# SANDIP INSTITUTE OF RESEARCH AND TECHNOLOGY

## UNIT I

## UNIT I: Introduction to Artificial Intelligence

Prepared By,

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***Syllabus: Definition of AI, History & Applications, Artificial intelligence as representation & Search, Intelligent Agents, Agent Architecture, Production system, Basics of problem solving: AI Techniques, problem representation paradigms, defining problem as a state space representation, Problem Characteristics.***

**Brief about AI:**

AI

A=Artificial

Non-living +Man Made But behave like living thing

I=Intelligence

Thinking Power+ Smartness

AI has the capacity to learn and solve problems.

In particular,

- The ability to solve novel problems (i.e solve new problems)
- The ability to act /think rationally (i.e act based on reason)
- The ability to act/think like humans

Definition:

- It is branch of CS (computer Science)
- By which we can create Intelligent M/C
- Alternative object / M/C which can looks like Human

    - Which can BEHAVE like a Human
    - Think LIKE Human
    - Take DECISION like Human

**Difference between Human and Machine Intelligence**

- Humans perceive by patterns whereas the machines perceive by set of rules and data.
    - (X, Y)
    - (4, Y)
    - (X, 3)----- (X-d , )
- Humans store and recall information by patterns, machines do it by searching algorithms. For example, the number 40404040 is easy to remember, store, and recall as its pattern is simple.
- Humans can figure out the complete object even if some part of it is missing or distorted; whereas the machines cannot do it correctly.

**Technical Definition:**

AI, or Artificial Intelligence, refers to the simulation of human intelligence processes by machines, especially computer systems. It involves creating algorithms and software that enable computers to perform tasks that typically require human intelligence, such as understanding natural language, recognizing patterns, solving complex problems, and making decisions.

**In Hindi**

एआई, या कृ त्रिम बुत्रिमत्ता, मानव बुत्रिमत्ता प्रत्रियाओं की मशीनों द्वारा अनुकरण करने को संके त करता है, खासकर कं प्यूटर प्रणात्रियों के द्वारा। इसमें एल्गोररदम और सॉफ़्टवेयर बनाने की शात्रमि है जो कं प्यूटर को कार्यों को करने की क्षमता प्रदान करते हैं जो सामान्यत: मानव बुत्रिमत्ता की आवश्यकता होती है, जैसे प्राकृ त्रतक भाषा की समझ, पैटनन की पहचान, जत्रटि समस्याओं का समाधान, और त्रनणनय िेना।

According to the father of Artificial Intelligence, John McCarthy, it is *"The science and engineering of making intelligent machines, especially intelligent computer programs".*

Artificial Intelligence is a way of making a computer, a computer-controlled robot, or a software think intelligently, in the similar manner the intelligent humans think.

AI is accomplished by studying how human brain thinks, and how humans learn, decide, and work while trying to solve a problem, and then using the outcomes of this study as a basis of developing intelligent software and systems

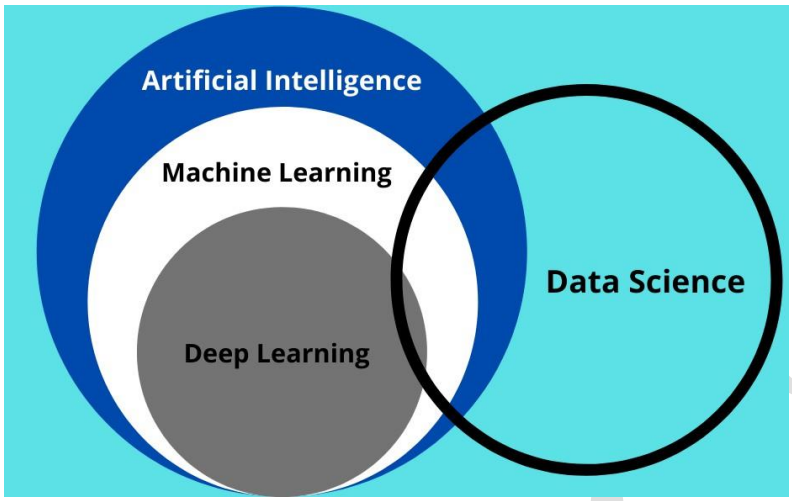
**How AI Works**

AI works by combining large amounts of data with fast, iterative processing and intelligent algorithms, allowing the software to learn automatically from patterns or features in the data. AI is a broad field of study that includes many theories, methods and technologies, as well as the following major subfields:

- Machine learning automates analytical model building. It uses methods from neural networks, statistics, operations research and physics to find hidden insights in data without explicitly being programmed for where to look or what to conclude.
- A neural network is a type of machine learning that is made up of interconnected units (like neurons) that processes information by responding to external inputs, relaying information between each unit. The process requires multiple passes at the data to find connections and derive meaning from undefined data.
- Deep learning uses huge neural networks with many layers of processing units, taking advantage of advances in computing power and improved training techniques to learn complex patterns in large amounts of data. Common applications include image and speech recognition.
- Computer vision relies on pattern recognition and deep learning to recognize what's in a picture or video. When machines can process, analyze and understand images, they can capture images or videos in real time and interpret their surroundings.
- Natural language processing (NLP) is the ability of computers to analyze, understand and generate human language, including speech. The next stage of NLP is natural language interaction, which allows humans to communicate with computers using normal, everyday language to perform tasks.

**Backend Support by,**

- Graphical processing units are key to AI because they provide the heavy compute power that's required for iterative processing. Training neural networks requires big data plus compute power.
- The Internet of Things generates massive amounts of data from connected devices, most of it unanalyzed. Automating models with AI will allow us to use more of it.
- Advanced algorithms are being developed and combined in new ways to analyze more data faster and at multiple levels. This intelligent processing is key to identifying and predicting rare events, understanding complex systems and optimizing unique scenarios.
- APIs, or application programming interfaces, are portable packages of code that make it possible to add AI functionality to existing products and software packages. They can add image recognition capabilities to home security sys





**Why AI: -**

Artificial Intelligence enhances the speed, precision and effectiveness of human efforts

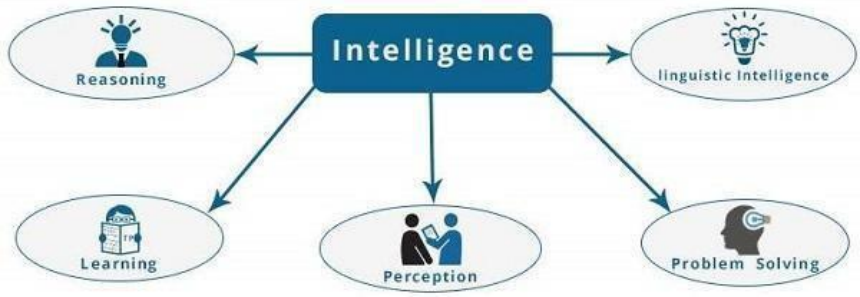
- Speed
- Efficiency
- Precision

**Components of AI:**

- Reasoning
    - Making Decision
    - Taking Judgment
    - Predict the thing
        - Aaabbbcccaaabbbccc
        - modeling the external world, given input

- solving new problems, planning, and making decisions

        - ability to deal with unexpected problems, uncertainties
- Learning
    - Adaption
    - Taking Knowledge
    - Accept the new things
    - Weight Updation
        - Wij=Wi+Wj
        - Delta Wij (Old + New)
        - Delta New
        - e.g., a baby learning to categorize and recognize animals




- Problem Solving
    - To reach the solution(Goal State)
    - To get solution
    - Working thought try try…..
- Perception
    - Selecting
    - Acquiring
    - Organizing
    - Interpretation
- Linguistic Intelligence
    - Identify human lang
    - Ability to Read and write (Language Cruxxxxxx)
    - Understanding/ the lang
    - Capacity to use certain lang to complete the goal

**Goals of AI:**

- To Create an Expert Systems − The systems which exhibit intelligent behavior, learn, demonstrate,

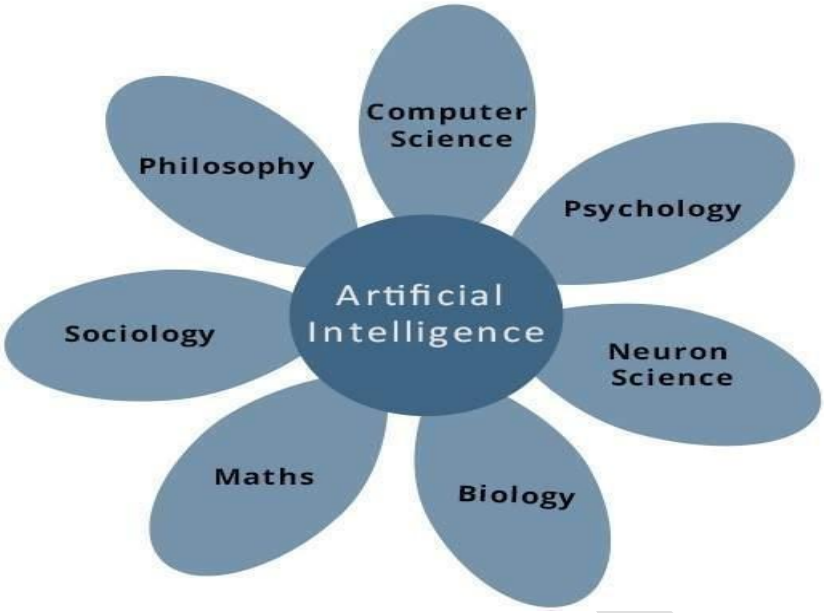
explain, and advice its users.

- To Implement Human Intelligence in Machines − Creating systems that understand, think, learn, and behave like humans.
- Replicate Human Intelligence
- Solve the Know- Intensive Task
- M/C which can perform Task:
    - Playing Game(Chess)
    - Providing theorem
    - Reminder //
    - Surgical operation
    - Traffic car drive
- In early days Artificial intelligence was used to develop reasoning and problem-solving skills.
- With Artificial intelligence knowledge representation has become easy. Knowledge representation is representing information that machine or computer can understand.
- Artificial planning helps agents sequence of actions to perform to achieve goals.
- Artificial intelligence main goal is develop intelligent machines that could learn on their own. No more human intervention for feeding data to machines.
- With artificial intelligence one can develop machines that can read and understand human languages are known as Natural learning processing. Thanks to natural learning processing acquisition of knowledge became easy.
- Artificial Intelligence helps to develop that could act on sensors (take input from sensors) and react accordingly.
- Robotics has transformed thanks to artificial intelligence, that help robots acquire intelligence and perform task smartly.
- Develop systems that can recognize, interpret, process and simulate human effects. All these can be achieved when intelligent systems can predict their motive and emotions. Quality of interpreting human affect could help in better decision making

**What Contributes to AI?**

Artificial intelligence is a science and technology based on disciplines such as Computer Science, Biology, Psychology, Linguistics, Mathematics, and Engineering. A major thrust of AI is in the development of computer functions associated with human intelligence, such as reasoning, learning, and problem solving.

Out of the following areas, one or multiple areas can contribute to build an intelligent system.

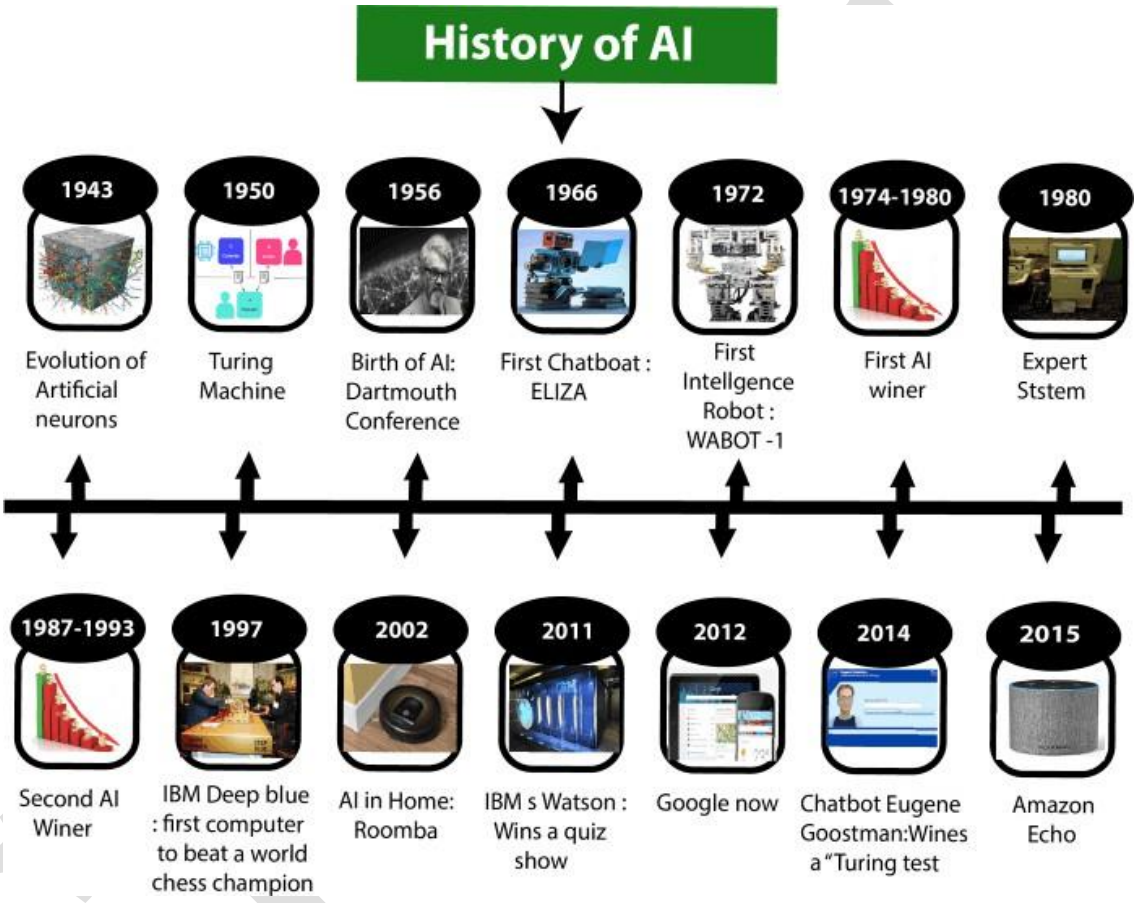



## Artificial intelligence use cases:

- Applications of AI can be seen in everyday scenarios such as financial services fraud detection, retail purchase predictions, and online customer support interactions. Here are just a few examples:
- Fraud detection. The financial services industry uses artificial intelligence in two ways. Initial scoring of applications for credit uses AI to understand creditworthiness. More advanced AI engines are employed to monitor and detect fraudulent payment card transactions in real time.
- Virtual customer assistance (VCA). Call centers use VCA to predict and respond to customer inquiries outside of human interaction. Voice recognition, coupled with simulated human dialog, is the first point of interaction in a customer service inquiry. Higher-level inquiries are redirected to a human.
- When a person initiates dialog on a webpage via chat (chatbot), the person is often interacting with a computer running specialized AI. If the chatbot can't interpret or address the question, a human intervenes to communicate directly with the person. These noninterpretive instances are fed into a machine-learning computation system to improve the AI application for future interactions.
- Advancements in AI for applications like natural language processing (NLP) and computer vision (CV) are helping industries like financial services, healthcare, and automotive accelerate innovation, improve customer experience, and reduce costs. Gartner estimates that up to 70% of people will interact with conversational AI platforms on a daily basis by the year 2022. NLP and CV provide a valuable link between humans and robots: NLP helps computer programs understand human speech, and CV applies machine learning models to images, and is perfectly suited for everything from selfie filters to medical imaging

# History of Artificial Intelligence

- Artificial Intelligence is not a new word and not a new technology for researchers.
- This technology is much older than we 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)**

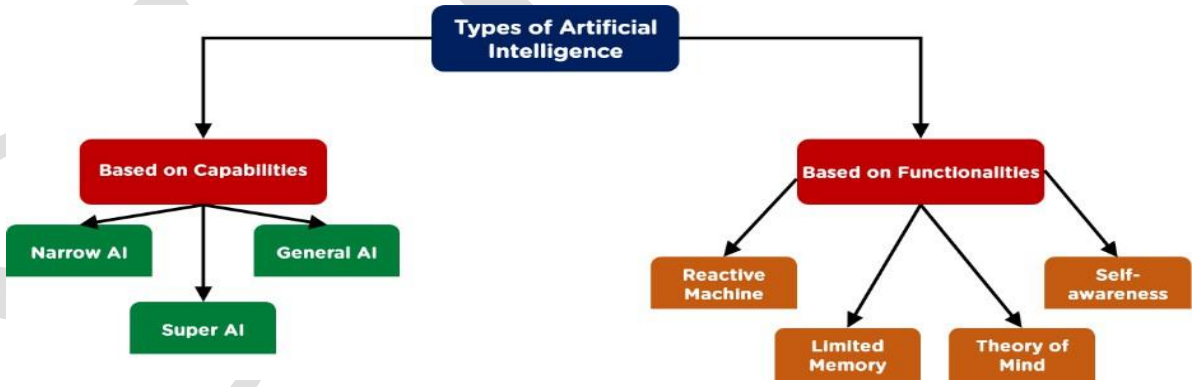
- Year 1997: In the year 1997, IBM Deep Blue beats world chess champion, Gary Kasparov, and became the first computer to beat a world chess champion.
- Year 2002: for the first time, AI entered the home in the form of Roomba, a vacuum cleaner.
- Year 2006: AI came in the Business world till the year 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.
- 2021 onwards-------

# Types of Artificial Intelligence:

Artificial Intelligence can be divided in various types, there are mainly two types of main categorization which are based on capabilities and based on functionally of AI. Following is flow diagram which explain the types of AI.




AI type-1: Based on Capabilities

1. **Weak AI or Narrow AI:**

- Narrow AI is a type of AI which is able to perform a dedicated task with intelligence. The most common and currently available AI is Narrow AI in the world of Artificial Intelligence.
- Narrow AI cannot perform beyond its field or limitations, as it is only trained for one specific task. Hence it is also termed as weak AI. Narrow AI can fail in unpredictable ways if it goes beyond its limits.

- Apple Siriis a good example of Narrow AI, but it operates with a limited pre-defined range of functions.

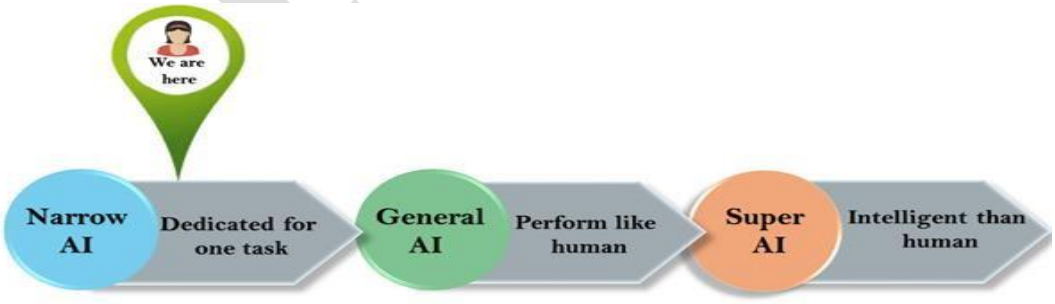
- IBM's Watson supercomputer also comes under Narrow AI, as it uses an Expert system approach combined with Machine learning and natural language processing.
- Some Examples of Narrow AI are playing chess, purchasing suggestions on e-commerce site, self-driving cars, speech recognition, and image recognition, goggle translator,

2. **General AI:**

- General AI is a type of intelligence which could perform any intellectual task with efficiency like a human.
- The idea behind the general AI to make such a system which could be smarter and think like a human by its own.
- Currently, there is no such system exist which could come under general AI and can perform any task as perfect as a human.
- The worldwide researchers are now focused on developing machines with General AI.
- As systems with general AI are still under research, and it will take lots of efforts and time to develop such systems.
- EXample:- Not success so far (Due to fast processing)---- K computer by fujitsu and Tihane 2

3. **Super/Strong AI:**

- Super AI is a level of Intelligence of Systems at which machines could surpass human intelligence, and can perform any task better than human with cognitive properties. It is an outcome of general AI.
- Some key characteristics of strong AI include capability include the ability to think, to reason,solve the puzzle, make judgments, plan, learn, and communicate by its own.
- Super AI is still a hypothetical concept of Artificial Intelligence. Development of such systems in real is still world changing task.
- Example:- Hypothetical ..Plying games, solving problem beyond human thinking




Artificial Intelligence type-2: Based on functionality

**1. Reactive Machines**

- Purely reactive machines are the most basic types of Artificial Intelligence.
- Such AI systems do not store memories or past experiences for future actions.

- These machines only focus on current scenarios and react on it as per possible best action.

- IBM's Deep Blue system is an example of reactive machines.
- Google's AlphaGo, IBM deep blue, Garry Kasparov chess payer is also an example of reactive machines.

**2. Limited Memory**

- Limited memory machines can store past experiences or some data for a short period of time.
- These machines can use stored data for a limited time period only.
- Self-driving cars are (traffic rule, traffic lane etc…)one of the best examples of Limited Memory systems. These cars can store recent speed of nearby cars, the distance of other cars, speed limit, and other information to navigate the road.

**3. Theory of Mind**

- Theory of Mind AI should understand the human emotions, people, beliefs, and be able to interact socially like humans.
- This type of AI machines are still not developed, but researchers are making lots of efforts and improvement for developing such AI machines.
- **Kismet, Sophia,**

**4. Self-Awareness**

- Self-awareness AI is the future of Artificial Intelligence. These machines will be super intelligent, and will have their own consciousness, sentiments, and self-awareness, emotions etc
- These machines will be smarter than human mind.
- Self-Awareness AI does not exist in reality still and it is a hypothetical concept.
- Just Pray Not to works otherwise……

# Agents in Artificial Intelligence:

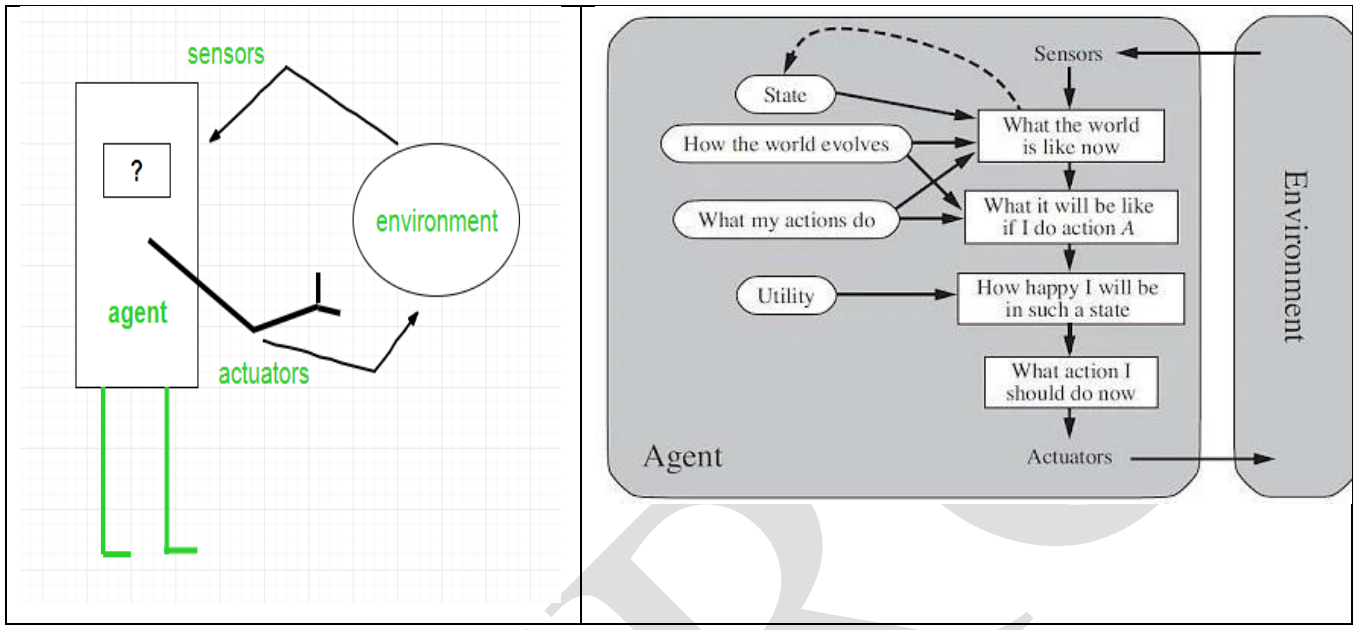
- Artificial intelligence is defined as the study of rational agents.
- A rational agent could be anything that makes decisions, as a person, firm, machine, or software, firm, program
- It carries out an action with the best outcome after considering past and current percepts (agent's perceptual inputs at a given instance).
- An AI system is composed of an agent and its environment.
- The agents act in their environment.
- The environment may contain other agents.

An agent is anything that can be viewed as:

- perceiving its environment through sensors and

- acting upon that environment through actuators

***Note: Every agent can perceive its own actions (but not always the effects)***




Agent------Percept----Decision---- Action

Sensor====Current + History======Percept

Actuators (Action) ====Change

**Goals**:-

- High Performance
- Optimize Results
- Rational Actor

- To understand the structure of Intelligent Agents, we should be familiar with *Architecture* and *Agent* programs.
- Architecture is the machinery that the agent executes on.
- It is a device with sensors and actuators, for example, a robotic car, a camera, a PC.
- Agent program is an implementation of an agent function.

An agent function is a map from the percept sequence (history of all that an agent has perceived to date) to an action.

*Agent = Architecture + Agent Program*

**The Functions of an Artificial Intelligence Agent**

Artificial Intelligence agents perform these functions continuously:

- Perceiving dynamic conditions in the environment
- Acting to affect conditions in the environment
- Using reasoning to interpret perceptions
- Problem-solving
- Drawing inferences
- Determining actions and their outcomes

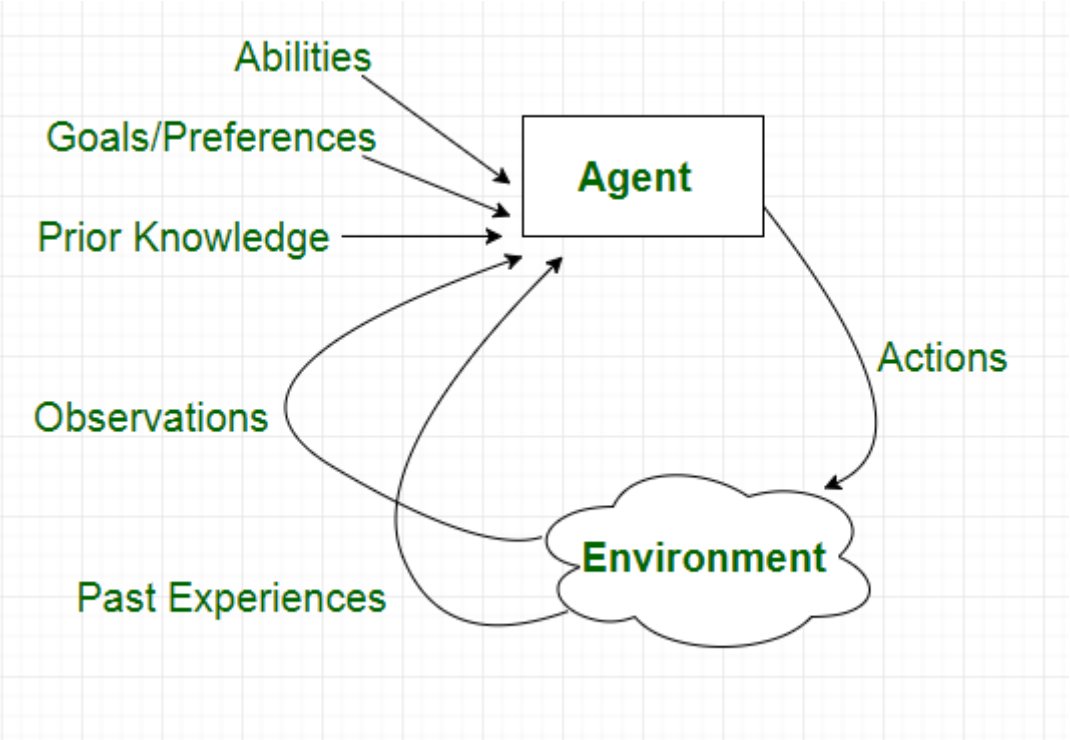
**Examples of Agent:**

- A **software agent** has Keystrokes, file contents, received network packages which act as sensors and displays on the screen, files, sent network packets acting as actuators.
- A **Human-agent** has eyes, ears, and other organs which act as sensors, and hands, legs, mouth, and other body parts acting as actuators.
- A **Robotic agent** has Cameras and infrared range finders which act as sensors and various motors acting as actuators.

**What Are Agents in Artificial Intelligence Composed Of?**

Agents in Artificial Intelligence contain the following properties:

- Environment
- Autonomous
- Flexibility
- Reactive
- Proactive-ness
- Using Response Rules




## Types of Agents

Agents can be grouped into four classes based on their degree of perceived intelligence and capability:

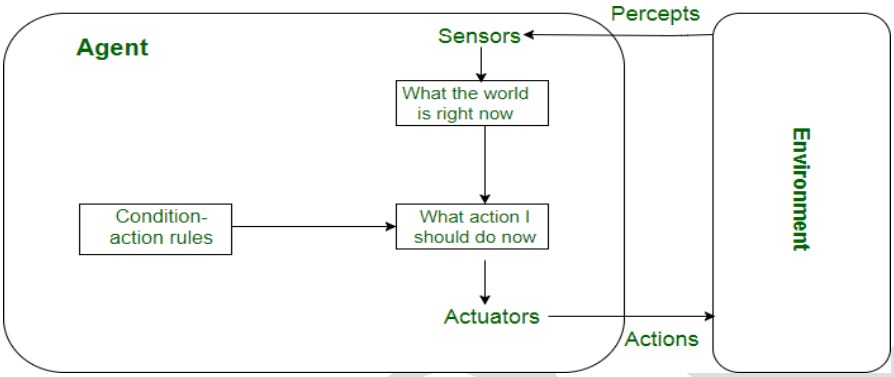
- Simple Reflex Agents
- Model-Based Reflex Agents
- Goal-Based Agents
- Utility-Based Agents
- Learning Agent

**1. Simple reflex agents**

- Simple reflex agents ignore the rest of the percept history and act only on the basis of the current percept.
- Percept history is the history of all that an agent has perceived to date.
- The agent function is based on the condition-action rule.
- A condition-action rule is a rule that maps a state i.e, condition to an action.
- If the condition is true, then the action is taken, else not.
- This agent function only succeeds when the environment is fully observable.
- For simple reflex agents operating in partially observable environments, infinite loops are often unavoidable.
- It may be possible to escape from infinite loops if the agent can randomize its actions.

**Disadvantages/Problems with Simple reflex agents are:**

- Very limited intelligence.
- No knowledge of non-perceptual parts of the state.
- Usually too big to generate and store.
- If there occurs any change in the environment, then the collection of rules need to be updated.

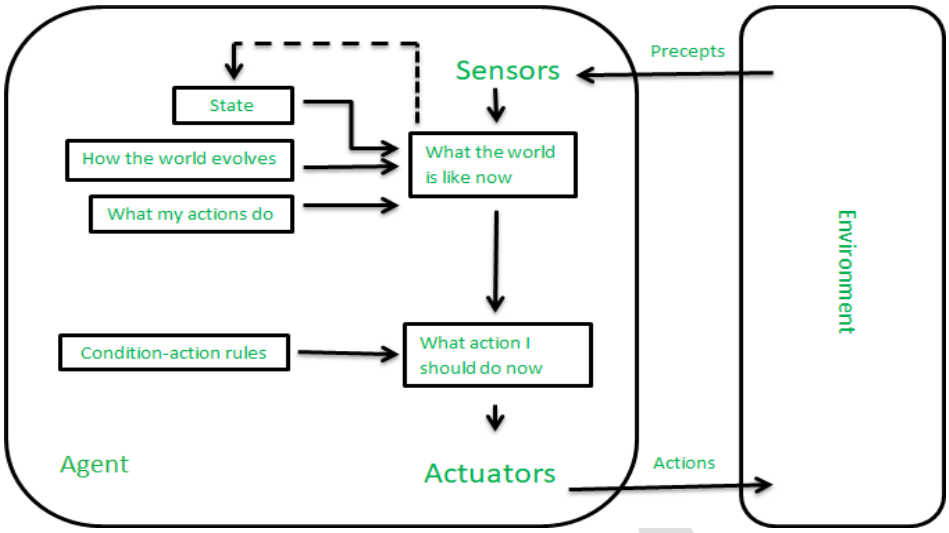



**Model-based reflex agents**

- It works by finding a rule whose condition matches the current situation.
- A model-based agent can handle partially observable environments by the use of a model about the world.
- The agent has to keep track of the internal state which is adjusted by each percept and that depends on the percept history.
- The current state is stored inside the agent which maintains some kind of structure describing the part of the world which cannot be seen.

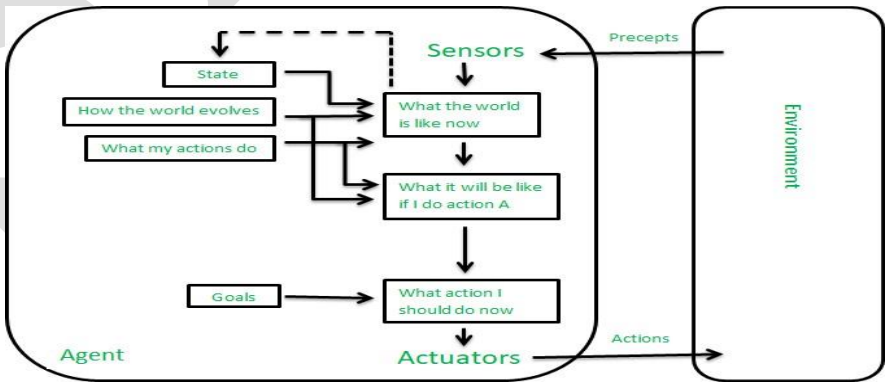
Updating the state requires information about:

- How the world evolves independently from the agent, and
- How the agent's actions affect the world.



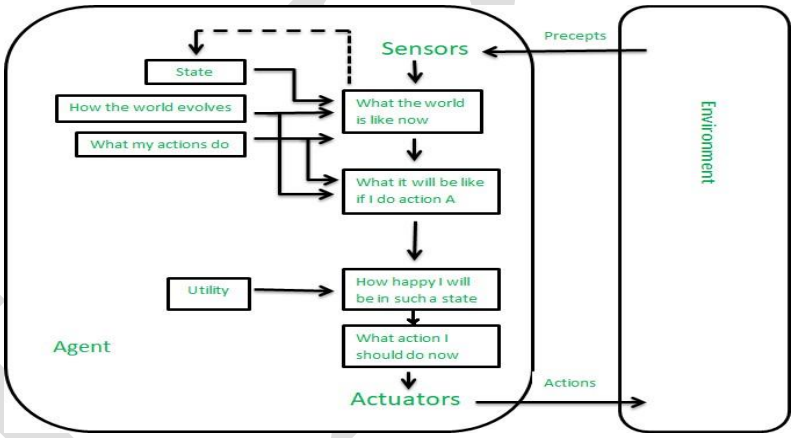

**Goal-based agents**

- These kinds of agents take decisions based on how far they are currently from their goal(description of desirable situations).
- Their every action is intended to reduce its distance from the goal.
- This allows the agent a way to choose among multiple possibilities, selecting the one which reaches a goal state.
- The knowledge that supports its decisions is represented explicitly and can be modified, which makes these agents more flexible.
- They usually require search and planning.
- The goal-based agent's behavior can easily be changed.



**Utility-based agents**

- The agents which are developed having their end uses as building blocks are called utility-based agents.
- When there are multiple possible alternatives, then to decide which one is best, utility-based agents are used.
- They choose actions based on a preference (utility) for each state.
- Sometimes achieving the desired goal is not enough.
- We may look for a quicker, safer, cheaper trip to reach a destination.
- Agent happiness should be taken into consideration.
- Utility describes how "happy" the agent is. Because of the uncertainty in the world, a utility agent chooses the action that maximizes the expected utility. A utility function maps a state onto a real number which describes the associated degree of happiness.

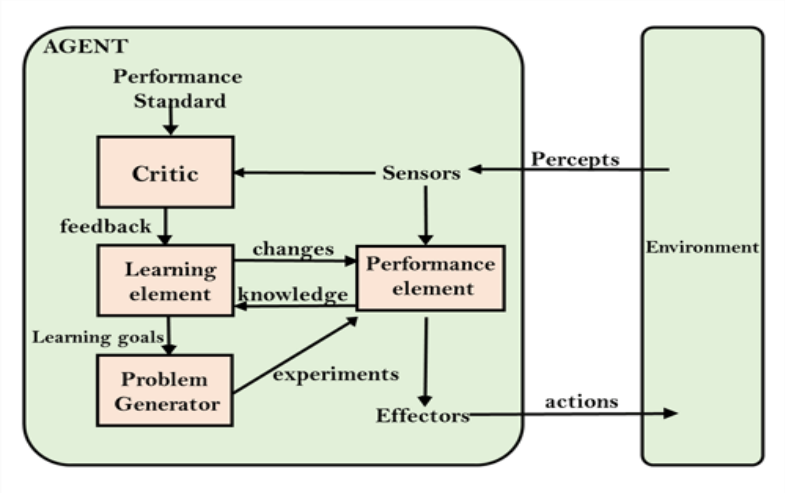



**Learning Agent :**

A learning agent in AI is the type of agent that can learn from its past experiences or it has learning capabilities. It starts to act with basic knowledge and then is able to act and adapt automatically through learning.

A learning agent has mainly four conceptual components, which are:

1. **Learning element:** It is responsible for making improvements by learning from the environment
2. **Critic:** The learning element takes feedback from critics which describes how well the agent is doing with respect to a fixed performance standard.
3. **Performance element**: It is responsible for selecting external action
4. **Problem Generator**: This component is responsible for suggesting actions that will lead to new and informative experiences.




**PEAS**

- It use to group similar types of agents together.
- We know that there are different types of agents in AI. PEAS System is used to categorize similar agents together.
- The PEAS system delivers the performance measure with respect to the environment, actuators, and sensors of the respective agent. Most of the highest performing agents are Rational Agents.
- Rational Agent: The rational agent considers all possibilities and chooses to perform a highly efficient action. For example, it chooses the shortest path with low cost for high efficiency.
- **PEAS stands for a *Performance measure, Environment, Actuator, Sensor.***
    1. Performance Measure: Performance measure is the unit to define the success of an agent. Performance varies with agents based on their different precepts.
    2. Environment: Environment is the surrounding of an agent at every instant. It keeps changing with time if the agent is set in motion. There are 5 major types of environments:
        - Fully Observable & Partially Observable
        - Episodic & Sequential
        - Static & Dynamic
        - Discrete & Continuous
        - Deterministic & Stochastic
    3. Actuator: An actuator is a part of the agent that delivers the output of action to the environment.
    4. Sensor: Sensors are the receptive parts of an agent that takes in the input for the agent.

| Agent | Performance Measure | Environment | Actuator | Sensor |
|---|---|---|---|---|
| Hospital Management System | Patient's health, Admission process, Payment | Hospital, Doctors, Patients | Prescription, Diagnosis, Scan report | Symptoms, Patient's response |
| Automated Car Drive | The comfortable trip, Safety, Maximum Distance | Roads, Traffic, Vehicles | Steering wheel, Accelerator, Brake, Mirror | Camera, GPS, Odometer |
| Subject Tutoring | Maximize scores, Improvement is students | Classroom, Desk, Chair, Board, Staff, Students | Smart displays, Corrections | Eyes, Ears, Noteboo |
| Subject Tutoring | Maximize scores, Improvement is students | Classroom, Desk, Chair, Board, Staff, Students | Smart displays, Corrections | Eyes, Ears, Notebooks |
| Part-picking robot | Percentage of parts in correct bins | Conveyor belt with parts; bins | Jointed arms and hand | Camera, joint angle sensors |
| Satellite image analysis system | Correct image categorization | Downlink from orbiting satellite | Display categorization of scene | Color pixel arrays |

**Example: - Self Driving car**

P=Performance can be Confort, safety, time, legal driving etc
E= Environment can be condition of road, Crossing, traffic signals etc
A= Actuators can be steering , breaks, horn, Accelerator etc
S= Sensor can be camera, mirror, parking sensors etc

## PEAS description of the "online shopping agent"

We need to describe the PEAS for the "shopping for DataWarehousing books on the internet" activity.

**Performance measures:**

- Price of the book
- Author of the book
- Quality of the book
- Book reviews on google.
- Obtain interested/desired books.

- Cost minimization.

**Environment:**

- Internet websites.
- Web pages of a particular website
- Vendors/Sellers
- Shippers

**Actuators:**

- Filling in the forms.
- Display to the user
- Follow URL

**Sensors:**

- Keyboard entry
- Browser used to find web pages
- HTML

# Advantages of Artificial Intelligence:

Artificial Intelligence is difficult for beginners yet it offer great opportunities for developing intelligent machines that can transform computer science on its head.

Few Advantages are,

•**Increased Efficiency:** AI can automate repetitive tasks, improving efficiency and productivity in various industries.

•**Data Analysis and Insights**: AI algorithms can analyze large data quickly, providing valuable insights for decision-making.

•**24/7 Availability**: AI-powered systems can operate continuously, offering round-the-clock services and support.

•**Improved Accuracy**: AI can perform tasks with high precision, reducing errors and improving overall accuracy.

•**Personalization**: AI enables personalized experiences and recommendations based on individual preferences and behavior.

•**Safety and Risk Reduction**: AI can be used for tasks that are hazardous to humans, reducing risks and ensuring safety.

Reduce human errors and perform various tasks with greater efficiency by using intelligent systems.

- The phrase “human error” was born because humans make mistakes from time to time. Computers, however, do not make these mistakes if they are programmed properly. With Artificial intelligence, the decisions are taken from the previously gathered information applying a certain set of algorithms. So errors are reduced and the chance of reaching accuracy with a

greater degree of precision is a possibility.

- Example: In Weather Forecasting using AI they have reduced the majority of human error.

- Intelligent systems can perform daunting tasks that are beyond human reach. For ex; exploring ocean, performing various hard laborious task with ease.
- Lot of applications has been developed using artificial intelligence. iPhones Siri and Microsofts cortana developed on the phenomenon of artificial intelligence. These are interactive robots that help you access Smart phones.
- With the help of artificial intelligence technology one can develop digital assistants that reduces man power. These assistants can perform tasks at amazing efficiency.
- In medical field Radio surgery has been used for tumor treatments developed using artificial intelligence.
- Use artificial intelligence and improve productivity, efficiency and accuracy of your products.
- Takes risks instead of Humans:
- This is one of the biggest advantages of Artificial intelligence. We can overcome many risky limitations of humans by developing an AI Robot which in turn can do the risky things for us. Let it be going to mars, defuse a bomb, explore the deepest parts of oceans, mining for coal and oil, it can be used effectively in any kind of natural or man-made disasters.
- Example: Have you heard about the Chernobyl nuclear power plant explosion in Ukraine? At that time there were no AI-powered robots that can help us to minimize the effect of radiation by controlling the fire in early stages, as any human went close to the core was dead in a matter of minutes. They eventually poured sand and boron from helicopters from a mere distance.
- AI Robots can be used in such situations where intervention can be hazardous.

Available 24x7:

- An Average human will work for 4–6 hours a day excluding the breaks. Humans are built in such a way to get some time out for refreshing themselves and get ready for a new day of work and they even have weekly offed to stay intact with their work-life and personal life. But using AI we can make machines work 24x7 without any breaks and they don't even get bored, unlike humans.
- Example: Educational Institutes and Helpline centers are getting many queries and issues which can be handled effectively using AI.
- Helping in Repetitive Jobs:
- In our day-to-day work, we will be performing many repetitive works like sending a thanking mail, verifying certain documents for errors and many more things. Using artificial intelligence we can productively automate these mundane tasks and can even remove "boring" tasks for

humans and free them up to be increasingly creative.

- Example: In banks, we often see many verifications of documents to get a loan which is a repetitive task for the owner of the bank. Using AI Cognitive Automation the owner can speed up the process of verifying the documents by which both the customers and the owner will be benefited.

**Digital Assistance:**

- Some of the highly advanced organizations use digital assistants to interact with users which saves the need for human resources. The digital assistants also used in many websites to provide things that users want. We can chat with them about what we are looking for. Some chatbots are designed in such a way that it's become hard to determine that we're chatting with a chatbot or a human being.
- Example: We all know that organizations have a customer support team that needs to clarify the doubts and queries of the customers. Using AI the organizations can set up a Voice bot or Chatbot which can help customers with all their queries. We can see many organizations already started using them on their websites and mobile applications.

**Faster Decisions:**

- Using AI alongside other technologies we can make machines take decisions faster than a human and carry out actions quicker. While taking a decision human will analyze many factors both emotionally and practically but AI-powered machine works on what it is programmed and delivers the results in a faster way.
- Example: We all have played Chess games in Windows. It is nearly impossible to beat CPU in the hard mode because of the AI behind that game. It will take the best possible step in a very short time according to the algorithms used behind it.

**Daily Applications:**

- Daily applications such as Apple's Siri, Window's Cortana, Google's OK Google are frequently used in our daily routine whether it is for searching a location, taking a selfie, making a phone call, replying to a mail and many more.
- Example: Around 20 years ago, when we are planning to go somewhere we used to ask a person who already went there for the directions. But now all we have to do is say "OK Google where is Visakhapatnam". It will show you Visakhapatnam's location on google map and the best path between you and any city (Visakhapatnam.)

- New Inventions:
- AI is powering many inventions in almost every domain which will help humans solve the majority of complex problems.

- Example: Recently doctors can predict breast cancer in the woman at earlier stages using advanced AI-based technologies.

# Disadvantages of Artificial Intelligence (AI)?

- **Job Displacement**: AI automation may lead to job losses in certain industries, affecting the job market and workforce.
- **Ethical Concerns:** AI raises ethical issues, including data privacy, algorithm bias, and potential misuse of AI technologies.
- **Lack of Creativity and Empathy**: AI lacks human qualities like creativity and empathy, limiting its ability to understand emotions or produce original ideas.
- **Cost and Complexity**: Developing and implementing AI systems can be expensive, require specialized knowledge and resources.
- **Reliability and Trust**: AI systems may not always be fully reliable, leading to distrust in their decision-making capabilities.
- **Dependency on Technology**: Over-reliance on AI can make humans dependent on technology and reduce critical thinking skills.
- Artificial intelligence is slowly making its way into real time applications. AI offers great prospects but it's really expensive. Small organizations can't afford High end machines, softwares, resources required for implementing AI.
- Artificial intelligent systems might replace humans in performing task in terms of productivity, but they can't take decisions. Robots can't decide what is right or what is wrong.
- With intelligent systems, you won't get creative with everyday experience. Humans tend to show creative ideas with every day experience.
- Replacing humans with intelligent systems might increase unemployment that lead to poor GDP.
- High Costs of Creation:
- As AI is updating every day the hardware and software need to get updated with time to meet the latest requirements. Machines need repairing and maintenance which need plenty of costs. It' s creation requires huge costs as they are very complex machines.
- Making Humans Lazy:
- AI is making humans lazy with its applications automating the majority of the work. Humans tend to get addicted to these inventions which can cause a problem to future generations.
- Unemployment:

- As AI is replacing the majority of the repetitive tasks and other works with robots,human interference is becoming less which will cause a major problem in the employment standards. Every organization is looking to replace the minimum qualified individuals with AI robots which can do similar work with more efficiency.
- No/less Emotions:
- There is no doubt that machines are much better when it comes to working efficiently but they cannot replace the human connection that makes the team. Machines cannot develop a bond with humans which is an essential attribute when comes to Team Management.
- Lacking Out of Box Thinking:
- Machines can perform only those tasks which they are designed or programmed to do, anything out of that they tend to crash or give irrelevant outputs which could be a major backdrop.

# Application areas of artificial intelligence

Modern AI-based technologies are relevant in any intelligent task, and the list of its applications continues to grow significantly. Let's take a quick look at some of them.

- Healthcare: Artificial intelligence has proven to be a life-saving aid in healthcare. For example, the AI algorithm in a smart watch monitors a person's vital activity to detect heart problems and even alerts emergency services. Additionally, AI has helped increase the speed and accuracy of drugs.
- Financial Services: Financial services have benefited from AI for the past three decades. AI is useful for bookkeeping management, stock forecasting, and even fraud prevention in banking. Large enterprises use AI to process and audit transactions under strict compliance.
- Retail Sector: In the retail business, AI algorithms can combat supply-chain problems by managing inventory. Apart from predicting future trends in the apparel business, AI can also help forecast demand and enhance customer experience through real-time data analysis.
- Automobile Industry: An important example of using AI is the automobile industry. An autonomous or self-driving car is the latest research area, and every carmaker is investing heavily in it. Several carmakers have already used AI features such as voice-control, lane-switch, collision-detection, and improved driver safety.

**1. AI Application in E-Commerce**

**Personalized Shopping**

Artificial Intelligence technology is used to create recommendation engines through which you can engage better with your customers. These recommendations are made in accordance with their browsing history, preference, and interests. It helps in improving your relationship with your customers and their loyalty towards your brand.

**AI-powered Assistants**

Virtual shopping assistants and chatbots help improve the user experience while shopping online. Natural Language Processing is used to make the conversation sound as human and personal as possible. Moreover, these assistants can have real-time engagement with your customers. Did you know that on amazon.com, soon, customer service could be handled by chatbots?

**Fraud Prevention**

Credit card frauds and fake reviews are two of the most significant issues that E-Commerce companies deal with. By considering the usage patterns, AI can help reduce the possibility of credit card frauds taking place. Many customers prefer to buy a product or service based on customer reviews. AI can help identify and handle fake reviews.

## 2. Applications Of Artificial Intelligence in Education

Although the education sector is the one most influenced by humans, Artificial Intelligence has slowly begun to seep its roots in the education sector as well. Even in the education sector, this slow transition of Artificial Intelligence has helped increase productivity among faculties and helped them concentrate more on students than office or administration work.

Some of these applications in this sector include:

## 3. Administrative Tasks Automated to Aid Educators

Artificial Intelligence can help educators with non-educational tasks like task-related duties like facilitating and automating personalized messages to students, back-office tasks like grading paperwork, arranging and facilitating parent and guardian interactions, routine issue feedback facilitating, managing enrollment, courses, and HR-related topics.

Creating Smart Content

Digitization of content like video lectures, conferences, and text book guides can be made using Artificial Intelligence. We can apply different interfaces like animations and learning content through customization for students from different grades.

Artificial Intelligence helps create a rich learning experience by generating and providing audio and video summaries and integral lesson plans.

Voice Assistants

Without even the direct involvement of the lecturer or the teacher, a student can access extra learning material or assistance through Voice Assistants. Through this, printing costs of temporary handbooks and also provide answers to very common questions easily.

Personalized Learning

Using AI technology, hyper-personalization techniques can be used to monitor students' data thoroughly, and

habits, lesson plans, reminders, study guides, flash notes, frequency or revision, etc., can be easily generated.

Applications of Artificial Intelligence in Lifestyle

Artificial Intelligence has a lot of influence on our lifestyle. Let us discuss a few of them.

Autonomous Vehicles

Automobile manufacturing companies like Toyota, Audi, Volvo, and Tesla use machine learning to train computers to think and evolve like humans when it comes to driving in any environment and object detection to avoid accidents.

Spam Filters

The email that we use in our day-to-day lives has AI that filters out spam emails sending them to spam or trash folders, letting us see the filtered content only. The popular email provider, Gmail, has managed to reach a filtration capacity of approximately 99.9%.

Facial Recognition

Our favorite devices like our phones, laptops, and PCs use facial recognition techniques by using face filters to detect and identify in order to provide secure access. Apart from personal usage, facial recognition is a widely used Artificial Intelligence application even in high security-related areas in several industries.

Recommendation System

Various platforms that we use in our daily lives like e-commerce, entertainment websites, social media, video sharing platforms, like youtube, etc., all use the recommendation system to get user data and provide customized recommendations to users to increase engagement. This is a very widely used Artificial Intelligence application in almost all industries.

**4. AI Applications in Navigation**

Based on research from MIT, GPS technology can provide users with accurate, timely, and detailed information to improve safety. The technology uses a combination of Convolutional Neural Network and Graph Neural Network, which makes lives easier for users by automatically detecting the number of lanes and road types behind obstructions on the roads. AI is heavily used by Uber and many logistics companies to improve operational efficiency, analyze road traffic, and optimize routes.

**5. AI Applications in Robotics**

Robotics is another field where artificial intelligence applications are commonly used. Robots powered by AI use real-time updates to sense obstacles in its path and pre-plan its journey instantly.

It can be used for -

Carrying goods in hospitals, factories, and warehouses

Cleaning offices and large equipment

Inventory management

## 6. AI Applications in Human Resource

Did you know that companies use intelligent software to ease the hiring process?

Artificial Intelligence helps with blind hiring. Using machine learning software, you can examine applications based on specific parameters. AI drive systems can scan job candidates' profiles, and resumes to provide recruiters an understanding of the talent pool they must choose from.

**7. AI Applications in Healthcare**

Artificial Intelligence finds diverse applications in the healthcare sector. AI applications are used in healthcare to build sophisticated machines that can detect diseases and identify cancer cells. Artificial Intelligence can help analyze chronic conditions with lab and other medical data to ensure early diagnosis. AI uses the combination of historical data and medical intelligence for the discovery of new drugs.

**8. AI Applications in Agriculture**

Artificial Intelligence is used to identify defects and nutrient deficiencies in the soil. This is done using computer vision, robotics, and machine learning applications, AI can analyze where weeds are growing. AI bots can help to harvest crops at a higher volume and faster pace than human laborers.

**9. AI Applications in Gaming**

Another sector where Artificial Intelligence applications have found prominence is the gaming sector. AI can be used to create smart, human-like NPCs to interact with the players.

It can also be used to predict human behavior using which game design and testing can be improved. The Alien Isolation games released in 2014 uses AI to stalk the player throughout the game. The game uses two Artificial Intelligence systems - 'Director AI' that frequently knows your location and the 'Alien AI,' driven by sensors and behaviors that continuously hunt the player.

**10. AI Applications in Automobiles**

Artificial Intelligence is used to build self-driving vehicles. AI can be used along with the vehicle's camera, radar, cloud services, GPS, and control signals to operate the vehicle. AI can improve the in-vehicle experience and provide additional systems like emergency braking, blind-spot monitoring, and driver-assist steering.

**11. AI Applications in Social Media**

**Instagram**

On Instagram, AI considers your likes and the accounts you follow to determine what posts you are shown on your explore tab.

**Facebook**

Artificial Intelligence is also used along with a tool called DeepText. With this tool, Facebook can understand conversations better. It can be used to translate posts from different languages automatically.

Twitter

AI is used by Twitter for fraud detection, removing propaganda, and hateful content. Twitter also uses AI to recommend tweets that users might enjoy, based on what type of tweets they engage with.

**12. AI Applications in Marketing**

Artificial intelligence (AI) applications are popular in the marketing domain as well.

Using AI, marketers can deliver highly targeted and personalized ads with the help of behavioral analysis, pattern recognition, etc. It also helps with retargeting audiences at the right time to ensure better results and reduced feelings of distrust and annoyance.

AI can help with content marketing in a way that matches the brand's style and voice. It can be used to handle routine tasks like performance, campaign reports, and much more.

Chatbots powered by AI, Natural Language Processing, Natural Language Generation, and Natural Language Understanding can analyze the user's language and respond in the ways humans do.

AI can provide users with real-time personalizations based on their behavior and can be used to edit and optimize marketing campaigns to fit a local market's needs.

13. AI Applications in Chatbots

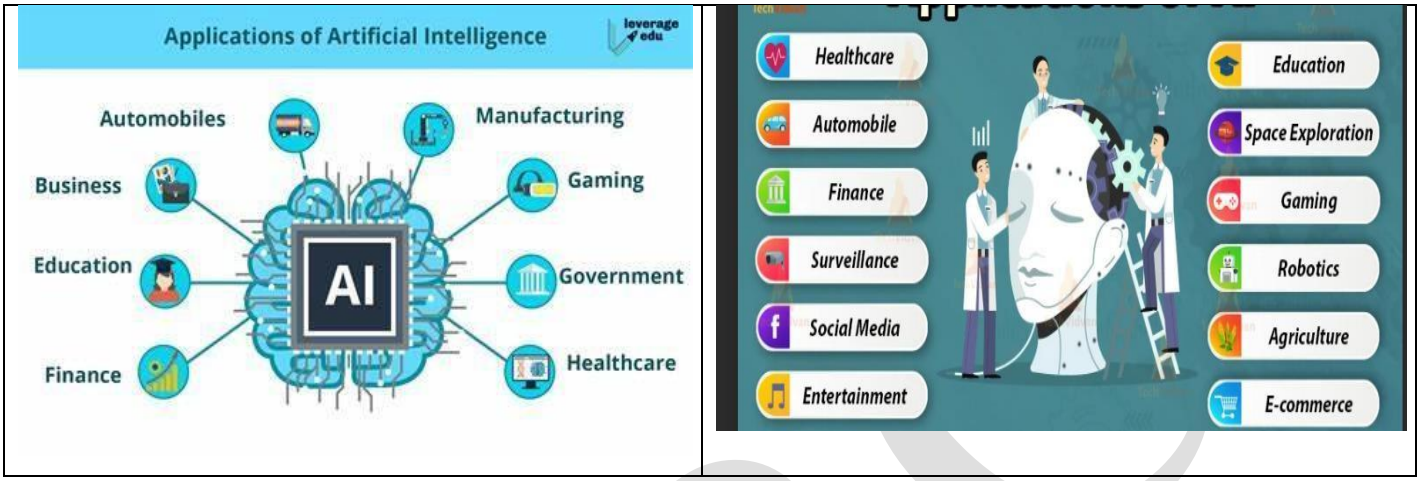
AI chatbots can comprehend natural language and respond to people online who use the "live chat" feature that many organizations provide for customer service. AI chatbots are effective with the use of machine learning, and can be integrated in an array of websites and applications. AI chatbots can eventually build a database of answers, in addition to pulling information from an established selection of integrated answers. As AI continues to improve, these chatbots can effectively resolve customer issues, respond to simple inquiries, improve customer service, and provide 24/7 support. All in all, these AI chatbots can help to improve customer satisfaction.

**14. AI Applications in Finance**

It has been reported that 80 percent of banks recognize the benefits that AI can provide. Whether it’s personal finance, corporate finance, or consumer finance, the highly evolved technology that is offered through AI can help to significantly improve a wide range of financial services. For example, customers looking for help regarding wealth management solutions can easily get the information they need through SMS text messaging

or online chat, all AI-powered. Artificial intelligence can also detect changes in transaction patterns and other

potential red flags that can signify fraud, which humans can easily miss, and thus saving businesses and individuals from significant loss. Aside from fraud detection and task automation, AI can also better predict and assess loan risks.




**AI Techniques:**

Artificial Intelligence problems span a very broad spectrum. They appear to have very little in common except that they are hard.

AI Research of earlier decades results into the fact that intelligence requires knowledge.

**Knowledge possesses following properties:**

- It is voluminous.
- It is not well-organized or well-formatted.
- It is constantly changing.
- It differs from data. And it is organised in a way that corresponds to its usage.

**AI technique is a method that exploits knowledge that should be represented in such a way that:**

- Knowledge captures generalisation. Situations that share common properties are grouped together. Without the property, inordinate amount of memory and modifications will be required.
- It can be easily modified to correct errors and to reflect changes in the world.
- It can be used in many situations even though it may not be totally accurate or complete.
- It can be used to reduce its own volume by narrowing range of possibilities.

## AI Techniques Parts:

AI technique is a method that achieves knowledge. The main AI techniques are:

**1. Search:-**

Search provides a way of solving problems for which no more direct approach is available as well as a framework into which any direct techniques that are available can be embedded. A search program finds a solutions for a problem by trying various sequences of actions or operators until a solution is found.

**Advantages**

It is the best way so far as no better way has been found to solve the problems.

To solve a problem using search, it is only necessary to code the operator that can be used; the search will find the sequence of actions that will provide the desired results.

**Disadvantages**

Most problems have search spaces so large that it is impossible to search for the whole space.

**2. Use of knowledge: -**

- The use of knowledge provides a way of solving complicated problems by manipulating the structures of the objects that are concerned.
- The way in which knowledge can be represented for usage in AI techniques:
- AI technique is a method that achieves knowledge that should be represented in such a way that:-
- Knowledge captures generalization. This meaning grouping situations that share important properties rather than representing each situation separately with such an arrangement of knowledge, an unreasonable amount of memory, and updating will no longer be required. Anything without this property is called data rather than knowledge.
- It should be represented in such a way that it can be understood by the people who must prepare it. For many programs, the size of the data can be achieved automatically by taking a reading from a number of instruments, but in many AI areas, most of the knowledge a program has must be provided by people in terms that they understand it.
- It could easily be adjusted to correct errors end to demonstrate changes in the world.
- It can be used to overcome its own through volume by helping to restrict the range of possibilities that must usually be considered or discussed.
- It could be used in different situations even though it may not entirely be complete.

**3. Abstraction: -**

Abstraction finds a way of separating important features and notifications from the unimportant ones that would otherwise confuse any process.

Example:- Header file use in program we use only readymade functions we are not bother about their definition.

Search Algorithms in Artificial Intelligence

Search algorithms are one of the most important areas of Artificial Intelligence.

## Problem-solving agents:

In Artificial Intelligence, Search techniques are universal problem-solving methods. Rational agents or Problem-solving agents in AI mostly used these search strategies or algorithms to solve a specific problem and provide the best result. Problem-solving agents are the goal-based agents and use atomic representation. In this topic, we will learn various problem-solving search algorithms.

Search Algorithm Terminologies:

- Search: Searching Is a step by step procedure to solve a search-problem in a given search space. A search problem can have three main factors:
    - . Search Space: Search space represents a set of possible solutions, which a system may have.
    - a. Start State: It is a state from where agent begins the search.
    - b. Goal test: It is a function which observe the current state and returns whether the goal state is achieved or not.
- Search tree: A tree representation of search problem is called Search tree. The root of the search tree is the root node which is corresponding to the initial state.
- Actions: It gives the description of all the available actions to the agent.

- Transition model: A description of what each action do, can be represented as a transition model.

- Path Cost: It is a function which assigns a numeric cost to each path.
- Solution: It is an action sequence which leads from the start node to the goal node.
- Optimal Solution: If a solution has the lowest cost among all solutions.

Properties of Search Algorithms:

Following are the four essential properties of search algorithms to compare the efficiency of these algorithms:

Completeness: A search algorithm is said to be complete if it guarantees to return a solution if at least any solution exists for any random input.

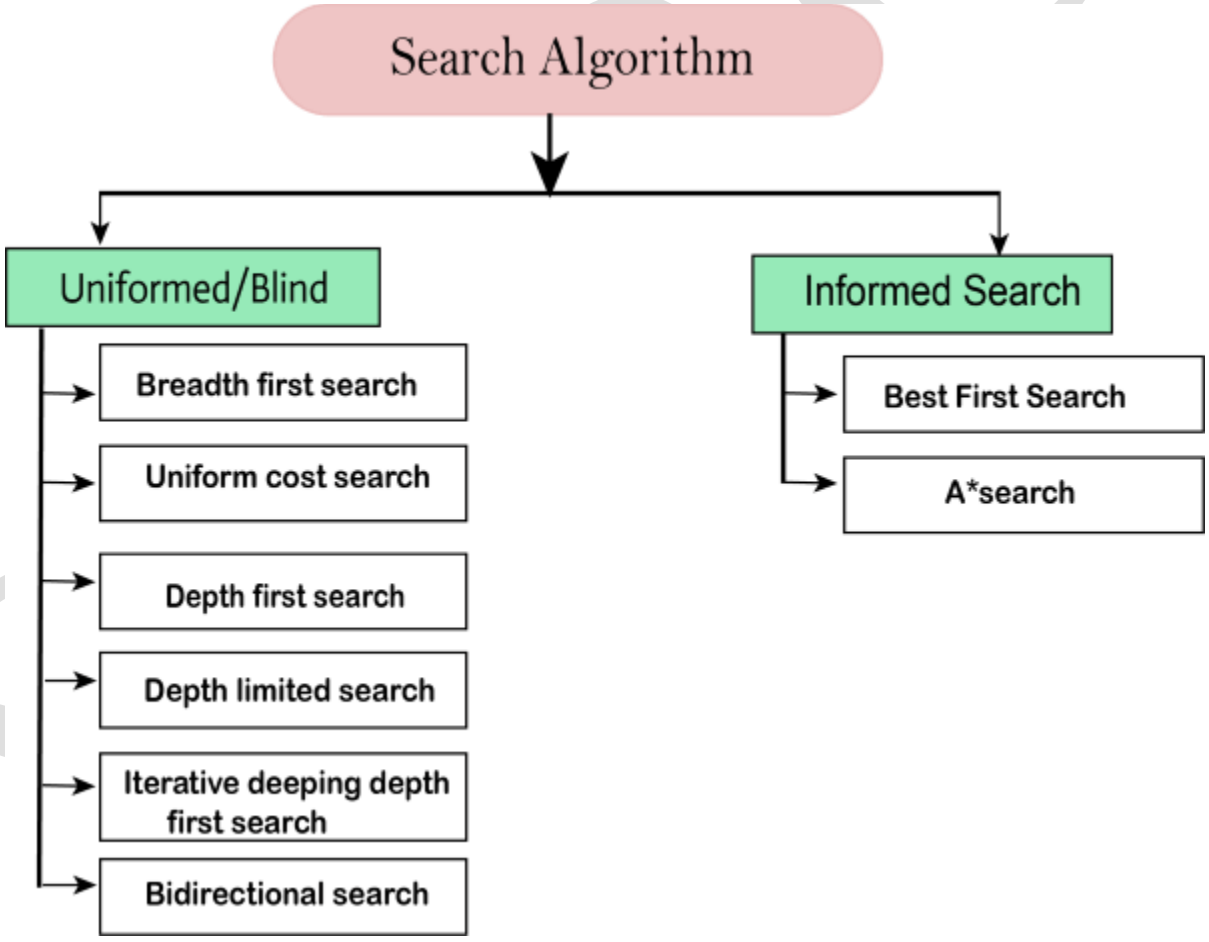
Optimality: If a solution found for an algorithm is guaranteed to be the best solution (lowest path cost) among all other solutions, then such a solution for is said to be an optimal solution.

Time Complexity: Time complexity is a measure of time for an algorithm to complete its task.

Space Complexity: It is the maximum storage space required at any point during the search, as the complexity of the problem.

Types of search algorithms

Based on the search problems we can classify the search algorithms into uninformed (Blind search) search and informed search (Heuristic search) algorithms.




Uninformed/Blind Search:

The uninformed search does not contain any domain knowledge such as closeness, the location of the goal. It operates in a brute-force way as it only includes information about how to traverse the tree and how to identify leaf and goal nodes. Uninformed search applies a way in which search tree is searched without any information about the search space like initial state operators and test for the goal, so it is also called blind search.It examines each node of the tree until it achieves the goal node.

It can be divided into five main types:

- Breadth-first search
- Uniform cost search
- Depth-first search
- Iterative deepening depth-first search
- Bidirectional Search

Informed Search

Informed search algorithms use domain knowledge. In an informed search, problem information is available which can guide the search. Informed search strategies can find a solution more efficiently than an uninformed search strategy. Informed search is also called a Heuristic search.

A heuristic is a way which might not always be guaranteed for best solutions but guaranteed to find a good solution in reasonable time.

Informed search can solve much complex problem which could not be solved in another way.

An example of informed search algorithms is a traveling salesman problem.

1. Greedy Search
2. A* Search

# Production System:

It helps us to structuring AI programs in a way that facilitates describing and performing the search process.

It consists of,

- Set of rules
- Knowledge base
- Control Strategy
- Rule Applier

**Steps:-**

- Reduce the problem so that it can be shown in precise statement
- Problem can be solved by searching path through space[start===goal]
- Solving process can be modeled

A production system is based on a set of rules about behavior. These rules are a basic representation found helpful in expert systems, automated planning, and action selection. It also provides some form of artificial intelligence. here we will talk about the production system in artificial intelligence in the following sequence:

- What is Production System?
- Features of Production System
- Control/Search Strategies
- Production System Rules
- Classes of Production System

- Advantages & Disadvantages
- Production System in AI: Example

**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.

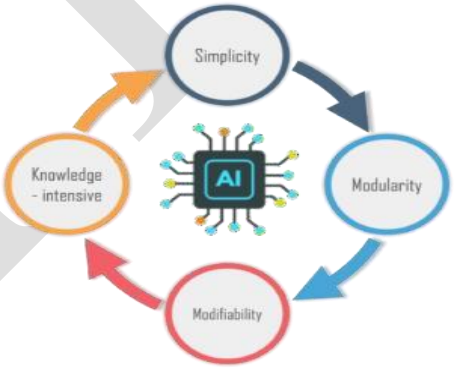
**Components of Production System**

The major components of Production System in Artificial Intelligence are:

- **Global Database**: The global database is the central data structure used by the production system in Artificial Intelligence.
- **Set of Production Rule**s: The production rules operate on the global database. Each rule usually has a precondition that is either satisfied or not by the global database. If the precondition is satisfied, the rule is usually be applied. The application of the rule changes the database.
- A Control System: The control system then chooses which applicable rule should be applied and ceases computation when a termination condition on the database is satisfied. If multiple rules are to fire at the same time, the control system resolves the conflicts.

**Features of Production System in Artificial Intelligence**

The main features of the production system include:




1. Simplicity: The structure of each sentence in a production system is unique and uniform as they use the "IF-THEN" structure. This structure provides simplicity in knowledge representation. This feature of the production system improves the readability of production rules.

2. Modularity: This means the production rule code the knowledge available in discrete pieces. Information can be treated as a collection of independent facts which may be added or deleted from the system with essentially no deleterious side effects.

3. Modifiability: This means the facility for modifying rules. It allows the development of production rules in a skeletal form first and then it is accurate to suit a specific application.

4. Knowledge-intensive: The knowledge base of the production system stores pure knowledge. This part does not contain any type of control or programming information. Each production rule is normally written as an English sentence; the problem of semantics is solved by the very structure of the representation.

**Control/Search Strategies**

How would you decide which rule to apply while searching for a solution for any problem?

There are certain requirements for a good control strategy that you need to keep in mind, such as:

- The first requirement for a good control strategy is that it should cause motion.
- The second requirement for a good control strategy is that it should be systematic.
- Finally, it must be efficient in order to find a good answer.

**Production System Rules**

Production System rules can be classified as:

- Deductive Inference Rules
- Abductive Inference Rules

You can represent the knowledge in a production system as a set of rules along with a control system and database. It can be written as:

*If(Condition) Then (Condition)*

The production rules are also known as condition-action, antecedent-consequent, pattern-action, situation-response, feedback-result pairs.

**Classes of Production System in Artificial Intelligence**

There are four major classes of Production System in Artificial Intelligence:

- **Monotonic Production System**: It's a production system in which the application of a rule never prevents the later application of another rule, that could have also been applied at the time the first rule was selected. [rules are independent]
- **Partially Commutative Production System:** It's a type of production system in which the application of a sequence of rules transforms state X into state Y, then any permutation of those rules that is allowable also transforms state x into state Y. Theorem proving falls under the monotonic partially communicative system.
- **Non-Monotonic Production Systems:** These are useful for solving ignorable problems. These systems are important from an implementation standpoint because they can be implemented without the ability to backtrack to previous states when it is discovered that an incorrect path was followed. This production

system increases efficiency since it is not necessary to keep track of the changes made in the search process.

- **Commutative Systems**: These are usually useful for problems in which changes occur but can be reversed and in which the order of operation is not critical. Production systems that are not usually not partially commutative are useful for many problems in which irreversible changes occur, such as chemical analysis. When dealing with such systems, the order in which operations are performed is very important and hence correct decisions must be made at the first attempt itself.

**Advantages & Disadvantages**

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.

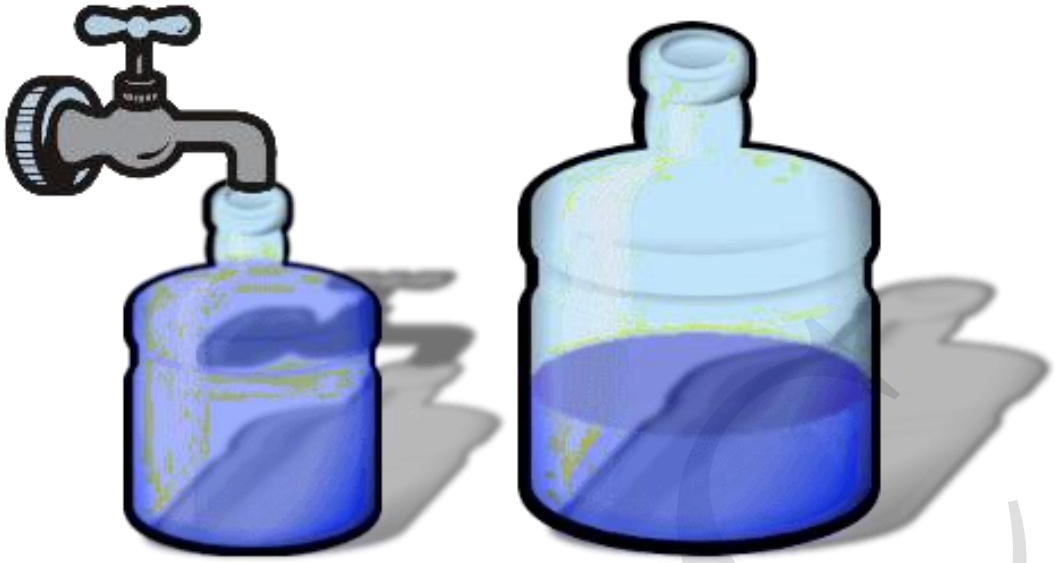
**Disadvantages:**

- 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.

**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.



Water JUG problem

1. Both can have different capacity
2. There is no marking on the can
3. But total capacity of can is given
4. Minimum steps
5. X==2 Liter
6. Y==3 Liter
7. Goal:- is to get 1 liter of water in 2 liter of can/Jug <1,0>

Solve: -

1. Initial state <0,0>
2. Intermediate State<0,3> <2,3>
3. Intermediate State<2,1> <2,0><0,3>
4. Intermediate State<0,1>
5. Goal State <1,0>

Example 4 L and 3 Liter Goal <2,0>

**Production System:**

- Fill the 5 liter jug from tap
- Empty the 5 liter jug
- Fill the 3 liter jug from tap
- Empty the 3 liter jug

- Then, empty the 3 liter jug to 5 liter

- Empty the 5 liter jug to 3 liter
- Pour water from 3 liters to 5 liters
- 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;

It is possible to have other solutions as well but these are the shortest and the 1st sequence should be chosen as it has the minimum number of steps.

X= 4 L

Y= 3 L

Goal State <2,0>

State <0,0>

<0,3>

<2,1>//

<2,0>

Solutions:-

<0,0>//Init

<0,3>//Fill Y by 3 l water <0,3>

<3,0>//fill X by 3 l (Exchanged from Y into X) <3,0>

<3,3>/ Both are filed <4,0>

<4,2>// <3,1>

<0,2>//X empty

<2,0>//Exchange

**THE PROBLEM-SOLVING PROCESS**

- In order to effectively manage and run a successful organization, leadership must guide their employees and develop problem-solving techniques.
- Finding a suitable solution for issues can be accomplished by following the basic four-step/6 problem-solving process and methodology outlined below.

| Step | Characteristics |
|---|---|

| | |
|---|---|
| 1. Define the problem 360^0 | • Differentiate fact from opinion<br>• Specify underlying causes<br>• Consult each faction involved for information |
| Step | Characteristics |
| | • State the problem specifically<br>• Identify what standard or expectation is violated<br>• Determine in which process the problem lies<br>• Avoid trying to solve the problem without data<br>• State the problem as clearly as possible.<br>• For example: “I don’t have enough money to pay the bills.”<br>• Be specific about the behaviour, situation, timing, and circumstances that make it a problem. For example: “I need to pay the phone and gas bills, and I don’t have enough money to cover both this month.” |
| 2. Generate alternative solutions | • Postpone evaluating alternatives initially<br>• Include all involved individuals in the generating of alternatives<br>• Specify alternatives consistent with organizational goals<br>• Specify short- and long-term alternatives<br>• Brainstorm on others' ideas<br>• Seek alternatives that may solve the problem<br>• List all the possible solutions; don’t worry about the quality of the solutions at this stage.<br>• Try to list at least 15 solutions, be creative and forget about the quality of the solution.<br>• If you allow yourself to be creative you may come up with some solutions that you would not otherwise have thought about. |

| | |
|---|---|
| 3. Evaluate and select an alternative | • Evaluate alternatives relative to a target standard<br>• Evaluate all alternatives without bias<br>• Evaluate alternatives relative to established goals<br>• Evaluate both proven and possible outcomes<br>• State the selected alternative explicitly<br>• The next step is to go through and eliminate less desirable or unreasonable solutions. |
| Step | Characteristics |
| | • Order the remaining solutions in order of preference.<br>• Evaluate the remaining solutions in terms of their advantages and disadvantages. |
| Step 4: Decide on a solution | • Specify who will take action.<br>• Specify how the solution will be implemented.<br>• Specify when the solution will be implemented.<br>• For example: tomorrow morning, phone the gas company and negotiate to pay the gas bill next month.<br>• |
| 5. Implement and follow up on the solution | • Plan and implement a pilot test of the chosen alternative<br>• Gather feedback from all affected parties<br>• Seek acceptance or consensus by all those affected<br>• Establish ongoing measures and monitoring<br>• Evaluate long-term results based on final solution |

| | |
|---|---|
| Step 6: Evaluate the outcome | • Evaluate how effective the solution was.<br>• Decide whether the existing plan needs to be revised, or whether a new plan is needed to better address the problem.<br>• If you are not pleased with the outcome, return to step 2 to select a new solution or revise the existing solution, and repeat the remaining steps.<br>• Problem solving is something we do every day. |

**Problem Solving in Artificial Intelligence**

- 

The reflex agent of AI directly maps states into action. Whenever these agents fail to operate in an environment where the state of mapping is too large and not easily performed by the agent, then the stated problem dissolves and sent to a problem-solving domain which breaks the large stored problem into the smaller storage area and resolves one by one. The final integrated action will be the desired outcomes.

On the basis of the problem and their working domain, different types of problem-solving agent defined and use at an atomic level without any internal state visible with a problem-solving algorithm. The problem-solving

agent performs precisely by defining problems and several solutions. So we can say that problem solving is a part of artificial intelligence that encompasses a number of techniques such as a tree, B-tree, heuristic algorithms to solve a problem.

We can also say that a problem-solving agent is a result-driven agent and always focuses on satisfying the goals.

**There are basically three types of problem in artificial intelligence:**
**1. Ignorable:** In which solution steps can be ignored.
**2. Recoverable:** In which solution steps can be undone.
**3. Irrecoverable:** Solution steps cannot be undo.
**Steps problem-solving in AI:** The problem of AI is directly associated with the nature of humans and their activities. So we need a number of finite steps to solve a problem which makes human easy works.
These are the following steps which require to solve a problem :

- **Problem definition:** Detailed specification of inputs and acceptable system solutions.
- **Problem analysis:** Analyse the problem thoroughly.
- **Knowledge Representation:** collect detailed information about the problem and define all possible techniques.
- **Problem-solving:** Selection of best techniques.

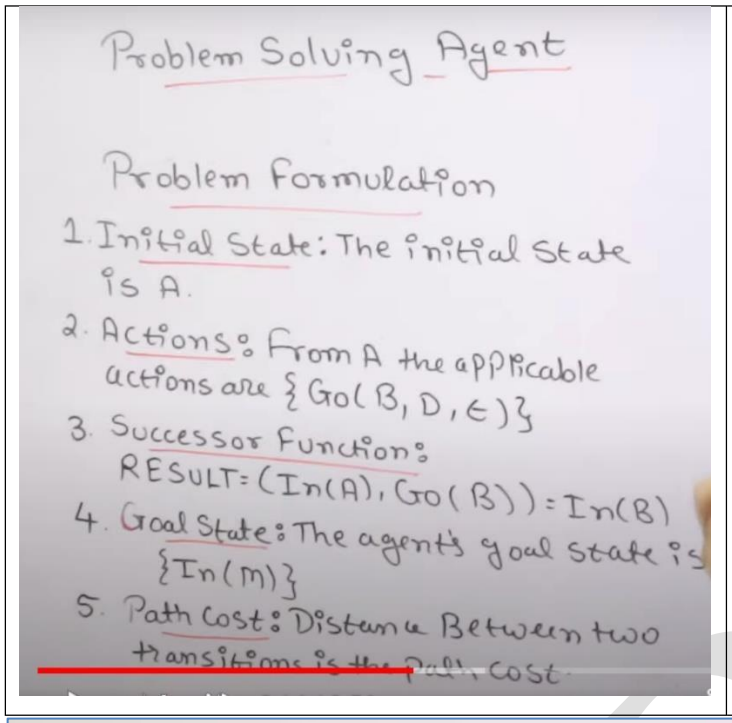
Components to formulate the associated problem:

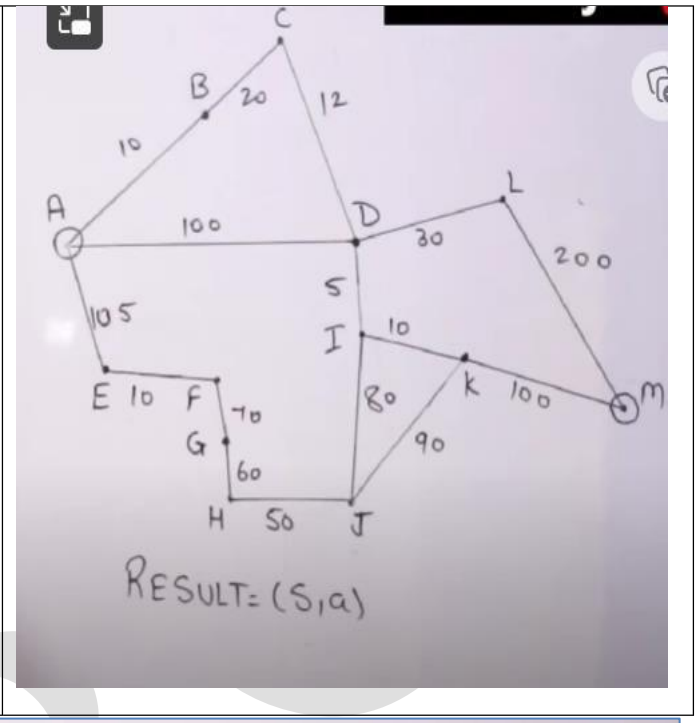
- **Initial State:** This state requires an initial state for the problem which starts the AI agent towards a specified goal. In this state new methods also initialize problem domain solving by a specific class.
- **Action:** This stage of problem formulation works with function with a specific class taken from the initial state and all possible actions done in this stage.
- **Transition:** This stage of problem formulation integrates the actual action done by the previous action stage and collects the final stage to forward it to their next stage.
- **Goal test:** This stage determines that the specified goal achieved by the integrated transition model or not, whenever the goal achieves stop the action and forward into the next stage to determines the cost to achieve the goal.
- **Path costing:** This component of problem-solving numerical assigned what will be the cost to achieve the goal. It requires all hardware software and human working cost.

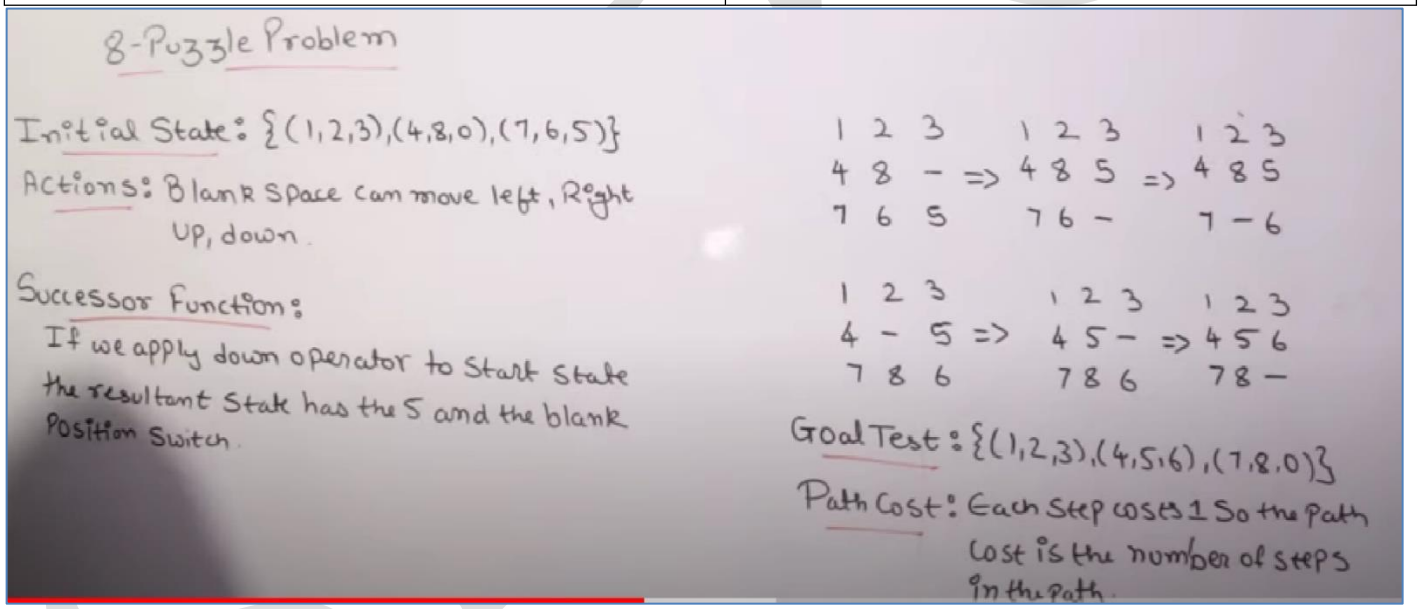
**Short Steps for PS:-**

- **Define the problem**
- **analyze the problem**
- **Identify the solution**
- **Choosing the solution**
- **Implementation**

**Example:**




**Programming Without and With AI**

| Programming Without AI | Programming With AI |
|---|---|
| A computer program without AI can answer the specific questions it is meant to solve. | A computer program with AI can answer the generic questions it is meant to solve. |

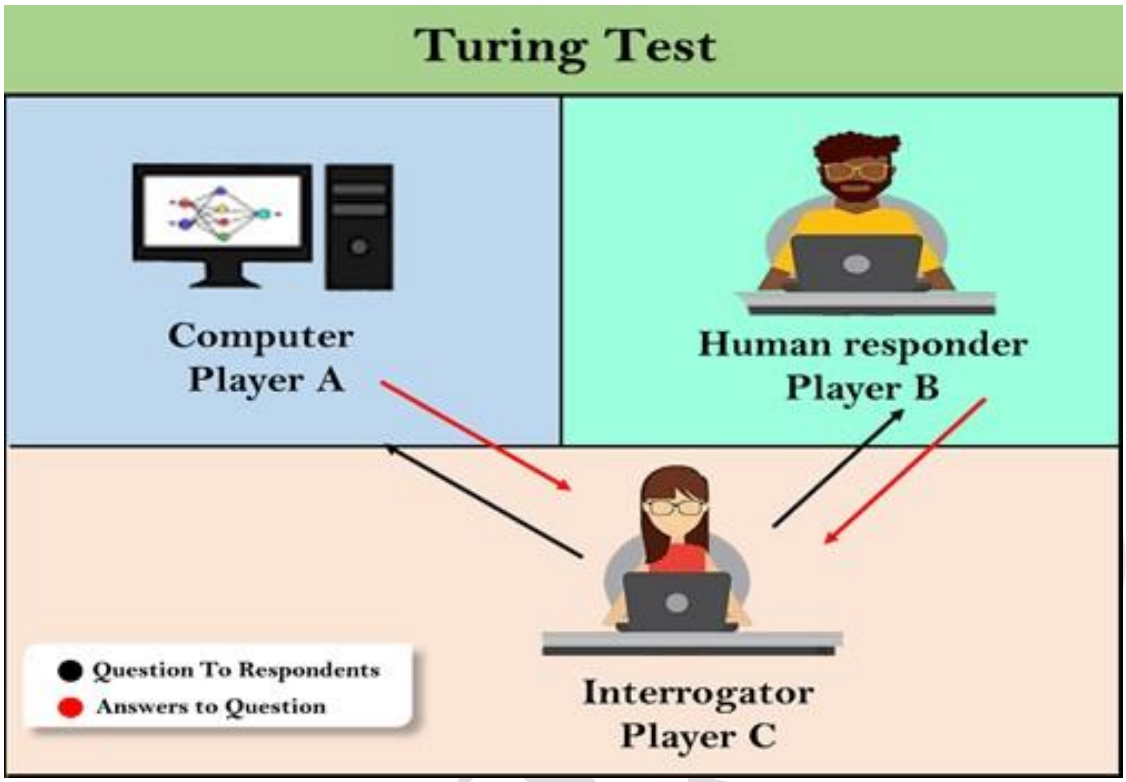
| | |
|---|---|
| Modification in the program leads to change in its structure. | AI programs can absorb new modifications by putting highly independent pieces of information together. Hence you can modify even a minute piece of information of program without affecting its structure. |
| Modification is not quick and easy. It may lead to affecting the program adversely. | Quick and Easy program modification. |

## The Turing Test Approach

- ❖ Test proposed by Alan Turing in 1950
- ❖ The computer is asked questions by a human interrogator.

The computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or not. Programming a computer to pass, the computer need to possess the following capabilities:

- ❖ Natural language processing to enable it to communicate successfully in English.
- ❖ Knowledge representation to store what it knows or hears
- ❖ Automated reasoning to use the stored information to answer questions and to draw new conclusions.
- ❖ Machine learning to adapt to new circumstances and to detect and extrapolate patterns. To pass the complete Turing Test, the computer will need
- ❖ Computer vision to perceive the objects, and
- ❖ Robotics to manipulate objects and move about.




## The cognitive modeling approach

We need to get inside actual working of the human mind:

(a) Through introspection – trying to capture our own thoughts as they go by;

(b) Through psychological experiments

Allen Newell and Herbert Simon, who developed GPS, the ―General Problem Solver‖ tried to trace the reasoning steps to traces of human subjects solving the same problems. The interdisciplinary field of cognitive science brings together computer models from AI and experimental techniques from psychology to try to construct precise and testable theories of the workings of the human mind.

## The "laws of thought approach"

The Greek philosopher Aristotle was one of the first to attempt to codify ―right thinking that is irrefutable (ie. Impossible to deny) reasoning processes. His syllogism provided patterns for argument structures that always yielded correct conclusions when given correct premises—for example, Socrates is a man; all men are mortal; therefore Socrates is mortal.‖. These laws of thought were supposed to govern the operation of the mind; their study initiated a field called logic.

## The rational agent approach

An agent is something that acts. Computer agents are not mere programs, but they are expected to have the following attributes also: (a) operating under autonomous control,

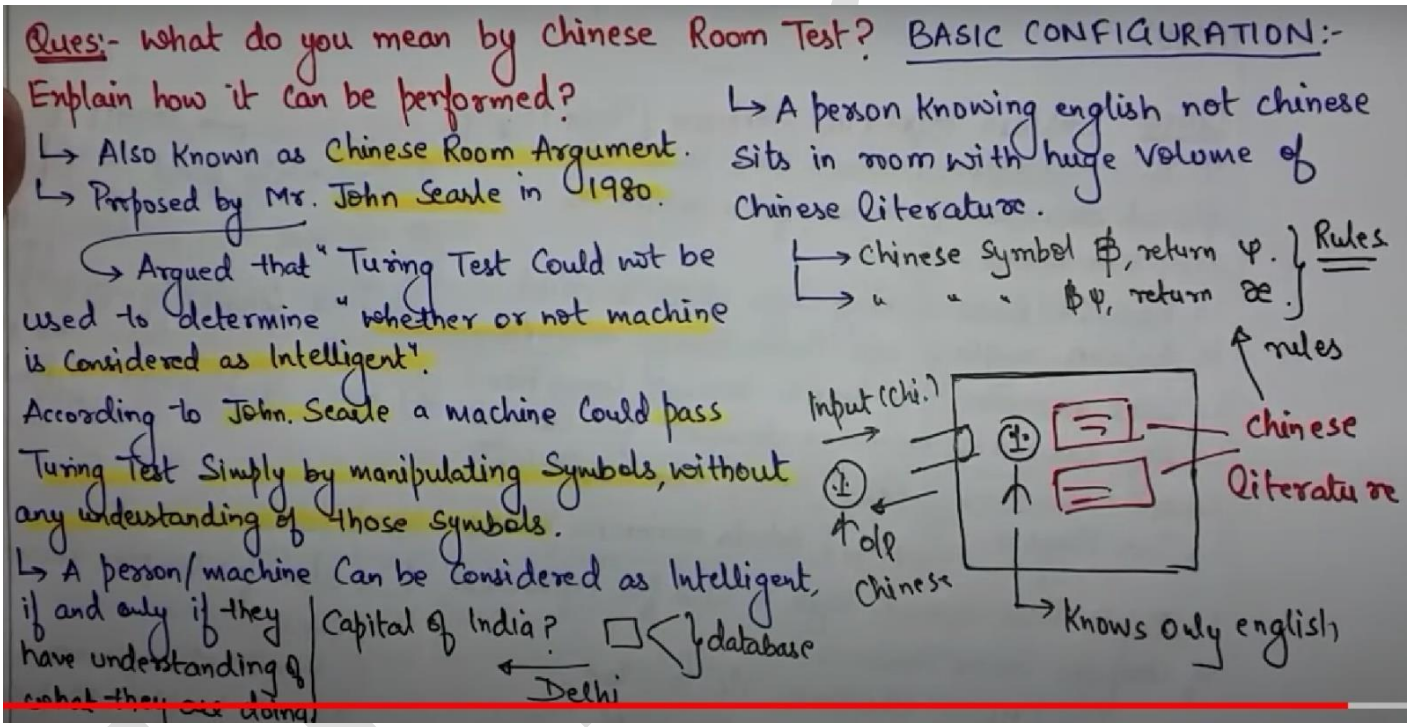
(b) perceiving their environment,

(c) persisting over a prolonged time period,

(e) adapting to change.

A rational agent is one that acts so as to achieve the best outcome.

## Chinses room test:




**Exampe:8-queens problem**

| | | | |
|---|---|---|---|
| Q1 | | | |
| | | Q2 | |
| | Q3 | | |
| | | | Q 4 |

| | | | |
|---|---|---|---|
| | Q1 | | |
| | | | Q2 |
| Q3 | | | |
| | | Q4 | |

The goal of the 8-queens problem is to place eight queens on a chessboard such that no queen attacks any other. (A queen attacks any piece in the same row, column or diagonal.

States: Any arrangement of 0 to 8 queens on the board is a state.

Initial state: No queens on the board.

Successor function: Add a queen to any empty square.

Goal test: 8 queens are on the board, none attacked.

Path cost: Zero (search cost only exists)

Fig : Solution to the 8 queens problem

# AI Problem Representation

Before the gathering of relevant information for the problem, we need to first define and represent the problem in a very precise manner. This is done using one of the commonly used approaches to represent a problem in AI. These are:

- State Space Representation
- Problem Reduction

## State Space Representation

The state space of a problem can be defined as the set of all possible states in which a problem can be represented

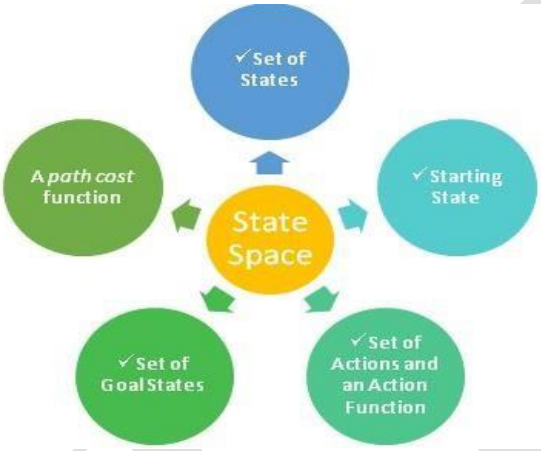
and solved.

The method of State Space Representation involves the process of defining the state space, defining the start and the goal states, and searching for a path from the start state to the goal state across this state space.

The state space hence forms a graph or tree, where states are represented as nodes and the arcs connecting the nodes represents the actions. The method of search for the goal state from the start state is governed by a set of rules known as the **production rules**.

Hence, a state space consists of the following:

- Set of States
- Starting State
- Set of Actions and an Action Function
- Set of Goal States
- Criteria to check the quality of the acceptable solution (optional)




## Example of State Space Representation

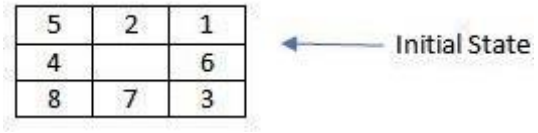
To understand the concept in a better manner, let us consider an example to solve the 8-puzzle. 8-puzzle is a tile puzzle which consists of numbers from 1-8 arranged in a 3 * 3 cube. One of the squares of the cube is empty which facilitates the motion of the squares numbered 1 to 8.

The aim of the puzzle is to reach the goal state where the numbers are arranged in an ascending order. i.e., as follows

| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| 7 | 8 | |

← Goal State

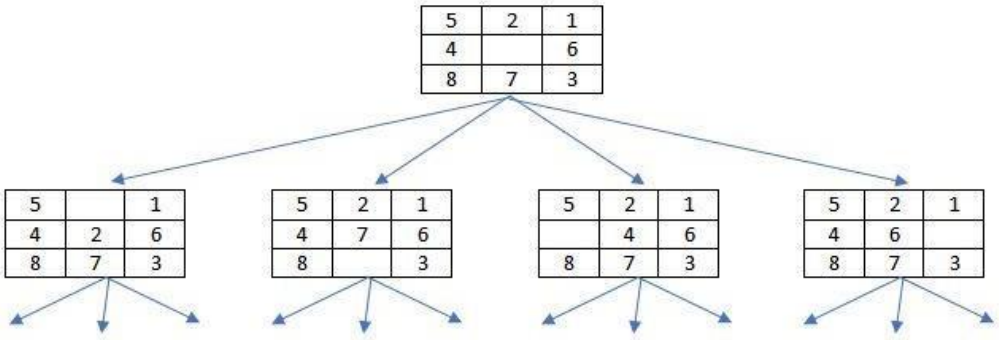
From a state where the numbers 1 to 8 are jumbled i.e.,




Now, a standard problem formulation of the above will be as follows:

- **States**–It is a set of all possible states where the location of the blank tile and the numbers will differ in each specific state.
- **Initial State –** The state from where the problem starts is its initial state.
- **Goal State –** The state to be reached is the goal state.
- **Legal Moves –** These are the rules which will be followed in order to reach the goal state. Here, the moves which are termed as legal are:
    - Blank square moves Left
    - Blank square moves Right
    - Blank square moves Up
    - Blank square moves Down
- **Cost of Path –** If we assume a cost of 1 here then the cost of the path will be the number of steps taken in order to reach the goal state.

Now, have a look at a part of the state space representation tree:




This will extend on and on till all the states are represented.

## Advantages of State Space Representation

State Space Search has the following advantages:

1. It defines a set of all possible states, operations and goal states.
2. It helps us to trace the path taken starting from the initial state to the goal state. This helps us in identifying or tracing the sequence of operations required in reaching till the goal state.

## Disadvantages of State Space Representation

State Space Search has the following disadvantages:

1. It is practically impossible to explore all the states for a given problem.
2. Due to the huge combinational states in the state space, we need a high amount of CPU resources for the computer system to handle the load efficiently.

# Problem Reduction

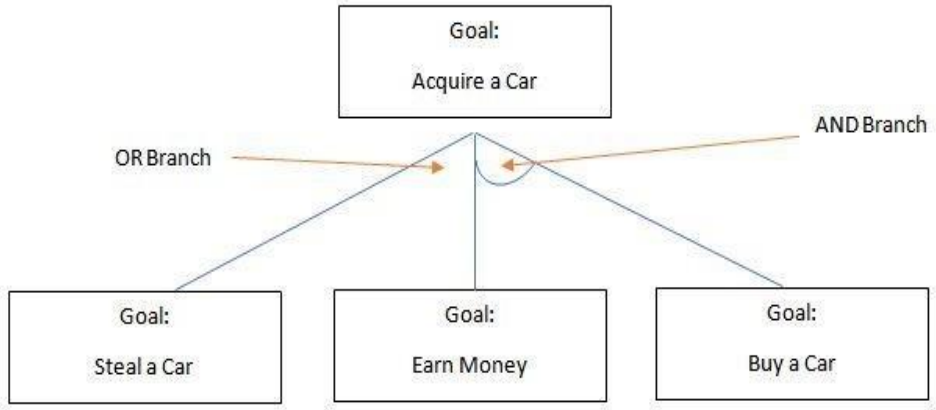
It is not an easy task to find the search space for all problems. When the problems get complex in nature it becomes easy to solve the problem by breaking it into smaller problems which would be easier to solve as compared to the problem as a whole. This is where problem reduction method is used.

In problem reduction method, the given problem is divided or broken down into a set of sub problems. Now, a solution to these sub problems is easy to obtain. Once the solutions to the sub problems are derived, these solutions are hence combined back in order to get to the solution for the problem as a whole.

The structure used to represent such problems is known as an **AND OR Graph / Tree**. In this graph, we select successor nodes based on the branch. If the branch is an AND branch, then we find solutions to all successors here. But, when we have an OR branch, then we find one best successor as the solution. Hence this graph is named the AND OR graph (or tree).

## Example for AND OR Graph

Let us assume a situation where you want to acquire a car for yourselves. Now, we would represent this situation using the AND OR graph as follows.




If we take a look at the graph, we come to know that if we pursue the AND branch then we will have to consider both the successor nodes as a combined solution for the parent node. Hence as a result we will first have to earn money first and then buy a car. But in case of an OR branch we simply select one alternate which is to steal here.

## Problem Characteristics in Artificial Intelligence

To choose an appropriate method for a particular problem first we need to categorize the problem based on the following characteristics.

1. Is the problem decomposable into small sub-problems which are easy to solve?
2. Can solution steps be ignored or undone?
3. Is the universe of the problem is predictable?
4. Is a good solution to the problem is absolute or relative?
5. Is the solution to the problem a state or a path?
6. What is the role of knowledge in solving a problem using artificial intelligence?
7. Does the task of solving a problem require human interaction?