2008

ARTIFICIAL INTELLIGENCE

PAPER—CS/MCA/2402

Full Marks : 100

Time : 3 hours

Answer any **five** questions

The figures in the right-hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

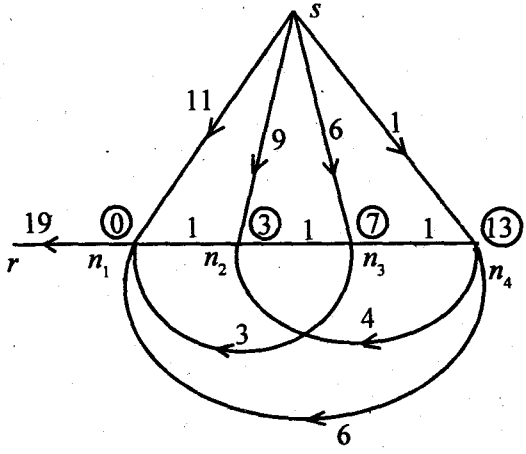
Illustrate the answers wherever necessary

1. (*a*) Write a Prolog program to calculate the GCD of two numbers.

(*b*) Write a Prolog program to calculate the sum of N natural numbers.

(*c*) Explain with examples: free variable and bound variables. 5 + 5 + 4

2. (*a*) Algorithm A^* is running on the search graph shown in the following figure,



Trace the execution of the algorithm indicating the sequence in which nodes get selected for expansion from OPEN.

(*b*) By tracing, you reach an optimal solution. Why ?

(*c*) Is it possible to change the heuristic values of some or all nodes, so that A^* will output a non-optimal solution path to this search graph ? If so, change the heuristic values and give the output solution path in this case. Otherwise give reasons why it is not possible. 7 + 2 + 5

3. (*a*) Compare between 'Depth first search algorithm' and 'Uniform cost algorithm.'

   (*b*) What are Q-paths? Do you agree with the statement— 'A^* algorithm outputs optimal solution path, in general'? Give reasons behind your answer. Show that A^* may output an optimal solution path in case where the heuristics are inadmissible. $3 + (2 + 1 + 3 + 5)$

4. Consider the game of tic-tac-toe. Assume MAX crossed (X) and MIN marks circles (O), MAX is to play first.

   (*a*) If p is not a winning position for either player, write an evaluation function $e(p)$ for use by MAX to evaluate nonterminal positions. Show the game tree up to the lookahead depth as 2 and evaluate the evaluation value of each leaf node.

   (*b*) Represent the configuration of a tic-tac-toe board by a nine-dimensional vector, C, having components equal to +1, 0, or -1 according to whether the corresponding cells are marked

with a X, an empty, or are marked with a O, respectively. Specify a nine-dimensional vector W such that the dot product $C . W$ is a useful evaluation function to be used by MAX (playing Xs) for evaluating nonterminal positions. 7 + 7

5. Consider a sliding block puzzle with the following initial configuration.

W	W	W	B	B	B	E

There are three white tiles (W), three black tiles (B) and an empty cell (E). The puzzle has the following moves:

(*a*) A tile may move into an adjacent empty cell with unit cost.

(*b*) A tile may hop over at most two other tiles into an empty cell with a cost equal to the number of tiles hopped over. The goal of the puzzle is to have all the black tiles to the left of all the white tiles (without regard for the position of the empty cell).

(*i*) Find a sequence of moves that will transform the initial configuration to a goal configuration. What is the cost of the solution ?

(*ii*) Specify a heuristic function h for this problem and show a part of search tree produced by algorithm A^* using this heuristic function. Is your heuristic function admissible ? 4 + 10

6. Assuming :

(*a*) s is the start node of a state-space search graph.

(*b*) $f(s)$ is the optimal solution cost.

Answer the following :

(*i*) Show that algorithm uniform cost (0) terminates successfully and output optimal solution path.

(*ii*) Prove that U never expands a node more than once. Is it true for algorithm A^* ? Justify your answer.

(*iii*) Prove that the heuristic "sum of manhattan distances' for the 8-puzzle problem is an admissible heuristic. 5 + 5 + 4

7. In the missionaries and unbelievers problem, three missionaries and three unbelievers stand at the left bank of the river. They wish to cross the river. There is a small boat (without a boatman) to ferry them across, but it holds at most two persons. Whenever there are more missionaries than unbelievers on either bank of the river, the missionaries will convert the unbelievers. The problem is to find out whether there is any possible sequence of ferrying for the six persons to cross the river without any of the unbelievers getting converted.

(*i*) Formulate the problem as state space search problem.

(*ii*) Draw implicit search graph.

(*iii*) Does there exist a solution to the problem ? If so, specify the solution. Otherwise, clearly explain why there is no solution.

(*iv*) What is expected to happen if you apply depth first search method to solve the problem ? 2 + 3 + 3 + 6

[*Internal Assessment* —30]