

Is there a Future for AI without Representation?

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June 12th, 2007 – MDH

1 Brooks – a way out of our troubles?

- Brooks' "new AI" to the rescue: remove bad cognitive science/lack of grounding/mere technical orientation; while solving practical issues in robotics
 - "Representation has been the central issue in artificial intelligence work over the last 15 years only because it has provided an interface between otherwise isolated modules and conference papers." ...
 - "Like the advocates of the symbol system we believe that in principle we have uncovered the fundamental foundation of intelligence." (Brooks 1990, 5.3)
- AI without representing the world?

2 Brooks program

2.2 Theoretical pronouncements/characteristics

Brooks' pronouncements

1. Layered subsumption architecture of augmented finite state machines, increasingly complex (“bottom-up”)
2. Demand for embodiment and situatedness
3. Rejection of central control, “emergence” of intelligence
4. Rejection of representation

Notes

1. Architectural feature
2. Situatedness in the world and embodiment in a physical body are necessary characteristics of *any* robot. (Embodiment implies situatedness.)
3. “There is no central model maintained of the world. ... There is no central locus of control.” (Brooks 1991a, sect. 6.1). (Though emergence + intervention.)
4. “The key problem that I see with all this work (apart from the use of search) is that it relied on the assumption that a complete world model could be built internally and then manipulated.” (Brooks 1991a, sect. 3.4)

2 Brooks program contd.

2.3 Abstraction and representation in robots

- “Input flows from left to right in the figure; output flows from right to left. Higher levels of abstraction are to the right.” (Crabbe 2006, 25)

	I	II	III	IV	V	VI
	Signal	Information	Attribute	Simple Model	Abstract Model	Lifetime
→ Input Channel	Sensor	Binary	Detection	Maps	Logic	Agent Modeling
← Output Channel	Motor	Kinematics	Action Selection	Path Planning	Task Planning	Goal Selection

2 Brooks' program contd.

2.4 Representation in Brooks' robotics (I)

- Robotics without representation
 - or
- Robotics with grounded representations
 - "... the largest recognizable subfield of Artificial Intelligence, [is] known as Knowledge Representation. It has its own conferences. It has theoretical and practical camps. Yet it is totally ungrounded." (Brooks 1991a, sect. 3.5)
 - Proposed remedy: "physical grounding hypothesis": "This hypothesis states that to build a system that is intelligent it is necessary to have its representations grounded in the physical world." (Brooks 1990, sect. 3).
- But which of the two?

3 What is representation?

3.1 When should we say that X represents? When that X represents Y?

- C. S. Peirce's classical theory of signs:
 - *Icons* are said to resemble what they represent (e.g. portrait paintings)
 - *Indices* are connected to what they represent by a causal connection (e.g. smoke indicates fire)
 - *Symbols* are connected to what they represent through use or convention only (like the words of a natural language).
 - But: anything is similar to anything else in some respect, icons need interpretation, so we really have two kinds: indices and symbols.

3.2 Classical theory

- **Information** is what can be learned from the causal history of an event/object (indices)
- **Representation** is dependent on people's intentions that something represents something else (symbols)
- Example: A rock outside, wet if rainy, warm if sunny, .. The rock conveys information, its states does not represent.
- But: Some things are made to convey information **for us** (clocks, thermometers)

3 Representation contd.

3.3 “Naturalist” theory

- “Naturalist” tradition of theory about intentionality and language (Hilary Putnam, Jerry Fodor, Fred Dretske, Ruth G. Millikan, ...).
 - The representational (or intentional) feature of symbols and signs must be explained with the help of **mental representations** (not mental representation via intentions: circular).
 - Mental representation is **functional** (e.g. something in the brain of a frog represents a fly on condition that it serves the biological function, the causal role, of allowing the frog to survive by catching flies)
- **Information** is whatever can be learned from the causal history of an event or object (indices)
- **Representation** is what is the function of an object to represent (natural: mental representation; conventional: symbols)
 - “disjunction problem” and “problem of error” of identifying what is represented

3 Representation contd.

3.4 Back to AI ...

- Not sufficient to produce some tokens and then **just to say** that they represent.
(Classical AI talk is only metaphorical. Though even traditional AI might be lucky and produce a causal structure that produces intelligent behavior.)
- Causal connection is necessary (even to be information)
- Represents for me **vs.** represents for the system
- Brooks' "nouvelle AI" now appears strangely unmotivated:
 - Discovering that classical AI is not representational, we propose another system that is not representational! ...
 - Architectural difference remains: absence of central control

4 Cognition without central control

4.1 Traditional AI/cognitive science/philosophy of mind:

- Central control is assumed and then representation is deemed necessary

Theses:

- 1) Cognition is the processing of outside information
- 2) Information comes in the form of representations
- 3) The processing of representations is computational

1) + 2) = representational theory of the mind

1) + 2) + 3) = computational theory of the mind (computationalism)

[→ Physical symbol system hypothesis]

4 Cognition without central control contd.

4.2 Indications against central control

- Mark Bickhard's critique of "encodingism": the mind does not decode and encode information; who does the decoding and encoding?
 - Ways out: **a)** remove the notion of encoding from that of representation via natural functions (tried and failed), **b)** abandon the notion of mental representation as a causal factor.
- John Searle's (1980) "Chinese room argument":
 - Searle looked at the processor in a computer, asked what the agent in a Chinese room would understand: "nothing". [Correct.]
 - "Systems reply": the agent does not understand, but the whole system, of which he is a part, might. [Correct] – But why should the system understand?
 - Brooks' inspired response: because there *is* no central agent in the system.
 - **Abandon the "Cartesian theatre"**: Searle was asking the wrong question, just like everybody else.

4 Cognition without central control contd.

4.3 Some alternatives

- Embodiment of cognition: intelligence in the body as a whole (Gallagher 2005, Wheeler 2005)
- Integration of cognition and action “... perceiving is a way of acting. Perception is not something that happens to us, or in us, it is something we do.” (Noë 2005, 1)
- – My view: ... indications that cognition, emotion and volition must be integrated.

4.4 What we do not get without central control: conscious representation

- *Conscious experience*, the experience of ‘what it is like’, the *having* of experience:
- “*I am the one* who does the perceiving, the thinking, the planning, the acting.”
- **Agency with experience requires the notion of a central agent**, of an “I” who is aware and thus responsible for its decisions and actions – central control (a tautological remark).

5 Conclusion

- Traditional AI had assumed that if the paradigm of central representation processing is given up, then AI is doomed.
- We have little evidence for this claim and evidence for the contrary is emerging. It may well turn out that if central control through representation processing is given up, AI will flourish!

Overview

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2.1. AI without representing the world?

2.2 Brooks' pronouncements/characteristics

2.3 Abstraction and representation in robots

2.4 Representation in Brooks' robotics (I)

3 What is representation?

3.1 When should we say that X represents? When that X represents Y? (Pierce)

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3.3 "Naturalist" theory

3.4 Back to AI ...

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5 Conclusion