

## Thinking Meat?!

How can we get Reason-respecting behavior out of a lump of flesh?

## The attribution problem in Cognitive Science

- We can't see the processes we care the most about, so we must infer them from observable behavior.
- But how can we infer the invisible?
- Well, ...what is visible?
- Reason-respecting behavior.
- How can we account for that?

## Formal Systems

- We know of another system that produces reason-respecting sequences.
- It's LOGIC
- FORMal, get it?
- Strings of symbols
- Rules for manipulating strings of symbols
- *"If you take care of the syntax, the semantics will take care of itself."* (Haugeland, 1981)

Formal Systems have a history

## Early Accounting Systems



Six ovoid tokens representing an account of six units of oil

## Early Accounting Systems



Plain tokens. Mesopotamia, 4000 B.C.

### Early Accounting Systems



An envelope and its contents representing 7 units of oil

### Early Accounting Systems



An envelope, its contents of tokens, and corresponding markings. 3300 B.C.

### Early Accounting Systems



Complex tokens. Sheep, oil, metal, garment. 3300 B.C.

### Early Accounting Systems



Impressed tablet showing an account of grain. 3100 B.C.

### Early Accounting Systems



Pictographic tablet showing 33 units of oil. 3100 B.C.

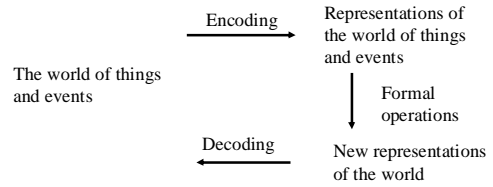
## Properties of Spoken and Written Language

- Spoken
  - Ephemeral
  - Dynamic
  - Auditory (sound)
  - Structure in time
- Written
  - Semi-permanent
  - Static
  - Visual (sight)
  - Structure in space

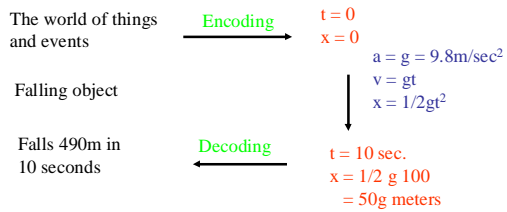
## decontextualization

decontextualization  
 weave or surrounds  
 with relation to  
 not to make or take  
 the act

## The Secret of Our Success



## The Secret of Our Success



## Getting symbols to behave in a way that fits the world

- Why does this turn out to be possible?
- Why is the world a place that can be modeled by mathematics?
- No one knows, but it DOES work!

## Can we get symbols to work in a way that fits the brain?

- An empirical hypothesis: Physical symbol system hypothesis.

## The Turing Machine

- An imaginary (theoretical) device.
- It works by manipulating meaningless symbols.
- It can compute the answer to any sufficiently well-specified problem.
- Digital computers are not imaginary, and they can be equivalent to a Turing machine.

### The three big pieces of early Cognitive Science

1. Formal Systems
2. Meaningful computation by mindlessly following rules
3. Mechanized symbol manipulation

### Could the brain be a meat computer?

- The program (the rules) run by the brain must be a formal system
- Brain states must correspond to symbols or propositions in a formal language.
- Functional equivalence of your brain states to mine – Not identity.
- Brain states must cause other brain states in just the right “reason-respecting” way.

### Mindware as reason-respecting Software

- In a formal system, state plus operator implies a new state,
- States of mind could lead to other states of mind in ways that follow rules.
- It is the program that matters.
- The machine it runs on is just an implementational detail.

### The meat wouldn't matter

- If we knew the program, we could run it on any suitable computer.
- Then we would have an artificial human mind!
- And we already know how to do this.

### Physical Symbol System Hypothesis

- Symbolic Codes
- Computation is a kind of search
- Cognition happens at the level of deliberative thought
- Intelligence, wherever it is found, will be found to be a physical symbol system.

### Reverse Engineering

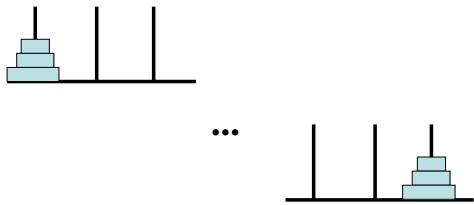
- Pick something that people do that is smart.
- Figure out how to do that same thing on a computer.
- Then look at the program in the computer. It should tell you something about the nature of the task and the things the person must do in order to perform the task.

## And it works!

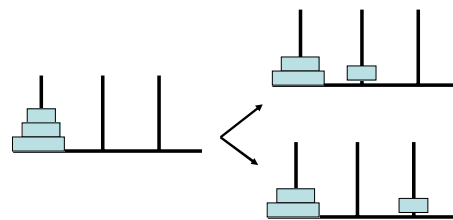
- This is exciting!
- Just document the I/O relations,
- build a program that can do the job (the *sufficiency* criterion),
- and then look inside to see how it does it.
- Wow!

## Computation as Search

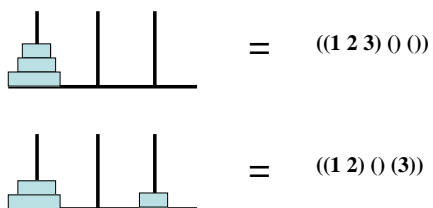
### Tower of Hanoi



### Legal Moves



### Symbolic Representation



### Rules to transform Strings of Symbols

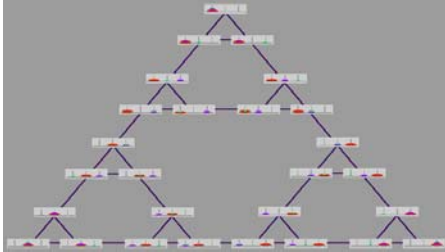
$((1\ 2\ 3)\ 0\ 0) \rightarrow ((1\ 2)\ 0\ (3))$

$((1\ 2\ 3)\ 0\ 0) \rightarrow ((1\ 2)\ (3)\ 0)$

**\*\*** $((1\ 2\ 3)\ 0\ 0) \rightarrow ((1\ 3)\ (2)\ 0)$ **\*\***

$((1\ 2\ 3)\ 0\ 0) \rightarrow \dots (0\ 0\ (1\ 2\ 3))$

## State Space for TOH Problem



## Ok, But....

- The time course of real-world action
- There are many levels of software. Are there also levels of mindware?
- Are games good representatives of cognitive tasks?
- Is the Turing test a good representative?

## OK, But...(continued)

- Engineering A/I vs Research A/I
- Consciousness (the C word) and qualia
- Language and Searle's Chinese Room

## Searle's Chinese Room

- A person (you?) in a room with a slot in the door.
  - Book of rules
  - Box of symbols
- Chinese people outside push strings of symbols through the slot
- You use the rules to make new strings and push them out the slot.
- Do you speak chinese? Does the room?

## Why not formal symbols?

- What symbolic computers do well and what people do well.
- Nature doesn't work like that.
- The metaphor is vague.
- Every device, considered at different levels, could be a model of many different things.

## Questions remain

- If the PSSH does not describe what the brain does, what explanation do you offer instead? What's the alternative?
- If the brain doesn't do PSSH,
  - What does the brain do?
  - And what does PSSH?
    - (because banishing PSSH from the brain doesn't make it go away.)

### Is the Meat Magic?

- The answer depends on whether or not we think consciousness is simply a matter of information processing.

### Two aspects of mindfulness ?

- Reason respecting flow of thoughts
- Everything else
  - Qualia
  - Affect/emotion
  - Embodiment

Are these really different aspects?