COMPUTATION & REPRESENTATION

Phil/Psych 256

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Computation & Cognitive Science: Useful distinctions

**Theory**: Hypothetical representations and processes to explain a behaviour (rules)

**Model**: Algorithmic and data structure realization of a theory (SOAR)

**Program**: Instructions in a computer language (LISP code)

**Platform** (implementation): hardware (IBM PC)
Mind as computer metaphor

Computer is like Mind

What counts as a representation?
What counts as a computation (algorithm)?
How can this metaphor help (hinder)?
Von Neumann architecture

Von Neumann (with ENIAC Manchester Mark 1 ~ .00083MIPS)
Atkinson and Shiffrin’s (1968) memory model.
Formal system

- A formal system is:
  - a method for token manipulation
  - usually digital
  - medium independent

- E.g.
  - chess, checkers, backgammon
  - boolean algebra, logic
Turing’s Machine (A Formal System)
## State Table for a Simple Adder

<table>
<thead>
<tr>
<th>State Number</th>
<th>Input</th>
<th>Output</th>
<th>Next State</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>R1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>R1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>L0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>R1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>L0</td>
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<tr>
<td></td>
<td>1</td>
<td>L0</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>R0</td>
<td>HALT</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>L1</td>
<td>4</td>
</tr>
<tr>
<td>State</td>
<td>Tape Configuration</td>
<td>Next State</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>--------------------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>1, 0 *</td>
<td>1 1 1 1 1 0</td>
<td>4, 0</td>
<td>1 1 1 1 1 1 0 0</td>
</tr>
<tr>
<td>1, 0 1</td>
<td>*</td>
<td>0 1 1 1 1 0</td>
<td>4, 0</td>
</tr>
<tr>
<td>1, 0 1 1</td>
<td>*</td>
<td>0 1 1 1 0</td>
<td>4, 0</td>
</tr>
<tr>
<td>2, 0 1 1 1 1</td>
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<td>1 1 1 0</td>
<td>4, 0</td>
</tr>
<tr>
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<td>*</td>
<td>1 1 1 0</td>
<td>4, 0</td>
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<tr>
<td>2, 0 1 1 1 1 1</td>
<td>*</td>
<td>1 1 0</td>
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</tr>
<tr>
<td>2, 0 1 1 1 1 1</td>
<td>*</td>
<td>1 0</td>
<td>4, *</td>
</tr>
<tr>
<td>3, 0 1 1 1 1 1</td>
<td>*</td>
<td>1 0</td>
<td>Halt</td>
</tr>
</tbody>
</table>

* = Current position of read/write head
Information (processing)

- The amount of information in a signal tells you how many yes/no questions it answers.
- Information is a dimensionless quantity
  - no ‘kinds’; no ‘mis’; etc.
- Turing machines can be thought of as manipulating the ‘answers’
- Turing test: If such a machine functions (verbally) like a human, it is intelligent
Intentionality

- Information doesn’t have meaning.

- Intentionality
  - ‘mark of the mental’
  - ‘aboutness’

- It seems like a relation, but is an odd one

- Existence
  - Often ignored in cog sci

*Original* intentionality is unique to cognitive systems
GOFAI and NFAI

- Specific design/architecture claims
  - serial/parallel
  - centralized/distributed
  - discrete/continuous
  - memory and processing distinction/or not

- Distinct strengths and weaknesses
  - language-like manipulation/pattern recognition
  - interpretable symbols/distributed representations
Criteria for a good representational theory

1. Representational power
2. Computational power
   a. Problem solving
      i. Planning
      ii. Decision
      iii. Explanation
   b. Learning
   c. Language
3. Psychological plausibility
4. Neurological plausibility
5. Practical applicability
   a. Education
   b. Design
   c. Intelligent systems