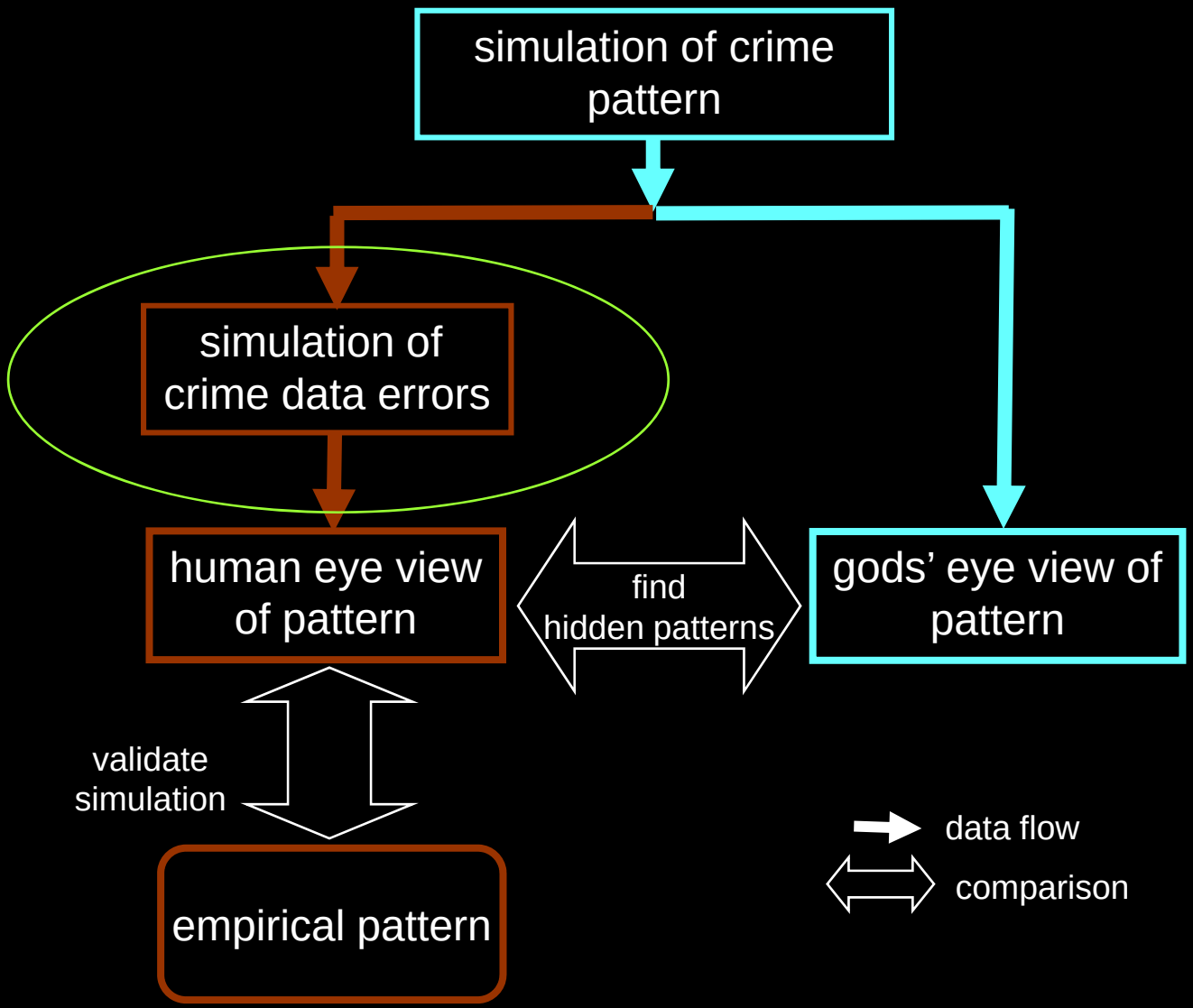
- Combination



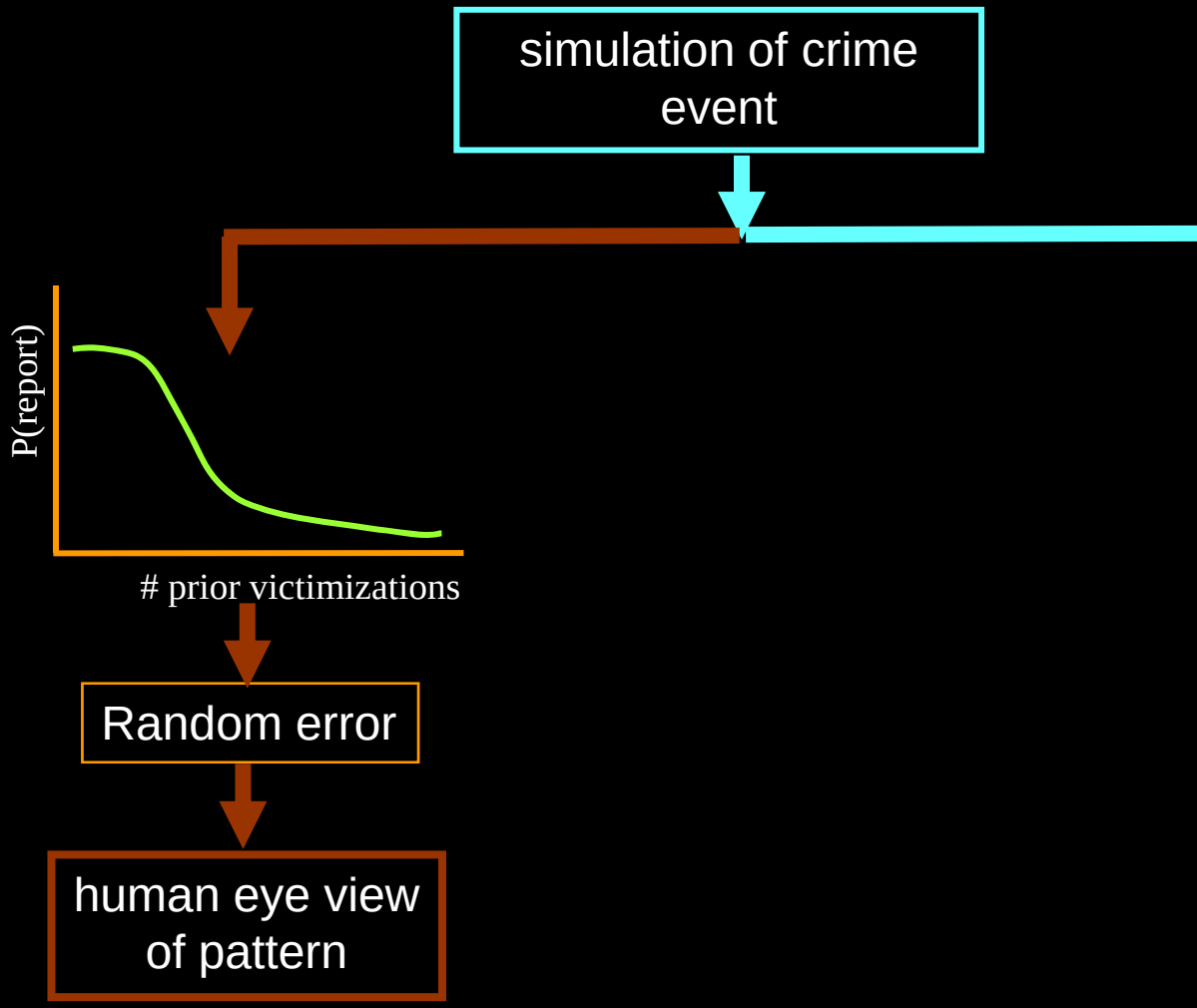
Crime Simulation Validation Paradox

- Crime data is highly error prone
- Simulation generates results
- Compare simulation to empirical patterns
- Do not match
  - Is the simulation wrong?
  - Is the data wrong?

Simulating Error



Example of Simulating Error



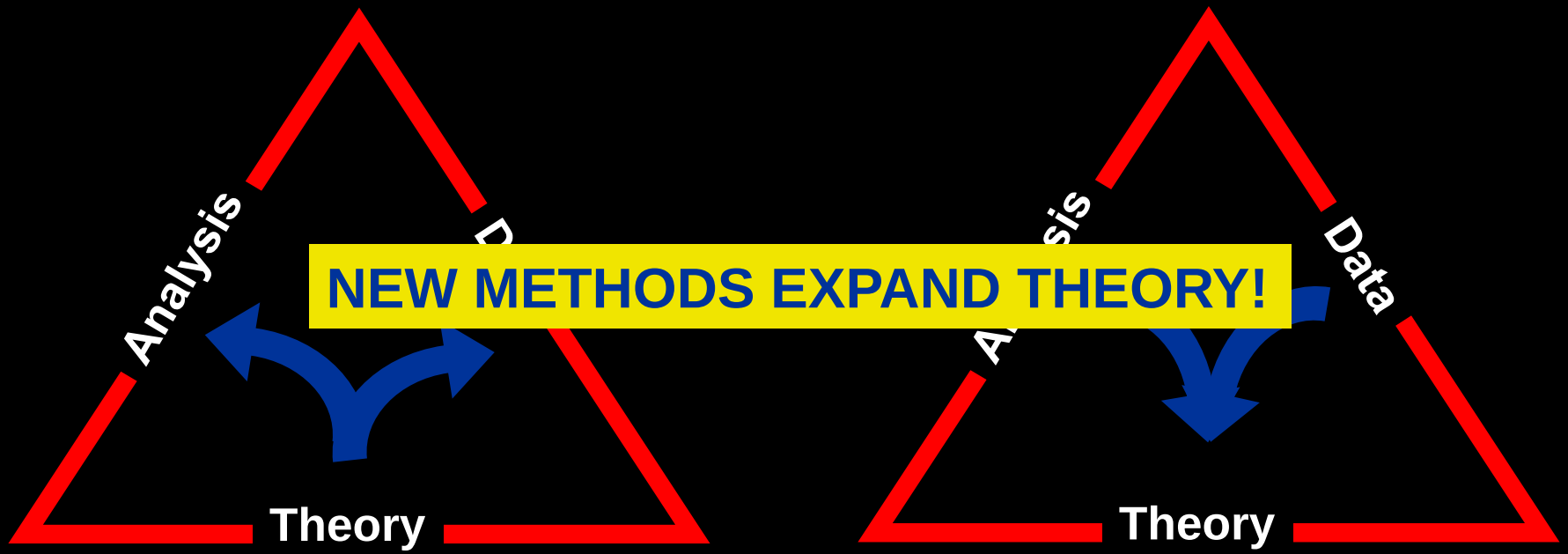
Some Uses of Simulation in Empirical Experiments

- Improving theory by formalizing
- Specifying mechanism
- Elimination of insufficient theories
- Generating expected outcomes of intervention
- Revealing hidden patterns
- Estimating time to impact
- Estimating time to wear off

Improving Theory by Expanding Methods

What we're taught

What really happens



Theory drives data & analysis

Limits on data & analysis constrain thought

end