Unit-1

Introduction to Artificial Intelligence

| Assessment Component	ICA (100 Marks) (Marks scaled to 50)					TEE (100 marks) (Marks scaled to 50)
	Lab Performance	Assignment/ Mini Project	Presentation of a research paper (Group activity)	Class Test1 and Class Test 2	Class Participation	
Weightage	10%	10%	5%	20%	5%	50%
Marks	20	20	10	20+20	10	100

Intelligence vs *Artificial Intelligence*

❑ Intelligence is a property/ability attributed to people, such as to know, to think, to talk, to learn.

Intelligence = Knowledge + ability to perceive, feel, comprehend, process, communicate, judge, learn.

❑ Artificial Intelligence is an <u>interdisciplinary</u> field aiming at developing techniques and tools for solving problems that people are good at.

Define Intelligence with the Help of its Traits
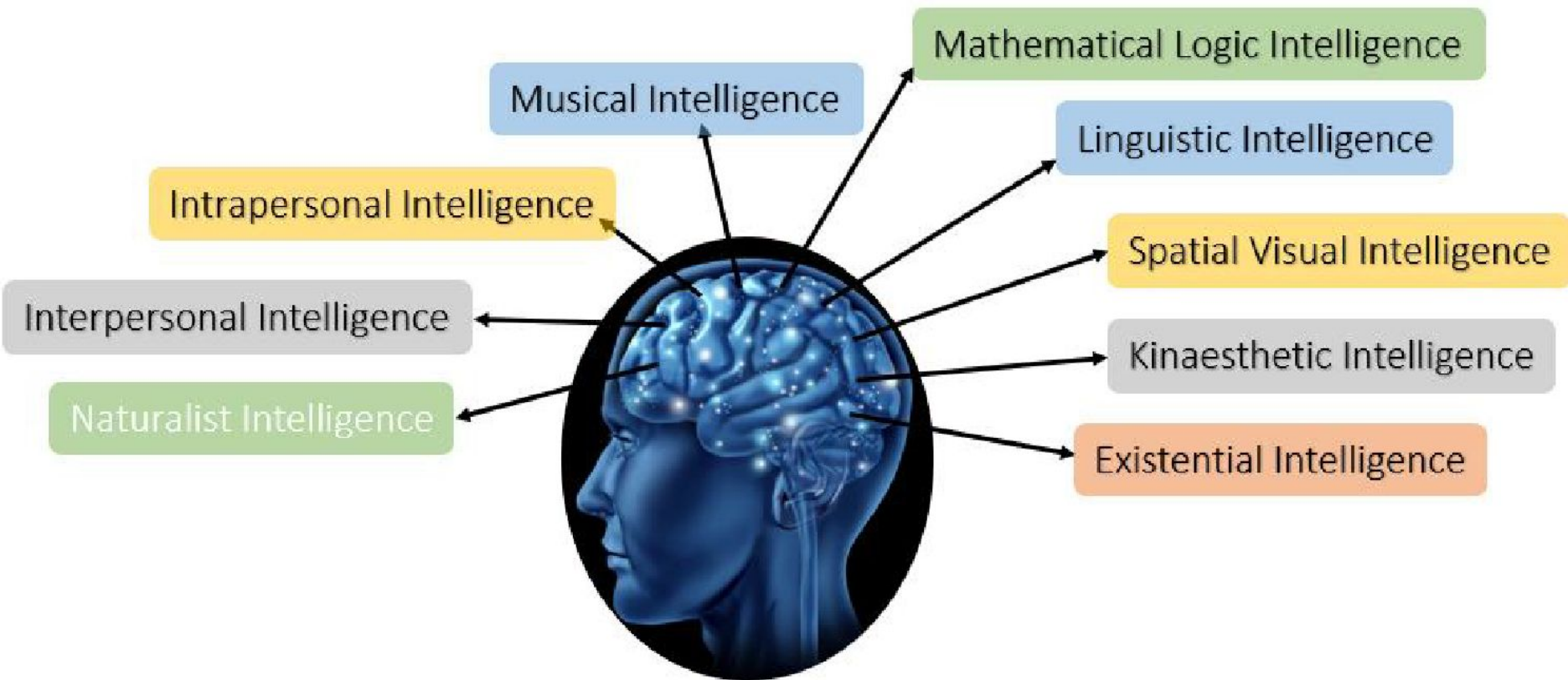
|	
Mathematical Logical Reasoning	• A person's ability to regulate, measure, and understand numerical symbols, abstraction and logic.
Linguistic Intelligence	• Language processing skills both in terms of understanding or implementation in writing or verbally.
Spatial Visual Intelligence	• It is defined as the ability to perceive the visual world and the relationship of one object to another.
Kineasthetic Intelligence	• Ability that is related to how a person uses his limbs in a skilled manilr.
Musical Intelligence	• As the name suggests, this intelligence is about a person's ability to recognize and create sounds, rhythms, and sound patterns.
Intrapersonal Intelligence	• Describes how high the level of self-awareness someone has is. Starting from realizing weakness, strength, to his own feelings.
Existential Intelligence	• An additional category of intelligence relating to religious and spiritual awareness.
Naturalist Intelligence	• An additional category of intelligence relating to the ability to process information on the environment around us.
Interpersonal intelligence	• Interpersonal intelligence is the ability to communicate with others by understanding other people's feelings & influence of the person.

You are locked inside a room with 3 doors to move out of the locked room and you need to find a safe door to get your way out. Behind the 1st door is a lake with a deadly shark. The 2nd door has a mad psychopath ready to kill with a weapon and the third one has a lion that has not eaten since the last 2 months.

CHOOSE THE RIGHT DOOR

1

2

3

TO SURVIVE

?

In other words, we may define intelligence as:

• **Ability to interact with the real world**
   o To perceive, understand and act
   ▪ Example: Speech Recognition
   ▪ Example: Image Recognition
   ▪ Example: Ability to take action: to have an effect

• **Reasoning and planning**
   o Modelling the external world, given input
   ▪ Solving new problems, planning and making decisions
   ▪ Ability to deal with unexpected problems, uncertainties

• **Learning and adaptation**
   o Continuous learning and adapting graph
   ▪ Our internal models are always being updated
   ▪ Example: Baby learning to categorize and recognise animals

Apply

Solve

Formulate
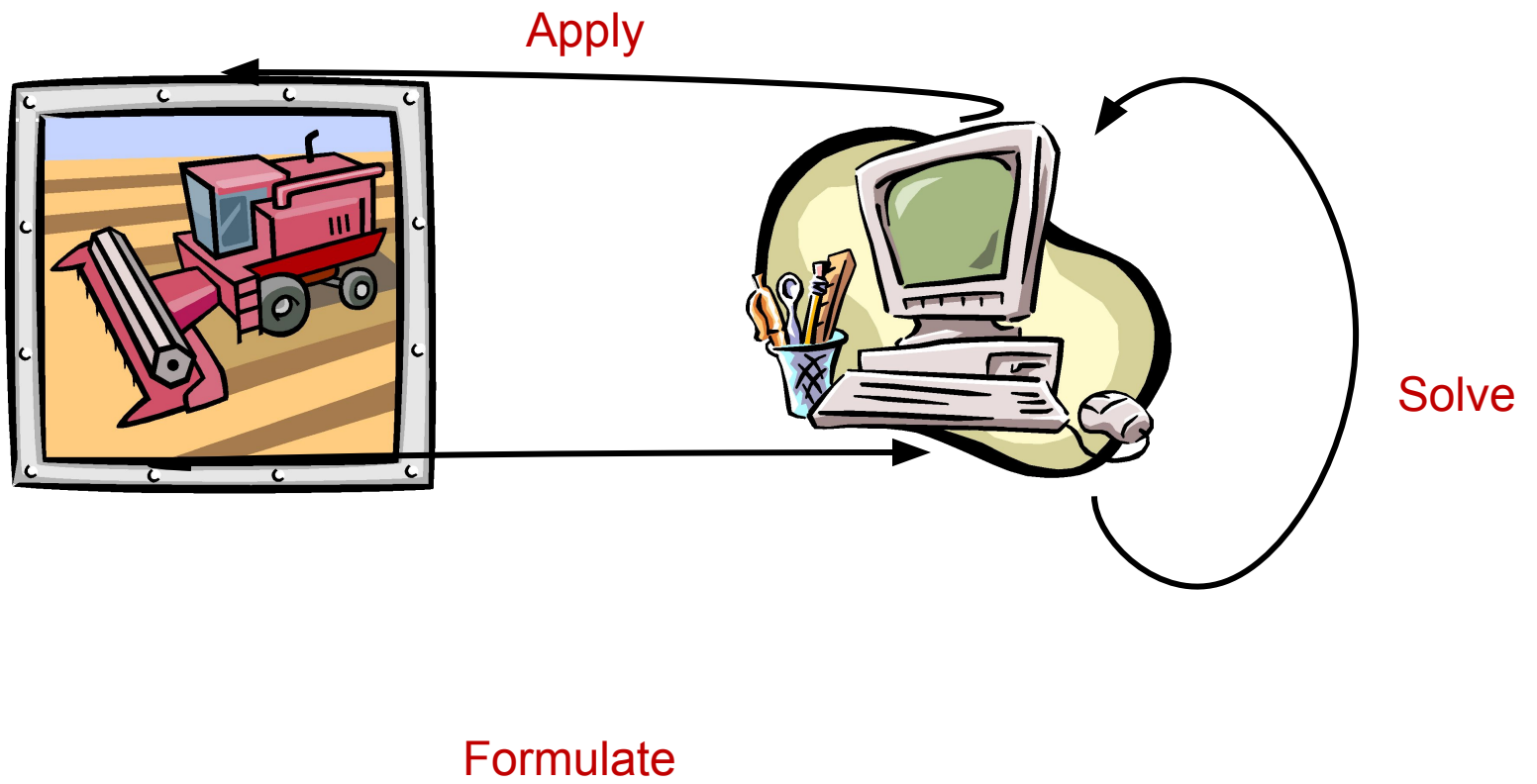
Definitions of AI

Existing definitions advocate everything from replicating human intelligence to simply solving knowledge-intensive tasks. Examples:

"Artificial Intelligence is a study of complex information processing problems that often have their roots in some aspect of biological information processing. The goal of the subject is to identify solvable and interesting information processing problems, and solve them." -- **David Marr**

"Artificial Intelligence is the design, study and construction of computer programs that behave intelligently." -- **Tom Dean**

"Artificial Intelligence is the enterprise of constructing physical symbol system that can reliably pass the Turing test." -- **Matt Ginsberg**.

"AI is defined as an experimental discipline utilizing the ideas and the methods of computation."

- As per first reference book, "**The study of how to make computers do things at which, at the moment, people are better.**"

                           Rich & Knight, 1991

Goals of Artificial Intelligence

- **Scientific goal**: understand the mechanism behind human intelligence.
- **Engineering goal**: develop concepts and tools for building intelligent agents capable of solving real world problems. Examples:
  - **Knowledge-based systems**: capture expert knowledge and apply them to solve problems in a limited domain.
  - **Common sense reasoning systems**: capture and process knowledge that people commonly hold which is not explicitly communicated.
  - **Learning systems**: posses the ability to expend their knowledge based on the accumulated experience.
  - **Natural language understanding systems**.
  - **Intelligent robots.**
  - **Speech and vision recognition systems.**
 - **Game playing (IBM's Deep Blue)**

Goals of Artificial Intelligence

- To make computers more useful by letting them take over dangerous or tedious tasks from human

- Understand principles of human intelligence

Applications of AI

- **Gaming** − AI plays important role for machine to think of large number of possible positions based on deep knowledge in strategic games. for example, chess, river crossing, N-queens problems and etc.

- **Natural Language Processing** − Interact with the computer that understands natural language spoken by humans.

- **Expert Systems** − Machine or software provide explanation and advice to the users.

- **Vision Systems** − Systems understand, explain, and describe visual input on the computer.

- **Speech Recognition** − There are some AI based speech recognition systems have ability to hear and express as sentences and understand their meanings while a person talks to it. For example Siri and Google assistant.

- **Handwriting Recognition** − The handwriting recognition software reads the text written on paper and recognize the shapes of the letters and convert it into editable text.

Aarti invited four of her friends to her House.. They hadn't seen each other in a long time, so they chatted all night long and had a good time. In the morning, two of the friends Aarti had invited, died. The police arrived at the house and found that both the friends were poisoned and that the poison was in the strawberry pie. The three surviving friends told the police that they hadn't eaten the pie. The police asked," Why didn't you eat the pie ?". Shiv said, " I am allergic to strawberries.". Seema said, " I am on a diet." And Aarti said, "I ate too many strawberries while cooking the pie, I just didn't want anymore."

Shiv

Seema

Aarti
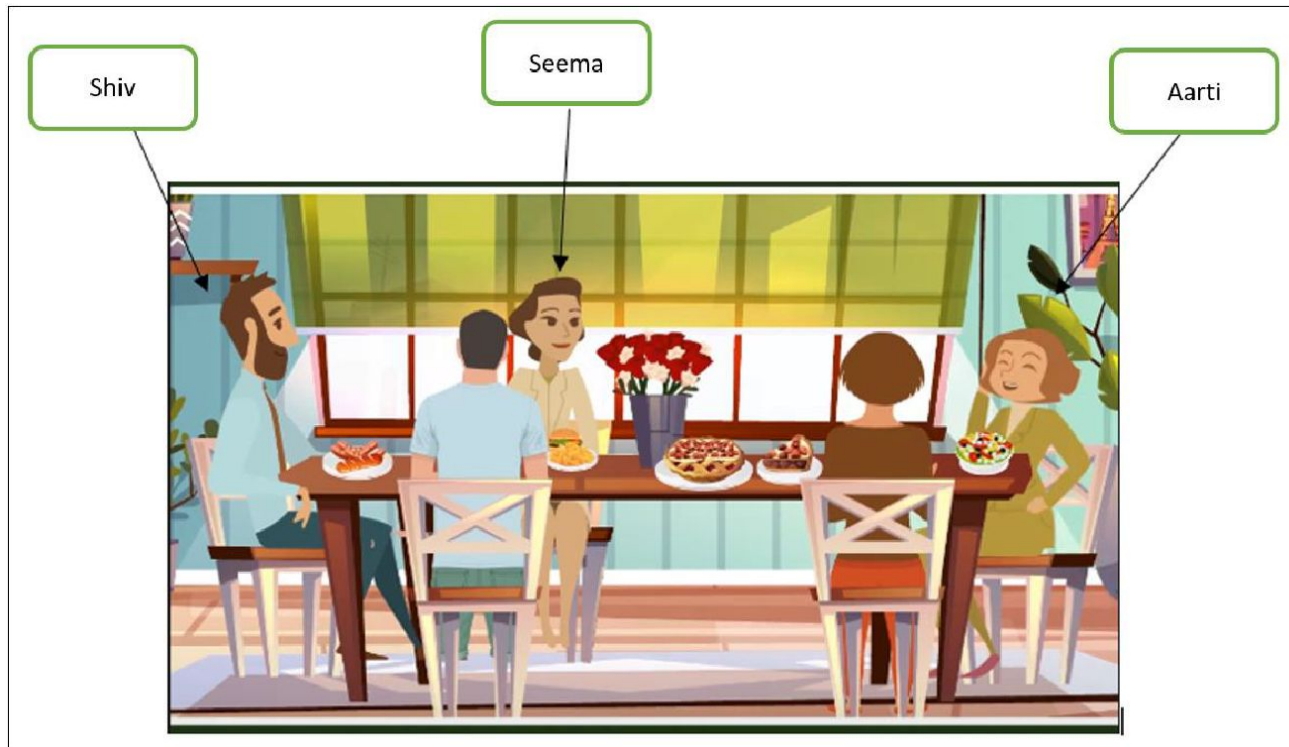
who is the murderer?

What is Artificial Intelligence ?

- making computers that think?

- the automation of activities we associate with human thinking, like decision making, learning ... ?

- the art of creating machines that perform functions that require intelligence when performed by people ?

- the study of mental faculties through the use of computational models ?

What is Artificial Intelligence ?

- the study of computations that make it possible to perceive, reason and act ?

- a field of study that seeks to explain and emulate intelligent behaviour in terms of computational processes ?

- a branch of computer science that is concerned with the automation of intelligent behaviour ?

- anything in Computing Science that we don't yet know how to do properly ? (!)

# What is Artificial Intelligence ?
(A rough classification)

|	HUMAN	RATIONAL
THOUGHT	Systems that think like humans	Systems that think rationally
BEHAVIOUR	Systems that act like humans	Systems that act rationally

Systems that act like humans: Turing Test

- "The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil)

- "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight)

Turing Test
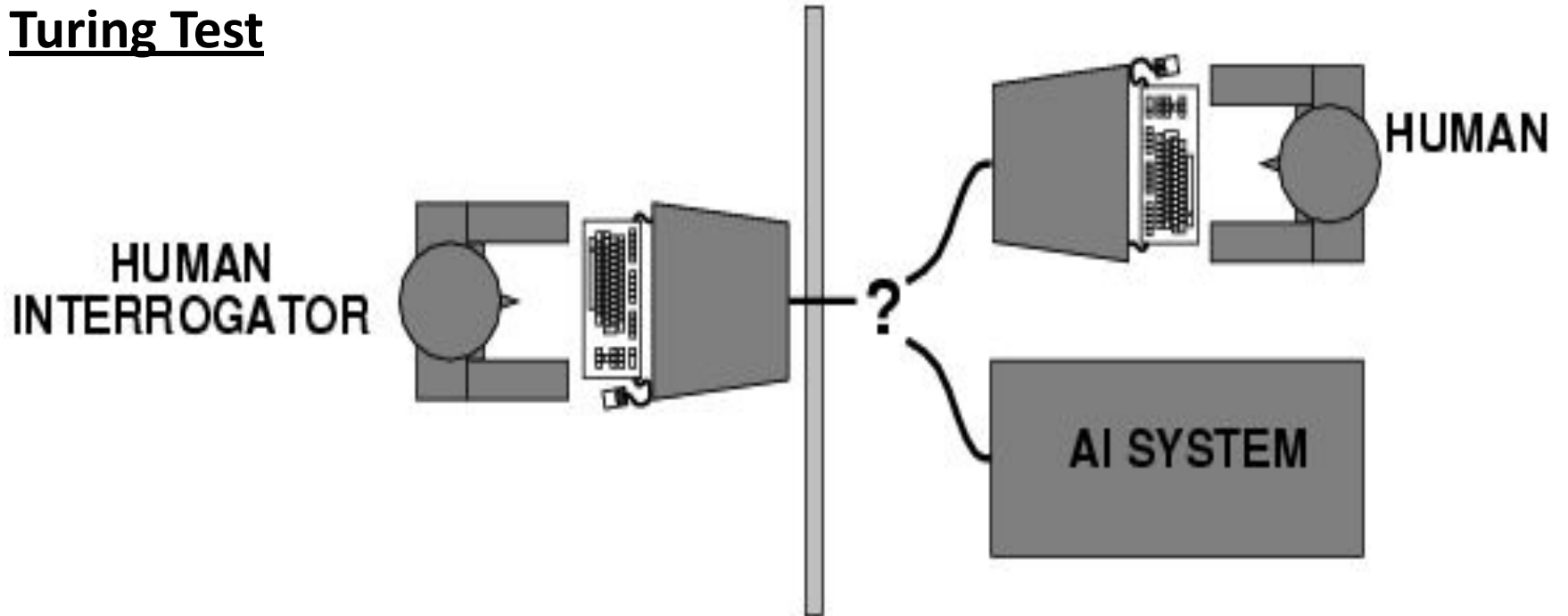
Systems that act like humans

?
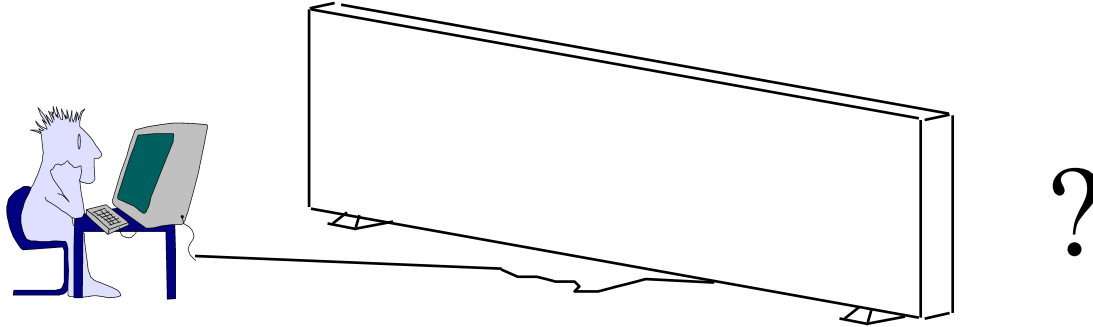
- You enter a room which has a computer terminal. You have a fixed period of time to type what you want into the terminal, and study the replies. At the other end of the line is either a human being or a computer system.

- If it is a computer system, and at the end of the period you cannot reliably determine whether it is a system or a human, then the system is deemed to be intelligent.

Systems that act like humans

- The Turing Test approach
  - a human questioner cannot tell if
    - there is a computer or a human answering his question, via teletype (remote communication)
  - The computer must behave intelligently
- Intelligent behavior
  - to achieve human-level performance in all cognitive tasks

Systems that act like humans

- These cognitive tasks include:
  - *Natural language processing*
    - for communication with human
  - *Knowledge representation*
    - to store information effectively & efficiently
  - *Automated reasoning*
    - to retrieve & answer questions using the stored information
  - *Machine learning*
    - to adapt to new circumstances

The total Turing Test

- Includes two more issues:
  - *Computer vision*
    - to perceive objects (seeing)
  - *Robotics*
    - to move objects (acting)

What is Artificial Intelligence ?

	Humanly	Rationally
Thinking	Thinking humanly — cognitive modeling. Systems should solve problems the same way humans do.	Thinking rationally — the use of logic. Need to worry about modeling uncertainty and dealing with complexity.
Acting	Acting humanly — the Turing Test approach.	Acting rationally — the study of rational agents: agents that maximize the expected value of their performance measure given what they currently know.

Systems that think like humans: cognitive modeling

- Humans as observed from 'inside'
- How do we know how humans think?
  - Introspection vs. psychological experiments
- Cognitive Science
- "The exciting new effort to make computers think … machines with *minds* in the full and literal sense" (Haugeland)
- "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning …" (Bellman)

What is Artificial Intelligence ?

	HUMAN	**RATIONAL**
THOUGHT	Systems that think like humans	Systems that think rationally
BEHAVIOUR	Systems that act like humans	Systems that act rationally

Systems that think 'rationally' "laws of thought"

- Humans are not always 'rational'
- Rational - defined in terms of logic?
- Logic can't express everything (e.g. uncertainty)
- Logical approach is often not feasible in terms of computation time (needs 'guidance')
- "The study of mental facilities through the use of computational models" (Charniak and McDermott)
- "The study of the computations that make it possible to perceive, reason, and act" (Winston)

What is Artificial Intelligence ?

	HUMAN	RATIONAL
THOUGHT	**Systems that think like humans**	**Systems that think rationally**
BEHAVIOUR	**Systems that act like humans**	**Systems that act rationally**

Systems that act rationally: "Rational agent"

- Rational behavior: doing the right thing
- The right thing: that which is expected to maximize goal achievement, given the available information
- Giving answers to questions is 'acting'.
- I don't care whether a system:
  - replicates human thought processes
  - makes the same decisions as humans
  - uses purely logical reasoning

Systems that act rationally

- Logic □ only *part* of a rational agent, not *all* of rationality
  - Sometimes logic cannot reason a correct conclusion
  - At that time, some *specific (in domain) human knowledge* or information is used
- Thus, it covers more generally different situations of problems
  - Compensate the incorrectly reasoned conclusion

Systems that act rationally

- Study AI as rational agent –

2 advantages:

- It is more general than using logic only
    - Because: LOGIC + Domain knowledge
- It allows extension of the approach with more scientific methodologies

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:

$$[f\colon \text{P*} \ \square \ \text{A}]$$

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

• computational limitations make perfect rationality unachievable
   $\square$ design best program for given machine resources

- Artificial
  - Produced by human art or effort, rather than originating naturally.
- Intelligence is the ability to acquire knowledge and use it" [Pigford and Baur]
- **So AI was defined as:**
  - AI is the study of ideas that enable computers to be intelligent.
  - AI is the part of computer science concerned with design of computer systems that exhibit human intelligence(From the Concise Oxford Dictionary)

From the above two definitions, we can see that AI has two major roles:

- Study the intelligent part concerned with humans.
- Represent those actions using computers.

AI Problems (Task Domains)

Mundane Tasks

- Perception
    - Vision
    - Speech
- Natural language
    - Understanding
    - Generation
    - Translation
- Commonsense reasoning
- Robot control

Formal Tasks

- Games
    - Chess
    - Backgammon
    - Checkers -Go
- Mathematics
    - Geometry
    - Logic
    - Integral calculus
    - Proving properties of programs

Expert Tasks

- Engineering
    - Design
    - Fault finding
    - Manufacturing planning
- Scientific analysis
- Medical diagnosis
- Financial analysis

Brief history of AI

- The history of AI begins with the following articles:
  - Turing, A.M. (1950), Computing machinery and intelligence, Mind, Vol. 59, pp. 433-460.

MIND

A QUARTERLY REVIEW

OF

PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

By A. M. Turing

I propose to consider the question, 'Can machines think?' . . .

Alan Turing - Father of AI

Alan Turing

- Born 23 June 1912, Maida Vale, London, England
- Died 7 June 1954 (aged 41), Wilmslow, Cheshire, England
- Fields: Mathematician, logician, cryptanalyst, computer scientist
- Institutions:
  - University of Manchester
  - National Physical Laboratory
  - Government Code and Cypher School (Britain's codebreaking centre)
  - University of Cambridge

Alan Turing memorial statue in Sackville Park, Manchester

Brief history of AI - The Birth of AI

- **The birth of artificial intelligence**
  - 1950: Turing's landmark paper "Computing machinery and intelligence" and Turing Test
  - 1951: AI programs were developed at Manchester:
    - A draughts-playing program by Christopher Strachey
    - A chess-playing program by Dietrich Prinz
    - These ran on the Ferranti Mark I in 1951.
  - 1955: Symbolic reasoning and the Logic Theorist
    - Allen Newell and (future Nobel Laureate) Herbert Simon created the "Logic Theorist". The program would eventually prove 38 of the first 52 theorems in Russell and Whitehead's Principia Mathematica
  - 1956: Dartmouth Conference - "Artificial Intelligence" adopted

Brief history of AI - The Birth of AI

- **The birth of artificial intelligence**
  - 1956: Dartmouth Conference - "Artificial Intelligence" adopted
  - The term 'Artificial Intelligence' was coined in a proposal for the conference at Dartmouth College in 1956

  - Check PDF

Brief history of AI – The Birth of AI

- One of the early research in AI is search problem such as for game-playing. Game-playing can be usefully viewed as a search problem in a space defined by a fixed set of rules
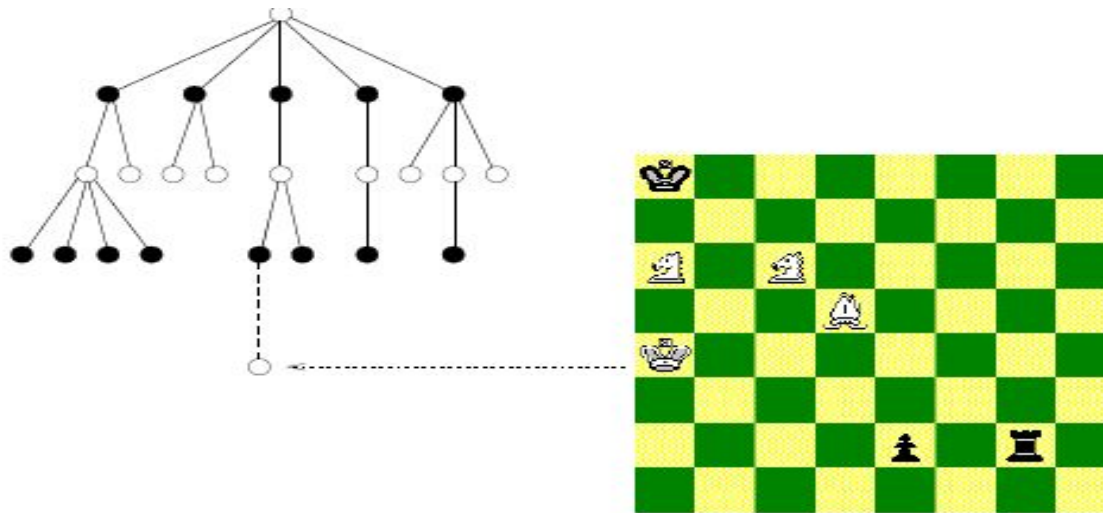
- Nodes are either white or black corresponding to reflect the adversaries' turns.
- The tree of possible moves can be searched for favourable positions.

Brief history of AI – The Birth of AI

- The real success of AI in game-playing was achieved much later after many years' effort.

- It has been shown that this search based approach works extremely well.

- In 1996 IBM Deep Blue beat Gary Kasparov for the first time. and in 1997 an upgraded version won an entire match against the same opponent.

Brief history of AI – The Birth of AI

- Another of the early research in AI was applied the similar idea to **deductive logic**:

All men are mortal	$\forall$ x (man(x) -> mortal(x))
Socrates is a man	man(Socrates)
Socrates is mortal	mortal(Socrates)

- The discipline of developing programs to perform such logical inferences is known as (automated) **theorem-proving**

- Today, theorem-provers are highly-developed . . .

Current status of AI

- In March 2016, Alpha-Go of DeepMind defeated Lee Sedol, who was the strongest human GO player at that time.
- This is a big news that may have profound meaning in the human history.
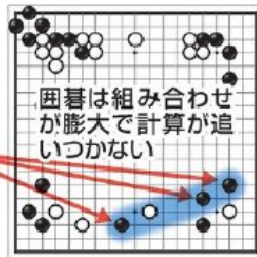
History of AI

1943	1950	1956	1966	1972	1974-1980	1980
Evolution of Artificial neurons	Turing Machine	Birth of AI: Dartmouth Conference	First Chatboat : ELIZA	First Intellgence Robot : WABOT -1	First AI winer	Expert Ststem

1987-1993	1997	2002	2011	2012	2014	2015
Second AI Winer	IBM Deep blue : first computer to beat a world chess champion	AI in Home: Roomba	IBM s Watson : Wins a quiz show	Google now	Chatbot Eugene Goostman:Wines a "Turing test	Amazon Echo
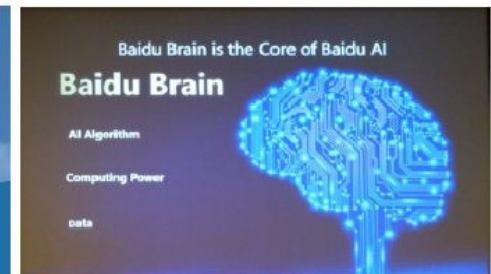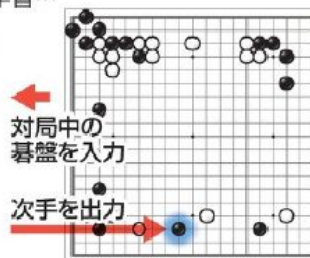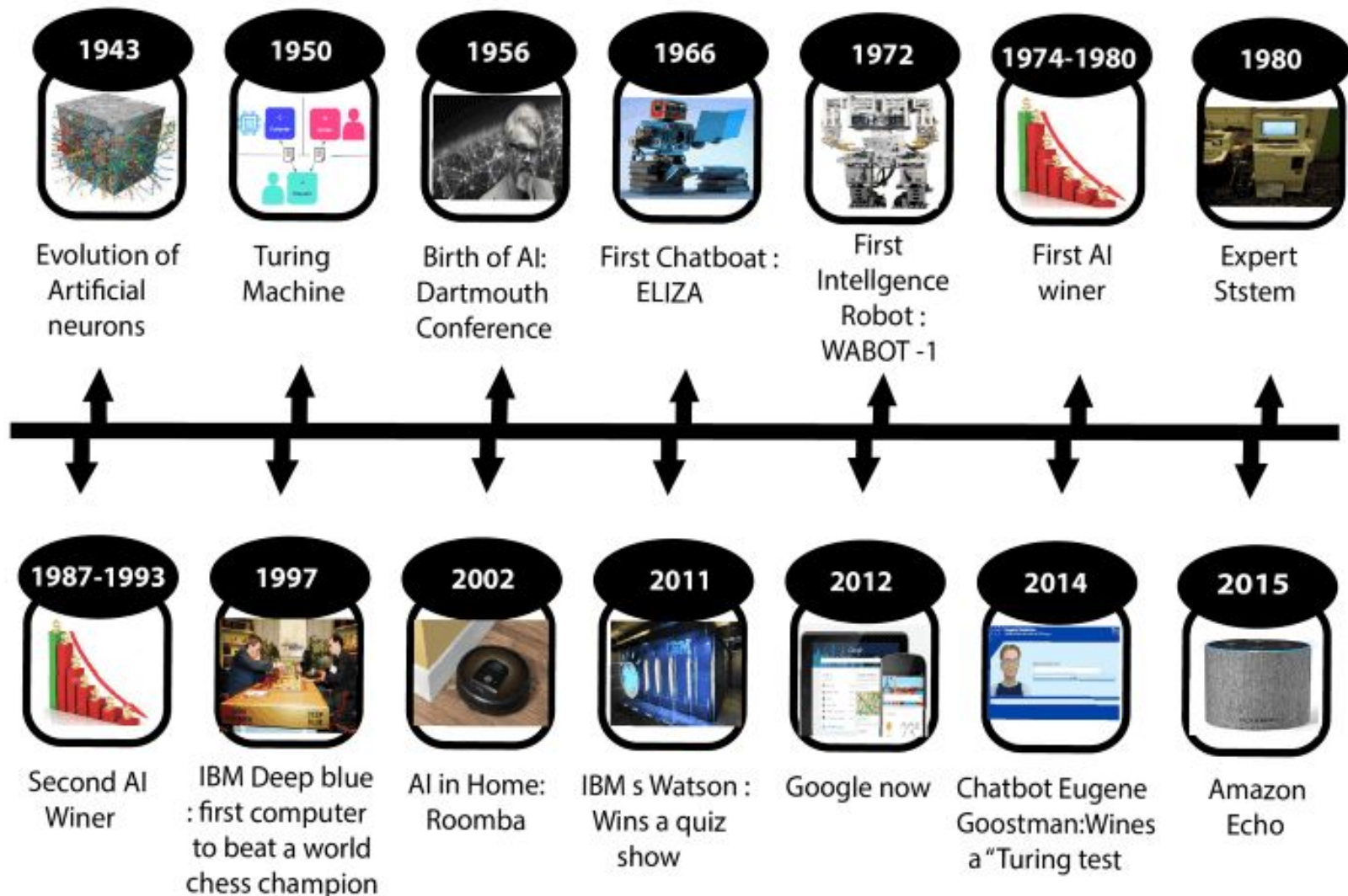
Related research fields

- Search and optimization

- Knowledge representation

- Reasoning and automatic proving

- Learning and understanding

- Pattern classification / recognition

- Planning

- Problem solving

Artificial vs. Human Intelligence

- Today's computers can do many well-defined tasks (for example, arithmetic operations), much faster and more accurate than human beings.

- However, the computers' interaction with their environment is not very sophisticated yet.

- How can we test whether a computer has reached the general intelligence level of a human being?

- **Turing Test:** Can a computer convince a human interrogator that it is a human?

- But before thinking of such advanced kinds of machines, we will start developing our own extremely simple "intelligent" machines.

The main topics in AI

Artificial intelligence can be considered under a number of headings:

- Search (includes Game Playing).
- Representing Knowledge and Reasoning with it.
- Planning.
- Learning.
- Natural language processing.
- Expert Systems.
- Interacting with the Environment
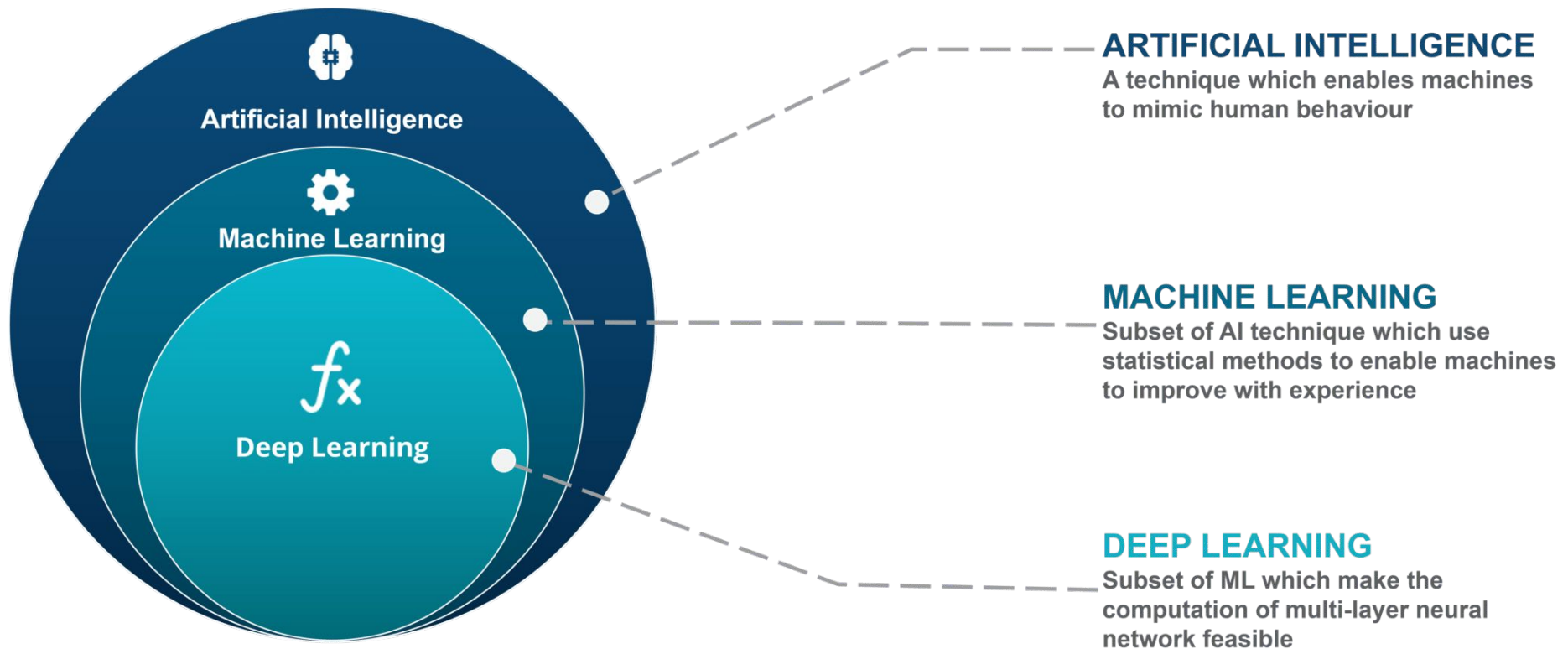   (e.g. Vision, Speech recognition, Robotics)

Some Advantages of Artificial Intelligence

- more powerful and more useful computers
- new and improved interfaces
- solving new problems
- better handling of information
- relieves information overload
- conversion of information into knowledge

Constraints

– increased costs

– difficulty with software development - slow and expensive

– few experienced programmers

– few practical products have reached the market as yet.

Artificial Intelligence, Machine Learning & Deep Learning

ARTIFICIAL INTELLIGENCE
A technique which enables machines to mimic human behaviour

MACHINE LEARNING
Subset of AI technique which use statistical methods to enable machines to improve with experience

DEEP LEARNING
Subset of ML which make the computation of multi-layer neural network feasible

10 most impressive Research Papers around Artificial Intelligence
https://analyticsindiamag.com/10-impressive-research-papers-around-artificial-intelligence/

Intelligent Agents
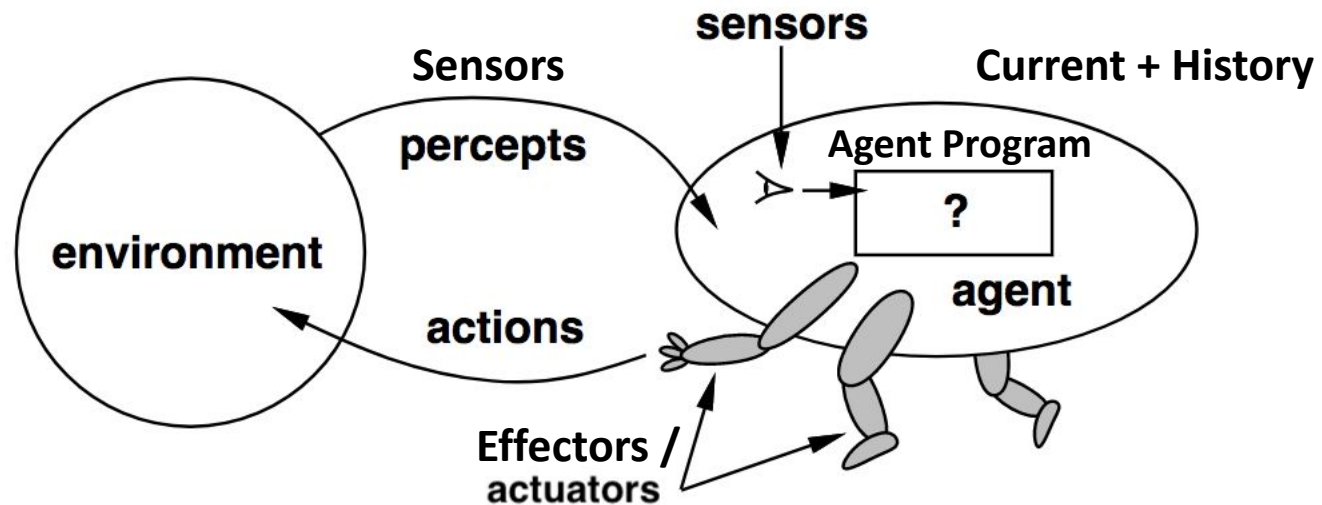
Goals of Agent

High Performance

Optimized Result

Rational (right) Action

Design Issues

Performance
Environment
Actions
Sensors

What is an Intelligent Agent (IA)?

- This agent has some level of autonomy that allows it to perform specific, predictable, and repetitive tasks for users or applications.

- It's also termed as 'intelligent' because of its ability to learn during the process of performing tasks.

- The two main functions of intelligent agents include perception and action. Perception is done through sensors while actions are initiated through actuators.

- Intelligent agents consist of sub-agents that form a hierarchical structure. Lower-level tasks are performed by these sub-agents.

- The higher-level agents and lower-level agents form a complete system that can solve difficult problems through intelligent behaviors or responses.

Characteristics of intelligent agents

- They have some level of autonomy that allows them to perform certain tasks on their own.
- They have a learning ability that enables them to learn even as tasks are carried out.
- They can interact with other entities such as agents, humans, and systems.
- New rules can be accommodated by intelligent agents incrementally.
- They exhibit goal-oriented habits.
- They are knowledge-based. They use knowledge regarding communications, processes, and entities.

The structure of intelligent agents

The IA structure consists of three main parts: architecture, agent function, and agent program.

- **Architecture:** This refers to machinery or devices that consists of actuators and sensors. The intelligent agent executes on this machinery. Examples include a personal computer, a car, or a camera.

- **Agent function:** This is a function in which actions are mapped from a certain percept sequence. Percept sequence refers to a history of what the intelligent agent has perceived.

- **Agent program:** This is an implementation or execution of the agent function. The agent function is produced through the agent program's execution on the physical architecture.

# Applications of intelligent agents

- Information search, retrieval, and navigation

- Repetitive office activities

- Medical diagnosis

- Vacuum cleaning

- Autonomous driving

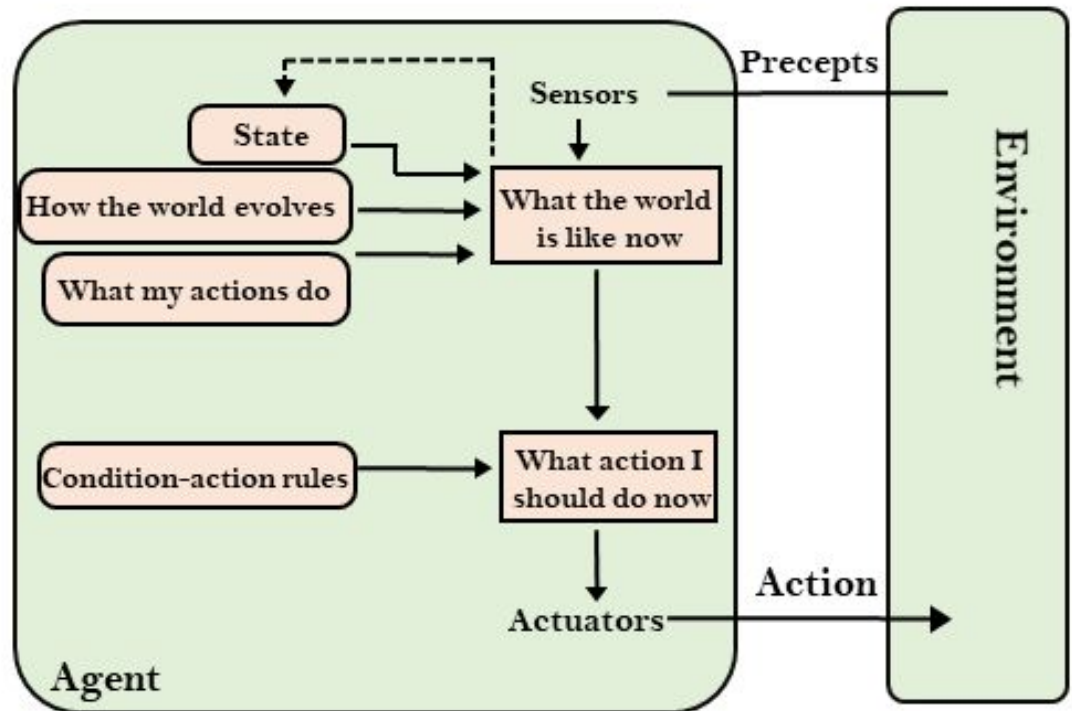# Types of Intelligent Agents

www.educba.com
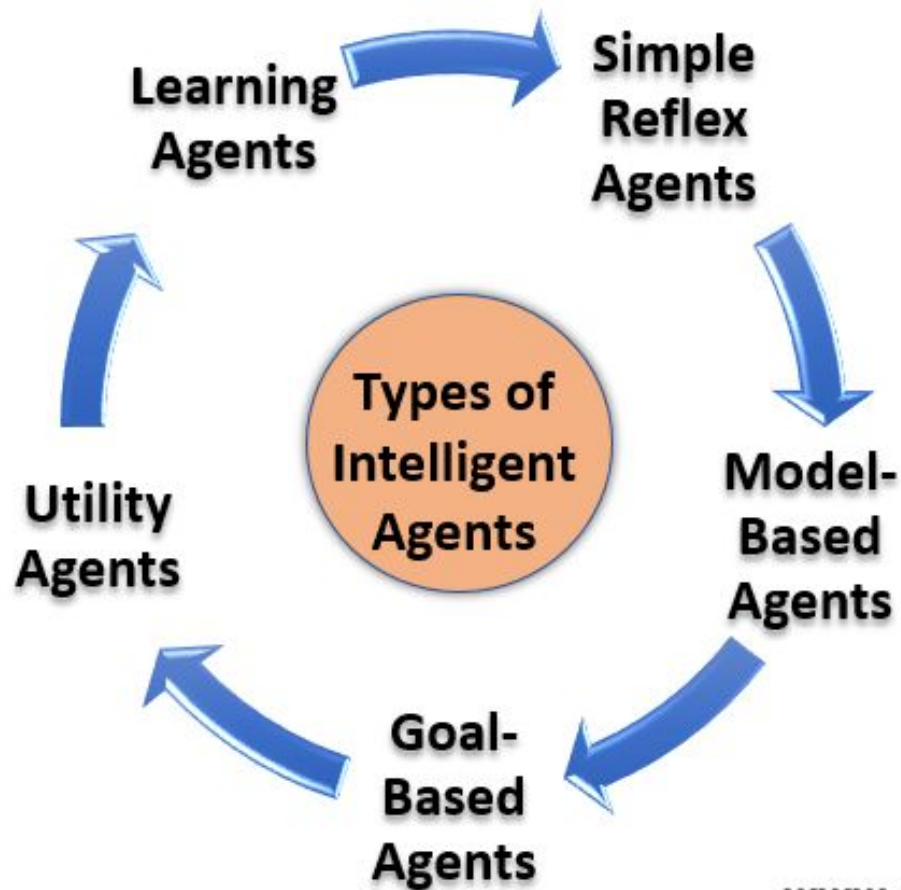
Simple Reflex Agent

- Act only on bases of current perception
- Ignore the rest of percept history
- Based on If-Else rules
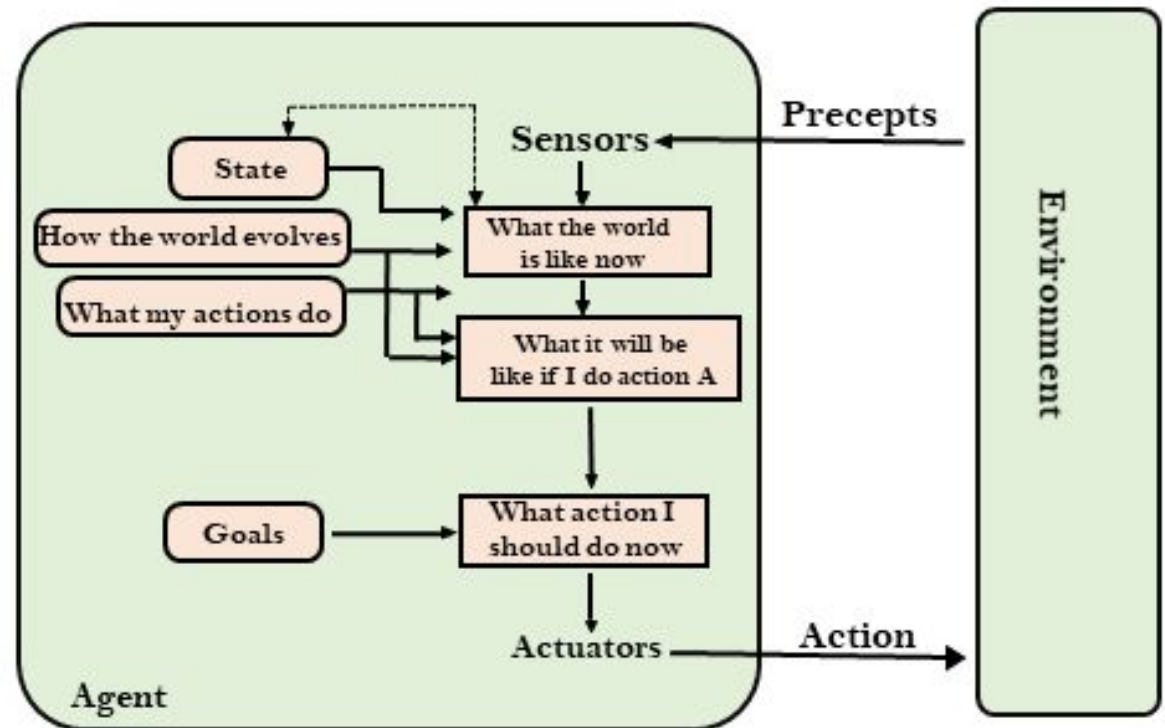- Environment should be fully observable (e.g. tic-tac-toe)
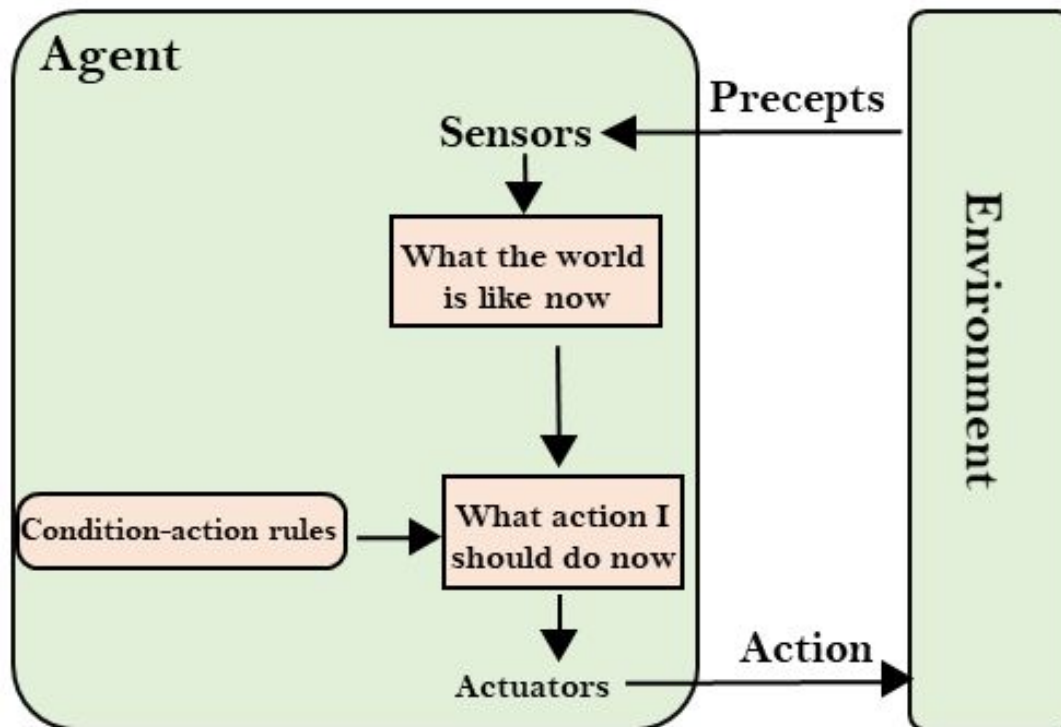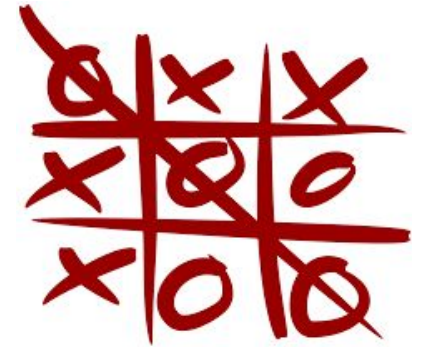
Model based agent

- e.g. Self driving Car
- Partially observable environment
- Store percept history

Goal based agent

- Expansion of model based agent
- Desirable situation (goal)
- Searching and planning

Utility agent

- These agents are similar to the goal-based agent but provide an extra component of utility measurement which makes them different by providing a measure of success at a given state.

- 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, and an agent has to choose in order to perform the best action.

- The utility function maps each state to a real number to check how efficiently each action achieves the goals.
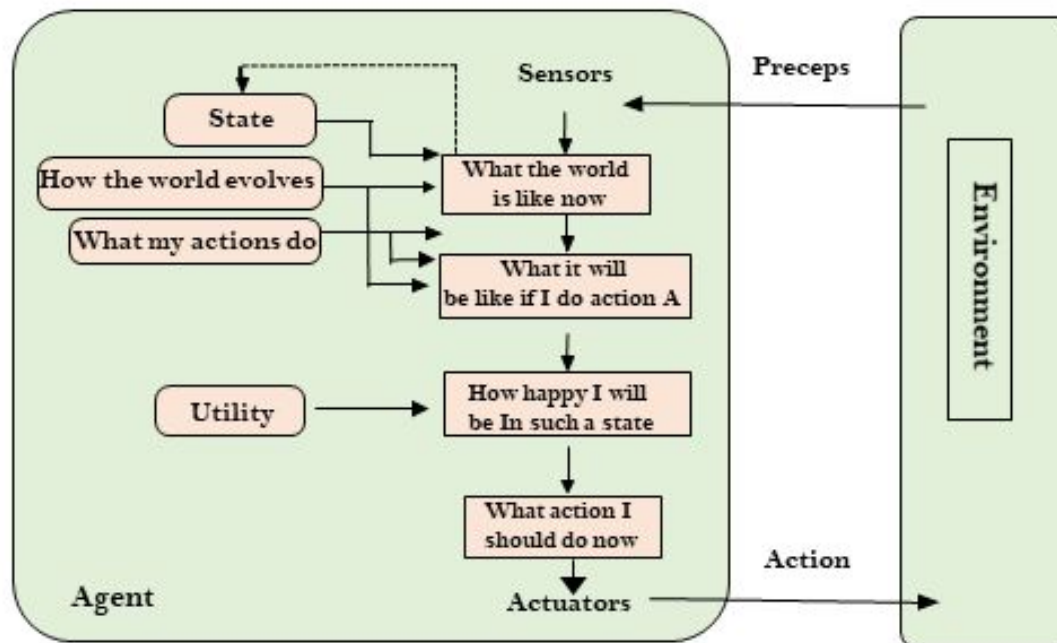
Learning Agents

- A learning agent in AI is the type of agent which can learn from its past experiences, or it has learning capabilities.

- It starts to act with basic knowledge and then able to act and adapt automatically through learning.

- A learning agent has mainly four conceptual components, which are:
  - **Learning element:** It is responsible for making improvements by learning from environment
  - **Critic:** Learning element takes feedback from critic which describes that how well the agent is doing with respect to a fixed performance standard.
  - **Performance element:** It is responsible for selecting external action
  - **Problem generator:** This component is responsible for suggesting actions that will lead to new and informative experiences.

- Hence, learning agents are able to learn, analyze performance, and look for new ways to improve the performance.
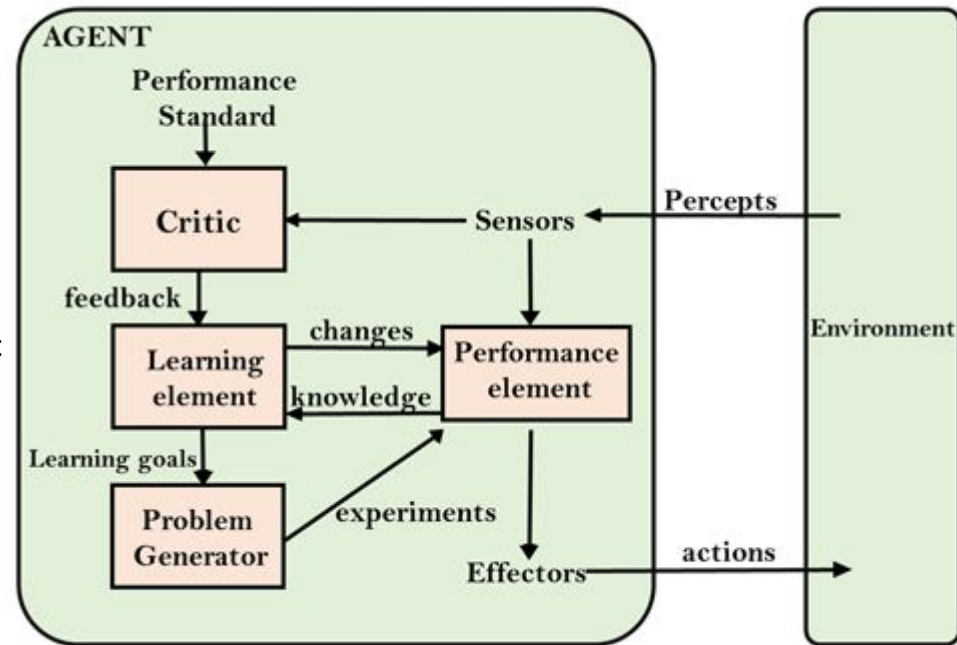
Research Paper (Group Activity)

- **Presentation of a research paper (10 marks)**
  - Make group of 2-3 students
  - Identify a <u>reputed</u> journal/conference research paper based on some topic relevant to the course
  - Get the topic approval
  - Read and understand the paper

- **Assessment:** will be based on how well students are able to understand and explain the algorithm and findings used to solve the problem using AI.