Overview

Issues and Methods

Psyc 6200, CSCI 6402, etc.

Instructors

Mike Eisenberg, Computer Science
duck@cs.colorado.edu

Peter Polson, Psychology
ppolson@psych.colorado.edu

Anita Bowles, Psychology, TA
bowlesa@psych.colorado.edu

Text: Pinker, S. “How the Mind Works”

Lots of reading!

Requirements

Six to eight sets of short essay questions

Term paper

Book review

Review of literature on a selected topic

E-mail, the Web, etc
Class Discussion List

Logon to your e-mail account. Persons using web-based email accounts should take care when sending their subscribe messages. Do NOT send specially-formatted messages, for example, messages with colors, backgrounds, etc.

You sign up by sending an e-mail message to listproc@psych.colorado.edu.

The program is really stupid. Your message must start on the first line and exactly follow the template below. The body of the message should be:

subscribe issues-methods Your name

followed by several blank lines

For example, a student named John Doe would sign up by sending:

subscribe issues-methods John Doe

You will get an e-mail message back from the system saying that you have successfully registered.
## Tentative Outline

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<th>Topic</th>
<th>Pinker</th>
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<td>Intro to course and basic themes</td>
<td>Ch. 1</td>
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<td>1/22-24</td>
<td>The computational model of mind; intro</td>
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<td>1/29-31</td>
<td>Problem solving as a model of mind</td>
<td>Ch. 2</td>
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<td>Generate and test; Connectionist models;</td>
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<td>Rule based models of skill acquisition &amp; expertise</td>
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<td>Vision: Computational and neuroscience</td>
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<td>3/5-7</td>
<td>continued</td>
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<td>3/12-14</td>
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<td>3/19-21</td>
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<td>4/23-25</td>
<td>Creativity, Scientific Discovery</td>
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<td>4/30-5/2</td>
<td>Culture and cognition</td>
<td>Ch. 7</td>
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Overview

Pinker’s
‘How the mind works”

Use as a starting place

Use each chapter as an introduction to topic(s)

Additional reading

Introduction to other viewpoints

Well written, very controversial

Best Introduction To

Computation Model of Mind

Evolution

Evolutionary Psychology

“Extreme” Views on

Evolution as Contrasted to Gould, etc

Language as Contrasted to Bates, Elman etc
Overview

**Where Is Pinker Leading Us?**
And Do We Want to Follow Him?

Chapter 1: Standard Equipment
- The Robot Challenge
- Psychology as Reverse Engineering
- Psychological Correctness
- Combine the Computation Model of Mind With the Adaptationist Program From Evolutionary Biology and Sociobiology

Chapter 2: Thinking Machines
- The Search for Intelligent Life In the Universe
- Natural Computation
- The Defending Champion
- Replaced By A Machine
- Connectoplasm
- Aladdin’s Lamp
The Robot Challenge

What is Pinker Up To?

Supporting the Claim That The Computation Problems Defined by

Vision,

Motor Control,

Common Sense Reasoning (the frame problem),

Language Production and Understanding,

Etc.

Are Very, Very Difficult

The Roles of Assumptions and Constraints

Performance Requirements

Goes On to Conclude That These Problems Are So Hard that They Can Only Be Solved By Highly Specialized Computational Systems

A General Propose Computing System CANNOT Solve These Problems

Claims about computational complexity!!!!
Cognitive Science as Reverse Engineering

Given Knowledge of The Functions/Purpose of A System

Discover Its

Rules of Operation
Internal Mechanisms

Herbert A. Simon: Sciences of the Artificial

Intelligent Systems are Like Artifacts
Purposes (Goals) and Behavior
Internal Structure

Very hard to discover internal mechanisms from knowledge of purposes and behavior

Adaptationist Of Views of Cognition and Evolution

Pinker Claims That
The Mind is A Collection of Mental Organs
Our Minds Evolved to Solve the Problems of Our Hunter-Gather Ancestors
The Basics of The Computational Model of Mind

Problems with Teleological (Goal Oriented) Explanations of Behavior

How can mental states (e.g. goals, beliefs) cause physical actions?

Computation Model of Mind Solves These Problems

Can Build Machines That Follow Rules to Achieve Goals (Solve Problems)

Intelligence Defined As Successful Problem Solving

All Intelligent Activities Can Be Described as Problem Solving Tasks

Problem Solving Can Be Described as Search Through A Space of Possible Solutions

Newell and Simon: The Problem Space Hypothesis

Intelligent Behavior as The Manipulation of Symbols (Information)

Universal Turing Machines

The Church-Turing Thesis: Effective Procedures
Production Systems


Production System

RULES

- Describe Knowledge Required to Perform Task
- Rules, Productions
  IF condition THEN action (Condition- Action Pair)
  IF (Goal and a specific situation)
  THEN (do actions)

WORKING MEMORY

- Symbolic Data, Working Memory Elements
  • Current Goals
  • Symbolic Representation of External World
The Human Information Processing System as a Production System

Newell and Simon (1972, pp. 804-5)

1. Capable of expressing arbitrary calculations.
2. Homogeneous representation of control information.
3. Each rule of an independent fragment of behavior.
   Implications for learning and skill acquisition.
4. Strong stimulus-response flavor; historical implications.
5. Meaningful elements of a complete skill.
6. Working Memory equivalent to Short Term Memory.
7. Rules possible general model for long term memory.
8. Nice balance between goal-direct and stimulus-bound control.
9. Parallel recognition process with serial action generation process
Overview

Production Systems and Wetware

How Do We Build Rule Following Computer System Out of Neurons?

Mulloch and Pitts “Neurons” to Logic Gates

Logic Gates to a Register Machine

A Register Machine Is A Turning Machine

But, real neurons are not organized directly into a register machine

Connectionism

Densely Interconnected Networks and Auto-Associators

   Content addressable memory

   “Graceful degradation” or pattern completion

Constraint satisfaction

Hard (symbolic) verses soft (real) constraints

Tradeoffs

Generalization

Learning

Build a Rule Following Machine Out of Connectionist Parts
Arguments About The Computation Properties of Mind

Lashley: “The Problem of Serial Order in Behavior

Chomsky; “Three Models of Language

Newell and Simon: “The Physical Symbol System Hypothesis”

Pinker: Five Problems with Connectionism
What is the Levels Issue?

Newell’s Formulation

Computer Architectures
The Near Independence of Levels
The Knowledge Level
  Principle of Rationality
    Goals + Knowledge ==> Behavior
    Goals, Selection, Implications, Knowledge

Marr’s Formulation

Computational Theory
  the goals of the computation
Representation and Algorithm
  representation, nature of transformation, algorithms
Hardware Implementation
Overview

Cognitive Architectures
The fixed structure that realizes a symbol system

[Knowledge Level]

[Symbol Level]

[Functional Architecture (Pylyshyn and Anderson)]

[Neural-Circuit Level]

All the same physical system — A matter of description

Fixed can mean changing relatively slowly

<table>
<thead>
<tr>
<th>Lifetime</th>
<th>$10^9$ s</th>
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<tr>
<td>Development</td>
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<tr>
<td>Architecture change?</td>
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<tr>
<td>Skill acquisition</td>
<td>$10^3$ s</td>
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<tr>
<td>Knowledge acquisition</td>
<td>10 s</td>
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<tr>
<td>Performance</td>
<td>1 s</td>
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<tr>
<td>Fixed</td>
<td></td>
</tr>
<tr>
<td>Internal actions</td>
<td>$10^{-1}$ s</td>
</tr>
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Anderson (1990)
Formulation of the Levels Issue

Biological Level
   NO Help in Dealing with Cognition

Implementation Level
   Focus of Most All Cognitive Research
   Lacks True Psychological Reality
   Identifiability Problems

Algorithm Level
   The Physical Symbol System Hypothesis
   Mapping on to Working Memory States

Rational Level
   Not “Psychologically Real”
   Not A Higher Level of Abstraction
   Important Class of Constraints
   Models of the Environment
   Goals of The System
   Adaptive Character of Cognitive Processes
Cosmides and Tooby

Human minds have a standard collection of reasoning and regulatory circuits that are

- Functionally specialized
- Frequently, domain-specific
- Modules that are analogous to organs
- Design by evolution
- Designed to solve problems faced by our hunter-gatherer ancestors

Vision
Hearing
Motor Control
Memory Systems
Language
Concept Formation and Reasoning
  - Physical causation
  - About plants and animals (natural kinds)
  - About artifacts
The Standard Social Science Model is Wrong