IITJ, III Year (CSE), II Semester
End Semester Examination, 2016
CS323:Artificial Intelligence

Duration: 3 Hours Max. Marks 100

- Attempt all questions.
- Every answer should be detailed, and supported with sufficient logic for justification.

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1. Consider the 3-puzzle problem, which is a simpler version of the 8-puzzle where the board is 2×2 and there are three tiles, numbered 1, 2, and 3, and *blank*. There are four operators, which move the *blank* tile **up**, **down**, **left**, and **right**. The **start** and **goal** states are given in figure 1. Show, how the path to the goal can be found using:

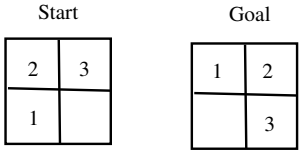

Figure 1: State Space search.

   (a) Breath-first search [5]

   (b) Depth-first search [5]

   (c) A^* search with the heuristic being sum of the number of moves and the number of misplaced tiles. [10]

   Assume that there is no possibility to remember states that have been visited earlier. Also, use the given operators in the given order unless the search method defines otherwise. Label each visited node with a number indicating the order in which they are visited. If a search method does not find a solution, explain why this happened.

2. Explain what algorithms or heuristics are suitable for solving constraint satisfaction problems under the following situations. Justify your answers.

   (a) The problem is so tightly constrained that it is highly unlikely that solutions exist. [5]

   (b) The domain sizes vary significantly: some variables have very large domains (over 1,000 values) and some have very small domains (with fewer than 10 values). [5]

   (c) The set of variables and set of domains are handled by a computer say, M. Each constraint is handled by a networked computer, say N. Traffic in the networks is slow. To check a particular constraint, computer M sends a message to computer N through the network, which in turn will send a message back to indicate whether the constraint is satisfied or violated. [10]

3. Two firms Alpha and Beta serve the same market. They have constant average costs of \$2 per unit. The firms can choose either a high price (\$10) or a low price (\$5) per unit for their product. When both firms set a high price, total demand is $10,000$ units, which is split evenly between the two firms. When both set a low price, total demand is $18,000$ units, which is again split evenly. If one firm sets a low price and the other a high price, the low priced firm sells $15,000$ units, while the high priced firm only $2,000$ units. Analyze the pricing decisions of the two firms as a non-cooperative game.

   (a) In the scenarios mentioned above, form representation, construct the pay-off matrix, where the elements of each cell of the matrix are the two firms' profits. [10]

   (b) Derive the equilibrium set of strategies. [5]

4. Apply alpha-beta search (from left to right) to the game tree in figure 2. Show the backed-up value of each node. Mark with an X any branches that are not searched.

   (a) Identify these as alpha / beta cut-offs, mark the best moves with an arrow from root node, [5]

   (b) compute the time complexity of search with worst case branching factor of 3 and height of tree as h. [5]

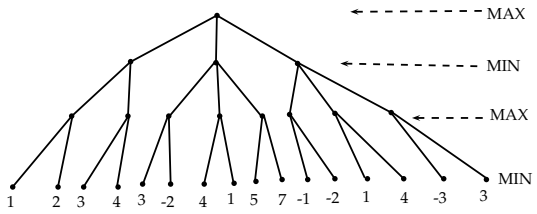

Figure 2: game-tree.

5. Assume that you have three operators:

   O_1 : Precondition: a; effect: $\neg a \wedge b$

   O_2 : Precondition: $a \wedge c$; effect: $\neg a \wedge b \wedge \neg c$

   O_3 : Precondition: $b \wedge c$; effect: $\neg c \wedge d$

   Show the first three layers (proposition, action and proposition) of the **graph plan** when initial state is $a \wedge c$ (a and c both are true). Include the mutual exclusions and justify each of them. [10]

6. Represent the following statements using semantic networks:

   (a) "John tells his students a lot of useful things." [5]

   (b) "Andrea tells John's students an enormous number of useful things." [5]

   Suppose you wanted to build an AI system that was able to work out "who tells John's students the greatest number of useful things." How could you do that? [5]

7. Is the following formula a default rule? Justify for yes/no. If it is no, what else is required to make it a default rule. [2]

$$\frac{bird(X) : flies(X)}{flies(X)}$$

   Compute the default extensions of following theories $T = (M, D)$, assuming the closed world representation.

   (a) $M = \{a\}, D = \{\frac{:\neg c}{d}, \frac{:\neg d}{e}\}$ [4]

   (b) $M = \{p \wedge q\}, D = \{\frac{:\neg q}{b}, \frac{:\neg p}{q}\}$ [4]