Pluralism and Computational Individuation

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October 28, 2019
Outline

1. Introduction: Individuation
2. Modeling
3. Computational Pluralism
What is computational individuation? A few different questions:

- What distinguishes physical systems that compute from those that don’t?
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- What distinguishes physical systems that compute from those that don’t?
- Among computing systems, what distinguishes those that perform the same task from those that don’t?
What is computational individuation? A few different questions:

- What distinguishes physical systems that compute from those that don’t?
- Among computing systems, what distinguishes those that perform the same task from those that don’t?
- Among those that perform the same task, what distinguishes those that perform the same task, in the same way, from those that don’t?
Example: tri-stable circuit

Q: why is this an issue?
Example: tri-stable circuit

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- A: even simple logic gates are ‘computationally indeterminate’.

Tri-stable circuit adapted from Shagrir (2018).
Example: tri-stable circuit

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A: even simple logic gates are ‘computationally indeterminate’.

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<thead>
<tr>
<th>Input 1</th>
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Tri-stable circuit adapted from Shagrir (2018).
Grouping 1: OR

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Grouping H and M together.

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### Grouping 2: AND

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Grouping M and L together.

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The semantic view

- Computational entities, tasks, and ways of performing them are always individuated at least partly in terms of their semantic properties.\(^1\)

\(^1\)Shagrir 2001, 2018; Sprevak 2010.
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States with same/similar contents are grouped together:

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  - If H, M have same/similar content, favour OR grouping.
  - if M, L have same/similar content, favour AND grouping.

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The causal-mechanical view

Here the idea is that it is enough to look at the causal-mechanical structure of a system to determine computational status.²

The causal-mechanical view

- Here the idea is that it is enough to look at the causal-mechanical structure of a system to determine computational status.\(^2\)
- Not obliged to consider content to determine computational structure in this case.

### Individuation Scheme of Dewhurst (2016)

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Individuation scheme of Coelho Mollo (2017).
Why choose?

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Causal-mechanical: what non-semantically characterized tasks are performed by the system perform, and how?
Why choose?

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  - Semantic: what representational tasks are performed by a system, and how?
  - Causal-mechanical: what non-semantically characterized tasks are performed by the system perform, and how?
- Given this, why do we have to choose just a single individuation scheme?
Outline

1. Introduction: Individuation
2. Modeling
3. Computational Pluralism
Modeling

Figure: from Godfrey-Smith 2007.
Some common features of models:\textsuperscript{3}

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Modeling

- Some common features of models:\(^3\)
  - Indirect representation.

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  - Mathematical models: Turing machines, DFAs, neural networks etc.
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  - The above supplemented with particular causal-mechanical, semantic, or teleofunctional properties as needed.
Figure: from Harris and Harris 2013, p. 397.
Computational modeling

- Indirect representation: results about e.g. TMs, microarchitectures deliver information about actual physical systems.
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- Models are judged to be successful (unsuccessful) to the extent that they are well (ill) suited to certain investigator interests, explanatory aims, etc.
- This suggests that there is no single, privileged model of a given system; instead, we should pluralists about modeling.
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Pluralism

**Pluralism** about some subject matter is the view that there are multiple different but equally useful, reasonable, legitimate, accurate, or even true accounts of that subject matter.
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- Legal pluralists think that there are multiple different but equally legitimate legal systems.
- Etiquette pluralists think that there are multiple different equally legitimate norms of etiquette.
- And so on...
One road to pluralism

One route to pluralism, although not the only route, goes by way of relativism.

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\footnote{See Shapiro (2014).}
One road to pluralism

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- Relativism about some subject matter X is the view that something is an X only relative to some Y.

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One road to pluralism

- One route to pluralism, although not the only route, goes by way of **relativism**.
- Relativism about some subject matter X is the view that something is an X only relative to some Y.
- Pluralism about X arises when Y may take on multiple different but equally legitimate values.\(^4\)

\(^4\)See Shapiro (2014).
Modeling pluralism

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Modeling pluralism

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- To the extent that different models may fulfill different explanatory aims, we get a kind of pluralism about scientific modeling.
Computational Pluralism

Modeling pluralism

- Relativism about modeling is the view that something is a good model of a system only relative to some explanatory aim.
- To the extent that different models may fulfill different explanatory aims, we get a kind of pluralism about scientific modeling.
- No need to view different models as ‘competitors’.
Computational pluralism is the view that there are multiple different but equally legitimate computational models.

- Computational pluralism
Computational pluralism

- **Computational pluralism** is the view that there are multiple different but equally legitimate computational models.

- The semantic and mechanistic individuation schemes (and perhaps others) home in on equally legitimate models, relative to different explanatory aims.
Computational pluralism

- **Computational pluralism** is the view that there are multiple different but equally legitimate computational models.
- The semantic and mechanistic individuation schemes (and perhaps others) home in on equally legitimate models, relative to different explanatory aims.
- In keeping with the modeling perspective, we needn’t view them as competitors. Instead, they are each better or worse suited to certain explanatory tasks.
Individuation schemes concern resemblance

Figure: from Godfrey-Smith 2007.
A case of non-semantic computation

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- For example: performance of a given pipelining scheme (or some datapath modification in general) measured in instructions per second.
- Here instructions are best individuated not in semantic terms – whether it’s an add or a multiply or whatever – but in terms of cycles to execute.
- Upshot: in these sorts of cases, a non-semantic model of computation is appropriate.
A case of semantic computation

Other times, computer scientists wish to explain ‘semantically laden’ tasks.
A case of semantic computation

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- For example: why two systems compute the same arithmetic function.
A case of semantic computation

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- For example: why two systems compute the same arithmetic function.
- Even if this also employs a non-semantic individuation scheme, e.g. of computational vehicles, a semantic scheme is required to answer the question about function computation.
Upshots

- The modeling perspective fits computation into the broader context of scientific modeling.
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- To the extent that modeling pluralism is correct, even mundane, computational pluralism follows as a special case.
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- To the extent that modeling pluralism is correct, even mundane, computational pluralism follows as a special case.
- Questions about computational individuation turn out to be questions about which computational models are appropriate for different explanatory purposes – but there no special problems here for computation.


