NOORUL ISLAM CENTRE FOR HIGHER EDUCATION
KUMARACOIL

AI32D1
FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE

QUESTION BANK

UNIT – I
PART A

1. **Define Artificial Intelligence (AI).**

AI may be defined as the branch of Computer Science that is concerned with the automation of intelligent behaviour.

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

2. **What are the capabilities, computer should posses to pass Turing test?**
    - Natural Language Processing
    - Knowledge representation
    - Automated reasoning
    - Machine Learning

3. **Define Rational Agent.**

It is one that acts, so as to achieve the best outcome (or) when there is uncertainty, the best expected outcome.

4. **Define Agent.**

An Agent is anything that can be viewed as perceiving (i.e.) understanding its environment through sensors and acting upon that environment through actuators.

5. **Give the structure of agent in an environment?**

Agent interacts with environment through sensors and actuators.

An Agent is anything that can be viewed as perceiving (i.e.) understanding its environment through sensors and acting upon that environment through actuators.

6. **Define Percept Sequence.**

An agent's choice of action at any given instant can depend on the entire percept sequence observed to elate.

7. **Define Agent Function.**

It is a mathematical description which deals with the agent's behavior that maps the given percept sequence into an action.

8. **Define Agent Program.**

Agent function for an agent will be implemented by agent program.

9. **What is important for task environment?**

PEAS

- P- Performance measure
- E – Environment

- Actuators
- S – Sensors

10. List the properties of environments.

- Fully Observable Vs Partially Observable
- Deterministic Vs Stochastic
- Episodic Vs Sequential
- Static Vs Dynamic
- Discrete Vs Continuous
- Single Agent Vs Multi agent

11. What are the components of a problem?

There are four components. They are

- Initial state
- Successor function
- Goal test
- Path cost

12. Define Path.

A path in the state space is a sequence of state connected by sequence of actions.

13. Define Path Cost.

A function that assigns a numeric cost to each path, which is the sum of the cost of the each action along the path.

14. Define search tree.

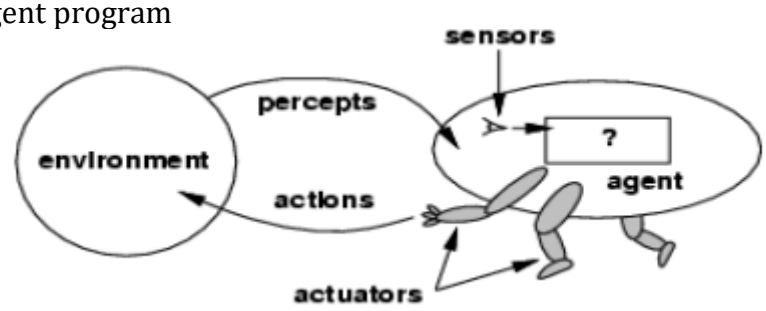
The tree which is constructed for the search process over the state space is called search tree.

15. Define search node.

The root of the search tree that is the initial state of the problem is called search node.

PART B

1. **Explain about Agents and Environments in detail.**
   - Percept
   - Percept Sequence
   - Agent function
   - Agent program



   - Agent function

Percept Sequence	Action
[A, Clean]	Right
[A, Dirty]	Suck
[B, Clean]	Left
[B, Dirty]	Suck
[A, Clean], [A, Clean]	Right
[A, Clean], [A, Dirty]	Suck
…	

Figure 1.4 Partial tabulation of a simple agent function

2. **Define Agents. Specify the PEAS descriptions for intelligent agent design with examples and explain basic types of agents.**

An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.

   - PEAS

Agent Type	Performance Measure	Environments	Actuators	Sensors
Taxi driver	Safe: fast, legal, comfortable trip, maximize profits	Roads,other traffic,pedestrians, Customers	Steering,accelerator, brake, Signal,horn,display	Cameras,sonar, Speedometer,GPS, Odometer,engine sensors,keyboards, accelerometer

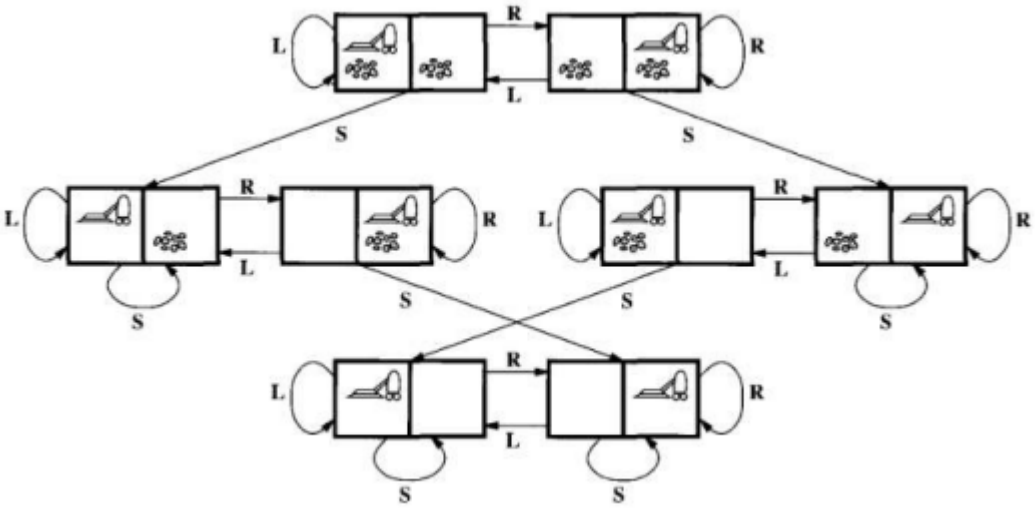
   - Properties of task environments

- ✓ Fully observable vs. partially observable
- ✓ Deterministic vs. Stochastic
- ✓ Episodic vs. Sequential
- ✓ Static vs. Dynamic
- ✓ Discrete vs. Continuous
- ✓ Single agent vs. Multiagent

- Some Agent Type
  - ✓ Table-driven agents
  - ✓ Simple reflex agents
  - ✓ Agents with memory
  - ✓ Agents with goals
  - ✓ Utility-based agents

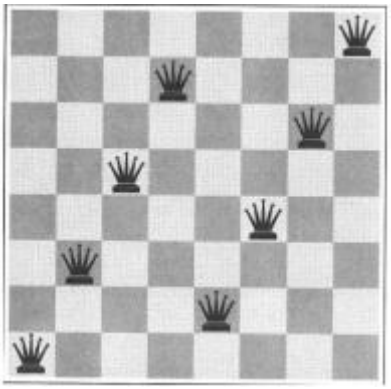
3. Discuss in detail about Vacuum World Problem.

- States
- Initial state
- Successor function
- Goal Test
- Path test



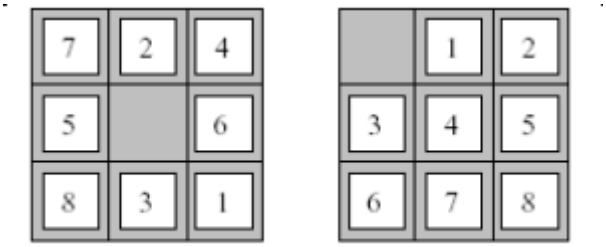
4. Formulate 8 queen problems. Discuss all the problem components.

- States
- Initial state
- Successor function
- Goal Test



5. Explain in detail about 8 puzzle problems.

- States
- Initial state
- Successor function
- Goal Test
- Path test



6. Discuss any two uninformed search methods with examples.

Uninformed Search Strategies have no additional information about states beyond that provided in the problem definition.

There are five uninformed search strategies as given below.

- Breadth-first search
- Uniform-cost search
- Depth-first search
- Depth-limited search
- Iterative deepening search

UNIT – II
PART A

1. **What is informed search?**

One that uses problem – specific knowledge beyond the definition of the problem itself and it can find solutions more efficiently than an uninformed strategy.

2. **List the various search strategies.**
   - BFS
   - Uniform cost search
   - DFS
   - Depth limited search
   - Iterative deepening search
   - Bidirectional search

3. **What is Best First Search?**

Best First Search is an instance of the general TREE SEARCH or GRAPH SEARCH algorithm in which a node is selected for expansion based on an evaluation function, f(n).

4. **Define Heuristic function, h (n).**

h (n) is defined as the estimated cost of the cheapest path from node n to a goal node.

5. **Define Greedy Best First Search.**

It expands the node that is closest to the goal (i.e.) to reach solution in a quicker way. It is done by using the heuristic function: f(n) = h(n).

6. **Define A* search.**

A* search evaluates nodes by combining g(n), the cost to reach the node and h(n), the cost to get from the node to the goal.

$$f(n) = g(n) + h(n)$$

7. **Define Admissible heuristic h (n).**

In A* search, if it is optimal then, h(n) is an admissible heuristic which means h(n) never overestimates the cost to reach the goal.

8. **What are the 2 types of memory bounded heuristic algorithms?**
   - Recursive Best First Search(RBFS)
   - Memory bounded A*(MA*)

9. **Define iterative deepening search.**

Iterative deepening is a strategy that sidesteps the issue of choosing the best depth limit by trying all possible depth limits: first depth 0, then depth 1, then depth 2 & so on.

10. **What is called as bidirectional search?**

The idea behind bidirectional search is to simultaneously search both forward from the initial state & backward from the goal & stop when the two searches meet in the middle.

11. Define Global minimum.

If elevation corresponds to cost, then the aim is to find the lowest valley is called global minimum.

12. Define Global Maximum.

If elevation corresponds to an objective function, then the aim is to find the highest peak is called global maximum.

13. Give the procedure of IDA* search.

Minimize f(n)=g(n)+h(n) combines the advantage of uniform cost search + greedy search A* is complete, optimal. Its space complexity is still prohibitive.
Iterative improvement algorithms keep only a single state in memory, but can get stuck on local maxima. In this algorithm each iteration is a dfs just as in regular iterative deepening. The depth first search is modified to use an f-cost limit rather than a depth limit. Thus each iteration expands all nodes inside the contour for the current f-cost.

14. What is Genetic Algorithms?

Genetic Algorithm is a variant of stochastic beam search in which successor states are generated by combining two parent states, rather than by modifying a single state.

15. Define Online Search agent.

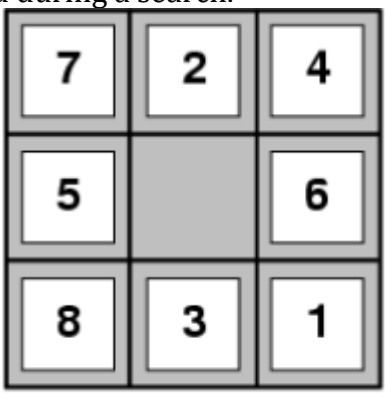
Agent operates by interleaving computation and action (i.e.) first it takes an action, and then it observes the environment and computes the next action.

PART B

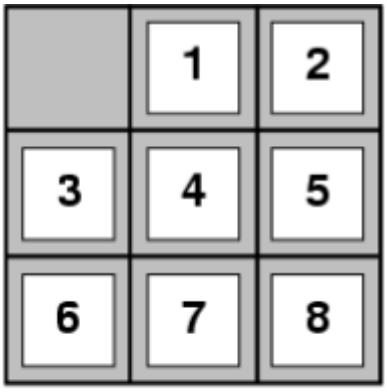
1. **Explain about Heuristic search Strategies in detail.**
   - Informed(Heuristic) Search Strategies
   - Best-first search
   - Heuristic functions
   - Greedy Best-first search
   - Properties of greedy search
   - A* Search
   - Recursive Best-first Search(RBFS)

2. **Specify the Heuristic Functions in detail.**

   A heuristic function or simply a heuristic is a function that ranks alternatives in various search algorithms at each branching step basing on an available information in order to make a decision which branch is to be followed during a search.



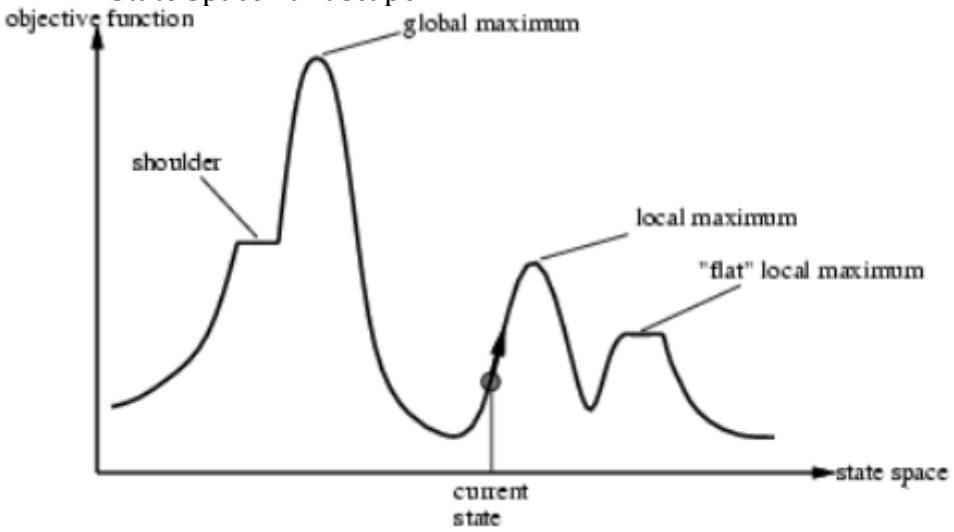
Start State



Goal State

   - The 8-puzzle

3. **Discuss in detail about Optimization Problems.**
   - State Space Landscape

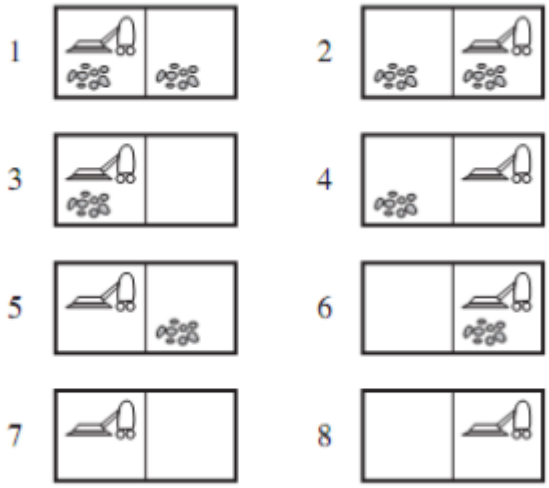


   - Hill-climbing search

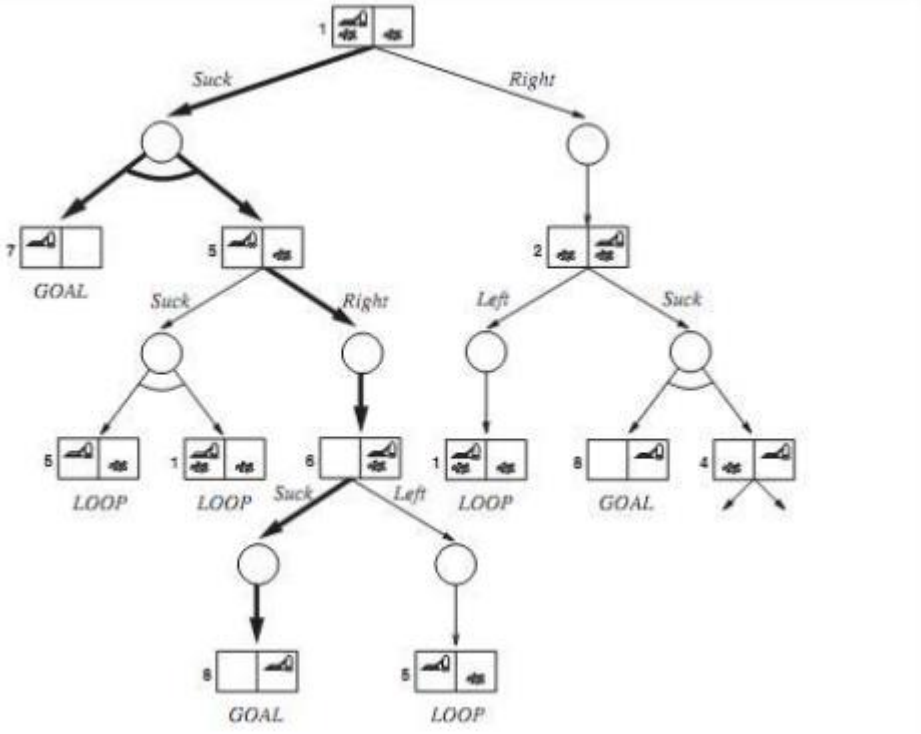
- Genetic algorithms

4. Formulate search with non-deterministic actions in detail.

- The erratic vacuum world

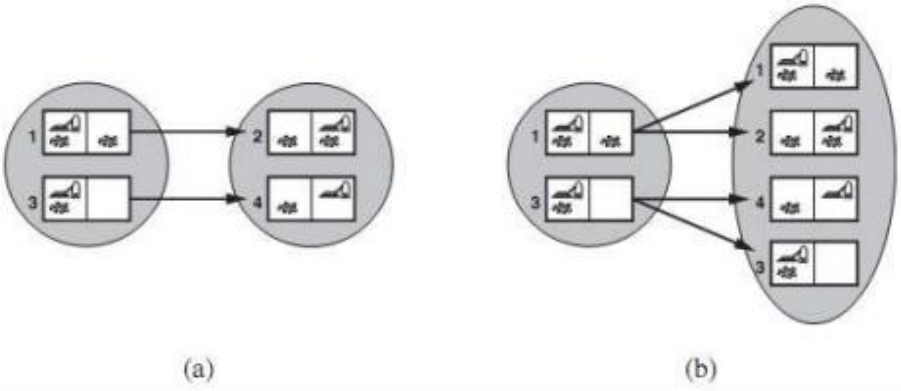


- AND–OR search trees

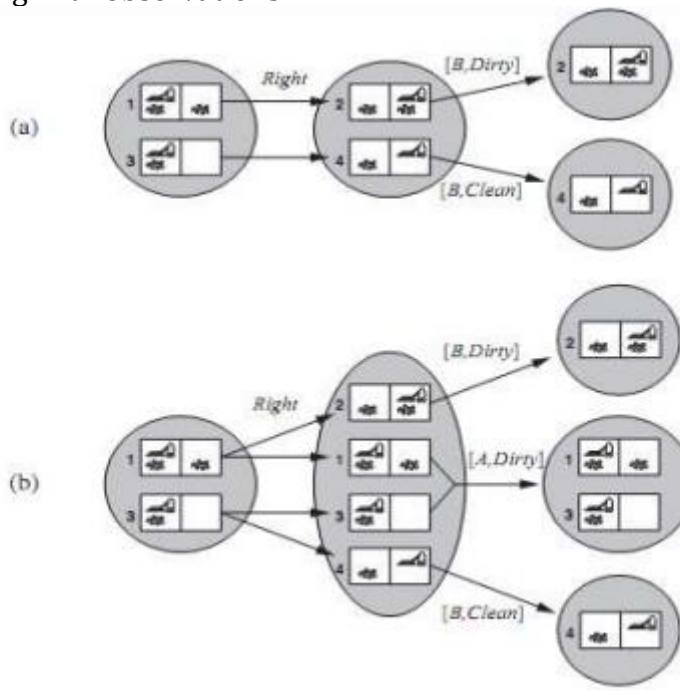


5. Explain in detail about search in partially observable environments.

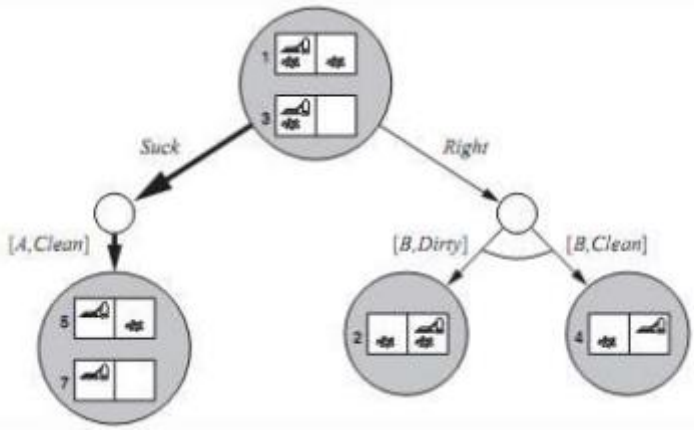
- Searching with no observation



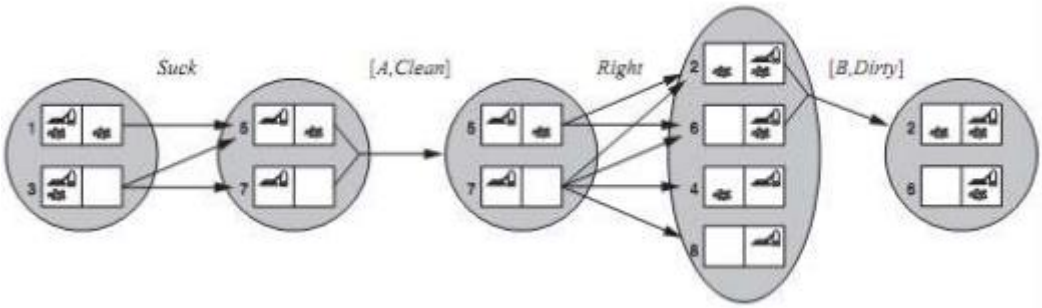
- Searching with observations



- Solving partially observable problems



- An agent for partially observable environments



6. Discuss about online search agents and unknown environments.

An online search agent interleaves computation and action: first it takes an action, then it observes the environment and computes the next action.

- Online search problems
- Online search agents
- Online local search
- Learning in online search

UNIT – III
PART A

1. **What is Adversarial Search?**

Adversarial search is a search, where we examine the problem which arises when we try to plan ahead of the world and other agents are planning against us.

2. **State the Formalization of the problem.**
   - Initial state:
   - Player(s)
   - Action(s)
   - Result(s, a)
   - Terminal-Test(s)
   - Utility(s, p)

3. **Define Game tree.**

A game tree is a tree where nodes of the tree are the game states and Edges of the tree are the moves by players. Game tree involves initial state, actions function, and result Function.

4. **Mention Properties of Mini-Max algorithm.**
   - Complete
   - Optimal
   - Time complexity
   - Space Complexity

5. **Define Alpha-Beta Pruning.**

Alpha-beta pruning is a modified version of the minimax algorithm. It is an optimization technique for the minimax algorithm.

6. **What are the Rules to find good ordering ?**

Following are some rules to find good ordering in alpha-beta pruning:

- Occur the best move from the shallowest node.
- Order the nodes in the tree such that the best nodes are checked first.
- Use domain knowledge while finding the best move. Ex: for Chess, try order: captures first, then threats, then forward moves, backward moves.

7. **Define Monte Carlo Tree Search (MCTS).**

Monte Carlo Tree Search (MCTS) is a search technique in the field of Artificial Intelligence (AI). It is a probabilistic and heuristic driven search algorithm that combines the classic tree search implementations alongside machine learning principles of reinforcement learning.

8. **Define Constraint Satisfaction Problems(CSP).**

A Constraint Satisfaction Problem(or CSP) is defined by a set of variables ,X1,X2,....Xn, and a set of constraints C1,C2,...,Cm. Each variable Xi has a nonempty domain D, of possible values. Each constraint Ci involves some subset of variables and specifies the allowable combinations of values for that subset.

9. Define Backtracking Search for CSPs.

The term backtracking search is used for depth-first search that chooses values for one variable at a time and backtracks when a variable has no legal values left to assign.

10. What is Constraint propagation?

Constraint propagation is the general term for propagating the implications of a constraint on one variable onto other variables.

11. Define consistent or legal assignment.

A State of the problem is defined by an assignment of values to some or all of the variables,{Xi = vi ,Xj = vj,...}. An assignment that does not violate any constraints is called a consistent or legal assignment.

12. State the Advantages of Monte Carlo Tree Search.

- MCTS is a simple algorithm to implement.
- Monte Carlo Tree Search is a heuristic algorithm. MCTS can operate effectively without any knowledge in the particular domain, apart from the rules and end conditions, and can can find its own moves and learn from them by playing random playouts.
- The MCTS can be saved in any intermediate state and that state can be used in future use cases whenever required.
- MCTS supports asymmetric expansion of the search tree based on the circumstances in which it is operating.

13. Mention the Disadvantages of Monte Carlo Tree Search.

- As the tree growth becomes rapid after a few iterations, it requires a huge amount of memory.
- There is a bit of a reliability issue with Monte Carlo Tree Search. In certain scenarios, there might be a single branch or path, that might lead to loss against the opposition when implemented for those turn-based games. This is mainly due to the vast amount of combinations and each of the nodes might not be visited enough number of times to understand its result or outcome in the long run.
- MCTS algorithm needs a huge number of iterations to be able to effectively decide the most efficient path. So, there is a bit of a speed issue there.

14. Define Exploitation.

Exploitation sticks to a single path that has the greatest estimated value. This is a greedy approach and this will extend the tree's depth more than its breadth.

15. Define two Parameters Alpha and Beta.

- Alpha: The best (highest-value) choice we have found so far at any point along the path of Maximizer. The initial value of alpha is $-\infty$.

- Beta: The best (lowest-value) choice we have found so far at any point along the path of Minimizer. The initial value of beta is $+\infty$.

PART B

1. **Explain about Game theory in detail.**
    - Adversarial Search
    - Types of Games in AI
    - Formalization of the problem
    - Game tree

2. **Specify the Alpha-Beta Pruning in detail.**
    - Condition for Alpha-beta pruning
    - Pseudo-code for Alpha-beta Pruning
    - Working of Alpha-Beta Pruning
    - Move Ordering in Alpha-Beta pruning
    - Rules to find good ordering

3. **Discuss in detail about Monte Carlo Tree Search.**
    - Monte Carlo Tree Search (MCTS) algorithm
    - Advantages of Monte Carlo Tree Search
    - Disadvantages of Monte Carlo Tree Search

4. **Formulate Stochastic games and Partially observable games in detail.**

In real life, many unpredictable external events can put us into unforeseen situations. Many games mirror this unpredictability by including a random element, such as the throwing of dice. We call these stochastic games.

- Evaluation functions for games of chance

Chess has often been described as war in miniature, but it lacks at least one major characteristic of real wars, namely, partial observability. In the —fog of war, the existence and disposition of enemy units is often unknown until revealed by direct contact. As a result, warfare includes the use of scouts and spies to gather information and the use of concealment and bluff to confuse the enemy. Partially observable games share these characteristics and are thus qualitatively different from the games.

- Kriegspiel: Partially observable chess

5. **Explain in detail about Constraint Satisfaction Problem.**

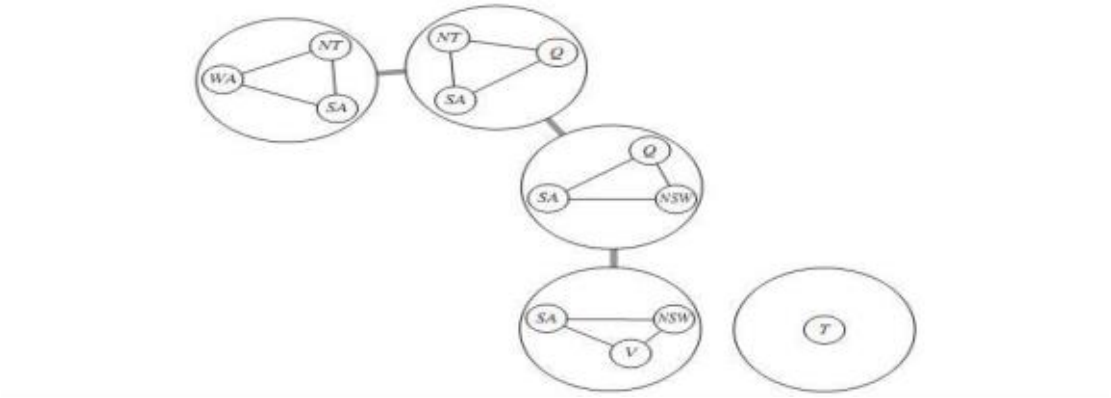
A Constraint Satisfaction Problem(or CSP) is defined by a set of variables ,X1,X2,....Xn, and a set of constraints C1,C2,...,Cm. Each variable Xi has a nonempty domain D,of possible values. Each constraint Ci involves some subset of variables and specifies the allowable combinations of values for that subset.

- Example for Constraint Satisfaction Problem
- Varieties of CSPs
- Solving partially observable problems

6. **Discuss about the Structure of Problems.**

- Problem Structure
- Independent Subproblems

- Tree-Structured CSPs



UNIT – IV
PART A

1. **Define wumpus world.**

The wumpus world is a cave consisting of rooms connected by passageways. Lurking somewhere in the cave is the wumpus, a beast that eats anyone who enters its room.

2. **What is meant by Propositional Logic?**

A very simple logic called propositional logic. Then we look at entailment-the relation between a sentence and another sentence that follows from it-and see how this leads to a simple algorithm for logical inference.

3. **Define Syntax.**

The syntax of propositional logic defines the allowable sentences. The atomic sentences the indivisible syntactic elements-consist of a single proposition symbol. Each such symbol stands for a proposition that can be true or false. We will use uppercase names for symbols: P, Q, R, and so on.

4. **Define Semantics.**

The semantics defines the rules for determining the truth of a sentence with respect toa particular model.

In propositional logic, a model simply fixes the truth value-true or false-for every proposition symbol.

5. **What is meant by Forward and backward chaining?**

- The forward-chaining algorithm PL-FC-ENTAILS?(KB, q) determines if a single proposition symbol q—the query—is entailed by a knowledge base of definite clauses.
- The backward-chaining algorithm, as its name suggests, works backward from the query. If the query q is known to be true, then no work is needed.

6. **State First order logic.**

FOL is sufficiently expressive to represent a good deal of our commonsense knowledge. First-Order Logic is a logic which is sufficiently expressive to represent a good deal of our commonsense knowledge.

7. **Define Terms.**

A term is a logical expression that refers to an object. Constant symbols are therefore terms, but it is not always convenient to have a distinct symbol to name every object.

8. **What is meant by Atomic sentences?**

An atomic sentence is true in a given model, under a given interpretation, if the relation referred to by the predicate symbol holds among the objects referred to by the arguments.

9. **State First-order definite clauses.**

First-order definite clauses closely resemble propositional definite clauses they are disjunctions of literals of which exactly one is positive.

10. What is Logic programming?

Logic programming is a technology that comes fairly close to embodying the declarative ideal should be constructed by expressing knowledge in a formal language and that problems should be solved by running inference processes on that knowledge.

Algorithm = Logic + Control .

11. Define Prolog.

Prolog is the most widely used logic programming language. Its users number in the hundreds of thousands. It is used primarily as a rapid-prototyping language and for symbol manipulation. Many expert systems have been written in Prolog for legal, medical, financial, and other domains. Prolog programs are sets of definite clauses written in a notation somewhat different from standard first-order logic.

12. Mention the two Principal Sources of Parallelization.

- OR-parallelism
- AND-parallelism

13. Define Skolemize.

Skolemization is the process of removing existential quantifiers by elimination. It is just like the Existential Instantiation rule. translate∀ x P(x) into P(A), where A is a new constant.

14. State the resolution inference rule.

The resolution rule for first-order clauses is simply a lifted version of the propositional resolution rule. Two clauses, which are assumed to be standardized apart so that they share no variables, can be resolved if they contain complementary literals.

15. What is Completeness of resolution?

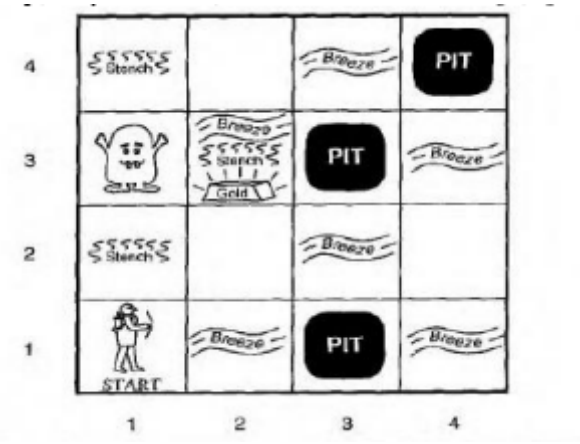
A resolution is refutation-complete, which means that if a set of sentences is unsatisfiable, then resolution will always be able to derive a contradiction.

PART B

1. **Explain about wumpus world in detail.**

The wumpus world is a cave consisting of rooms connected by passageways. Lurking somewhere in the cave is the wumpus, a beast that eats anyone who enters its room. The wumpus can be shot by an agent, but the agent has only one arrow.

- Performance measure
- Environment
- Actuators
- Sensors



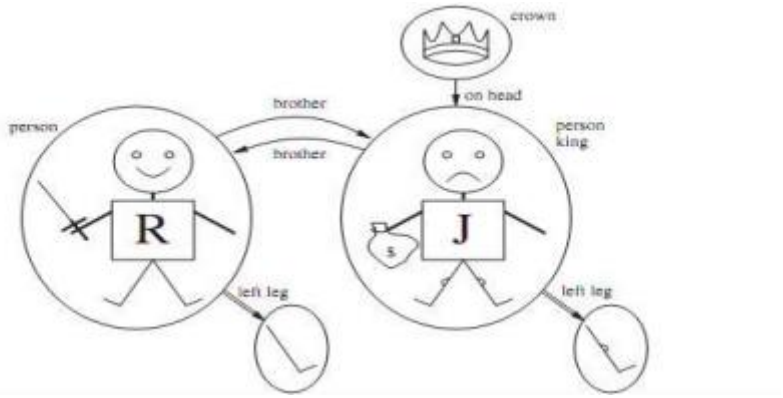
2. **Specify the Propositional theorem proving in detail.**
   - Inference and proofs
   - Proof by resolution
   - Conjunctive normal form
   - A resolution algorithm
   - Completeness of resolution
   - Horn clauses and definite clauses
   - Forward and backward chaining

3. **Discuss in detail about Agents based on propositional logic.**
   - The current state of the world
   - A hybrid agent
   - Logical state estimation
   - Making plans by propositional inference

4. **Formulate First order logic and Syntax and Semantics of First order logic in detail.**

FOL is sufficiently expressive to represent a good deal of our commonsense knowledge. First-Order Logic is a logic which is sufficiently expressive to represent a good deal of our commonsense knowledge.

- Representation Revisited
- Models for first-order logic



- Terms
- Atomic sentences
- Quantifiers
- Existential quantification (∃)
- Nested quantifiers
- Equality

5. Discuss about the Forward and Backward Chaining.

A forward-chaining algorithm idea is simple it starts with the atomic sentences in the knowledge base and apply Modus Ponens in the forward direction, adding new atomic sentences, until no further inferences can be made.

- First-order definite clauses
- A simple forward-chaining algorithm
- Efficient forward chaining

Backward chaining algorithms work backward from the goal, chaining through rules to find known facts that support the proof.

- A backward chaining algorithm
- Logic programming

6. Explain in detail about Resolution.

Resolution can be extended to first-order logic. The question of the existence of complete proof procedures is of direct concern to mathematicians.

- Eliminate implications
- Move ¬ inwards
- Standardize variables
- Skolemize
- Drop universal quantifiers
- Distribute ∨ over ∧
- The resolution inference rule
- Completeness of resolution
- Herbrand universe
- Saturation
- Herbrand base
- Resolution Strategies

UNIT – V
PART A

1. **Define Ontology.**

It is a branch of metaphysics that studies the nature of being, the nature of existence. Ontologies enable more effective knowledge representation and reasoning in AI Systems. Ontologies provide a structured and formal way to represent knowledge.

2. **What is meant by Conceptualization?**

Conceptualization is an abstract simplified view of some selected part of the world, containing objects and concepts.

3. **State Ontological engineering.**

It is a discipline within artificial intelligence (AI) and computer science that focuses on creating and managing ontologies to enable more effective knowledge representation and reasoning in AI systems.

4. **Define Intrinsic and extrinsic properties.**

- Intrinsic properties :They belong to the very substance of the object, rather to the object as a whole.

Eg: density, boiling point,flavor, color, ownership, and so on

- Extrinsic properties :They are not retained under subdivision. They do depend on the size of a sample.

Eg: weight, length, shape, and so on.

5. **Mention how Events are represented.**

- Situation Calculus
- Event Calculus

6. **Explain on what Propositional attitudes are used to represent?**

Propositional attitudes are used to represent mental events - An agent can have toward mental objects: attitudes such as Believes, Knows, Wants, Intends, and Informs. The difficulty is that these attitudes do not behave like "normal" predicates.

7. **State the two ways for organizing and reasoning with categories.**

- Semantic networks: Semantic networks provide graphical aids for visualizing a knowledge base and efficient algorithms for inferring properties of an object on the basis of its category membership.
- Description logics: Description logics provide a formal language for constructing and combining category definitions and efficient algorithms for deciding subset and superset relationships between categories.

8. **Mention the Types of Reasoning.**

- Deductive reasoning
- Inductive reasoning
- Abductive reasoning
- Common Sense Reasoning

- Monotonic Reasoning
- Non-monotonic Reasoning

9. Define Deductive reasoning.

Deductive reasoning is deducing new information from logically related known information. It is the form of valid reasoning, which means the argument's conclusion must be true when the premises are true.

10. What is planning in AI?

The planning in Artificial Intelligence is about the decision making tasks performed by the robots or computer programs to achieve a specific goal. The execution of planning is about choosing a sequence of actions with a high likelihood to complete the specific task.

11. Define Planning Domain Definition Language.

PDDL, the Planning Domain Definition Language in which a state of the world is represented by a collection of variables that allows us to express all Actions with one action schema

12. Mention the Advantage of non-Linear planning.

- Non-linear planning may be an optimal solution with respect to plan length (depending on search strategy used)

13. State Heuristics for Planning.

A heuristic function h(s) estimates the distance from a state s to the goal and that if we can derive an admissible heuristic for this distance—one that does not overestimate—then we can use A∗search to find optimal solutions.

14. Define Hierarchical planning.

Hierarchical planning is a planning method based on Hierarchical Task Network(HTN) or HTN planning.

15. Mention the Disadvantages of Hierarchical Planning.

- Many of the HTN planners require a Deterministic environment.
- Many of the HTN planners are unable to handle uncertain outcomes of actions.

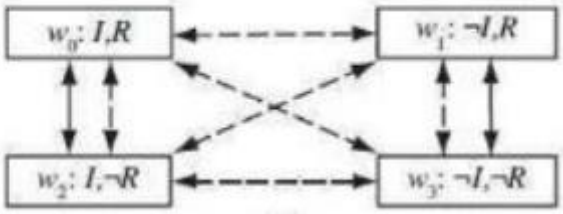
PART B

1. **Explain about categories and objects in detail.**

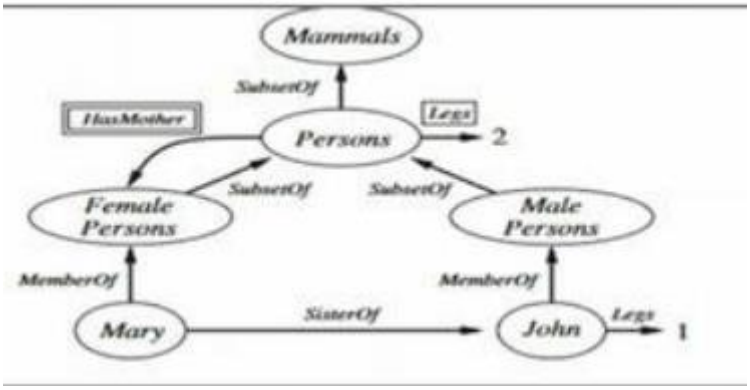
The organization of objects into categories is a vital part of knowledge representation

- Relations between Categories
- Objects

2. **Specify the mental events and mental objects in detail.**
    - Modal logic



3. **Discuss in detail about reasoning systems for categories.**
    - Two ways for organizing and reasoning with categories
    - Semantic networks



- Description logic

4. **Explain reasoning with default information in detail.**

The reasoning is the mental process of deriving logical conclusion and making predictions from available knowledge, facts, and beliefs. Or we can say, "Reasoning is a way to infer facts from existing data." It is a general process of thinking rationally, to find valid conclusions. In artificial intelligence, the reasoning is essential so that the machine can also think rationally as a human brain, and can perform like a human.

- Deductive reasoning
- Inductive reasoning
- Abductive reasoning
- Common Sense Reasoning
- Monotonic Reasoning
- Non-monotonic Reasoning

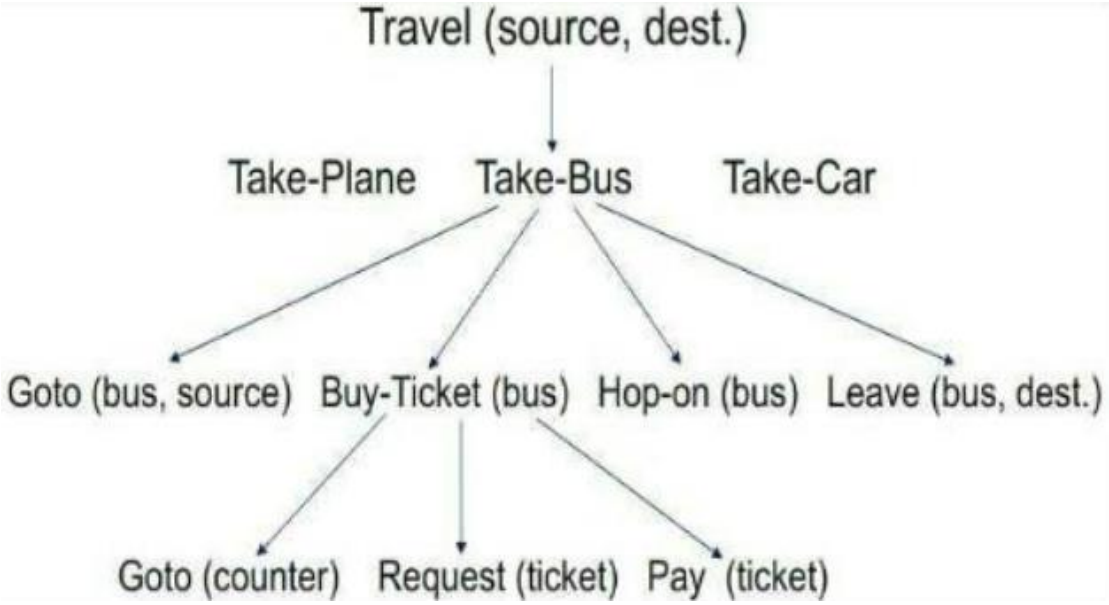
5. **Discuss about the classical planning.**

- Planning Domain Definition Language
- Action schema
- Components of Planning System
- Goal stack planning

6. **Explain in detail about Heuristics for Planning and Hierarchial Planning.**

A heuristic function h(s) estimates the distance from a state s to the goal and that if we can derive an admissible heuristic for this distance—one that does not overestimate—then we can use A∗search to find optimal solutions.

- Hierarchical planning



- Advantages of Hierarchical Planning
- Disadvantages of Hierarchical Planning
- Standardize variables
- Skolemize
- Drop universal quantifiers
- Distribute ∨ over ∧
- The resolution inference rule
- Completeness of resolution
- Herbrand universe
- Saturation
- Herbrand base
- Resolution Strategies