Artificial Intelligence

Chapter 1

What is AI

Artificial intelligence (AI) is the ability of a computer or a robot controlled by a computer to do tasks that are usually done by humans because they require human intelligence and discernment.

Examples:

The following are the examples of AI-Artificial Intelligence:

Google Maps and Ride-Hailing Applications

Face Detection and recognition

Text Editors and Autocorrect

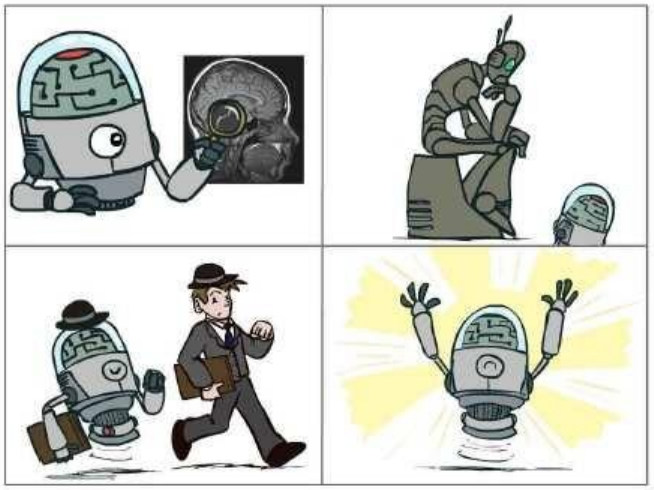
Chatbots

CONT…..

E-Payments
Search and Recommendation algorithms
Digital Assistant
Social media
Healthcare
Gaming
Online Ads-Network
Banking and Finance
Smart Home devices
Security and Surveillance
Smart Keyboard App
Smart Speaker
E-Commerce
Smart Email Apps
Music and Media Streaming Service
Space Exploration

What is AI?

Think like people



Think rationally

Act like people

Act rationally

Thinking humanly: The automation of activities that we associate with human thinking, activities such as decision-making, problem solving, learning...(Richard Bellman, 1978)

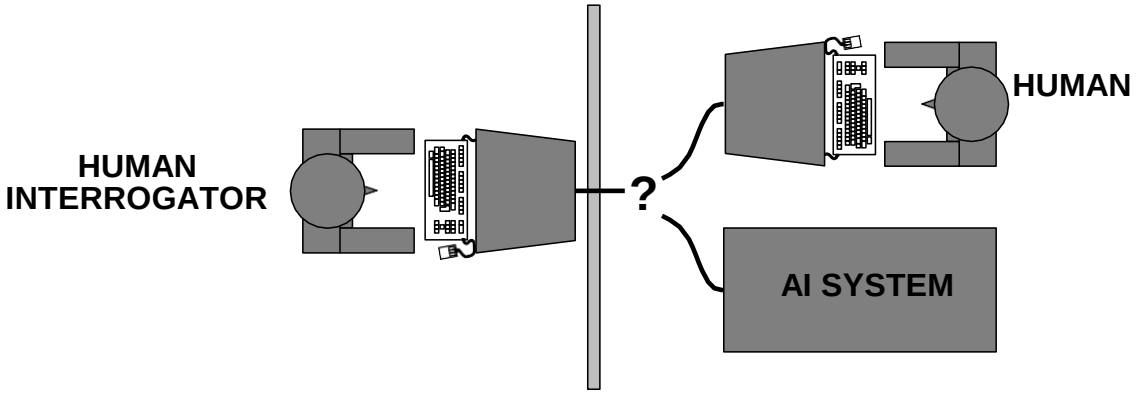
Acting Humanly: "The art of creating machines that perform functions that require intelligence when performed by people." (Ray Kurzweil, 1990)

Acting rationally: AI . . . is concerned with intelligent behavior in artifacts (Nilsson, 1998)

Acting humanly: The Turing test approach

Turing Test, proposed by Alan (1950) "Computing machinery and intelligence":

- "Can machines think?" $\dashrightarrow$ "Can machines behave intelligently?"
- Operational test for intelligent behavior: the Imitation Game



- Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes
- Suggested major components of AI: knowledge, reasoning, language understanding, learning
- Total Turing test: computer vision, robotics

Thinking humanly: Cognitive modelling approach

If we are going to say that a given program thinks like a human, we must have some way of determining how humans think. We need to get inside the actual workings of human minds.

There are three ways to do this: through introspection—trying to catch our own thoughts as they go by; through psychological experiments—observing a person in action; and through brain imaging—observing the brain in action. Once we have a sufficiently precise theory of the mind, it becomes possible to express the theory as a computer program. If the program's input—output behavior matches corresponding human behavior, that is evidence that some of the program's mechanisms could also be operating in humans

Thinking rationally: Laws of Thought approach

Normative (or prescriptive) rather than descriptive

Aristotle: what are correct arguments/thought processes?

Several Greek schools developed various forms of logic:

notation and rules of derivation for thoughts;
may or may not have proceeded to the idea of mechanization

Logicist tradition withi AI hopes to build on such programs to create intelligent systems.

Problems:
1) Not all intelligent behavior is mediated by logical deliberation
2) What is the purpose of thinking? What thoughts should I have out of all the thoughts (logical or otherwise) that I could have?

Acting rationally:The rational agent approach

Rational behavior: doing the right thing

The right thing: that which is expected to maximize goal achievement, given the available information

Doesn't necessarily involve thinking—e.g., blinking reflex—but thinking should be in the service of rational action

Aristotle (Nicomachean Ethics):

> Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good

Rational agents

An agent is an entity that perceives and acts

This course is about designing rational agents

Abstractly, an agent is a function from percept histories to actions:

$$f : \mathrm{P}^* \rightarrow \mathrm{A}$$

For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance

Caveat: computational limitations make perfect rationality unachievable

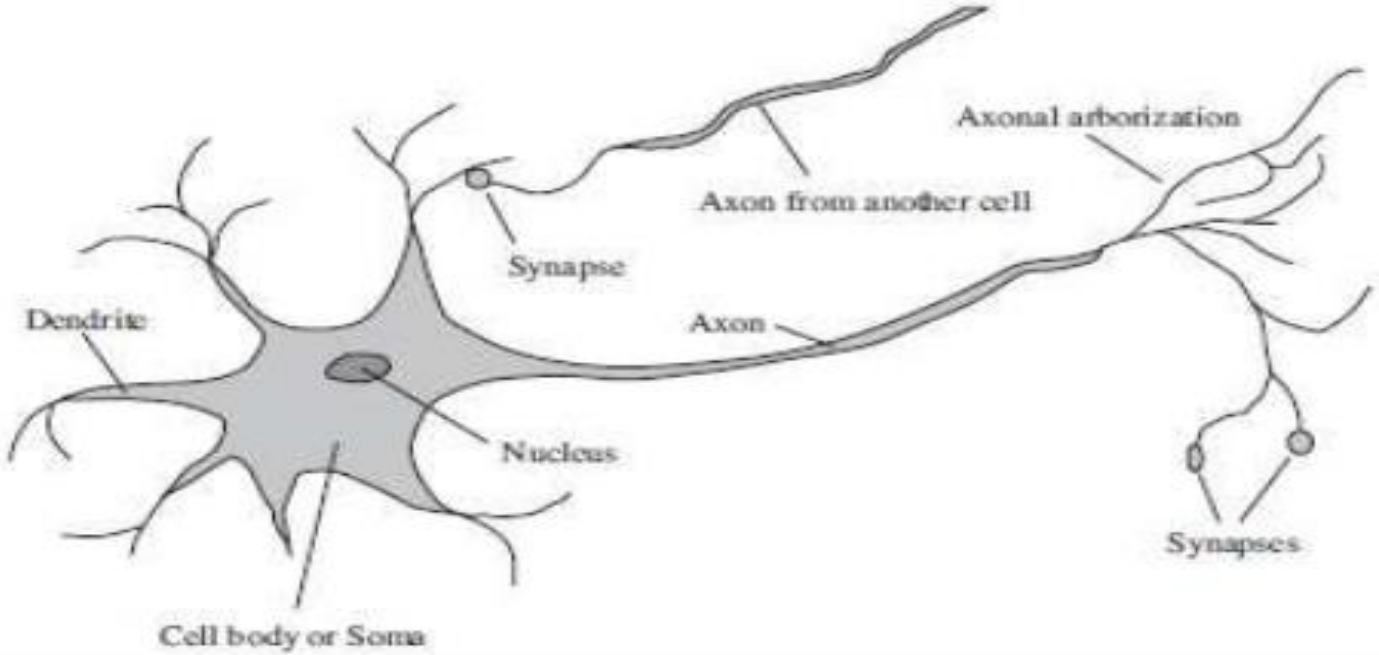
→ design best program for given machine resources

Interplay of reasoning and perception:

Foundation of AI:AI prehistory

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
Psychology	adaptation
	phenomena of perception and motor control
	experimental techniques (psychophysics, etc.)
Economics	formal theory of rational decisions
Linguistics	knowledge representation
	grammar
Neuroscience	plastic physical substrate for mental activity
Control theory	homeostatic systems, stability
	simple optimal agent designs

Neuron



	Supercomputer	Personal Computer	Human Brain
Computational units	10^4 CPUs, 10^{12} transistors	4 CPUs, 10^9 transistors	10^{11} neurons
Storage units	10^{14} bits RAM	10^{11} bits RAM	10^{11} neurons
	10^{15} bits disk	10^{13} bits disk	10^{14} synapses
Cycle time	10^{-9} sec	10^{-9} sec	10^{-3} sec
Operations/sec	10^{15}	10^{10}	10^{17}
Memory updates/sec	10^{14}	10^{10}	10^{14}

A neuron (or neurone) is a nerve cell that carries electrical impulses. Neurons are the basic units of our nervous system. Neurons have a cell body (soma or cyton), dendrites and an axon. Dendrites and axons are nerve fibers. There are about 86 billion neurons in the human brain, which is about 10% of all brain cells

Neuron

- The parts of a nerve cell or neuron. Each neuron consists of a cell body, or soma, that contains a cell nucleus. Branching out from the cell body are a number of fibers called dendrites and a single long fiber called the axon.

- The axon stretches out for a long distance, much longer than the scale in this diagram indicates. Typically, an axon is 1 cm long 000 times the diameter of the cell body), but can reach up to 1 meter.

- A neuron makes connections with 10 to 100,000 other neurons at junctions called synapses Signals are propagated from neuron to neuron by a complicated electrochemical reaction.

- The signals control brain activity in the short term and also enable long-term changes in the connectivity of neurons. These mechanisms are thought to form the basis fur learning in the brain. Most information processing goes en in the cerebral cortex, the outer layer of the brain. The basic

- organizational unit appears to be a column of tissue about 0.5 ram in diameter, containing about 20,000 neurons and extending the full depth of the cortex about 4 mm in humans).

The history of AI

The gestation (1943-1955):

♦1943: McCulloch & Pitts: model of neurons → Boolean circuit of the brain

♦1949: Donald Hebb - updading rule for modifying the connection strengths (Hebbian learning)

♦1950: Turing's Computing Machinery and Intelligence: introduces Turing Test, machine learning, genetic algorithms, and reinforcement learning.

The birth of artificial intelligence(1956):

♦McCarthy (1927 -2011): 2 month, 10 man study of AI, to make machine use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves.

♦ Main actors for the next 20 years from MIT, CMU, Standford and IBM

The history of AI

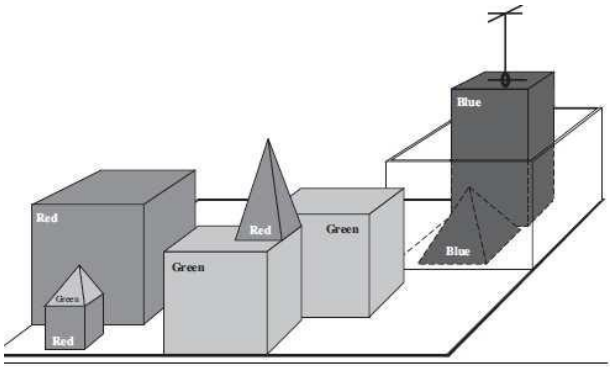
Early enthusiasm, great expectations (1952-1969):

♦Geometry Theorem Prover, Logic Theorist, General Problem Solver, Play- ing checkers (Given the primitive computers and programming tools)

- ♦ McCarthy: Lisp (1958), Time sharing (1959), AdviceTaker
- ♦ Minsky: Microwords- algebra story problems, blocks world

from figure-"A scene from the blocks world. S HRDLU (Winograd, 1972) has just completed the command "Find a block which is taller than the one you are holding and put it in the box."

A typical task in this world is to rearrange the blocks in a certain way, using a robot hand that can pick up one block at a time



The history of AI

A dose of reality (1966-1973):

♦Translation of Russian scientific paper in context of Sputnik (Alpack report 1966)

”the spirit is willing but the flesh is weak”

”the vodka is good but the meat is rotten”

♦Lighthill report (1973) most successful algorithms would halt on real world problems and were only suitable for solving ”toy” versions.

false optimism on: cobinatorial explosion to be solved by faster hardware and larger memories, no progress on genetic algorithms

2 input perceptron cannot be trained to recognize that the inputs are different

The history of AI

Knowledge-based systems: The key to power? (1969-1979)

- expert systems: Dendral, Mycin (certainty factor)
- Prolog, 1972 (EU), Planner (US)
- Minsky: frames - facts about a particular object, taxonomy of types roots for OOP

AI becomes an industry (1980-present)

- The first successful commercial expert system, R1 (savings of 40milion a year)
- 1981, the Japanese announced the "Fifth Generation project, a 10-year plan to build intelligent computers running Prolog.
- hundreds of companies building expert systems, vision systems, robots,
- the return of neural networks: complements the symbolic approaches

The history of AI

AI adopts the scientific method (1987-present)

- build on existing theories than to propose brand-new ones
- to base claims on rigorous theorems or hard experimental evidence rather than on intuition
- and to show relevance to real-world applications rather than toy examples
- speech recongition (HMM), datamining, bayesian networks

The emergence of intelligent agents (1995-present)

- Internet, the most important environment

The availability of very large data sets (2001-present)

Mycin

Have you obtained positive cultures?

Yes.

What type of infection is it?

Primary bacteremia.

When did the symptomps first appear?

May 5

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Potted history of AI

1943	McCulloch & Pitts: Boolean circuit model of brain
1950	Turing's "Computing Machinery and Intelligence"
1952–69	Look, Ma, no hands!
1950s	Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
1956	Dartmouth meeting: "Artificial Intelligence" adopted
1965	Robinson's complete algorithm for logical reasoning
1966–74	AI discovers computational complexity Neural network research almost disappears
1969–79	Early development of knowledge-based systems
1980–88	Expert systems industry booms
1988–93	Expert systems industry busts: "AI Winter"
1985–95	Neural networks return to popularity
1988–	Resurgence of probability; general increase in technical depth "Nouvelle AI": ALife, GAs, soft computing
1995–	Agents, agents, everywhere . . .
2003–	Human-level AI back on the agenda

State of the art

Robotic vehicles: A driverless robotic car named STANLEY sped through the rough terrain of the Mojave dessert at 22 mph, finishing the 132-mile course first to win the 2005 DARPA Grand Challenge

Speech recognition: A traveler calling United Airlines to book a flight can have the en- tire conversation guided by an automated speech recognition and dialog management system

Autonomous planning and scheduling

Game playing: BM's DEEP BLUE became the first computer program to defeat the world champion in a chess match when it bested Garry Kasparov by a score of 3.5 to 2.5 in an exhibition match (Goodman and Keene, 1997)

Spam fighting: Each day, learning algorithms classify over a billion messages as spam, saving the recipient from having to waste time deleting what, for many users, could comprise 80% or 90% of all messages, if not classified away by algorithms

Logistics planning: During the Persian Gulf crisis of 1991, U.S. forces deployed a Dynamic Analysis and Replanning Tool, DART (Cross and Walker, 1994), to do automated logistics planning and scheduling for transportation

Robotics: The iRobot Corporation has sold over two million Roomba robotic vacuum cleaners for home use

Machine Translation: A computer program automatically translates from Arabic to English, allowing an English speaker to see the headline

State of the art

Which of the following can be done at present?

- Play a decent game of table tennis

State of the art

Which of the following can be done at present?

- Play a decent game of table tennis
- Drive safely along a curving mountain road

State of the art

Which of the following can be done at present?

- Play a decent game of table tennis
- Drive safely along a curving mountain road
- Drive safely along Telegraph Avenue

State of the art

Which of the following can be done at present?

- Play a decent game of table tennis
- Drive safely along a curving mountain road
- Drive safely along Telegraph Avenue
- Buy a week's worth of groceries on the web

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- Buy a week's worth of groceries at Berkeley Bowl

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- Play a decent game of table tennis
- Drive safely along a curving mountain road
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- Buy a week's worth of groceries on the web
- Buy a week's worth of groceries at Berkeley Bowl
- Play a decent game of bridge

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- Play a decent game of table tennis
- Drive safely along a curving mountain road
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- Buy a week's worth of groceries on the web
- Buy a week's worth of groceries at Berkeley Bowl
- Play a decent game of bridge
- Discover and prove a new mathematical theorem

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- Play a decent game of bridge
- Discover and prove a new mathematical theorem
- Design and execute a research program in molecular biology

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- Buy a week's worth of groceries at Berkeley Bowl
- Play a decent game of bridge
- Discover and prove a new mathematical theorem
- Design and execute a research program in molecular biology
- Write an intentionally funny story

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- Write an intentionally funny story
- Give competent legal advice in a specialized area of law

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- Discover and prove a new mathematical theorem
- Design and execute a research program in molecular biology
- Write an intentionally funny story
- Give competent legal advice in a specialized area of law
- Translate spoken English into spoken Swedish in real time

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- Discover and prove a new mathematical theorem
- Design and execute a research program in molecular biology
- Write an intentionally funny story
- Give competent legal advice in a specialized area of law
- Translate spoken English into spoken Swedish in real time
- Converse successfully with another person for an hour

State of the art

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- Converse successfully with another person for an hour
- Perform a complex surgical operation

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- Design and execute a research program in molecular biology
- Write an intentionally funny story
- Give competent legal advice in a specialized area of law
- Translate spoken English into spoken Swedish in real time
- Converse successfully with another person for an hour
- Perform a complex surgical operation
- Unload any dishwasher and put everything away

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- Converse successfully with another person for an hour
- Perform a complex surgical operation
- Unload any dishwasher and put everything away

Unintentionally funny stories

One day Joe Bear was hungry. He asked his friend Irving Bird where some honey was. Irving told him there was a beehive in the oak tree. Joe threatened to hit Irving if he didn't tell him where some honey was. The End.

Henry Squirrel was thirsty. He walked over to the river bank where his good friend Bill Bird was sitting. Henry slipped and fell in the river. Gravity drowned. The End.

Once upon a time there was a dishonest fox and a vain crow. One day the crow was sitting in his tree, holding a piece of cheese in his mouth. He noticed that he was holding the piece of cheese. He became hungry, and swallowed the cheese. The fox walked over to the crow. The End.

Unintentionally funny stories

Joe Bear was hungry. He asked Irving Bird where some honey was. Irving refused to tell him, so Joe offered to bring him a worm if he'd tell him where some honey was. Irving agreed. But Joe didn't know where any worms were, so he asked Irving, who refused to say. So Joe offered to bring him a worm if he'd tell him where a worm was. Irving agreed. But Joe didn't know where any worms were, so he asked Irving, who refused to say. So Joe offered to bring him a worm if he'd tell him where a worm was . . .

Summary

Approach AI with different goals: Are you concerned with thinking or behavior? Do you want to model humans or work from an ideal standard?

Rational action: intelligent agent takes the best possible action in a situation

Philosophers: "mind is in some ways like a machine"

Mathematicians: logical and probabilistic statements

Economists: decisions that maximize the expected outcome.

Neuroscientists: how the brain works and the ways in which it is similar to and different from computers.

Psychologists: humans can be considered information-processing machines.

Control theory: devices that act optimally on the basis of feedback.

The history of AI has had cycles of success, misplaced optimism, and resulting cutbacks in enthusiasm and funding.

Acknowledgment

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