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# Artificial Intelligence

### Attendance Policy

- As per university rules and regulation.
- Attendance will be taken at any moment.
- No compensation for attendance.

## Homework Policy

- All homework assignments must be done individually or as directed
- No plagiarism
- Hardcopy to be submitted in class on the due date
- May also require uploading a soft-copy

# Rules

## Text and Reference Books

- Artificial Intelligence: A Modern Approach 3<sup>rd</sup> Edition Stuart Russell and Peter Norvig
- Hart, P.E., Stork, D.G. and Duda, R.O., 2001. Pattern classification. John Willey & Sons.
- Luger, G.F. and Stubblefield, W.A., 2009. AI algorithms, data structures, and idioms in Prolog, Lisp, and Java. Pearson Addison–Wesley

# What is Intelligence?

- Intelligence is the ability to think, to learn from experience, to solve problems, and to adapt to new situations. Intelligence is important because it has an impact on many human behaviours.
- the ability to solve problems.
- Biology – Intelligence is the ability to adapt to new conditions and to successfully cope with life situations.
- Psychology – a general term encompassing various mental abilities, including the ability to remember and use what one has learned, in order to solve problems, adapt to new situations, and understand and manipulate one's reality.

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# What is Artificial Intelligence?

- The art of creating machines that perform functions that require intelligence when performed by people.
- Alternate definitions:
  - the automation of activities we associate with human thinking, like decision making, learning
  - making computers think or behave like humans
  - It is the science and engineering of making intelligent machines, especially intelligent computer programs.

# Aspects of AI?

Systems that think like humans.	Systems that think rationally.
Systems that act like humans.	Systems that act rationally.

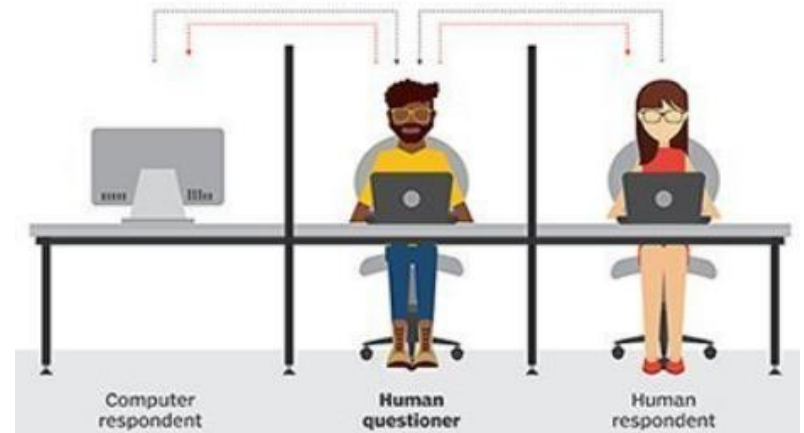
# Aspects of AI

- **Human-like** (“How to simulate humans intellect and behavior on by a machine.”)
  - Mathematical problems (puzzles, games, theorems)
  - Common-sense reasoning (if there is parking-space, probably illegal to park)
  - Expert knowledge: lawyers, medicine, diagnosis
  - Social behavior
- **Rational-like:**
  - A system is rational if it does the “right thing,” given what it know (Reasoning)

# What is Artificial Intelligence?

## ➤ Acting Humanly: The Turing Test

- The Turing Test, proposed by Alan Turing (1950)
- A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer



## ➤ Intelligent behavior

- to achieve human-level performance in all cognitive tasks

# What is Artificial Intelligence?

- The computer would need to possess the following capabilities:
  - ☐ Natural language
  - ☐ Knowledge representation
  - ☐ Automated reasoning
  - ☐ Machine learning
  - ☐ (vision, robotics) for full test



# What is Artificial Intelligence?

- **Thinking humanly: The cognitive modeling approach**
  - How do we know how humans think?
  - 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.
  - Requires detailed matching of computer behavior and timing to detailed measurements of human subjects gathered in psychological experiments.

# What is Artificial Intelligence?

- **Thinking humanly: The cognitive modeling approach**
  - 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
  - Example: General Problem Solver(Newell and Simon, 1961)



# What is Artificial Intelligence?

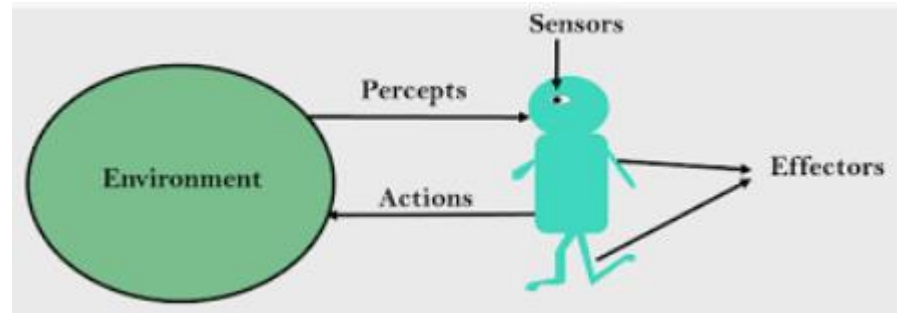
## Thinking rationally:

- Logic
- Example:
  - “Ali is a man; all men are mortal; therefore, Ali is mortal.”
- Problems: how to represent and reason in a domain available.

# What is Artificial Intelligence?

## Acting rationally:

- Acting Rationally: Rational Agents
- An agent is an entity that perceives its environment and is able to execute actions to change it.
- Agents have inherent goals that they want to achieve (e.g. survive, reproduce).
- A rational agent acts in a way to maximize the achievement of its goals.



# What is Artificial Intelligence?

## Rational Agents :

- All computer programs do something, but computer agents are expected to do more:
  - **Operate autonomously** (to act independently),
  - Perceive their environment,
  - Persist (continue) over a prolonged time period
  - Adapt to change, and create and pursue goals.



***Curiosity*** (rover) Curiosity is a car-sized Mars rover designed to explore the Gale crater (large bowl-shaped dry lake) on Mars as part of NASA's Mars Science Laboratory mission

# What is Artificial Intelligence?

## Rational Agents :

- A rational agent is one that acts so as to **achieve the best outcome** or, when there is **uncertainty**, the best expected outcome.
- **Rational behavior**: doing the right thing
- The right thing: the optimal (best) thing that is expected to maximize the chances of achieving a set of goals, in a given situation

# Acting rationally: Rational agent

- Making correct inferences (a conclusion reached on the basis of evidence and reasoning) is part of being a rational agent
- There are also ways of acting rationally that cannot be said to involve inference -- **Reflex actions**.
  - E.g., recoiling from a hot stove is a reflex action that is usually more successful than a slower action taken after careful deliberation

# History of Artificial Intelligence? 1950s

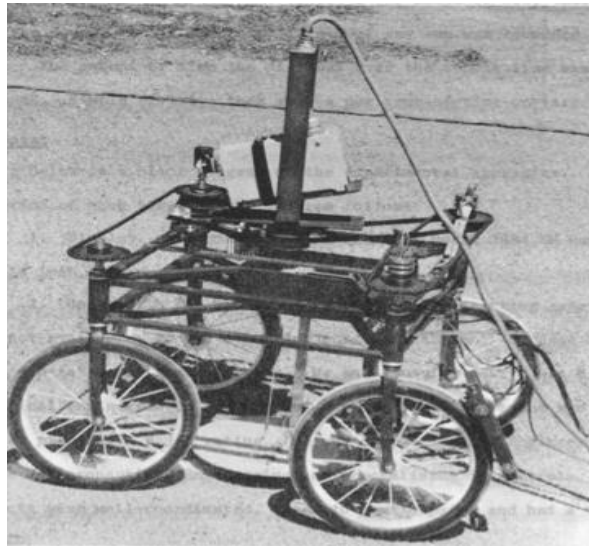
- Computers were thought of as an electronic brains
- Term “Artificial Intelligence” coined by John McCarthy
- John McCarthy also created Lisp in the late 1950s
- Alan Turing defines intelligence as passing the Turing Test
- AI research largely revolves around toy domains
- Computers of the era didn’t have enough power or memory to solve useful problems
- Problems being researched include
  - games (e.g., checkers)
  - early neural networks researched: the perceptron
  - automated theorem proving and mathematics problem solving

# History of Artificial Intelligence? 1960s

- AI attempts to move beyond toy domains
- Syntactic knowledge alone does not work, domain knowledge required
- Knowledge-based systems – that contain domain-specific knowledge giving them more problem-solving power
  - Expert Systems. The industry adopted them on a relatively large scale, but many such projects failed.
- Earliest expert system created: Dendral
- US sponsored research into AI targets specific areas – not including machine translation
- Early machine translation could translate English to Russian

# History of Artificial Intelligence? 1960s

- 1979 – The Stanford Cart, built by Hans Moravec, the first computer-controlled autonomous vehicle.



- 80s – neural networks with backpropagation algorithm become popular, evolutionary computation

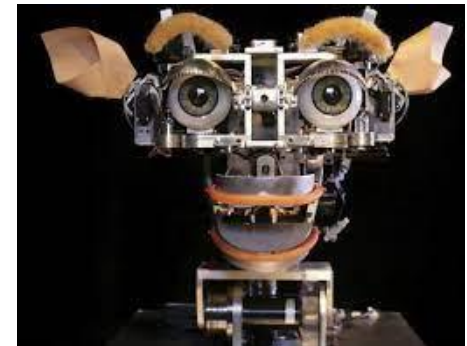


# History of Artificial Intelligence?

- 1997 – Deep Blue beats G. Kasparov, first Robo-Cup.



- 2000 – Interactive robots commercially available, Kismet (MIT), robots used for real applications



# History of Artificial Intelligence? March 2016

➤ Google DeepMind's AlphaGo beats Go grandmaster Mr. Lee Sedol



# History of Artificial Intelligence?

## Question Answering: IBM's Watson

- Won **Jeopardy challenge** on February 16, 2011!



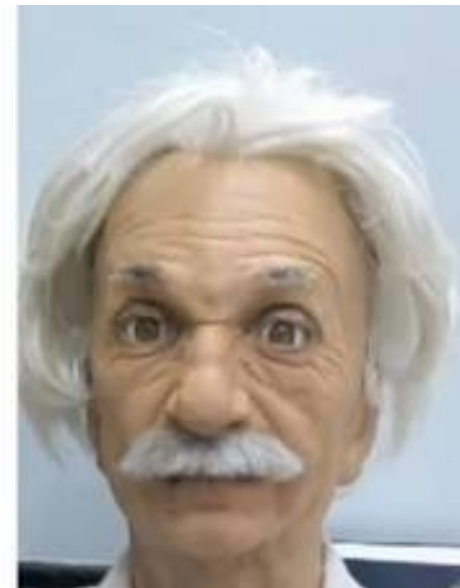
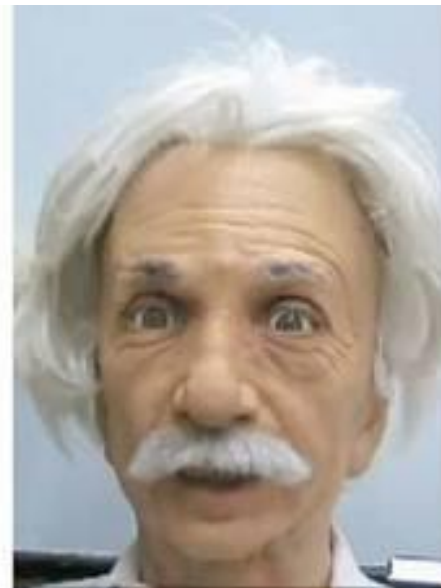
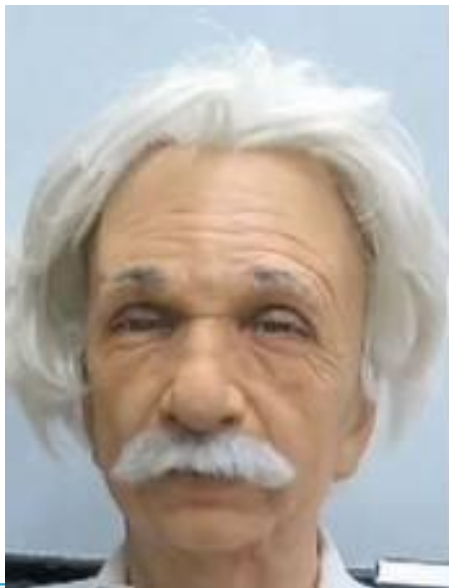
- Watson had access to 200 million pages of structured and unstructured content consuming 4TB of disk storage, including the Wikipedia, but was not connected to the Internet during the game



# AI Areas: Robotics



# AI Areas: Robots with facial expressions



# Main areas of AI

➤ By their own admission, AI researchers are not doing “AI”, they are doing

- Intelligent agents, multi-agent systems/collaboration
- Ontologies
- Machine learning and data mining
- Adaptive and perceptual systems
- Robotics, path planning
- Search engines, filtering, recommendation systems

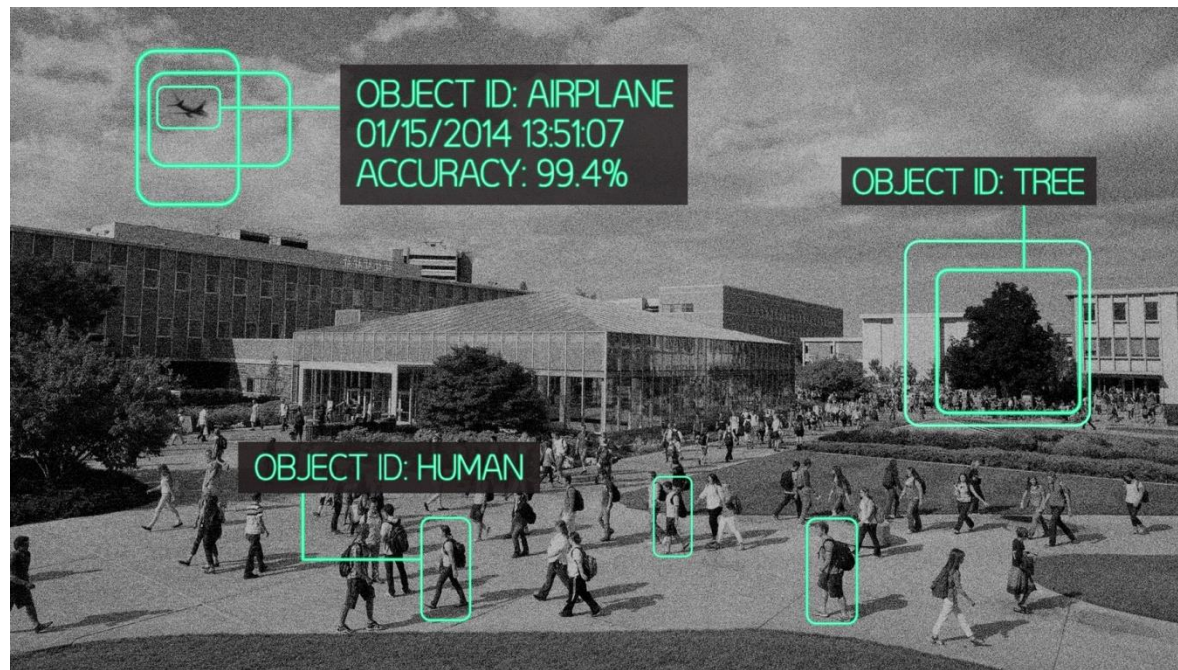
# Main areas of AI

- **Natural Language processing**
  - Speech technologies
    - Automatic speech recognition (ASR)
    - Text-to-speech synthesis (TTS)
    - Dialog systems
  - Language Processing Technologies
    - Machine Translation
    - Information Extraction
    - Information Retrieval
    - Text classification
    - Spam filtering.

# Main areas of AI

## ➤ Computer Vision:

- Object and Character Recognition
- Image Classification
- Scenario Reconstruction etc.





# Main areas of AI

- Game-Playing

  - Strategy/FPS games, Deep Blue, AlphaGo etc

- Logic-based programs

  - Proving theorems

  - Reasoning etc.

- Decision Support systems

  - Medicine, Weather forecast, Finance, etc.

- Autonomous planning and scheduling

- Machine learning

- Biologically inspired algorithms

- Autonomous control, robotics

- Natural language processing