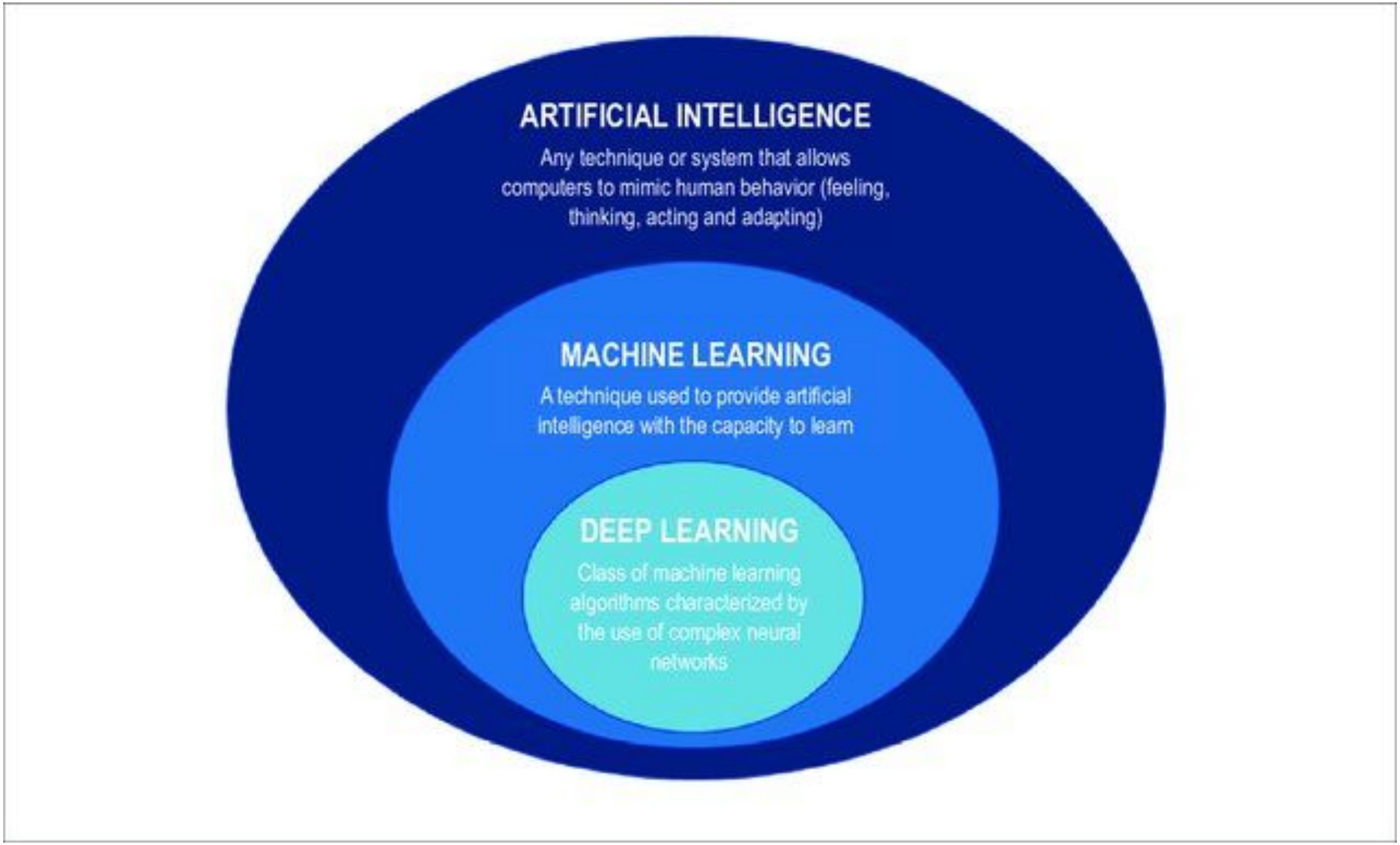
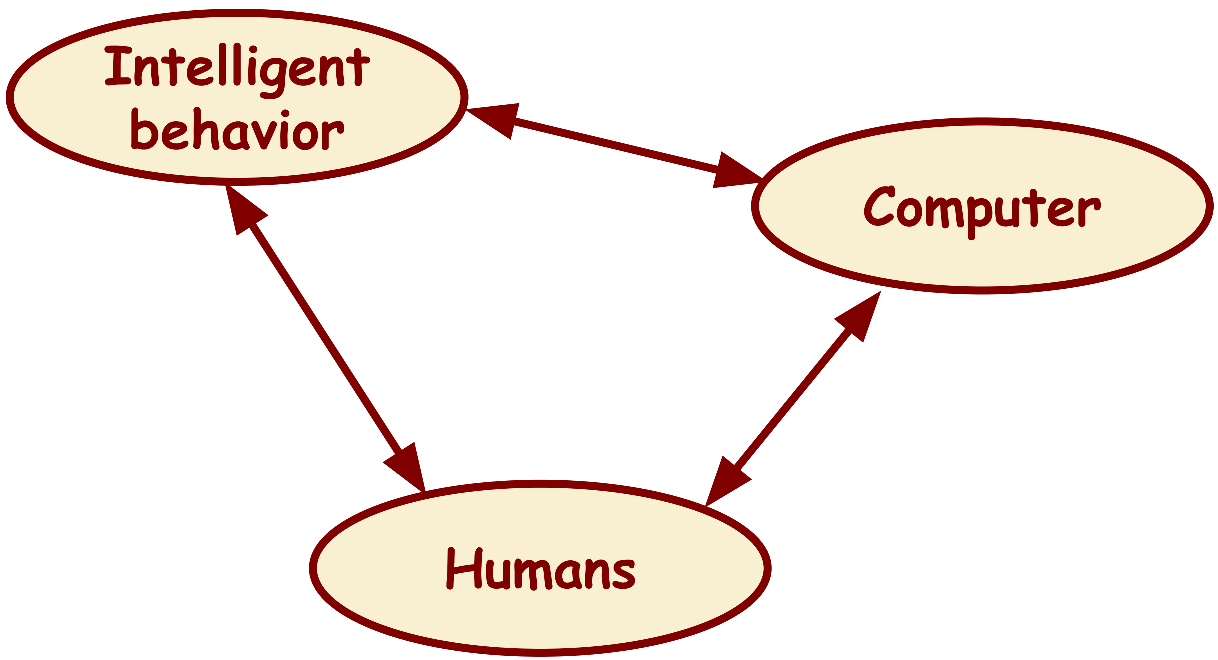
Introduction to AI


ARTIFICIAL INTELLIGENCE
Any technique or system that allows computers to mimic human behavior (feeling, thinking, acting and adapting)
MACHINE LEARNING
A technique used to provide artificial intelligence with the capacity to learn
DEEP LEARNING
Class of machine learning algorithms characterized by the use of complex neural networks

What is AI?

an attempt of

- AI is ~~the~~ reproduction of human reasoning and intelligent behavior by computational methods



Different AI Perspectives

2. Systems that *think like humans*	3. Systems that *think rationally (optimally)*
"The exciting new effort to make computers think ... *machines with minds*, in the full and literal sense" (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning ..." (Bellman, 1978)	"The study of mental faculties through the use of computational models" (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act" (Winston, 1992)
"The art of creating machines that perform functions that require intelligence when performed by people" (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better" (Rich and Knight, 1991)	"A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes" (Schalkoff, 1990) "The branch of computer science that is concerned with the automation of intelligent behavior" (Luger and Stubblefield, 1993)
1. Systems that *act like humans*	4. Systems that *act rationa lly*

What is AI?
(R&N)

Discipline that systematizes and automates reasoning processes to create machines that:

Act like humans	Act rationally
Think like humans	Think rationally

A human Centered approach must be an empirical Science, involving Hypothesis and Experimental Confirmation.
A rationalist approach involves a combination of mathematics and engineering.

A system is rational if it does the "right thing" given what it knows.

Act like humans	Act rationally
Think like humans	Think rationally

- The goal of AI is to create computer systems that perform tasks regarded as requiring intelligence when done by humans
- □ AI Methodology: Take a task at which people are better, e.g.:
  - Prove a theorem
  - Play chess
  - Plan a surgical operation
  - Diagnose a disease
  - Navigate in a building

  and build a computer system that does it automatically
- But do we want to duplicate human imperfections?

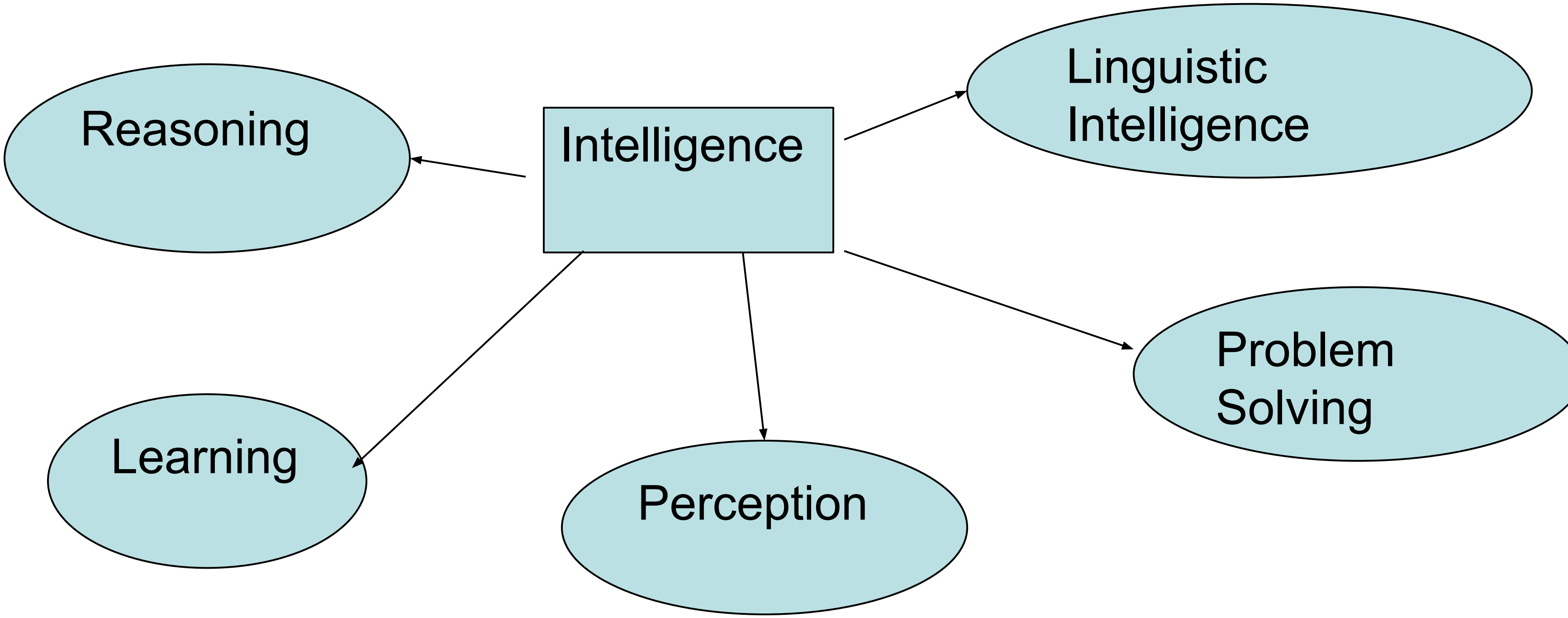
Why AI

- Solve real world problems very easily and accurately such as health issue , marketing, traffic issue etc.
- Create personal virtual assistant like siri, google assistance.
- Robot which can work in a environment where survival of human can be at risk

Goals of AI

- Replicate Human Intelligence
- Solve Knowledge –intensive task
- An intelligent connection of perception and action
- Building a m/c which can perform task that requires human intelligence such as:
  - Providing theorem
  - Playing chess
  - Plan surgical operation
  - Driving a car

Intelligence Composed of

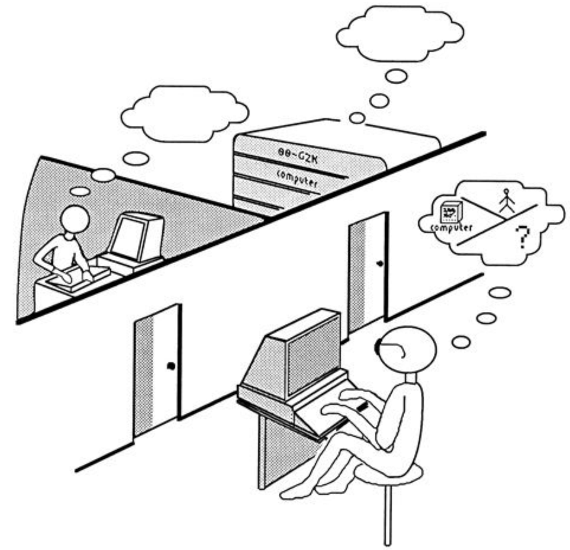


Can Machines Act/Think Intelligently?

"If there were machines which bore a resemblance to our bodies and imitated our actions as closely as possible for all practical purposes, we should still have two very certain means of recognizing that they were not real men. The first is that they could never use words, or put together signs, as we do in order to declare our thoughts to others… Secondly, even though some machines might do some things as well as we do them, or perhaps even better, they would inevitably fail in others, which would reveal that they are acting not from understanding, …"

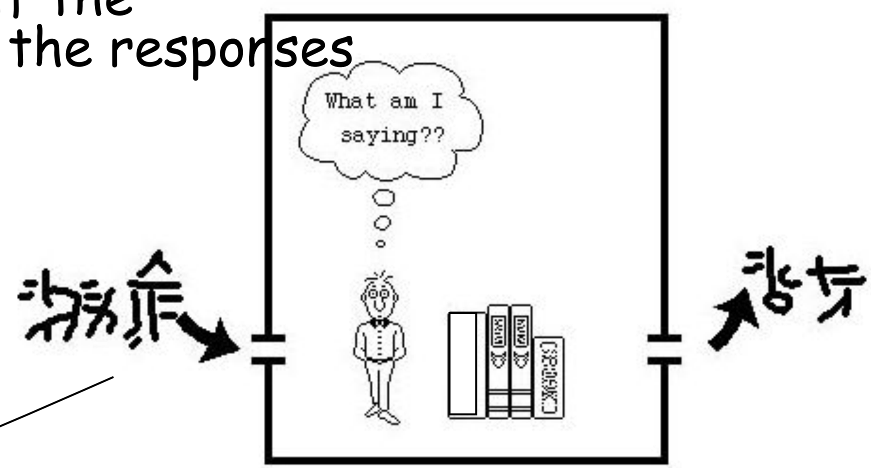
Discourse on the Method, by Descartes (1598-1650)

Can Machines Act/Think Intelligently?



Turing Test: Acting humanly

- http://plato.stanford.edu/entries/turing-test/
- Test proposed by Alan Turing in 1950 was designed to provide a satisfactory operational definition of intelligence.
- The computer is asked questions by a human interrogator. It passes the test if the interrogator cannot tell whether the responses come from a person or not
- No physical interaction
- Chinese Room (J. Searle)



The computer would need to possess the following capabilities:

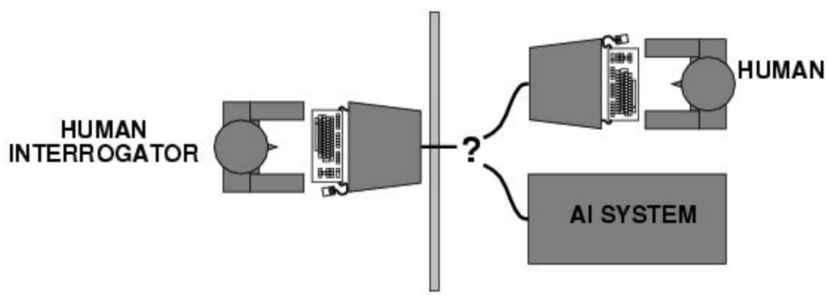
- **natural language processing** to enable it to communicate successfully in English (or someother human language);
- **knowledge representation** to store information provided before or during the interrogation;
- **automated reasoning** to use the stored information to answer questions and to draw new conclusions;
- **machine learning** to adapt to new circumstances and to detect and extrapolate patterns.
- **computer vision** to perceive objects, and
- **robotics** to move them about

Thinking Humanly: The cognitive approach

- "Can machines think?" □ "Can machines behave intelligently
- The interdisciplinary field of **cognitive science** brings together computer models from AI and experimental techniques from psychology to try to construct precise and testable theories of the workings of the human mind.
- There are two ways to do this:

GPS : general problem solver

❑ Introspection—trying to catch our own thoughts as they go by
❑ psychological experiments.



Thinking Rationally Codify "Right Thinking"

logic

- The development of formal which , provided a precise notation for statements about all kinds of things in the world and the relations between them.
- There are two main obstacles to this approach.

❑ It is not easy to take informal knowledge and state it in the formal terms required by logical notation.

❑ There is a big difference between being able to solve a problem "in principle" and doing so in practice.

Acting Rationally

rational
agent

- Acting rationally means acting so as to achieve one's goals, given one's beliefs. An **agent** is just something that perceives and acts.
- It act to achieve best outcome or when there is a uncertainty the best expected outcome.

low of thought : correct inferences

Academic Disciplines relevant to AI

- Philosophy Logic, methods of reasoning, mind as physical system, foundations of learning, language, rationality.

- Mathematics Formal representation and proof, algorithms, computation, (un)decidability, (in)tractability

- Probability/Statistics modeling uncertainty, learning from data
- Economics utility, decision theory, rational economic agents
- Neuroscience neurons as information processing units.
- Psychology/ Cognitive Science how do people behave, perceive, process cognitive information, represent knowledge.

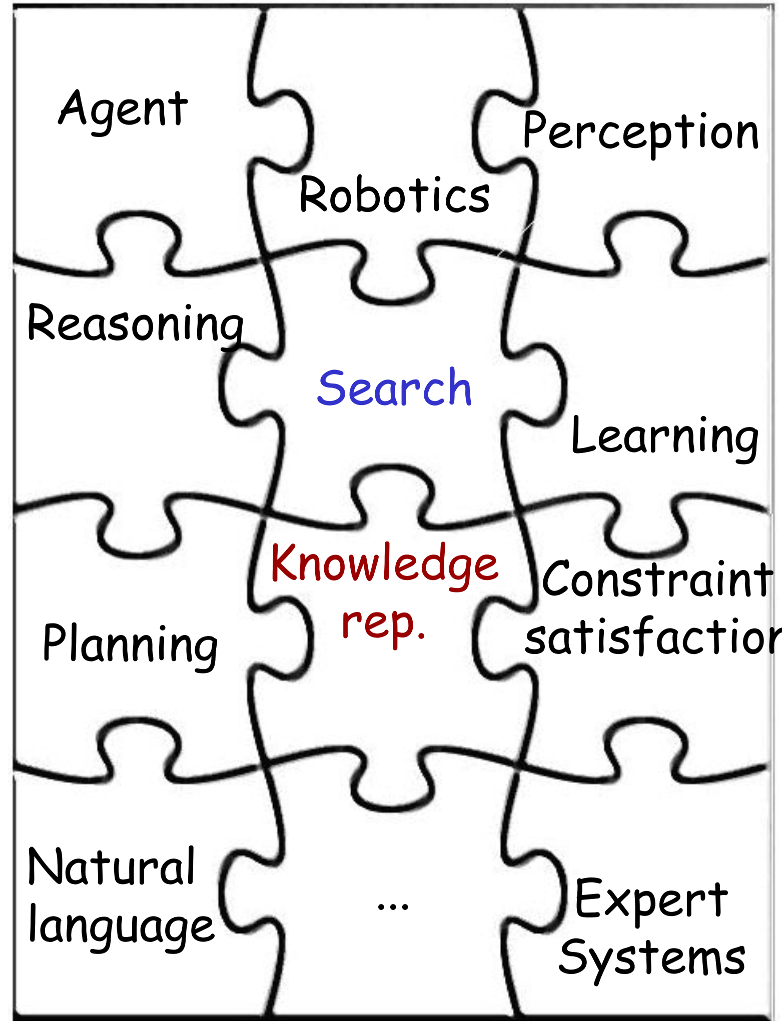
- Computer engineering building fast computers

- Control theory design systems that maximize an objective function over time

- Linguistics knowledge representation, grammars

Main Areas of AI

- Knowledge representation (including formal logic)
- Search, especially heuristic search (puzzles, games)
- Planning
- Reasoning under uncertainty, including probabilistic reasoning
- Learning
- Agent architectures
- Robotics and perception
- Natural language processing



History of AI

- 1943: early beginnings
  – McCulloch & Pitts: Boolean circuit model of brain
- 1950: Turing
  – Turing's "Computing Machinery and Intelligence“ ,therein introduced tuning test , machine learning , genetic and reinforcement learning algo
- 1956: birth of AI
  – **McCarthy** : Dartmouth college meeting: "Artificial Intelligence“ name adopted
- 1950s: initial promise
  – Early AI programs, including
  – Samuel's checkers program
  – Newell & Simon's Logic Theorist
- 1955-65: “great enthusiasm”
  – Newell and Simon: GPS, general problem solver
  – Gelertner: Geometry Theorem Prover
  – McCarthy: invention of LISP

History of AI

- 1966—73: Reality dawns
  - Realization that many AI problems are intractable
  - Limitations of existing neural network methods identified
    - Neural network research almost disappears

- 1969—85: Adding domain knowledge
  - Development of knowledge-based systems
  - Success of rule-based expert systems,
    - E.g., DENDRAL, MYCIN
    - But were brittle and did not scale well in practice

- 1986-- Rise of machine learning
  - Neural networks return to popularity
  - Major advances in machine learning algorithms and applications

- 1990-- Role of uncertainty
  - Bayesian networks as a knowledge representation framework

- 1995-- AI as Science
  - Integration of learning, reasoning, knowledge representation
  - AI methods used in vision, language, data mining, etc

The State of The Art

- Game Playing: Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997
- Autonomous Planning and Scheduling: NASA's on-board autonomous planning program controlled the scheduling of operations for a spacecraft
- Autonomous Control:ALVINN computer vision was trained to steer a car to keep in lane. No hands across America (driving autonomously 98% of the time from Pittsburgh to San Diego)
- Logistics Planning: During the 1991 Gulf War, US forces deployed an AI logistics planning and scheduling program (DART) that involved up to 50,000 vehicles, cargo, and people
- Language Understanding and Problem Solving: Proverb solves crossword puzzles better than most humans
- Diaganosis:Medical diagnosis based on probabilistic analysis have been able to perform at level of an expert in areas of medicine

Consider what might be involved in building a “intelligent” computer….

- What are the “components” that might be useful?

  - Fast hardware?
  - Foolproof software?
  - Chess-playing at grandmaster level?
  - Speech interaction?
    - speech synthesis
    - speech recognition
    - speech understanding
  - Image recognition and understanding ?
  - Learning?
  - Planning and decision-making?

Can we build hardware as complex as the brain?

- How complicated is our brain?
  - a neuron, or nerve cell, is the basic information processing unit
  - estimated to be on the order of 10^{11} neurons in a human brain
  - many more synapses (10^{14}) connecting these neurons
  - cycle time: 10^{-3} seconds (1 millisecond)

- How complex can we make computers?
  - 10^{6} or more transistors per CPU
  - supercomputer: hundreds of CPUs, 10^{9} bits of RAM
  - cycle times: order of 10^{-8} seconds

- Conclusion
  - **YES**: in the near future we can have computers with as many basic processing elements as our brain, but with
    - far fewer interconnections (wires or synapses) than the brain
    - much faster updates than the brain
  - **but** building hardware is very different from making a computer behave like a brain!

Must an Intelligent System be Foolproof?

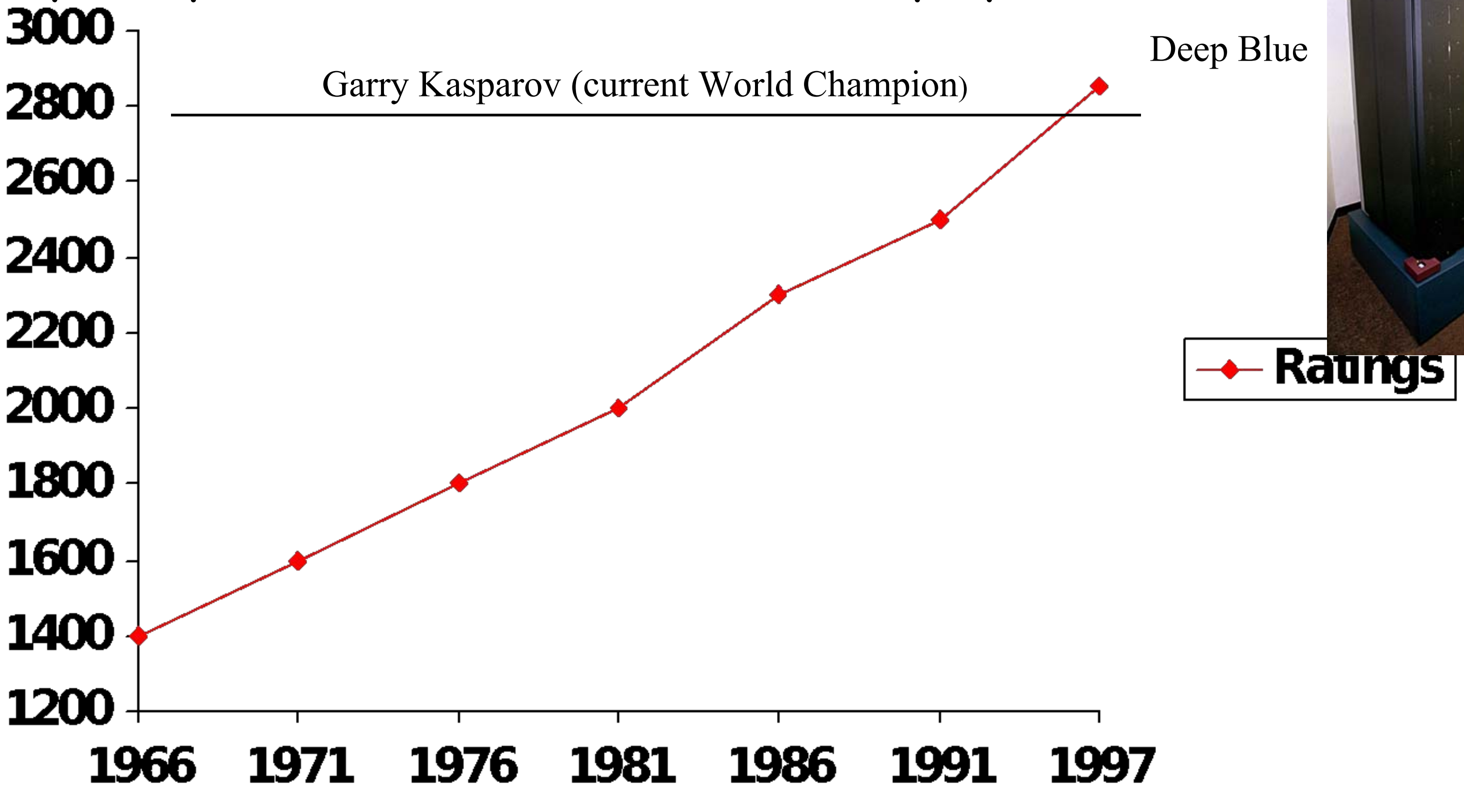
- A "foolproof" system is one that never makes an error:
  - Types of possible computer errors
    - hardware errors, e.g., memory errors
    - software errors, e.g., coding bugs
    - "human-like" errors
  - Clearly, hardware and software errors are possible in practice
  - what about "human-like" errors?

- An intelligent system can make errors and still be intelligent
  - humans are not right all of the time
  - we learn and adapt from making mistakes
    - e.g., consider learning to surf or ski
      - we improve by taking risks and falling
      - an intelligent system can learn in the same way

- Conclusion:
  - **NO**: intelligent systems will not (and need not) be foolproof

Can Computers play Humans at Chess?

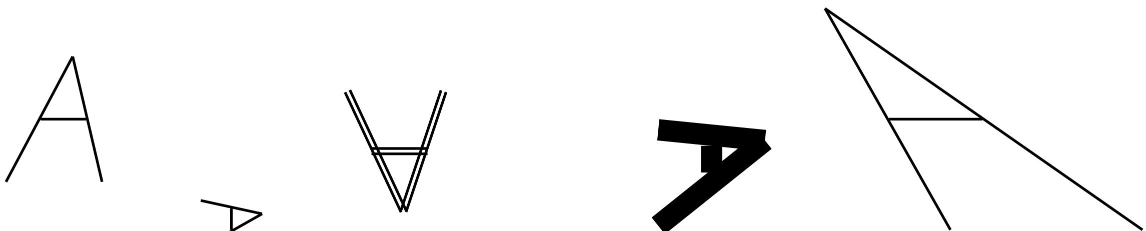
- Chess Playing is a classic AI problem
  - well-defined problem
  - very complex: difficult for humans to play well



Conclusion: YES: today's computers can beat even the best human

Can Computers "see"?

- Recognition v. Understanding (like Speech)
  - Recognition and Understanding of Objects in a scene
    - look around this room
    - you can effortlessly recognize objects
    - human brain can map 2d visual image to 3d "map"
- Why is visual recognition a hard problem?



Conclusion: mostly NO: computers can only "see" certain types of objects under limited circumstances: but YES for certain constrained problems (e.g., face recognition)

Can Computers Recognize Speech?

- Speech Recognition:
  - mapping sounds from a microphone into a list of words.
  - Hard problem: noise, more than one person talking, occlusion, speech variability,..
  - Even if we recognize each word, we may not understand its meaning.
- Recognizing single words from a small vocabulary
  - systems can do this with high accuracy (order of 99%)
  - e.g., directory inquiries
    - limited vocabulary (area codes, city names)
    - computer tries to recognize you first, if unsuccessful hands you over to a human operator
    - saves millions of dollars a year for the phone companies

Recognizing human speech (ctd.)

- Recognizing normal speech is much more difficult
  - speech is continuous: where are the boundaries between words?
    - e.g., "John's car has a flat tire"
  - large vocabularies
    - can be many tens of thousands of possible words
    - we can use **context** to help figure out what someone said
      - try telling a waiter in a restaurant: "I would like some dream and sugar in my coffee"
  - background noise, other speakers, accents, colds, etc
  - on normal speech, modern systems are only about 60% accurate
- Conclusion: NO, normal speech is too complex to accurately recognize, but YES for restricted problems
  - (e.g., recent software for PC use by IBM, Dragon systems)

Can Computers Understand speech?

- Understanding is different to recognition:
  - "Time flies like an arrow"
    - assume the computer can recognize all the words
    - but how could it understand it?
      - 1. time passes quickly like an arrow?
      - 2. command: time the flies the way an arrow times the flies
      - 3. command: only time those flies which are like an arrow
      - 4. "time-flies" are fond of arrows
    - only 1. makes any sense, but how could a computer figure this out?
      - clearly humans use a lot of implicit commonsense knowledge in communication
- Conclusion: NO, much of what we say is beyond the capabilities of a computer to understand at present