Lewandowsky (1993). The rewards and hazards of computer simulations. *Psychological Science, 4*, 236-243.

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Rewards & Pitfalls of Simulations

Rewards of simulations:

1. disambiguate new (unconstrained) ideas in a formal framework
2. explore complex models (due to our limited reasoning ability)
3. specify simple models to reveal logical inconsistencies
4. predict counterintuitive findings
5. uncover hidden relationships among disparate findings
6. open to replication & scrutiny just like experiments
7. allow manipulations not possible in humans

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Rewards & Pitfalls of Simulations

Pitfalls of simulations:

1. code may differ from theory
2. predictions don't come from theory but from modeling choices (real world vs. simulated world).
3. Bonini paradox
   - the simulation is no easier to understand than the real world processes it was supposed to illustrate

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Dror & Gallogly
Why use biologically implausible models?

- Attention to advances in neuroscience has increased the use of *biological plausibility* as a guiding principle in the construction of computational models of cognition.
- The aspect of connectionism that has received the most criticism regarding biological implausibility is the use of "backprop" in some models.

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Dror & Gallogly
Why use biologically implausible models?

Some users of "backprop" have tried to argue:

1) The algorithm is not literally true, but it reflects same algorithm used by brain.
2) The final configuration is plausible, so this does not detract from plausibility of "mature model."
3) A node does not equal a neuron.
4) The algorithm is functionally equivalent to a biologically plausible algorithm.
5) The model is a simplified version of the brain.
6) Backprop *is* biologically plausible.

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Dror & Gallogly
Why use biologically implausible models?

Marr described 3 levels of analysis that are needed to understand complex information processing:

1) computational theory,
2) representation and algorithm,
3) hardware implementation.

- This hierarchy has set up the idea in cognitive neuroscience that biologically implausible models can't make a contribution.

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Dror & Gallogly
Why use biologically implausible models?

- A more constructive view is a modified version of Kosslyn & Koenig (1992)
  - "Triangle" with behavior at the top (the ultimate goal of our science) and computational analysis and biology at the vertices.
- After all, the goal of cognitive neuroscience is to understand the cognitive (computational) processes that underlie human intelligence and the human mind, not to understand any computational entity per se.

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Dror & Gallogly
Why use biologically implausible models?

Contributions of biologically implausible models:

- Explore and characterize the *problem* that the system encounters and resolves:
  - One problem, or
  - Composed of computationally distinct subproblems [what/where]
    - In such cases, there are probably distinct cognitive modules and neuronal substrates.
  - Computational complexity of the problem
    - Qualitative hierarchy suggests different structural mechanisms
    - Quantitative hierarchy suggests differences in amount of effort, number of steps.

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Dror & Gallogly
Why use biologically implausible models?

Contributions of biologically implausible models:

- Analysis of the problem may highlight a mismatch between the complexity of the problem and the amount of resources needed to solve it
  - May force us to a re-conceptualize the problem.
- Examine availability of information in the environment and its representation
  - Computationally efficient methods may guide search in biological system, or
  - May lead to questions of why the biological system may NOT use computationally most efficient method
    - Mother nature is NOT an engineer
- Evaluating and understanding the solution enables us to understand +/- of different information processing schemata, and may help establish criteria for evaluating and examining actual neural solution.

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