**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**

**II YEAR / III SEM**

**CS3491 – ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**

**UNIT 1 – PROBLEM SOLVING**

**SYLLABUS:**

Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP)

## PART A

***1. What is Artificial Intelligence? Or Define Artificial Intelligence.***

- Artificial intelligence is a wide-ranging branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence.
- Artificial Intelligence is the process of building intelligent machines from vast volumes of data.
- Systems learn from past learning and experiences and perform human-like tasks.
- It enhances the speed, precision, and effectiveness of human efforts.

***2. How Artificial Intelligence is Defined? List the Types Of Approaches for Artificial Intelligence.***

- Thinking humanly: mimicking thought based on the human mind.
- Thinking rationally: mimicking thought based on logical reasoning.
- Acting humanly: acting in a manner that mimics human behavior.
- Acting rationally: acting in a manner that is meant to achieve a particular goal.

***3. What Are The Four Types Of Artificial Intelligence?***

- Reactive machines: able to perceive and react to the world in front of it as it performs limited tasks.
- Limited memory: able to store past data and predictions to inform predictions of what may come next.
- Theory of mind: able to make decisions based on its perceptions of how others feel and make decisions.

- Self-awareness: able to operate with human-level consciousness and understand its own existence.

***4. List the types of Artificial Intelligence-based on capabilities.***

- Narrow AI
- General AI
- Super AI

***5. List the types of Artificial Intelligence-based on functionalities -***

- Purely Reactive or Reactive Machines
- Limited Memory
- Theory of Mind
- Self Awareness

***6. Tabulate the comparison of Artificial Intelligence-based on functionalities.***

| Reactive Machines | Limited Memory | Theory of Mind | Self-Awareness |
|---|---|---|---|
| Simple classification and pattern recognition tasks | Complex classification tasks | Understands human reasoning and motives | Human-level intelligence that can by-pass human intelligence too |
| Great when all parameters are known | Uses historical data to make predictions | Needs fewer examples to learn because it understands motives | Sense of self-consciousness |
| Can't deal with imperfect information | Current state of AI | Next milestone for the evolution of AI | Does not exist yet |

***7. List the Four possible goals to pursue in artificial intelligence.***

- Systems that think like humans.
- Systems that think rationally.
- Systems that act like humans
- Systems that act rationally

***8. Point out the subfields of Artificial Intelligence.***

- Machine Learning
- Deep Learning
- Neural Networks
- Cognitive Computing
- Computer Vision
- Natural Language Processing

***9. What are the advantages of Artificial Intelligence?***

- Reduced human error
- Risk avoidance
- Replacing repetitive jobs
- Digital assistance

***10. List the limitations of Artificial Intelligence***

- High cost of creation.
- No emotions.
- Box thinking.
- Can't think for itself.

***11. Differentiate Deep learning vs. machine learning***

- **Machine Learning**
  - Machine Learning is the learning in which a machine can learn on its own from examples and previous experiences.
  - It is machine learning that gives AI the ability to learn.
  - This is done by using algorithms to discover patterns and generate insights from the data they are exposed to.
- **Deep Learning**
  - Deep learning, is a subcategory of machine learning, provides AI with the ability to mimic a human brain's neural network.
  - It can make sense of patterns, noise, and sources of confusion in the data.

***12. Compare Data Science, Artificial Intelligence and Machine Learning.***

| Data Science | Artificial Intelligence | Machine Learning |
|---|---|---|
| Data Science is used for data sourcing, cleaning, processing, and visualizing for analytical purposes. | AI combines iterative processing and intelligent algorithms to imitate the human brain's functions. | Machine Learning is a part of AI where mathematical models are used to empower a machine to learn with or without being programmed regularly. |
| Data Science deals with both structured and unstructured data for analytics. | AI uses decision trees and logic theories to find the best possible solution to the given problem. | Machine Learning utilizes statistical models and neural networks to train a machine. |
| Some of the popular tools in Data Science are Tableau, SAS2, Apache, MATLAB, Spark, and more. | Some of the popular libraries include Keras, Scikit-Learn, and TensorFlow. | As a subset of AI, Machine Learning also use the same libraries, along with tools such as Amazon Lex2, IBM Watson, and Azure ML Studio. |

| | | |
|---|---|---|
| Data Science includes data operations based on user requirements. | AI includes predictive modeling to predict events based on the previous and current data. | ML is a subset of Artificial Intelligence. |
| It is mainly used in fraud detection, healthcare, BI analysis, and more. | Applications of AI include chat bots, voice assistants, and weather prediction. | Online recommendations, facial recognition, and NLP are a few examples of ML. |

***13. List the various Applications of Artificial Intelligence or AI Applications.***

- AI Application in E-Commerce
  - Personalized Shopping
  - AI-powered Assistants
  - Fraud Prevention
- AI Application in Education
  - Administrative Tasks Automated to Aid Educators
  - Creating Smart Content
  - Voice Assistants
  - Personalized Learning
- AI Application in Lifestyle
  - Autonomous Vehicles
  - Spam Filters
  - Facial Recognition
  - Recommendation System
- AI Application in Navigation
- AI Application in Robotics
  - Carrying goods in hospitals, factories, and warehouses
  - Cleaning offices and large equipment
  - Inventory management
- AI Application in Human Resource
- AI Application in Healthcare
- AI Application in Agriculture
- AI Application in Gaming
- AI Application in Automobiles
- AI Application in Social Media
  - Instagram
  - Facebook
  - Twitter
- AI Application in Marketing
- AI Application in Chatbots

## PART B

**1. Define Artificial Intelligence and its types, goals, advantages and limitations in detail.**

**ARTIFICIAL INTELLIGENCE:**


***1.1 Artificial Intelligence Definition***

***1.2 Types of Artificial Intelligence***

*1.2.1 Types of Artificial Intelligence-based on capabilities*

*1.2.2 Types of Artificial Intelligence-based on functionalities*

***1.3 Four possible goals to pursue in artificial intelligence:***

*1.3.1 Acting humanly: The Turing test approach*

*1.3.2 Thinking humanly: The cognitive modeling approach*

*1.3.3 Thinking rationally: The "laws of thought" approach*

*1.3.4 Acting rationally: The rational agent approach*

***1.4 Subfields of Artificial Intelligence***

***1.5 Advantages of Artificial Intelligence***

***1.6 Limitations of Artificial Intelligence***


### 1.1 Artificial Intelligence Definition

- Artificial Intelligence is the process of building intelligent machines from vast volumes of data.
- Systems learn from past learning and experiences and perform human-like tasks.
- It enhances the speed, precision, and effectiveness of human efforts.
- AI uses complex algorithms and methods to build machines that can make decisions on their own as shown in Figure 1.1.
- Machine Learning and Deep learning forms the core of Artificial Intelligence.

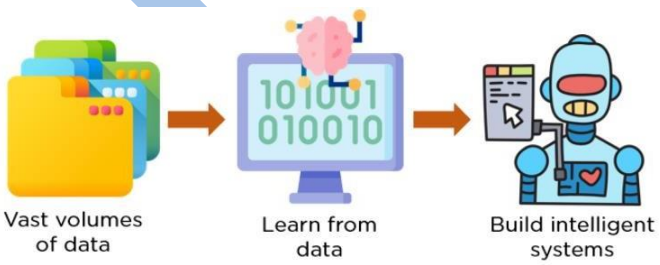



***Figure 1.1 - Artificial Intelligence***

### 1.2 Types of Artificial Intelligence

- Artificial Intelligence can be divided based on capabilities and functionalities as in figure 1.2.
- Types of Artificial Intelligence-based on capabilities -
  - Narrow AI
  - General AI
  - Super AI

- Types of Artificial Intelligence-based on functionalities -
  - Reactive Machines
  - Limited Memory
  - Theory of Mind
  - Self Awareness

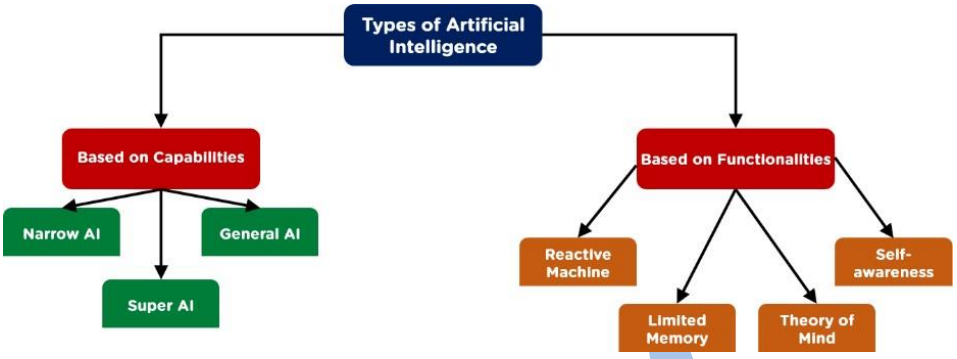



*Figure 1.2 - Types of Artificial Intelligence*

### 1.2.1 Types of Artificial Intelligence-based on capabilities -

- Narrow AI
- General AI
- Super AI

- **Narrow AI**:
  - Referred as Weak AI, focuses on one automate specific task and cannot perform beyond its limitations.
  - Example: Alexa and other smart assistants, Self-driving cars, Google search, Email spam filters, Netflix's recommendations,
- **Artificial General Intelligence (AGI)**:
  - Referred as "strong AI," can understand and learn any intellectual task that a human being can.
  - Example: Fujitsu has built the K computer, which is one of the fastest supercomputers in the world
- **Super Intelligence**:
  - Super AI surpasses human intelligence and can perform any task better than a human.
  - Some of the critical characteristics of super AI include thinking, solving puzzles, making judgments, and decisions on its own.

### 1.2.2 Types of Artificial Intelligence-based on functionalities -

- Purely Reactive or Reactive Machines
- Limited Memory
- Theory of Mind
- Self Awareness

- **Purely Reactive or Reactive Machines**
  - These machines do not have any memory or data to work with, specializing in just one field of work.
  - For example, in a chess game, the machine observes the moves and makes the best possible decision to win.
- **Limited Memory**
  - These machines collect previous data and continue adding it to their memory.
  - They have enough memory or experience to make proper decisions, but memory is minimal.
  - For example, this machine can suggest a restaurant based on the location data that has been gathered.
- **Theory of Mind**
  - This kind of AI can understand thoughts and emotions, as well as interact socially. However, a machine based on this type is yet to be built.
- **Self-Aware**
  - Self-aware machines are the future generation of the new technologies. It will be intelligent, sentient, and conscious.

***Table 1.1 - Comparison of types of Artificial Intelligence-based on functionalities:***

| Reactive Machines | Limited Memory | Theory of Mind | Self-Awareness |
|---|---|---|---|
| Simple classification and pattern recognition tasks | Complex classification tasks | Understands human reasoning and motives | Human-level intelligence that can by-pass human intelligence too |
| Great when all parameters are known | Uses historical data to make predictions | Needs fewer examples to learn because it understands motives | Sense of self-consciousness |
| Can't deal with imperfect information | Current state of AI | Next milestone for the evolution of AI | Does not exist yet |

## 1.3 Four possible goals to pursue in artificial intelligence:

- Systems that think like humans.
- Systems that think rationally.
- Systems that act like humans
- Systems that act rationally
  - Refer Figure 1.3

**Four Approaches from two dimensions**

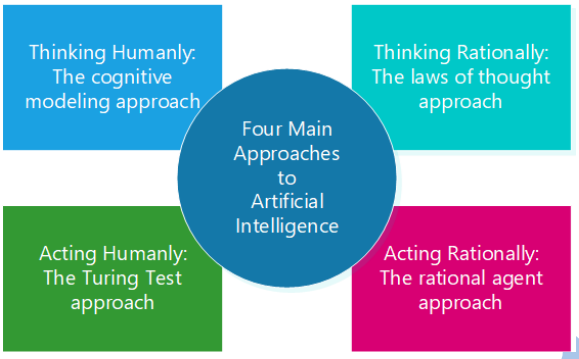



***Figure 1.3 - Four Approaches from two dimensions***

### 1.3.1 Acting humanly: The Turing test approach

- The **Turing test**, proposed by Alan Turing (1950), was designed as a method for determining if a machine is intelligent or not.
- The computer would need the following capabilities:
  - **natural language processing** to communicate successfully in a human language;
  - **knowledge representation** to store what it knows or hears;
  - **automated reasoning** to answer questions and to draw new conclusions;
  - **machine learning** to adapt to new circumstances and to detect and extrapolate patterns.
- However, other researchers have proposed a **total Turing test**.
- To pass the total Turing test, a robot will need
  - **computer vision** and speech recognition to perceive the world;
  - **robotics** to manipulate objects and move about.

### 1.3.2 Thinking humanly: The cognitive modeling approach

- Thinking humanly is to make a system or program to think like a human.
- Can learnabout human thought in three ways:
  - **Introspection**—trying to catch own thoughts as they go by;
  - **Psychological experiments**—observing a person in action;
  - **Brain imaging**—observing the brain in action.

**Cognitive Science**

- Cognitive science is the interdisciplinary study of mind and intelligence, embracing philosophy, psychology, artificial intelligence, neuroscience, linguistics, and anthropology.

### 1.3.3 Thinking rationally: The "laws of thought" approach

- The Greek philosopher Aristotle was one of the first to attempt to codify "right thinking"—that is, irrefutable reasoning processes.
- His **syllogisms** provided patterns for argument structures that always yielded correct conclusions when given correct premises.
- These laws of thought were supposed to govern the operation of the mind; the study initiated the field called **logic**.
- By 1965, programs could solve *any* solvable problem described in logical notation. The so-called **logicist** tradition.
- The theory of **probability** allows rigorous reasoning with uncertain information.
- In principle, it allows the construction of a comprehensive model of rational thought, leading from raw perceptual information to an understanding of how the world works to predictions about the future.

### 1.3.4 Acting rationally: The rational agent approach

- An **agent** is just something that acts to do.
- Computer agents are expected to do more: operate autonomously, perceive their environment, persist over a prolonged time period, adapt to change, and create and pursue goals.
- A **rational agent** is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.

## 1.4 Subfields of Artificial Intelligence

- **Machine Learning**
  - Machine Learning is the learning in which a machine can learn on its own from examples and previous experiences.
  - It is machine learning that gives AI the ability to learn.
  - This is done by using algorithms to discover patterns and generate insights from the data they are exposed to.

  **Deep Learning**
  - Deep learning, is a subcategory of machine learning, provides AI with the ability to mimic a human brain's neural network.
  - It can make sense of patterns, noise, and sources of confusion in the data.
- **Neural Networks**
  - Artificial Neural Networks (ANNs) are one of the most important tools in Machine Learning to find patterns within the data, which are far too complex for a human to figure out and teach the machine to recognize.

- **Cognitive Computing:**
  - The ultimate goal of cognitive computing is to imitate the human thought process in a computer model.
  - Using self-learning algorithms, pattern recognition by neural networks, and natural language processing, a computer can mimic the human way of thinking.
  - Here, computerized models are deployed to simulate the human cognition process.
- **Computer Vision:**
  - Computer vision works by allowing computers to see, recognize, and process images, the same way as human vision does, and then it provides an appropriate output.
  - The computer must understand what it sees, and then analyze it, accordingly.
- **Natural Language Processing:**
  - Natural language processing means developing methods that help us communicate with machines using natural human languages like English.

## 1.5 Advantages of Artificial Intelligence

- **Reduced human error:**
  - With humans involved in the tasks where precision is required, there will always be a chance of error. However, if programmed properly, machines do not make mistakes and easily perform repetitive tasks without making many errors, if not at all.
- **Risk avoidance:**
  - Replacing humans with intelligent robots is one of the biggest advantages of Artificial Intelligence.
- **Replacing repetitive jobs:**
  - Our day-to-day work includes many repetitive tasks that we have to do every day without any change. Now, machines have replaced these tasks so that humans can spend this time doing creative things.
- **Digital assistance:**
  - With digital assistants to interact with users 24/7, organizations can save the need for human resources and deliver faster service to customers.

## 1.6 Limitations of Artificial Intelligence

- High cost of creation.
- No emotions.
- Box thinking.
- Can't think for Itself.

## 2. Compare and differentiate between Data Science vs Artificial Intelligence Vs. Machine Learning.

**DATA SCIENCE Vs. ARTIFICIAL INTELLIGENCE**
*2.1 Deep learning vs. machine learning*
*2.2 Data Science vs. Artificial Intelligence vs. Machine Learning*

### 2.1 Deep learning vs. machine learning

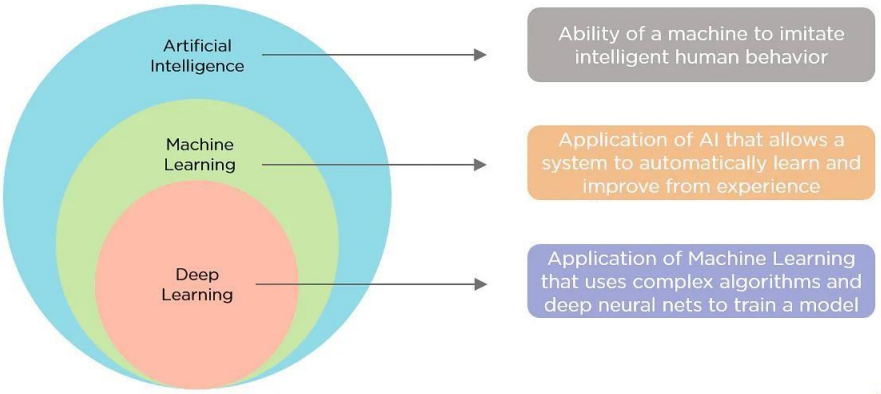



***Figure 1.4 - Deep learning vs. machine learning***

- "Artificial intelligence is a set of algorithms and intelligence to try to mimic human intelligence.
- Machine learning is one of them, and deep learning is one of those machine learning techniques as shown in figure 1.4."
- **Machine Learning**
  - Machine Learning is the learning in which a machine can learn on its own from examples and previous experiences.
  - It is machine learning that gives AI the ability to learn.
  - This is done by using algorithms to discover patterns and generate insights from the data they are exposed to.
- **Deep Learning**
  - Deep learning, is a subcategory of machine learning, provides AI with the ability to mimic a human brain's neural network.
  - It can make sense of patterns, noise, and sources of confusion in the data.

### 2.2 Data Science vs. Artificial Intelligence vs. Machine Learning

- Data Science, Machine Learning, and Artificial Intelligence are interconnected, but each one of them uniquely serves a different purpose as mentioned in table 1.2

*Table 1.2 - Comparison of Data Science, Artificial Intelligence and Machine Learning:*

| Data Science | Artificial Intelligence | Machine Learning |
|---|---|---|
| Data Science is used for data sourcing, cleaning, processing, and visualizing for analytical purposes. | AI combines iterative processing and intelligent algorithms to imitate the human brain's functions. | Machine Learning is a part of AI where mathematical models are used to empower a machine to learn with or without being programmed regularly. |
| Data Science deals with both structured and unstructured data for analytics. | AI uses decision trees and logic theories to find the best possible solution to the given problem. | Machine Learning utilizes statistical models and neural networks to train a machine. |
| Some of the popular tools in Data Science are Tableau, SAS2, Apache, MATLAB, Spark, and more. | Some of the popular libraries include Keras, Scikit-Learn, and TensorFlow. | As a subset of AI, Machine Learning also use the same libraries, along with tools such as Amazon Lex2, IBM Watson, and Azure ML Studio. |
| Data Science includes data operations based on user requirements. | AI includes predictive modeling to predict events based on the previous and current data. | ML is a subset of Artificial Intelligence. |
| It is mainly used in fraud detection, healthcare, BI analysis, and more. | Applications of AI include chat bots, voice assistants, and weather prediction. | Online recommendations, facial recognition, and NLP are a few examples of ML. |

**3. Explain the history of artificial intelligence.**

- The important events and milestones in the evolution of artificial intelligence include the following:

**1943:**

- The first work that is now generally recognized as AI was done by Warren McCulloch and Walter Pitts (1943).
- Inspired by the mathematical modeling work of Pitts's advisor Nicolas they drew on three sources:
  - knowledge of the basic physiology and function of neurons in the brain;
  - a formal analysis of propositional logic;
  - Turing's theory of computation.

**1949:**

- Donald Hebb (1949) demonstrated a simple updating rule for modifying the connection strengths between neurons.
- His rule, now called Hebbian learning, remains an influential model to this day.

**1950:**

- Alan Turing publishes *Computing Machinery and Intelligence.* In the paper, Turing—proposes to answer the question 'can machines think?' and introduces the Turing Test to determine if a computer can demonstrate the same intelligence as a human. The value of the Turing test has been debated ever since.

**1956:**

- John McCarthy coins the term 'artificial intelligence' at the first-ever AI conference at Dartmouth College. Later that year, Allen Newell, J.C. Shaw, and Herbert Simon create the Logic Theorist, the first-ever running AI software program.

**1958:**

- In 1958, John McCarthy had defined the high-level language Lisp, which was to become the dominant AI programming language for the next 30 years.

**1959:**

- At IBM, Nathaniel Rochester and his colleagues produced some of the first AI programs.
- Herbert Gelernter (1959) constructed the Geometry Theorem Prover, which was able to prove theorems that many students of mathematics would find quite tricky.

**1967:**

- Frank Rosenblatt builds the Mark 1 Perceptron, the first computer based on a neural network that 'learned' though trial and error.

**1980s:**

- Neural networks which use a back propagation algorithm to train itself become widely used in AI applications.

**1997:**

- IBM's Deep Blue beats then world chess champion Garry Kasparov, in a chess match (and rematch).

**2011:**

- IBM Watson beats champions Ken Jennings and Brad Rutter at *Jeopardy!*

**2015:**

- Baidu'sMinwa supercomputer uses a special kind of deep neural network called a convolution neural network to identify and categorize images with a higher rate of accuracy than the average human.

**2016:**

- DeepMind'sAlphaGo program, powered by a deep neural network, beats Lee Sodol, the world champion Go player, in a five-game match.

- The first "robot citizen," a humanoid robot named Sophia, is created by Hanson Robotics and is capable of facial recognition, verbal communication and facial expression.

**2018:**

- Google releases natural language processing engine BERT, reducing barriers in translation and understanding by ML applications.

**2020:**

- Baidu releases its Linear Fold AI algorithm to scientific and medical teams working to develop a vaccine during the early stages of the SARS-CoV-2 pandemic.
- OpenAI releases natural language processing model GPT-3, which is able to produce text modeled after the way people speak and write.

**2022:**

- The National Institute of Standards and Technology releases the first draft of its AI Risk Management Framework, voluntary U.S. guidance "to better manage risks to individuals, organizations, and society associated with artificial intelligence."
- DeepMind unveils Gato, an AI system trained to perform hundreds of tasks, including playing Atari, captioning images and using a robotic arm to stack blocks.

## 4. List and explain the various Applications of Artificial Intelligence or AI Applications.

**APPLICATIONS OF AI:**

*4.1. AI Application in E-Commerce*
*4.2. AI Application in Education*
*4.3. AI Application in Lifestyle*
*4.4. AI Application in Navigation*
*4.5. AI Application in Robotics*
*4.6. AI Application in Human Resource*
*4.7. AI Application in Healthcare*
*4.8. AI Application in Agriculture*
*4.9. AI Application in Gaming*
*4.10. AI Application in Automobiles*
*4.11. AI Application in Social Media*
*4.12. AI Application in Marketing*
*4.13. AI Application in Chatbots*
*4.14. AI Application in Finance*

### 4.1. AI Application in E-Commerce

- **Personalized Shopping**
  - Artificial Intelligence technology is used to create recommendation engines.

- These recommendations are made in accordance with their browsing history, preference, and interests.
- It helps in improving the relationship with the customers and the loyalty towards the 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.
- **Fraud Prevention**
  - Credit card frauds and fake reviews are two of the most significant issues that E-Commerce companies deal with.
  - Many customers prefer to buy a product or service based on customer reviews.
  - AI can help identify and handle fake reviews.

### 4.2. AI Application in Education

- **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.
  - 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.
- **Personalized Learning**
  - Using top AI technologies, 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.

### 4.3. AI Application in Lifestyle

- **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 has AI that filters out spam emails sending them to spam or trash folders.
  - The popular email provider, Gmail, has managed to reach a filtration capacity of approximately 99.9%.
- **Facial Recognition**
  - 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.
  - Facial recognition is a widely used Artificial Intelligence application even in high security-related areas in several industries.
- **Recommendation System**
  - Various platforms in 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.

### 4.4. AI Application in Navigation

- The technology uses a combination of Convolution 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.

### 4.5. AI Application 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

### 4.6. AI Application in Human Resource

- Artificial Intelligence helps with blind hiring.
- AI drive systems can scan job candidates' profiles, and resumes to provide recruiters an understanding of the talent pool they must choose from.

### 4.7. AI Application in Healthcare

- 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.

### 4.8. AI Application 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.

### 4.9. AI Application in Gaming

- 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.

### 4.10. AI Application 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.

### 4.11. AI Application in Social Media

- Instagram
- Facebook
- Twitter

### 4.12. AI Application in Marketing

- Artificial intelligence (AI) applications are popular in the marketing domain as well.
- AI can provide users with real-time personalization's based on their behavior and can be used to edit and optimize marketing campaigns to fit a local market's needs.

### 4.13. AI Application 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.
- As AI continues to improve, these chatbots can effectively resolve customer issues, respond to simple inquiries, improve customer service, and provide 24/7 support.

### 4.14. AI Application in Finance

- 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.
- 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.

## 5. Explain in detail about agents and its types in detail.

**AGENTS**

*5.1 Agents and Environments*
*5.2 Basic Terminologies*
*5.3 Steps in designing an agent*
*5.4 Types of Agent*

## 5.1 Agents and Environments

### Agent

- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators as in Figure 1.5.
- **Example:**
  - A human agent has eyes, ears, and other organs for sensors and hands, legs, vocaltract, and so on for actuators.
  - A robotic agent might have cameras and infrared range findersfor sensors and various motors for actuators.
  - A software agent receives file contents, network packets, and human input (keyboard/mouse/touch screen/voice) as sensory inputsand acts on the environment by writing files, sending network packets, and displaying information or generating sounds.

### Environments

- The environment could be everything—the entire universe.

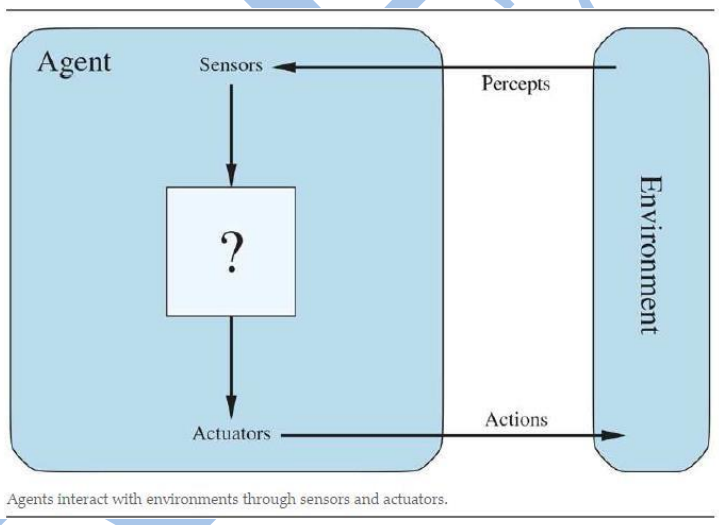



***Figure 1.5: Agents and Environments***

## 5.2 Basic Terminologies

### Agent Function

- The agent function for an agent specifies the action taken by the agent in response to any percept sequence.

### Performance Measure

- The performance measure evaluates the behavior of the agent in an environment.

**Rational Agent**

- A rational agent acts so as to maximize the expected value of the performance measure, given the percept sequence it has seen so far.

**Task Environment**

- A task environment specification includes the performance measure, the external environment, the actuators, and the sensors.

## 5.3 Steps in designing an agent

- In designing an agent, the first step must always be to specify the task environment as fully as possible.
- The agent program implements the agent function.
- There exists a variety of basic agent program designs reflecting the kind of information made explicit and used in the decision process.
- The designs vary in efficiency, compactness, and flexibility.
- The appropriate design of the agent program depends on the nature of the environment.
- All agents can improve their performance through learning.

## 5.4 Types of Agent

- **Simple reflex agents** respond directly to percepts. Refer fig 1.6
- **Model-based reflex** agents maintain internal state to track aspects of the world that are not evident in the current percept. Refer fig 1.7
- **Goal-based agents** act to achieve their goals Refer fig 1.8
- **Utility-based agents** try to maximize their own expected "happiness." Refer fig 1.9

## Simple reflex agents

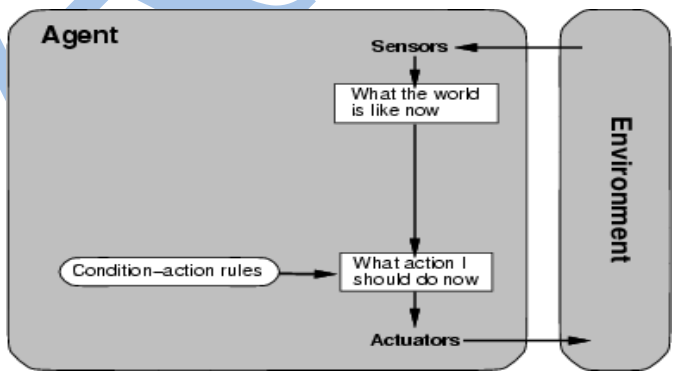



***Figure 1.6: Simple reflex agents***

## Model-based reflex

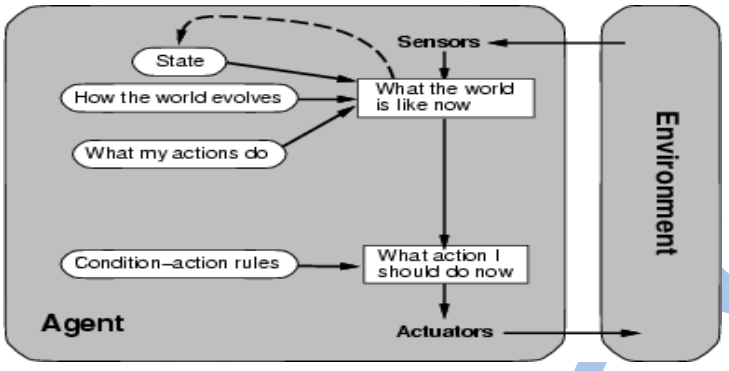



*Figure 1.7: Model-based reflex*

## Goal-based agents

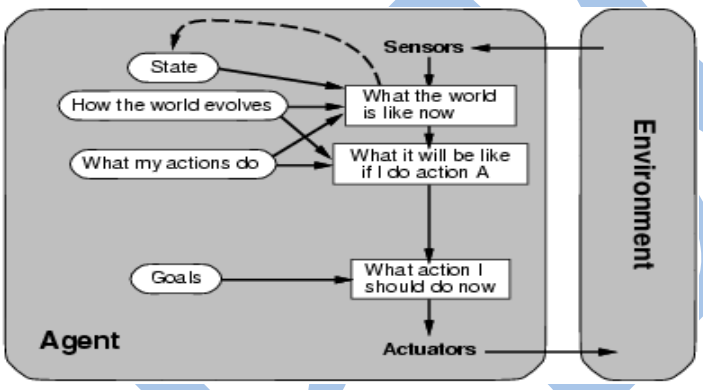



*Figure 1.8: Goal-based agents*

## Utility-based agents

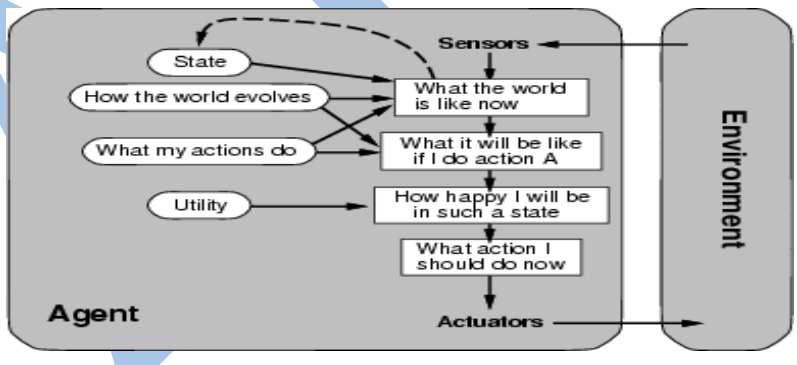



*Figure 1.9: Utility-based agents*

## Learning agents:

It allows the agent to operate in initially unknown environments and to become more competent than its initial knowledge alone might allow. A learning agent can be divided into four conceptual components, as shown in figure 1.10:

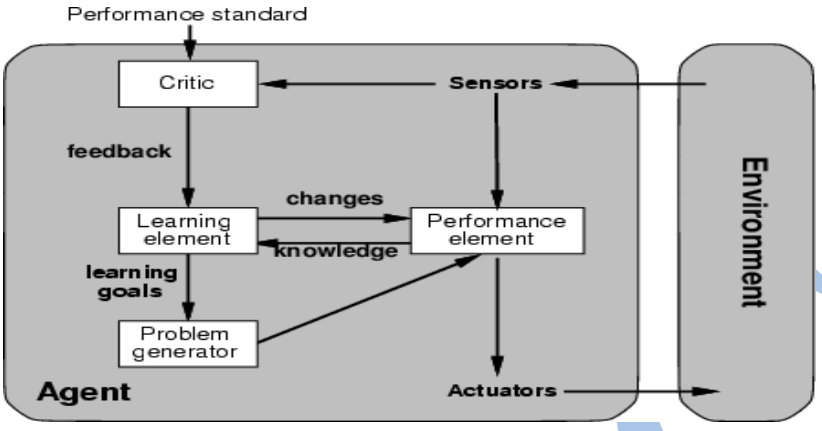



***Figure 1.10: Learning agents***

**6. Explain in detail about problem solving agent with example in detail.**

**PROBLEM SOLVING AGENT**

*6.1 Problem Solving Agent Definition*
*6.2 Steps performed by Problem-solving agent*
*6.3 Types of problem approaches:*
*6.3.1 Toy Problem or Standardized Problem*
*6.3.2 Real-world Problem*

### 6.1 Problem Solving Agent Definition

- Problem-solving agent is a goal-based agent that focus on goals using a group of algorithms and techniques to solve a well-defined problem.
- An agent may need to plan a sequence of actions that form a path to a goal state.
- Such an agent is called a problem-solving agent, and the computational process it undertakes is called search.

### 6.2 Steps performed by Problem-solving agent

- **Goal Formulation:**
  - It is the first and simplest step in problem-solving.
  - It organizes the steps/sequence required to formulate one goal out of multiple goals as well as actions to achieve that goal. Goal

formulation is based on the current situation and the agent's performance measure

- **Problem Formulation:**
  - It is the most important step of problem-solving which decides what actions should be taken to achieve the formulated goal.
  - **Components** in problem formulation:
    1. **Initial State:** It is the starting state or initial step of the agent towards its goal.
    2. **Actions:** It is the description of the possible actions available to the agent.
    3. **Transition Model:** It describes what each action does.
    4. **Goal Test:** It determines if the given state is a goal state.
    5. **Path cost:** It assigns a numeric cost to each path that follows the goal.

    The problem-solving agent selects a cost function, which reflects its performance measure.
  - Initial state, actions, and transition model together define the state-space of the problem implicitly.
  - State-space of a problem is a set of all states which can be reached from the initial state followed by any sequence of actions.
  - The state-space forms a directed map or graph where nodes are the states, links between the nodes are actions, and the path is a sequence of states connected by the sequence of actions.
- **Search:**
  - It identifies all the best possible sequence of actions to reach the goal state from the current state. It takes a problem as an input and returns solution as its output.
- **Solution:**
  - It finds the best algorithm out of various algorithms, which may be proven as the best optimal solution.
- **Execution:**
  - It executes the best optimal solution from the searching algorithms to reach the goal state from the current state.

## 6.3 Types of problem approaches:

### 6.3.1 Toy Problem or Standardized Problem:

- It is a concise and exact description of the problem which is used by the researchers to compare the performance of algorithms.

**Example Problem 1 - 8 Puzzle Problem:**

- Consider a 3x3 matrix with movable tiles numbered from 1 to 8 with a blank space.
- The tile adjacent to the blank space can slide into that space.
- The objective is to reach a specified goal state similar to the goal state, as shown in the below figure 1.11
- The task is to convert the current state into goal state by sliding digits into the blank space

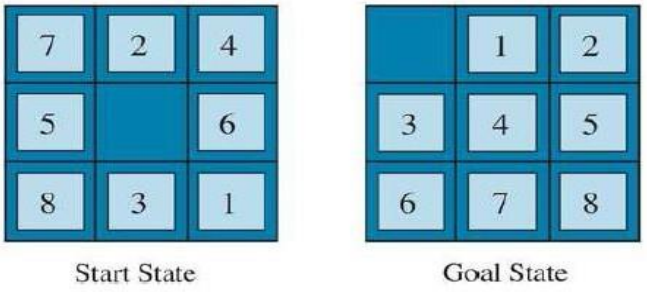



***Figure 1.11: Agents and Environments***

**The problem formulation is as follows:**

- **States:**
  - It describes the location of each numbered tiles and the blank tile.
- **Initial State:**
  - Can start from any state as the initial state.
- **Actions:**
  - Actions of the blank space is defined, i.e., either **left, right, up or down**
- **Transition Model:**
  - It returns the resulting state as per the given state and actions.
- **Goal test:**
  - It identifies whether have reached the correct goal-state.
- **Path cost:**
  - The path cost is the number of steps in the path where the cost of each step is 1.

**Note:** The 8-puzzle problem is a type of sliding-block problem which is used for testing new search algorithms in artificial intelligence.

**Example Problem 2 – Grid World Problem:**

- A **grid world** problem is a two-dimensional rectangular array of square cells in which agents can move from cell to cell.
- Typically the agent can move to any obstacle-free adjacent cell—horizontally or vertically and in some problems diagonally.

- Cells can contain objects, which the agent can pick up, push, or otherwise act upon; a wall or other impassible obstacle in acell prevents an agent from moving into that cell.
- The **vacuum world** canbe formulated as a grid world problem as shown in figure 1.12:

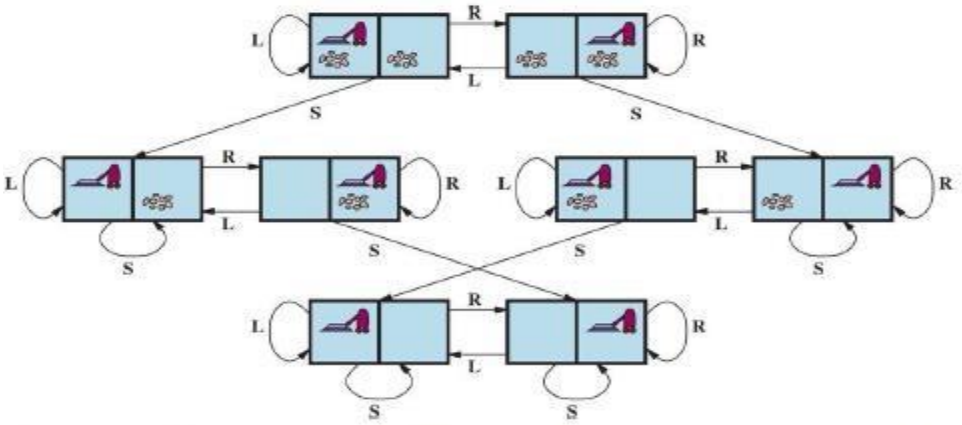



***Figure 1.12: Vacuum World***

**The problem formulation is as follows:**

- **States:**
  - For the vacuum world, the objects are the agent and any dirt. In the simple two-cell version, the agent can be in either of the two cells, and each cell can either contain dirt or not.
- **Initial state:**
  - Any state can be designated as the initial state.
- **Actions:**
  - In the two-cell world three actions are: *suck*, move *left*, and move *Right*, *upward* and *downward*, or *forward, backward, turnright*, and *turnleft*.
- **Transition model:**
  - *Suck* removes any dirt from the agent's cell;
  - *Forward* moves the agent ahead one cell in the direction it is facing, unless it hits a wall, in which case the action has no effect.
  - *Backward* moves the agent in the opposite direction
  - *Turnright* and *turnleft* change the direction it is facing by.
- **Goal states:**
  - The states in which every cell is clean.
- **Action cost:**
  - Each action costs 1.

### 6.3.2 Real-world Problem:

- It is real-world based problems which require solutions.

**Example Problem 1 – Route-Finding Problem:**

- **Route-finding problem** is defined in terms of specified locations and transitions along edges between them.

**The problem formulation is as follows:**

- Consider the airline travel problems that must be solved by a travel-planning Web site:

- **States:**
  - Each state obviously includes a location (e.g., an airport) and the current time.
- **Initial state:**
  - The user's home airport.
- **Actions:**
  - Take any flight from the current location, in any seat class, leaving after the current time, leaving enough time for within-airport transfer if needed.
- **Transition model:**
  - The state resulting from taking a flight will have the flight's Destination as the new location and the flight's arrival time as the new time.
- **Goal state:**
  - A destination city.
- **Action cost:**
  - A combination of monetary cost, waiting time, flight time, customs and Immigration procedures, seat quality, time of day, type of airplane, frequent-flyer reward Points, and so on.

**Algorithm – Problem solving agent**

```
function SIMPLE-PROBLEM-SOLVING-AGENT(percept) returns an action
  persistent: seq, an action sequence, initially empty
              state, some description of the current world state
              goal, a goal, initially null
              problem, a problem formulation

  state ← UPDATE-STATE(state, percept)
  if seq is empty then
      goal ← FORMULATE-GOAL(state)
      problem ← FORMULATE-PROBLEM(state, goal)
      seq ← SEARCH(problem)
      if seq = failure then return a null action
  action ← FIRST(seq)
  seq ← REST(seq)
  return action
```

**7. Explain in detail about search algorithms in detail with example.**

**SEARCH ALGORITHMS**

**7.1 Search Algorithm**

**7.2 Types of Search Algorithm**

**7.2.1 UNINFORMED SEARCH ALGORITHMS**

7.2.1.1 Depth First Search

7.2.1.2 Depth Limited Search

7.2.1.3 Breadth First Search

7.2.1.4 Iterative Deepening Search

7.2.1.5 Uniform Cost Search

7.2.1.6 Bidirectional Search

**7.2.2 INFORMED (HEURISTIC) SEARCH STRATEGIES**

7.2.2.1 Greedy Search

7.2.2.2 A* Tree Search

7.2.2.3 A* Graph Search

## 7.1 Search Algorithm

- A search algorithm takes a search problem as input and returns a solution.

## 7.2 Types of Search Algorithm

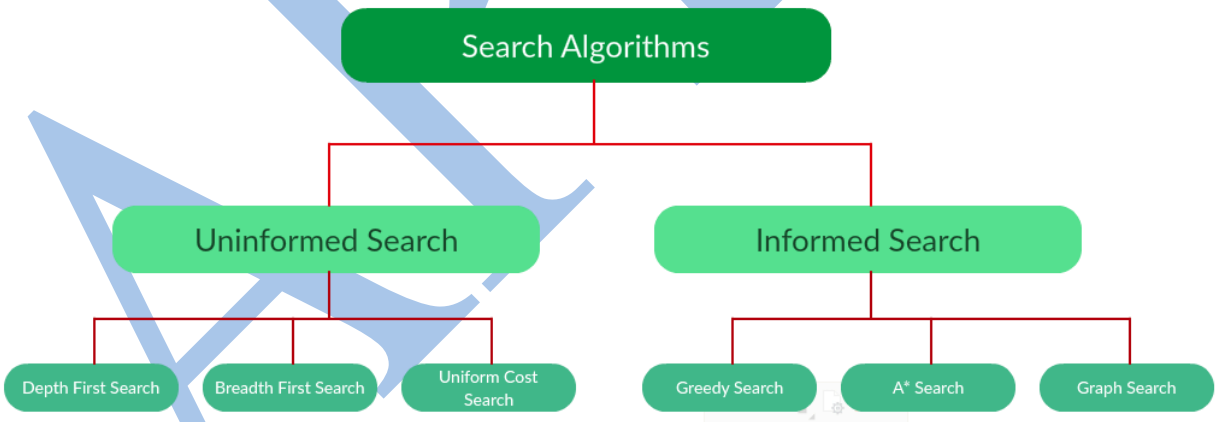



***Figure 1.13: Types of Search Algorithms***

### 7.2.1 UNINFORMED SEARCH ALGORITHMS:

- Uninformed search is also called **Blind search**.
- These algorithms can only generate the successors and differentiate between the goal state and non goal state.

- These type of search does not maintain any internal state, that's it is also known as Blind search.
- Types of uninformed search algorithms are shown in Figure 1.13.
  - 7.2.1.1 Depth First Search
  - 7.2.1.2 Depth Limited Search
  - 7.2.1.3 Breadth First Search
  - 7.2.1.4 Iterative Deepening Search
  - 7.2.1.5 Uniform Cost Search
  - 7.2.1.6 Bidirectional Search

Each of these algorithms will have:

- A problem **graph,** containing the start node S and the goal node G.
- A **strategy,** describing the manner in which the graph will be traversed to get to G.
- A **fringe,** which is a data structure used to store all the possible states (nodes) from the current states.
- A **tree,** that results while traversing to the goal node.
- A solution **plan,** which the sequence of nodes from S to G.

### 7.2.1.1 DEPTH FIRST SEARCH:

- Depth-first search (DFS) is an algorithm for traversing or searching tree or graph data structures.
- The algorithm starts at the root node and explores as far as possible along each branch before backtracking.
- It uses last in-first-out strategy and hence it is implemented using a stack.

***d= the depth of the search tree = the number of levels of the search tree.***

***n^i = number of nodes in level i***

- ***DFS Example - Refer Figure 1.14***

**The performance measure of DFS**

- **Completeness:** DFS does not guarantee to reach the goal state.
- **Optimality:** It does not give an optimal solution as it expands nodes in one direction deeply.
- **Space complexity**: It needs to store only a single path from the root node to the leaf node. Therefore, DFS has **O(bm)** space complexity where b is the **branching factor(i.e., total no. of child nodes, a parent node have)** and m is the **maximum length of any path.**
- **Time complexity**: DFS has **O($b^m$)** time complexity.

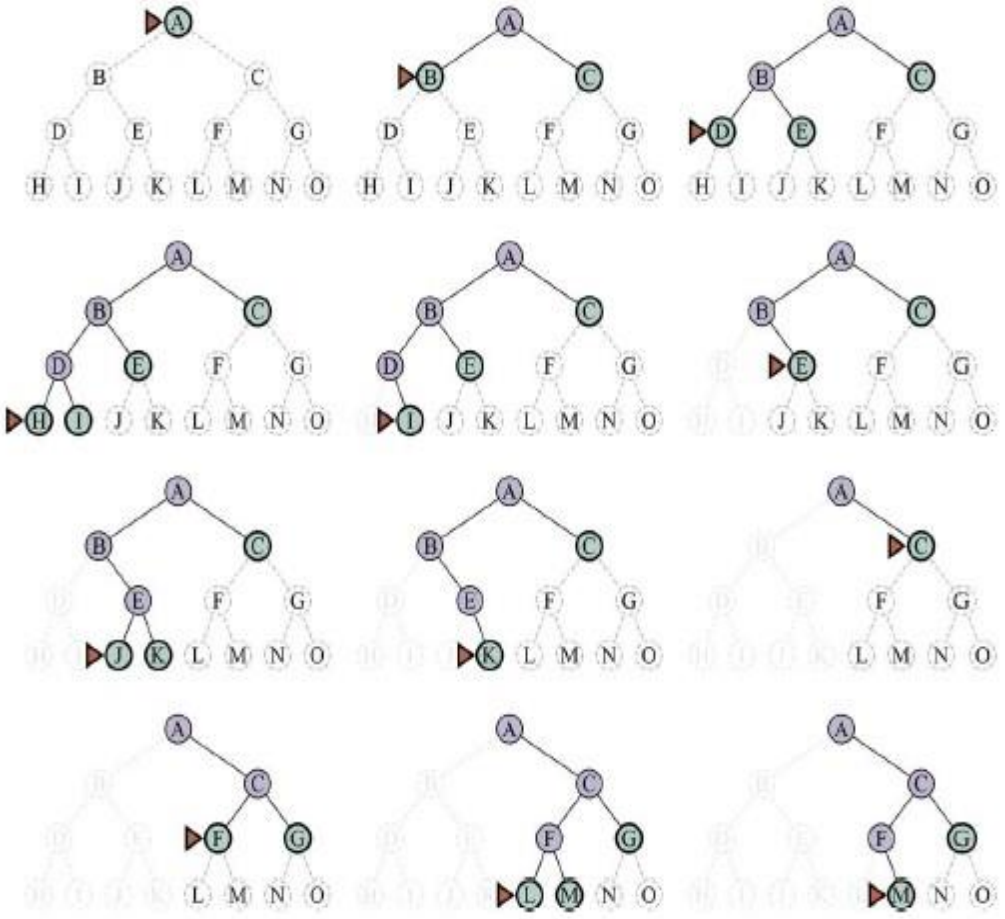


*Figure 1.14: DFS Example*

**Advantage of Depth-first Search:**

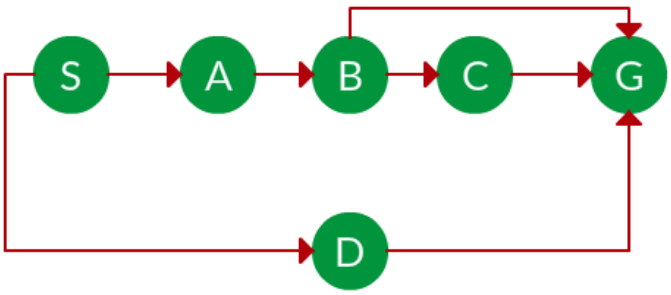
- DFS uses extremely little memory.
- It takes less time to reach the goal node than the BFS method.

**Disadvantage of Depth-first Search:**

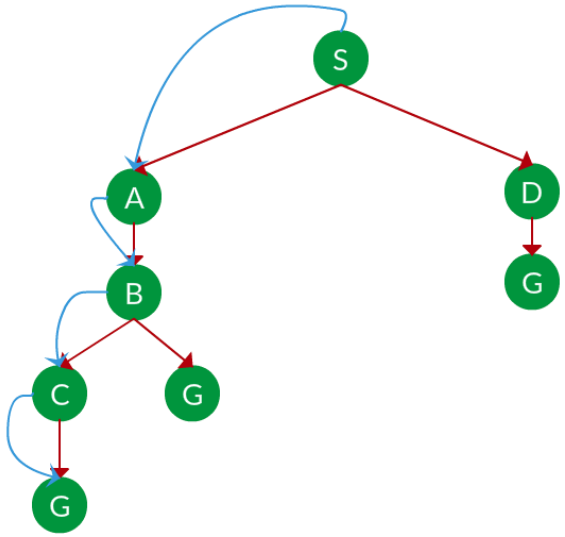
- There's a chance that many states will recur, and there's no certainty that a solution will be found.
- The DFS algorithm performs deep searching and may occasionally enter an infinite cycle.

**Example:**

***Which solution would DFS find to move from node S to node G if run on the graph below?***




**Solution.**




**Path:** S -> A -> B -> C -> G

**Algorithm**

```
function DEPTH-FIRST-SEARCH(initialState, goalTest)
    returns SUCCESS or FAILURE :

    frontier = Stack.new(initialState)
    explored = Set.new()

    while not frontier.isEmpty():
        state = frontier.pop()
        explored.add(state)

        if goalTest(state):
            return SUCCESS(state)

        for neighbor in state.neighbors():
            if neighbor not in frontier ∪ explored:
                frontier.push(neighbor)

    return FAILURE
```