Marcin Miłkowski,
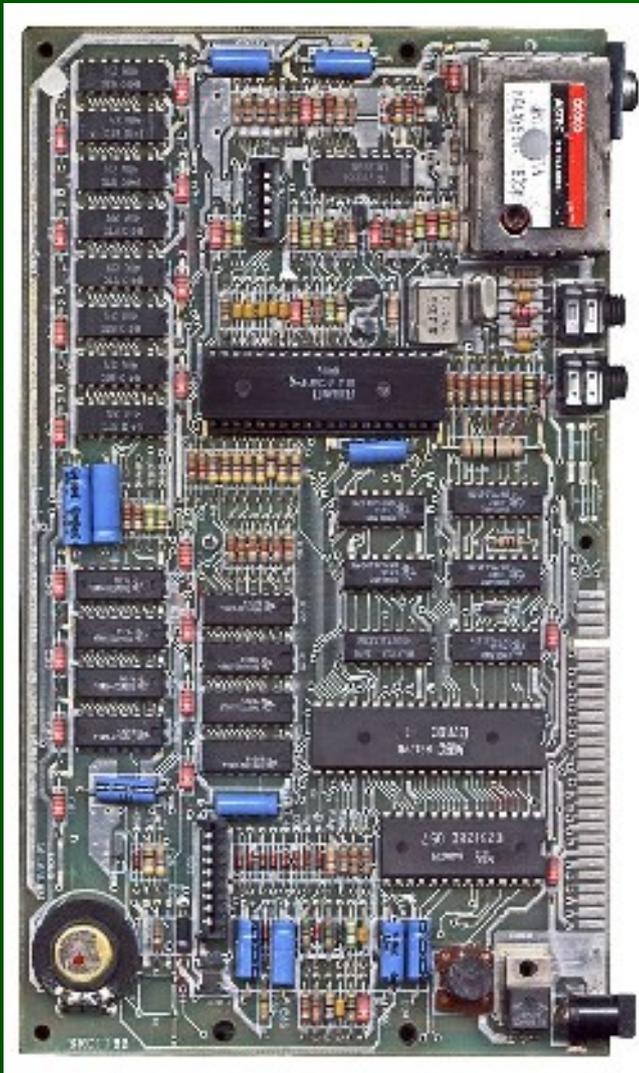**Polish Academy of Science, Warsaw Institute of Philosophy & Sociology**

When physical systems realize computation?

27/08/08

Overview

- Computational explanations as mechanistic

- Criteria of ascribing computations:
  - Epistemic
  - Mechanistic
  - Code correspondence

Do physical and biological systems compute?

=

?

Computational Explanations

- Computational Explanations are a kind of mechanistic explanations: how a mechanism realizes a function?
    - Explanations involve specifying the component parts and the interactions between them (Cummins, Bechtel, Craver)
    - Computational processes are not different from any other mathematically specifiable processes

Computational Explanations

- According to Searle & Putnam, computational properties are conventional but it makes all science conventional as well

- I'm arguing that computation is a natural kind

- BUT: computation and information can be ascribed to objects of any scale and size, like fundamental physical properties

Explicating Computation...

- Is all information processing computation? (What about analog computation?)

- What about hyper-Turing computation?
  - These are mostly verbal problems

Epistemic Criteria

- Explanatory and predictive value
  - More E&P value than purely mechanistic/functional explanation in causal terms (Occam's Razor)

- Constant and coherent ascriptions
- Simplicity and parsimony

Mechanistic Criteria

- Computational systems must be systems (or subsystems)
  - Frequency of interaction delineates the system
  - Systems must be relatively isolated (but open to be able to interact) and cohesive
  - Implementation of computational process in the mechanism requires supervenience over causal structure

Mechanistic criteria

- Mechanism must be identifiable on the lower level:

  - It must be a mechanism not just in virtue of computational description but of the structure of the whole system

  - There must be functional structures that implement it

Code Correspondence Criteria

- The computation must be specified in terms of code:

  - ≥ 0 output values

  - ≥ 0 input values

  - The code must match (intensionally) the causal structure of the process from start to end; the algorithm is to be specified not just in terms of I/O

  - For a general notion, it is not required that code is specified in terms of digital computation (can be analog)

Code Correspondence Criteria

- Classical digital computation: UTM-specifiable (=partial recursive functions etc.)

  - The explication should only require that code be specified in any ideal computation theory that could supersede the current one (transparent computationalism, Chrisley)

  - Representations are not required in the computational system (but not excluded!)

Test Case 1: PDP-11

- PDP-11:
  - A successful DEC minicomputer (the first one where C and Unix became popular)
  - Fulfills all criteria

Test Case 2: Searle's Wall™

- According to Searle, this wall implements WordStar™

- But criteria are not fulfilled:

  - No new prediction/explanation
  - No code actually ascribed to mechanism
  - No mechanism identified

Test Case 3: *Lavatera cretica*

- Paco Calvo 2007:
    - Do plants compute? The blunt answer is "yes".
    - Leaf laminas of *Lavatera cretica* can not only anticipate the direction of the sunrise, but also allow for this anticipatory behavior to be retained for a number of days in the absence of solar tracking.

Conclusion

- ▫ Proposed criteria require vast knowledge about physical systems, so computational explanations in many cases will be idealizations

- ▫ It is not decidable a priori whether a physical system contains a certain mechanism: computational explanation is a tool of empirical science

Thank you!
http://marcinmilkowski.pl

Kazimierz Naturalise Everything Workshop:
http://www.obf.edu.pl/