# What is AI?

- AI = making systems that do what people do
- Hardware
  - Some chess programs use parallel processing (multiple computers) so they can try more possibilities faster
- Software (programs)
  - More common approach

# Three Approaches to AI

- Three approaches
  - Imitate the brain
  - Imitate higher cognitive processing
  - Imitate the results

# Three Approaches to AI

- Simulate the brain
  - Can't be a perfect imitation of a living thing
  - ... and one which is not completely understood yet
  - E.g. neural networks
- Simulate higher cognitive processing
  - Imitating the "mind"
  - Implementing (programming) a mental model

# Three Approaches (cont.)

- Imitate the results
- Don’t care how the program does it
  - Birds and airplanes don’t fly the same way
  - People did not succeed in flying until they gave up on the idea of imitating birds
- Let people do what they do best, let computers do what they do best
  - Chess: people are good at recognizing patterns, computers are good at trying many options fast

# Questions Cognitive Scientists hate

- Linguists
  - “ • Is this correct grammar?”
    - ... because it’s the wrong question
- AI people
  - “Can computers really think?”
  - ... because it’s the wrong question
  - As soon as a program can do something (e.g. play chess), some people define that as “not intelligence”
  - If an ATM imitates what a bank teller does, does that mean it’s intelligent?

# Three Approaches to Representing Knowledge

- Symbolic
  - Language-like
  - Lists of features
  - Propositions
- Non-symbolic
  - Connectionist
    - Info is represented distributed over a network
    - Info is stored in connection weights
- Mixed
  - Spreading activation
  - Symbolic base
  - Numeric updating

# Examples of Symbolic AI

- Propositional networks (Anderson, 1983)
- Feature comparison model
- Schankian approach (Schank, 1970 ff.)
  - Scripts
  - Frames

# Implementation of Prop. Network

- How to get this knowledge into a program?
- One approach: enter each relation separately
- Example
  - (item1 agent item2)
  - (item2 attribute tall)
  - (item2 category lawyer)
  - (item1 attribute past)
  - (item1 relation believe)
  - (item1 object item3)

# Feature Comparison Model

- Concepts are represented as a set of features
- Two types of features:
  - Defining features
  - Characteristic features
- Relations between concepts computed based on shared features

# Feature Comparison Example

- Bird
  - Animate
  - Feathered
  - Has beak
- Robin
  - Animate
  - Feathered
  - Red breast
  - Eats worms

# Schankian Approach

- Schank, 1970 ff.
- Attempts had different basic data structures
  - Scripts
  - Frames
  - MOPs (memory organization packets)
  - All based on assertions
  - Use different types of logic

# Why AI is Hard

- Computers are pickier than people
- = Programming is more precise than human language or thought
  - What % of features is high/medium/low overlap?
  - Which features are the defining features?
  - What is a match?
    - Number of features?
    - Percent of features?
  - How did you decide? How do you know if you're right?

# Why AI is Hard (2)

- Computers have no “common sense”
  - Dog = [animate  canine]
  - Is a robin a dog?
    - Why not? They share 50% of the dog’s features.
  - How to fix this?
    - Minimum number of features?
    - Features which rule out a match?
    - E.g. [canine large black noisy] (a black Lab) doesn’t match [avian large black noisy] (a big crow)

# Other Problems with Feature Comparison Model

- "Defining feature" is a problematic concept
- Most researchers today think in terms of prototype/fuzzy set model
  - Features are (more or less) characteristic
  - They are typical of an item but do not have to apply for successful classification
  - E.g., green lemon, "chair" with three or no legs

# Why AI is Hard (3)

- “World knowledge” problem
- Related to common sense
- CYC (Lenat)
- Relation to pragmatics
- Charniak
  - Janet needed money. She got her piggybank.
  - Janet needed money. She got her gun.
  - Janet needed money. She got her gun, and took it to the pawn shop.

# Why AI is Hard (4)

- Language input problem

- Charniak ignores the language input problem
  - He says he ignores syntax
  - Parsing is more than syntax (computability)
  - Disambiguation of word senses
  - Identification of noun phrase referents
- He assumes there is an internal representation
  - Is that fair? How does he know one exists?
  - Suppose it exists but it's not computable
  - To start with, what grammar should we use?

# Why AI is Hard (5)

- The logic problem

- Everybody who gets Disease X gets drug Y.
- Janet has disease X.
- Does Janet get drug Y?

- Everybody who gets Disease X gets drug Y.
- Janet has disease X.
- Janet is allergic to drug Y.
- Does Janet get drug Y?

- So simple mathematical logic may not be appropriate for all AI applications.

# Why AI is Hard (6)

- The equality problem (for concepts)

- Are these the same person?
  - George Bush
  - G. Bush
  - G. H. W. Bush
  - the President
- How do you know?

- Not the same as mathematical “=”

# Why AI is Hard (7)

- The equality problem (for numbers)

- How far is it from San Francisco to Boston?
  - 3000 miles
  - 3012.4 miles
- What does the question mean?
  - From downtown to downtown?
  - From airport to airport?
  - From Kim's house to Hilary's house?

# What makes AI possible now?

- Early philosophy and logic (ca. -500)
- Early linguistics (Panini)
- Formal logic (19th century)
- “Scientific” psychology (19th century)
- Modern linguistics (20th century)

- Computer hardware (1940+)
- Computer software (likewise)

# Early History of AI

- 1950's and 60's: first pioneers and first programs
  - Geometry Theorem Prover
  - Calculus integration problems
- 1970's: knowledge-based systems
  - If-then structure
  - Dendral
  - Prospector
  - R1/XCON (DEC)
- 1980's: overselling the field

# Computer vs. Brain (1)

- Computational units
  - Brain: 10,000,000,000 neurons
  - Computer (1994): 10,000 gates
  - Computer (2005): 5,000,000 gates
- Working memory
  - Brain: 100 billion neurons
  - Computer (1994) 1 billion bits (= 1 MB)
  - Computer (2005) 1000 billion bits (= 1 GB)
- Storage (“hard disk”)
  - Brain: 100 billion synapses
  - Computer (1994): 100 billion bits (= 100 MB)
  - Computer (2005): 100,000 billion bits (= 100GB)

# Computer vs. Brain (2)

- Cycle time
  - Brain: 1000 cycles/second
  - Computer (1994): 100,000,000 cycles/second
  - Computer (2005): 2,000,000,000 cycles/second
- Bandwidth (internal transfer speed)
  - Brain: 10,000 billion bits/second
  - Computer (1994): 1 billion bits/second
  - Computer (2005): 10 billion bits/second
- Neural network processing speed (logical as opposed to physical)
  - Brain: 100,000,000,000,000 updates/second
  - Computer (1994): 10,000 updates/second
  - Computer (2005): 200,000 updates/second

# Computer vs. Brain (summary)

- Important factors
  - Time for an individual computation ("cycle time")
  - Number of computations that can happen at the same time
    - Computer: one at a time (or maybe a few)
    - Brain: all neurons and synapses fire simultaneously
    - Implications of parallelism
- These are the two most important factors
  - Memory (short-term and long-term) is less important

# Advantages of the Brain

- Computer and brain aren't really comparable
- Example: facial recognition
  - Brain: less than a second (= less than 1000 computations)
  - Computer:  several billion computations
  - And brain is a lot better
- Brain hardware is more robust
  - Brain cells die all the time
  - Computer: one hardware failure ...
- Brain software is more robust
  - Knows "that's not a face"

# Advantages of the Computer

- Advantages computers have
  - Not biased
  - Doesn't get tired or make mistakes
- So what?
  - The point isn't to do the comparison
  - The point is to see what we can do with computers