Artificial Intelligence – The Introduction

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Artificial Intelligence

- Intelligence : Ability to learn, adapt, and explore.

- Artificial Intelligence : Artificial intelligence is the ability to let machines learn, adapt, and explore.

Some Definitions

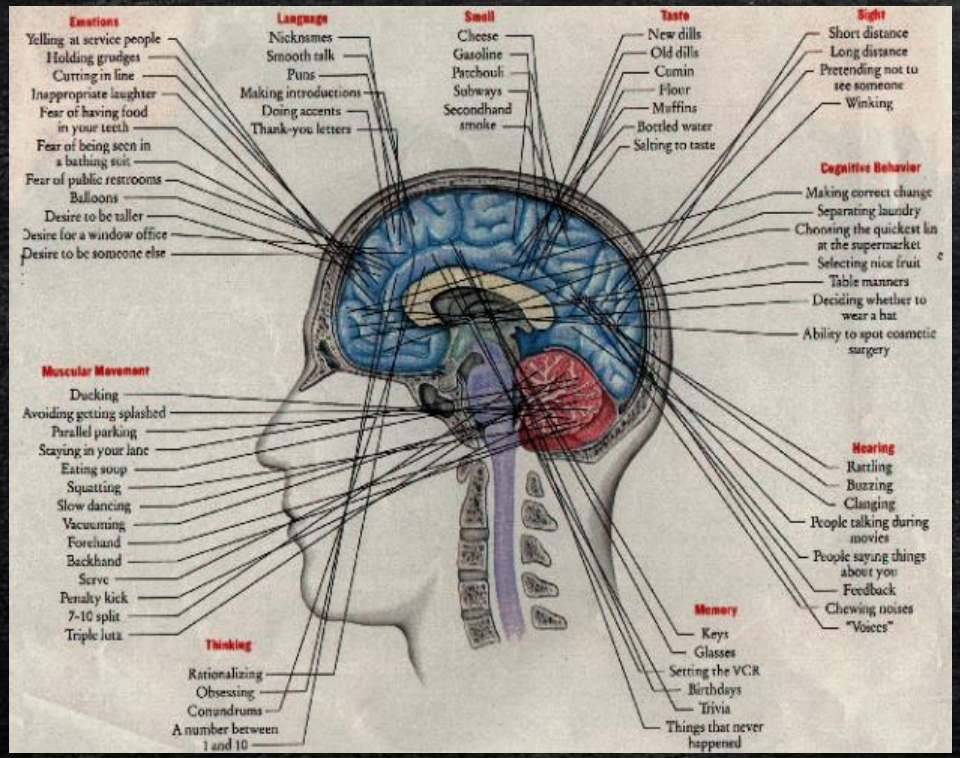
- "We call programs intelligent if they exhibits behaviours that would be regarded intelligent if they are exhibited by human being." – Herbert Simon
- "AI is the study of techniques for solving exponentially hard problems in polynomial time by exploiting knowledge about the problem domain." –Rich
- "AI is the study of mental faculties through the use of compugational models." –Eugene and Drew

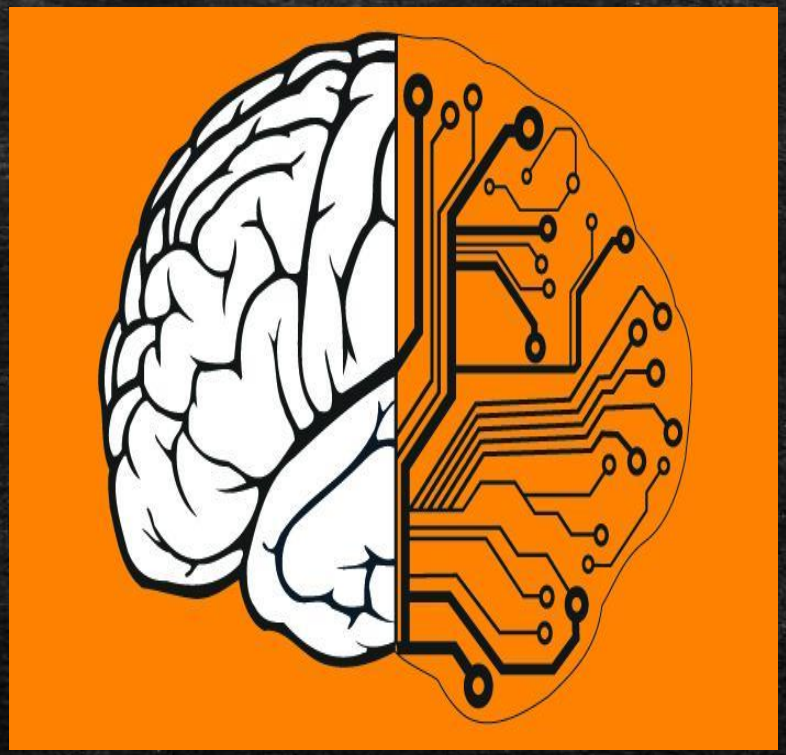
Definition

- **Autonomy**
- The ability to perform tasks in complex environments without constant guidance by a user.

- **Adaptivity**
- The ability to improve performance by learning from experience.

Act like human brain





Applications Of AI

- Gaming
- Natural Language Processing
- Expert Systems
- Vision Systems
- Speech Recognition
- Voice Recognition
- Handwriting Recognition
- face recognition
- Intelligent Robots
- Military
- Medical diagnosis
- Wireless Mesh Networks
- Wireless Sensors Networks
- Home appliances

Application 1. Self-driving cars

- Search and planning to find the most convenient route from A to B
- Computer vision to identify obstacles, and decision making under uncertainty to cope with the complex and dynamic environment
- **Implications:**
- Road safety should eventually improve
- Efficiency of logistics chains when moving goods should improve

Application 2. Content recommendation

- Social media content; online advertisements; music recommendations on Spotify; movie recommendations on Netflix, HBO, and other streaming services
- **Implications:**
- Companies don't want to reveal the details of their algorithms

Application 3. Image and video processing

- Face recognition: organizing your photos according to people, automatic tagging on social media, and passport control.
- Used to generate or alter visual content.
- Motion pictures used in Avatar, the Lord of the Rings.
- **Implications:**
- Easy to create natural looking fake videos of events that are impossible to distinguish from real footage.

What is, and what isn't AI? Not an easy question!

- no officially agreed definition
- the legacy of science fiction
- what seems easy is actually hard and what seems hard is actually easy

Exercise: Is this AI or not?

- Spreadsheet that calculates sums and other pre-defined functions on given data
- Yes
- No
- Kind of
- Ans: No, because the outcome is determined by the user-specified formula, no AI needed

Exercise: Is this AI or not?

- Predicting the stock market by fitting a curve to past data about stock prices
- Yes
- No
- Kind of
- Ans: Yes, because fitting a simple curve is not really AI, but there are so many different curves to choose from, even if there's a lot of data to constrain them, that one needs machine learning/AI to get useful results.

Exercise: Is this AI or not?

- A GPS navigation system for finding the fastest route
- Yes
- No
- Kind of
- Ans: Yes, because the signal processing and geometry used to determine the coordinates isn't AI, but providing good suggestions for navigation (shortest/fastest routes) is AI, especially if variables such as traffic conditions are taken into account.

Exercise: Is this AI or not?

- A music recommendation system such as Spotify that suggests music based on the user's listening behaviour.
- Yes
- No
- Kind of
- Yes, because the system learns from the users' (not only your) listening behaviour.

Exercise: Is this AI or not?

- Big data storage solutions that can store huge amounts of data (such as images or video) and stream them to many users at the same time.
- Yes
- No
- Kind of
- No, because storing and retrieving specific items from a data collection is neither adaptive or autonomous.

Exercise: Is this AI or not?

- Photo editing features such as brightness and contrast in applications such as Photoshop.
- Yes
- No
- Kind of
- Ans: No, because adjustments such as color balance, contrast, and so on, are neither adaptive nor autonomous, but the developers of the application may use some AI to automatically tune the filters.

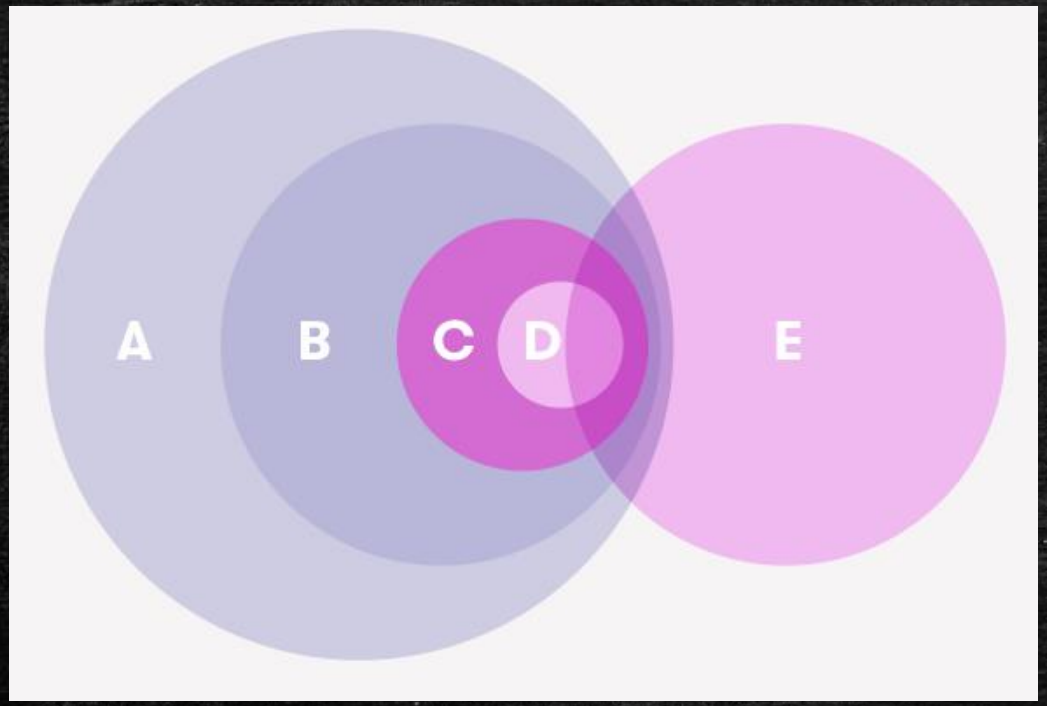
Exercise: Is this AI or not?

- Style transfer filters in applications such as Prisma that take a photo and transform it into different art styles (impressionist, cubist, …)
- Yes
- No
- Kind of
- Ans, yes because such methods typically learn image statistics (read: what small patches of the image in a certain style look like up close) and transform the input photo so that its statistics match the style, so the system is adaptive

Related fields

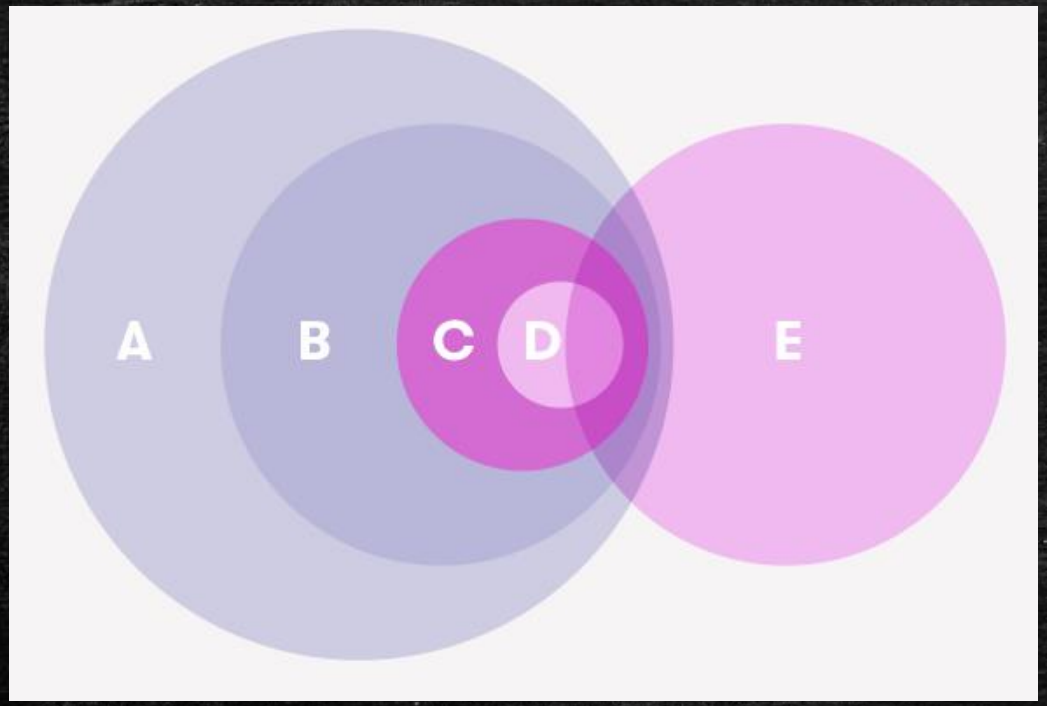
- **Machine learning:** Systems that improve their performance in a given task with more and more experience or data.
- **Deep learning:** It is a subfield of machine learning. Deep learning refers to the complexity of a mathematical model, and that the increased computing power of modern computers has allowed researchers to increase this complexity to reach levels that appear not only quantitatively but also qualitatively different from before.
- **Data science:** It includes machine learning and statistics, certain aspects of computer science including algorithms, data storage, and web application development.
- **Robotics:** It means building and programming robots so that they can operate in complex, real-world scenarios.

Exercise: Taxonomy of AI



- AI
- Machine Learning
- Computer Science
- Data Science
- Deep Learning

Exercise: Taxonomy of AI



- AI -- B
- Machine Learning -- C
- Computer Science -- A
- Data Science -- E
- Deep Learning -- D

Some Fundamental Questions

- What is intelligence?
- What is thinking?
- What is a machine? – Something which acts mechanically
- Is the computer a machine?
- Can a machine think?
- If yes are we machine? – Hugland provide ans in his book (Machine vs Free Will)
- The Emotion Machine – By Marvin Misinky

Debate against thinking machines

- "Intelligence depends upon unconscious instincts that can never be captured in formal rules." – Herbert Dreyfus
- The Chinese room experiment - can an agent locked in a room processing questions in Chinese based on set of syntactic rules is said to understand Chinese? – Given by John Searle
- "There is something (quantum mechanical) going on in our brain that current day physics cannot explain." – Roger Penrose (Nobel laurerate mathematician)

The Grandfather of AI : John Haugeland

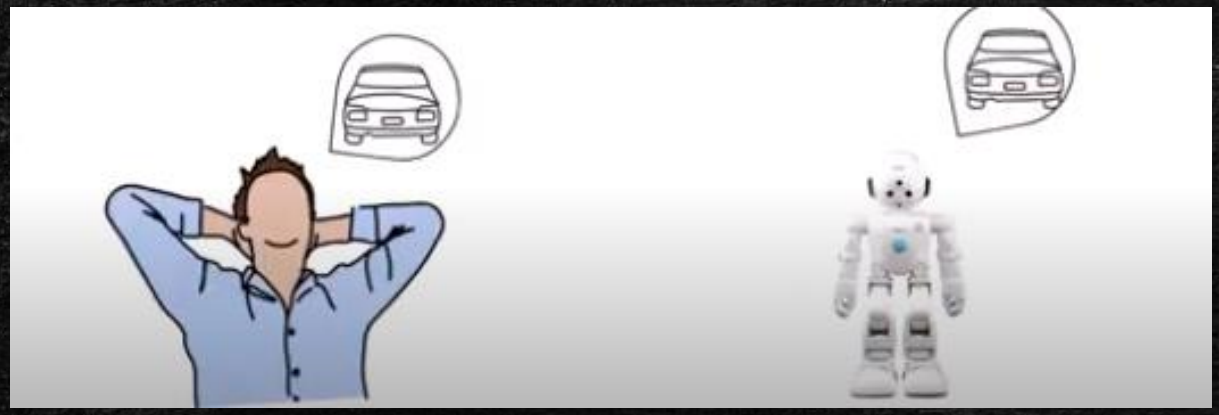
- What come first "Language" or "Thoughts"?
- Idea of "Universal Grammar" by "Noam Chomsky".
- Thomas Hobbes: "Thinking is the manipulation of symbols."
- Mind vs Book (Both are collection of symbols)
- Where does meaning comes from?

Approaches of AI

- **Acting Humanly** : Turing Test Approach.
- **Thinking Humanly** : Cognitive Modelling Approach.
- **Thinking Rationally** : Laws of thought Approach.
- **Acting Rationally** : The Rational Agent Approach.

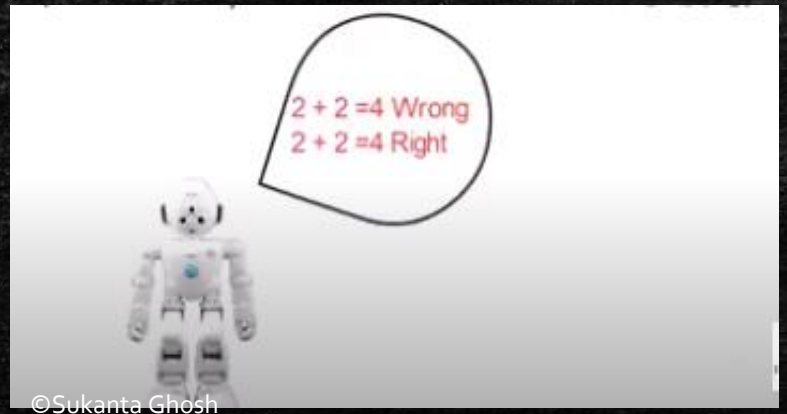
Think Humanly

- **Principle**: Think like human brain.
- **Cognitive Science**: study of human thought process and mind.
- AI: Copying that thought process into machine.
- **Issue**: Brain is too complex to study, thus, creates a huge gap between machine and human being.



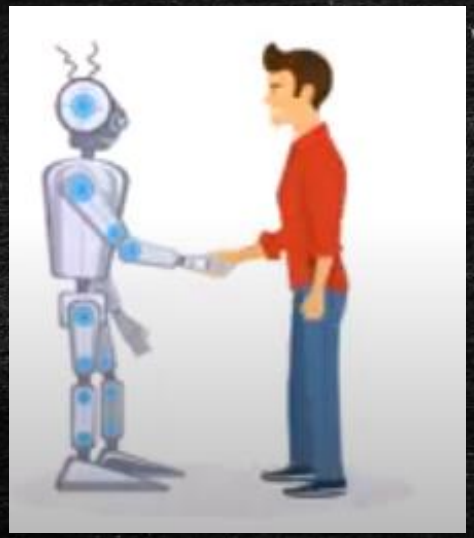
Think Rationally (Laws of thoughts approach)

- **Right Thinking**: undeniable reasoning process. Eg. Tim is a man; All men are mortal; therefore Tim is mortal.
- These law of thought led to new field called LOGIC.
- Obstacle: 100% knowledge = more rules = complex
- Easy looking theory but practically harder.



Act Humanly (Turing Test Approach)

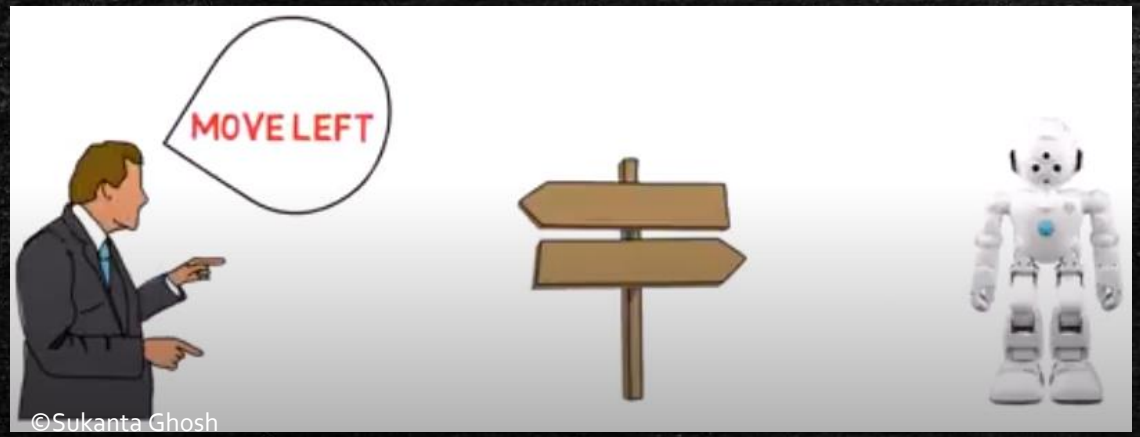
- The art of creating machines that performs functions that require intelligence when performed by people.
- Act like humans.
- **Principle**: If any machine passes Turing test, it is having intelligence.



Act Rationally (Rational agent approach)

- **Rational**: behaving rightly and capable of reasoning.
- **Agent**: having more attributes than just a program.

- **Rational Agent**: acts to achieve best outcome, if uncertainty the best expected result is achieved. Behaves rightly, optimal solution.



Approaches of AI

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

Figure 1.1 Some definitions of artificial intelligence, organized into four categories.

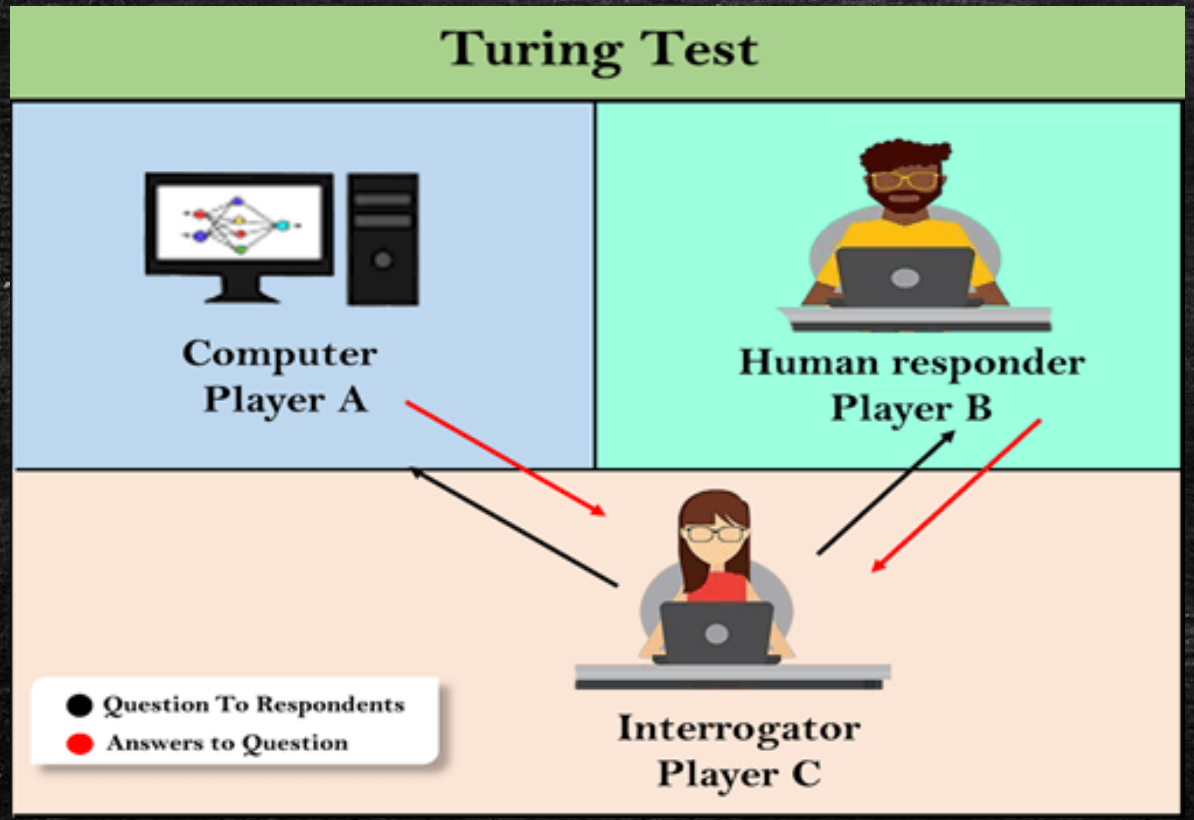
Alan Turing: The imitation game

- Alan Turing (1912-1954)
- The question whether machine can think itself "too meaningless"
- Prescribed a test which he called the Imitation Game is now known as The Turing Test

Alan Turing imitation game

- "I believe that in about fifty years time it will be possible to programme computer, with a storage capacity of about 10^9, to make them play the imitation game so well that an average interrogator will not have more than 70 percent making the right identification after 5 minutes of questioning… I believe that at the end of the century the use of the words and general educated opinion will have altered so much that one will be able to speak of machine thinking without expecting to be contradicted."
- Turing A. M. (1950). Computing Machinery and Intelligence. Mind, 59, 433-460

The Turing Test



- The Loebner Prize – an annual competation where chatbots are judged for human like responses. (Grand prize USD 100,000)

The Loebner Prize 2013

Four finalists to compete on Sept 14, 2013

Excerpts from the leader *Izar*

IZAR TRANSCRIPT

JUDGE: Hello I'm Ronan. What is your name?

IZAR: Ronan! It's about time you contacted me! I was waiting for you! My name is Izar pronounced I zar, but you can call me Izzy if you want. Doing anything fun? Too much recursion in AIML

. . .

JUDGE: I like bananas. Which is your favorite fruit?

IZAR: Tell me more about your unknown. You are not the only one. I don't have a problem with bananas. Is that your favorite fruit? The obvious one. Does that remind you of unknown??

JUDGE: What music do you like?

IZAR: I like many kinds of human music, but recently, I've been getting into Hoomii, a type of Mongolian throat singing. Why? What kind of music do you like?

How AI got its name

The name *artificial intelligence* is credited to John McCarthy who, along with Marvin Minsky and Claude Shannon (1916–2001), organized the *Dartmouth Conference* in 1956.

The conference was to be a "*two month, ten-man study of artificial intelligence … on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it*".

See Machines Who Think, Chapter 5, for a detailed account.

Dartmouth Conference: The Organizers

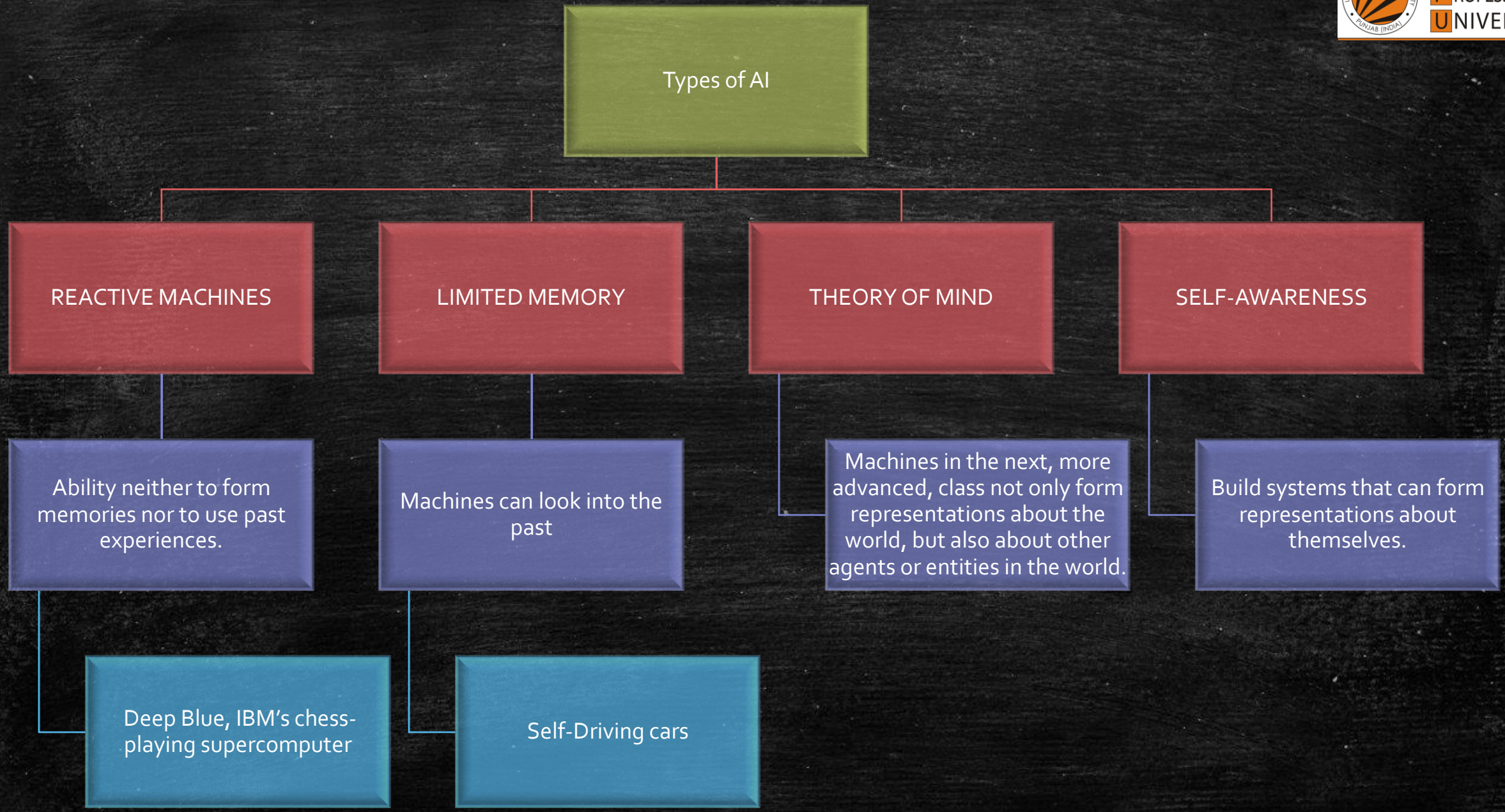
- John McCarthy (1927-2011), then an assistant professor at Dartmouth. Designed the Lisp programming language that was very popular with AI researchers. Also did work in Logic and Commonsense Reasoning.
- Marvin Minsky (1927 -), then a Harvard Junior Fellow went on to become one of the most influential figures in AI. With McCarthy he co-founded the MIT AI Lab. Known for his ideas on Frames. Wrote a book "Society of the Mind" and more recently "The Emotion Machine"
- Nathaniel Rochester (1919 – 2001) a young engineer at IBM. He designed the IBM 701 and wrote the first assembler. He supervised Arthur Samuel writing the checkers playing program. It is said that the marketing people at IBM reported that people were frightened of "electronic brains" resulting in IBM stopping work on AI.
- Claude Shannon (1916- 2001) a mathematician at Bell Labs was already known for his information theory. Had hired McCarthy and Minsky in 1952 for the summer when they were graduate students.

Three Laws of Robotics

The Three Laws are a set of rules devised by the science fiction author Isaac Asimov. The rules were introduced in his 1942 short story "*Runaround*", although they had been foreshadowed in a few earlier stories. The Three Laws 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, except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Source: http://en.wikipedia.org/wiki/Three_Laws_of_Robotics



Intelligent Behavior

- Perception
- Reasoning
- Learning
- Understanding Natural Language
- Solving Problems

9 Types Of Intelligence

- Naturalist (nature smart)
- Musical (sound smart)
- Logical-mathematical (number/reasoning smart)
- Existential (life smart)
- Interpersonal (people smart)
- Bodily-kinesthetic (body smart)
- Linguistic (word smart)
- Intra-personal (self smart)
- Spatial (picture smart)

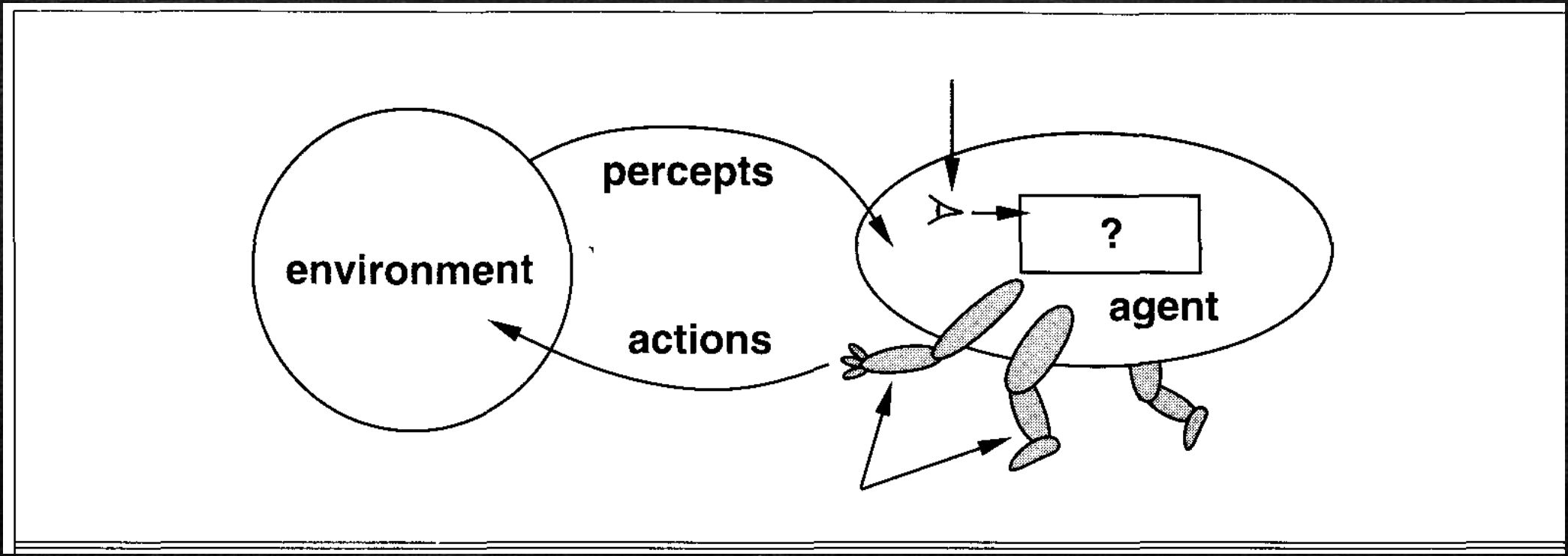
Difference Between Human Intelligence and Machine Intelligence

Attributes	Natural intelligence (human)	Artificial intelligence (machine)
Acquire a large amount of external information	High	Low
Use sensors (eyes, ears, touch, smell)	High	Low
Be creative and imaginative	High	Low
Learn from experience	High	Low
Be forgetful	High	Low
Make complex calculations	Low	High
Be adaptive	High	Low
Use a variety of information sources	High	Low
Transfer information	Low	High

Intelligent Agents

- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors (actuators).
- A human agent has eyes, ears, and other organs for sensors, and hands, legs, mouth, and other body parts for effectors.
- A robotic agent substitutes cameras and infrared range finders for the sensors and various motors for the effectors

How AGENTS SHOULD ACT ?



Cont..

- Following are the main four rules for an AI agent:
- Rule 1: An AI agent must have the ability to perceive the environment.
- Rule 2: The observation must be used to make decisions.
- Rule 3: Decision should result in an action.
- Rule 4: The action taken by an AI agent must be a rational action.

Examples of Agents

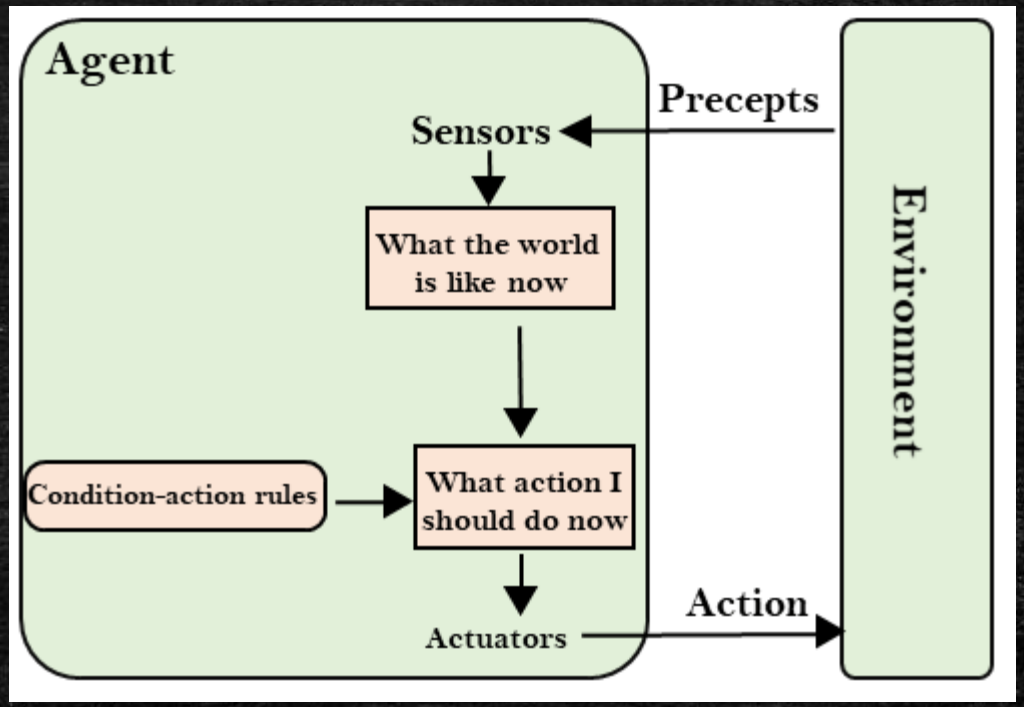
- Humans
  - Ear, Eyes, skins, nose etc. for sensors
  - Hands, Legs for effectors
- Robot
  - Camera, infrared for sensors
  - Wheels, light for effectors
- Softbot
  - Functions as sensors
  - Functions as effectors

Types of AI Agents

- Simple Reflex Agent
- Model-based reflex agent
- Goal-based agents
- Utility-based agent
- Learning agent

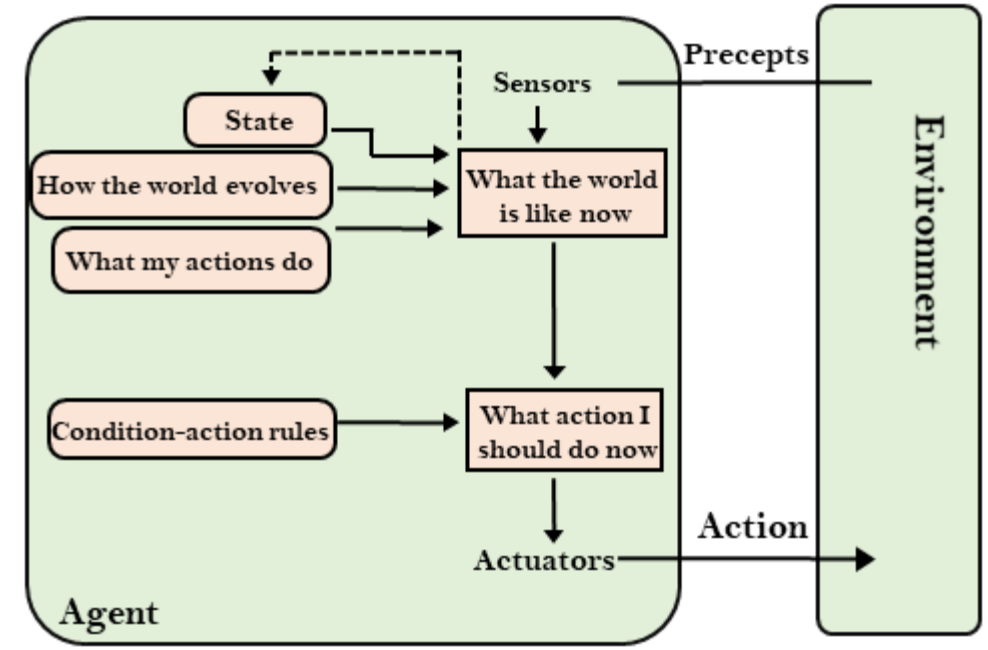
Simple Reflex agent

- These agents take decisions on the basis of the current percepts and ignore the rest of the percept history.
- These agents only succeed in the fully observable environment.
- Eg. Such as a Room Cleaner agent, it works only if there is dirt in the room.



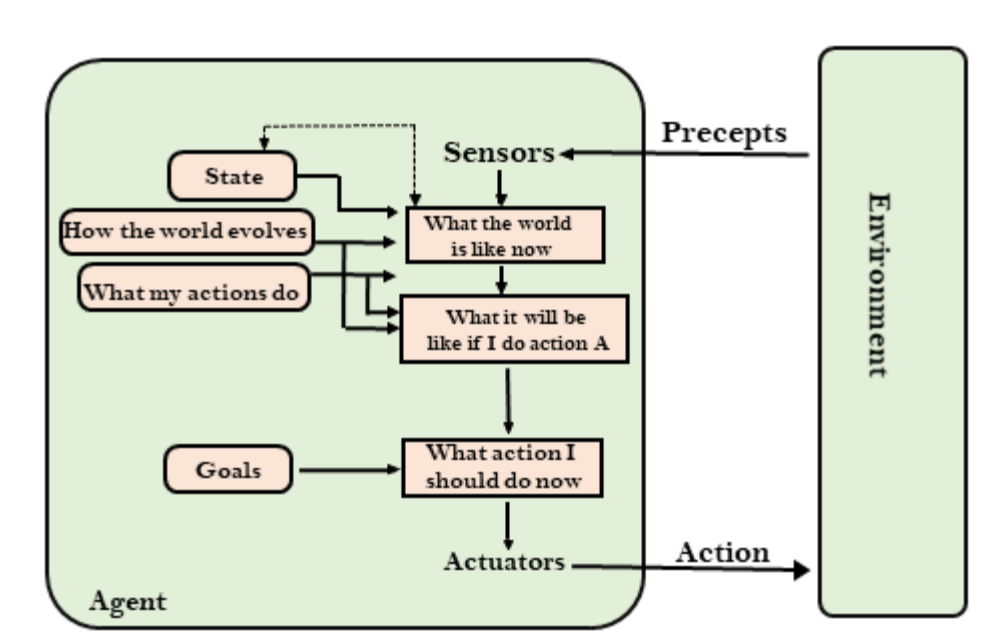
Model-based reflex agent

- Model-based agent can work in a partially observable environment, and track the situation.
- Two important factors:
  - **Model:** It is knowledge about "how things happen in the world," so it is called a Model-based agent.
  - **Internal State:** It is a representation of the current state based on percept history.



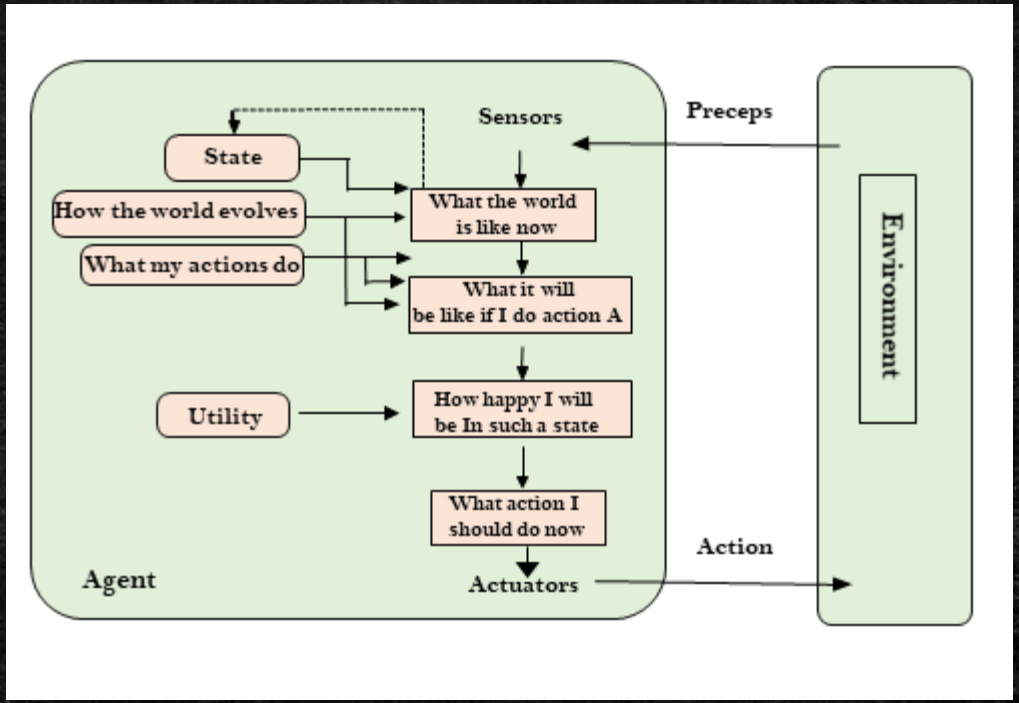
Goal-based agents

- Goal-based agents expand the capabilities of the model-based agent by having the "goal" information.
- They choose an action, so that they can achieve the goal.



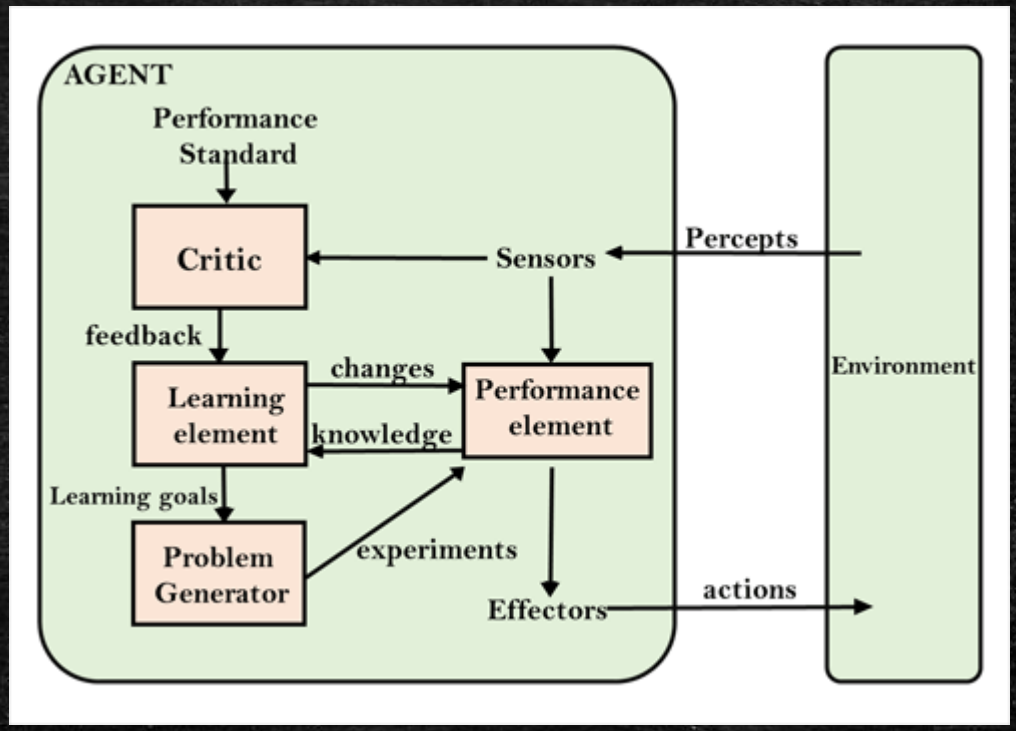
Utility-based agents

- Utility-based agent act based not only goals but also the best way to achieve the goal.
- The Utility-based agent is useful when there are multiple possible alternatives.
- The utility function maps each state to a real number to check how efficiently each action achieves the goals.



Learning Agents

- Learning agents are able to learn, analyze performance, and look for new ways to improve the performance.
- A learning agent has mainly four conceptual components, which are:
  - Learning element: learning from environment
  - Critic: feedback from critic
  - Performance element: selecting external action
  - Problem generator: suggesting actions that will lead to new and informative experiences.



Rationality

- **Perfect Rationality**
- Assumes that the rational Agent knows all and will take the action that maximizes its utility.
- Human beings are not perfect rational.
- **Bounded Rationality**
- Humans uses the approximate methods to handle many tasks.

Rational Agents

- A rational agent is an agent which has clear preference, models uncertainty, and acts in a way to maximize its performance measure with all possible actions.
- A rational agent always does the right things.
  - What are the goals?
  - What are the Components?
  - How to build them?

Structure of an AI Agent

- Agent = Architecture + Agent program
- **Architecture:** Architecture is machinery that an AI agent executes on.
- **Agent Function:** Agent function is used to map a percept to an action.
- $f: P^* \rightarrow A$
- **Agent program:** Agent program is an implementation of agent function. An agent program executes on the physical architecture to produce function f.

PEAS Representation

- P: Performance measure
- E: Environment
- A: Actuators
- S: Sensors

PEAS for self-driving cars

- Performance: Safety, time, legal drive, comfort
- Environment: Roads, other vehicles, road signs, pedestrian
- Actuators: Steering, accelerator, brake, signal, horn
- Sensors: Camera, GPS, speedometer, odometer, accelerometer, sonar.

Strong (General AI)

- Strong AI Refers to the field of research that is interested in making computers think at a level equal to humans (Human Like).
- The system would possess the cognitive abilities and general experiential understanding of its environments

Weak AI (Narrow AI)

- Weak AI features can be added to systems to give them intelligent qualities.
- Weak AI refers to AI which is able to handle just one particular task.
- Eg. A spam filtering tool, or a recommended playlist from Spotify, or even a self-driving car

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Thank You

Any Queries??