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AI questions
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Moodle questions

Assume there is a binary constraint between the variables X and Y. What does it mean that X is arc consistent w.r.t. Y?

It means that for each value x in the domain of X, there is some value y in the domain of Y that satisfies the constraint between X and Y.

How can we enforce X to be arc-consistent w.r.t Y?

Remove all the values x in the domain of X for which there is no corresponding value y in the domain of Y that satisfies the constraint between X and Y.

What are the possible outcomes of the arc consistency algorithm?

We have three possible outcomes:

- At least one domain could be empty, in which case there is no solution.
- Each domain could have a single value, in which case there is a unique solution.
- some domains could have multiple values.

Provide an example of a constraint satisfaction problem which is arc consistent but with no solution

Consider a CSP problem with three variables A, B, and C with the same domain $D = \{1, 2\}$ and the three constraints $A \neq B$, $B \neq C$ and $C \neq A$.

How can we find an optimal solution in an acyclic CP-net?

First consider independent variable and assign them their most preferred values. Then consider dependent variables that directly depend on the assigned variables and assign them their most preferred values that are consistent with the values previously assigned to their parents. We repeat this last passage until we assign a value to all the variables.

How do we compute the Borda score?

We need to compute for each candidate the Borda score, that is the number of candidates that it beats in the agents' preferences. The candidate with the highest Borda score wins.

Provide the formal definition of the Gale-Shapley algorithm

- Initialize every person to be free.
- While exists a free man:
 - Find best woman he hasn't proposed to yet
 - If this woman is free, declare them engaged
 - else:
 - * if this woman prefers this proposal to her current fiancée, then declare them engage and free the current fiancée
 - * else if this woman prefers her current fiancée rejects the proposal

Briefly explain the search strategies we have seen in the course

A search strategy is defined by picking the order of node expansion. We have seen 3 different search strategies:

- Breadth-first search, which expands the shallowest unexpanded node first;
- Depth-first search, which expands the deepest unexpanded node first;
- Iterative deepening search, which calls depth-first search with increasing depth limits until a goal is found.

Give the formal definition of the A^* algorithm

A^* expands first the node with the lowest value of $f(n)=g(n)+h(n)$, where $g(n)$ is the path cost from the start node to node n , and $h(n)$ is the estimated cost of the cheapest path from n to goal.

Give the definition of admissible heuristic

An heuristic h is admissible if for every node n , we have $h(n) \leq h^*(n)$, where $h^*(n)$ is the true cost from n to goal.

Provide the definitions of agent, agent function and agent program

An agent is a system that persists in its environment through sensor and acts upon it through actuators. An agent function takes as input the whole perceived history. An agent Program inputs only the current perception, runs only on the physical architecture.

Provide the notion of consistent heuristic

A heuristic h is consistent if for every node n , for every successor n' of n generated by action a , we have $h(n) \leq c(n, a, n') + h(n')$. Notice that is the instance of triangular inequality. Heuristic consistency implies heuristic admissibility.

Provide the definition of the simple problem solving agent

At first, it formulates a goal and a problem. Then it searches for a sequence of actions that would solve the problem. It then executes the actions one at a time.

Provide the definition of a Fuzzy constraint

It is mathematically defined as $\langle [0, 1], max, min, 0, 1 \rangle$, where the aim is to maximize the minimum preferences.

Provide the definition of Weighted constraints

It is mathematically defined as $\langle R \cup +\infty, min, +, +\infty, 0 \rangle$, where the aim is to minimize the sum of the cost.

Provide the formal definition of the CSP

The CSP is composed by variables, each one define over a domain. The aim is to find a solution which is complete and consistent, i.e., all the variable appears in the solution and all constraints are satisfied.

Provide the definition of Bayesian Network

It is a network model used to reason under uncertainty, which works according to the laws of probability theory. It is a directed graph, where each node in the set of node is a variable. We have a set of oriented arc. For each node X_i , we have a conditional probability distribution given parents of X_i : $P(X_i|Parents(X_i))$.

What are the similarity between Bayesian and CPnets?

CPnets are formalism to compactly represent qualitative and conditional preferences. Bayesian networks work on conditional probabilities. They both use tables to either show the preferences among choices or probabilities, both representation use CPT. They can both be seen as graph, where each one of the node represent a variable. It is a directed graph as a Bayesian network. CPnets can be cyclic while Bayesian cannot. (This last sentence is only a supposition).

What are the five components of the search problem?

They are:

- Q is a finite set of states;
- $S \subseteq Q$ is a non-empty set of start states;
- $G \subseteq Q$ is a non-empty set of goal state;
- A function which takes a state as input and returns a set of states as output;
- A cost function, which tells us the cost of the action we take for going to one state to the other.

Describe a solution of the search problem

The solution is a sequence of action leading from the initial state to the goal state. A solution is defined as optimal if it is the solution with minimum cost among the set of possible solution.

What is the local beam?

We keep track of k states rather than just one. We start with k randomly generated states. At each iteration all the successors of all k states are generated. From here we have two choices: if any one is a goal state, the algorithm stops; else select the k best successors from the complete list and repeat. In this last case, the k best successors could be all successors of the same node.

Provide the notion of path consistency w.r.t a third variable

A two variable set $\{x_i, x_j\}$ is path consistent w.r.t a third variable x_m if and only if for every assignment $x_i = a$ and $x_j = b$, consistent with the constraint $\{x_i, x_j\}$, it exists an assignment on x_m which satisfies the constraints x_i, x_m and x_m, x_j .

Provide the notion of soft CSP

A SCSP is a set of soft constraints over a set of variables based on a specific c-semiring $\langle A, +, x, 0, 1 \rangle$. The solution of a SCSP is a complete assignment of the variable which satisfies all the constraints. The optimal solution is the one with minimum cost in general. For the fuzzy version is the one that maximizes the minimums of the choices, while for the weighted one is the minimum of the sum of costs.

Provide the notion of syntax and semantic of a Bayesian Network

The syntax is the following:

- It is a directed graph;
- It has a set of nodes, one for each variable;
- It has a set of oriented arcs
- For each node, we define a conditional probability w.r.t its parents.

The semantics is defined as the product of the local conditional distributions: $P(x_1, \dots, x_n) = \prod_{i=1} P(x_i | \text{Parents}(x_i))$.

Provide an algorithm to find the optimal solution of a CPnet

For the acyclic CPnet we can find an optimal solution with the following procedure:

- Consider the independent variables and assign to them their most preferred values.
- Consider the dependent variables that directly depends on the assigned variables and assign them their most preferred values that are consistent with the values previously assigned to their parents.

Do this until all the variables have got an assignment.

Provide the notion of Hill climbing

It modifies the current state to try to improve it. Often when we are trying to find the best optimal solution we get stuck. The aim of this method is to improve the situation we are in by using a little perturbation. It picks a neighbor with the highest value. It usually chooses among neighbors with maximum value. It terminates when it reaches a peak where no neighbor has an higher value.

Provide the notion of global constraint

It is a constraint that involves an arbitrary number of variables.

Provide the notion of Degree heuristic

It is the most constraining variable. Choose the variable involved in most constraints with unassigned variables. it reduces the branching factor, selecting the variable as defined above. The chosen variable minimizes the number of conflicts of other variable.

Define a blocking pair

A blocking pair is a pair (m,w) , where m is a man and w a woman, such that the marriage contains (m,w') and (m',w) , but m prefers w to w' and w prefers m to m' .

What are the agents components?

There are five components in an agent: Percepts, sensors, actions, environment and actuators.

Provide the notion of greedy algorithm

The only greedy algorithm we have seen is the greedy first search, which expands the node that is closest to the goal. The evaluation function is $f(n)=h(n)$. It is not optimal and it can finish in loops. It is exponential but a good heuristic can improve it. It is not complete.

When can we say that a constraint graph is a tree

A constraint graph is a tree where any two variables are connected by only one path.

What is the tree width of a tree decomposition?

It is the minimal tree width over all possible tree decomposition. Is $s-1$, where s is the size of the largest sub problem.