

## **UNIT-I**

### **2 MARKS**

#### **1. What is Artificial Intelligence?**

It is a branch of computer science by which we can create intelligent machines which can behave like a human, think like humans, and able to make decisions.

#### **2. Why Artificial Intelligence?**

Following are some main reasons to learn about AI:

- With the help of AI, you can create such software or devices which can solve real-world problems very easily and with accuracy such as health issues, marketing, traffic issues, etc.
- With the help of AI, you can create your personal virtual Assistant, such as Cortana, Google Assistant, Siri, etc.
- With the help of AI, you can build such Robots which can work in an environment where survival of humans can be at risk.
- AI opens a path for other new technologies, new devices, and new Opportunities.

#### **3. What is the Goals of Artificial Intelligence?**

The main goals of Artificial Intelligence:

1. Replicate human intelligence
2. Solve Knowledge-intensive tasks
3. An intelligent connection of perception and action
4. Building a machine which can perform tasks that requires human intelligence such as:
  - Proving a theorem
  - Playing chess
  - Plan some surgical operation

- Driving a car in traffic
- 5. Creating some system which can exhibit intelligent behavior, learn new things by itself, demonstrate, explain, and can advise to its user.

#### **4. What Comprises to Artificial Intelligence?**

The Intelligence is an intangible part of our brain which is a combination of Reasoning, learning, problem-solving perception, language understanding, etc.

- Mathematics
- Biology
- Psychology
- Sociology
- Computer Science
- Neurons Study
- Statistics

#### **5. What are the Advantages of Artificial Intelligence?**

- High Accuracy with less errors
- High-Speed
- High reliability
- Useful for risky areas
- Digital Assistant
- Useful as a public utility

#### **6. What are the Disadvantages of Artificial Intelligence?**

- High Cost
- Can't think out of the box
- No feelings and emotions
- Increase dependency on machines
- No Original Creativity

#### **7. What is the Turing Test in Artificial Intelligence?**

The basis of the Turing Test is that the Artificial Intelligence entity should be able to hold a conversation with a human agent. The human agent ideally should not be able to conclude that they are talking to an Artificial Intelligence.

## **8. What are the Types of Artificial Intelligence?**

They are 3 Types of Artificial Intelligence

- Artificial Narrow Intelligence (ANI)
- Artificial General Intelligence (AGI)
- Artificial Super Intelligence (ASI)

## **9. What is the need for Artificial Intelligence?**

- To create expert systems that exhibit intelligent behavior with the capability to learn, demonstrate, explain, and advise its users.
- Helping machines find solutions to complex problems like humans do and applying them as algorithms in a computer-friendly manner.

## **10. What are the Characteristics of AI?**

- Is the problem decomposable or not
- Can the solution steps be ignored
- Is the solution universe predictable
- Is the solution to a problem absolute or relative
- Is the knowledge base consistent or not
- The role of the knowledge
- Is the interaction with computer necessary.

## **11. What is Production system?**

- Production system or production rule system is a computer program typically used to provide some form of artificial intelligence, which consists primarily of a set of rules about behavior but it also includes the mechanism necessary to follow those rules as the system responds to states of the world.

## **12. What are the Components of Production System?**

- Global Database
- Set of Production Rules
- A Control System

### **13. What are the features of Production Systems?**

- Simplicity
- Modularity
- Modifiability
- Knowledge-intensive

### **14. What are the Production System Rules?**

- Deductive Inference Rules
- Abductive Inference Rules

### **15. What are the Classes of a Production System?**

- Monotonic Production System
- Partially Commutative Production System
- Non-monotonic Production System
- Commutative System

### **16. What is the State Space Search?**

State space search is a process used in the field of computer science, including artificial intelligence (AI), in which successive configurations or states of an instance are considered, with the goal of finding a *goal state* with a desired property.

### **17. What is the Application of AI?**

- Google's AI-powered predictions (E.g.: Google Maps)
- Ride-sharing applications (E.g.: Uber, Lyft)
- AI Autopilot in Commercial Flights
- Spam filters on E-mails
- Plagiarism checkers and tools
- Facial Recognition

- Search recommendations
- Voice-to-text features
- Smart personal assistants (E.g.: Siri, Alexa)
- Fraud protection and prevention.

## **18. What are the major branches of AI?**

- Machine learning
- Neural Network
- Robotics
- Expert Systems
- Fuzzy Logic
- Natural Language Processing

## **19. What is Machine learning?**

Machine learning is a subfield of artificial intelligence, which is broadly defined as the capability of a machine to imitate intelligent human behavior. Artificial intelligence systems are used to perform complex tasks in a way that is similar to how humans solve problems.

## **20. What are the main types of machine learning?**

There are four types of machine learning algorithms: supervised, semi-supervised, and unsupervised and reinforcement.

## **21. What is the neural network?**

In simple terms, a neural network is a set of algorithms that are used to find the elemental relationships across the bunches of data via the process that imitates the human brain operating process.

## **22. What are the Expert Systems?**

An expert system refers to a computer system that mimics the decision-making intelligence of a human expert. It conducts this by deriving knowledge from its knowledge base by implementing reasoning and insights rules in terms with the user queries.

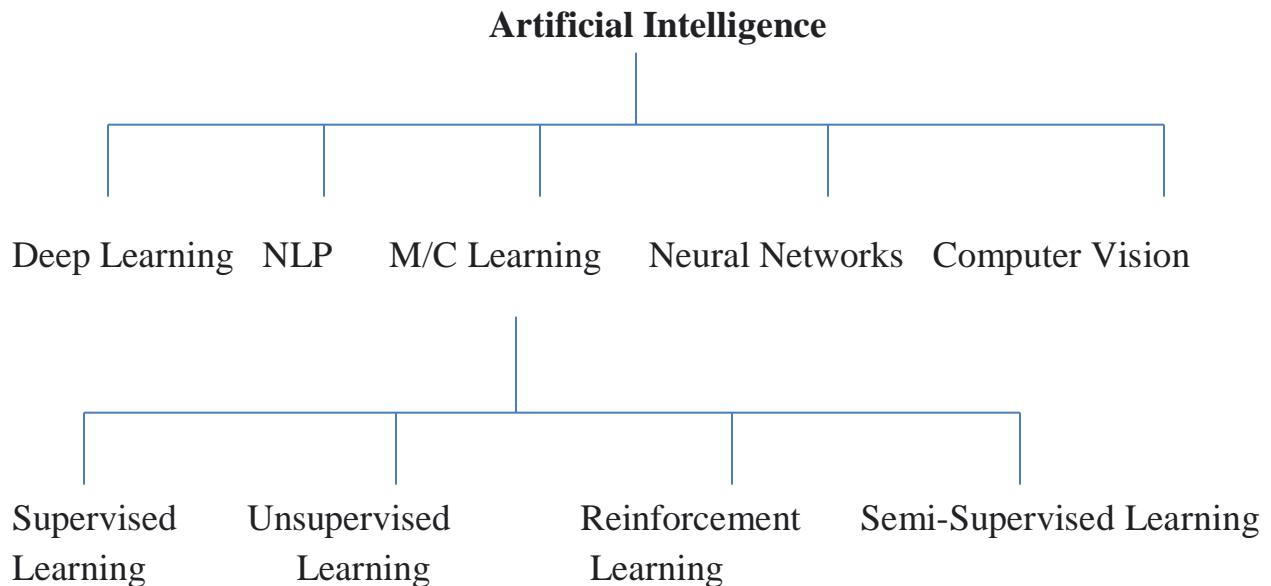
### 23. What is fuzzy logic?

It is simply the generalization of the standard logic where a concept exhibits a degree of truth between 0.0 to 1.0. If the concept is completely true, standard logic is 1.0 and 0.0 for the completely false concept. But in fuzzy logic, there is also an intermediate value too which is partially true and partially false.

### 24. What is Natural Language Processing?

NLP is a method that deals in searching, analyzing, understanding and deriving information from the text form of data. In order to teach computers how to extract meaningful information from the text data, NLP libraries are used by programmers.

### 25. What is the classification of AI?



**5 MARKS:**

#### 1. What is the Introduction of AI?

- An intelligent entity created by humans.
- Capable of performing tasks intelligently without being explicitly instructed.
- Capable of thinking and acting rationally and humanely.

- Artificial Intelligence exists when a machine can have human based skills such as learning, reasoning, and solving problems
- With Artificial Intelligence you do not need to pre-program a machine to do some work, despite that you can create a machine with programmed algorithms which can work with own intelligence, and that is the awesomeness of AI.
- It is believed that AI is not a new technology, and some people says that as per Greek myth, there were Mechanical men in early days which can work and behave like humans.

## **2. What are the Artificial intelligence problems?**

- To understand AI, we can define some problems that we encounter in our daily life.
- Almost all the problem stated in AI commonly uses the term STATE.
- It defines the state of the solution for given problem at that particular step.
- In short, the solution of a problem by a collection of the problem state.
- The problem solving procedure used is to apply an operator to a state to get the next state.
- The process of deriving a new state from the current state by applying the operator till desired state is reached is called State space approach

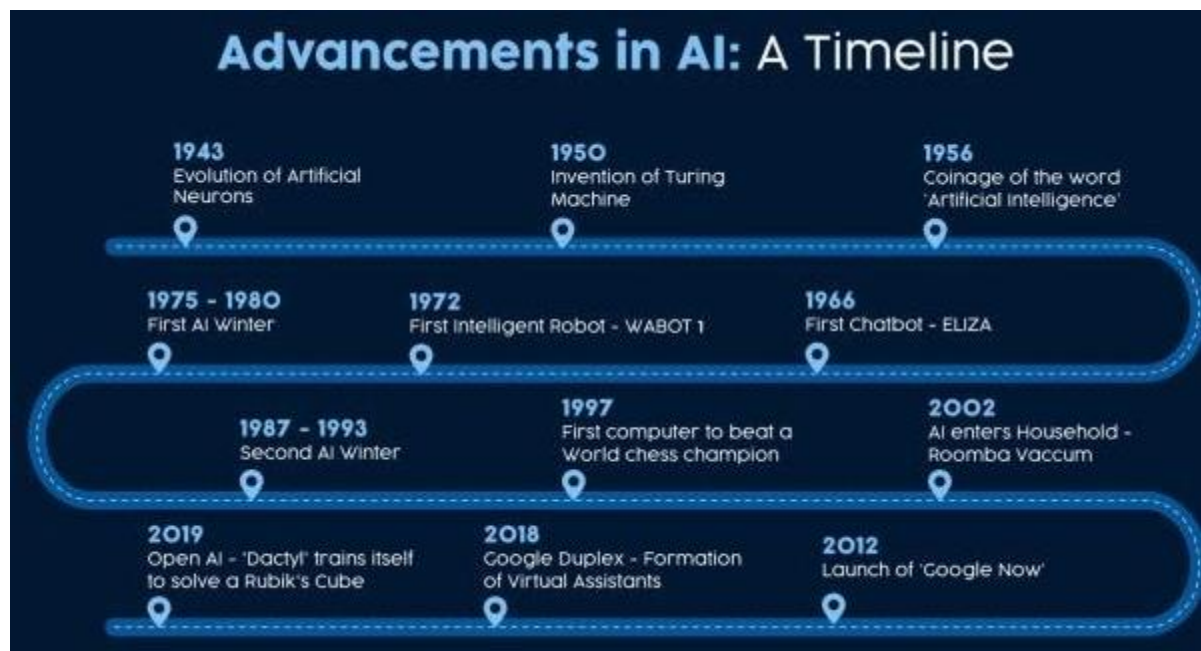
### **Problems and how it is differ from other**

- If a problem need symbolic representation in computer
- If there is combinational explosion in out putting
  - 8 queen problem
  - Travelling sales man problem
- Fuzzy set for un characterize data
- The Knowledge base of an AI problem is Voluminous.
- The data or Knowledge base is Changing fast
- Doing work without tiredness and fatigue.

## Characteristics of AI – How the Problem is analyzed

- Is the problem decomposable or not
- Can the solution steps be ignored
- Is the solution is universe predictable
- Is the solution to a problem is absolute or relative
- Is the knowledge base consistent or not
- The role of the knowledge
- Is the interaction with computer is Necessary.

### 3.What are the evolution and timeliness of AI?



### 4. Defining State & Search Space and explain it.

- A **state** is a representation of problem elements at a given moment.
- A **State space** is the set of all states reachable from the initial state.
- A state space forms a **graph** in which the nodes are states and the arcs between nodes are actions.
- In the state space, a **path** is a sequence of states connected by a sequence of actions.
- The **solution** of a problem is part of the graph formed by the state space.



## **Problem**

- “It is the question which is to be solved. For solving the problem it needs to be precisely defined. The definition means, defining the start state, goal state, other valid states and transitions”.
- A state space representation allows for the formal definition of a problem which makes the movement from initial state to the goal state quite easily.
- So we can say that various problems like planning, learning, theorem proving etc. are all essentially search problems only.

## **For Example:**

- The eight tile puzzle problem formulation
- The eight tile puzzle consist of a 3 by 3 ( $3 \times 3$ ) square frame board which holds 8 movable tiles numbered 1 to 8. One square is empty, allowing the adjacent tiles to be shifted. The objective of the puzzle is to find a sequence of tile movements that leads from a starting configuration to a goal configuration



7	2	4
5		6
8	3	1

Start State

	1	2
3	4	5
6	7	8

Goal State

states? locations of tiles

actions? move blank left, right, up, down

goal test? = goal state (given)

path cost? 1 per move

**The states of 8 tile puzzle**

Let's do a standard formulation of this problem now.

**States:** It specifies the location of each of the 8 tiles and the blank in one of the nine squares.

**Initial state:** Any state can be designated as the initial state.

**Goal:** Many goal configurations are possible one such is shown in the figure

### **Legal moves (or state):**

They generate legal states that result from trying the four actions-

Blank moves left

Blank moves right

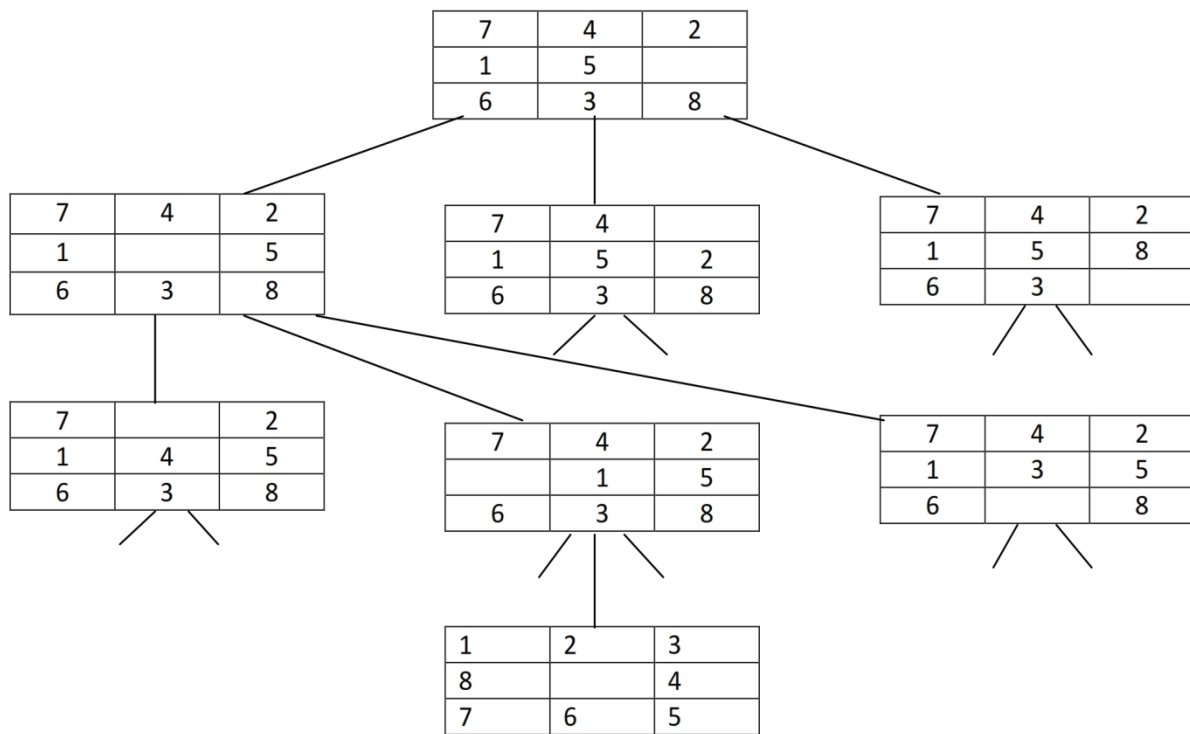
Blank moves up

Blank moves down

- **Path cost:** Each step costs 1, so the path cost is the number of steps in the path

### **5. Explain the gaming tree concept?**

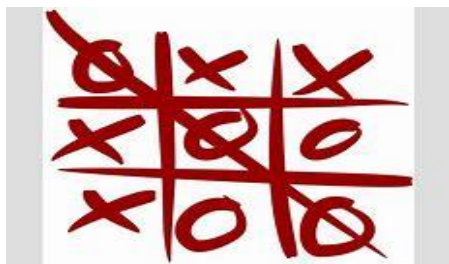
- A Game Tree is a structure for organizing all possible (legal) game states by the moves which allow transition from one game state to the next.
- This structure helps the computer to evaluate which moves to make because, by traversing the game tree, a computer (program) can easily see the outcome of a move and can decide whether to take it or not.



The following states are used to represent a game tree

1. **The board state:** This is an initial stage.
2. **The current player:** It refers to the player who will be making the next move.
3. **The next available moves:** For humans, a move involves placing a game token while the computer selects the next game state.
4. **The game state:** It includes the grouping of the three previous concepts.
5. **Final Game States:** In final game states, AI should select the winning move in such a way that each move assigns a numerical value based on its board state.

## TIC TAC TOE



- The first Game State will show nine moves, one for each of the empty spaces on its board.
- Similarly, the next level of Game States will show eight moves and continues for each Game State.
- The computer evaluates each of its current possible moves by representing the game as a game tree. This also helps to determine whether it will result into a win or a loss.

## **10 marks**

### **1. Explain about the Application of AI in various fields in today's world?**

Artificial Intelligence has various applications in today's society. It is becoming essential for today's time because it can solve complex problems with an efficient way in multiple industries, such as Healthcare, entertainment, finance, education, etc. AI is making our daily life more comfortable and fast.

Following are some sectors which have the application of Artificial Intelligence:

#### **1. AI in Astronomy**

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

#### **2. AI in Healthcare**

- In the last, five to ten years, AI becoming more advantageous for the healthcare industry and going to have a significant impact on this industry.
- 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.

#### **3. 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.

#### **4. 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.

#### **5. AI in Data Security**

- The security of data is crucial for every company and cyber-attacks are growing very rapidly in the digital world. 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.

#### **6. 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.

#### **7. 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 suggesting 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.

#### **8. AI in Automotive Industry**

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

#### **9. 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 named as Erica and Sophia has been developed which can talk and behave like humans.

## **10. AI in Entertainment**

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

## **11. 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. AI in agriculture can be very helpful for farmers.

## **12. 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.

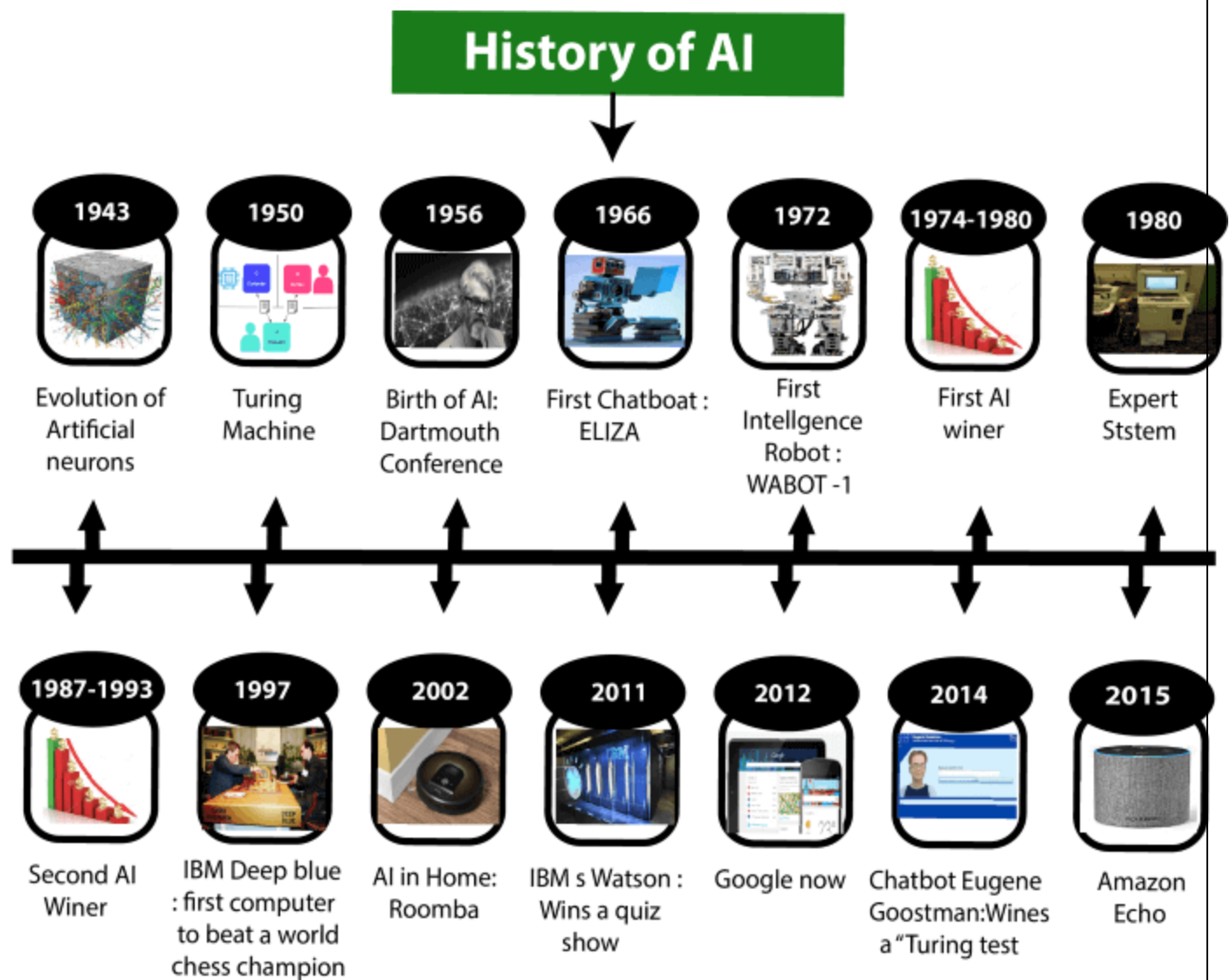
## **13. AI in education**

- 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 any place.

## **2. Explain and brief about the evolution of Artificial Intelligence?**

Artificial Intelligence is not a new word and not a new technology for researchers. This technology is much older than you would imagine. Even there are the myths of Mechanical men in Ancient Greek and Egyptian Myths. Following

are some milestones in the history of AI which defines the journey from the AI generation to till date development.



### Maturation of Artificial Intelligence (1943-1952)

- **Year 1943:** The first work which is now recognized as AI was done by Warren McCulloch and Walter pits in 1943. They proposed a model of **artificial neurons**.
- **Year 1949:** Donald Hebb demonstrated an updating rule for modifying the connection strength between neurons. His rule is now called **Hebbian learning**.



- **Year 1950:** The Alan Turing who was an English mathematician and pioneered Machine learning in 1950. Alan Turing publishes "**Computing Machinery and Intelligence**" in which he proposed a test. The test can check the machine's ability to exhibit intelligent behavior equivalent to human intelligence, called a **Turing test**.

### **The birth of Artificial Intelligence (1952-1956)**

- **Year 1955:** An Allen Newell and Herbert A. Simon created the "first artificial intelligence program" Which was named as "**Logic Theorist**". This program had proved 38 of 52 Mathematics theorems, and find new and more elegant proofs for some theorems.
- **Year 1956:** The word "Artificial Intelligence" first adopted by American Computer scientist John McCarthy at the Dartmouth Conference. For the first time, AI coined as an academic field.

At that time high-level computer languages such as FORTRAN, LISP, or COBOL were invented. And the enthusiasm for AI was very high at that time.

### **The golden years-Early enthusiasm (1956-1974)**

- **Year 1966:** The researchers emphasized developing algorithms which can solve mathematical problems. Joseph Weizenbaum created the first chatbot in 1966, which was named as ELIZA.
- **Year 1972:** The first intelligent humanoid robot was built in Japan which was named as WABOT-1.

### **The first AI winter (1974-1980)**

- The duration between years 1974 to 1980 was the first AI winter duration. AI winter refers to the time period where computer scientist dealt with a severe shortage of funding from government for AI researches.
- During AI winters, an interest of publicity on artificial intelligence was decreased.

### **A boom of AI (1980-1987)**

- **Year 1980:** After AI winter duration, AI came back with "Expert System". Expert systems were programmed that emulate the decision-making ability of a human expert.
- In the Year 1980, the first national conference of the American Association of Artificial Intelligence **was held at Stanford University**.

### **The second AI winter (1987-1993)**

- The duration between the years 1987 to 1993 was the second AI Winter duration.
- Again Investors and government stopped in funding for AI research as due to high cost but not efficient result. The expert system such as XCON was very cost effective.

### **The emergence of intelligent agents (1993-2011)**

- **Year 1997:** In the year 1997, IBM Deep Blue beats world chess champion, Gary Kasparov, and became the first computer to beat a world chess champion.
- **Year 2002:** for the first time, AI entered the home in the form of Roomba, a vacuum cleaner.
- **Year 2006:** AI came in the Business world till the year 2006. Companies like Facebook, Twitter, and Netflix also started using AI.

### **Deep learning, big data and artificial general intelligence (2011-present)**

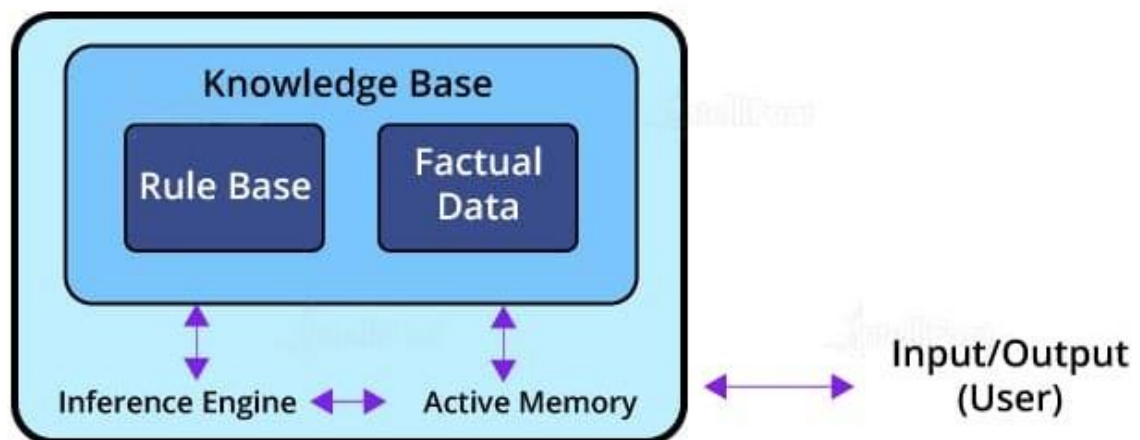
- **Year 2011:** In the year 2011, IBM's Watson won jeopardy, a quiz show, where it had to solve the complex questions as well as riddles. Watson had proved that it could understand natural language and can solve tricky questions quickly.
- **Year 2012:** Google has launched an Android app feature "Google now", which was able to provide information to the user as a prediction.
- **Year 2014:** In the year 2014, Chatbot "Eugene Goostman" won a competition in the infamous "Turing test."

- **Year 2018:** The "Project Debater" from IBM debated on complex topics with two master debaters and also performed extremely well.
- Google has demonstrated an AI program "Duplex" which was a virtual assistant and which had taken hairdresser appointment on call, and lady on other side didn't notice that she was talking with the machine.

### 3. What is a Production System in AI?

A production system in AI helps create AI-based computer programs. With the help of it, the automation of various types of machines has become an easy task. The types of machines can be a computer, mobile applications, manufacturing tools, or more. The set of rules in a production system in Artificial Intelligence defines the behavior of the machine. It helps the machine respond to the surroundings.

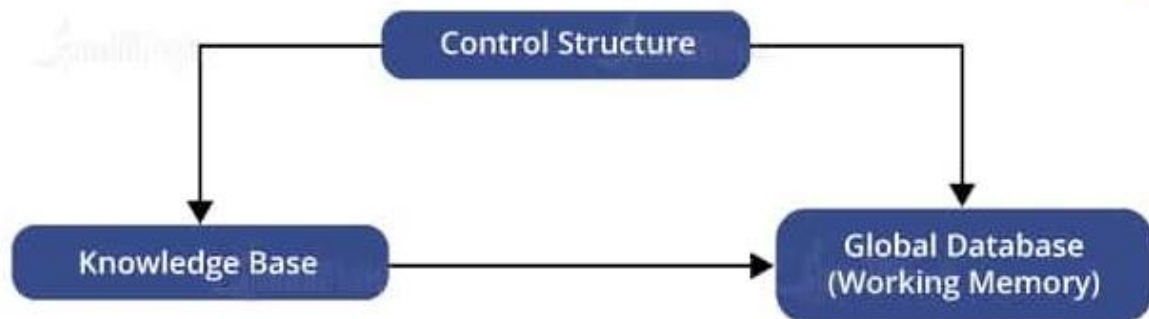
A production system in AI is a type of cognitive architecture that defines specific actions as per certain rules. The rules represent the declarative knowledge of a machine to respond according to different conditions. Today, many expert systems and automation methodologies rely on the rules of production systems. Below is the basic architecture of production systems in AI:



The rules in a production system are determined by LHS (left-hand side) and RHS (right-hand side) equations, where LHS denotes the specific condition to be applied, and RHS shows the output of the applied condition.

### **Components of a Production System in AI**

For making an AI-based intelligent system that performs specific tasks, we need an architecture. The architecture of a production system in Artificial Intelligence consists of production rules, a database, and the control system.



Let us discuss each one of them in detail.

### **Global Database**

A global database consists of the architecture used as a central data structure. A database contains all the necessary data and information required for the successful completion of a task. It can be divided into two parts as permanent and temporary. The permanent part of the database consists of fixed actions, whereas the temporary part alters according to circumstances.

### **Production Rules**

Production rules in AI are the set of rules that operates on the data fetched from the global database. Also, these production rules are bound with precondition

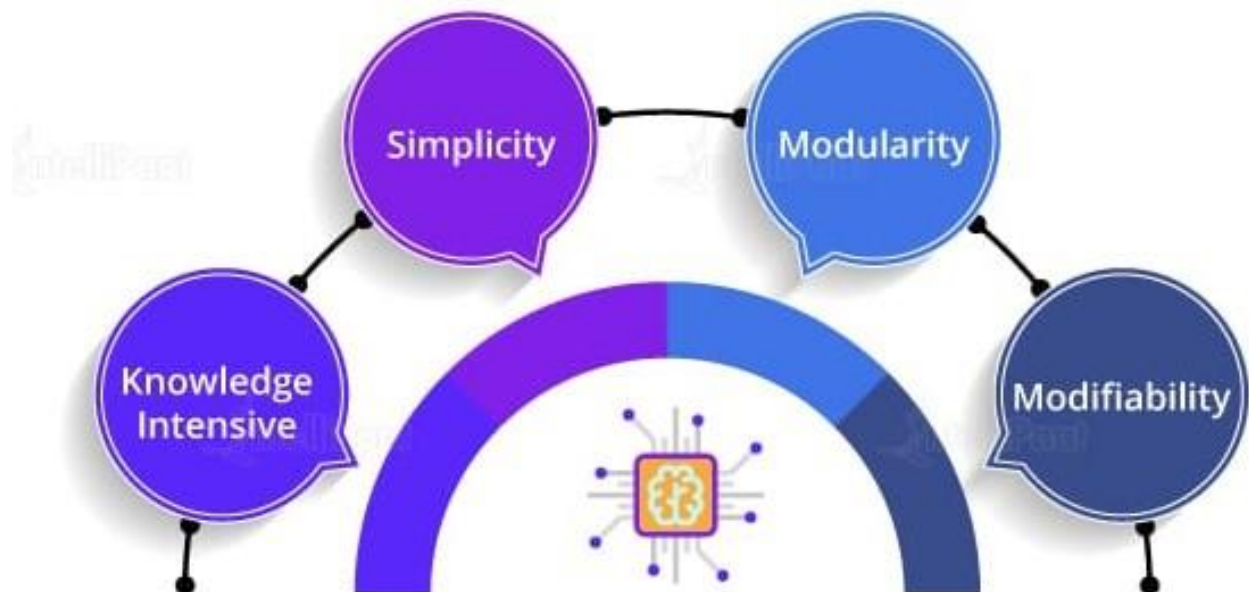
and postcondition that gets checked by the database. If a condition is passed through a production rule and gets satisfied by the global database, then the rule is successfully applied. The rules are of the form  $A \textcircled{R} B$ , where the right-hand side represents an outcome corresponding to the problem state represented by the left-hand side.

## Control System

The control system checks the applicability of a rule. It helps decide which rule should be applied and terminates the process when the system gives the correct output. It also resolves the conflict of multiple conditions arriving at the same time. The strategy of the control system specifies the sequence of rules that compares the condition from the global database to reach the correct result.

## Characteristics of a Production System

There are mainly four characteristics of the production system in AI that is simplicity, modifiability, modularity, and knowledge-intensive.



## **Simplicity**

The production rule in AI is in the form of an 'IF-THEN' statement. Every rule in the production system has a unique structure. It helps represent knowledge and reasoning in the simplest way possible to solve real-world problems. Also, it helps improve the readability and understanding of the production rules.

## **Modularity**

The modularity of a production rule helps in its incremental improvement as the production rule can be in discrete parts. The production rule is made from a collection of information and facts that may not have dependencies unless there is a rule connecting them together. The addition or deletion of single information will not have a major effect on the output. Modularity helps enhance the performance of the production system by adjusting the parameters of the rules.

## **Modifiability**

The feature of modifiability helps alter the rules as per requirements. Initially, the skeletal form of the production system is created. We then gather the requirements and make changes in the raw structure of the production system. This helps in the iterative improvement of the production system.

## **Knowledge-intensive**

Production systems contain knowledge in the form of a human spoken language, i.e., English. It is not built using any programming languages. The knowledge is represented in plain English sentences. Production rules help make productive conclusions from these sentences.

## **Disadvantages of a Production System**

We discussed various features of a production system in the previous section. However, many disadvantages are also there in a production system in Artificial Intelligence, and they are as given below:



### **Opacity**

Communication between the rule interpreter and the production rules creates difficulty for the understanding of the control system and its strategies. This condition arises due to the impact of the combined operation of the control program. There exist difficulties in understanding the hierarchy of operations.

### **Inefficiency**

There are various rules that we employ for solving a problem. The rules can be effective in different ways. There are conditions where multiple rules get activated during execution. All the individual rules apply exhaustive searches in each cycle that reduces the efficiency of the production system.

### **Inability to Learn**

A simple production system based on certain rules is not capable of learning through experience, unlike advanced AI systems. They are simply bound to specific rules for actions. We can understand the rules and break them.

## **Conflict Resolution**

To satisfy a condition, various production rules are employed. The condition may arise when there is a triggering of more than one rule. In that condition, the control system has to determine the best possible rule from the set of conflicting rules. This may reduce the efficiency of the production system.

## **Classes of a Production System**

There are four types of production systems that help in categorizing methodologies for solving different varieties of problems. Let us have a look at each one of them.

### **Monotonic Production System**

In this type of a production system, the rules can be applied simultaneously as the use of one rule does not prevent the involvement of another rule that is selected at the same time.

### **Partially Commutative Production System**

This class helps create a production system that can give the results even by interchanging the states of rules. If using a set of rules transforms State A into State B, then multiple combinations of those rules will be capable to convert State A into State B.

### **Non-monotonic Production System**

This type of a production system increases efficiency in solving problems. The implementation of these systems does not require backtracking to correct the previous incorrect moves. The non-monotonic production systems are necessary from the implementation point of view to find an efficient solution.



## Commutative System

Commutative systems are helpful where the order of an operation is not important. Also, problems where the changes are reversible use commutative systems. On the other hand, partially commutative production systems help in working on problems, where the changes are irreversible such as a chemical process. When dealing with partially commutative systems, the order of processes is important to get the correct results.

## Inference Rules

There are many production rules in Artificial Intelligence. One of them is the inference rule. It is a type of rule that consists of a logical form used for transformation. Let us look at the types of inference rules:

### Deductive Inference Rule

It consists of a logic that helps reasoning with the help of multiple statements to reach a conclusion.

Let us understand with the help of an example:

#### Example:

If it is given that 'A implies B,' then we can infer the conclusion as 'B.'

A:  $B \Rightarrow B$

Where,

A: The students are studying well.

B: If the students are studying well, then all the students will pass the exam.

#### Output:

B: All the students will pass the exam.

## Abductive Inference Rule

This rule helps explain the conclusion in the simplest way by using the given observations.

Let us look at an example to understand the abductive inference rule.

### Example:

It is given that 'A implies B,' and there is a possibility to get the output as 'A.'

A:  $B \Rightarrow A$

Where,

A: All the students will pass the exam.

B: If the students are studying well, then all the students will pass the exam.

### Output:

The students are studying well.

Now, we will take a look at a use case to understand how to use production rules to solve a problem.

## Use Case: Sorting a String in a Production System

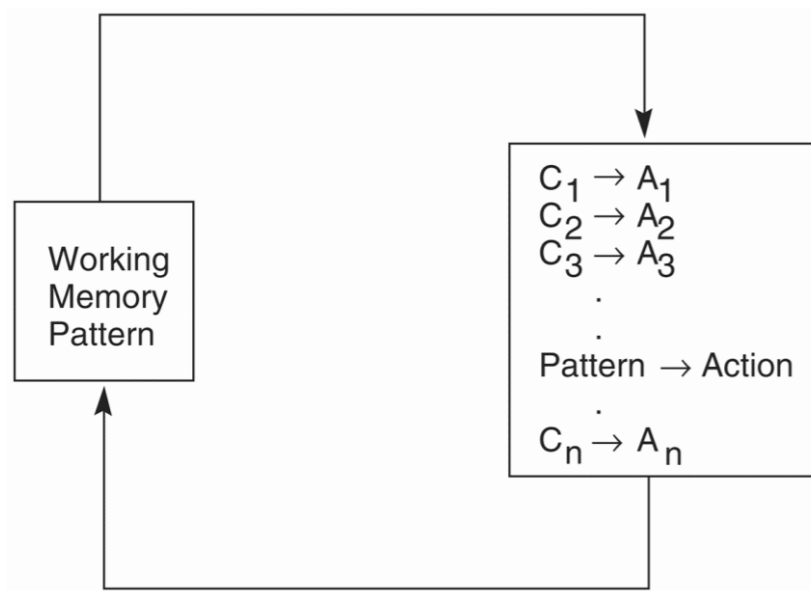
In the previous sections of this blog, we discussed the details of a production rule. Now, we will understand the use of production rules with an example of sorting a string.

**Initial String:** 'cbaca'

**Final String:** 'aabcc'

Let us look at the mechanism for sorting a string using the production system in AI.

- The production rules that we use for sorting will be enabled when it satisfies the condition by finding the sub-string in memory.
- When a particular rule is selected, it replaces the matched string by the string present on the right-hand side of the production rule.
- The loop of production rules will iterate until it finds the correct output.



Let us look at a basic production rule that can be used in this case:

1.  $ba \rightarrow ab$
2.  $ca \rightarrow ac$
3.  $cb \rightarrow bc$

Iteration #	Working memory	Conflict set	Rule fired
0	cbaca	1, 2, 3	1
1	cabca	2	2
2	acbca	2, 3	2
3	acbac	1, 3	1
4	acabc	2	2
5	aacbc	3	3
6	aabcc	Ø	Halt

Here, the conflict set represents the set of all the rules that are applicable to the string. We have to decide which rule should be used.

Hence, by using three production rules and seven iterations, we are able to convert the string 'cbaca' to 'aabcc.'

### **Production System in Artificial Intelligence: Example**

#### **Problem Statement:**

- We have two jugs of capacity 5l and 3l (liter), and a tap with an endless supply of water. The objective is to obtain 4 liters exactly in the 5-liter jug with the minimum steps possible

#### **Production System:**

1. Fill the 5 liter jug from tap
2. Empty the 5 liter jug
3. Fill the 3 liter jug from tap
4. Empty the 3 liter jug
5. Then, empty the 3 liter jug to 5 liter

6. Empty the 5 liter jug to 3 liter
7. Pour water from 3 liters to 5 liter
8. Pour water from 5 liters to 3 liters but do not empty

**Solution:**

- **1,8,4,6,1,8** or **3,5,3,7,2,5,3,5;**

**Advantages**

- Some of the **advantages** of Production system in artificial intelligence are:
- Provides **excellent tools** for structuring AI programs
- The system is highly **modular** because individual rules can be added, removed or modified independently
- Separation of **knowledge** and **Control-Recognises Act Cycle**
- A natural **mapping** onto state-space research data or goal-driven
- The system uses pattern directed control which is more **flexible** than algorithmic control
- Provides opportunities for **heuristic control** of the search
- A good way to model the **state-driven nature** of intelligent machines
- Quite helpful in a **real-time** environment and applications

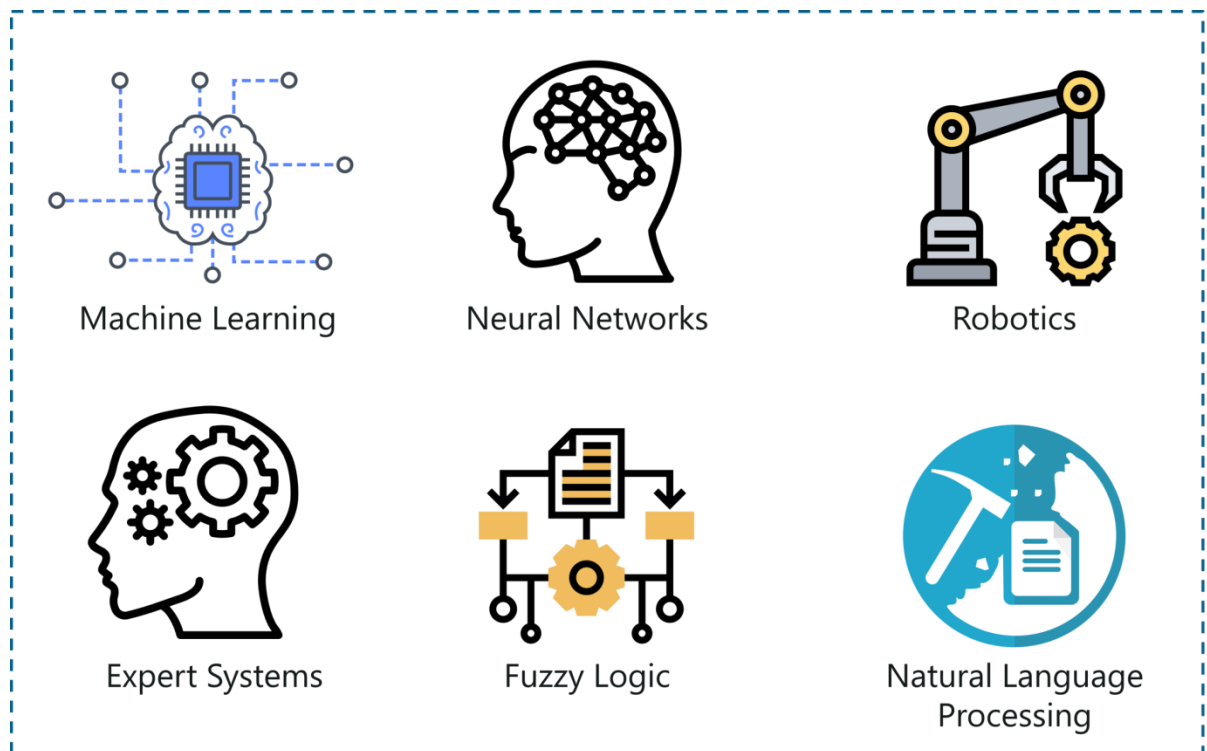
**Disadvantages**

- It is very **difficult** to analyze the flow of control within a production system
- It describes the operations that can be performed in a search for a solution to the problem.
- There is an **absence of learning** due to a rule-based production system that does not store the result of the problem for future use.
- The rules in the production system should not have any type of **conflict resolution** as when a new rule is added to the database it should ensure that it does not have any conflict with any existing rule.

### 3. Explain and briefly tell about the Branches of Artificial Intelligence?

- Machine learning
- Neural Network
- Robotics
- Expert Systems
- Fuzzy Logic
- Natural Language Processing

There is a broad set of techniques that come in the domain of artificial intelligence such as linguistics, bias, vision, planning, robotic process automation, natural language processing, decision science, etc. Let us acquire information about some of the major subfields of AI in deep;



## **Machine learning**

- Machine Learning is the technique that gives computers the potential to learn without being programmed, it is actively being used in daily life, machine learning applications in daily life, even without knowing that. Fundamentally, it is the science that enables machines to translate, execute and investigate data for solving real-world problems.

## **Types of machine learning**

- **Supervised Learning:** In this type of learning, data experts feed labelled training data to algorithms and define variables to algorithms for accessing and finding correlations. Both the input and output of the algorithm are particularized/defined.
- **Unsupervised Learning:** This type of learning include algorithms that train on unlabelled data, an algorithm analyzes datasets to draw meaningful correlations or inferences. For example, one method is cluster analysis that uses exploratory data analysis to obtain hidden or grouping patterns or groups in datasets.
- **Reinforcement Learning:** For teaching a computer machine to fulfil a multi-step process for which there are clearly defined rules, reinforcement learning is practised. Here, programmers design an algorithm to perform a task and give it positive and negative signal to act as algorithm execute to complete the task. Sometimes, the algorithm even determines on its own what action to take to go ahead.

## **Neural Network**

- In simple terms, a neural network is a set of algorithms that are used to find the elemental relationships across the bunches of data via the process that imitates the human brain operating process.

- Neural network replicates the human brain where the human brain comprises an infinite number of neurons and to code brain-neurons into a system or a machine is what the neural network functions

### **Robotics**

- Robotics is an interdisciplinary field of science and engineering incorporated with mechanical engineering, electrical engineering, computer science, and many others.
- Robotics determines the designing, producing, operating, and usage of robots. It deals with computer systems for their control, intelligent outcomes, and information transformation

### **Expert Systems**

- An expert system refers to a computer system that mimics the decision-making intelligence of a human expert. It conducts this by deriving knowledge from its knowledge base by implementing reasoning and insights rules in terms with the user queries.
- The effectiveness of the expert system completely relies on the expert's knowledge accumulated in a knowledge base. The more the information collected in it, the more the system enhances its efficiency. For example, the expert system provides suggestions for spelling and errors in Google Search Engine

### **Fuzzy Logic**

- In the real world, sometimes we face a condition where it is difficult to recognize whether the condition is true or not, their fuzzy logic gives relevant flexibility for reasoning that leads to inaccuracies and uncertainties of any condition.



- It is simply the generalization of the standard logic where a concept exhibits a degree of truth between 0.0 to 1.0. If the concept is completely true, standard logic is 1.0 and 0.0 for the completely false concept. But in fuzzy logic, there is also an intermediate value too which is partially true and partially false.

### **Natural Language Processing**

- NLP is the part of computer science and AI that can help in communicating between computer and human by natural language. It is a technique of computational processing of human languages. It enables a computer to read and understand data by mimicking human natural language
- NLP is a method that deals in searching, analyzing, understanding and deriving information from the text form of data. In order to teach computers how to extract meaningful information from the text data, NLP libraries are used by programmers. A common example of NLP is spam detection, computer algorithms can check whether an email is a junk or not by looking at the subject of a line, or text of an email.