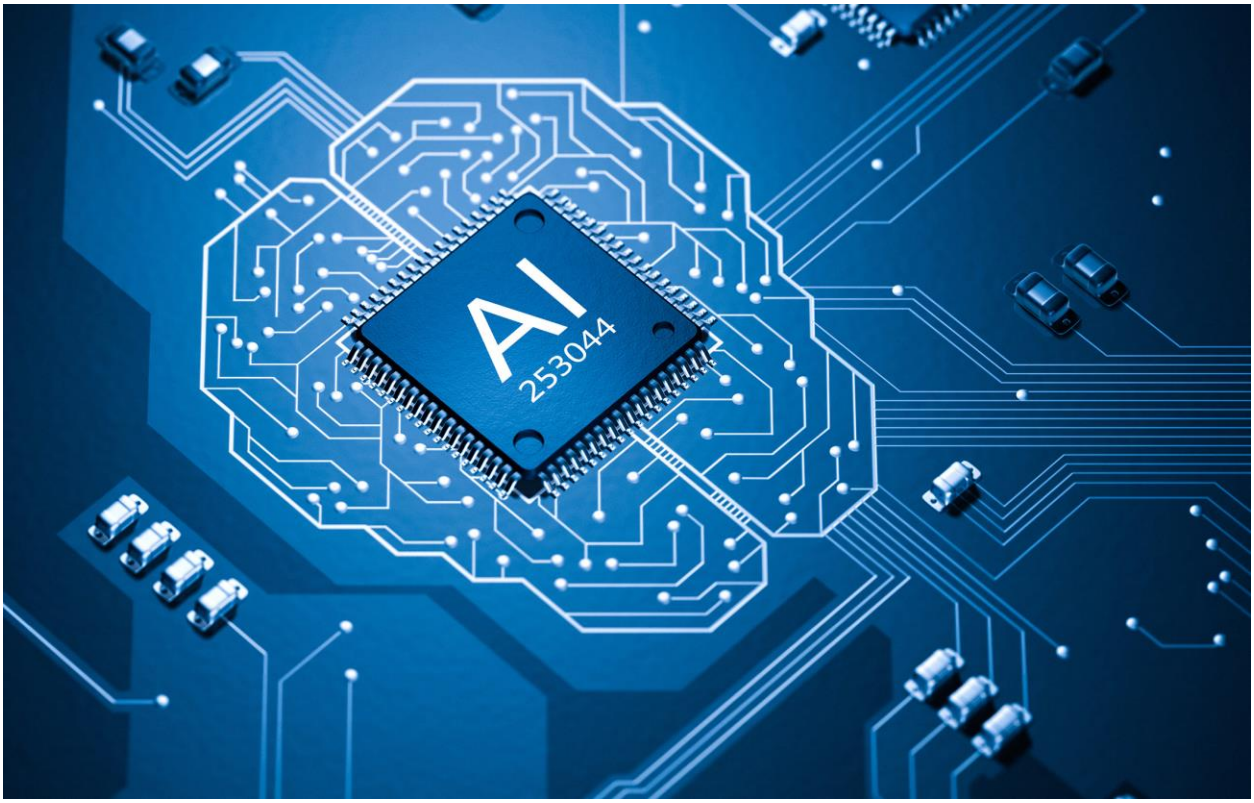
AI



Lect0

Key Topics in AI

1. **Goals of AI**:
    - Make computers useful by handling dangerous or tedious tasks.
    - Understand human intelligence principles.
    - Design systems that exhibit human-like intelligence.
2. **Major Roles of AI**:
    - Study human intelligence.
    - Represent intelligent actions using computers.
3. **Main Topics in AI**:
    - **Search**: Fundamental technique (blind/uninformed vs. informed search).
    - **Knowledge Representation & Reasoning**: Describing the environment and drawing inferences.
    - **Planning**: Constructing sequences of actions to achieve goals.
    - **Learning**: Adapting actions based on experience.
    - **Natural Language Processing (NLP)**: Enabling machines to understand and generate human language.
    - **Expert Systems**: AI systems that emulate decision-making of human experts.
    - **Interacting with the Environment**: Includes vision, speech recognition, and robotics.
4. **Types of AI**:
    - **Artificial Narrow Intelligence (ANI)**: Weak AI, performs specific tasks (e.g., voice assistants).

    - **Artificial General Intelligence (AGI)**: Strong AI, thinks and makes decisions like humans (not yet achieved).
    - **Artificial Super Intelligence (ASI)**: Surpasses human intelligence (hypothetical).
5. **Disciplines Contributing to AI**:
    - Computer Science, Mathematics, Neuroscience, Biology, Sociology, Psychology, Philosophy.
6. **Applications of AI**:
    - Factory automation, robotics, medical care, education, entertainment, biometrics, surveillance, etc.
7. **Challenges in AI**:
    - Uncertainty, dynamic environments, time-consuming computations, and mapping real-world data.

Question

Fill-in-the-Blank Questions

1. The two major roles of AI are to study the _____ part concerned with humans and represent those actions using _____.
2. _____ is the fundamental technique of AI, which can be either "blind" or "informed."
3. _____ is the stage of AI where machines can perform only a narrowly defined set of specific tasks.
4. The process of constructing a sequence of actions to achieve a set of goals is called _____.
5. AI systems that emulate the decision-making ability of human experts are called _____.

6. The ability of a system to change its actions based on experience is referred to as _____.
7. _____ is the stage of AI where machines will possess the ability to think and make decisions like humans.
8. The transformation from the 3D world to the 2D world in computer vision is called _____.
9. _____ is a major challenge in AI where physical sensors provide limited, noisy, and inaccurate information.
10. AI applications like factory automation, robotics, and medical care fall under the category of _____ systems.

True/False Questions

1. **True/False**: Artificial Narrow Intelligence (ANI) can perform a wide range of tasks just like humans.
2. **True/False**: Informed search uses guesses about what is ahead to decide where to look next.
3. **True/False**: Planning in AI involves searching through a small and manageable search space.
4. **True/False**: Natural Language Processing (NLP) is concerned with enabling machines to understand and generate human language.
5. **True/False**: Artificial Super Intelligence (ASI) has already been achieved and is widely used today.
6. **True/False**: Knowledge representation is the most important concept in AI.
7. **True/False**: AI systems cannot learn from experience.
8. **True/False**: Expert systems are designed to emulate the decision-making ability of human experts.

9. **True/False**: AI is a single-discipline field that only involves computer science.
10. **True/False**: One of the challenges in AI is dealing with uncertainty in sensor data.

Definition Questions

1. Define **Artificial Intelligence (AI)**.
2. What is **Artificial General Intelligence (AGI)**?
3. Explain the concept of **informed search** in AI.
4. What is the purpose of **knowledge representation and reasoning** in AI?
5. Define **Natural Language Processing (NLP)**.
6. What is an **expert system** in AI?
7. Explain the term **planning** in the context of AI.
8. What is the difference between **Artificial Narrow Intelligence (ANI)** and **Artificial Super Intelligence (ASI)**?
9. Define **learning** in AI.
10. What is the significance of **interdisciplinary contributions** to AI?

Short Answer Questions

1. What are the two major roles of AI?
2. List three main topics in AI and briefly explain each.
3. What are the three types of AI, and how do they differ?
4. Explain the difference between "blind" and "informed" search techniques in AI.
5. What are some challenges faced in AI research?

6. Name three applications of AI and describe how they are used in real-world scenarios.
7. How does AI contribute to fields like medicine and education?
8. What is the role of mathematics in AI?
9. Why is knowledge representation important in AI?
10. What are the advantages and disadvantages of AI?

Multiple Choice Questions

1. Which of the following is NOT a type of AI?
   a) Artificial Narrow Intelligence (ANI)
   b) Artificial General Intelligence (AGI)
   c) Artificial Super Intelligence (ASI)
   d) Artificial Limited Intelligence (ALI)
2. What is the primary goal of AI?
   a) To replace humans in all tasks
   b) To make computers more useful by taking over dangerous or tedious tasks
   c) To eliminate the need for programming
   d) To create machines that can only perform mathematical calculations
3. Which of the following is a challenge in AI?
   a) Static environments
   b) Unlimited computational resources
   c) Uncertainty in sensor data
   d) Lack of interdisciplinary contributions
4. What is the purpose of planning in AI?
   a) To create a sequence of actions to achieve goals
   b) To replace human decision-making entirely

c) To eliminate the need for learning
d) To focus only on theoretical concepts

5. Which discipline is NOT directly involved in AI?
   a) Computer Science
   b) Mathematics
   c) Sociology
   d) Geology

Essay Questions

1. Discuss the importance of knowledge representation and reasoning in AI. Provide examples to support your answer.
2. Compare and contrast Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Super Intelligence (ASI).
3. Explain the challenges faced in AI research and how they impact the development of intelligent systems.
4. Describe the role of AI in modern applications such as healthcare, education, and robotics.
5. How do interdisciplinary contributions from fields like psychology, neuroscience, and philosophy enhance the development of AI?
6. What is different AI vs ML vs DL?

Lect1

1. Knowledge-Based Agents

- **Definition:** Agents that reason using internal representations of knowledge.
- **Knowledge Base (KB):** A set of sentences known by an agent.
- **Inference:** The process of deriving new sentences from existing ones.

2. Propositional Logic

- **Propositional Symbols:** Represent facts (e.g., P, Q, R).
- **Logical Connectives:**
  - **Negation (¬):** NOT
  - **Conjunction (∧):** AND
  - **Disjunction (∨):** OR
  - **Implication (→):** IF-THEN
  - **Biconditional (↔):** IF AND ONLY IF (IFF)

3. Truth Tables

- Understand the truth values for:
  - **AND (∧)**
  - **OR (∨)**
  - **IMPLICATION (→)**
  - **BICONDITIONAL (↔)**

4. Models and Entailment

- **Model:** An assignment of truth values to propositional symbols.
- **Entailment (⊨):** If KB ⊨ α, then in every model where KB is true, α is also true.

5. Inference Methods

- **Model Checking:** Checking if KB ⊨ α by evaluating all possible models.

6. Logic Puzzles

- Applying propositional logic to reasoning problems, like:
  - Who visited whom?
  - Which house does each person belong to?

7. Knowledge Engineering

- **Encoding real-world problems into logical statements.**
- **Example:** "If it didn’t rain, Harry visited Hagrid today" can be written as:
  - ¬P→Q\neg P \rightarrow Q¬P→Q
  - QVRQ \vee RQVR (Harry visited Hagrid or Dumbledore, but not both)

Example Problem

Given:

- PP: It is raining.
- QQ: Harry visited Hagrid.
- RR: Harry visited Dumbledore.

KB:

1. ¬P→Q$\neg P \rightarrow Q$ (If it didn't rain, Harry visited Hagrid.)
2. Q⊕R$Q \oplus R$ (Harry visited Hagrid or Dumbledore, but not both.)
3. RR (Harry visited Dumbledore.)

Query: Did it rain today?

Solution:

- From $\mathrm{R}R$ and $\mathrm{Q}\oplus\mathrm{R}Q\oplus R$, we infer $\neg\mathrm{Q}\neg Q$ (Harry did not visit Hagrid).
- From $\neg\mathrm{Q}\neg Q$ and $\neg\mathrm{P}\rightarrow\mathrm{Q}\neg P\rightarrow Q$, we infer $\mathrm{P}P$ (It rained today).

Question

1. Fill-in-the-Blank Questions

1. A _____ is a set of sentences known by a knowledge-based agent.
    - **Answer**: knowledge base (KB)
2. The process of deriving new sentences from old ones is called _____.
    - **Answer**: inference
3. In propositional logic, the symbol $\neg\neg$ represents _____.
    - **Answer**: not
4. The logical connective $\rightarrow\rightarrow$ represents _____.
    - **Answer**: implication (if-then)
5. A _____ is an assignment of truth values to every propositional symbol.
    - **Answer**: model

6. $\alpha \models \beta$ $\alpha \models \beta$ means that in every model where α α is true, _____ is also true.
    - **Answer**: β β
7. The process of enumerating all possible models to determine if $\mathrm{KB} \models \alpha$ $KB \models \alpha$ is called _____.
    - **Answer**: model checking
8. In the Clue game, the propositional symbol "mustard" might represent _____.
    - **Answer**: Colonel Mustard (or a specific player/character)
9. The logical connective $\leftrightarrow$ $\leftrightarrow$ represents _____.
    - **Answer**: biconditional (if and only if)
10. A _____ is an assertion about the world in a knowledge representation language.
    - **Answer**: sentence

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2. True/False Questions

1. **True/False**: A knowledge-based agent reasons by operating on internal representations of knowledge.
    - **Answer**: True
2. **True/False**: In propositional logic, $\mathrm{P} \wedge \mathrm{Q}$ $P \wedge Q$ is true only if both P P and Q Q are true.
    - **Answer**: True
3. **True/False**: The implication $\mathrm{P} \rightarrow \mathrm{Q}$ $P \rightarrow Q$ is false only when P P is true and Q Q is false.

    - **Answer**: True
4. **True/False**: $\alpha \models \beta$ $\alpha \models \beta$ means that β β is true in some models where α α is true.
    - **Answer**: False (It must be true in **all** models where α α is true.)
5. **True/False**: Model checking is an inference algorithm that works by enumerating all possible models.
    - **Answer**: True
6. **True/False**: In the Clue game, the sentence $\text{mustard} \vee \text{plum} \vee \text{scarlet}$ $\text{mustard} \vee \text{plum} \vee \text{scarlet}$ me ans that only one of these characters is guilty.
    - **Answer**: False (It means at least one of them is guilty.)
7. **True/False**: The biconditional $\text{P} \leftrightarrow \text{Q}$ $P \leftrightarrow Q$ is true when P P and Q Q have the same truth value.
    - **Answer**: True
8. **True/False**: A knowledge base (KB) can contain only true sentences about the world.
    - **Answer**: True
9. **True/False**: In propositional logic, $\text{P} \vee \text{Q}$ $P \vee Q$ is false only if both P P and Q Q are false.
    - **Answer**: True
10. **True/False**: The sentence "Harry visited Hagrid or Dumbledore today, but not both" can be represented as $\text{Q} \oplus \text{R}$ $Q \oplus R$.
    - **Answer**: True

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3. Definition-Based Questions

1. Define **propositional logic**.
2. What is a **knowledge base (KB)**?
3. Explain the term **entailment** ($\alpha \models \beta$ $\alpha \models \beta$).
4. What is **model checking**?
5. Define **logical connectives**.
6. What is a **model** in propositional logic?
7. What does the **biconditional** ($\leftrightarrow$ $\leftrightarrow$) connective mean?
8. Define **inference**.
9. What is a **propositional symbol**?
10. Explain the **exclusive or (XOR)** operation.

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4. Application-Based Questions

1. Translate the following sentence into propositional logic: "If it is Tuesday and not raining, Harry will go for a run."
2. Given the KB:
   - $\neg P \rightarrow Q$ $\neg P \rightarrow Q$
   - $Q \oplus R$ $Q \oplus R$
   - R R

   Prove whether P P is true.

3. Create a truth table for $P \rightarrow Q$.
4. Solve the logic puzzle:
    - Gilderoy is in Gryffindor or Ravenclaw.
    - Pomona is not in Slytherin.
    - Minerva is in Gryffindor.
    - Assign each person to a house.

Lect1-2

Key Concepts in the Sentence:

1. **Inference Rules**:
    - **Modus Ponens**: If "α → β" and "α" are true, then "β" is true.
    - **And Elimination**: If "α ∧ β" is true, then "α" is true.
    - **Double Negation Elimination**: If "¬(¬α)" is true, then "α" is true.
    - **Implication Elimination**: "α → β" is equivalent to "¬α ∨ β".
    - **Biconditional Elimination**: "α ↔ β" is equivalent to "(α → β) ∧ (β → α)".
    - **De Morgan's Laws**: Transformations between conjunctions and disjunctions using negations.
    - **Distributive Property**: Distributes logical OR over AND and vice versa.
2. **Search Problems**:

- **Initial State**: The starting point of the problem.
- **Actions**: Possible moves or steps.
- **Transition Model**: How actions change the state.
- **Goal Test**: Determines if the goal state is reached.
- **Path Cost Function**: Measures the cost of a path.

3. **Theorem Proving**:
   - **Initial State**: Starting knowledge base.
   - **Actions**: Application of inference rules.
   - **Transition Model**: Updates to the knowledge base after applying inference rules.
   - **Goal Test**: Checks if the statement to be proven is derived.
   - **Path Cost Function**: Number of steps in the proof.
4. **Resolution**:
   - A rule of inference used in automated theorem proving.
   - Combines clauses to derive new clauses until the goal is reached or no new clauses can be derived.
5. **Conjunctive Normal Form (CNF)**:
   - A way of structuring logical sentences as a conjunction of disjunctions (clauses).
   - Essential for resolution and other automated reasoning techniques.
6. **First-Order Logic**:

- Extends propositional logic by including quantifiers and predicates.
- **Universal Quantification (∀)**: Statements that apply to all elements.
- **Existential Quantification (∃)**: Statements that apply to at least one element.

Question

Fill in the Blanks

1. If it is raining, then Harry is inside. It is raining. By _____, we can conclude that Harry is inside.
2. The rule _____ states that from , we can conclude .
3. The statement "It is not true that Harry did not pass the test" simplifies to "Harry passed the test" by applying _____.
4. The inference rule that transforms into is called _____.
5. The conversion of into follows the rule of _____.
6. The logical rule that allows us to distribute conjunction over disjunction is called _____.

True/False Questions

1. Modus Ponens states that if and are true, then must be true.
2. De Morgan’s Law allows us to transform into .
3. The Distributive Property states that is equivalent to .
4. Resolution allows us to derive a conclusion from a set of premises by combining clauses that contain complementary literals.

5. Universal Quantification states that a property holds for at least one object in the domain.

Definitions

1. **Modus Ponens**:
    - Definition: If and are both true, then must also be true.
    - Example: "If it is raining, then Harry is inside. It is raining. Therefore, Harry is inside."
2. **And Elimination**:
    - Definition: If we know that is true, we can conclude that is true (and also that is true).
    - Example: "Harry is friends with Ron and Hermione. Therefore, Harry is friends with Hermione."
3. **Double Negation Elimination**:
    - Definition: The principle that simplifies to .
    - Example: "It is not true that Harry did not pass the test" simplifies to "Harry passed the test."
4. **Implication Elimination**:
    - Definition: The transformation of into .
    - Example: "If it is raining, then Harry is inside" can be rewritten as "It is not raining or Harry is inside."
5. **Biconditional Elimination**:
    - Definition: The transformation of into .
    - Example: "It is raining if and only if Harry is inside" can be rewritten as "If it is raining, then Harry is inside, and if Harry is inside, then it is raining."
6. **De Morgan's Laws**:
    - Definition: A set of transformation rules for negations of conjunctions and disjunctions.
    - Example: is equivalent to .

7. **Distributive Property**:
    - Definition: A logical transformation that distributes over and vice versa.
    - Example: is equivalent to .

Additional Questions

1. What are the five components of a search problem?
2. Explain the difference between a clause and conjunctive normal form (CNF).
3. How does inference by resolution work in theorem proving?
4. Convert the following expression into CNF: .
5. Describe the key difference between propositional logic and first-order logic

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Lect 2-1

1. Key Definitions

- **Agent**: An entity that perceives its environment and acts upon it.
- **State**: A configuration of the agent and its environment.
- **Initial State**: The state in which the agent begins.
- **Actions**: Choices that can be made in a state.
- **Transition Model**: Describes how the state changes after an action.
- **State Space**: The set of all states reachable from the initial state.
- **Goal Test**: Determines if a given state is a goal state.
- **Path Cost**: The cost associated with a given path.

- **Solution**: A sequence of actions that leads from the initial state to a goal state.
- **Optimal Solution**: The solution with the lowest path cost.

2. Search Strategies

- **Depth-First Search (DFS)**:
  - Expands the deepest node first.
  - Uses a **stack** (Last-In-First-Out, LIFO).
  - Not guaranteed to find the shortest path.
- **Breadth-First Search (BFS)**:
  - Expands the shallowest node first.
  - Uses a **queue** (First-In-First-Out, FIFO).
  - Guarantees finding the shortest path.
- **Uninformed Search**:
  - No domain-specific knowledge used.
  - Examples: DFS and BFS.

3. Search Problem Approach

1. Start with a **frontier** that contains the initial state.
2. Repeat:
   - If the **frontier** is empty, return "no solution."
   - Remove a node from the frontier.
   - If the node contains the **goal state**, return the solution.
   - Expand the node, add resulting nodes to the frontier.

Question

Fill in the Blanks

1. An _____ is an entity that perceives its environment and acts upon it.
2. The _____ state is the starting point of a search problem.
3. _____ describes how the state changes after an action is performed.
4. A _____ is a sequence of actions leading from the initial state to a goal state.
5. _____ search expands the deepest node first and uses a stack (LIFO).
6. _____ search expands the shallowest node first and guarantees finding the shortest path.
7. The set of all states reachable from the initial state is called the _____.
8. A solution with the lowest path cost is called an _____ solution.

True/False Questions

1. Depth-First Search (DFS) always finds the shortest path.
2. Breadth-First Search (BFS) guarantees finding the shortest path.
3. The Transition Model describes how an agent perceives its environment.
4. In a search problem, if the frontier is empty, the algorithm returns "no solution."
5. Uninformed search strategies use domain-specific knowledge to find solutions.

Definitions

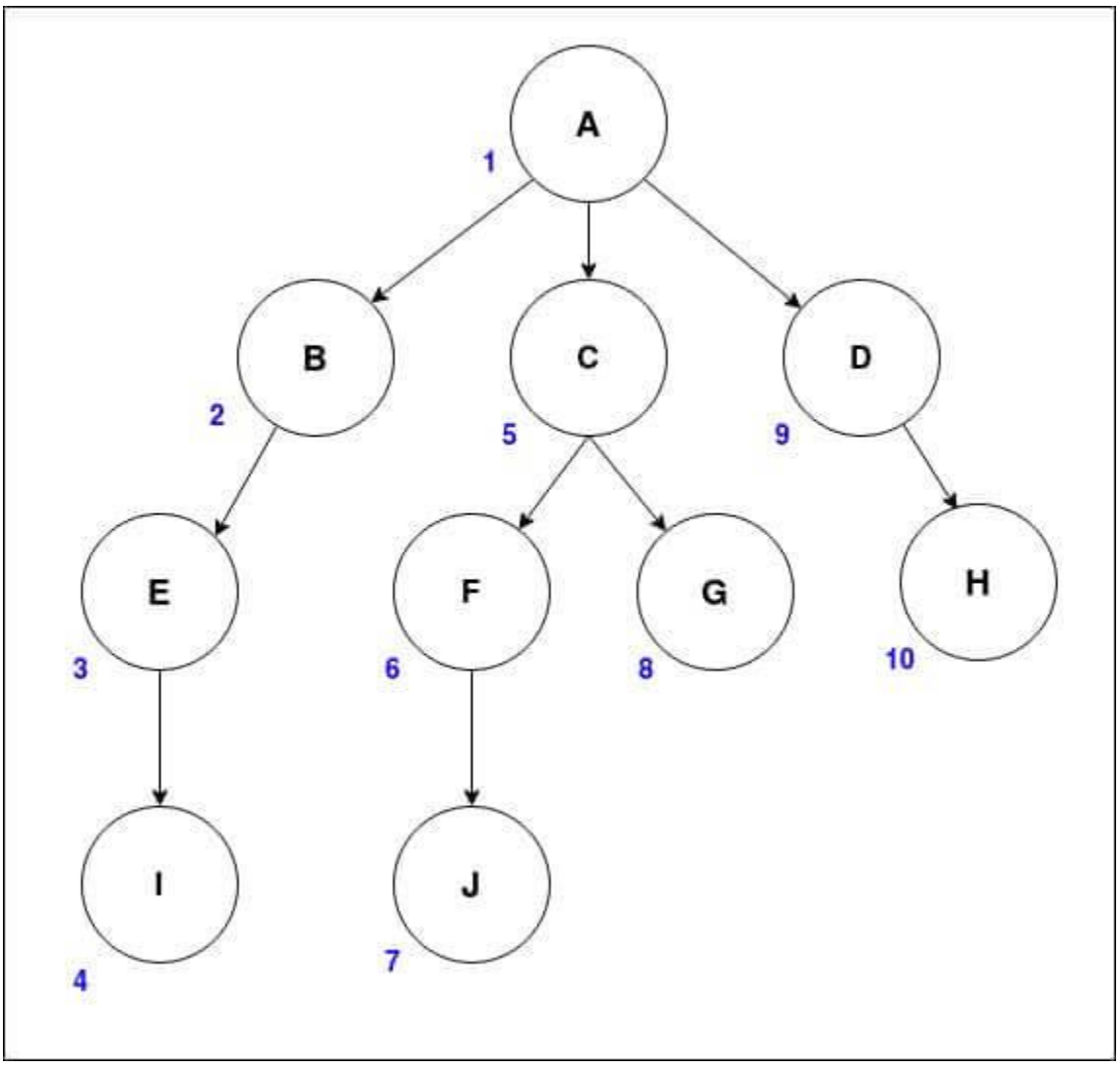
1. Define "Agent" in the context of search problems.
2. What is a "Goal Test" in a search strategy?
3. Explain "Path Cost" and its significance in search problems.
4. Describe "State Space" in relation to search strategies.
5. What is the difference between "Uninformed Search" and "Informed Search"?

Additional Questions

1. What data structure does Depth-First Search (DFS) use?
2. What data structure does Breadth-First Search (BFS) use?
3. How does the search algorithm determine if a state is a goal state?
4. What happens if the frontier becomes empty during a search problem?
5. What are the steps involved in solving a search problem?

DFS Question

Use DFS Algorithm to get from A to J:



Lect2-2

1. Search Strategies

- **Uninformed Search:** No problem-specific knowledge is used.
- **Informed Search:** Uses problem-specific knowledge to find solutions more efficiently.

2. Greedy Best-First Search (GBFS)

- Expands the node closest to the goal, estimated by a **heuristic function** h(n)h(n)h(n).
- **Heuristic function:** Estimates the cost from a node nnn to the goal.
- **Advantages:** Fast, low memory usage, simple implementation.
- **Disadvantages:** Can get stuck in local optima, not guaranteed to find the optimal solution, requires a good heuristic.

*3. A Search Algorithm**

- Expands node with the lowest value of f(n)=g(n)+h(n)f(n) = g(n) + h(n)f(n)=g(n)+h(n), where:
  - g(n)g(n)g(n) = cost to reach node nnn.
  - h(n)h(n)h(n) = estimated cost from nnn to the goal.

4. Key Differences:

- **Greedy Best-First Search** uses only h(n)h(n)h(n) (heuristic-based, faster but not optimal).
- *A Search** uses g(n)+h(n)g(n) + h(n)g(n)+h(n) (considers actual cost + heuristic, optimal if h(n)h(n)h(n) is admissible).

Question

1. Fill in the Blanks

1. _____ search does not use any problem-specific knowledge, while _____ search uses problem-specific knowledge to find solutions efficiently.
2. In **Greedy Best-First Search**, the algorithm expands the node with the lowest _____ value.
3. A heuristic function **h(n)** estimates the cost from node _____ to _____.
4. *A Search** expands the node with the lowest value of _____**,** which is calculated as **f(n) = g(n) + h(n)**.
5. One disadvantage of **Greedy Best-First Search** is that it can get stuck in _____, meaning it might not find the best solution.

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2. True or False

1. *A Search is always faster than Greedy Best-First Search.**
2. Greedy Best-First Search only considers heuristic values and ignores actual costs.

3. A heuristic function must always be accurate to be useful in search algorithms.
4. Greedy Best-First Search guarantees finding the shortest path.
5. *A Search is complete and optimal if the heuristic function is admissible and consistent.**

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3. Definitions (Short Answer)

1. **Define heuristic function.**

2. ***What is the main difference between Greedy Best-First Search and A Search?****

3. ***Why does A Search guarantee finding the optimal solution if the heuristic is admissible?****

4. **What does it mean for a heuristic to be "admissible"?**

4.use A* search Algorithm to solve 8 Puzzel