Unit-I
Artificial Intelligence and Knowledge representation

1.1. Introduction to Artificial Intelligence and its evolution.

What is artificial intelligence (AI)?

Intelligence system which is created through human intelligence/ ability to take own decision it have sensor, accelerator (to make action).

The Science of getting machine to mimic the behavior of humans.

Artificial Intelligence (AI) is a multidisciplinary field of computer science that focuses on creating intelligent agents or systems that can perform tasks typically requiring human intelligence. These tasks include understanding natural language, recognizing patterns, making decisions, learning from data, and solving complex problems. AI systems aim to simulate human cognitive functions, such as reasoning, problem-solving, perception, and language understanding, to automate tasks and improve decision-making.

Artificial intelligence is a wide-ranging branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence.

The evolution of AI can be divided into several distinct phases:

Early Foundations (1950s-1960s): The birth of AI can be traced back to the work of Alan Turing and others who laid the theoretical groundwork for machine intelligence. Early AI research focused on symbolic reasoning and problem-solving using logic-based approaches.

Expert Systems (1960s-1980s): During this period, AI researchers developed expert systems, which were rule-based programs designed to mimic the decision-making abilities of human experts in specific domains. Expert systems found applications in areas like medicine and finance.

AI Winter (Late 1980s-1990s): High expectations and overhyped promises led to a period of decreased funding and disillusionment in the field. Progress in AI research slowed down, leading to what is known as the first "AI winter."

Machine Learning Resurgence (2000s): Advances in machine learning, particularly in neural networks, reignited interest in AI. Researchers developed more powerful algorithms and had access to larger datasets and faster computers. This led to significant breakthroughs in areas such as computer vision, natural language processing, and speech recognition.

Deep Learning Revolution (2010s): Deep learning, a subfield of machine learning, gained prominence with the development of deep neural networks, often referred to as deep learning. These networks showed remarkable performance in various AI tasks, including image recognition and language understanding. Companies like Google, Facebook, and OpenAI played pivotal roles in advancing deep learning technologies.

Narrow AI Applications (Present): AI technologies have become ubiquitous in our daily lives. Narrow or specialized AI systems are being used in diverse fields, including healthcare, finance, autonomous vehicles, and entertainment. These systems excel at specific tasks but lack general intelligence.

Towards Artificial General Intelligence (AGI) (Future): The ultimate goal of AI research is to develop artificial general intelligence, which can perform any intellectual task that a human can. Achieving AGI remains a long-term goal and a subject of ongoing research and speculation.

Ethical and Societal Considerations: As AI technologies continue to advance, ethical and societal concerns have come to the forefront. Topics such as bias in AI, job displacement, privacy, and responsible AI development and deployment are central to the AI discourse.

Interdisciplinary Collaborations: AI has increasingly become an interdisciplinary field, with contributions from computer science, neuroscience, psychology, philosophy, and more. Collaborations between these disciplines are essential to advancing our understanding of AI.

In summary, AI has evolved from its theoretical foundations to practical applications in various domains. While we have made significant progress, the quest for artificial general intelligence continues, and the field continues to evolve with ethical considerations at the forefront.

AI is poised to play an increasingly important role in shaping the future of technology and society.

Top of Form

- AI is a branch of science and assist machines to findsolutions to complex problems in a more human-likefashion.
- Artificial Intelligence is the future of Next GenerationTechnology.
- It encompasses variety of disciplines like Medical,Finance, Engineering.

Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems. Specificapplications of AI include expert systems, natural language processing, speech recognition and machine vision

History of AI:

The history of Artificial Intelligence (AI) is a fascinating journey that spans several decades and has seen significant milestones and developments. Here is a condensed overview of the history of AI:

Foundations of AI (1950s): The roots of AI can be traced back to the mid-20th century when computer scientists and mathematicians began exploring the idea of creating machines that could mimic human intelligence. Key figures during this period include Alan Turing, who developed the concept of the Turing Test as a measure of machine intelligence, and John McCarthy, who coined the term "Artificial Intelligence" and organized the Dartmouth Workshop, often considered the birth of AI as a field.

Early Symbolic AI (1950s-1960s): The initial years of AI research focused on symbolic reasoning and logic-based approaches. Researchers attempted to represent human knowledge in formal systems and create rule-based expert systems. Programs like the Logic Theorist and General Problem Solver were early AI projects in this era.

Machine Learning and Neural Networks (1950s-1960s): During the same period, researchers also explored machine learning techniques and neural networks. Frank Rosenblatt developed the Perceptron, a type of neural network, which gained attention for its potential to learn from data.
AI Optimism and Funding (1960s-1970s): There was a surge in optimism and government funding for AI research during this period. Researchers believed that general AI was within reach, leading to the development of more complex expert systems and natural language processing systems.

AI Winter (Late 1970s-1980s): The high expectations of AI progress led to disappointment when the field failed to deliver on its promises. Funding for AI research declined, and there was a general slowdown in AI advancements. This period is often referred to as the first "AI Winter."

Expert Systems (1980s): Despite the AI Winter, expert systems continued to be developed and found practical applications in various domains, such as medical diagnosis and finance. These systems used knowledge-based approaches to mimic human expertise.

Second AI Spring (Late 1980s-1990s): AI research experienced a resurgence with the advent of subfields like machine learning, particularly with the development of techniques like backpropagation in neural networks and reinforcement learning.

The Rise of Practical AI (2000s-Present): The 21st century has seen remarkable progress in AI, driven by advancements in machine learning and computational power. Key milestones include IBM's Watson winning on "Jeopardy!" in 2011, the emergence of deep learning, and AI applications becoming integral to industries like healthcare, finance, and self-driving cars.

AI Ethics and Concerns (Present): As AI technologies become more prevalent, concerns about ethics, transparency, bias, and safety have come to the forefront. Organizations and researchers are actively addressing these issues to ensure responsible AI development.

Toward Artificial General Intelligence (AGI) (Ongoing): The pursuit of AGI, or machines with human-level general intelligence, remains a long-term goal in AI research. Achieving AGI is a subject of ongoing exploration and debate.

AI's history is marked by periods of optimism, followed by challenges and setbacks. However, with each setback, the field has rebounded stronger, leading to the current era of practical AI applications and continued efforts toward achieving artificial general intelligence. The history of AI reflects the relentless pursuit of creating intelligent machines and the enduring belief in its transformative potential.

AI Evaluation:

AI evaluation is the process of assessing the performance, capabilities, and effectiveness of artificial intelligence systems. It involves various methodologies, metrics, and criteria to determine how well an AI system accomplishes its intended tasks or objectives. AI evaluation is crucial for both developers and users to understand the system's strengths, weaknesses, and areas for improvement.

Here are some key aspects of AI evaluation:

Performance Metrics: AI systems are often evaluated based on specific performance metrics that align with their intended tasks. These metrics can vary widely depending on the application. For example:

- In computer vision, metrics like accuracy, precision, recall, and F1-score are used to assess image recognition or object detection systems.
- In natural language processing, metrics like BLEU, ROUGE, and perplexity are used to evaluate machine translation or text generation models.
- In reinforcement learning, metrics like reward functions and learning curves are used to measure an agent's performance in a particular environment.

Data Quality: The quality and quantity of data used for training, validation, and testing are critical factors in AI evaluation. Evaluators must ensure that the datasets are representative and free from biases that could affect system performance.

Benchmarking: AI researchers and practitioners often compare their systems to benchmark models or datasets. Benchmarking helps establish a baseline for performance and allows for fair comparisons between different AI approaches.

User Experience (UX): For AI systems designed for user interaction, evaluating the user experience is essential. Usability testing, user feedback, and user satisfaction surveys can be used to assess how well the AI system meets user needs and expectations.

Ethical and Fairness Evaluation: Evaluating AI systems for ethical considerations, including bias and fairness, is becoming increasingly important. Assessments should determine if the AI system exhibits bias against certain demographic groups and whether it adheres to ethical guidelines.

Robustness and Security: Evaluating an AI system's robustness against adversarial attacks and vulnerabilities is crucial, especially in applications involving sensitive data or critical tasks. Security assessments help identify potential weaknesses and vulnerabilities.

Scalability and Efficiency: AI systems need to be evaluated for their scalability and efficiency in real-world scenarios. This includes assessing how well the system performs as the dataset or workload size increases and whether it meets latency and resource constraints.

Interpretability and Explainability: In some domains, such as healthcare or finance, it's important to evaluate an AI system's interpretability and explainability.

Deployment and Integration: Evaluating how well an AI system can be integrated into existing workflows, systems, or platforms is vital for practical applications. This includes assessing compatibility, ease of deployment, and integration costs.

Continuous Monitoring: AI evaluation is not a one-time process. It should be an ongoing effort, with continuous monitoring of the AI system's performance in real-world conditions. This helps ensure that the system remains effective and adapts to changing circumstances.

AI evaluation is a multifaceted process that involves assessing various aspects of AI systems, including performance, data quality, fairness, ethics, robustness, and user experience. Comprehensive evaluation helps developers improve AI systems, make informed decisions about deployment, and build trust among users and stakeholders.

1.2 What is Intelligence and Artificial Intelligence:

Intelligence

Intelligence is a complex and multifaceted concept that can be challenging to define precisely due to its various manifestations and interpretations. However, in general terms, intelligence can be understood as the ability to acquire, understand, apply, and adapt knowledge and skills to solve problems, make decisions, learn from experience, and effectively interact with the environment.

Intelligence is a multifaceted trait, and there is no single, universally accepted measure or definition of intelligence. Different cultures, fields of study, and individuals may have varying perspectives on what constitutes intelligence. Additionally, intelligence is not fixed; it can develop and change over time through education, experiences, and personal development efforts. This adaptability and potential for growth make intelligence a dynamic and evolving concept.

Here are some key aspects and characteristics often associated with intelligence:

Problem-Solving: Intelligent individuals have the capacity to analyze complex situations, identify problems, and devise effective solutions. They can apply critical thinking and reasoning to overcome challenges.

Learning: Intelligence involves the ability to acquire new information, learn from experience, and adapt to changing circumstances. It includes both formal education and informal learning throughout one's life.

Adaptation: Intelligent individuals can adjust to new situations and environments. They can apply their existing knowledge and skills to unfamiliar contexts and learn quickly when faced with novel challenges.

Memory: A good memory is often considered a component of intelligence. This includes the ability to store and retrieve information as needed, which is essential for problem-solving and learning.

Creativity: Intelligence is not merely rote memorization or problem-solving by following established rules. Creative thinking and the ability to generate innovative ideas and solutions are also integral to intelligence.

Abstract Thinking: Intelligent individuals can think abstractly, which means they can conceptualize ideas, make connections between seemingly unrelated concepts, and work with symbols, metaphors, and theories.

Reasoning and Logic: Intelligence involves the capacity for logical reasoning, including deductive and inductive reasoning. This allows individuals to draw valid conclusions from available information.

Emotional Intelligence: Emotional intelligence is the ability to recognize, understand, manage, and effectively use one's own emotions and those of others. It plays a significant role in interpersonal relationships and social interactions.

Social and Interpersonal Skills: Intelligence extends to how well individuals navigate social situations, communicate effectively, and form meaningful relationships. Social intelligence is essential for cooperation and collaboration.

Self-Awareness: Intelligent individuals often possess a degree of self-awareness, which allows them to reflect on their own thoughts, emotions, and actions. This self-reflection can lead to personal growth and self-improvement.

Artificial Intelligence(AI):

Artificial Intelligence (AI) refers to the development of computer systems or software that can perform tasks typically requiring human intelligence. These tasks include learning from experience, understanding natural language, recognizing patterns, making decisions, and solving complex problems. AI systems aim to simulate human cognitive functions, such as reasoning, problem-solving, perception, and language understanding, to automate tasks and improve decision-making.

AI has numerous applications across various industries, including healthcare, finance, transportation, entertainment, and more. It continues to advance rapidly, with ongoing research and development efforts aimed at improving AI capabilities, making AI systems more accessible, and addressing ethical and societal concerns associated with AI technologies.

Here are some key aspects and components of artificial intelligence:

Machine Learning: Machine learning is a subset of AI that focuses on the development of algorithms and models that allow computers to learn from data. These algorithms enable AI systems to improve their performance on tasks over time without being explicitly programmed.

Deep Learning: Deep learning is a subfield of machine learning that uses neural networks with many layers (deep neural networks) to analyze and process large amounts of data. Deep learning has been particularly successful in tasks like image recognition and natural language processing.

Natural Language Processing (NLP): NLP is a branch of AI that focuses on enabling computers to understand, interpret, and generate human language. NLP is used in applications like chatbots, language translation, and sentiment analysis.

Computer Vision: Computer vision involves the development of AI systems that can understand and interpret visual information from the world, such as images and videos. It's used in tasks like object detection, facial recognition, and autonomous vehicles.

Robotics: AI is applied to robotics to create intelligent machines capable of performing tasks in the physical world. These robots can be found in manufacturing, healthcare, and exploration.

Expert Systems: Expert systems are AI programs that mimic the decision-making abilities of human experts in specific domains. They use a knowledge base and inference engine to solve problems and provide recommendations.

Reinforcement Learning: Reinforcement learning is a type of machine learning where an AI agent learns to make decisions by interacting with an environment. It receives feedback in the form of rewards or penalties, allowing it to improve its decision-making policy.

AI Ethics and Fairness: As AI systems become more prevalent, there is a growing focus on ethical considerations, including issues related to bias, transparency, accountability, and the responsible development and deployment of AI technologies.

Artificial General Intelligence (AGI): While most AI systems are designed for narrow or specialized tasks, the ultimate goal of AI research is to develop artificial general intelligence (AGI), which can perform any intellectual task that a human can. Achieving AGI remains a long-term and challenging goal.

Difference between Intelligence and Artificial Intelligence:

Aspect	Intelligence	Artificial Intelligence (AI)

Nature	Innate human trait	Man-made construct
Biological Basis	Brain's neural networks	Algorithms and computational power
General Versatility	Versatile and adaptable	Often narrow and specialized
Subjectivity and Consciousness	Accompanied by consciousness	Lacks subjective experiences and consciousness
Learning	Learning from experience	Learning from data and algorithms
Emotions and Sentience	Emotions and subjective experiences	Lacks emotions and sentience
Problem-Solving and Reasoning	Inherent reasoning abilities	Algorithm-based reasoning
Self-Awareness	Self-awareness	Lacks self-awareness
Biological Constraint	Limited by human biology	Limited by computational resources and algorithms
Versatility in Tasks	Can perform a wide range of tasks	Often designed for specific tasks or domains
Ethical and Moral Judgment	Capable of ethical and moral reasoning	Lacks ethical and moral judgment
Origin	Natural phenomenon	Human-designed technology

1.3 How AI is affecting on real life

Artificial Intelligence (AI) is having a significant impact on various aspects of real life across multiple industries and domains. AI's impact on real life is vast and continually expanding as researchers and developers explore new applications and capabilities. While it offers numerous benefits, it also raises ethical and societal questions, such as privacy concerns, bias in algorithms, and the potential displacement of certain jobs.

Here are some of the ways AI is affecting and transforming our daily lives:

1.Healthcare:
- Diagnosis and Treatment: AI algorithms assist medical professionals in diagnosing diseases, interpreting medical images (like X-rays and MRIs), and recommending treatment plans.
- Drug Discovery: AI accelerates drug discovery processes by analyzing vast datasets and predicting potential drug candidates.
- Personalized Medicine: AI helps tailor treatments and interventions based on an individual's genetic makeup and medical history.

2.Finance:
- Algorithmic Trading: AI-driven algorithms are used for high-frequency trading, predicting market trends, and managing investment portfolios.
- Fraud Detection: AI systems identify fraudulent transactions by analyzing patterns and anomalies in financial data.
- Customer Service: Chatbots and virtual assistants provide customer support and financial advice.

3.Transportation:
- Autonomous Vehicles: AI powers self-driving cars and trucks, promising safer and more efficient transportation.
- Traffic Management: AI optimizes traffic flow, reduces congestion, and enhances road safety.
- Ride-Sharing: AI algorithms match riders and drivers, optimizing routes and fares.

4.Retail:
- Recommendation Systems: AI algorithms provide personalized product recommendations based on a user's browsing and purchase history.
- Inventory Management: AI optimizes inventory levels, reducing waste and ensuring product availability.
- Supply Chain: AI enhances supply chain efficiency by predicting demand, optimizing logistics, and reducing costs.

5.Education:
- Personalized Learning: AI-based educational software tailors content and pacing to individual students' needs.
- Grading and Assessment: AI automates grading and assessment tasks, saving educators time.
- Language Learning: AI-powered language learning apps assist users in acquiring new languages.

6.Entertainment:
- Content Recommendation: Streaming platforms use AI to suggest movies, TV shows, and music based on user preferences.
- Content Creation: AI generates art, music, and written content, sometimes indistinguishable from human-created work.

7.Security:
- Cybersecurity: AI helps detect and prevent cyber threats by analyzing network traffic and identifying suspicious activity.

- Facial Recognition: AI-powered facial recognition systems enhance security in airports, government facilities, and smartphones.

8.Environment and Energy:

- Energy Efficiency: AI optimizes energy consumption in buildings and industries, reducing environmental impact.
- Climate Prediction: AI models analyze climate data to make more accurate predictions and inform climate change mitigation strategies.

9.Agriculture:

- Precision Agriculture: AI helps farmers optimize crop management, irrigation, and pest control, increasing yields and reducing resource use.

10.Language Translation: AI-powered translation tools facilitate communication across languages and promote global connectivity.

11.Accessibility: AI-driven assistive technologies improve accessibility for individuals with disabilities, enabling them to interact with digital devices and services more easily.

12.Legal and Compliance: AI automates legal research, contract analysis, and compliance monitoring in the legal industry.

1.4 Different branches of AI

Artificial Intelligence (AI) is a multidisciplinary field with several subfields or branches, each focused on different aspects of AI research and application. Here are some of the main branches of AI:

Machine Learning (ML): Machine learning is a subfield of AI that focuses on developing algorithms and models that enable computers to learn from data and make predictions or decisions. It includes techniques like supervised learning, unsupervised learning, and reinforcement learning.

Deep Learning: Deep learning is a subset of machine learning that uses neural networks with multiple layers (deep neural networks) to analyze and process large amounts of data. It has been particularly successful in tasks like image recognition and natural language processing.
Natural Language Processing (NLP): NLP is concerned with enabling computers to understand, interpret, and generate human language. It is essential for tasks like language translation, sentiment analysis, and chatbots.

Computer Vision: Computer vision involves the development of AI systems that can interpret and understand visual information from the world, such as images and videos. It is used in applications like object detection, facial recognition, and autonomous vehicles.

Robotics: Robotics combines AI with mechanical engineering to create intelligent machines capable of performing tasks in the physical world. It is used in industries like manufacturing, healthcare, and space exploration.

Reinforcement Learning: Reinforcement learning is a type of machine learning where an agent learns to make decisions by interacting with an environment. It receives feedback in the form of rewards or penalties, allowing it to improve its decision-making policy.

Expert Systems: Expert systems are AI programs that mimic the decision-making abilities of human experts in specific domains. They use a knowledge base and inference engine to solve problems and provide recommendations.

Knowledge Representation and Reasoning: This branch focuses on how AI systems can represent and manipulate knowledge to make logical inferences and solve complex problems.

Speech Recognition: Speech recognition technology converts spoken language into text and is used in applications like voice assistants, transcription services, and voice-controlled devices.

Planning and Optimization: AI planning involves developing algorithms and techniques to enable systems to plan sequences of actions to achieve specific goals efficiently.

Cognitive Computing: Cognitive computing aims to create AI systems that can simulate human thought processes, including reasoning, problem-solving, and learning from experience.

AI Ethics and Fairness: This branch focuses on the ethical and societal implications of AI, including issues related to bias, transparency, accountability, and responsible AI development and deployment.

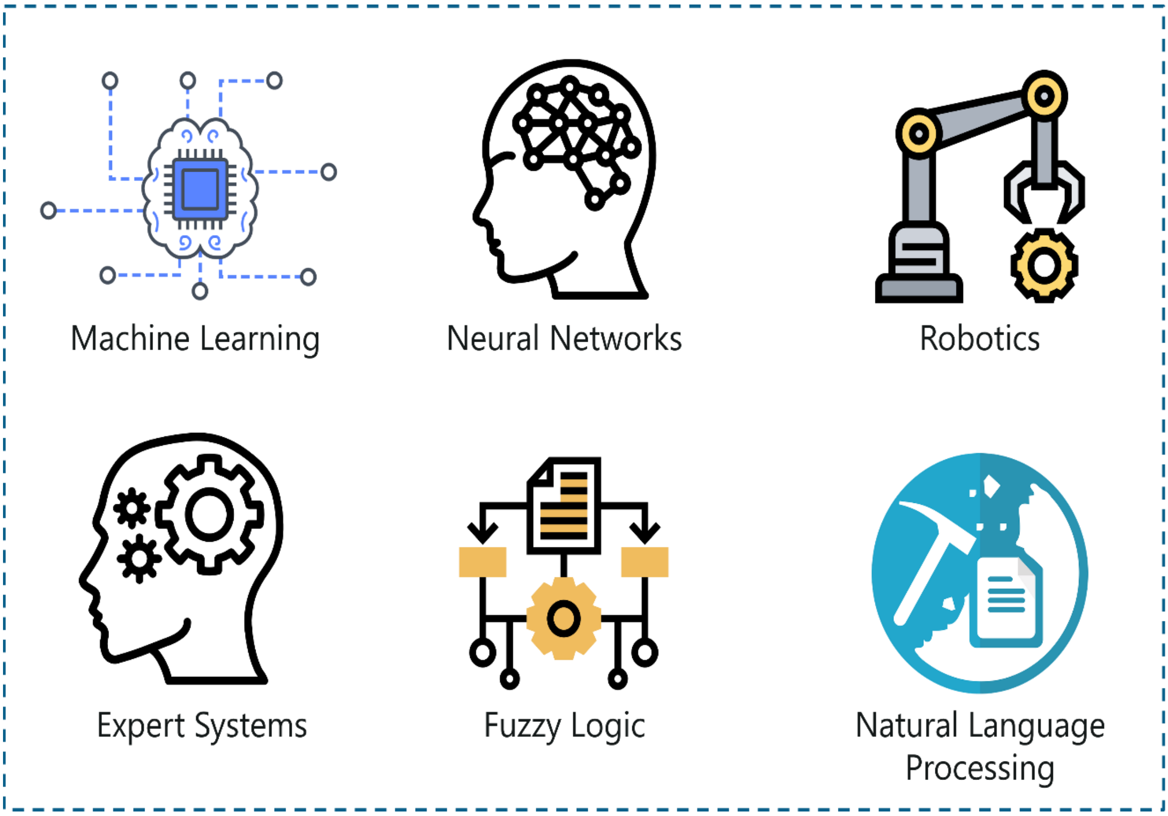
AI in Healthcare: AI is extensively used in healthcare for tasks such as medical diagnosis, drug discovery, personalized medicine, and health data analysis.

AI in Finance: AI applications in finance include algorithmic trading, fraud detection, risk assessment, and portfolio management.

AI in Education: AI is used in education for personalized learning, automated grading, intelligent tutoring systems, and educational content creation.

AI in Agriculture: Precision agriculture uses AI for optimizing crop management, monitoring soil conditions, and improving yield prediction.

These branches of AI represent the diverse range of applications and research areas within the field, and they often overlap and complement each other in solving complex problems and advancing the capabilities of AI systems.



1.5 Limitations of AI:

- Lack of Common Sense: AI systems often lack common-sense reasoning abilities that humans possess. They may struggle to understand context, make inferences, or interpret information outside their training data.

- Data Dependence: AI algorithms heavily rely on large amounts of high-quality data for training and generalization. If the training data is biased or incomplete, it can lead to biased or inaccurate AI models.

- Limited Creativity: AI systems can generate creative outputs to some extent, but they lack true creativity, imagination, and the ability to think outside predefined boundaries.

- Lack of Emotional Intelligence: AI lacks emotional intelligence and cannot understand or respond to human emotions, making it challenging to develop truly empathetic AI systems.

- Ethical and Bias Concerns: AI can inherit biases from its training data, leading to discriminatory or unfair decisions. Ensuring ethical AI and addressing bias issues is an ongoing challenge.

- Interpretability and Explainability: Many AI models, especially deep learning models, are often considered "black boxes" because it can be challenging to explain how they arrive at specific decisions or predictions. This lack of transparency can be problematic, especially in critical applications.

- Resource Intensive: Training advanced AI models requires significant computational power and energy consumption. This can be environmentally unsustainable and economically costly.

- Limited Contextual Understanding: AI often struggles with understanding the broader context of a problem, which can lead to misinterpretation of user inputs or generating irrelevant responses.

- Security Risks: As AI becomes more integrated into various applications, it can also be susceptible to attacks, such as adversarial attacks that manipulate input data to fool AI systems.

- Job Displacement: While AI can automate repetitive tasks and improve efficiency, it also raises concerns about job displacement in certain industries, which can have economic and social implications.

- Dependence on Expertise: Developing and maintaining AI systems requires specialized knowledge and expertise, making it challenging for organizations without access to AI talent to harness its potential.

- Privacy Concerns: AI systems can process vast amounts of personal data, raising concerns about user privacy and data security, especially when not handled properly.

- Limited Generalization: AI models may perform well on specific tasks they were trained for but may struggle when faced with tasks outside their training scope.

- Lack of Contextual Understanding: AI often lacks a deep understanding of the context in which it operates, which can lead to misinterpretation of user input or generation of irrelevant responses.

- Long Training Times: Training complex AI models can take a long time, ranging from hours to weeks, depending on the model and available computing resources.

1.6 Need of knowledge Representation:

Humans are best at understanding, reasoning, and interpreting knowledge. Human knows things, which is knowledge and as per their knowledge they perform various actions in the real world. Buthow machines do all these things comes under knowledge representation and reasoning.

Hence, we can describeKnowledge representation as following:

- Knowledge representation and reasoning (KR, KRR) is the part of Artificial intelligence which concerned with AI agents thinking and how thinking contributes to intelligent behavior of agents.

- It is responsible for representing information about the real world so that a computer can understand and can utilize this knowledge to solve the complex real-world problems such as diagnosis a medical condition or communicating with humans innatural language.

- It is also a way which describes how we can represent knowledge in artificial intelligence. Knowledge representation isnot just storing data into some database, but it also enables an intelligent machine to learn from that knowledge and experiences so that it can behave intelligently like a human.

What is Knowledge Representation?

Knowledge Representation and Reasoning (KR, KRR) represent data from the real world. A computer can comprehendand then use this knowledge to solve complex real-world problems, such as communicating with humans in natural language. Additionally, it is a way of describing how machines can represent learning in artificial intelligence. Knowledge representation is not just storing data in some database. Still, it also enables an intelligent device to learn from that knowledge and experience to behave intelligently like a human.

What to Represent:

Following is the kind of knowledge which needs to berepresented in AI systems:

- **Object:** All the facts about objects in our world domain. E.g., Guitars contains strings, trumpets are brass instruments.
- **Events:** Events are the actions which occur in our world.
- **Performance:** It describe behavior which involves knowledge about how to do things.
- **Meta-knowledge:** It is knowledge about what we know.
- **Facts:** Facts are the truths about the real world and what we represent.
- **Knowledge-Base:** The central component of the knowledge- based agents is the knowledge base. It is represented as KB. TheKnowledgebase is a group of the Sentences (Here, sentences areused as a technical term and not identical with the Englishlanguage).

1.7 Knowledge Representation and Mapping schemes

Knowledge Representation (KR) originated as a sub-field of Artificial Intelligence (AI). In the early daysof AI, it was sometimes imagined that to endow a computer with intelligence it would be sufficient to giveit a capacity for pure reasoning; it quickly became apparent, however, that the exercise of intelligence inevitably involves interaction with an external world, and such interaction cannot take place without some kindof knowledge of that world.

There are four types of Knowledge representation:

Relational, Inheritable, Inferential, and Declarative /Procedural.

Relational Knowledge:

provides a framework to compare two objects based onequivalent attributes. any instance in which two different objects are comparedis a relational type of knowledge.

Inheritable Knowledge

It is obtained from associated objects. It prescribes a structure in which new objects are created which may inherit all or a subset of attributes from existing objects.

Inferential Knowledge:

It is inferred from objects through relations among objects. e.g., a word alone is a simple syntax, but with the help of other words in phrase the reader may infer more from a word;this inference within linguistic is called semantics.

Declarative Knowledge:

A statement in which knowledge is specified, but the useto which that knowledge is to be put is not given.

e.g. laws, people's name; these are facts which can standalone, not dependent on other knowledge.

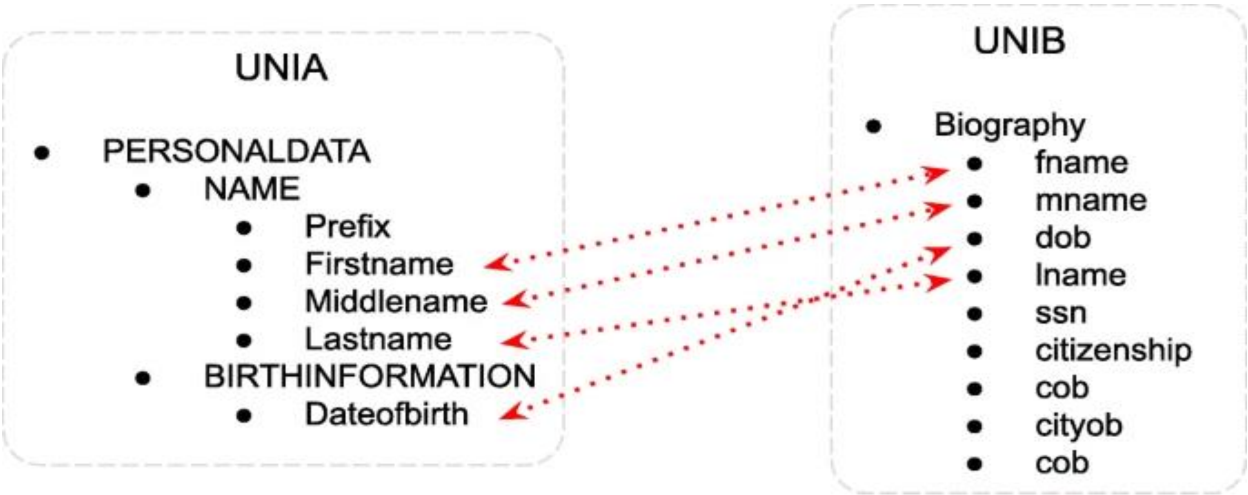
Mapping Schema:

Abstract—Schema Matching is a method of finding attributes that are either similar to each other linguistically or represent the same information. In this project, we take a hybrid approach at solving this problem by making use of both the provided data and the schema name to perform one to one schema matching and introduce creation of a global dictionary to achieve one to many schema matching. We experiment with two methods of one to one matching and compare both based on their F-scores, precision and recall. We also compare our method with the ones previously suggested and highlight differences between them.

Keywords—Schema Matching, Machine Learning, SOM, Edit Distance, One to Many Matching, one to one Matching.

EXAMPLE:

Consider the (simplified) schemas of databases on academic information from universities illustrated in Fig. 1. The schema matching task is to identify the matchings (depicted as dotted lines) between elements from those schemas. In this example, the diagram on the left illustrates how the database schema from University A (UNIA) models data about students. The diagram on the right illustrates how the database schema from University B (UNIB) models the same data. Notice that the same data is represented differently, even using particular representations of hierarchy and attribute names. For instance, UNIA.PERSONALDATA.NAME.Firstname and UNIB.Biography.fname represent the student's first name. Also, there might be more challenging matchings to be discovered, e.g., UNIA.BIRTHINFORMATION. Dateofbirth and UNIB.Biography.dob, both are representing the student's date of birth, which may be validated only by a domain specialist or the schema owners. Finally, some elements might not have any correspondences on the other schema, e.g., UNIB.Biography.citizenship.



1.8 Properties of good knowledge-based system

A good knowledge-based system (KBS) in artificial intelligence (AI) should possess several key properties to be effective and reliable. These properties help ensure that the system can efficiently represent, reason with, and apply knowledge to solve specific problems or make decisions. Here are some essential properties of a good knowledge-based system:

Knowledge Representation:

Effective representation of domain-specific knowledge: The system should be capable of representing knowledge about the problem domain accurately, comprehensively, and in a structured format. Common representation methods include rules, frames, semantic networks, or ontologies.

Knowledge Acquisition:

Ability to acquire and update knowledge: The KBS should be able to learn and adapt its knowledge base over time as new information becomes available or as it gains experience.

Inference and Reasoning:

Efficient inference engine: The system should employ a robust reasoning mechanism to derive conclusions and make decisions based on the available knowledge. Common reasoning methods include deduction, induction, abduction, and fuzzy logic.

Knowledge Validation:

Validation and verification of knowledge: The KBS should have mechanisms in place to assess the quality and reliability of the knowledge it uses, preventing the incorporation of erroneous or outdated information.

Explanation Facility:

Ability to provide explanations: The system should be able to explain its reasoning process and the rationale behind its decisions to users, enhancing transparency and user trust.

Domain Expertise:

Domain expertise and specificity: A good KBS should be designed for a specific problem domain, allowing it to leverage domain-specific knowledge and provide more accurate and context-aware solutions.

Knowledge Maintenance:

Knowledge maintenance and updates: Regularly update and maintain the knowledge base to ensure it remains relevant and up-to-date with changing conditions or requirements.

Knowledge Elicitation:

Knowledge elicitation tools: Provide tools or interfaces for domain experts to contribute their knowledge to the system, making it easier to capture expertise.

Scalability:

Scalability and performance: The KBS should be capable of handling a growing knowledge base and efficiently processing large volumes of data or complex knowledge structures.

Adaptability:

Adaptability to evolving domains: The system should be able to adapt to changes in the problem domain or the environment it operates in, ensuring its continued relevance and usefulness.

Error Handling:

Robust error handling: Implement mechanisms to detect and handle errors, inconsistencies, or conflicts in the knowledge base to maintain the system's reliability.

Interoperability:

Interoperability with other systems: Ensure compatibility and integration capabilities with other AI systems, databases, or external data sources to enhance its utility.

User-Friendliness:

User-friendly interfaces: Provide intuitive interfaces for users to interact with the KBS, making it accessible to both experts and non-experts in the domain.

Ethical Considerations:

Ethical and responsible AI: Adhere to ethical guidelines and principles to ensure the responsible use of AI and knowledge-based systems, including fairness, transparency, and privacy considerations.

Performance Monitoring:

Performance monitoring and feedback: Implement mechanisms for monitoring the system's performance, collecting user feedback, and making continuous improvements.

1.9 Types of knowledge

In the field of artificial intelligence (AI), knowledge can be categorized into several types, each serving a specific purpose in AI systems. These types of knowledge are used for various tasks, including problem-solving, decision-making, and learning.
Here are some common types of knowledge in AI:

Declarative Knowledge:

- Factual Knowledge: This type of knowledge represents facts about the world, such as "The Earth orbits the Sun" or "Water boils at 100 degrees Celsius." It is often represented using statements or propositions.

Procedural Knowledge:

- Heuristic Knowledge: Heuristics are rules of thumb or strategies used to solve problems efficiently. They guide the decision-making process but do not guarantee an optimal solution.
- Algorithmic Knowledge: These are step-by-step instructions or algorithms used to perform specific tasks. Algorithms can be simple, like sorting a list, or complex, like those used in machine learning models.

Meta-Knowledge:

- Meta-Knowledge refers to knowledge about knowledge. It includes information about how knowledge is structured, organized, and used within a system. Examples include data dictionaries, ontologies, or metadata.

Tactical Knowledge:

- Strategic Knowledge: This type of knowledge involves high-level strategies and plans for achieving specific goals. In AI, strategic knowledge might guide the behavior of an agent in a complex environment.

Domain Knowledge:

- Domain-Specific Knowledge: This knowledge is specific to a particular problem domain or field, such as medicine, finance, or manufacturing. It includes facts, concepts, and rules relevant to that domain.

Common-Sense Knowledge:

- Common-sense knowledge represents the everyday understanding and reasoning abilities that humans possess. It includes knowledge about the physical world, causality, and typical human behavior.

Uncertain Knowledge:

- Uncertain or Probabilistic Knowledge: In situations where knowledge is uncertain, AI systems may use probabilities to represent beliefs or likelihoods. Bayesian networks and probabilistic graphical models are examples of techniques for handling uncertain knowledge.

Temporal Knowledge:

- Temporal Knowledge deals with information related to time. It includes knowledge about events, sequences, durations, and timestamps. Temporal reasoning is essential in applications like scheduling and planning.

Spatial Knowledge:

- Spatial Knowledge pertains to information related to space and location. It is important in applications such as robotics, navigation, and geographic information systems (GIS).

Experiential Knowledge:

- Experiential Knowledge is gained through direct experience or observation. Machine learning algorithms, for example, can extract patterns and knowledge from large datasets through experience.

Contextual Knowledge:

- Contextual Knowledge takes into account the context in which information is used. It recognizes that the meaning and relevance of knowledge can vary depending on the situation.

Social and Cultural Knowledge:

- Social and Cultural Knowledge includes information about societal norms, customs, and cultural practices. Understanding this type of knowledge is important in applications involving human interaction and cultural context.

Self-Knowledge:

- Self-Knowledge is knowledge about the system itself. It can include information about the system's capabilities, limitations, and internal state.

1.10 Knowledge Representation issues

The main objective of knowledge representation is to draw the conclusions from the knowledge, but there are many issues associated with the use of knowledge representation techniques.

Some of them are listed below:

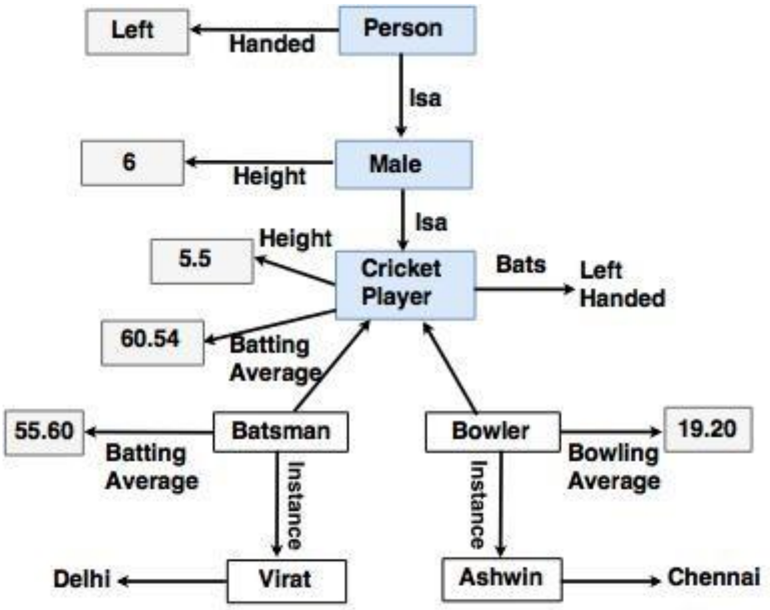


Fig: Inheratable Knowledge Representation

Refer to the above diagram to refer to the following issues.

1. Important attributes

There are two attributes shown in the diagram, **instance** and **isa.** Since these attributes support property ofinheritance, they are of prime importance.

2. Relationships among attributes

Basically, the attributes used to describe objects are nothing but theentities. However, the attributes of an object do not depend on the encoded specific knowledge.

3. Choosing the granularity of representation

While deciding the granularity of representation, it is necessary toknow the following:

i. What are the primitives and at what level should the knowledge berepresented?

ii. What should be the number (small or large) of low-level primitivesor high-level facts?

High-level facts may be insufficient to draw the conclusion whileLow-level primitives may require a lot of storage.

For example: Suppose that we are interested in following facts:John spotted Alex

Now, this could be represented as "Spotted (agent(John), object(Alex))"

Such a representation can make it easy to answer questions such as:Who spotted Alex?

Suppose we want to know: "Did John see Sue?" Given only one fact, user cannot discover that answer.

Hence, the user can add other facts, such as "Spotted (x, y) → saw (x,y)"

4. Representing sets of objects.

There are some properties of objects which satisfy the condition of aset together but not as individual;

Example: Consider the assertion made in the sentences: "There are more sheep than people in Australia", and "Englishspeakers can be found all over the world."
These facts can be described by including an assertion to the setsrepresenting people, sheep, and English.

5. Finding the right structure as needed

To describe a particular situation, it is always important to find theaccess of right structure. This can be done by selecting an initial structure and then revising the choice.

While selecting and reversing the right structure, it is necessary tosolve following problem statements. **They include the process onhow to:**

- Select an initial appropriate structure.
- Fill the necessary details from the current situations.
- Determine a better structure if the initially selected structure isnot appropriate to fulfill other conditions.
- Find the solution if none of the available structures is appropriate.
- Create and remember a new structure for the given condition.
- There is no specific way to solve these problems, but some ofthe effective knowledge representation techniques have the potential to solve them.

1.11 AND-OR Graph

The AND-OR GRAPH (or tree) is useful for representing the solution of problems that can solved by decomposing them into a setof smaller problems, all of which must then be solved. This decomposition, or reduction, generates arcs that we call AND arcs.
One AND arc may point to any number of successor nodes, all of which must be solved in order for the arc to point to a solution. Just asin an OR graph, several arcs may emerge from a single node, indicating a variety of ways in which the original problem might be solved. This is why the structure is called not simply an AND-graph but rather an AND-OR graph (which also happens to be an AND-OR tree)

In artificial intelligence, an "AND-OR graph" is a graphical representation used to depict and reason about various paths or combinations of conditions and actions within a knowledge representation or planning framework. AND-OR graphs are commonly used in knowledge representation and problem-solving tasks.

Here's a brief overview of AND-OR graphs:

AND Nodes: These nodes represent conditions or subgoals that must all be satisfied simultaneously. In other words, for an AND node to be true, all of its child conditions or subgoals must also be true. AND nodes are typically represented as circles or ovals in the graph.

OR Nodes: These nodes represent alternative choices or options. An OR node has multiple child nodes, and only one of these children needs to be satisfied for the OR node to be true. OR nodes are often depicted as diamonds or rectangles in the graph.

Edges: Edges in the graph connect nodes and represent relationships or dependencies between them. An edge coming out of an OR node represents a choice between different options, while an edge coming out of an AND node represents a logical AND relationship.

AND-OR graphs are commonly used in several AI-related tasks:

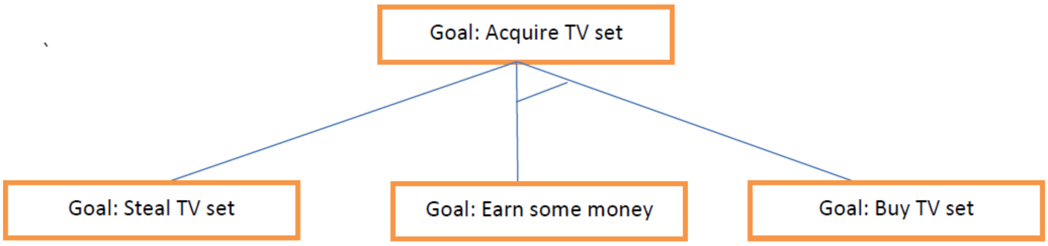
Search and Planning: In AI planning and search algorithms like STRIPS (Stanford Research Institute Problem Solver), AND-OR graphs can represent the conditions and actions required to achieve a goal. OR nodes represent choices of actions, and AND nodes represent conditions that must be met before taking those actions.

Knowledge Representation: In knowledge representation systems, AND-OR graphs can be used to represent complex relationships and dependencies between pieces of knowledge. OR nodes might represent alternative hypotheses, while AND nodes represent conditions that collectively support a piece of knowledge.

Constraint Satisfaction Problems: In constraint satisfaction problems (CSPs), AND-OR graphs can represent constraints and variables. OR nodes represent choices for variable assignments, while AND nodes represent constraints that must be satisfied simultaneously.\

Game Trees: In game theory and game-playing AI, AND-OR trees are used to represent the possible moves and outcomes in a game. OR nodes represent player choices, and AND nodes represent game states or conditions.

EXAMPLE FOR AND-OR GRAPH



A SIMPLE AND-OR GRAPH

ALGORITHM:

1. Let G be a graph with only starting node INIT.
2. Repeat the followings until INIT is labeled SOLVED orh(INIT) > FUTILITY

a) Select an unexpanded node from the most promising pathfrom INIT (call it NODE)
b) Generate successors of NODE. If there are none, set h(NODE) = FUTILITY (i.e., NODE is unsolvable); otherwise for each SUCCESSOR that is not an ancestor of NODE do the following:
   i. Add SUCCESSSOR to G.
   ii. If SUCCESSOR is a terminal node, label it SOLVEDand set h(SUCCESSOR) = 0.
   iii. If SUCCESSPR is not a terminal node, compute its h

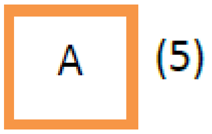
c) Propagate the newly discovered information up the graph by doingthe following: let S be set of SOLVED nodes or nodes whose h valueshave been changed and need to have values

propagated back to their parents.
Initialize S to Node. Until S is empty repeat the followings:

a) Remove a node from S and call it CURRENT.
b) Compute the cost of each of the arcs emerging fromCURRENT. Assign minimum cost of its successors as its h.
c) Mark the best path out of CURRENT by markingthe arc that had the minimum cost in step ii
d) Mark CURRENT as SOLVED if all of the nodes connected to it through new labeled arc have been labeled SOLVED
e) If CURRENT has been labeled SOLVED or itscost was just changed, propagate its new cost back up through thegraph. So add all of the ancestors of CURRENT to S.

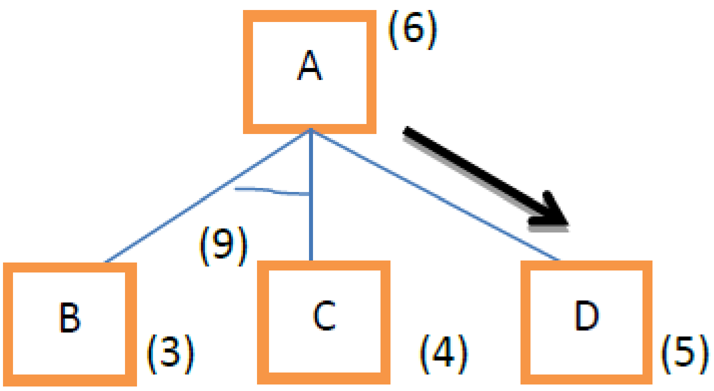
EXAMPLE: 1

STEP 1:



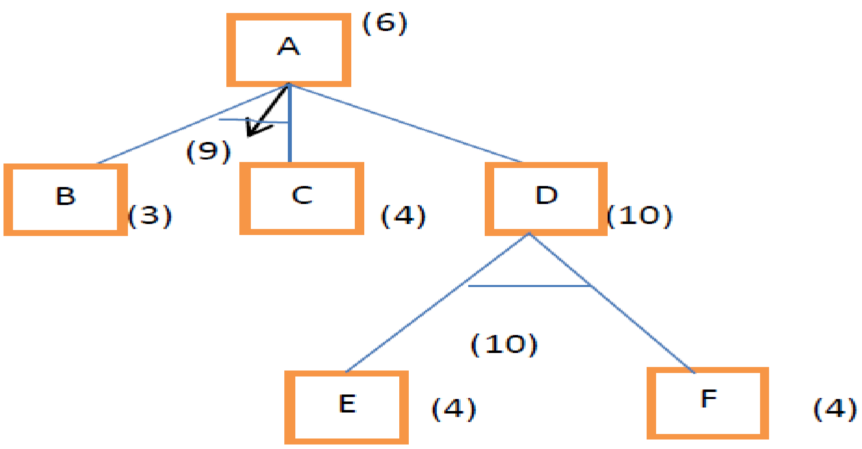
A is the only node, it is at the end of the current best path. It is expanded, yielding nodes B, C, D. The arc to D is labeled as the mostpromising one emerging from A, since it costs 6compared to B and C,which costs 9.

STEP 2:



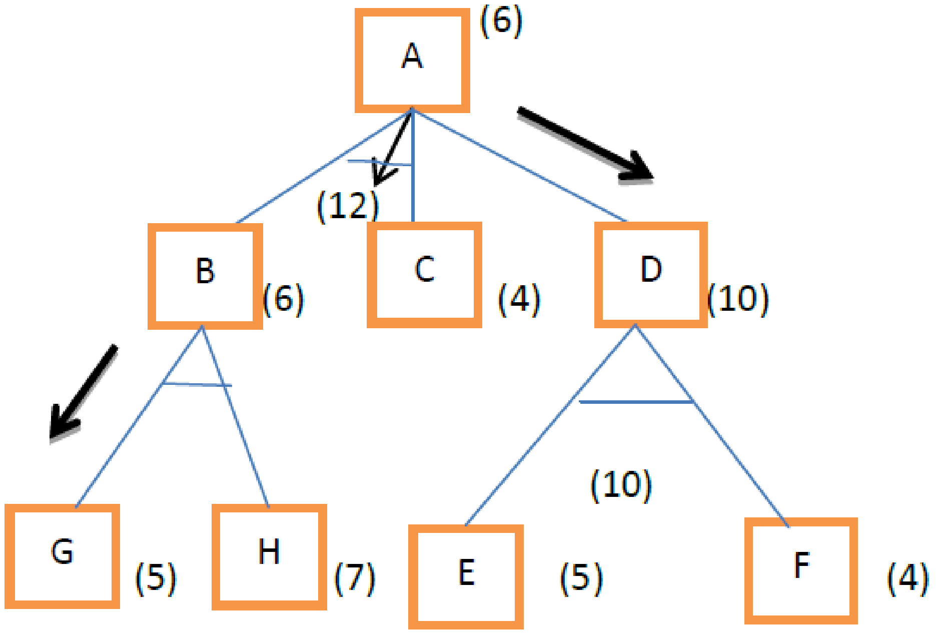
Node B is chosen for expansion. This process produces one new arc, the AND arc to E and F, with a combined cost estimate of 10.so we update the f' value of D to 10. Going back one more level, we see thatthis makes the AND arc B-C better than the arc to D, so it is labeled as the current best path.

STEP 3:



We traverse the arc from A and discover the unexpanded nodes B and C. If we going to find a solution along this path, we will have to expand both B and C eventually, so let’s choose to explore B first. This generates two new arcs, the ones to G and to H. Propagatingtheir f’ values backward, we update f’ of B to 6(since that is the best we think we can do, which we can achieve by going through G). This requires updating the cost of the AND arc B-C to 12(6+4+2). After doing that, the arc to D is again the better path from A, so we record that as the current best path and either node E or node F will chose forexpansion at step 4.

STEP4:



1.12 The Wumpus World

The **Wumpus world problem** depicts the value of a knowledge-based agent and the interpretation of that knowledge withthe help of reasoning and planning.

The **Wumpus world** is a 4x4 cave with 16 rooms connected toeach other through passageways. The knowledge-based agent goes forward in this world.

In Wumpus World:

- The cave has a room with a Wumpus, and the game is over when the agent enters the room; however, the Wumpus stays inone room.
- The agent is given a single arrow that can be used to kill theWumpus.
- There are some “Pits” rooms in the cave, and if the agent falls ina Pit, they will be stuck there forever.
- The Wumpus world is a simple world example to illustrate theworth of a knowledge-based agent and to represent knowledge.
  representation. It was inspired by a video game **Hunt the Wumpus** by Gregory Yob in 1973.
- The Wumpus world is a cave which has 4/4 rooms connected with passageways. So there are total 16 rooms which are connected with each other. We have a knowledge-based agent who will go forward in this world. The cave has a room with a beast which is called Wumpus, who eats anyone who enters the room. The Wumpus can be shot by the agent, but the agent has asingle arrow. In the Wumpus world, there are some Pits rooms which are bottomless, and if agent falls in Pits, then he will be stuck there forever. The exciting thing with this cave is that in one room there is a possibility of finding a heap of gold. So the agent goal is to find the gold and climb out the cave without fallen into Pits or eaten by Wumpus. The agent will get a rewardif he comes out with gold, and he will get a penalty if eaten by Wumpus or falls in the pit.

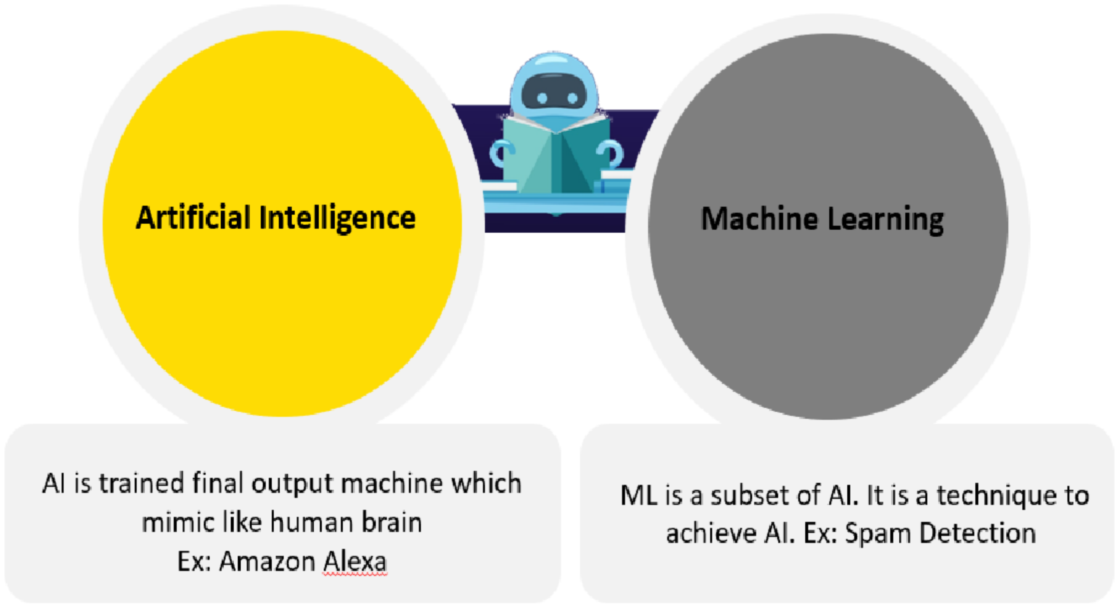
The Wumpus world Properties:

- **Partially observable:** The Wumpus world is partially observable because the agent can only perceive the close environment such as an adjacent room.
- **Deterministic:** It is deterministic, as the result and outcome of the world are already known.
- **Sequential:** The order is important, so it is sequential.
- **Static:** It is static as Wumpus and Pits are not moving.
- **Discrete:** The environment is discrete.
- **One agent:** The environment is a single agent as we have one agent only and Wumpus is not considered as an agent.

Extra notes of Unit-I

What Are the Applications of Artificial Intelligence?

- Personalized Shopping. ...
- AI-powered Assistants. ...
- Fraud Prevention. ...
- Administrative Tasks Automated to Aid Educators. ...
- Creating Smart Content. ...
- Voice Assistants. ...
- Personalized Learning. ...
- Autonomous Vehicles.



1. **Automated Customer Support:**
   - Online shopping experience has been greatly enhancedby chatbots because of the following reasons:
   - They increase user retention by sending reminders andnotifications
   - They offer instant answers compared to human assistants, thus reducing response time
   - Chatbots provide upselling opportunities through personalized approach

2. **Personalized Shopping Experience:**
   - Implementation of artificial intelligence makes it possiblefor online stores to use the smallest piece of data about every followed link or hover to personalize your experience on a deeper level.
   - This personalization results into timely alerts, messages, visuals that should be particularly interesting to you, and dynamic content that modifies according to users' demandand supply.

3. **Healthcare:**

   - AI-enabled workflow assistants are aiding doctors free up their schedules, reducing time and cost by streamlining processes and opening up new avenues for the industry.
   - In addition, AI-powered technology helps pathologists in analyzing tissue samples and thus, in turn, making more accurate diagnosis.

4. **Finance:**

   - Automated advisors powered by AI, are capable of predicting the best portfolio or stock based on preferencesby scanning the market data.
   - Actionable reports based on relevant financial data is alsobeing generated by scanning millions of key data points, thus saving analysts numerous hours of work.

5. **Smart Cars and Drones:**

- With autonomous vehicles running on the roads and autonomous drones delivering the shipments, a significant amount of transportation and service-related issues can be resolved faster and more effectively.

6. **Travel and Navigation:**

- With AI-enabled mapping, it scans road information and utilizes algorithms to identify the optimal route to take, beit in a bike, car, bus, train, or on foot.

7. **Social media:**

- Face book uses advanced machine learning to do everything from serving content to you and to recognize your face in photos to target users with advertising.
- Instagram (owned by Facebook) uses AI to identifyvisuals.
- LinkedIn uses AI to offer job recommendations, suggestpeople you might like to connect with, and serving you specific posts in your feed.

8. **Smart Home Devices:**

- The connected devices of smart homes provide the dataand the AI learns from that data to perform certain taskswithout human intervention.

9. **Creative Arts:**

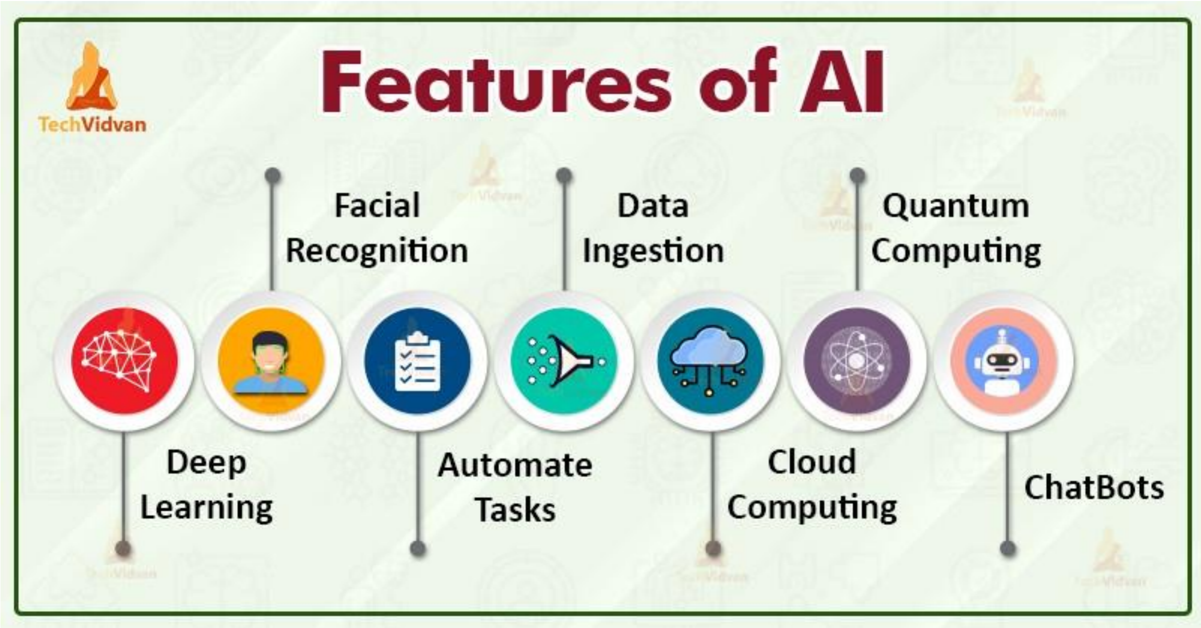
- AI-powered technologies can help musicians create newthemes.

10. **Security and Surveillance:**

- AI is making possible for humans to constantly monitormultiple channels with feeds coming in from a huge number of cameras at the same time.

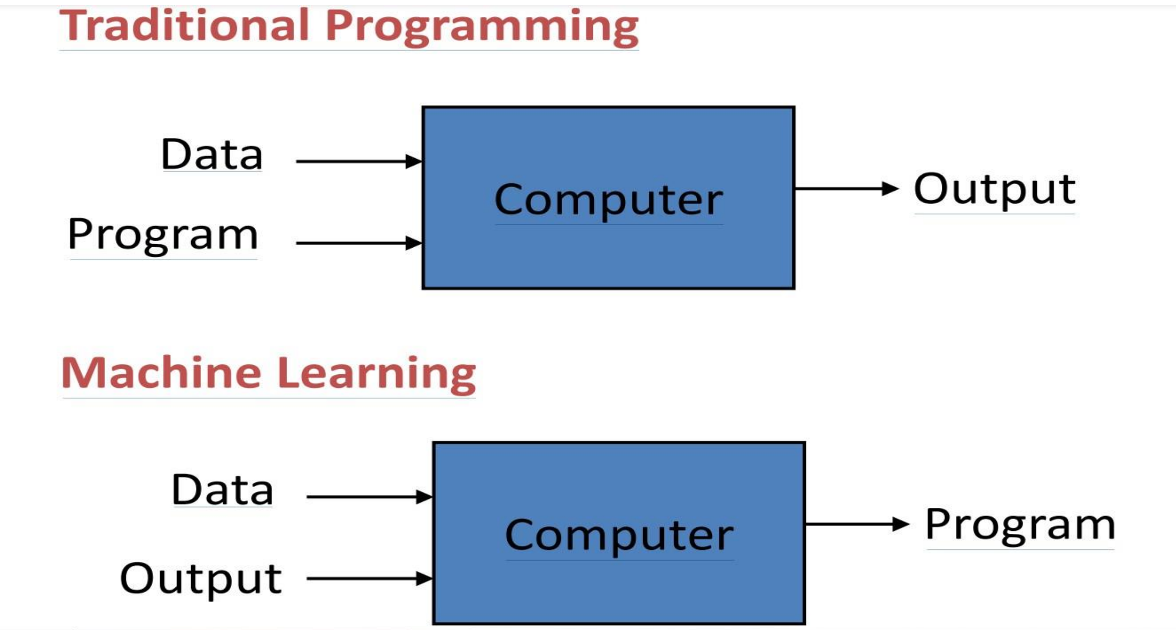
Avenues

- Hospital and Medicine
- Game Playing
- Speech Recognition
- Understanding Natural Language
- Computer Vision
- Cyber Security
- Face Recognition
- Transport
- Marketing & Advertising



What is Machine Learning?

"Learning is any process by which a system improves performance from experience." - Herbert Simon



Branches of Artificial Intelligence

- **Machine Learning:**
  Machine Learning is the technique that gives computersthe potential to learn without being programmed, it is activelybeing used in daily life.

- **Deep Learning:**

  The Deep Learning Specialization is a foundational program that will help you understand the capabilities, challenges, and consequences of deep learning and prepare you to participate in the development of leading-edge AI technology.

- **Natural Language Processing:**

  NLP is the part of computer science and AI that can helpin communicating between computer and human by natural

  language. It is a technique of computational processing of human languages. It enables a computer to read and understanddata by mimicking human natural language.

- **Robotics:**

  Robots are deployed often for conducting tasks that might be laborious for humans to perform steadily. Major of robotics tasks involved- assembly line for automobile manufacturing, for moving large objects in space by NASA. AI researchers are alsodeveloping robots using machine learning to set interaction at social levels.

- **Expert Systems:**

  Expert systems are built to deal with complex problems via reasoning through the bodies of proficiency, expressed especially in particular of "if-then" rules instead of traditionalagenda to code. The key features of expert systems include extremely responsive, reliable, understandable and highexecution.

- **Fuzzy Logic:**

  In simpler terms, Fuzzy logic is a technique that represents and modifies uncertain information by measuring the degree to which the hypothesis is correct. Fuzzy logic is also used for reasoning about naturally uncertain concepts. Fuzzy logic is convenient and flexible to implement machine learning techniques and assist in imitating human thought logical

Following is the kind of knowledge which needs to berepresented in AI systems:

- **Object:** All the facts about objects in our world domain. E.g., Guitars contains strings, trumpets are brass instruments.
- **Events:** Events are the actions which occur in our world.
- **Performance:** It describe behaviour which involvesknowledge about how to do things.

- **Meta-knowledge:** It is knowledge about what we know.
- **Facts:** Facts are the truths about the real world and what we represent.
- **Knowledge-Base:** The central component of the knowledge-based agents is the knowledge base. It is represented as KB. The Knowledgebase is a group of the Sentences (Here, sentences are used as a technical term and not identical with the English language).

An Artificial intelligence system has the followingcomponents for displaying intelligent behavior:

- Perception
- Learning
- Knowledge Representation and Reasoning
- Planning
- Execution