Is computationalism trivial?

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Is computationalism trivial?

Computationalism =

'Cognition involves computation'.

Cognition involves computation

- This claim is denied by opponents of classical AI (Searle, embodied cognition theory)

BUT

- It seems trivial if basic physical processes are computational (S. Wolfram, E. Fredkin, G. Chaitin, S. Lloyd, Y. Jack Ng, and D. Dennett)

Cognition involves computation

- I will show versions of this claim which are both:

  - plausible and
  - non-trivial even if digital physics is true.

- First I'll disambiguate the computationalism claim.

Cognition involves computation

- The claim is vague:
  - Lacks quantification:
    - Every cognition involves computation.
    - Some cognition involves computation.
  - Terms are vague:
    - *Involves*
      - Neccessarily is?
      - Is reducible to?
      - Requires?
      - Is based on?
    - *Computation*
    - *Cognition* – cognitive processes?

What is computation?

- Computational processes = algorithmic processes

- 'Algorithmic' means:
1. exposing non-stochastic regularity which could be accounted for in some compression algorithm (Chaitin/Kolmogorov sense of 'algorithmic')

What is computation?

- Computational processes = algorithmic processes

- Algorithmic =
2. Implementing recursive functions, or realizing computations (well defined, having input and output data, finite, feasible)

What is computation?

- Computational processes = algorithmic processes

- Algorithmic$_1$ = non-stochastic
- Algorithmic$_2$ = implementing recursive functions

- Algorithmic$_1$ is <u>too weak</u> for any controversial computationalism

Computation as implementing recursive functions

The original claim would translate into:

Cognition involves implementing recursive function.

'Involves' could mean here:
1. is described in terms of...
2. is realized by...
3. is generated by...

Computation as implementing recursive functions

1. is described in terms of...

Cognition is (should/could be) **described** in terms of implementing recursive functions.

- ➤ *Descriptive-algorithmic* meaning of computationalism claim.
  - To be found in 'computer-metaphor' talk
  - Requires only possibility of simulation of cognitive processes by algorithmic processes
  - **Every** finite sequence of discrete values is descriptive-algorithmic

Computation as implementing recursive functions

2. is realized by...

Cognition is realized by implementing recursive functions.

➤ *Realization-algorithmic* meaning of computationalism claim.
- Classical computationalism
- To be found in strong AI

Computation as implementing recursive functions

3. is generated by...

Cognition is generated by implementing recursive functions.

- ➤ *Derivative-algorithmic* meaning of computationalism claim.
  - Could be implied by universal computationalism of digital philosophy (BUT **trivial**)

Realization of recursive functions

- Mere descriptions of algorithms do NOT implement (realize) any functions, if they are causally inert
- 'Realization' should be defined in terms of *discrete states of physical causal processes*

- Multiplication table is not a working computer!
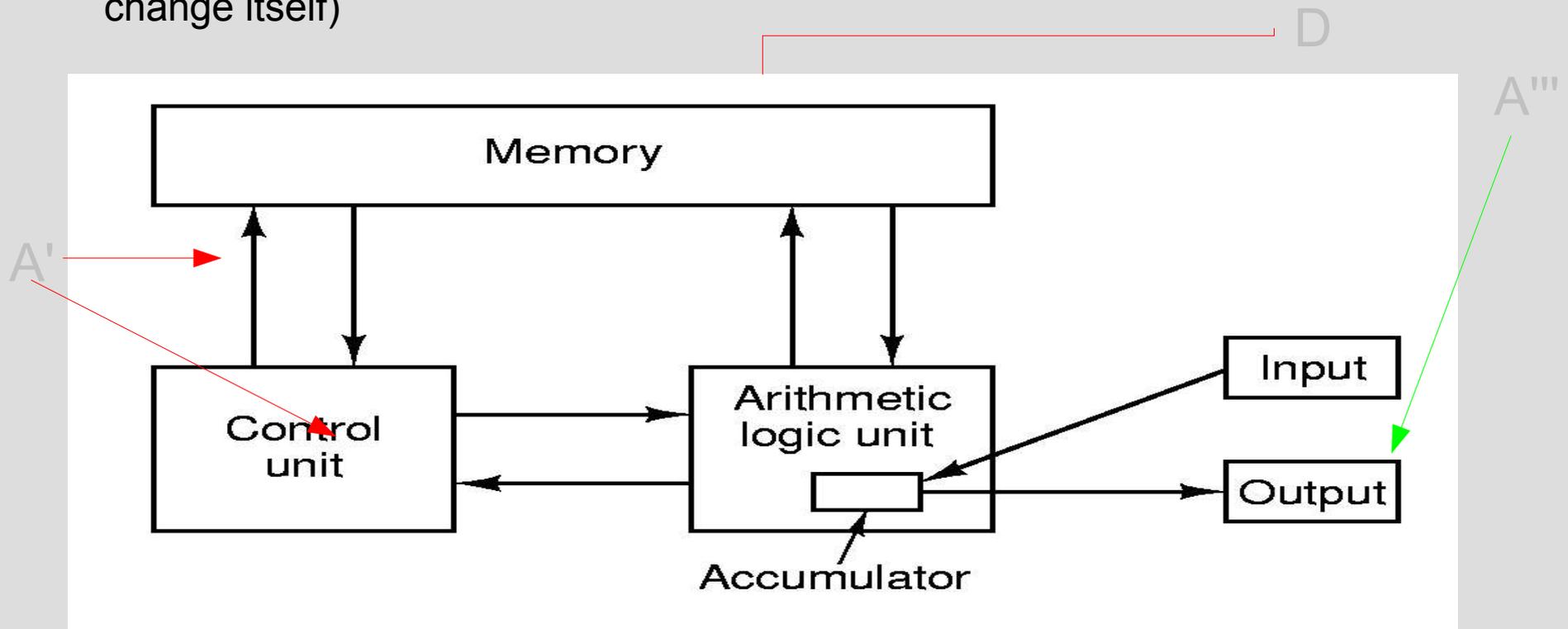
Realization of recursive functions

An algorithm A is **realized** iff
there is a descriptive-algorithmic sequence A'
  encoded in a physical medium that in
  connection with a physical device D causes
  some derivative algorithmic process A'' which
  in turn generate descriptive algorithmic
  sequences A'''.

Realization of recursive functions

A – algorithm realized (for example, source code in Pascal)
A' – algorithm encoded in medium (machine code)
A'' – algorithmic process (machine code realized by integrated circuits) generating new states in the resulting process A''' (could be identical with A' or not; code could change itself)

Realization of recursive functions

An algorithm A is **realized** iff
there is a descriptive-algorithmic sequence A'

- Descriptive-algorithmic sequence is a sequence of states that can be described in terms of recursive functions (physical states interpreted as states of a program).

Realization of recursive functions

An algorithm A is **realized** iff
there is a descriptive-algorithmic sequence A'
encoded in a physical medium

- Coding can be conceived as discrete (but analog as well)

that in connection with a physical device D

- Algorithms are realized by devices (machines)

Realization of recursive functions

An algorithm A is **realized** iff
there is a descriptive-algorithmic sequence A' encoded in a physical medium that in connection with a physical device D causes some derivative algorithmic process A" which in turn generate descriptive algorithmic sequences A"'.

- Algorithms (A') are realized by programs (A") which output descriptive-algorithmic sequences (A"') – they are causally active

Realization of recursive functions

The claim 'Cognition is realized by recursive functions' is however <u>trivial</u> if all processes are realized by computational processes (if 'digital physics/philosophy' is right).

Non-trivial computationalism

The claim 'Cognition is realized by recursive functions' is <u>non-trivial</u> if we accept a multi-level model of cognitive systems. Base-level physical computation would realize then some other algorithms than cognitive-level components.

Multi-level model of cognition

- Levels are defined as local maxima of regularity and predictability in the phase space of alternative modes of organization of matter (Wimsatt:1994)
- Individual levels are emergent (non-aggregative in Wimsatt's sense)

Multi-level model of cognition

- If we accept digital philosophy view, on all levels of organization, there would be computational processes, but they could implement different algorithms.
- Some of these algorithms could be more cognition-specific

Multi-level model of cognition

Levels of organization in cognitive systems

- Physical & chemical
- Neuro-biological
- Computational
- Representational
- Environmental/adaptive
- Experiential/conscious

Multi-level model of cognition

Levels of organization	Implemented algorithms
Physical & chemical	Basic automata
Neuro-biological	Neuronal nets
Computational	*Internal information processing*
Representational	External information processing
Environmental/adaptive	Adaptation/procedural processing
Experiential/conscious	Global workspace models?

Non-trivial computational level

It is not trivial that there is a separate internal information processing level in any cognitive system.

Is it necessary for any cognitive system? Possible? Actual?

Trivial and ultra-weak versions of computationalism

	Weak	Strong
Non-stochastic (algorithmic1)	Cognitive processes can be described as non-stochastic	Cognitive processes are non-stochastic
Derivative-algorithmic	Cognitive processes can be generated by computational devices	Cognitive processes are generated by computational devices

Stronger versions of computationalism

	Weak	Strong
Simulation	Cognitive processes can be simulated as recursive functions	Cognitive processes are simulated as recursive functions
Realization	Cognitive processes can be implemented as recursive functions	Cognitive processes are actually implemented as recursive functions
Multi-level	CP could be described as RF on some level of organization	CP are implemented by RF on some level of organization

Is computationalism empirical?

- The computationalism claim is ascribed various statuses:
  - Empirical
  - Heuristic
  - Conceptual
- In its purely trivial versions it is *conceptual*
- In its non-trivial versions it is (also) *empirical*, and could play a *heuristic* role.
- Algorithmic structure is not, pace Searle, only a matter of interpretation. The causal structure realizing algorithms is as real as any functional causal structure.

What could make computationalism true?

- In its trivial versions, digital physics
- In its multi-level version, it must be shown that such cognitive systems are possible or actual

Summary: non-trivial multi-level claim

- In full form, the multi-level claim would be as follows:

- "Every cognition is realized by recursive functions which implement algorithms on the internal information processing level of cognitive systems"