

ERIC BAUM

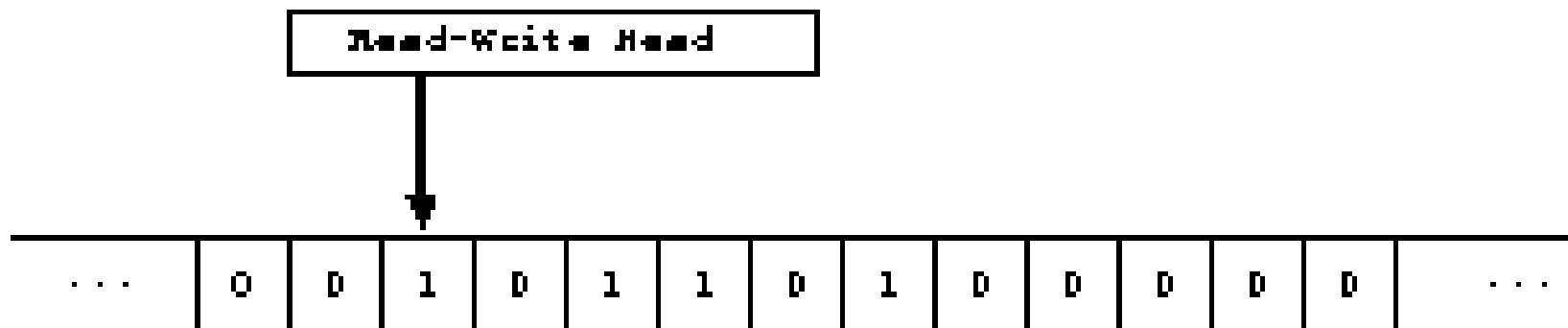
WHAT IS THOUGHT?



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The mind is a computer program

- Effective procedure = sequence of syntactic steps
- Church-Turing Thesis: any physical system simulatable by Turing machine

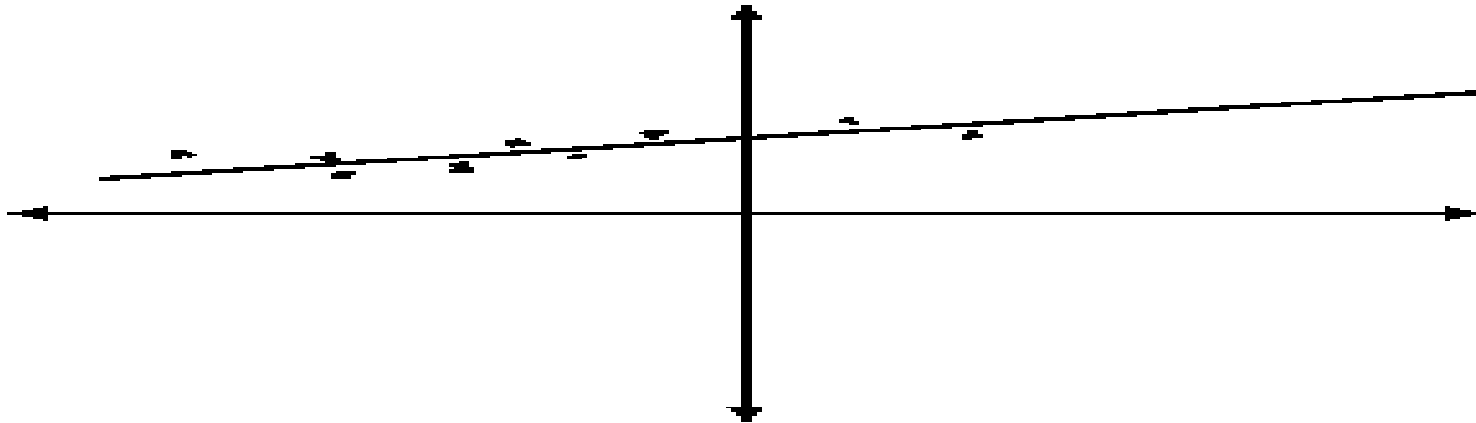


Problems (Searle, Dreyfus, Chalmers...):

- How can my feeling of awareness etc come from syntax?
- How can syntax give rise to semantics?
- How can syntax correspond to events in the world?
- Why can't computers understand?

Occam's Razor

- Find a sufficiently compact description of enough data, and it corresponds to the world.



Occam's Razor

- Three formal views, explained.
- Compact program consistent with vast data only if process has underlying structure that is exploited for prediction.
- Conversely, need inductive bias to learn.

2, 4, 6, 8, 10, 12, ?

Extrapolated Occam

- Train a robot to interact with the world, perceive, compute, act...
- A compact program behaving on enough reinforcement learning trials exploits structure and will continue to behave effectively.
- It is compact by virtue of code reuse, developing modules corresponding to real concepts in the world, reused in metaphor and pleiotropy.

Meaning is the computational exploitation of the underlying structure of the world, and mind is execution of an evolved program, mostly encoded in the DNA, that is all about meaning.

Why computers don't understand

- AI programs not compact.
 - List of answers not compact
 - Expert systems not compact because:
 - Human programmers not capable of compaction.
- Finding Occam programs NP-hard.

Exploiting structure

- Is 7788779909777885687654 even?
- Extracting compact structure and exploiting it separate computationally hard problems.
- Discuss chess, Go, Blocks World, Rubik's cube, traveling salesman... and real world.
- Show evolution of Hayek Machine to solve problems, model of insight.

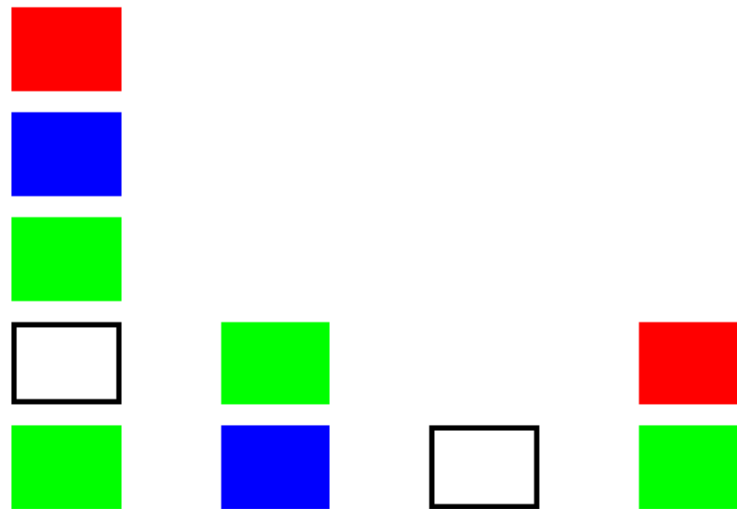
Hayek

- Evolves a population of agents.
- Economic organization promotes cooperation.
- Sequence of agents win auctions, solve problems.
- Has generated population collaborating on solutions of Blocks World, Rubik, Rushhour.
- But still hits wall if has to generate too large a chunk of code.

Results on Blocks World (Durdanovic)

- evolves universal solver

- (1) $(x5) (x6) (x1) (x7) \rightarrow g1d3,$ bid 7.78
(2) $(x6y0x2) (x6) (x5 y0) (x3) \rightarrow g2d1,$ bid 8.07
(3) $(x2y0x5) (x2) (x3) (x7 y0 x0) \rightarrow g3d2.$
(4) $(x3y0x5) (x3 y0) (x0) (x1) \rightarrow g2d3,$ bid 8.05
(5) $(x4y0) (x4) (x7 y0) (x1) \rightarrow g2d1*,$ bid 35.8



Mind code exploits structure in world

- Mind consists of modular program, with modules that exploit compact structure of world, achieving compactness through code reuse.
- Modularity from psychophysics, neuroanatomy, stroke victims, imaging,...
- Metaphor = code reuse. Metaphor pervasive
eg time is money (Lakoff and Johnson)--
buy, spend, borrow, waste etc time.

Compact Explanation is DNA

- 1-10 MB, a fraction of Powerpoint source code. Brain 100 million times larger.
- 10^{35} (44?) creatures/RL trials, little computation in learning during life (LDL).
- LDL highly biased in— many examples, including grammar learning in humans.
- Evolution of learning to be expected, learning and development two faces of coin.

Evolution of Language

- Computational modules present in animals
- Words are labels for modules
- Solves Gavagai problem.
- Language evolution stuck in local optima till humans (Nowak).
- Language allows cumulative progress in building program.

Why people are different than apes.

- Grow huge modular program
- Because of language, progress cumulative
- Hard search problem, finding program...
but we have invested cumulative effort
comparable to that evolution invested in
chimps.
- Affects everything, eg. Theory of mind.

Evolution of Consciousness

- Evolve: “sovereign agents” that maximize inborn rewards.
- Occam’s razor says: treat these as conscious.
- Awareness is of semantic quantities: outputs of modules affecting our decisions directly .“Comes together” at CDU/homunculus?
- All thought is execution of code, including qualia.

Tell me everything physical there is to tell about what is going on in a living brain and... you won't have told me about the hurtfulness of pains, the itchiness of itches, pangs of jealousy or about the characteristic experience of tasting a lemon, smelling a rose, hearing a loud noise,... (F. C. Jackson)

But in fact these are easy to explain...

What is Thought?

- Thought is execution of a program that exploits the compact structure of the world
- Program is built on evolved modules the learning of which is coded in DNA.
- Consciousness arises as coding of decision maker/learner
- Theory will make predictions for gene expression, imaging, psychophysics...

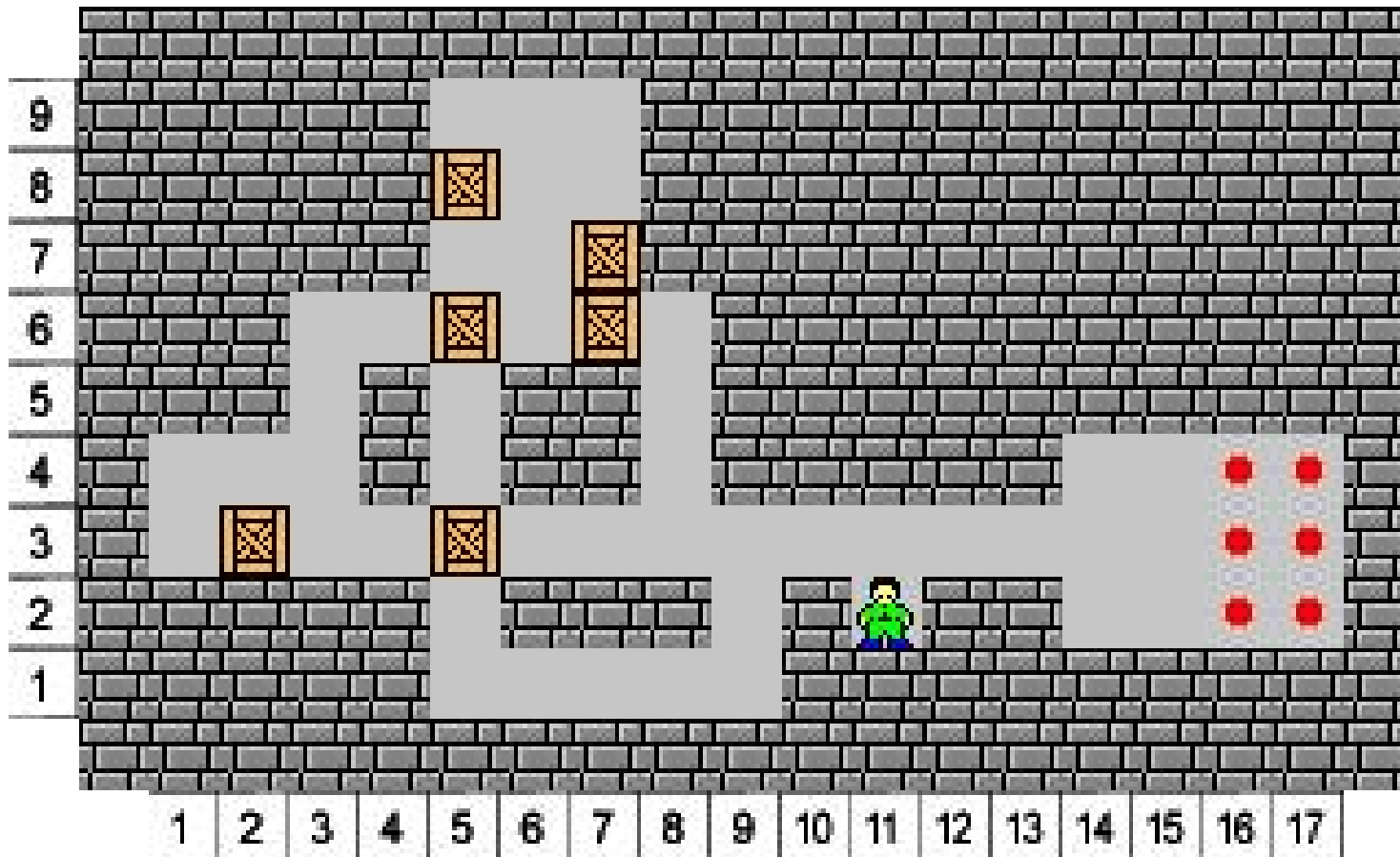
How to Construct a Cognitive Program?

- WIT? Concluded: AI may be impossible because we don't have the resources evolution expended.
- Compact software construction hard.
- If answer exists, must lie in human-computer collaboration. Guide algorithmic construction of powerful modular program.

Overall Strategy

- Build collection of building blocks.
(scaffolds – procedures possibly with extra annotations). Cyc, with the right components!
- “Building” is done by training (EC) from examples, and hand coding, including use of built instructions.
- Any given evolutionary step limited.

Sokoban (Schaul)



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