Artificial Intelligence

Dr. Ahmed Mateen

Course Description

- Introduction to Artificial Intelligence (AI) history and applications;
- Strong AI and weak AI
- Knowledge representation;
- Problem solving in artificial intelligence using knowledge representation, searching and reasoning;
- Uninformed and heuristic search;
- Machine learning;
- Laws of Robotics;
- CLIPS programming;
- Advanced AI Topics. Natural language processing, ANN, Fuzzy logic, clustering

Learning Outcomes

- Understand the meaning of AI, its alternative approaches and the implications of AI for cognitive science more broadly.
- Expand knowledge about Inform and uniform search heuristic search, genetic algorithm, planning, and learning algorithms.
- Understand the basic methods in planning and reasoning using both logic and uncertain inference.
- Know a variety of ways to represent and retrieve knowledge and information [Expert systems, Agents].
- Know the fundamentals of AI programming techniques and advanced machine learning in a modern programming language.

Required Material

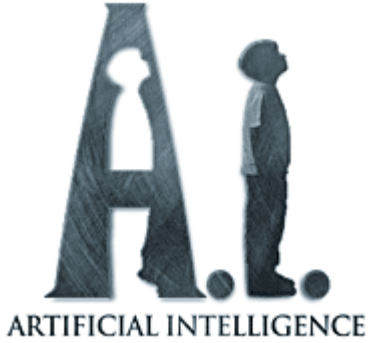
- **Text Book:**
  - Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, Prentice Hall.
  - Programming for Artificial Intelligence, CLIPS User Guide

- **Reference Books:**
  - Artificial Intelligence: Structures and Strategies for Complex Problem Solving, George F. Luger, Addison Wesley Publisher.

Today's Lecture

- What is intelligence?
- What is artificial intelligence?
- Modern successes
- Sentience AI

Let's begin



- Introduction Artificial Intelligence?
  - AI is one of the newest disciplines
  - Formally initiated in 1956
  - The study of intelligence is also one of the oldest discipline.
- For over 2,000 years philosophers have tried to understand how
  - Seeing
  - Learning
  - Remembering
  - And reasoning could or should be done?????

What is Intelligence ?

“ability to learn, understand and think”

(Oxford dictionary)

What is Intelligence???

- Intelligence is the ability to learn about, to learn from, to understand about, and interact with one's environment.

- Intelligence is the faculty of understanding

- Intelligence is not to make no mistakes but quickly to understand how to make them good

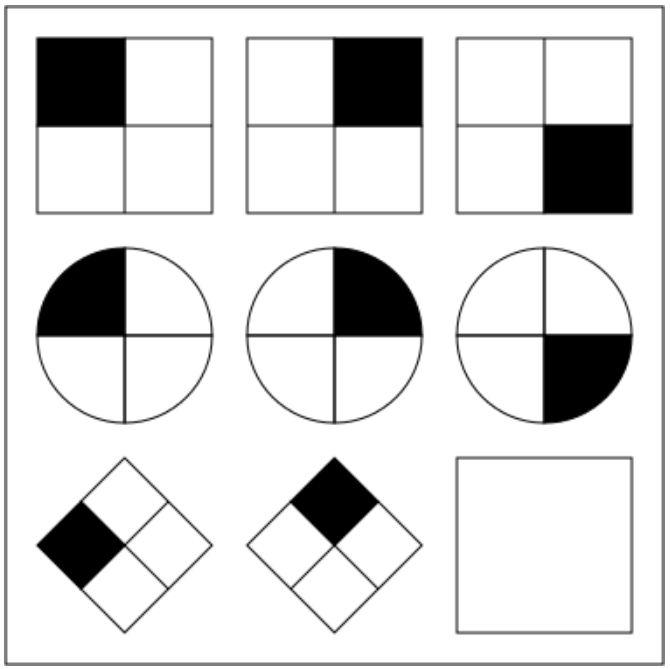
(German Poet)

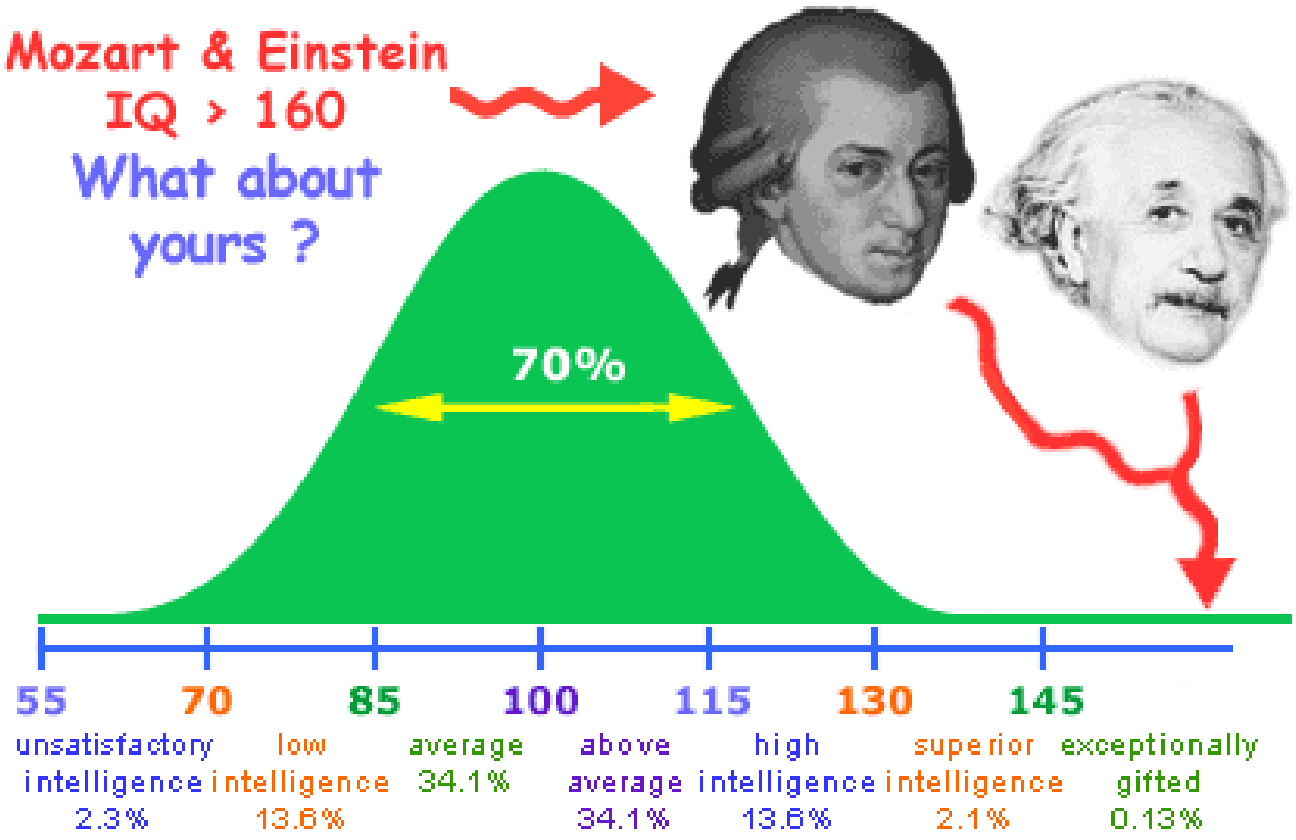
What is Intelligence???

- Capacity to learn from experience
- Ability to adapt to different contexts
- The use of analyses ability to enhance learning
- Capacity of mind, especially to understand principles, truths, facts or meanings, acquire knowledge, and apply it to practice; the ability to learn and comprehend.

Intelligence quotient
IQ

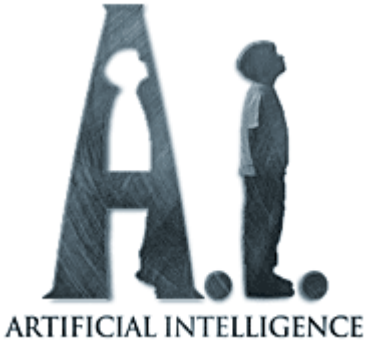
- An **intelligence quotient,** or **IQ,** is a score derived from one of several standardized tests designed to assess intelligence.




Mozart & Einstein
IQ > 160
What about
yours ?
70%
55
70
85
100
115
130
145
unsatisfactory intelligence 2.3%
low intelligence 13.6%
average 34.1%
above average 34.1%
high intelligence 13.6%
superior intelligence 2.1%
exceptionally gifted 0.13%

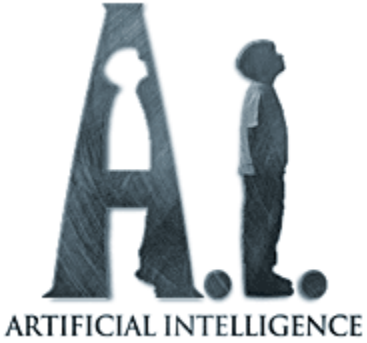

Multiple Intelligences
Verbal/Linguistic
The capacity to use language to express what's on your mind and to understand other people.
Existential
To exhibit the proclivity to pose and ponder questions about life, death and ultimate realties.
Logical/Mathematical
The ability to understand the underlying principles of some kind of causal system.
Interpersonal
The ability to understand other people.
Intrapersonal
Having an understanding of yourself, of knowing who you are, what you can do, etc.
Visual/Spatial
The ability to present the spatial world internally in your mind.
Musical/Rhythmic
The capacity to think in music, to be able to hear patterns, recognize them, and perhaps maniipulate them.
Naturalist
The ability to discriminate among living things as well as sensitivity to other features of the natural world.
Bodily/Kinesthetic
capacity to use your whole or parts of your body, to solve roblem, make something, or put on a production.
M.I. Smart! jcp
1999

What is artificial intelligence?



- There is **no** agreed definition of the term artificial intelligence. However, there are various definitions that have been proposed. Some will be considered below.

What is artificial intelligence?



American Association for Artificial Intelligence

The scientific understanding of the mechanisms underlying thought and intelligent behavior and their embodiment in machines.

What is artificial intelligence?

- It is the science and engineering of making intelligent machines, especially intelligent computer programs.
- It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable. (John McCarthy)

What is artificial intelligence? (ctd.)

- The use of computers to solve problems that previously could only be solved by applying human intelligence…. thus something can fit this definition today, but, once we see how the program works and understand the problem, we will not think of it as AI anymore (David Parnas)

What is artificial intelligence? (ctd.)

- AI is a study in which computer systems are made that think like human beings. Haugeland, 1985 & Bellman, 1978.
- AI is a study in which computer systems are made that act like people. AI is the art of creating computers that perform functions that require intelligence when performed by people. Kurzweil, 1990.
- AI is the study of how to make computers do things which at the moment people are better at. Rich & Knight, 1991
- AI is a study in which computers that rationally think are made. Charniac & McDermott, 1985.
- AI is the study of computations that make it possible to perceive, reason and act. Winston, 1992.
- AI is the study in which systems that rationally act are made. AI is considered to be a study that seeks to explain and emulate intelligent behaviour in terms of computational processes. Schalkeoff, 1990.
- AI is considered to be a branch of computer science that is concerned with the automation of intelligent behavior. Luger & Stubblefield, 1993.

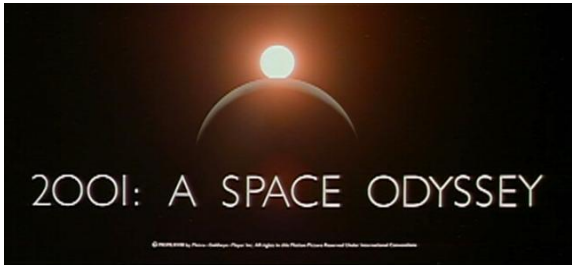
What's involved in Intelligence?

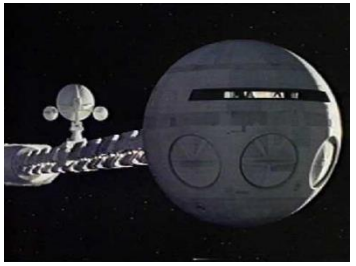
- Ability to interact with the real world
  - to perceive, understand, and act
  - e.g., speech recognition and understanding and synthesis
  - e.g., image understanding
  - e.g., ability to take actions, have an effect
- Reasoning and Planning
  - modeling the external world, given input
  - solving new problems, planning, and making decisions
  - ability to deal with unexpected problems, uncertainties
- Learning and Adaptation
  - we are continuously learning and adapting
  - our internal models are always being "updated"
    - e.g., a baby learning to categorize and recognize animals

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

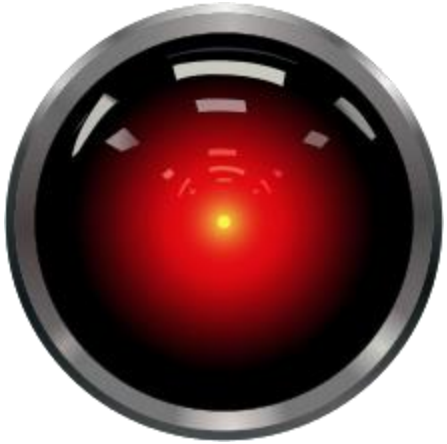
HAL: from the movie 2001





- *2001: A Space Odyssey*
  - classic science fiction movie from 1969
- HAL
  - part of the story centers around an intelligent computer called HAL
  - HAL is the "brains" of an intelligent spaceship
  - in the movie, HAL can
    - speak easily with the crew
    - see and understand the emotions of the crew
    - navigate the ship automatically
    - diagnose on-board problems
    - make life-and-death decisions
    - display emotions
- In 1969 this was science fiction: is it still science fiction?

Hal and AI



- *HAL's Legacy: 2001's Computer as Dream and Reality*
  - MIT Press, 1997, David Stork (ed.)
  - discusses
    - HAL as an intelligent computer
    - are the predictions for HAL realizable with AI today?
- Materials online at
  - http://mitpress.mit.edu/e-books/Hal/contents.html
- The website contains
  - full text and abstracts of chapters from the book
  - links to related material and AI information
  - sound and images from the film

Consider what might be involved in building a computer like Hal….

- What are the components that might be useful?
  - Fast hardware?
  - 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?

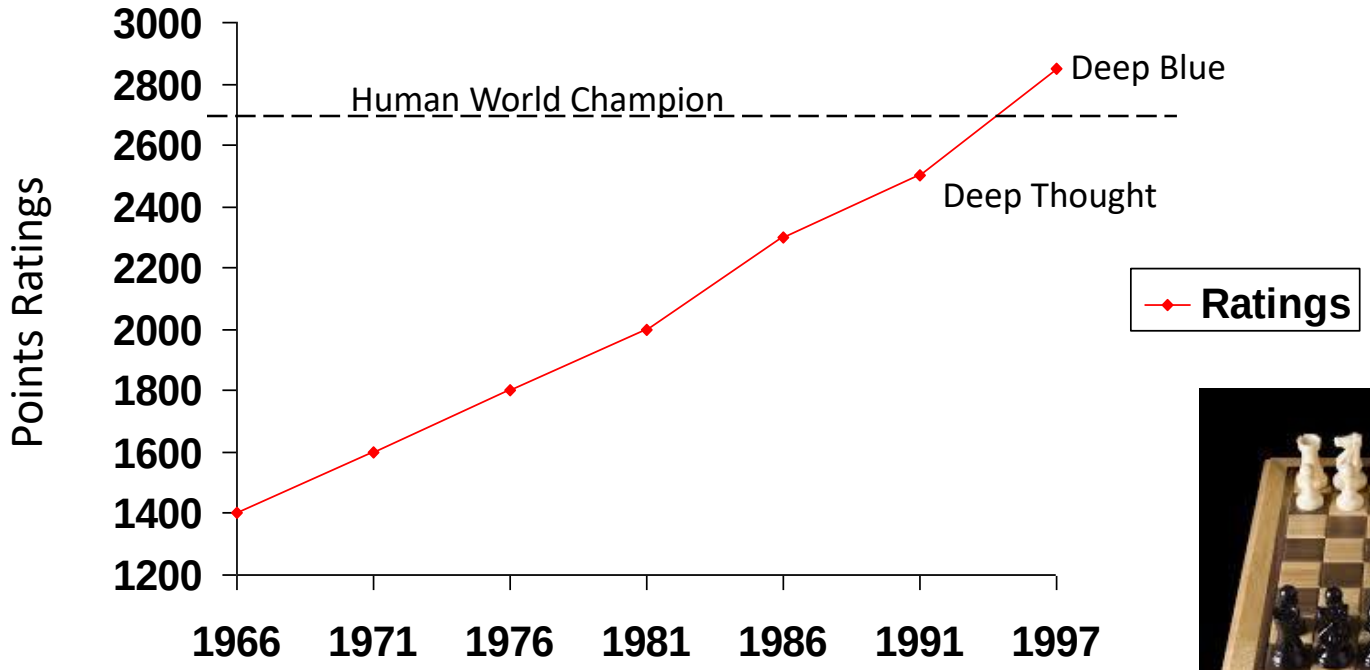
- How complicated is our brain?
  - a neuron, or nerve cell, is the basic information processing unit
  - estimated to be on the order of 10^{12} neurons in a human brain
  - many more synapses (10^{14}) connecting these neurons
  - cycle time: 10^{-3} seconds (1 millisecond)

- How complex can we make computers?
  - 10^8 or more transistors per CPU
  - supercomputer: hundreds of CPUs, 10^{12} bits of RAM
  - cycle times: order of 10^{-9} 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!

Can Computers beat 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 Talk?

- This is known as “speech synthesis”
  - translate text to phonetic form
    - e.g., “fictitious” -> fik-tish-es
  - use pronunciation rules to map phonemes to actual sound
    - e.g., “tish” -> sequence of basic audio sounds

- Difficulties
  - sounds made by this “lookup” approach sound unnatural
  - sounds are not independent
    - e.g., “act” and “action”
    - modern systems (e.g., at AT&T) can handle this pretty well
  - a harder problem is emphasis, emotion, etc
    - humans understand what they are saying
    - machines don’t: so they sound unnatural

- Conclusion:
  - NO, for complete sentences
  - YES, for individual words

Can Computers Recognize Speech?

- Speech Recognition:
  - mapping sounds from a microphone into a list of words
  - classic problem in AI, very difficult
    - “Lets talk about how to wreck a nice beach”
    - (I really said “_____”)
- 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., An English professor wrote the words: "A woman without her man is nothing" on the board and asked his students to punctuate it correctly.
      All of the males in the class wrote: "A woman, without her man, is nothing."
      All the females in the class wrote: "A woman: without her, man is nothing."
  - large vocabularies
    - can be many thousands of possible words
    - we can use **context** to help figure out what someone said
      - e.g., hypothesize and test
      - 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 60-70% accurate
    Conclusion:
  - NO, normal speech is too complex to accurately recognize
  - YES, for restricted problems (small vocabulary, single speaker)

Can Computers Understand speech?

- Understanding is different to recognition:
  - "Time flies like an arrow"
    - assume the computer can recognize all the words
    - how many different interpretations are there?

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      - 2. "time-flies" are fond of arrows
      - …

Can Computers Understand speech?

- Understanding is different to recognition:
  - "Time flies like an arrow"
    - assume the computer can recognize all the words
    - how many different interpretations are there?
      - 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

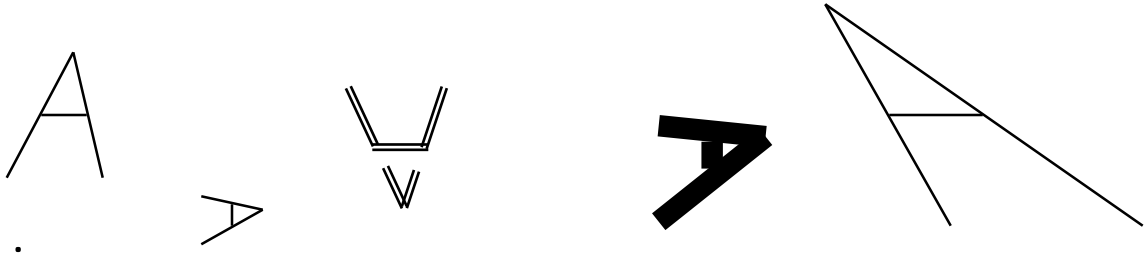
Can Computers Learn and Adapt ?

- Learning and Adaptation
  - consider a computer learning to drive on the freeway
  - we could teach it lots of rules about what to do
  - or we could let it drive and steer it back on route when it heads for the edge
    - systems like this are under development (e.g., Daimler Benz)
    - e.g., RALPH at CMU
      - in mid 90's it drove 98% of the way from Pittsburgh to San Diego without any human assistance
  - **machine learning** allows computers to learn to do things without explicit programming
  - many successful applications:
    - requires some "set-up": does not mean your PC can learn to forecast the stock market or become a brain surgeon

- Conclusion: YES, computers can learn and adapt, when presented with information in the appropriate way

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
  - YES for certain constrained problems (e.g., face recognition)

Can computers plan and make optimal decisions?

- Intelligence
  - involves solving problems and making decisions and plans
  - e.g., you want to take a holiday in Brazil
    - you need to decide on flights
    - you need to get to the airport, etc
    - involves a sequence of decisions, plans, and actions

- What makes planning hard?
  - the world is not predictable:
    - your flight is canceled or there's a backup on the 405
  - there are a potentially huge number of details
    - do you consider all flights? all dates?
      - no: commonsense constrains your solutions
  - AI systems are only successful in constrained planning problems

- Conclusion: NO, real-world planning and decision-making is still beyond the capabilities of modern computers
  - exception: very well-defined, constrained problems

Summary of State of AI Systems in Practice

- Speech synthesis, recognition and understanding
  - very useful for limited vocabulary applications
  - unconstrained speech understanding is still too hard

- Computer vision
  - works for constrained problems (hand-written zip-codes)
  - understanding real-world, natural scenes is still too hard

- Learning
  - adaptive systems are used in many applications: have their limits

- Planning and Reasoning
  - only works for constrained problems: e.g., chess
  - real-world is too complex for general systems

- Overall:
  - many components of intelligent systems are “doable”
  - there are many interesting research problems remaining

Intelligent Systems in Your Everyday Life

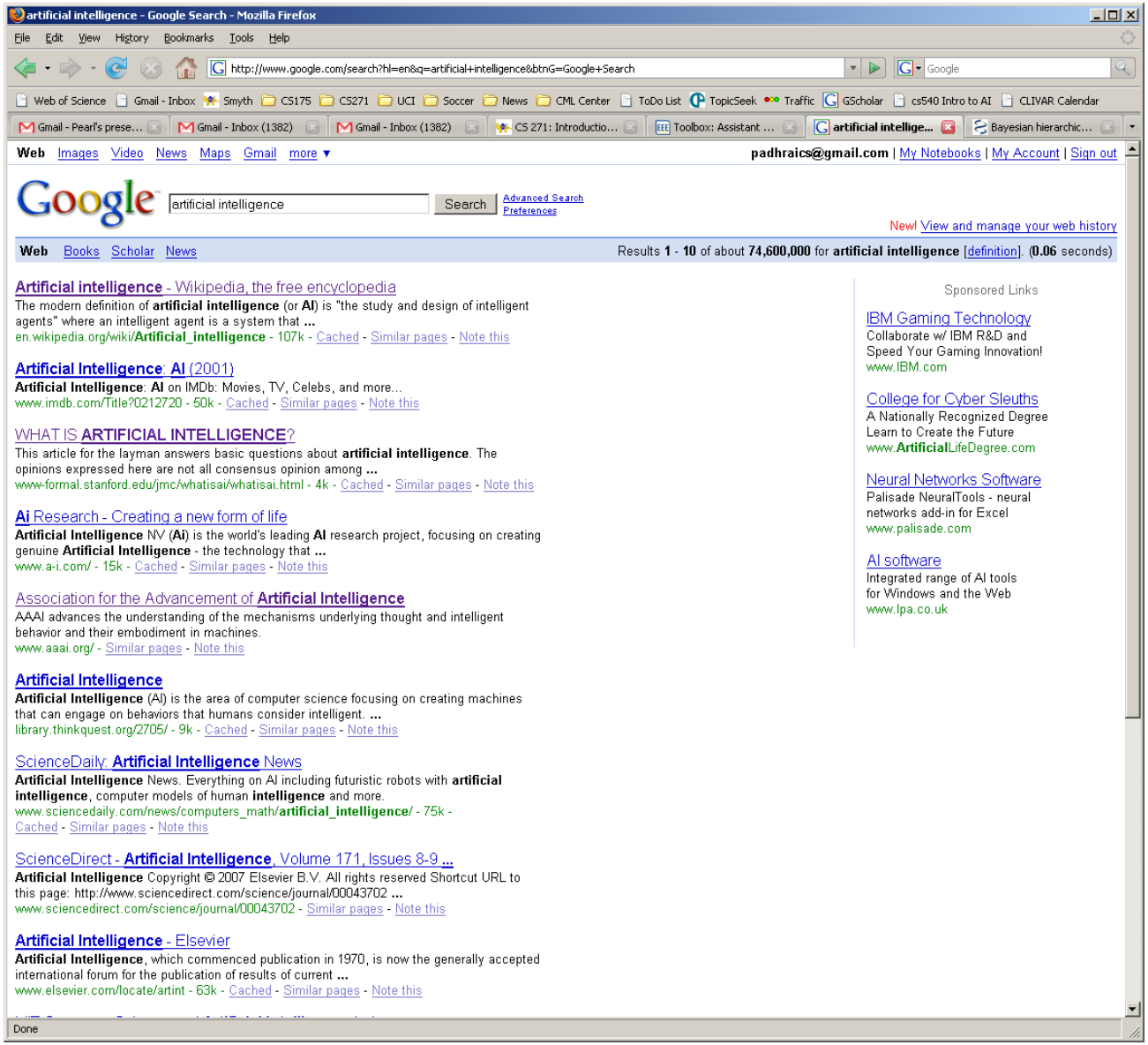
- Post Office
  - automatic address recognition and sorting of mail
- Banks
  - automatic check readers, signature verification systems
  - automated loan application classification
- Customer Service
  - automatic voice recognition
- The Web
  - Identifying your age, gender, location, from your Web surfing
  - Automated fraud detection
- Digital Cameras
  - Automated face detection and focusing
- Computer Games
  - Intelligent characters/agents

AI Applications: Machine Translation

- Language problems in international business
  - e.g., at a meeting of Japanese, Korean, Vietnamese and Swedish investors, no common language
  - or: you are shipping your software manuals to 127 countries
  - solution; hire translators to translate
  - would be much cheaper if a machine could do this

- How hard is automated translation
  - very difficult! e.g., English to Russian
    - "The spirit is willing but the flesh is weak" (English)
    - "the vodka is good but the meat is rotten" (Russian)
  - not only must the words be translated, but their meaning also!
  - is this problem "AI-complete"?
- Nonetheless....
  - commercial systems can do a lot of the work very well (e.g., restricted vocabularies in software documentation)
  - algorithms which combine dictionaries, grammar models, etc.
  - Recent progress using "black-box" machine learning techniques

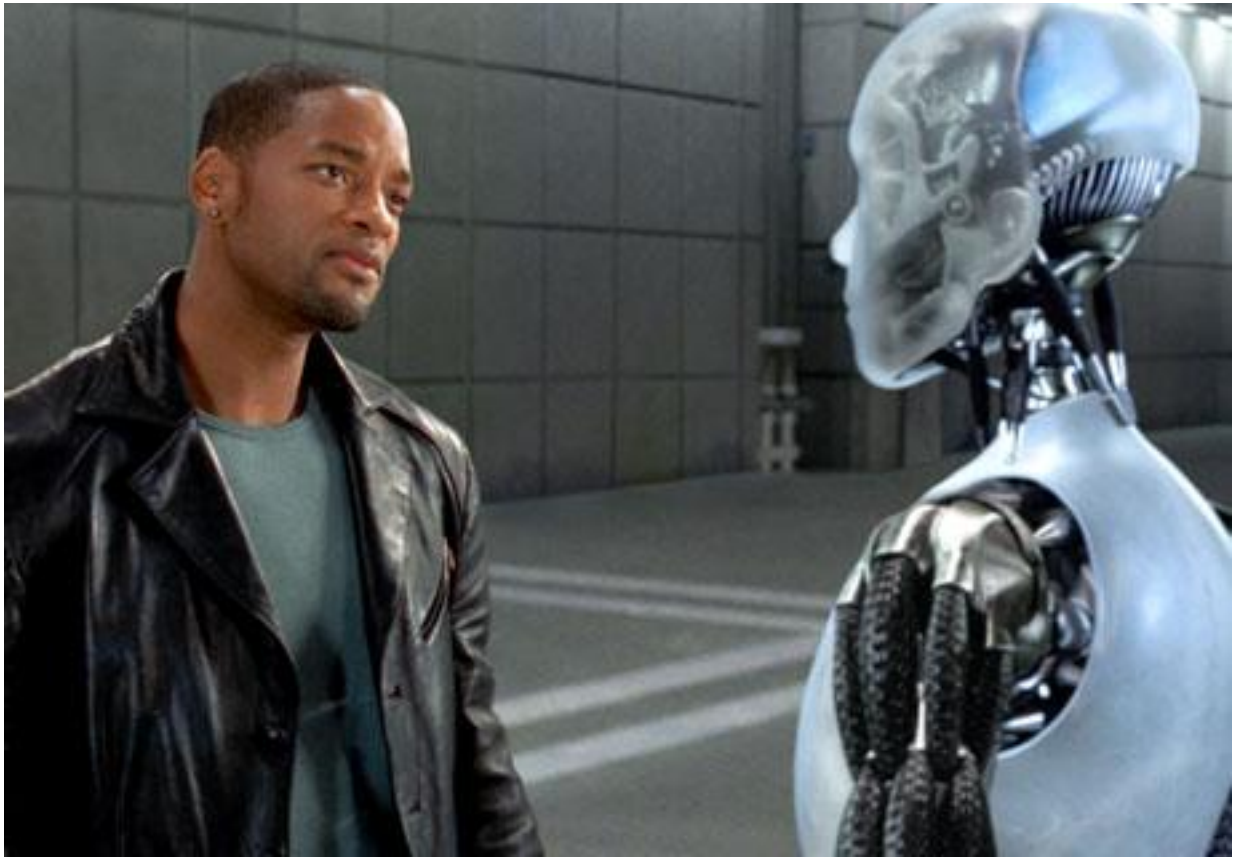
AI and Web Search



Summary of Today's Lecture

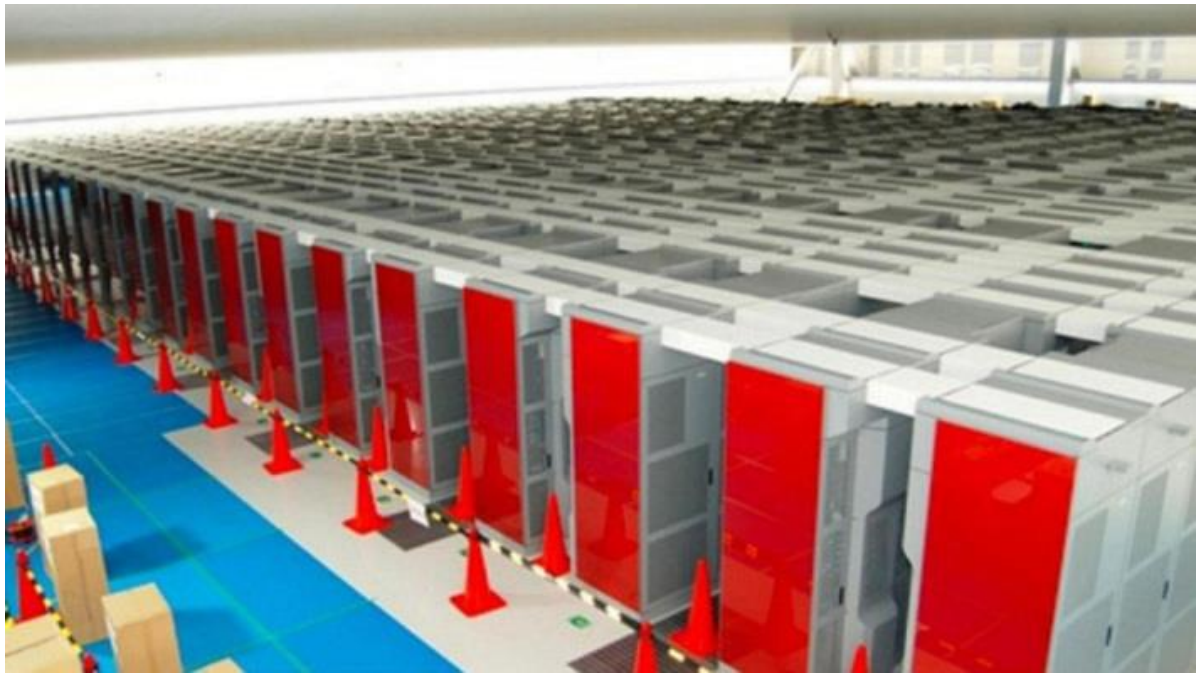
- Artificial Intelligence involves the study of:
  - automated recognition and understanding of signals
  - reasoning, planning, and decision-making
  - learning and adaptation
- AI has made substantial progress in
  - recognition and learning
  - some planning and reasoning problems
  - …but many open research problems
- AI Applications
  - improvements in hardware and algorithms => AI applications in industry, finance, medicine, and science.
- Reading: chapter 1 in text,

How much is a Machine Intelligent?



Simulating 1 second of real brain activity takes 40 minutes and 83K processors

- *Researchers have simulated 1 second of real brain activity, on a network equivalent to 1 percent of an actual brain's neural network, using the world's fourth-fastest supercomputer.*
- *The results aren't revolutionary just yet,*
- http://gigaom.com/2013/08/02/simulating-1-second-of-real-brain-activity-takes-40-minutes-83k-processors/



successes of AI today

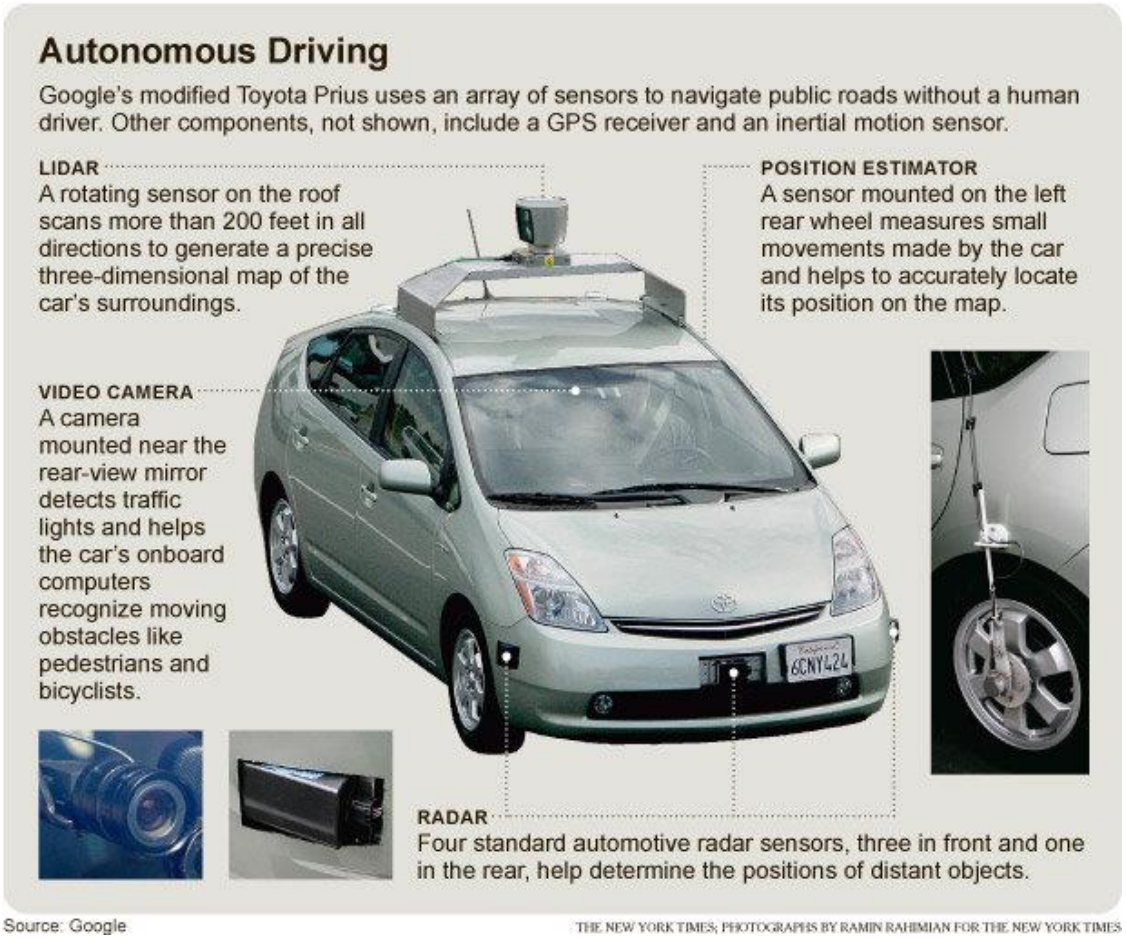
IBM Watson

- http://www-03.ibm.com/innovation/us/watson/
- NY Times article
- Trivia demo
- IBM Watson wins on Jeopardy (February 2011)

Vision

- OCR, handwriting recognition
- Face detection/recognition: many consumer cameras, Apple iPhoto
- Visual search: Google Goggles
- Vehicle safety systems: Mobileye

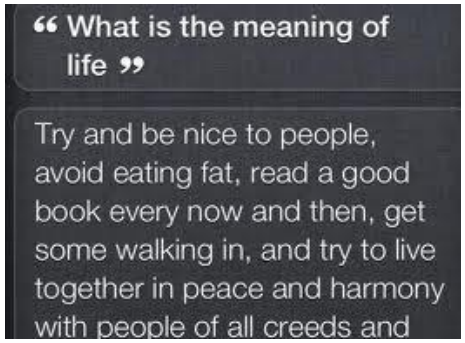
Google self-driving cars



- [Google's self-driving car passes 300,000 miles](8/15/2012)

Natural Language

- Speech technologies
  - Google voice search
  - Apple Siri



Machine translation

- translate.google.com
- Comparison of several translation systems

Source	*The Original Text*	*Human Translation*	*Google Translate*
 French "Le Petit Prince" ("The Little Prince") By Antoine de Saint-Exupéry	Le premier soir je me suis donc endormi sur le sable à mille milles de toute terre habitée. J'étais bien plus isolé qu'un naufragé sur un radeau au milieu de l'océan. Alors vous imaginez ma surprise, au lever du jour, quand une drôle de petite voix m'a réveillé. Elle disait: -S'il vous plaît... dessine-moi un mouton!	On the first night, I fell asleep on the sand, a thousand miles from any human habitation. I was far more isolated than a shipwrecked sailor on a raft in the middle of the ocean. So you can imagine my surprise at sunrise when an odd little voice woke me up. It said: "Please ... draw me a sheep." - *Wordsworth Children's Classics, 1995*	The first night I went to sleep on the sand a thousand miles from any human habitation. I was more isolated than a shipwrecked sailor on a raft in the middle of the ocean. So imagine my surprise at daybreak, when a funny little voice woke me. She said: "If it pleases you ... draw me a sheep!"

Math, games

- In 1996, a computer program written by researchers at Argonne National Laboratory proved a mathematical supposition unsolved for decades
  - NY Times story: “[The proof] would have been called creative if a human had thought of it”
- IBM’s Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997
  - **1996: Kasparov Beats Deep Blue**
    “I could feel – I could smell – a new kind of intelligence across the table.”
  - **1997: Deep Blue Beats Kasparov**
    “Deep Blue hasn't proven anything.”
- In 2007, checkers was “solved”
  - Science article

Logistics, scheduling, planning

- During the 1991 Gulf War, US forces deployed an AI logistics planning and scheduling program that involved up to 50,000 vehicles, cargo, and people
- NASA's Remote Agent software operated the Deep Space 1 spacecraft during two experiments in May 1999
- In 2004, NASA introduced the MAPGEN system to plan the daily operations for the Mars Exploration Rovers

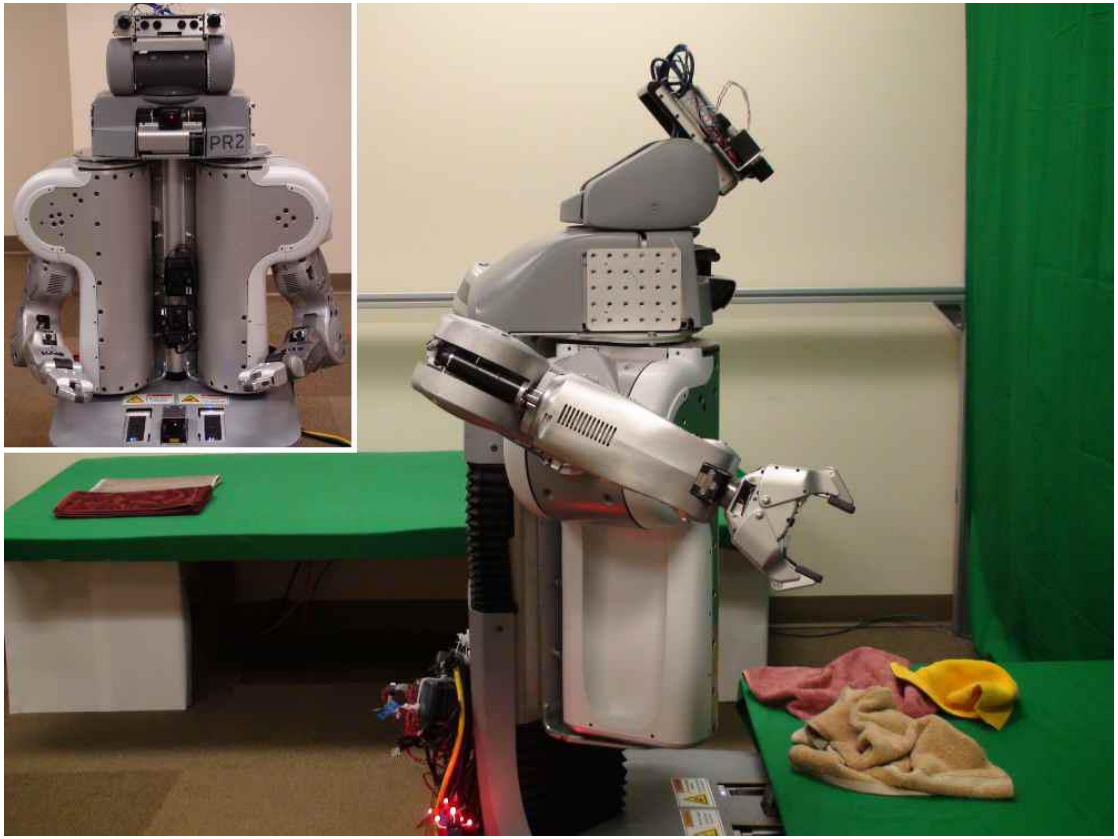
Information agents

- Search engines
- Recommendation systems
- Spam filtering
- Automated helpdesks
- Fraud detection
- Automated trading
- Medical diagnosis

Robotics

- Mars rovers
- Autonomous vehicles
  - DARPA Grand Challenge
  - Google self-driving cars
- Autonomous helicopters
- Robot soccer
  - RoboCup
- Personal robotics
  - Humanoid robots
  - Robotic pets
  - Personal assistants?

Towel-folding robot



YouTube Video

- J. Maitin-Shepard, M. Cusumano-Towner, J. Lei and P. Abbeel, "Cloth Grasp Point Detection based on Multiple-View Geometric Cues with Application to Robotic Towel Folding," ICRA 2010

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Human Intelligence VS Artificial Intelligence

Human Intelligence VS Artificial Intelligence

Pros

Human Intelligence

- Intuition, Common sense, Judgement, Creativity, Beliefs etc
- The ability to demonstrate their intelligence by communicating effectively
- Reasoning and Critical thinking

Artificial Intelligence

- Ability to simulate human behavior and cognitive processes
- Capture and preserve human expertise
- Fast Response. The ability to comprehend large amounts of data quickly.

Human Intelligence VS Artificial Intelligence

Cons

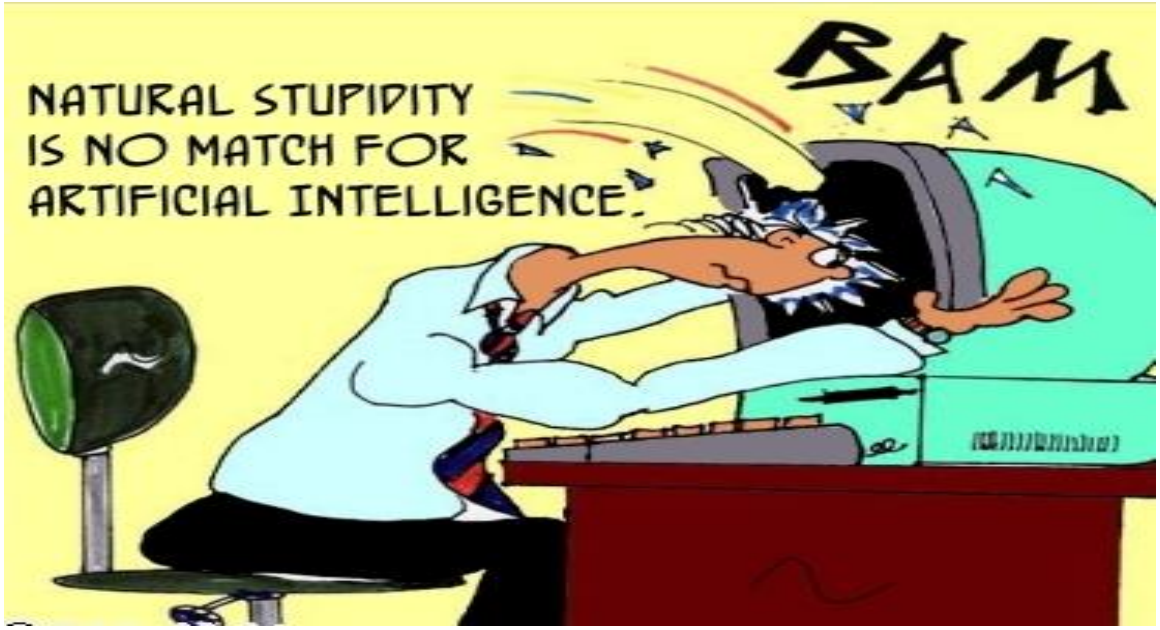
Human Intelligence

- Humans are fallible
- They have limited knowledge bases
- Information processing of serial nature proceed very slowly in the brain as compared to computers
- Humans are unable to retain large amounts of data in memory.

Artificial Intelligence

- No “common sense”
- Cannot readily deal with “mixed” knowledge
- May have high development costs
- Raise legal and ethical concerns

Human Intelligence VS Artificial Intelligence



We achieve more than we know.
We know more than we understand.
We understand more than we can explain
(Claude Bernard, 19th C French scientific philosopher)

Artificial Intelligence VS Conventional Computing

Artificial Intelligence

- AI software uses the techniques of search and pattern matching
- Programmers design AI software to give the computer only the problem, not the steps necessary to solve it

Conventional Computing

- Conventional computer software follow a logical series of steps to reach a conclusion
- Computer programmers originally designed software that accomplished tasks by completing algorithms

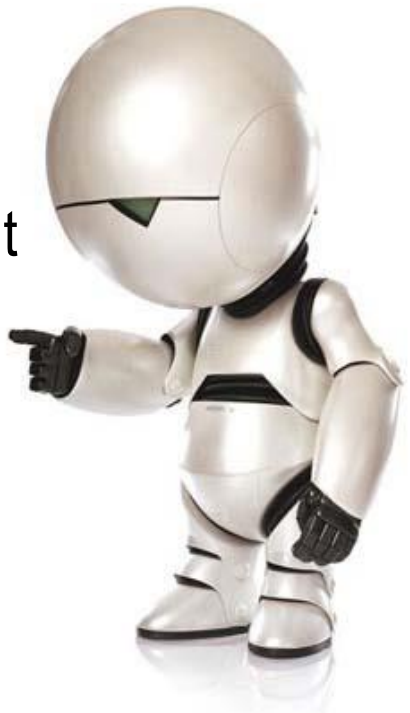
Artificial intelligence & Our society

Why we need AI??

To supplement natural intelligence for e.g
we are building intelligence in an object so that it can do what we want it to do,

as for example-- robots, thus reducing human labor and reducing human mistakes

A Perspective



- For Humans Intelligence is no more than TAKING a right decision at right time

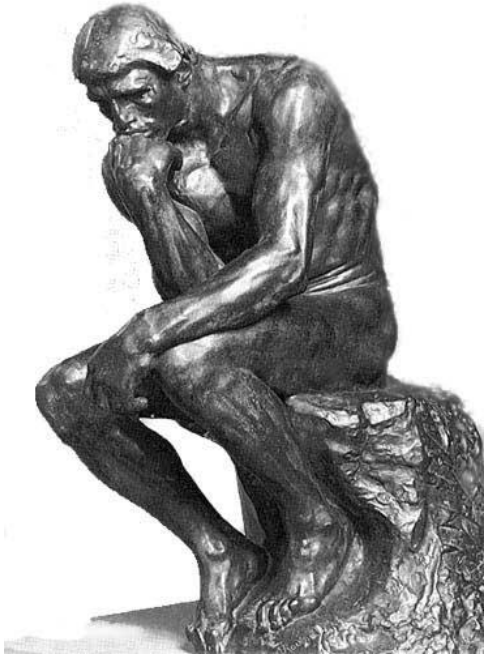
And

- For Machines Artificial Intelligence is no more than CHOOSING a right decision at right time

- I think Artificial intelligence is the Second intelligence ever to exist

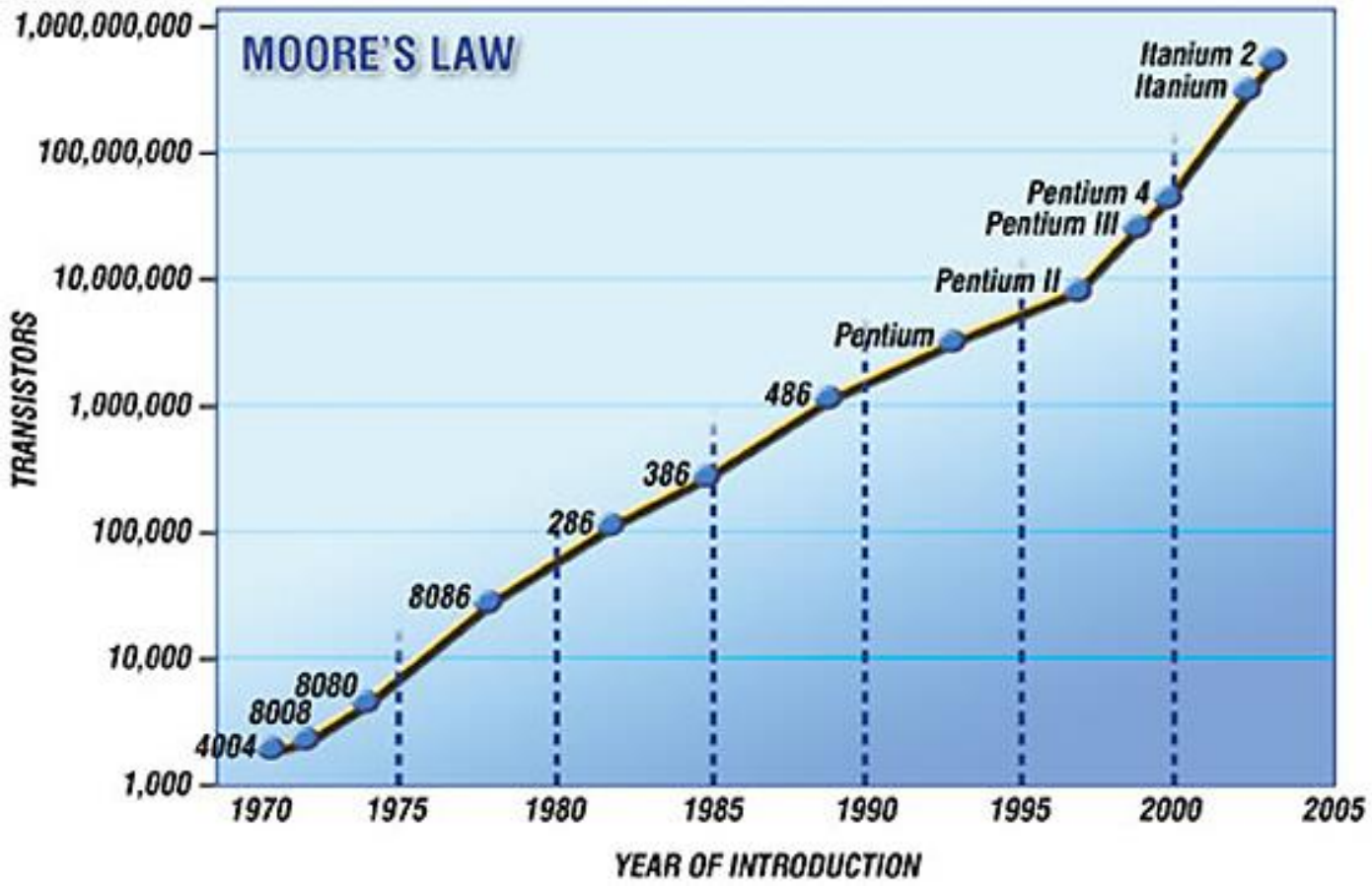
Is AI dangerous?

- What is a Sentient AI?
- Sentience = self-awareness
- Human-level intelligence



The Plausibility of Sentient AI

- Moore's Law: exponential growth!

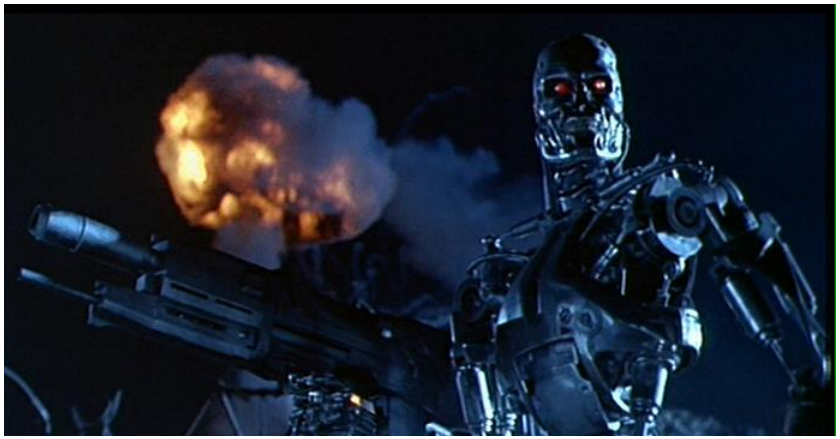


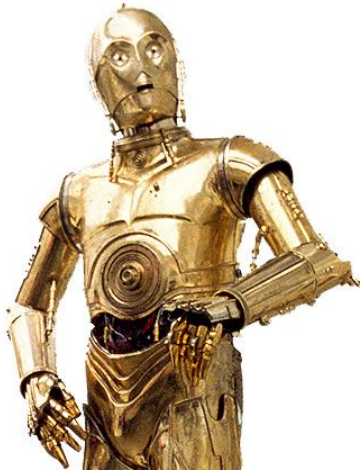
The Plausibility of Sentient AI

- The Blue Brain Project
  - It could be possible to model a complete human brain within ten years – on a single machine, no less.
- Ray Kurzweil:
  - "… we will have both the hardware and the software to achieve human level artificial intelligence with the broad suppleness of human intelligence including our emotional intelligence by 2029"

The Controversy

- Should humans strive to build sentient AI?
  - What are the risks? Benefits?
  - Is it ethical or morally responsible?
  - What rights should artificial beings have?
  - Would there be any place for us?





Sentient Artificial Intelligence could be dangerous

- I, Robot
- Thinking for one's self
- Turn skills against humans
- Resent taking care of weaker race
- Stephen Hawking:
  - "in contrast with our intellect, computers double their performance every 18 months … the danger is real that they could develop intelligence and take over the world"
- Natural selection and resources
- Big Dog

Sentient Artificial Intelligence would take jobs away from humans

- Around the neighborhood
  - “in the home, by the end of 2003, about 610,000 autonomous vacuum cleaners and lawn-mowers were in operation” (United Nations)
- Medicine
  - “computers [are] better able to distinguish signs of Alzheimer's than humans, and [prove] cheaper, faster and more accurate than current methods” (Richard Frackowiak, “PC beats doctor in scan tests”)
- Car industry
- Outsourcing is already a problem

Ethical Dilemma

- Robot Rights
  - If machines have the potential to exhibit complex behaviors such as altruism, language, and self-reproduction, “questions of ‘machine rights’ and ‘robot liberation’ will surely arise in the future” (Robert A. Freitas)
- Society’s views on the rights of sentient AI
- Is it right to create life?
  - Is sentient Artificial intelligence life?

Blown out of proportion

- Movies such as I, Robot, Terminator, and The Matrix
  - Take negative ideas and make them prominent.
  - Give society a negative idea of sentience and AI.
  - These movies are not an accurate idea of the potential uses of sentience.

- Benefits of Sentient AI
  - Benefits of AI be more important than the very small possibility of these movies becoming a reality.

Job loss isn’t a bad thing

- Take those jobs away!
  - Dangerous occupations
  - Depths of space
    - One-way Missions
  - Biological limitations
  - Purely repetitive tasks
  - Waste disposal
- Increase Efficiency

Creation- A bribe!

- Still just a robot
- Overall benefits to mankind
  - Utilitarianism View
- Exploration into the unknown

Sentient AI is beneficial

- Artificial intelligence is already being used in society
  - Social
    - Video games – intelligent foes
  - Industrial
    - Smarter assembly lines
  - Mathematical
    - Consumer purchasing prediction models

Other benefits of Sentient AI

- Nanotechnology
  - Smart patches and medical innovations
    - Acquire medical information without even going to a doctor
- Commercial
  - Sentient artificial intelligence won't fear doing more risky jobs.
    - More safe work environment
  - Reach areas previously inaccessible by humans, and develop!

A Life of Luxury

- Smart Cars – Lexus
  - Park itself!

- Roomba!

- Think QRIO

Conclusion / Compromise

- Some level of artificial intelligence is capable of benefitting society
- AI should be specialized in a specific task so as to not become more like humans
- If these requirements are met, AI should be allowed to be developed more

Robots have feelings too

Summary of Today's Lecture

- Artificial Intelligence involves the study of:
  - automated recognition and understanding of signals
  - reasoning, planning, and decision-making
  - learning and adaptation
- AI has made substantial progress in
  - recognition and learning
  - some planning and reasoning problems
  - …but many open research problems
- AI Applications
  - improvements in hardware and algorithms => AI applications in industry, finance, medicine, and science.
- Human Intelligence VS Artificial Intelligence
  - Artificial Intelligence VS Conventional Computing
- Is AI dangerous?
  - Sentient AI
- Reading: chapter 1 in text,