Varieties of Reproducibility
in Empirical and Computational Domains

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Workshop on Reproducibility in Machine Learning
RML@ICML 2018
computational cognitive neuroscience

cognitive modelling

computer science

psychology, neuroscience, cognitive science

Ph.D. reproducing comp models
Reproducibility


Talk Outline

What is reproducibility? Why is it important?
What is reproducibility? Why is it important?

How can we achieve it?
What is reproducibility?

running the same experiment and getting the same* results in the same lab
What is reproducibility?

running the same experiment and getting the same results in a different lab

https://doi.org/10.1371/journal.pone.0141357
What is reproducibility?

running the same or conceptually similar experiment and getting the same* results under slightly different conditions

https://cogbio.univie.ac.at/research/research-groups/pigeon-lab/
What is reproducibility?

running the same code and getting the same* results on the same machine
What is reproducibility?

running the same code and getting the same* results on a different machine
What is reproducibility?

running the same code and getting the same* results after 3 years; after updating libraries; etc.
What is reproducibility?

time- and machine-independent code
What is reproducibility?

But what about time- and machine-independent understanding, ideas, theories?

What is reproducibility?

What about software, a model, being reproducible given a theory or specification?
What is reproducibility?

If we use a model to demonstrate a theory then the theory should be enough to recreate the model...
What is reproducibility?

**Type 1:** software people predominantly care about code being time- and machine-independent
What is reproducibility?

**Type 2:** scientists/modellers also care about the specification.
What is reproducibility?

**Type 2**: can software written based on the article capture the theory?
What is reproducibility?

90% of all code comments:

Specification ≠ comments
What is reproducibility?

90% of all code comments:

Specification ≠ documentation
What is reproducibility?

90% of all code comments:

Specification ≠ code
Why is reproducibility important?

Classical Mechanics

Law I.

Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impress'd thereon.

Law II.

The alteration of motion is ever proportional to the motive force impress'd; and is made in the direction of the right line in which that force is impress'd.

Law III.

To every Action there is always opposed an equal Reaction: or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.

Motte (1729)
Classical Mechanics

\[ \sum F = 0 \iff \frac{dv}{dt} = 0 \]

\[ F = m \frac{dv}{dt} = ma \]

\[ F_A = -F_B \]
Cellular Automata

**rule 30**


left XOR (centre OR right)
Achieving reproducibility

Share code
Achieving reproducibility

Share code, share data... but not enough!
Achieving reproducibility

Write stuff up well!

The Scientific Method as an Ongoing Process

- **Make Observations**: What do I see in nature? This can be from one's own experiences, thoughts, or reading.
- **Think of Interesting Questions**: Why does that pattern occur?
- **Think of Hypotheses**: What are the general causes of the phenomenon I am wondering about?
- **Gather Data to Test Predictions**: Relevant data can come from the literature, new observations, or formal experiments. Thorough testing requires replication to verify results.
- **Develop Testable Predictions**: If my hypothesis is correct, then I expect a, b, c,...
- **Refine, Alter, Expand, or Reject Hypotheses**: Develop General Theories: General theories must be consistent with most or all available data and with other current theories.

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Thank you!

