FINAL GLOSSARY

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- **A* search:** It is defined as a form of Best-First search which evaluates nodes by f(n) which combines g(n) and h(n) and estimates the cheapest solution through 'n'. [1]
- **Abstraction:** The process of removing irrelevant detail from a representation is called Abstraction. The goal of a good abstraction involves removing as much detail as possible while retaining validity and ensuring that the abstract actions are easy to carry out. Suppose if we are traveling from Lincoln to Omaha, several external factors like whether we are using radio or not is irrelevant and thus it is abstracted in determining the solution. [1]
- **Action Schema:** It is defined as a representation of a set of ground actions. It is a lifted representation which lifts the level of reasoning from propositional logic to a restricted subset of First-order logic. [1] page:367
- **Admissible Heuristic:** It is defined as a heuristic function that never overestimates the cost to reach the goal. [1]

- **Agent:** An agent is something which perceives from their environment, acts autonomously in its environment to do some changes in the environment. [1]
- **Alldiff constraint**: It is defined as a global constraint which imposes a condition that all variables involved in the constraint must have different values. [1] Page: 206
- **Alliances:** These are defined as a union or association formed for mutual benefit among players in a multiplayer game. [1] page: 185, [9]
- **Alpha-Beta Pruning:** It is defined as an adversarial search technique which computes the standard minimax decision from a minimax tree by pruning away branches that cannot possibly influence the final decision. [1] page: 186
- **And-elimination:** It is an inference rule which says that from a conjunction, any of the conjuncts can be inferred. If $a \land b$ then b can be inferred. [1] Page:250
- **Anytime algorithm:** It is defined as an algorithm whose output quality gradually improves over time, so that it has a reasonable decision ready whenever it is interrupted. [1] Page: 1048
- **Arc Consistency**: A variable in a CSP is defined as arc consistent if every value in its domain has a supporting value in the other variable's domain with respect to a binary constraint between them. [1] Page: 208
- **Arity:** The number of arguments for a relation or function is defined as arity. [1] page:292
- **Assertion:** The sentences which are representation of real world facts are added to KB called as assertions. [1] page:301
- **Atmost constraint**: It is defined as a global constraint which states the maximum number of occurrences of a particular value among a list of variables. [14]
- **Atomic sentences:** An atomic sentence is the simplest form of a sentence consisting of a single propositional symbol. [1] page:244

- **Autonomy:** Autonomy means acting independently without any external help. An autonomous agent acts on its own without any help from other agents. [1]
- **Axiom:** It is defined as a sentence which is taken directly without any derivation from other sentences. [1] page:235
- **Back jumping:** It is defined as a search technique which backtracks to the most recent assignment in the conflict set while checking for the legal values to assign. [1] Page: 219
- **Background knowledge:** It is defined as the knowledge which might be present beforehand about an environment, this knowledge is initially contained in the knowledge base. [1] page: 235
- **Backtracking search:** It is defined as a depth-first search technique which chooses values for one variable at a time and backtracks when a variable has no legal values to assign. [1] Page: 218
- **Backtracking search:** It is defined as a type of depth-first search that choses values for one variable at a time and then backtracks when no other possible values are left to assign. [1]
- **Backward Chaining:** It is a process of goal directed reasoning which works backwards from the goal and touches only relevant facts. [2] Slide:37
- **Belief State:** It is defined as the agent's current belief about the possible physical states it might be in, given the current sequence of actions and percepts. [1]
- **Best first search:** It is defined as a search technique where a node is selected for expansion based on an evaluation function f(n). [1]
- **Bi Conditional:** It is defined as a connective which has the meaning 'if and only if' and is represented by double arrow. [1] page:244
- **Bidirectional Search:** It is defined as an uninformed search technique where two simultaneous searches-one from the initial state and the other backward from the goal are started with a hope of meeting in the middle. [1]
- **Binary Constraints:** It is defined as a type of constraint which exists among two variables. It relates two variables by a constraint. [1] Page: 206
- **Binding List:** Assigning values to a variable is called as substitution or binding list. This binding of values to the variable in the predicate must yield a true statement. [1] page:301
- **Blind search:** It is also called as uninformed search because it doesn't contain any additional information regarding the states other than the problem description.
- **Boolean CSPs:** These are defined as the type of CSPs whose domain of all variables consists of only two Boolean values of either true or false. [2] Slide:5
- **Bounded differences:** It is defined as a type of constraint where the values of a domain are bounded by some values at both ends. Eg: 2<= c-a <= 6. [2] Slide: 11
- **Bounds Propagation:** It is defined as a technique of representing the domain by lower and upper bounds and then revising the domain bounds to preserve the constraints upon it. [10]
- **Branching factor:** Branching factor is defined as the maximum number of successors of any node. Complexity of a search is indicated in terms of Branching Factor 'b'. [1]

- **Breadth first search:** It is defined as an uninformed search technique where the root node is expanded first, then all the successors of the root node and then their successors and so on until a goal node is obtained. [1]
- **C*:** It is defined as the cost corresponding to an optimal path. [5]
- **Causal Links:** It is defined as a link between actions which protects the post condition of first action which is required as a precondition for second action. [2] slide:39
- **Chinese Room Experiment:** This experiment states that a computer can converse in chinese to a live chinese speaker efficiently but it doesn't actually have any consciousness or doesn't understand the conversation. It simply performs the commands of the program, so can any english speaker with those program commands, which concludes that the assumption of strong AI is false. [1]
- **Chronological Backtracking**: It is defined as backtracking technique where the most recent decision point revisited in case of a failure. [1] Page: 218
- **Closed World Assumption:** It is defined as an assumption where anything that is not mentioned in a state is considered false. [1] page:417
- **Coercion:** It is defined as several states being merged in to a single state by a series of actions no matter what the initial state may be in a sensor less version of an agent. [1]

- **Cognitive Science:** It is an interdisciplinary field of AI, which brings computer models and techniques from psychology to produce some theories of human mind. [1]
- **Competitive Agent:** A Competitive agent is defined as the one which achieves to maximize its own utility while competing with other agents in a multi-agent environment. In case of chess playing agent, it tries to maximize its chances of winning. [1]
- **Complementary literals:** A literal is said to be complementary to another literal if it is the negation of the other. [1] page:252
- **Complete-state Formulation**: It is defined as where each state has all the objects in a problem. It uses all the objects and then tries to approach a solution. [1]
- **Completeness:** An inference procedure is said to be complete if it can derive any sentence that is entailed and always terminates. [1] page:242
- **Completeness**: It is defined as 'Is an algorithm guaranteed to find a solution when there is one?' [1]
- **Compositional languages:** A compositional language is defined as a language where the meaning of a sentence is a function of the meaning of its parts. [1] page:286
- **Compositionality:** It is defined as a property of a language which means 'the meaning of a sentence is a function of the meaning of its parts'. [1] page:286
- **Condition Action Rule:** A condition- action rule is defined as a look-up table is present where if a condition occurs then the following action has to be taken. Simple Reflex agents work on Condition-action Rule. [1]
- **Conflict directed back jumping**: It is defined as a back jumping algorithm which used the conflict sets to backtrack to a variable whose assignment is the reason for the failure. [1] Page: 129

- **Conflict set**: It is defined as a set of assignments which are in conflict with some value of a variable. [1] page: 219
- **Conjunctive Normal Form:** it is defined as a form where a sentence is expressed as a conjunction of clauses. [1] page:253
- **Connectionism:** It is an approach related to neural networks where several simpler units are interconnected together as a network to produce a sophisticated mental model. [1]
- **Consistency:** A heuristic function h(n) is defined as consistent if for every node 'n' and every successor n' of n generated by an action 'a', the estimated cost of reaching the goal from 'n' is no more than the step cost from n to n' and the estimated cost from n' to the goal. [1]
- **Consistent assignment**: It is defined as the assignment of values to variables in a CSP such that no constraint is violated. [1] Page: 203
- **Consistent Plan:** It is defined as a plan that has no cycle in the ordering constraints and no conflicts with the causal links. [2] Slide:40
- **Constant Symbol:** It is a type of symbol which represents the objects in a predicate of first-order logic. [1] page:292
- **Constraint arity**: It is defined as the number of variables participating in a constraint. [2] Slide: 14
- **Constraint graph**: It is defined as a graph which is obtained by representing the variables as nodes and the constraints between variables are their respective edges. [1] page: 203
- **Constraint Hypergraph**: It is defined as a graph which consists of variables as ordinary nodes and the n-ary constraints among the variables as hyper nodes. [1] page: 206
- **Constraint Propagation**: It is defined as a step where the number of legal values for a variable is reduced based on the constraints upon it, which in turn can reduce the legal values for another variable and so on. [1] Page: 208
- **Constraint scope**: It is defined as a set of variables which are involved in a constraint. [3]
- **Constructive search**: It is defined as a search technique where the solution is obtained from partial assignments. A solution is obtained systematically by assigning values to variables one by one. [3]
- **Contingency Problem:** It is defined as a problem where an agent is partially observable, non-deterministic and the future actions will depend on future percepts and the solution to the problem is not an action but a contingency plan is called Contingency problem. The exact prediction is not possible in contingency problems. [1]
- **Continuous domains**: It is defined as the domains whose values are precise, that is the domain values are not discrete but consists of large number of values which are separated by a negligible difference. [1] Page: 206
- **Contours:** It is defined as the set of nodes which have the same or less values of a f(n) function. [1]
- **Crossover:** These are defined as the points which are chosen at random from positions of each individual from which an offspring is generated. [2] Slide: 18

- **Current state:** It is defined as the description of a state at a particular point of time. [1] page:121
- **Cut-set conditioning:** It is defined as an algorithmic approach which tries to solve a CSP graph by converting it to a tree structure with the help of cycle cut set. [1] page: 225
- **Cycle cut set:** It is defined as a technique of choosing a subset S from a CSP's variables such that the constraint graph becomes a tree after removal of S. The subset S is called Cycle cut set. [1] Page: 225
- **Data driven:** It is defined as a technique where the reasoning occurs with the focus on known data. [1] page: 258
- **Data Mining:** It is the process of obtaining useful knowledge from a large quantity of data by certain techniques, like statistics, inference models etc. [1]
- **Decision problem:** It is defined as a complex problem which involves many trade-offs and a careful observation to obtain a decision. [1] Page: 65
- **Deduction theorem:** It is defined as:
- **Deduction:** Deduction means obtaining a conclusion from certain statements or predicates by the process of reasoning. [1]
- **Definite clause:** It is defined as a disjunction of literals of which exactly one is positive. For example, if we have a clause of 3 literals of which only one is positive then it a definite clause. [1] page: 256
- **Degree:** It is defined as the number of constraints incident on variable in the CSP. [3]
- **Depth first search:** It is defined as a search technique which always expands the deepest node in the current fringe of the search tree. [1]
- **Depth Limited search:** It is defined as a depth first search technique where a node is expanded until a certain depth limit 'l' and the nodes at depth 'l' are considered as if they have no children. [1]
- **Diameter:** It is defined as the greatest distance between any pair of vertices in a graph 'G'. [5]
- **Domain:** It is defined as the set of allowable values for a variable. [1] page: 202
- **Domain:** The domain of a model is the set of all objects it contains. This domain contains the objects and must be non-empty. [1] page:290
- **Domain/degree heuristic:** It is defined as a heuristic which is useful for variable ordering. It considers the ratio of domain size to degree of a variable to obtain the heuristic value. [2] Slide: 34
- **Domination:** If a heuristic h1 is more efficient in determining the goal state in less number of steps than the other heuristic h2, then we say that h1 dominates h2.
- **Effective branching factor:** It is defined as the branching factor that a uniform tree of depth 'd' would have to have in order to contain N+1 nodes. [1]
- **Empty Delete List Heuristic:** It is defined as a heuristic used for state space search which removes all the negative effects of actions. [2] Slide:35
- **Entailment:** It is defined as a relation between sentences where a sentence follows logically from another sentence. [1] page: 240

- **Environment:** The task environment is defined as a notation which specifies the performance measure, environment, actuators and sensors. The different types of environments are:

  o **Deterministic vs Stochastic:** If the next state of an environment depends on the actions executed in current state, then the environment is said to be deterministic. Otherwise, it is called a stochastic environment. [2]

  o **Discrete vs Continuous:** If an environment has a finite set of states, percepts and actions then it is said to be a discrete environment, whereas if an environment consists of states, percepts that are continuous and change over time then it is called a continuous environment. [1]

  o **Episodic vs Sequential:** If the action taken in a particular state doesn't influence the action to be taken in another state then it is called an episodic environment, whereas if actions taken in prior states influence those to be taken in next states, then it is called a sequential environment. [1]

  o **Fully vs partially observable:** If the agent's sensors give complete information about the environment at any particular point in time then it is fully observable. If the agent's sensors give only part of the environment data then it is said to be partially observable. [1]

  o **Single agent vs Multi agent:** If only a single agent is present in an environment then it is called a single agent environment whereas if several agents which may be co-operative or competitive are present in the same environment then it is siad to be in multi agent environment. [2]

  o **Static vs dynamic:** If the environment doesn't change when the agent is acting then it is called a static environment whereas if an environment is changing when an agent is acting then it is called a dynamic environment. In case of dynamic environment, the agent must keep looking at the environment even when it is deciding on an action. [1]

  o **Strategic:** An environment is considered strategic if the environment is deterministic except for the actions of other agents. The actions of an agent depend on the actions of other agents in the system. [4]

- **Epistemological level:** It is defined as a level where the information is an abstract description of what the agent knows about a world. [2] slide: 13
- **Event Calculus:** It is defined as a mechanism for representing planning. In Event calculus, the points of time are considered instead of situations for representing planning. [1] page:446
- **Exploration problem:** It is defined as a problem where an agent has no idea about the states and actions of its environment and tries to explore the search space to obtain a solution. [1]
- **Extended Interpretation:** It is defined as the set of all possible assignments to a variable in the knowledge base to an object in the world. [17]
- **Extension:** It is defined as a representation of constraint where all the allowed tuples consisting of variable values are listed. [2] Slide: 15
- **F(n):** It is defined as an evaluation function which evaluates a node by combining g(n), the cost to reach the node and h(n), the estimated cost to get from the node to the goal. It is an estimated cost of the cheapest solution through 'n' [1]
- **Factoring:** The removal of multiple copies of literals is called factoring. [1] page:253
- **Finite Domains:** It is defined as the domains whose size is finite or discrete. The variables in the CSP have finite domain sizes. [1] Page: 205

- **First Choice Hill Climbing:** It is defined as a technique which implements stochastic hill climbing by generating successors randomly until one is generated that is better than the current state. [1] Page:124
- **First order Logic:** It is a type of logic which is used for representation of commonsense knowledge and is also used to represent complex environmental knowledge in a concise way. [1] page:285
- **Fitness function:** It is defined as a function which rates the states by an objective function. A fitness function returns higher values for better states. [1] Page: 127
- **Fixed point:** It is defined as a point where no new inferences are possible. [1] page:258
- **Forward chaining:** It is a process of data driven reasoning which works with the known facts and continue until the goal q is added to the query. [2] slide: 35
- **Forward checking:** It is defined as a technique which establishes arc-consistency among any two variables. If a variable is assigned then the unassigned variables that are connected to it are revised and their domains are updated. [1] Page: 217
- **Fringe**: It is defined as the set of all leaf nodes that are available for expansion at any given point is called the Fringe. [1]
- **Frontier**: It is defined as the set of all leaf nodes that are available for expansion at any given point is called the Frontier. [1]
- **Function:** A function is defined as a relationship between as set of inputs and a set of outputs with the restriction that each input is exactly related to one output. [2]
- **Function:** It is defined as a relation between a set of inputs and a set of permissible outputs with the property that each input is related to exactly one output. [11]
- **g(n):** It is defined as the function which provides the cost of the path from initial state to the node 'n'. [1]
- **Genetic algorithm:** It is defined as a variant of stochastic beam search in which successor states are generated by combining two parent states rather than modifying a single state. [1] Page: 127
- **Global Constraint:** It is defined as a constraint which involves an arbitrary number of variables. [1] page: 211
- **Global optimum:** It is defined as the best optimal value in the entire search space. The global optimal solution has an objective value better than all other feasible solutions to a model. [2] Slide: 8
- **Goal directed reasoning:** It is defined as process which works backwards from the goal and touches only relevant facts. [2] slide:37
- **Goal test**: It is defined as a test which answers 'whether we are at the final destination specified by the user?'. [1]
- **Gradient ascent:** It is defined as maximizing an objective function. It means we make changes to current state to improve the quality. [2] Slide: 7
- **Greedy algorithm:** It is defined as a search technique which tries to expand the node that is closest to the solution, assuming that it is likely to lead to an optimal solution quickly. [1]

- **Greedy Local search:** It is defined as a search technique which grabs a good neighbor state without thinking ahead about where to go next. [1] Page: 122
- **Ground term:** It is defined as a term which is made of only constants that is it doesn't contain any variables. [1] Page:295
- **Grounding:** It is defined as the connection between the logical reasoning or entailment and the real environment in which an agent exists. [1] page: 243
- **h(n):** It is defined as the heuristic function which provides the estimated cost of the cheapest path from the state at node 'n' to a goal state. [1]
- **Heuristic function:** It is defined as a function which estimates the cost of a solution from a node 'n' and is denoted as h(n). [1]
- **Heuristic search:** It is defined as a search strategy where a problem specific knowledge beyond the definition of the problem is provided to find solutions more effectively. [1]
- **Higher order logic:** It is defined as a logic which view the relations and functions referred to by first-order logic as objects in themselves. [1] page:289
- **Horn clause:** It is defined as a clause which is a disjunction of literals of which at most one is positive. Horn form is the representation of a horn clause in implication form. The premise in horn form is called body and the conclusion is called head. [1] page:256
  If a heuristic h1 is more efficient than the other h2 then we say h1 dominates h2. [1]
- **Incremental Formulation**: It is defined as the technique which starts with an empty state and finally approaches the goal state by performing actions incrementally. [1]
- **Induction:** Induction is a form of reasoning where axioms are constructed based on observations of consequences of previous values. If a statement holds for k values then it will also hold for k+1th value. Eg: Mathematical Induction. [1]
- **Inference:** It is defined as a procedure of new statements from the old data. In terms of logic, it means deriving new propositions from old. [1] page:235
- **Informed search:** It is defined as a search strategy where a problem specific knowledge beyond the definition of the problem is provided to find solutions more effectively. [1]
- **Initial state**: It is defined as the state from which an agent starts in the beginning. [1]
- **Instantiated variable:** It is defined as a variable whose value has been assigned. [3]
- **Intended Interpretation:** It is defined as a specific interpretation that an author of a sentence would have. [17]
- **Intension:** It is defined as representation of constraint where the constraint is denoted in a mathematical notation which represents all the acceptable tuples regarding a constraint. [2] Slide: 15
- **Interpretation:** An interpretation specifies exactly the objects, relations and functions are referred to by the constant, predicate and function symbols. [1] page:292
- **Intractability:** It is defined as a problem which cannot be solved in polynomial time as the complexity of a problem exponentially grows with size. [1]
- **Intractability**: It is defined as a problem which cannot be solved in polynomial time as the complexity of a problem exponentially grows with size. [1]

- **Iterative deepening search:** It is defined as a search technique which is often used in combination with depth first search, that finds the best depth limit. It does this by gradually increasing the limit from 1,2 and so on until a goal is found. [1]
- **Iterative Lengthening search:** It is defined as a search technique which is often used in combination with uniform cost search, that finds the path cost limit. It does this by gradually increasing the path cost limits until a goal is found. [1]
- **k-CNF:** It is defined as conjunction of clauses where each clause is of size at most k. [2] slide:30
- **K-Consistency:** A CSP is defined as K-consistent if, for any k-1 variables are assigned with consistent values then there exists a consistent value which can be assigned to any kth variable. [1] Page:211
- **Knowledge acquisition:** It is defined as a process of acquiring knowledge from the experts in a domain. Working with real experts to extract what they know is called knowledge acquisition. [1]
- **Knowledge base:** It is defined as a database which consists of a set of statements. [1] page:235
- **Knowledge representation language:** It is defined as a formal language which is used to represent a fact in the world. [2] slide: 12
- **Knowledge Representation:** Any agent after perceiving input must store it in an organized format that a computer can utilize to solve complex tasks called as Knowledge Representation. [1]
- **Leaf node**: It is defined as node with no children in a tree. [1]
- **Levels in a Planning Graph:** It is defined as an indication of time stamps in a planning graph. The state and action nodes are present in alternating levels. [2] Slide:49
- **Limited Rationality:** It means acting appropriately when there isn't enough time to perform all computations. It approaches a best possible optimal solution in a situation. [1]
- **Linear constraints:** It is defined as those constraints where each variable appears in only linear form. [1] page: 205
- **Linear programming:** It is defined as a method to achieve the best outcome in a mathematical model whose requirements are represented by linear relationships. [12]
- **Linearization of POP graph:** It is defined as the conversion of a POP graph in to a linear structure or total order plan which provides the sequence of actions that need to be performed to obtain a goal. [2] Slide:38
- **Literal:** It is defined as either an atomic sentence or a negated atomic sentence. [1] page:244
- **Local beam search:** It is defined as a search technique in which it keeps track of k best successors generated from a group of previous k best states until a goal state is obtained. [1] Page: 126
- **Local optimum:** It is defined as a solution which is optimal within a neighborhood set of possible solutions. [2] Slide: 8

- **Local search:** It is defined as a search algorithm which operates using a single current node and generally move on to neighbors of that node until a goal node is reached. It doesn't keep track of the path followed. [1] Page: 121
- **Logical connectives:** These are used to construct complex sentences from simple sentences and has a certain logical meaning. [1] page:244
- **Logical equivalence:** Two sentences are said to be logically equivalent if they are true in the same set of models. [1] page:249
- **Loopy path**: It is defined as a path whose complete search tree is infinite because there is no limit on how one can traverse a loop. Loopy paths generate repeated states. [1] Machine Learning

- **Manhattan distance:** It is defined as the sum of distances of the tiles or states from their goal position strictly along horizontal and vertical path. [1]
- **Markov Decision Process:** It is defined as a mathematical framework for modelling decision making in situations where outcomes are partly random and partly under control of a decision maker. [18]
- **Min-conflict heuristic:** It is defined as a value ordering heuristic which selects the value that results in minimum number of conflicts with other variables. [1] page: 220
- **Minimax Algorithm:** It is defined as an adversarial search technique which computes the utility of each terminal state and then iteratively backs up from leaves to the root to compute the minimax decision for MAX player. [2] Slide: 13
- **Minimax decision:** It is defined as the decision which is obtained by minimax algorithm at the root, an action a1 is chosen for max because it leads to the state with the highest minimax value under the assumption that the opponent will play perfectly to his/her own advantage. [1] Page: 184
- **Minimax value:** It is defined as the value computed at each node which is used to determine the optimal strategy and represents the utility of being in the corresponding state. [1] Page: 183
- **Minimum remaining values:** It is defined as a heuristic which chooses the variable with the fewest legal values remaining. It is also called fail-first heuristic. [1] page: 216
- **Missionaries and Cannibals Problem**: It is defined as a problem where three missionaries and three cannibals are on one side of a river, along with a boat that can hold one or two people. Find a way to get everyone to the other side without ever leaving a group of missionaries in one place outnumbered by the cannibals in that place. [1]
- **Model checking:** It is defined as an inference procedure which enumerates all the possible models and then checks whether α is true, where ever the KB is true. [1] page:242
- **Model in propositional logic:** A model is defined as a possible world/environment where an agent might or might not be in. It is an abstraction where each sentence is given a truth value. [1] page: 240
- **Model:** A model is defined as system or thing which is used as an example or a representation. [15]

- **Modus Ponens:** It is defined as an inference rule, a -> b, a then b can be inferred. [1] page:250
- **Monotonicity:** It is defined as a condition of a heuristic function, if for every node 'n' and every successor n' of n generated by an action 'a', the estimated cost of reaching the goal from 'n' is no more than the step cost from n to n' and the estimated cost from n' to the goal. [1]
- **Monotonicity:** It is defined as a property of logical systems which states that the set of entailed sentences can only increase if new information is added to the knowledge base. [1] page:251
- **Mutation:** It is defined as a change in the structure of a state. [1] Page: 127
- **Mutual Exclusion:** It is defined as a link between conflicting actions and conflicting literals in a planning graph. The mutex link states that the actions or literals cannot exist at the same time. [2] Slide:52
- **N-queen problem**: The goal of the N-queen problem is to place N queens on a chessboard such that no queen attacks any other. (A queen attacks any piece in the same row, column or diagonal.) [1]
- **Natural Language Processing:** Processing of a human language and interpreting/understanding it so as to communicate successfully in english. [1]
- **Nearly Decomposable problems:** It is defined as a set of problems where the planner can work on sub-goals independently, but might need some additional work to combine the resulting solutions. [2] Slide:45
- **Negation as Failure:** It is defined as a proof technique which tries to prove that the negation of a sentence is a failure, which means that the sentence is true. [1] Page: 417
- **Node consistency:** A variable is said to be node-consistent if all the values in the variable's domain satisfy the variable's unary constraints. [1] page:208
- **Node Expansion**: It is defined as expanding a node by applying the possible set of actions. A search strategy is defined by picking the order of node expansion. [1]
- **NP-Completeness:** A problem is said to be NP-Complete if it cannot be solved in polynomial time, rather a solution to a problem can be verified in polynomial time. [1]
- **Objective Function:** It is defined as a function which determines the quality of a goal in an optimization problem. An objective function returns higher values for better states. [1] page: 121
- **Occam's Razor:** It is a principle from philosophy and states that the more assumptions you make, the more unlikely the explanation is. If we have many alternatives, we find it hard to obtain a single solution. [3]
- **Omniscience:** Omniscience is defined as an agent knows everything about the actual result of actions in an environment. So, an omniscience agent acts according to the results of actions as needed which is impossible in reality. [1]
- **Open pre-condition:** It is defined as the set of conditions that needs to be met in planning. Sub-goals may be added during the planning process as pre-conditions. [2] Slide: 39
- **Open World Assumption:** It is defined as an assumption where both positive and negative fluents are considered. If a fluent is not mentioned then its value is considered unknown. [1] Page: 417

- **Open-Loop:** An agent which performs its actions ignoring the percepts is called an open-loop system because it breaks the loop between agent and environment. [1]
- **Operator:** It is defined as those things which augment the state description. The problem-solving procedure or an algorithm applies an operator to a "state" to get the next state. [1]
- **Optimal Solution:** It is defined as the solution which has the lowest cost among all the solutions. [1]
- **Optimally efficient:** An algorithm 'A*' is defined as optimally efficient if no other optimal algorithm is guaranteed to expand fewer nodes than the 'A*' algorithm. An algorithm that extends search paths from root and use the same heuristic information is optimally efficient for any given consistent heuristic. [1]
- **Optimization problem:** It is defined as a problem of finding the best solution from all the feasible solutions. This problem may require to either maximize or minimize an objective function. [1] Page: 121
- **Ordering Constraints:** It is defined as a set of constraints which specifies the order in which different states must occur in a planning. [2] Slide: 41
- **Partially observable MDPs:** It is a generalization of MDP which models an agent decision process in which it is assumed that the system dynamics are determined by an MDP, but the agent cannot directly observe the underlying state. [19]
- **Path Consistency:** It is defined as a consistency which tightens the binary constraints by using implicit constraints that are obtained by looking at a set of three variables. [1] page: 210
- **Path Cost:** It is defined as a function which assigns a numeric cost to each path. The problem-solving agent chooses a cost function that reflects its own performance measure. [1]
- **Path:** It is defined as a sequence of states in the state space connected by a sequence of actions. [1]
- **Pathmax equation:** A heuristic can be made consistent using the pathmax equation. If a child node's total estimated path cost is less than its parent's then the parent's total path cost is used called as pathmax equation. [6]
- **Payoff function:** It is defined as a function which defines the final numeric value for a game that ends in terminal state 's' for a player 'p'. [1] Page: 181
- **Percept Sequence:** A percept sequence is defined as everything that an agent has observed till date. The complete history of everything that an agent has ever perceived is said to be percept sequence. [2]
- **Performance Measure:** Performance measure is defined as the desirability of an action performed by an agent in an environment. It defines the criteria required by an agent to be successful in an environment. [1]
- **Persistent Actions:** It is defined as an action where a literal can persist if no action negates it. [1] Page:380
- **Planning:** It is defined as devising a Course of action to achieve one's goals. [1]
- **Plateau:** It is defined as a flat local optimum from which no uphill move exists or a shoulder. [1] Page: 123

- **Ply:** Each turn a player takes in a game is called a ply. [1] Page:164
- **Predecessors:** It is defined for a state 'n' as the set of all those states which have 'n' as a successor. [1]
- **Predicate symbol:** It is defined as a symbol which is present in first order logic and stands for objects. [1] page:292
- **Premise:** In an implication statement, the proposition which is present to the left side of implication symbol is called premise. [3]
- **Problem Formulation:** It is defined as the process of deciding what actions and states to consider, given a goal. [1]
- **Progression Planning:** It is defined as a type of planning where the planning starts from an initial state and moved forward. [2] Slide:24
- **Proof:** It is defined as a sequence of derivations/conclusions that leads to a desired goal. [1] page:250
- **Property:** The unary relation which specifies the characteristic of an object is called a property. [1] page:288
- **Propositional logic:** It is defined as a type of logic where each fact in a world is represented as a proposition and the syntax defines the allowable sentences. [1] page:243
- **Propositional symbol:** It is defined as a symbol which represents a proposition and can be either true or false. [1] page:244
- **Pruning:** It is defined as a method of ignoring portions of search tree that make no difference to the final choice. [1] Page: 162
- **Pruning:** It is defined as eliminating possibilities from consideration without having to examine them. It helps in being on the right path to obtain a solution. [1]
- **Qualification Problem:** It is defined as problem which defines the circumstances under which an action is guaranteed to work. [2] Slide: 11
- **Ramification Problem:** It is defined as a problem which defines the proliferation of implicit consequences of actions. It defines the implicit changes which might be caused due to an action. [2] Slide:11
- **Random restart Hill climbing:** It is defined as a hill climbing technique which conducts a series of hill climbing searches from randomly generated initial states until a goal state is found. [1] Page: 124
- **Random restart:** Sometimes a run appears not to be making progress. In this case we can start over from the top (random initial state) of the search tree, rather than trying to continue. This process is called Random restart. [1] Page: 124
- **Random Walk:** It is defined as a technique which simply selects at random one of the available actions from the current state and proceeds. [1] Page: 124

- **Rationality:** The ability to do the right thing at a particular scenario. Obtaining the best possible outcome under uncertainty or constraints is called as restricted rationality. [1]
- **Reasoning about action and change:** The area of using logic for planning is informally called as 'Reasoning about action and change'. [2] Slide:10

- **Reduction ad absurdum:** It is defined as a form of argument which attempts either to disprove a statement by showing it inevitably leads to an impractical conclusion or to prove that if it were true the result would be impossible. It proves by checking the unsatisfiablity of a statement. [16]
- **Refutation completeness:** It is defined as 'if a set of sentences are unsatisfiable, then the resolution will always result in a contradiction.' [1] page:350
- **Regression Planning:** It is defined as a type of planning where the planning starts from the goal state and moved backward. [2] Slide:24
- **Relation:** It is defined as a collection of ordered pairs containing one object from each set. A relation is allowed to have an object in first set and more than one object on the second set. [13]
- **Relation:** It is defined as the way in which two are more objects are connected to one another. [1] page:288
- **Relaxed problem:** It is defined as a problem with a fewer restrictions on actions. [1]
- **Resolution closure:** It is defined as a set of all clauses which are derivable by repeated application of the resolution rule to clauses and their derivatives. [1] page:256
- **Resolution:** It is defined as converting a set of statements in to a smaller set using the resolution rule. If two opposing literals are present in two statements then it can be represented as a combination of all the literals from the two statements as a conjunction except the opposing literals. The resolution can yield a complete inference algorithm if applied on CNF. [1] page:252
- **Route Finding problem:** It is defined as a problem where a route must be found in terms of specified locations and transitions along links between them. [1]
- **Satisfiability:** A sentence is said to be satisfiable is it is true in at least one model. [1] page:250
- **Search Cost:** It is defined as the cost required in searching a goal state and typically depends on the time complexity but can also include a term for memory usage whereas total cost combines both search cost and the path cost of the solution found. [1]
- **Search Node:** It is defined as the node that correspond to state in the search tree of a problem. It is a node in the search tree. [1]
- **Search strategy:** It is defined as the strategy followed by an algorithm, about how they choose which state to expand next. [1]
- **Search tree:** It is defined as a tree which is formed with initial state as root and the possible set of action sequences starting from initial state as branches to corresponding nodes. [1]
- **Search:** It is defined as the process of looking for a sequence of actions that reaches the goal. [1]
- **Semantics:** It is defined as the meaning of a sentence. It also defines whether the sentence holds with respect to each possible world. [1] page:240
- **Sentence:** It is defined as a representation of a fact about the world. [1] page:235
- **Serial Planning Graph:** It is defined as a planning graph which consists of only one action per level. [2] Slide:56

- **Sideway move:** It is defined as a technique which is used upon reaching a plateau, which states to jump somewhere else and restart the search. [8]
- **Simulated annealing:** It is defined as a version of stochastic hill climbing where some downhill moves are allowed. These downhill moves are accepted early in the annealing schedule and then less often as time goes on. It is useful when stuck in a local optimum. [1] Page: 125
- **Situation Calculus:** It is defined as a type of representation where each time step is called a situation and allows to represent plans and reason about actions and change. [2] Slide:5
- **Solution Quality:** It is defined as the quality of a solution which is measured by the path cost function. An optimal solution has the lowest path cost among all solutions. [1]
- **Soundness:** An inference procedure is said to be sound if it directly implements the definition of entailment and derives only entailed sentences. [1] page:242
- **State Constraints:** It is defined as the formulas that should be true in all states. [20]
- **State space Landscape:** It is defined as a landscape which has both location as defined by a state and elevation as defined by the value of heuristic cost function or an objective function. It represents the state space as a landscape. [1] Page: 121
- **State space:** It is defined as a directed graph which consists of all possible states as nodes and the actions among states as directed edges among them. [1]
- **Step cost:** It is defined as the cost of taking an action 'a' in state 's' to reach as state 's'. [1]
- **Stochastic beam search:** It is defined as a search technique which select k successors at random with the probability of choosing a given successor being an increasing function of its value rather than k best neighbors. [1] Page: 126
- **Stochastic Hill climbing:** It is defined as a hill climbing technique which chooses at random from all the possible uphill moves. [1] Page: 124
- **Straight line distance:** It is a defined as the distance between the current node and the goal node which is calculated by the Euclidean geometry. [1], [7]
- **STRIPS:** It is an acronym for Stanford Research Institute Problem Solver. It is the first major planning system which illustrates the interaction of influences and was designed as the planning component of the shakey robot project at SRI. [1] Page: 393
- **Strong k-consistency:** A CSP is said to be strong k-consistent if it is k-1 consistent, k-2 consistent, … all the way down to 1-consistent. [1] page: 211
- **Sub goal independence assumption:** It is defined as a heuristic for state space search which uses the divide and conquer strategy. The cost of solving a conjunction of sub goals is the sum of costs of solving each sub goal independently. [2] Slide: 32
- **Substitution:** Assigning values to a variable is called as substitution. [1] page:301
- **Successor Function:** It is defined as a function which returns the set of all successors. A successor refers to any state reachable from a given state by a single action. [1]
- **Syllogism:** Given a set of premises, we obtain a form of reasoning in which a conclusion is drawn, which is called as Syllogism. [2]
- **Syntax:** It is defined as a rule of a language which specifies all the sentences of a language that are well-formed. [1] page:240
- **Tautology:** It is defined as a sentence which is true in every model. [1] page:249

- **Term:** It is defined as a logical expression which refers to an object. [1] page:294
- **Terminal States:** These nodes are defined as the states where the game has ended. The Terminal test for these states returns true as the game has ended. [1] Page: 162
- **Terminal test:** It is defined as a test which returns true when the game is over and false otherwise. [1] Page: 162
- **Ternary constraint:** It is defined as a type of constraint which involves three variables. The arity of the constraint is 3. [3]
- **Theorem:** It is defined as the statements which are entailed by the axioms. In propositional logic, it is proved by a chain of reasoning. [1] page:302
- **Total Turing Test:** If a human interrogator after posing some questions, cannot tell whether the responses come from a person or computer, then the computer is said to have passed Turing test. Total Turing test also includes physical interaction with the system to perceive and make some changes in the environment. It must have the following capabilities. [1]
  Knowledge Representation.
  Automated Reasoning.

  Natural Language Processing
  Computer Vision.

  Robotics

- **Touring problem:** It is defined as a problem where each state must include not just the current location but also the set of states the agent has visited. In this problem, every node must be visited at least once. [1]
- **Toy problem:** It is defined as a problem which is intended to illustrate or exercise various problem-solving methods. It can be given a concise, exact description and hence is usable by different researchers to compare the performance of algorithms. [1]
- **Traveling Salesperson problem:** It is defined as a touring problem in which each city must be visited exactly once and be returned to the starting city. The aim is to find the shortest tour. The Travelling Salesman Problem describes a salesman who must travel between N cities with the aim of cost function minimized. [1]
- **Tree decomposition:** It is defined as a technique where the CSP graph is decomposed in to a tree structure, where the nodes of a CSP are clustered into sub problems which are organized in a tree structure. [2] Slide: 46
- **Tree width:** The width of a tree decomposition is the size of its largest set minus one. The tree width of a graph G is the minimum width among all possible tree decompositions of G. [14]
- **Triangle inequality:** It is defined as an inequality which stipulates that each side of a triangle cannot be longer than the sum of other two sides. [1]
- **Truth table:** It is defined as a table which enumerates all the possible truth value assignments for a complex sentence. [1] page:245
- **Turing Machine:** It is a machine which is capable of computing any computable function. It has a finite ID cell tape, one cell has a read/write tape and the machine can

be in any one of the states, the tape head moves to left or right along the input tape and performs reads/writes on the tape according to the symbol it encounters. [1]

- **Turing Test:** An AI system is said to pass Turing test, if a human interrogator after posing some questions cannot tell whether the responses come from a person or a computer. [1]

- **Unary constraint:** It is defined as a constraint which applies to the domain of a single variable. [1] page: 206

- **Uniform-cost Search:** It is defined as a search technique which expands a node 'n' with the lowest path cost g(n) in the fringe until a goal node is obtained. [1]

- **Uninformed search:** It is defined as a set of search techniques where the search strategy has no additional information about states beyond what is provided in the problem description. [1]

- **Unit clause:** It is defined as a clause which consists of a single literal. [1] page:253

- **Universal Constraint:** It is defined as an absence of a constraint between two variables in a CSP. [3]

- **Utility Function:** Utility Function is defined as an internal representation of performance measure in a utility based agent. If both internal utility function and external performance measure are in resonance then an agent always tries to maximize its utility function which means it tries to achieve better performance measure in an environment. [1]

- **Validity:** A logical sentence is said to be valid if it is true in all of the possible models. [1] page:250

- **Validity:** A sentence is said to be valid if it is true in all models. It is also called as tautology. [1] page:249

- **Value ordering heuristic:** it is defined as a technique which obtains the ordering of values of a variable to be considered. [3]

- **Variable ordering heuristic:** It is defined as a technique which obtains the order of variables to be expanded. [3]

- **Variable:** It is defined as an element that represents a real valued object in a CSP. [3]

- **Width of a graph:** It is defined as the tree width of a graph G which is the minimum of all possible tree decompositions of G. [14]

- **Zero-sum game:** It is defined as the game where the total payoff to all players is the same for every instance of game. [1] Page: 162

    $\alpha \vdash \beta$ if and only if the sentence $\alpha \rightarrow \beta$ is valid. [1] page:249

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