

# The Computer Experiment in Computational Biology



# The Epistemological Questions

- How do we come to know biological knowledge?
- What do we (or should we) accept as support for proposition in biological science research?
  - Often “real” experiments are not possible
    - Only one real history
    - Ethical issues
- What role can simulation play in answering the above?
- Does simulation have a role beyond “fishing expeditions”?
  - Simulation just discovers phenomenon for “real experiments”?

# Classical Scientific Method

1. Observe the world
  - a) Identify a puzzling phenomenon
2. Generate a falsifiable hypothesis (K. Popper)
3. Design and conduct an experiment with the goal of disproving the hypothesis
  - a) If the experiment “fails”, then the hypothesis is accepted (until replaced)
  - b) If the experiment “succeeds”, then reject hypothesis, but additional insight into the phenomenon may be obtained and steps 2-3 repeated
4. Then add to the body of theory
  - a) A new axiom/law
  - b) A new model
  - c) Then derive new deductions or model conclusions

(Note: Realism vs Instrumentalism)

# The Computer Experiment

The New York Times

Editorials/Op-Ed

March 4, 2003

HOME

JOB MARKET

REAL ESTATE

AUTOS

NEWS

[International](#)

[National](#)

[Washington](#)

[Business](#)

[Technology](#)

[Science](#)

[Health](#)

[Sports](#)

[New York Region](#)

[Education](#)

[Weather](#)

[Obituaries](#)

[NYT Front Page](#)

[Corrections](#)

OPINION

[Editorials/Op-Ed](#)

[- Columns](#)

[Readers' Opinions](#)

FEATURES

[Arts](#)

[Books](#)

[Movies](#)

[Travel](#)

[NYC Guide](#)

[Dining & Wine](#)

[Home & Garden](#)

[Fashion & Style](#)

SEARCH [Go to Advanced Search/Archive](#)

Past 30 Days

[GO TO MEMBER CENTER](#)

[LOG OUT](#)

Welcome, [gmadey](#)

## The Real Scientific Hero of 1953

By STEVEN STROGATZ

THACA, N.Y.

Last week newspapers and magazines devoted tens of thousands of words to the 50th anniversary of the discovery of the chemical structure of DNA. While James D. Watson and Francis Crick certainly deserved a good party, there was no mention of another scientific feat that also turned 50 this year — one whose ramifications may ultimately turn out to be as profound as those of the double helix.

In 1953, Enrico Fermi and two of his colleagues at Los Alamos Scientific Laboratory, John Pasta and Stanislaw Ulam, invented the concept of a "computer experiment." Suddenly the computer became a telescope for the mind, a way of exploring inaccessible processes like the collision of black holes or the frenzied dance of subatomic particles — phenomena that are too large or too fast to be visualized by traditional experiments, and too complex to be handled by pencil-and-paper mathematics. The computer experiment offered a third way of doing science. Over the past 50 years, it has helped scientists to see the invisible and imagine the inconceivable.

E-Mail This Article

Printer-Friendly Format

Most E-Mailed Articles

ARTICLE TOOLS  
SPONSORED BY

STARBUCKS.COM

### TIMES NEWS TRACKER

Topics

[Fermi, Enrico](#)

[DNA \(Deoxyribonucleic Acid\)](#)

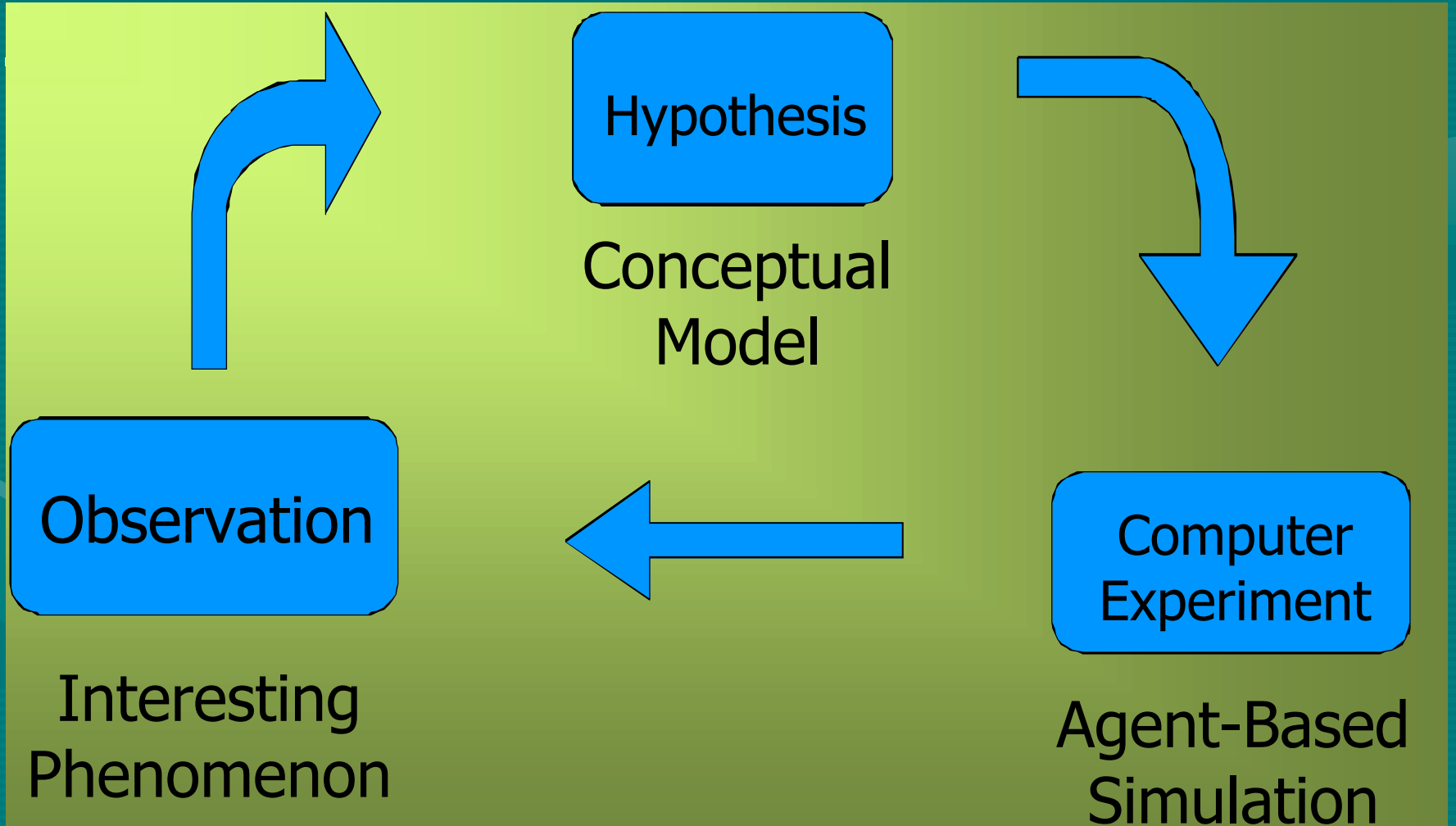
[Science and Technology](#)

[Create Your Own](#) | [Manage Alerts](#)  
[Take a Tour](#)

[Sign Up for Newsletters](#)

Alerts

# Agent-Based Simulation as a Component of the Scientific Method



# Discussion

- Is simulation better for falsification, but weaker at confirmation of hypotheses?
- Under what conditions can simulation results be accepted as confirmation of a hypothesis?
  - Need more validation/verification of simulations
    - Confidence in results
    - Case of computer proofs (four color problem in mathematics)
- Or is the real value of the simulation for “fishing around” for developing new hypotheses? Discovery?
  - Hidden relationships/rules-of-operations
  - Hidden features of components
  - Black-box, grey-box, white-box models
  - Discovery by reverse engineering