

# ARTIFICIAL INTELLIGENCE (III/II)

Course Code: CT-653  
(Module#1)

Dhawa Sang Dong  
(Lecturer)

KATHMANDU ENGINEERING COLLEGE  
Kalimati, Kathmandu

January 2023



# CHAPTER#1

## INTRODUCTION TO ARTIFICIAL INTELLIGENCE

### ✓ Class Outline

- ① Introduction to Artificial Intelligence
- ② Brief History of Artificial Intelligence
- ③ Importance and Applications of Artificial Intelligence
- ④ Knowledge and Learning
- ⑤ Intelligent Agent

# Course Evaluation

## Theory (100)

- I Internal weight (20/100)
  - Assignments (in total 6/7) for each module [ **10** ]
  - Class Attendance, Activities and 3 - ADT [ **4 + 6 = 10** ]
    - ✚ 3 - ADT [ **1 + 2 + 3 = 6** ]
- II External weight (80/100)
  - End Semester Exam by IOE, TU

## Practical (25) – Internal only

- Lab Attendance [ **5** ] – 1 marks per Lab.
- Lab Report and Minor ML Project (Python) [ **10 + 10 = 20** ]

## References

- Artificial Intelligence A modern approach – Stuart J. Russell and Peter Norvig
- Introduction to Artificial Intelligence – Prof.Dr.Wolfgang Ertel

# Introduction

## # What is Intelligence?

- ✓ Behave as intelligently as human (one school of thought – accept humans are intelligent).
- ✓ behave in best manner or most rational behavior (other school of thought – however, as human would not behave intelligently all the time).

## # behavior

- ✓ thinking behavior – reasoning properly to come of with best solution to the problem.
- ✓ acting behavior – acting in best possible manner for the best solution.

# Introduction

## # Intelligence:

Roberto Colom, 2010 – *Human Intelligence and Brain Networks:*

---

Intelligence can be defined as a *general mental ability* for reasoning, problem solving, and learning. Because of its general nature, intelligence integrates *cognitive functions* such as perception, attention, memory, language, or planning.

On the basis of this definition, intelligence can be reliably measured by standardized tests with obtained scores predicting several broad social outcomes such as educational achievement, job performance, health, and longevity.

## # Artificial Intelligence(AI) [cognition = knowledge]:

- ✓ AI is defined as the science of making computers do things that requires intelligence when the same things are done by human.
- ✓ Machines try to mimic human intelligence/Machines mimic human cognitive functions such as *learning* and *problems solving*.

# Introduction...

## # Artificial Intelligence:...

In a broad sense, AI can be referred as the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions.

- AI refers to the simulation or approximation of human intelligence in machines.
- The goals of artificial intelligence include computer-enhanced learning, reasoning, and perception.
- Weak AI tends to be simple and single-task oriented, while strong AI carries on tasks that are more complex and human-like.
- AI is being used today across different industries from finance to healthcare.

# Introduction...

## Strong Artificial Intelligence

Strong artificial intelligence (AI), also known as *artificial general intelligence (AGI)* or general AI, is a theoretical form of AI used to describe a certain mindset of AI development.

If researchers are able to develop Strong AI, the machine would require an intelligence equivalent to humans; it would have a self-aware consciousness that has the ability to solve problems, learn, and plan for the future.

From the definition, Strong AI is expectation; Strong AI will be achieved when machines have the cognitive functionalities/abilities that humans have without any human intervention.

# Introduction...

## Weak Artificial Intelligence

Weak AI, also known as *Narrow AI*, focuses on performing a specific task, such as answering questions based on user input or playing chess. It can perform one type of task, but not both, whereas Strong AI can perform a variety of functions, eventually teaching itself to solve for new problems.

Weak AI relies on human interference to define the parameters of its learning algorithms and to provide the relevant training data to ensure accuracy.

All the AI systems in existence today are Weak AI; Self-driving cars and virtual assistants, like Siri, are examples of Weak AI.



# Introduction...

John McCarthy – one of the AI Pioneers, in 1955:

“Artificial Intelligence is the science and engineering of making machine intelligent.”

Roughly it can be restated as: “The goal of AI is to develop machines that behaves as though they were intelligent.”

Definition of AI found in [Encyclopedia Britannica](#):

“AI is the ability of digital computers or computer controlled robot to solve problems that are commonly associated with the higher intellectual processing capabilities of human.”

Elaine Rich in 1985 - *Artificial Intelligence and Humanities*:

“Artificial Intelligence is the study of how to make computers do things at which, at the moment, people are better.”

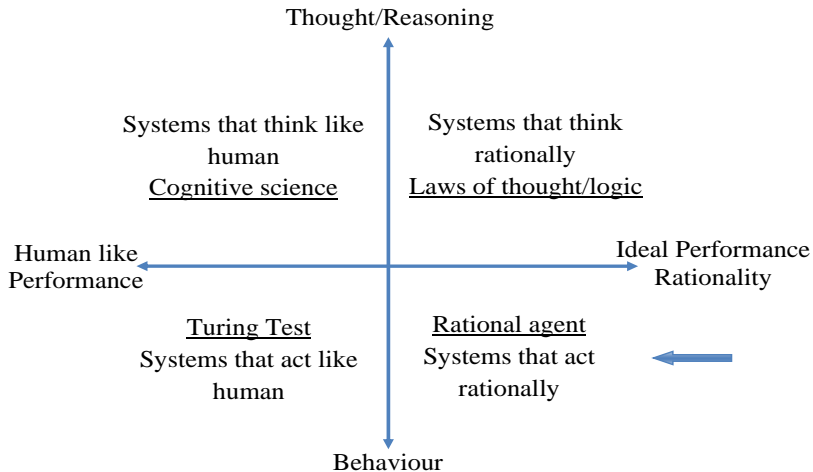
# Introduction...

Unsurprisingly, Some of the daily activities with AI tie-up:

- ✓ When using Google search engine [RankBrain-2015, BERT-2019, multitask unified model (MUM)-2021] that recommends words or combination of words.
- ✓ While using Netflix or Youtube, recommendation systems (an AI application) recommend movies or videos of our taste.
- ✓ Siri, Apple; Alexa, Amazon; and Google Assistant/Ok Google, Google are another AI-powered virtual assistants to process voice inquiries, which uses natural language processing.
- ✓ Getting notifications in Facebook, Twitter, and Instagram for the timeline post by a user for which we mostly view or comment.

# Introduction...

## # Approaches to AI



# Introduction...

## **Systems that think humanly**

“The exciting new effort to make computer think... machines with minds, in the full and literal sense”  
- Haugeland, 1985.

“Automation of Activities that we associate with human thinking, problem solving, learning...” – Bellman, 1978.

## **System that acting humanly**

“The art of creating machines that perform functions that require intelligence when performed by people.” – Kurzweil, 1990

“The study of how to make computer do things at which at the moment people are better.” – Rich & Night, 1991.

## **Systems that think rationally**

“The study of mental faculties through the use of computational models” – Charniak and McDermott, 1985. (~~Reason, Memory, Imagination, Perception~~)

“The study of computations that make it possible to perceive, reason, and act” – Wiston, 1992.

## **Systems that acting rationally**

“Computational intelligence is the study of design of intelligent agent” – Poole et. al., 1998.

“AI... is concerned with intelligent behavior in artifact” – Nilsson, 1998

# Artificial Intelligence Approaches

## Thinking Like Human - cognitive modeling approach

- It needs understanding the phenomena of human thinking activities such as decision making, problem solving and learning etc.
- the phenomena is to be implemented to the AI system; therefore, needs overlapping of human brain and AI computing system.



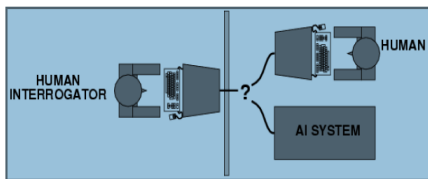
**Fig. 1** Human brain vs Computing System

👉 Figure displayed shows non-overlapping but approaching human brain and computing system.

# Artificial Intelligence Approaches

## Acting Like Human - Turing Test approach

- If the reply to human interrogator makes the interrogator confused whether reply from human or AI system, the AI system action is said to be equivalent to human action.
- for this AI System needs almost all knowledge as by human.



**Fig. 2** Turing Test Approach

# Turing Test approach...

## Factors required to pass the Turing Test:

- ✓ **Natural Language Processing(NLP):** it enables AI system communicate easily and successfully.
- ✓ **Knowledge Representation:** to store information in the form easy to reason.
- ✓ **Automated Reasoning:** AI system should use the stored information to answer questions and to make inference.
- ✓ **Machine Learning:** AI should adapt to new environment or circumstances and detect extrapolate patterns.

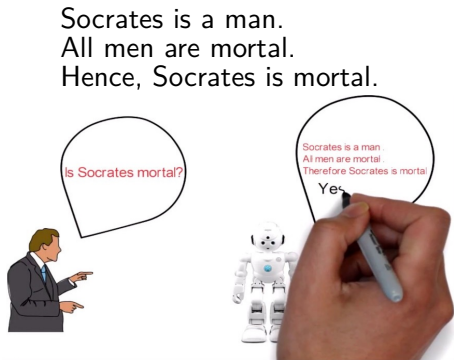
# Artificial Intelligence Approaches

## Thinking Rationally - The Laws of Thought approach

How can machine think Rationally?

If a machine is able to develop right logic, then machine can be able to think rationally (~~does right thing for what it knows~~).

- Logicians in 19th century developed different logics that can in principle solve any problem described in logical notations.
- Hard to model informal knowledge, e.g., probability, into standard logic.
- Solve a problem in principle vs. in practice.



**Fig. 3** Laws of Thought Approach



# Artificial Intelligence Approaches

## Acting Rationally - Rational Agent approach

- An agent (from Latin word agere, to do) is something (e.g., program, robot and even human) that acts.
- A rational agent is one that acts to achieve the best outcome.
- Our course concentrate on this category of AI, which includes studying general principles of rational agents and components for constructing them.
  - \* It builds on mathematical rationality, not human thinking or acting.
  - \* It extends the “laws of thinking” because reasoning logically is part of being a rational agent.  
E.g., retreating from hot stove is a quick reflex action.

# Brief History of Artificial Intelligence

VOL. LIX. No. 236.]

[October, 1950

## MIND A QUARTERLY REVIEW OF PSYCHOLOGY AND PHILOSOPHY

### I.—COMPUTING MACHINERY AND INTELLIGENCE

By A. M. TURING

#### 1. *The Imitation Game.*

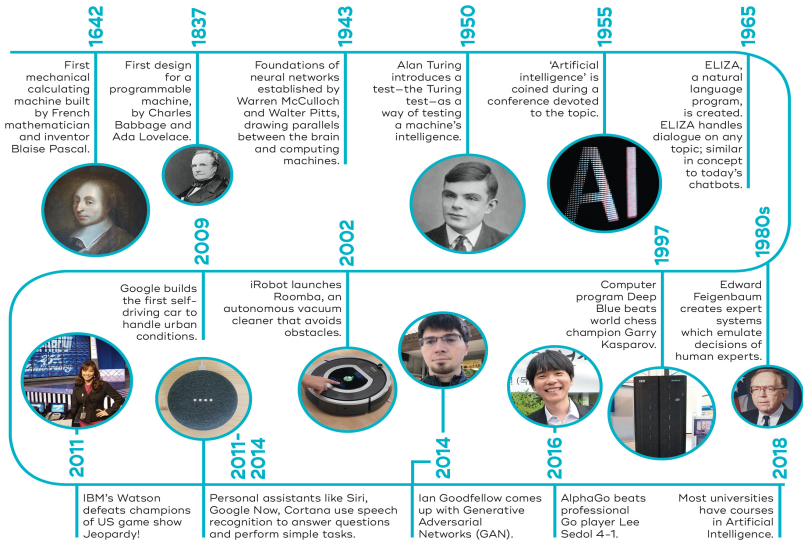
I PROPOSE to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words '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 a game which we call the 'imitation game'. It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. He knows them by labels X and Y, and at the end of the game he says either 'X is A and Y is B' or 'X is B and Y is A'. The interrogator is allowed to put questions to A and B thus:

C: Will X please tell me the length of his or her hair?  
Now suppose X is actually A, then A must answer. It is A's

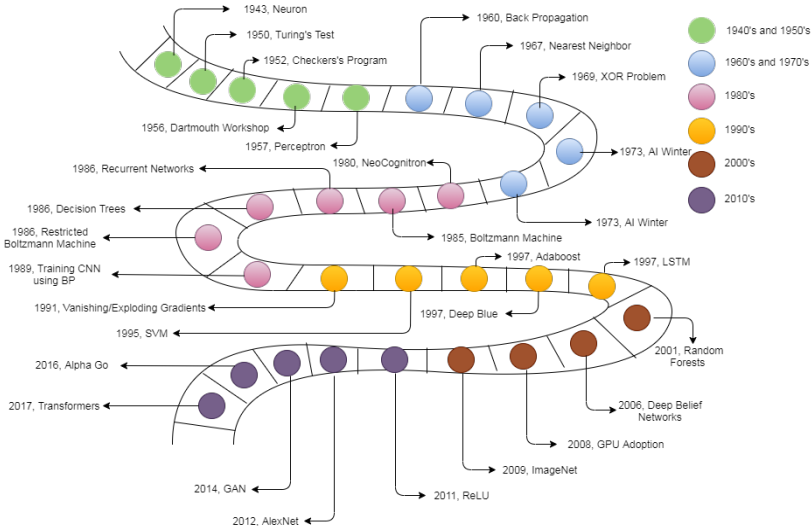


# Brief History of Artificial Intelligence...



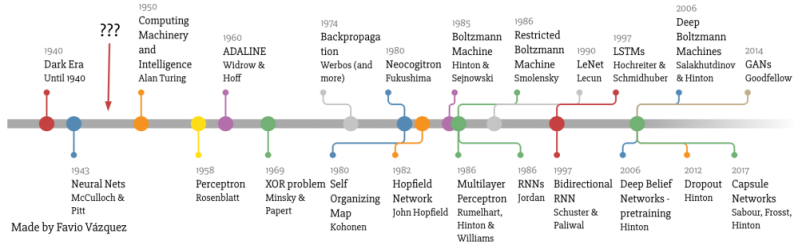
**Fig. 4** How AI evolved to today's industrial applications  
(Ref. Queensland Brain Institute - UoQ)

## Brief History of Artificial Intelligence



**Fig. 5** How AI evolved to today's industrial applications

# Brief History of Artificial Intelligence



**Fig. 6** How Neural Network evolved to today's industrial applications

# Artificial Intelligence techniques

- 1 Symbolic AI (👉 which has roots in logic)
- 2 Connectionist AI (👉 which has roots in Neuroscience)

## Symbolic AI

- more commonly known as rule-based AI, or good old-fashioned AI (GOFAI) or classic AI.
- Earlier AI development and research was based on Symbolic AI inserting human behavior and knowledge in the form of computer codes and processed by expert system.
- Symbolic AI system has a combination of characters signifying real-world concepts or entities through a series of symbols.
- These symbols can easily be arranged through networks and lists or arranged hierarchically telling AI algorithms how each symbol is related to each other in totality.

# Artificial Intelligence techniques

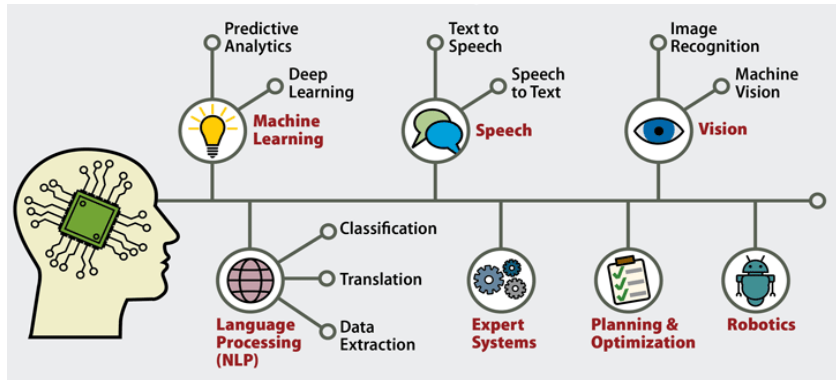
## Connectionist AI/Non-Symbolic AI

- it is also known as neural AI and more popular these days.
- Neural AI is based on how a human mind functions and its neural interconnections; that is neural network.
- Neural Network is made up of hundreds of single processing units called neurons.
- They are a layered format forming connections with weights (parameters) which are adjustable.

# Importance and Applications of Artificial Intelligence

## Scope of Artificial Intelligence

Artificial Intelligence scope can be studied as:



**Fig. 7** Scope of Artificial Intelligence



# Importance and Applications of Artificial Intelligence...

## One perspective of classifying AI applications:

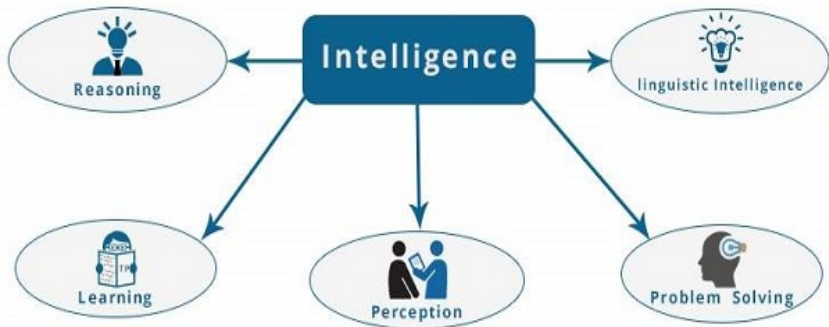
- 1 Learning
- 2 Reasoning
- 3 Problem solving
- 4 Language understanding/Linguistic Intelligence
- 5 Perception

## Another perspective of classifying AI applications:

- 1 Mundane Task (👉 perception-vision, speech, NLP)
- 2 Formal Task (👉 games, maths, geometry, logic, integral)
- 3 Expert Task (👉 financial analysis, medical diagnosis)

# Applications of of Artificial Intelligence...

## Components of Artificial Intelligence

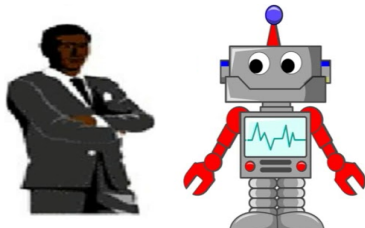


**Fig. 8** Components of Intelligence

# Applications of Artificial Intelligence...

## Learning

- it means to acquire new knowledge or things.
- it provides system the learning ability to automatically learn from the data (experience) and improve performance without being explicitly programmed.



**Fig. 9** Learning(Human & Machine)

- ✓ Learning that involves generalization performs better in situations not previously encountered.

# Applications of Artificial Intelligence...

## Reasoning

- Reasoning means to infer facts from given facts.
- Reasoning is a form of inference and logical techniques that is expressed through words (qualitative) and other symbols (quantitative reasoning).



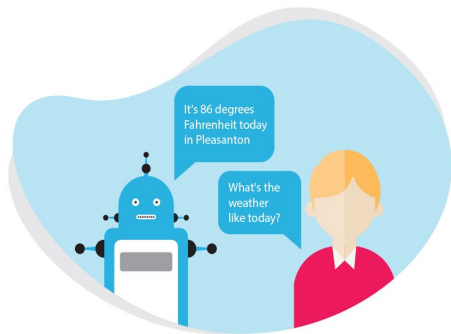
**Fig. 10** Reasoning in Intelligence

- ✓ Reasoning in artificial intelligence helps machines think rationally and perform functions like humans.
- ✓ Probabilistic Reasoning in Artificial Intelligence allows machines to deal with and represent uncertain knowledge and information.

# Applications of Artificial Intelligence...

## Linguistic Intelligence

- Language understanding means to understand natural Language meaning.
- It is one's ability to use, comprehend, speak, and write the verbal and written language.
- in AI, it means understand user speech, written materials and respond accordingly.



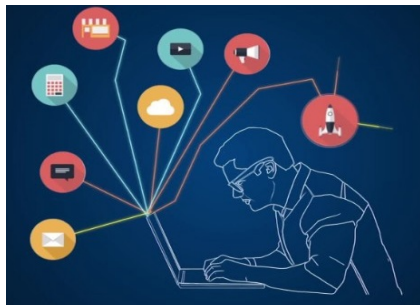
**Fig. 11** Language Understanding

- ✓ In broad sense, **Language Understanding** in artificial intelligence helps machines for ① machine translation, ② sentiment analysis, ③ information extraction, ④ question answering.

# Applications of Artificial Intelligence...

## Problem Solving

- Problem-solving means to move towards the goal.
- Psychologically, it refers to a state where we wish to reach to a definite goal from a present state or condition.”
- in AI, problem-solving encompasses a number of techniques such as search algorithms, heuristics to solve a problem.



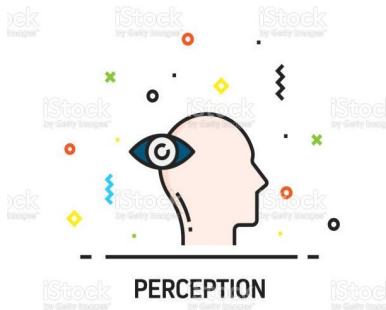
**Fig. 12** Problem Solving

- ✓ It is the process in which one perceives and tries to arrive at a desired solution from a present situation by taking some path.

# Applications of Artificial Intelligence...

## Perception

- It is the process of acquiring, interpreting, selecting, and organizing sensory information.
- Perception presumes sensing.
- In humans, perception is aided by sensory organs.

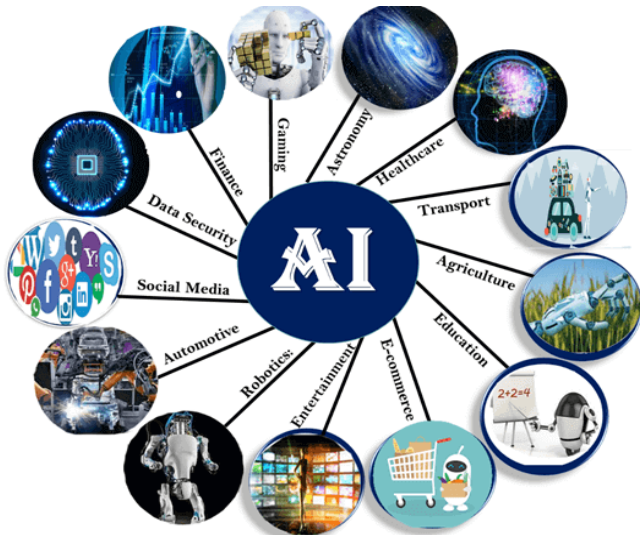


**Fig. 13** Perception in Intelligence

- ✓ In the domain of AI, perception mechanism puts the data acquired by the sensors together in a meaningful manner.

# Applications of Artificial Intelligence...

## Applications of Artificial Intelligence



**Fig. 14** Applications of Artificial Intelligence



# Applications of Artificial Intelligence...

## AI in Astronomy

- Artificial Intelligence can be very useful to solve complex universe (astronomical) problems.
- AI technology can be helpful for understanding the universe such as how it works, origin, etc.

## AI in Healthcare

- For the last decade, AI is becoming more advantageous for the healthcare industry and predicted to have significant impact to the industry. 📌 diabetic retinopathy diagnosis, cancer classification, covid diagnosis.
- Healthcare Industries are applying AI to make a better and faster diagnosis than humans.
- AI can help doctors with diagnoses and can inform when patients are worsening so that medical help can reach to the patient before hospitalization.

# Applications of Artificial Intelligence...

## AI in Gaming

- AI can be used for gaming purpose.
- The AI machines can play strategic games like chess, where the machine needs to think of a large number of possible places.

## AI in Finance

- AI and finance industries are the best matches for each other.
- The finance industry is implementing automation, chatbot, adaptive intelligence, algorithm trading, and machine learning into financial processes.

# Applications of Artificial Intelligence...

## AI in Data Security

- The security of data is crucial for every company and cyber-attacks are growing very rapidly in the digital domain.
- AI can be used to make your data more safe and secure.
- Some examples such as AEG bot, AI2 Platform, are used to determine software bug and cyber-attacks in a better way.

## AI in Social Media

- Social Media sites such as Facebook, Twitter, and Snapchat contain billions of user profiles, which need to be stored and managed in a very efficient way.
- AI can organize and manage massive amounts of data.
- AI can analyze lots of data to identify the latest trends, hashtag, and requirement of different users.

# Applications of Artificial Intelligence...

## AI in Travel & Transport

- AI is becoming highly demanding for travel industries.
- AI is capable of doing various travel related works such as from making travel arrangement to suggest the hotels, flights, and best routes to the customers.
- Travel industries are using AI-powered chatbots which can make human-like interaction with customers for better and fast response.

## AI in Automotive Industry

- Some Automotive industries are using AI to provide virtual assistant to their user for better performance.
- Tesla has introduced TeslaBot, an intelligent virtual assistant.
- Various Industries are currently working for developing self-driven cars making journey more safe and secure.

# Applications of Artificial Intelligence...

## AI in Robotics

- Artificial Intelligence has a remarkable role in Robotics. Usually, general robots are programmed such that they can perform some repetitive task, but with the help of AI, we can create intelligent robots which can perform tasks with their own experiences without pre-programmed.
- Humanoid Robots are best examples for AI in robotics, recently the intelligent Humanoid robot, Erica and Sophia, has been developed which can talk and behave like humans.

## AI in Entertainment

- We are currently using some AI based applications in our daily life with some entertainment services: Netflix or Amazon.
- With the help of ML/AI algorithms, these services show the recommendations for programs/shows or videos.

# Applications of Artificial Intelligence...

## AI in Agriculture

- Agriculture is an area which requires various resources, labor, money, and time for best result.
- Now a day's agriculture is becoming digital, and AI is emerging in this field.
- Agriculture is applying AI as agriculture robotics, solid and crop monitoring, predictive analysis.
- Therefore, AI in agriculture can be very helpful for farmers.

## AI in E-commerce

- AI is providing a competitive edge to the e-commerce industry, and it is becoming more demanding in the e-commerce business.
- AI is helping shoppers to discover associated products with recommended size, color, or even brand.

# Applications of Artificial Intelligence...

## AI in education

- AI can automate grading so that the tutor can have more time to teach.
- AI chatbot can communicate with students as a teaching assistant.
- AI in the future can be work as a personal virtual tutor for students, which will be accessible easily at any time and from any place.

# Knowledge and Learning

## # Data:

- are streams of raw facts obtained through acquisition system.
- data represents process or phenomena (*stochastic process*).
- can be arranged into the form *understandable* and *usable*.

## # Information:

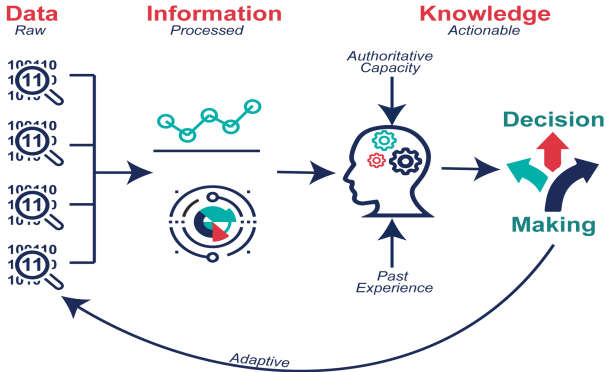
- is processed and organized data .
- is structured to give context and meaning.
- in other words, data shaped into form meaningful (*understandable, interpretable*) and usable to human.

## # Knowledge(Psychological result of perception; learning and reasoning):

- is what we know, and is unique to individual.
- is accumulation of past experience and insights that could reshape the *interpretation* and assign meaning to information.



# Knowledge and Learning...



**Fig. 15** Transformation of data to knowledge through information

# Knowledge and Learning...

## # Cognitive Process:

Before defining **Learning**, let's talk about “**cognitive process**.”

👉 Physically, cognitive processes are series of chemical and electrical signals stimulated in brain that allows to comprehend your environment and gain knowledge.

Neurons release chemicals that create electrical signals in nearby neurons, creating mass of signals that are then translated into conscious and unconscious thoughts.

Denise Krch, 2011: “Cognitive processing is (a general term to describe) a series of cognitive operations carried out in the creation and manipulation of mental representations of information.”

Cognitive Process includes: 👉 attention, perception, reasoning, emotion, learning, synthesizing, manipulation of stored information, memory storage, retrieval.

# Knowledge and Learning...

## # Learning:

- it is cognitive process of acquiring skill or knowledge.
- it makes useful change in our mind with mental representation of information(mental state).
- it constructs or modifies the representation of what is being experienced.

[Herbert Simon, 1983](#): Learning is the phenomenon of knowledge acquisition in the absence of explicit programming.

Learning involves three factors: ***Changes, Generalization, and Improvement.***

# Knowledge and Learning...

## Changes:

*Learning* changes learner. In machine learning, problem is determining the nature of following changes (random process) and represent them in the best form (✓ model the distribution).

## Generalization:

*AI/learning*, in fact, is *Generalization* where performance must improve not only on the same task but on similar task.

## Improvement:

*Learning* leads to the improvements. It must address the possible degradation of performance for some changes. Generally, *Learning* should improve performance.

# Intelligent Agent

## # Agent

An agent is something that can be viewed as perceiving its environment through sensors and acting up on that environment through effectors/actuators.

In electrical and computer term, agents are the combination of *architecture and programs*. The **agent program** is a function that implement the agent mapping true percepts (percept sequence) to action through actuators. The program runs devices with sensors and actuators which is called **architecture**.

Mathematically, the task or behavior of agent is to described by **agent function** which is implemented as **agent-program**.

# Intelligent Agent...

## Human Agent

Eyes, ears and other organs for sensors; hands legs, mouth and another body parts for actuators.

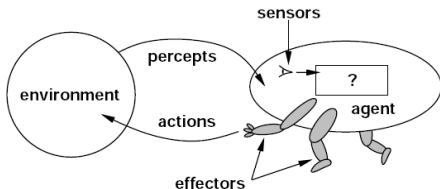
## Robotic Agent

Cameras and infrared for sensor; various motor for the actuators.

## Software Agent

It receives keystrokes, file contents, and network packets as sensory inputs; (acts on the environment by) displaying on the screen, writing files, and sending network packets are action by effectors/actuators.

# Intelligent Agent...



**Fig. 16** Agents interacting with environment

- The term “percept” refers to as the agent’s perceptual input at any given instant – the location and state of the environment.
- An agent’s percept sequence is the complete history of everything the agent has ever perceived.
- The agent function maps from percept histories to actions.

# Intelligent Agent...

## # Intelligent Agent

An agent perceives its environment(**E**) via sensors(**S**) and acts *rationally* upon environment with its actuators/effectors(**A**) to maximize its performance measure(**P**) based on the evidence by percepts sequence and whatever knowledge built-in the agent has (can be called rational agent). 🍷 PEAS Representation.

In terms of computer science, an intelligent agent is a computer software system whose main characteristics are situatedness, autonomy, adaptivity, and sociability.

## Situatedness

The agent receives some form of sensory input from its environment, and it performs some action that changes its environment in some way. Examples of environments: the physical world and the Internet.



# Intelligent Agent...

## Autonomy

The agent can act without direct intervention by humans or other agents; it has control over its own actions and internal state.

## Adaptivity

The agent is capable of

- ✓ (1) reacting flexibly to changes in its environment;
- ✓ (2) taking goal-directed initiative (i.e., is pro-active), when appropriate; and
- ✓ (3) learning from its own experience, its environment, and interactions with others.

## Sociability

The agent is capable of interacting in a peer-to-peer manner with other agents or humans.

# Intelligent Agent...

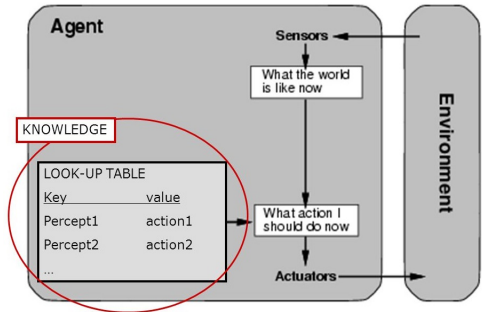
There are five basic types of agents:

- ① Table-driven agents
- ② Simple reflex agents
- ③ Model-based reflex agents
- ④ Goal-based agents
- ⑤ Utility based agents

# Intelligent Agent...

## Table-driven agents:

- it uses a percept sequences/action pairs in memory to find the next action to be performed.
- they are implemented by a lookup table.
- it takes long time to build lookup table.
- not adaptable to the change environment, requires change in lookup table.

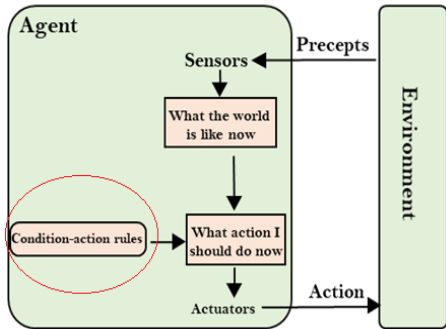


**Fig. 17** Table-driven agent

# Intelligent Agent...

## Simple Reflex agents:

- agents are based on condition-action (if-then) rules and *immediate percept*.
- they are *stateless* devices which do not have a memory of the past state.
- environment should be fully observable.

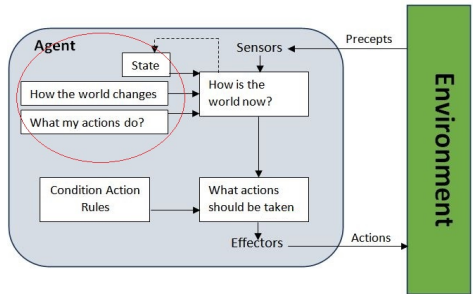


**Fig. 18** Simple-Reflex agent

# Intelligent Agent...

## Model based Reflex agents:

- model based means knowledge based agent.
- agents with memory have its internal state .
- next action will be based on present and past experience or state(percept history).
- it is partially observable.

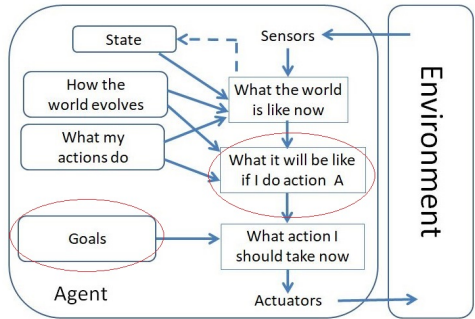


**Fig. 19** Model based Reflex agents

# Intelligent Agent...

## Goal based agents:

- expansion of model based agent (with percept history).
- agents have state information and goal information (supervised).
- goal information describes the desirable situation.
- agents of this kind has to consider future events.
- searching and planning to reach goal state.

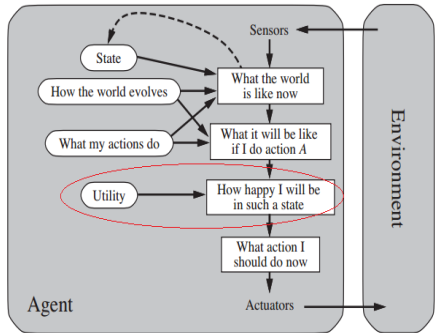


**Fig. 20** Goal based agents

# Intelligent Agent...

## Utility-based agents:

- decisions are based on classic axiomatic utility theory.
- deals with happy and unhappy states.
- utility function measures if the agent is in happy state.
- it is partially observable.



**Fig. 21** Utility based agents

# Module Assignment – As You Go

Module#1 Assignment is available at MS-Team.

**Submission Deadline:** 27th January 2023 (*Before 3:00 PM*)