1. Introduction

Compiled By

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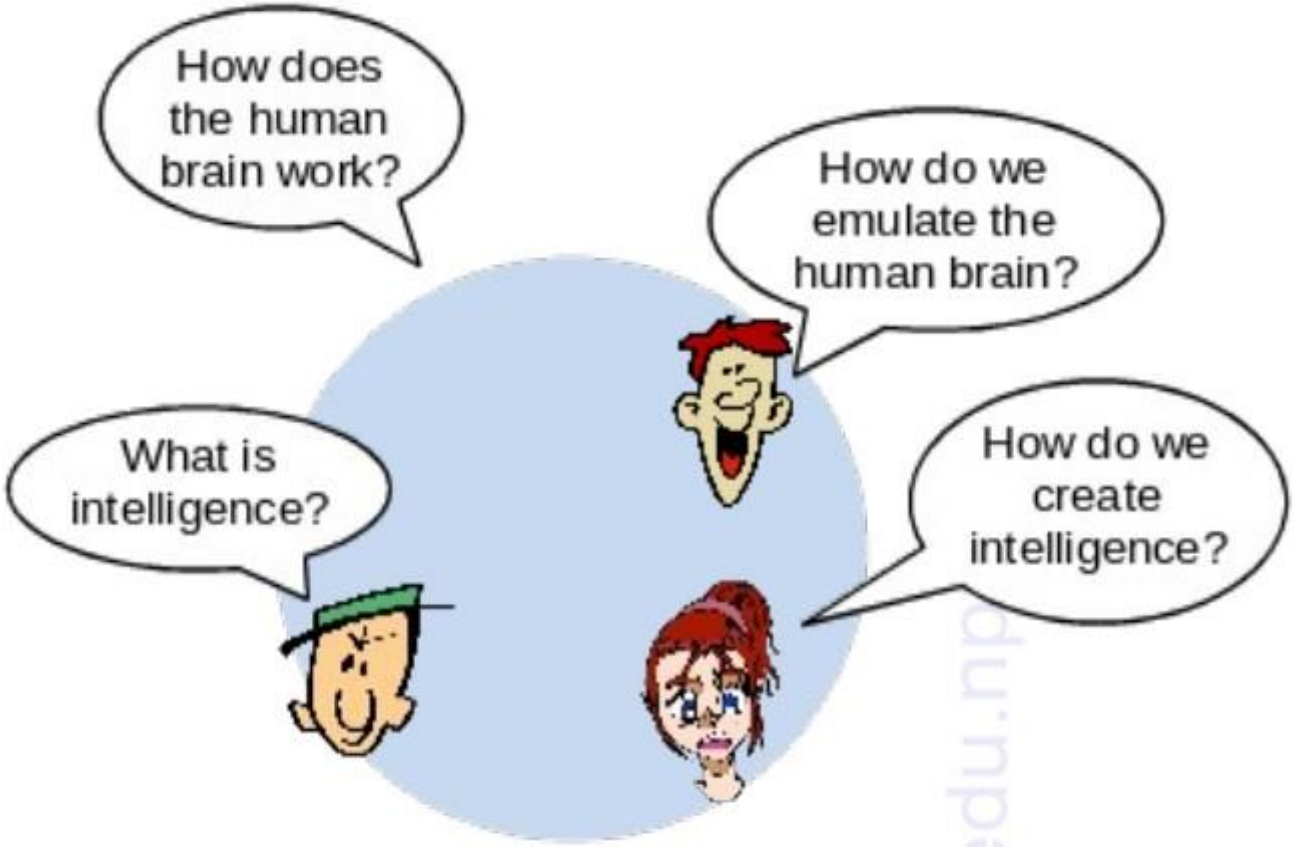
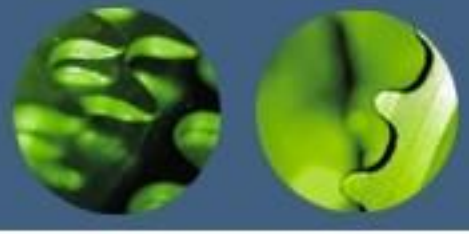
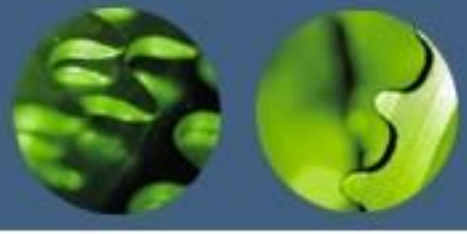
What is AI?


How does the human brain work?
How do we emulate the human brain?
What is intelligence?
How do we create intelligence?



Intelligent behaviors

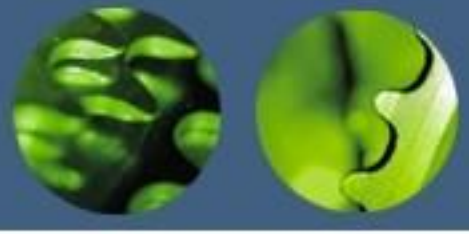
- **Everyday tasks**: recognize a friend, recognize who is calling, translate from one language to another, interpret a photograph, talk, cook a dinner
- **Formal tasks**: prove a logic theorem, geometry, calculus, play chess etc.
- **Expert tasks**: engineering design, medical designers, financial analysis.



Intelligent behaviors

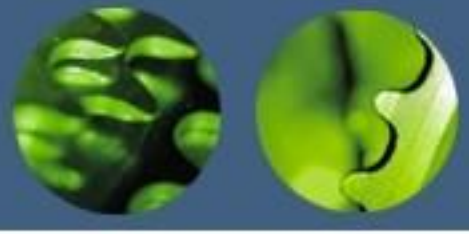
Intelligence is:

- The ability to reason
- The ability to understand
- The ability to create. .
- Can we produce a machine with all these abilities?
- The answer is no, so then what is AI?



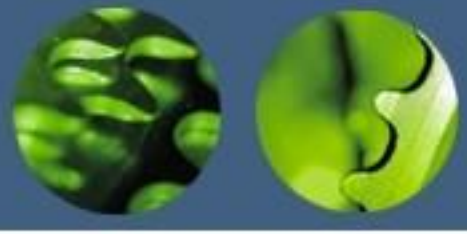
Artificial Intelligence

"The art of creating machines that perform functions that require intelligence when performed by people" - ***Kurzwell***



Artificial Intelligence

"The science of making computers, do things that require intelligence like humans" - ***Minskey***



Artificial Intelligence

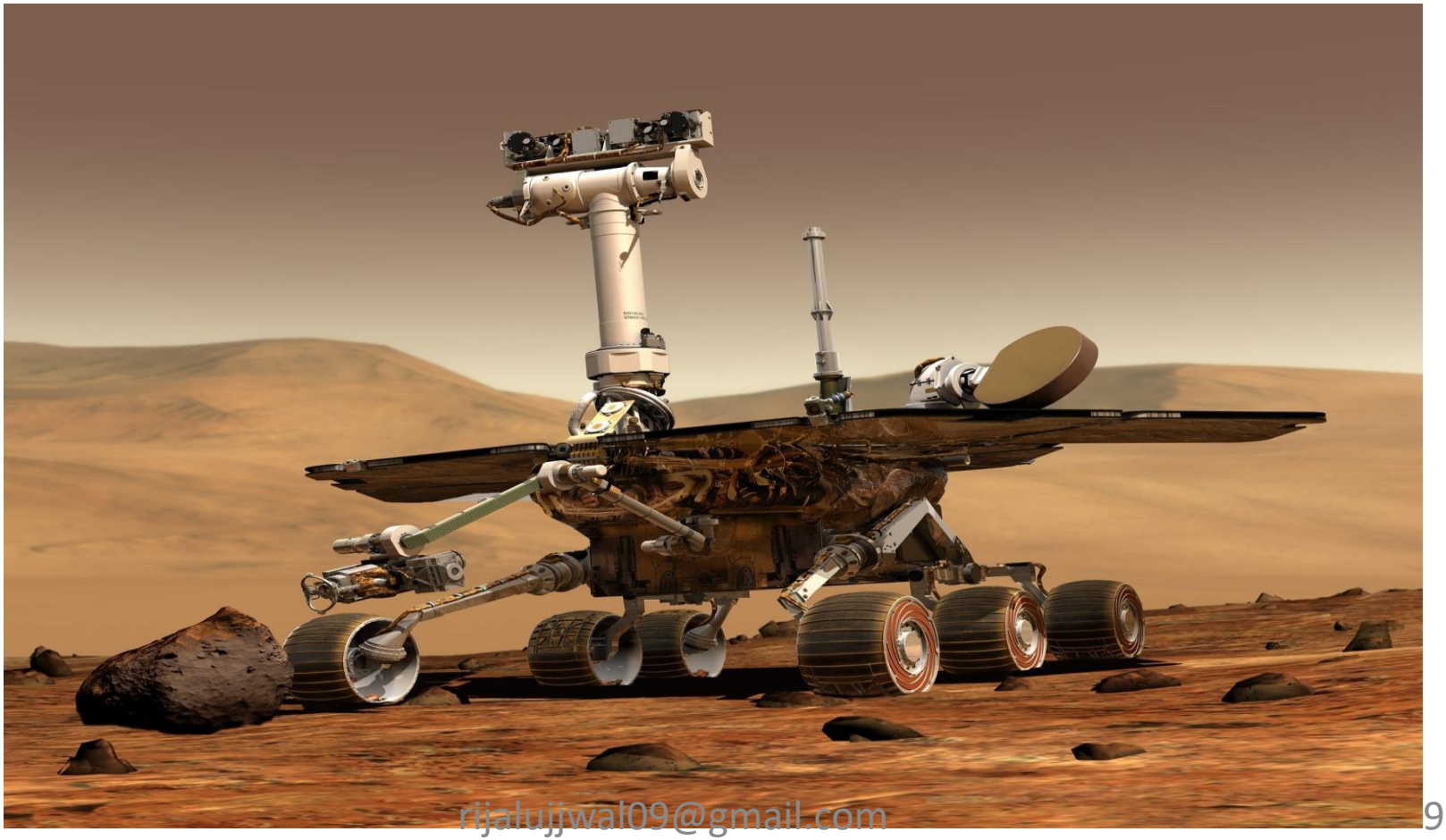
"AI is the study of how to make computers do things at which, at the moment, people are better" **- *Elaine Rich***

AI Today

- Diagnose Diseases

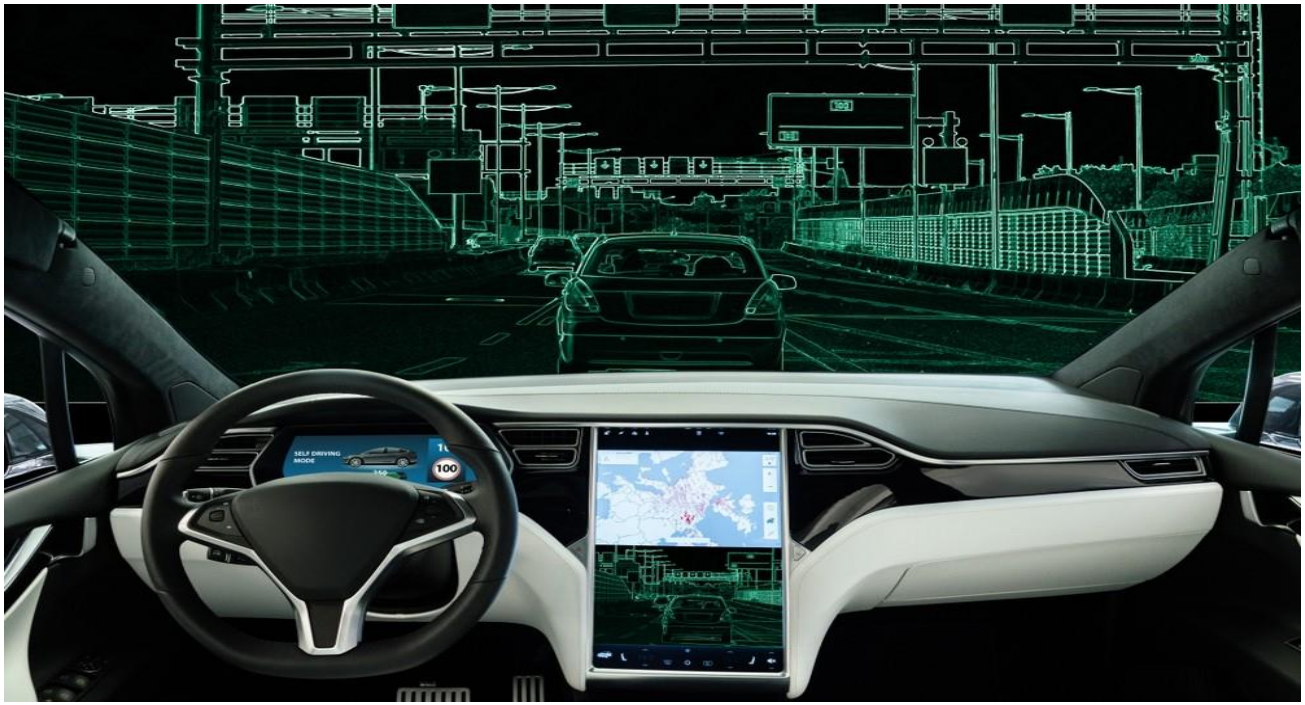
AI Today

- Monitor space missions



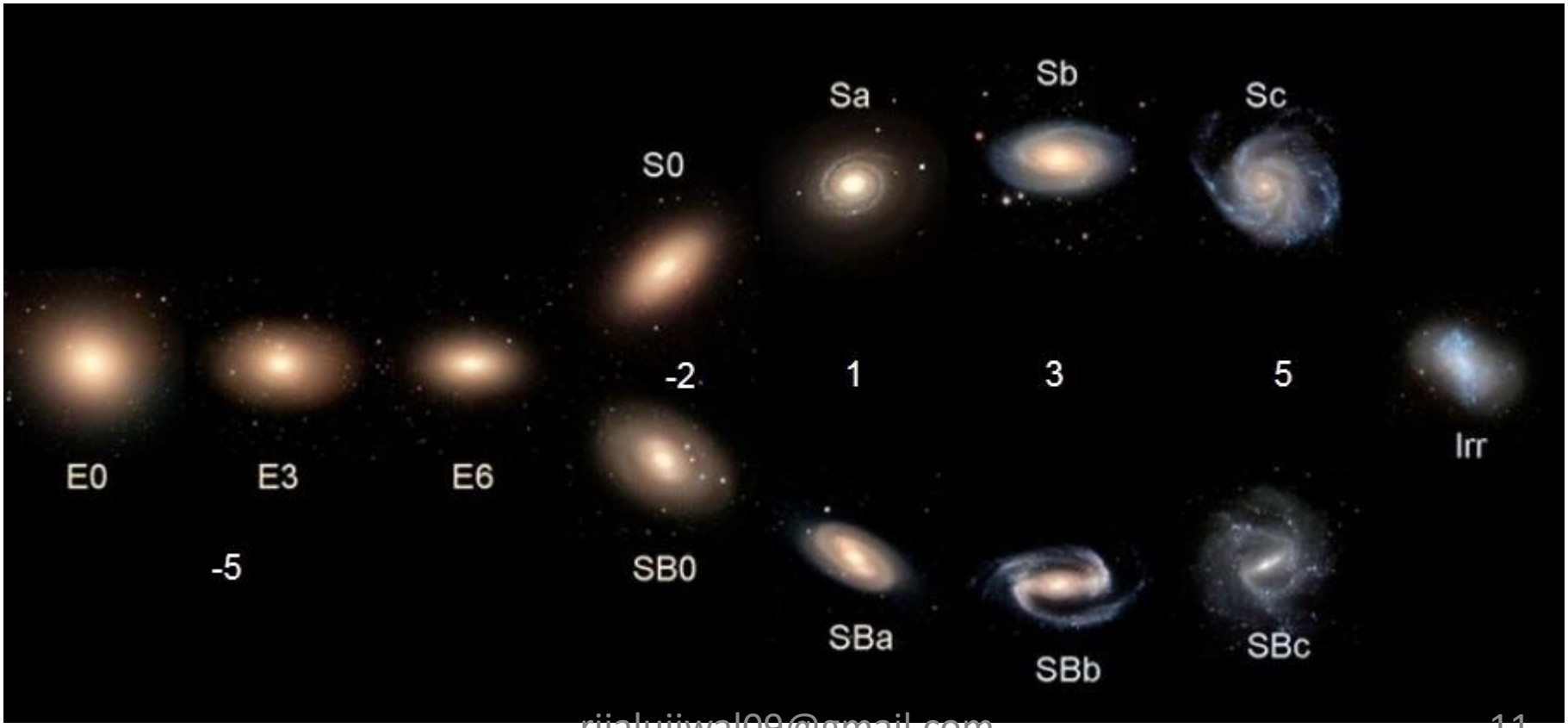
AI Today

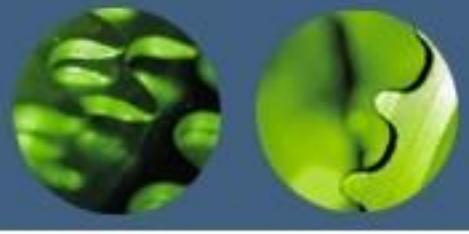
- Automatic vehicle control



AI Today

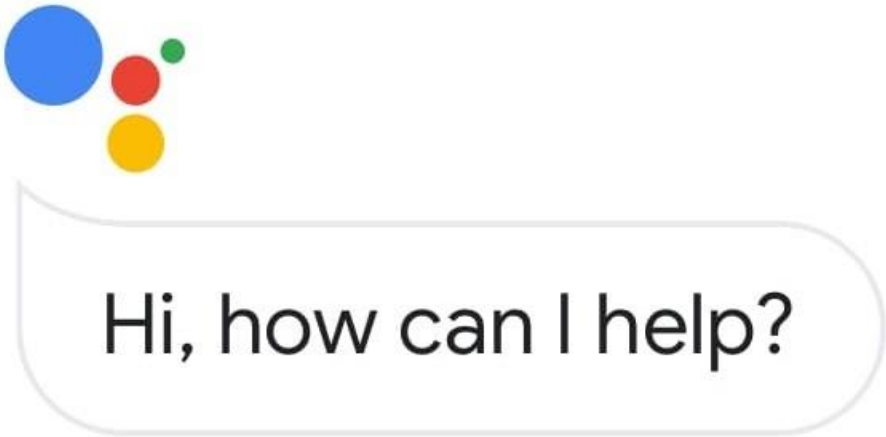
- Classify astronomical objects

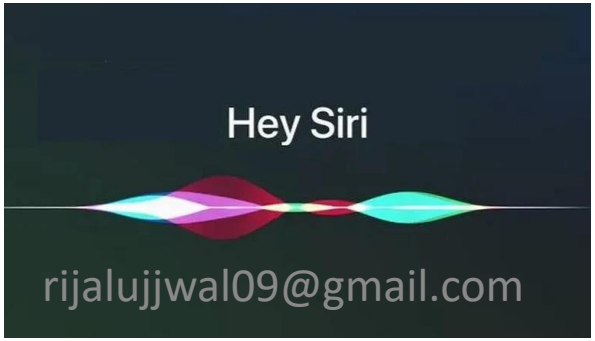




AI Today

- Speech understanding systems





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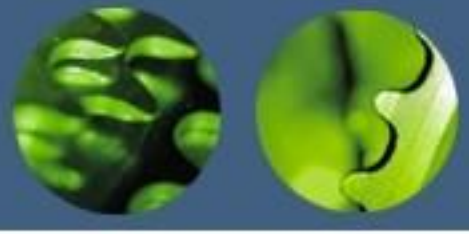
AI Today

- Beat world's best players in chess, checkers, and backgammon.

AlphaGo

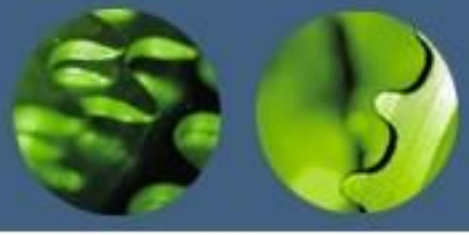
- Check out AlphaGo documentary on YouTube.



Is AI Ethical?

Joseph Weizenbaum (1976) in ***Computer Power and Human Reason*** argues:

- A *real* AI would indeed be an autonomous, intelligent agent. Hence, out of our control
- It will not share our: motives, constraints, ethics
- There is no obvious upper bound on intelligence. And perhaps there is no upper bound at all.
- When our interests and AI's interests conflict, guess who loses.
- Therefore, AI research is unethical.



Asimov's Law of Robotics

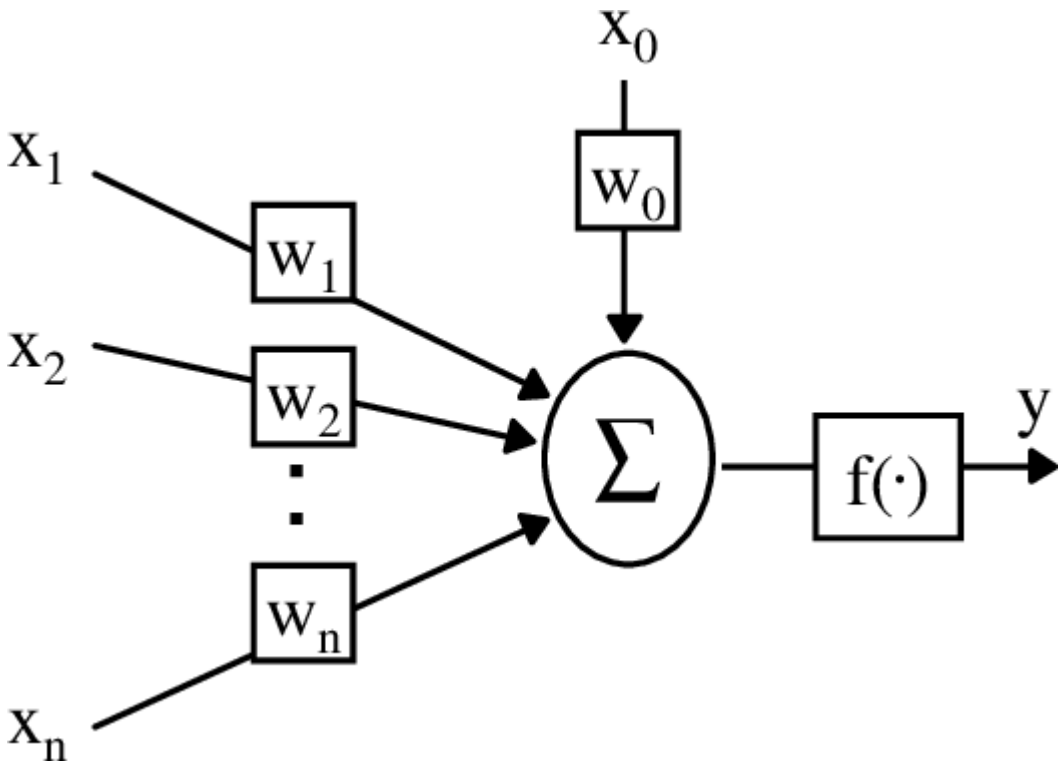
- A method to insert ethics into AI.
- The three laws of robotics are:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given to it by human beings.
3. A robot must protect its own existence.

- **Meta-law:** Precedence order is lower to higher.

Brief history

- 1943 McCulloch & Pitts: Boolean circuit model of brain.



Brief history

- 1950 Turing's "Computing Machinery and Intelligence“

I.—COMPUTING MACHINERY AND INTELLIGENCE

By A. M. Turing

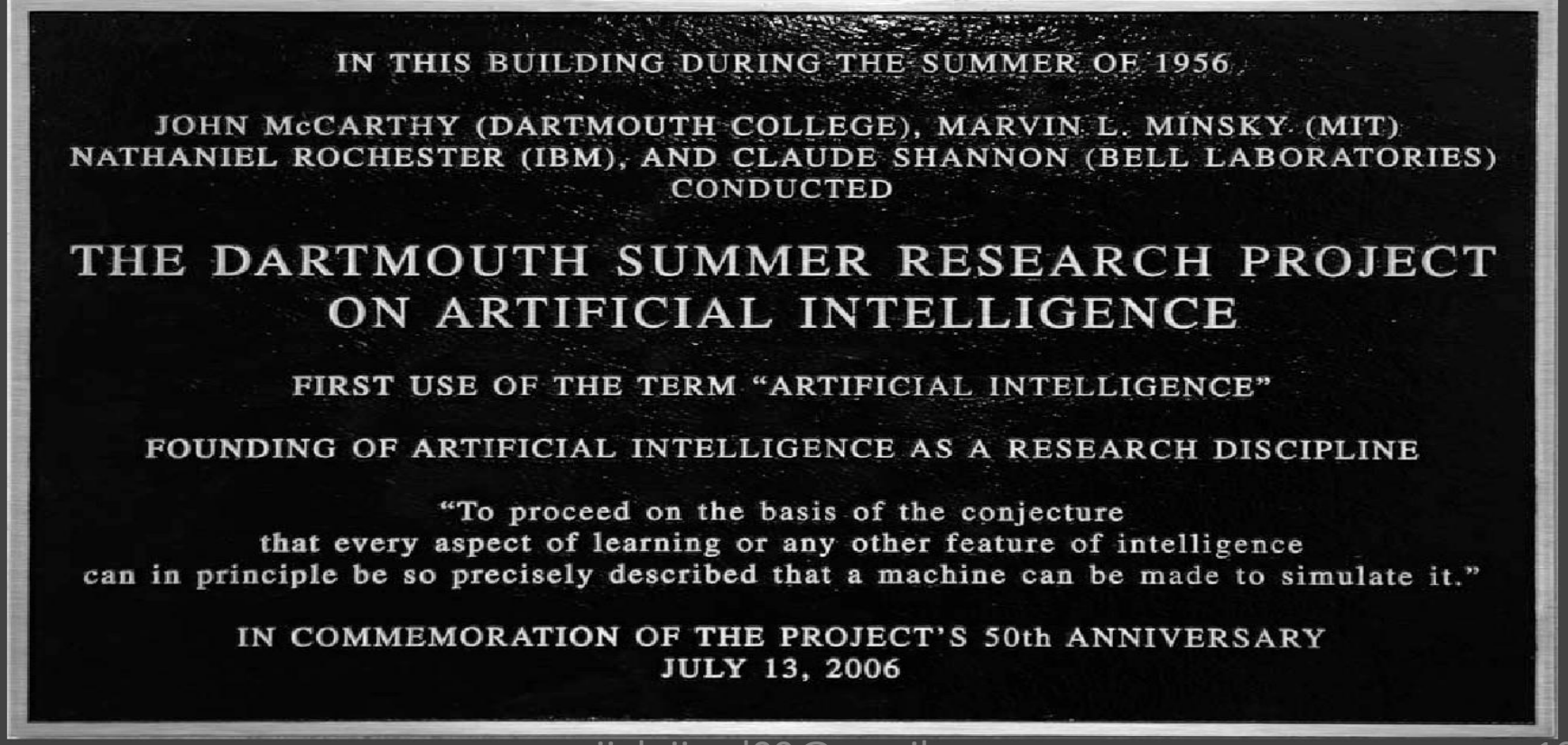
1. *The Imitation Game.*

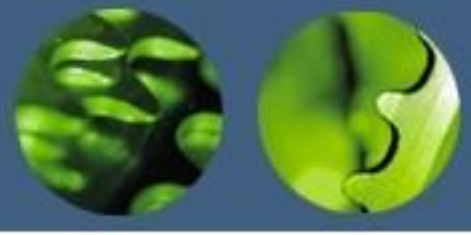
I propose to consider the question, ‘Can machines think?’ This should begin with definitions of the meaning of the terms ‘machine’ and ‘think’. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words ‘machine’ and ‘think’ are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, ‘Can machines think?’ is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

The new form of the problem can be described in terms of

Brief history

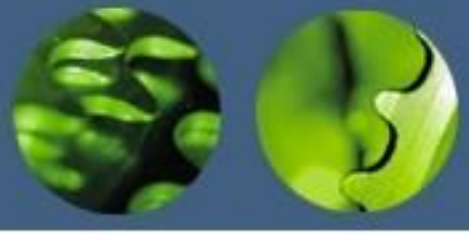
- 1956 Dartmouth meeting: "Artificial Intelligence" adopted





Brief history

- 1965 Robinson's complete algorithm for logical reasoning

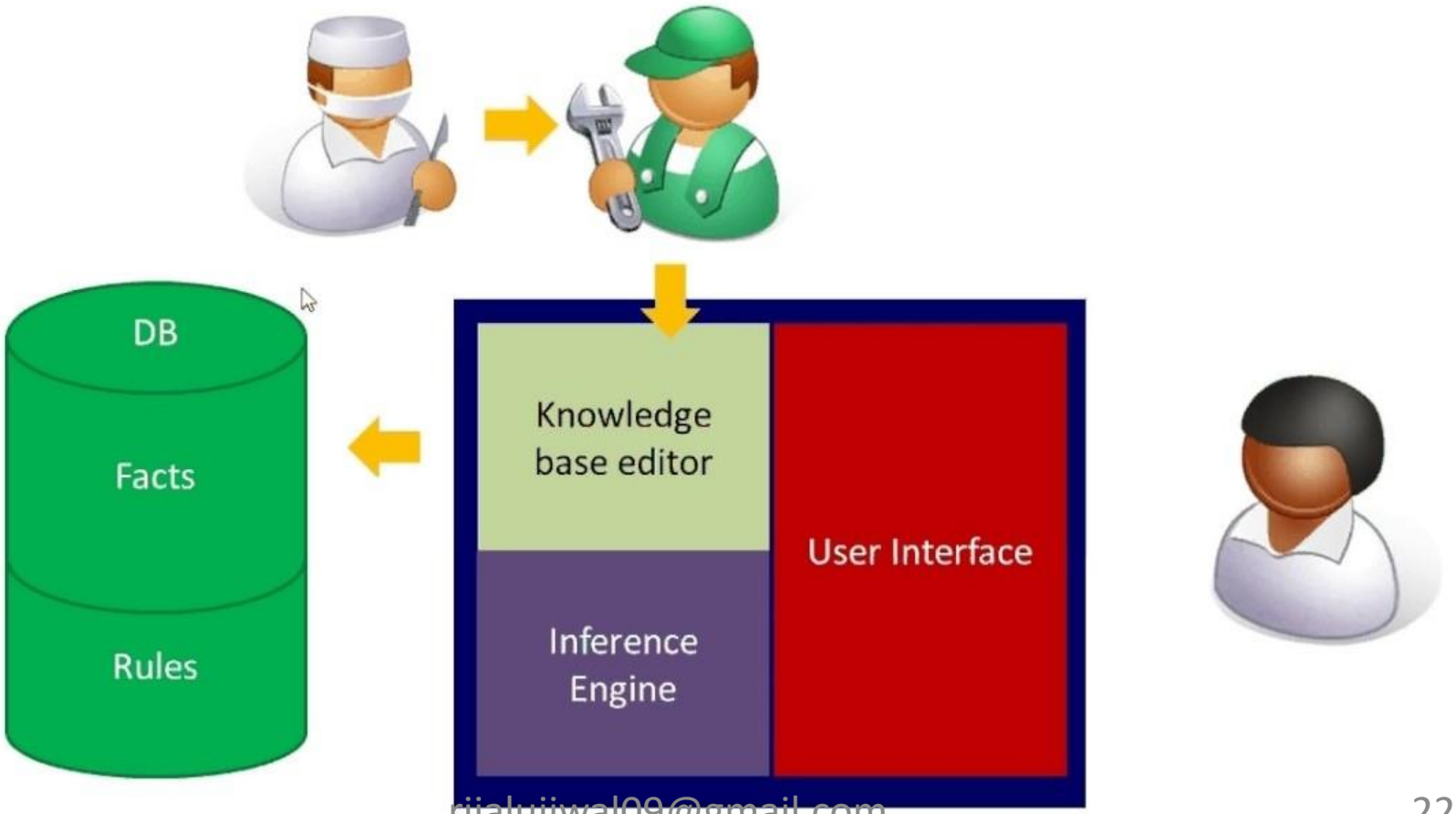


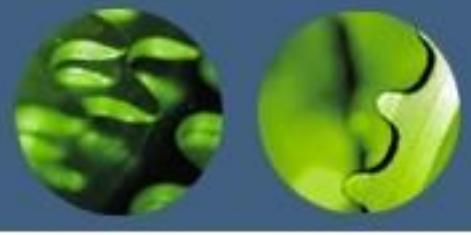
Brief history

- 1966—73 AI discovers computational complexity, neural network research almost disappears

Brief history

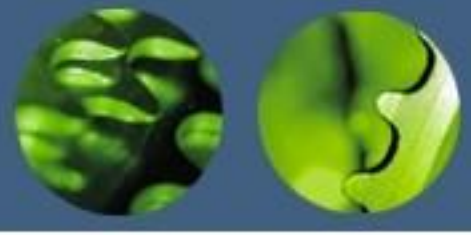
- 1969—79 early development of knowledge-based systems





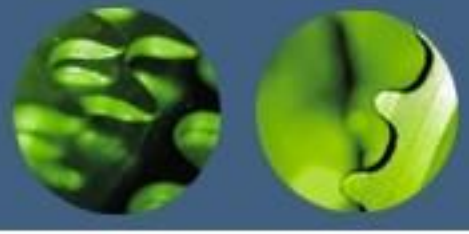
Brief history

- 1980-- AI becomes an industry



Brief history

- 1986-- Neural networks return to popularity

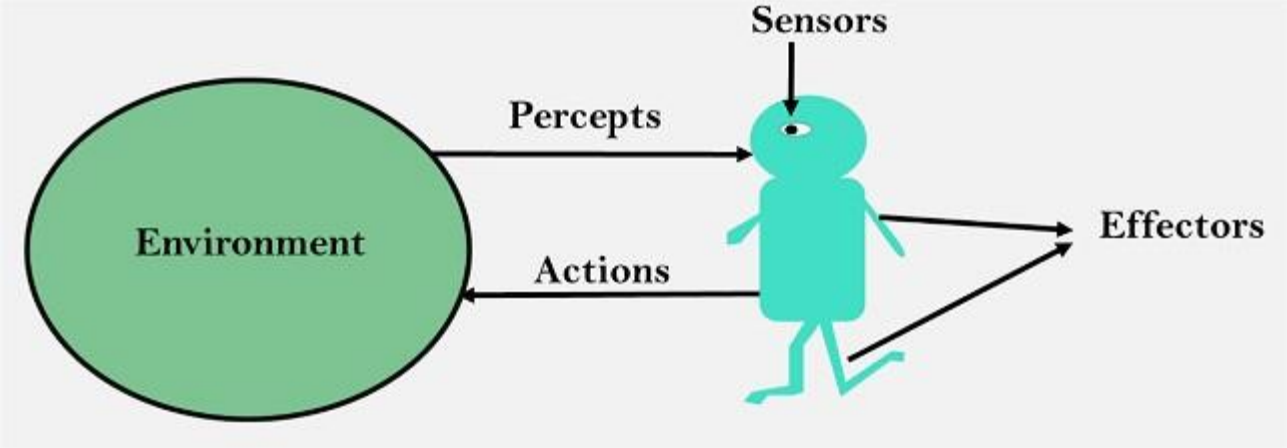


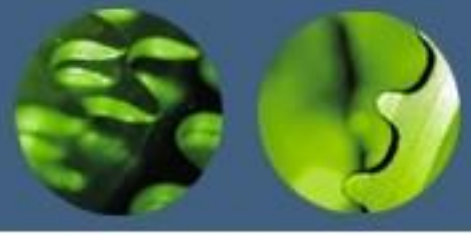
Brief history

- 1987-- AI becomes a science

Brief history

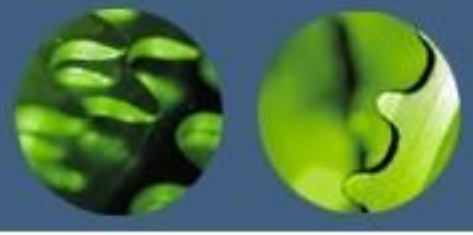
- 1995-- The emergence of intelligent agents





Brief history

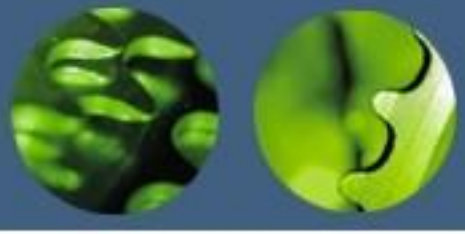
- The availability of very large data sets (2001–present)



Approaches of AI

- Acting humanly
- Thinking humanly
- Acting rationally
- Thinking rationally

Approaches of AI



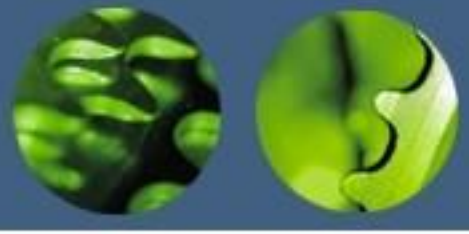
Four Main Approaches to Artificial Intelligence

Thinking Humanly: The cognitive modeling approach

Thinking Rationally: The laws of thought approach

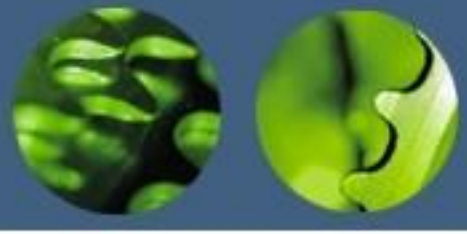
Acting Humanly: The Turing Test approach

Acting Rationally: The rational agent approach



Approaches of AI

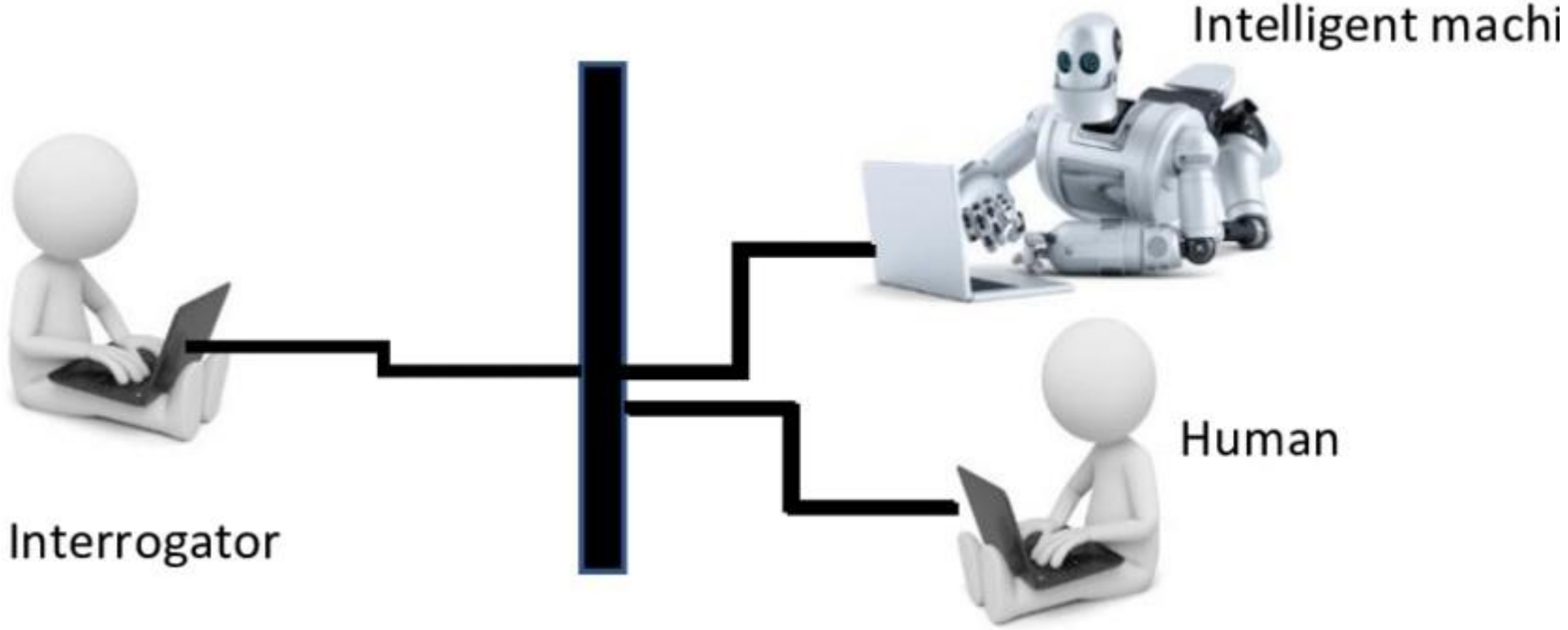
Thinking Humanly	Thinking Rationally
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)
"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998)
"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

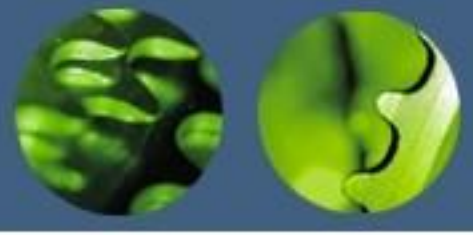


Acting humanly

- Machine is required to act as humans do.
- **Turing Test**, proposed by Alan Turing (1950).
- Turing's definition of intelligent behavior as the ability to **achieve *human-level performance*** in all cognitive tasks.
- The test involves an interrogator who interacts with one human and one machine.
- Within a given time the interrogator has to find out which of the two the human is, and which one the machine

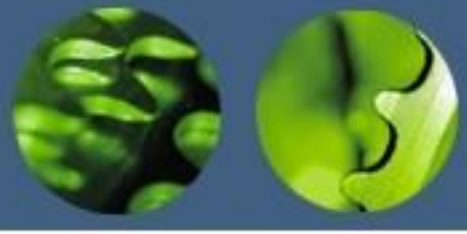
Acting humanly





Acting humanly

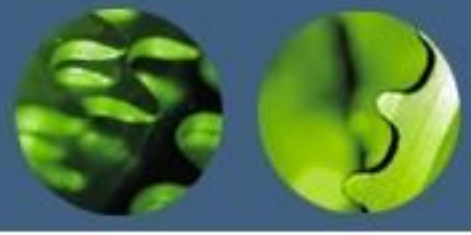
- To solve in order to pass the test using a terminal: natural language processing, knowledge representation automated reasoning, machine learning.
- Additional requirements for the “total Turing test”: computer vision, speech recognition, speech synthesis, robotics.



Acting humanly

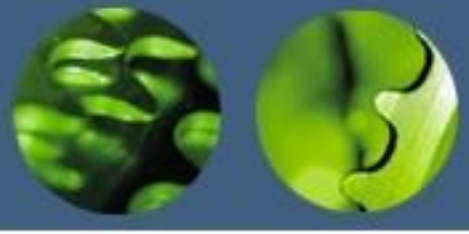
Critics of Turing test

- Test is not reproducible, amenable or constructive to mathematical analysis as it is more important to study the underlined principles of intelligence than to duplicate example.
- Trying to evaluate machine intelligence in terms of human intelligence is fundamental mistake. It focuses too much on the behavior of conversation.



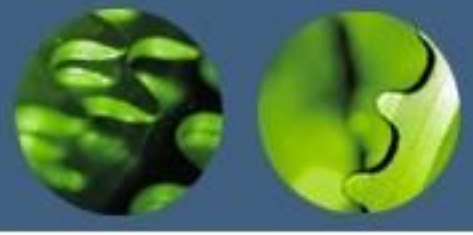
Thinking humanly

- It is the action or process of acquiring knowledge and understanding thought, experience or the sense. Machine needs to understand how humans think.
- It is mainly concerned with the investigation, development of human behavior and the working of human mind in the computer.



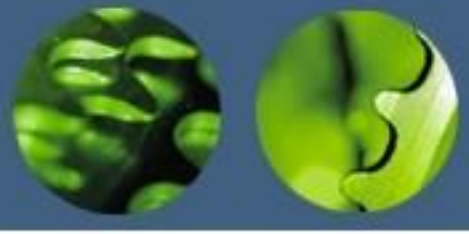
Thinking humanly

- **Example**: **General Problem Solver (GPS)** developed by Newell & Simon in 1961 attempted to synthesize the human solving process.
- Compares the steps of the problem with the reasoning of human subjects solving the same problem.
- **Critics:** Lacks scientific theories of internal activities of brain. Level of abstraction of the approach is vague too.



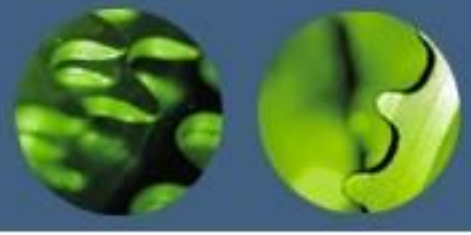
Thinking rationally

- Aristotle made first attempt to harness “right thinking”. Famous example: “Socrates is a man; all men are mortal; therefore Socrates is mortal.”
- Formal logic (late nineteenth, early twentieth century’s) provides a precise notation of statements of all kinds of things and relations between them.
- Programs that can find the solution to a logical problem if one exists have been around since 1965.
- Given enough memory and time, they should be able to solve everything.



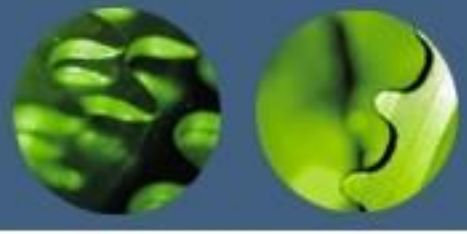
Thinking rationally

- **Critics:** It is not easy to take informal knowledge and state in the formal terms required by logical notation specially when knowledge is less than 100% certain.
- There is big difference between being able to solve a problem in principle and doing so in practice .



Acting rationally

- An agent is just something that acts (**agent** comes from the Latin **agere**, to do).
- Of course, all computer programs do something, but computer agents are expected to do more: operate autonomously, perceive their environment, persist over a prolonged time period, adapt to change, and create and pursue goals.



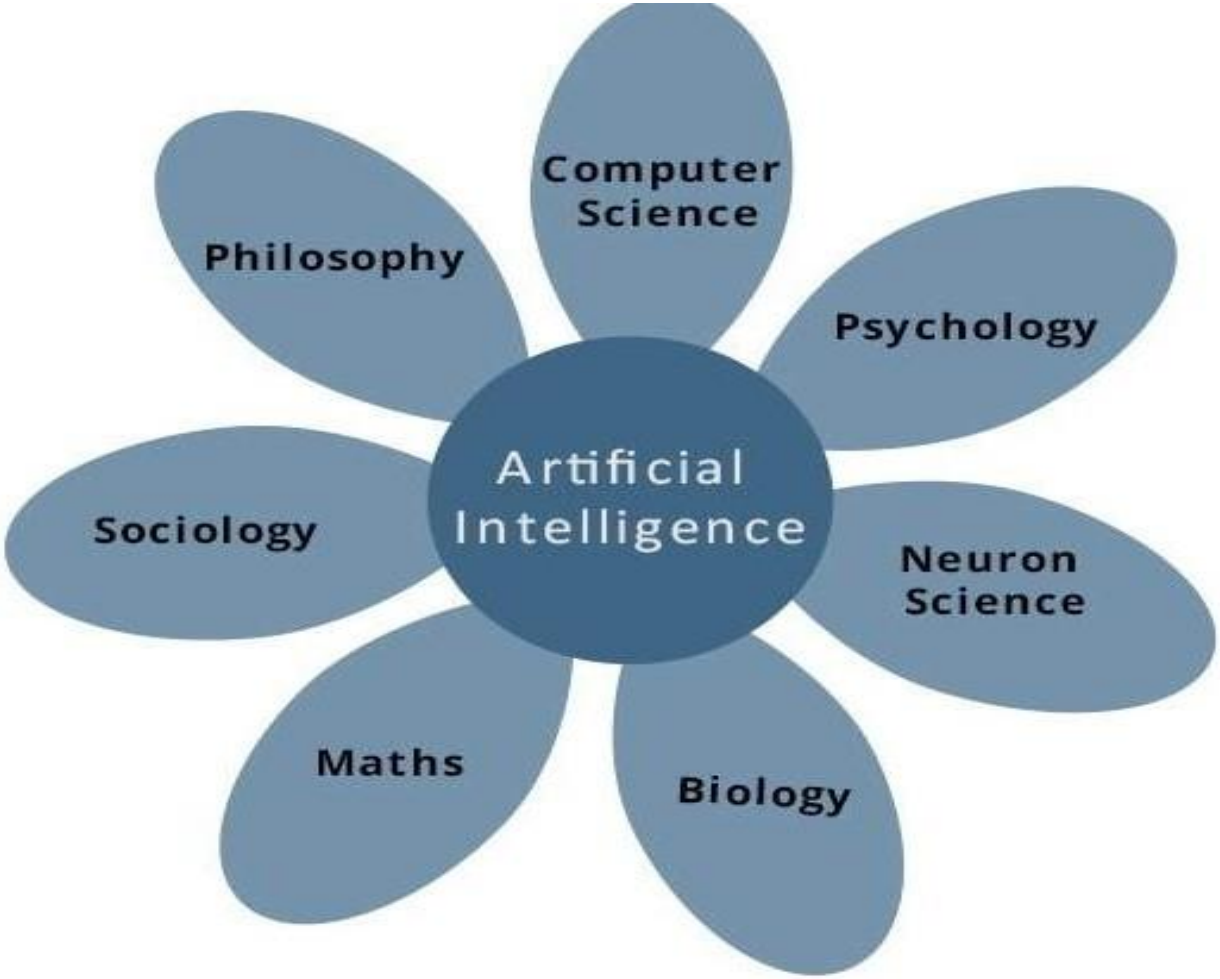
Acting rationally

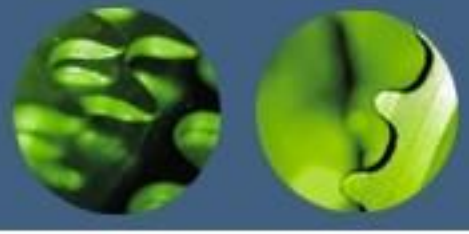
- Rational agent: acts to achieve the best outcome on when there is uncertainty of the best expected outcome

Advantages

- More general than laws of thought approach
- More amenable to scientific development then approach based on human behaviors.

Foundations of AI

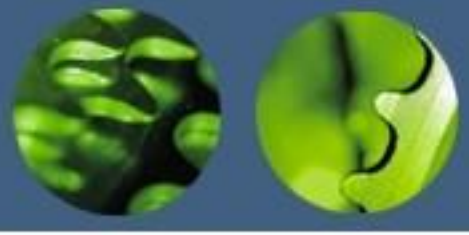




Foundations of AI

Philosophy

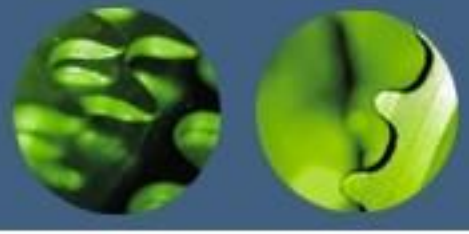
- Artificial intelligence has close connections with philosophy because both use concepts that have the same names.
- Can a machine act intelligently?
- Can it solve any problem that a person would solve by thinking?
- Are human intelligence and machine intelligence the same?
- Is the human brain essentially a computer?
- Can a machine have a mind, mental states, and consciousness in the same sense that a human being can?
- Can it feel how things are?



Foundations of AI

Psychology

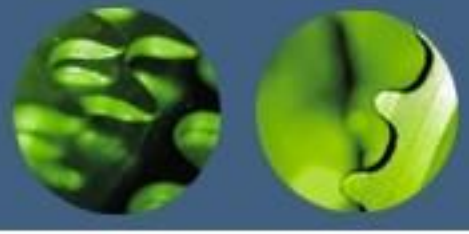
- Psychology is the study of human brain and its nature.
- How do humans and animals think and act?
- Artificial Intelligence is about understanding how the human brain functions and apply the similar principles in computing to arrive at the decision.
- Hence,Psychology is one of the parent element of AI.



Foundations of AI

Mathematics

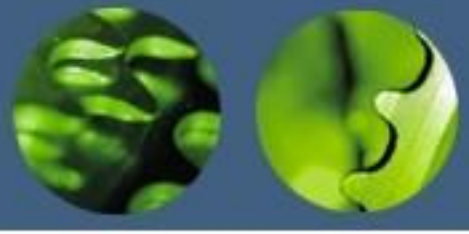
- “Mathematics is the language with which God has written the universe.” -Galileo Galilei
- What are the formal rules to draw valid conclusions?
- What can be computed?
- How do we reason with uncertain information?
- The primary purpose of Artificial intelligence is to create an acceptable model for human understanding.
- And these models can be prepared with the ideas and strategies from various branches of Mathematics.



Foundations of AI

Computer Science

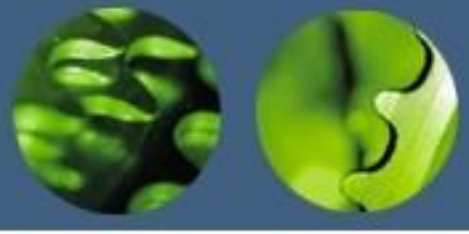
- How can we build an efficient computer?
- For artificial intelligence to succeed, we need two things: intelligence and an artifact.
- The computer has been the artifact of choice.
- The computer is strongly deterministic and ideal for building models.
- AI is often said to be a computer science but this statement is debatable.
- But in the current context, the field of AI is strongly dependent upon the field of Computer Science.



Foundations of AI

Linguistics

- How does language relate to thought?
- Modern linguistics and AI were “born” at about the same time.
- They intersected in a hybrid field called computational linguistics or natural language processing.



Foundations of AI

Neuroscience

- Neuroscience is the study of the nervous system, particularly the brain.
- It is truly amazing that a collection of simple cells can lead to thought,action, and consciousness.

	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}

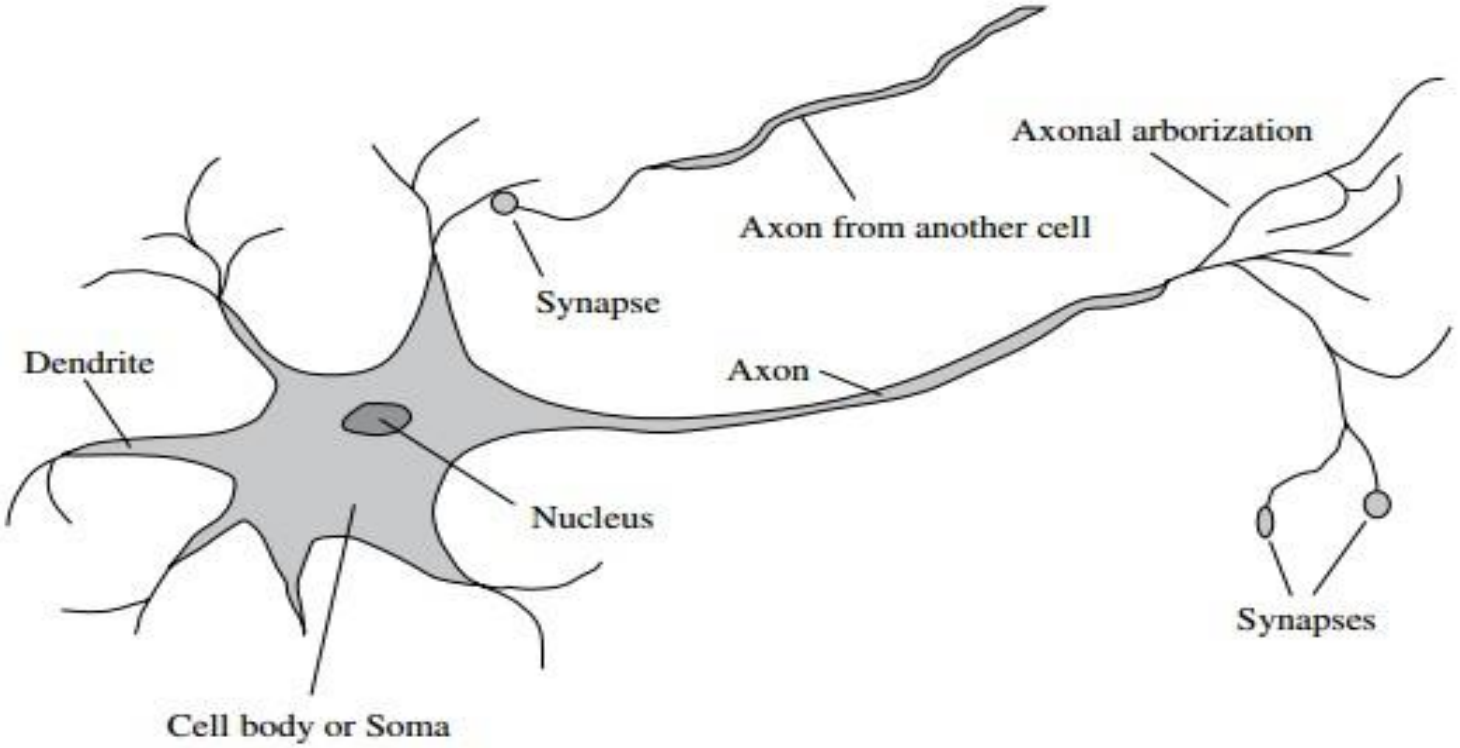
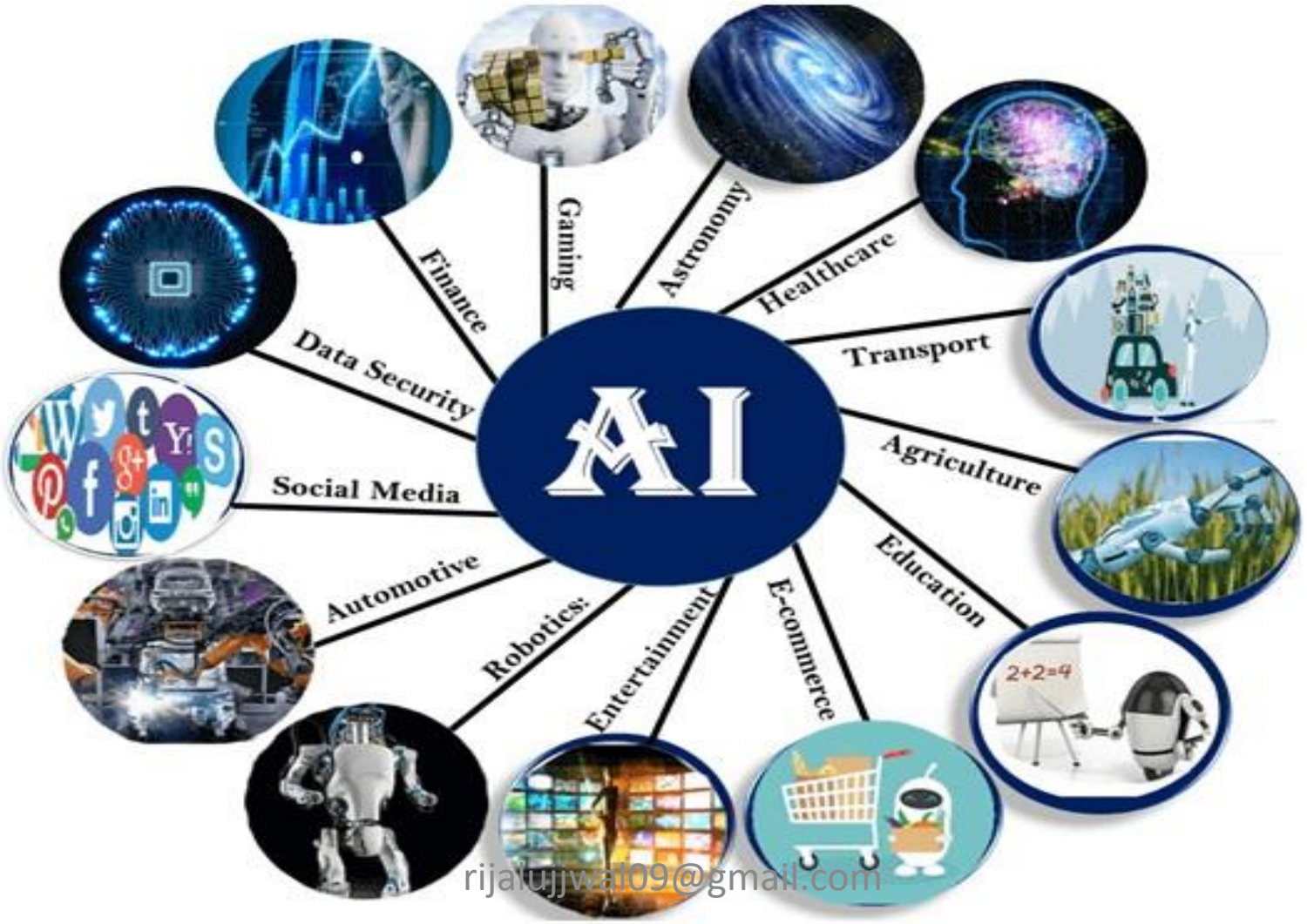


Figure 1.2 The parts of a nerve cell or neuron. Each neuron consists of a cell body, or soma, that contains a cell nucleus. Branching out from the cell body are a number of fibers called dendrites and a single long fiber called the axon. The axon stretches out for a long distance, much longer than the scale in this diagram indicates. Typically, an axon is 1 cm long (100 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 for learning in the brain. Most information processing goes on in the cerebral cortex, the outer layer of the brain. The basic organizational unit appears to be a column of tissue about 0.5 mm in diameter, containing about 20,000 neurons and extending the full depth of the cortex about 4 mm in humans).

Applications of AI



Applications of AI

Applications of AI

Applications of AI

Applications of AI

AI in Finance

Applications of AI

AI in Agriculture

Applications of AI

AI in Space Exploration

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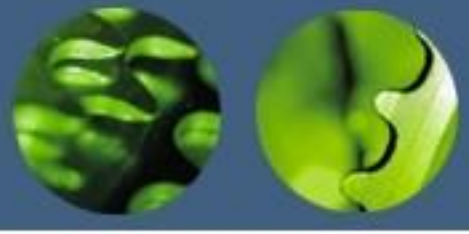
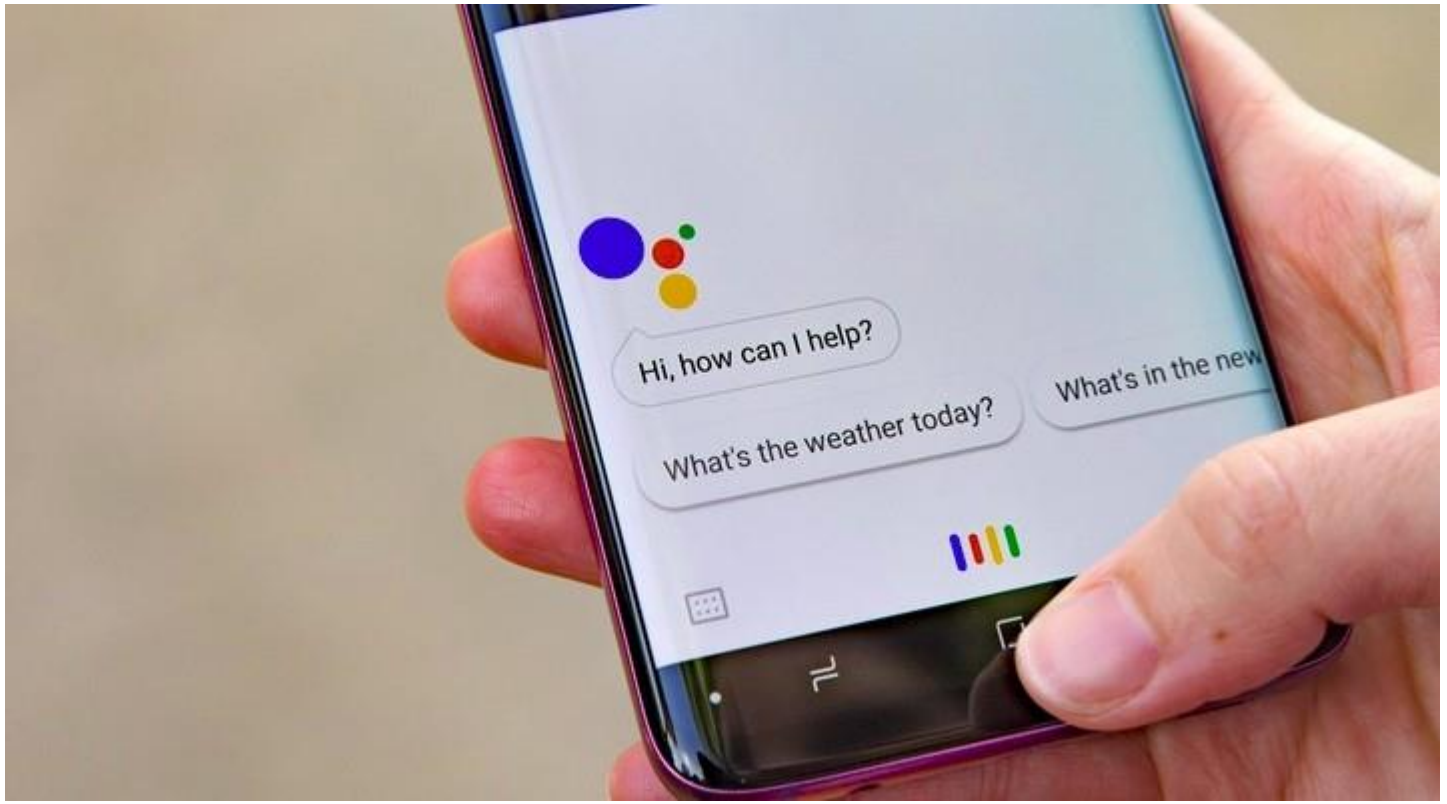
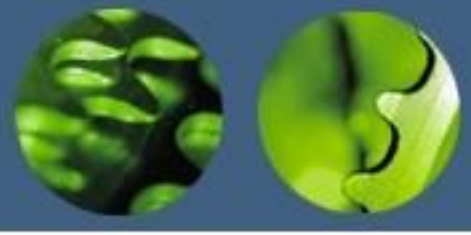


Applications of AI

Applications of AI

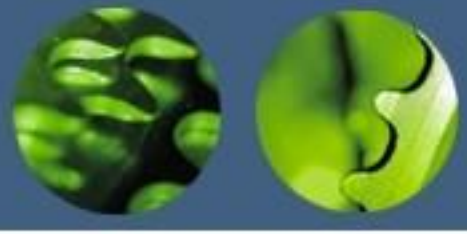


AI in Chatbots



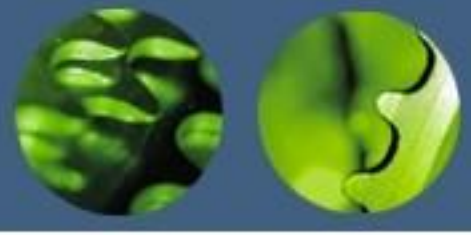
Applications of AI

- ✓ Gaming − AI plays crucial role in strategic games such as chess, poker, tic-tac-toe, etc., where machine can think of large number of possible positions based on heuristic knowledge.
- ✓ Natural Language Processing − It is possible to interact with the computer that understands natural language spoken by humans.
- ✓ Expert Systems −There are some applications which integrate machine, software, and special information to impart reasoning and advising. They provide explanation and advice to the users.



Applications of AI

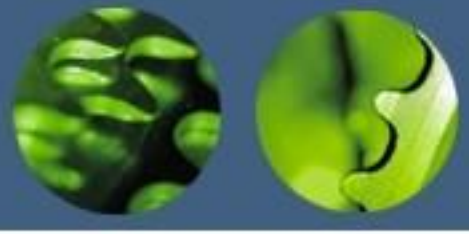
- ✓ Vision Systems –These systems understand, interpret, and comprehend visual input on the computer. For example,
  - A spying plane takes photographs, which are used to figure out spatial information or map of the areas.
  - Doctors use clinical expert system to diagnose the patient.
  - Police use computer software that can recognize the face of criminal with the stored portrait made by forensic artist.
- ✓ Speech Recognition –Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talks to it. It can handle different accents, slang words, noise in the background, change in human's noise due to cold, etc.



Applications of AI

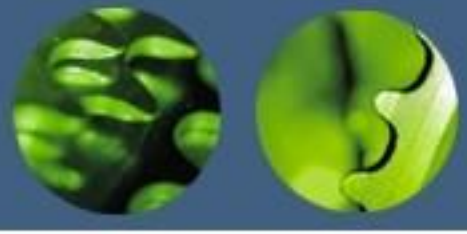
- ✓ Handwriting Recognition − The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus. It can recognize the shapes of the letters and convert it into editable text.

- ✓ Intelligent Robots −Robots are able to perform the tasks given by a human. They have sensors to detect physical data from the real world such as light, heat, temperature, movement, sound, bump, and pressure. They have efficient processors, multiple sensors and huge memory, to exhibit intelligence. In addition, they are capable of learning from their mistakes and they can adapt to the new environment.



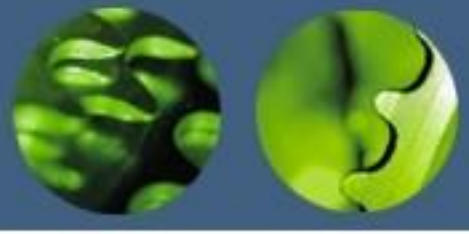
Review Questions

- Do you agree “the development of Artificial Intelligence has had some negative effect on the society”? If you agree list some of them and put your opinion in the support of development of Artificial Intelligence.
- What is ‘Turing Test in AI? Criticize the performance of the ‘Turing Test’ to measure the intelligent of the machine.
- Define with suitable supporting statements and examples, “Artificial Intelligence is the system that act like humans”.
- Justify that “System that think rationally” and “System that act rationally” are the part of artificial intelligence. Explain it with practical examples.



Review Questions

- “System that think like humans” and “System that act like humans” are the part of artificial intelligence. Justify that statement with practical examples.
- What is ‘Turing Test’ in Artificial Intelligence (AI)? Criticize the performance of the ‘Turing Test’ to measure the intelligence of the machine.
- What is Artificial Intelligence (AI)? Describe your own criteria for computer program to be considered intelligent.
- What is AI? How can you define AI from the perspective of thought process?



Assignment #1

1) Do you agree “the development of Artificial Intelligence has had some negative effect on the society”? If you agree list some of them and put your opinion in the support of development of Artificial Intelligence.

2) What is ‘Turing Test’ in Artificial Intelligence (AI)? Criticize the performance of the ‘Turing Test’ to measure the intelligence of the machine.