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Thapar Institute of Engineering & Technology, Patiala

Department of Computer Science & Engineering

MID SEMESTER EXAMINATION

B. E. (Third Year): Semester-V (COE)	Course Code: UCS521 Course Name: Artificial Intelligence
September 25, 2019	Wednesday, 8:00-10:00 hrs
Time: 2 Hours, M. Marks: 30	Name Of Faculty: JS, SMA, HRS, SA

Note: Attempt all questions. Assume missing data, if any, suitably

Q.1 Consider a compiler for a machine with one register and set of instructions (described in Table 1). The first four instructions can only be executed when the register's contents are not divisible by 3 and when the register's contents are divisible by 3, the only instruction available is DIVIDE. The problem to consider is how to put a constant value in register assuming that the register begins with a value 1.

Consider this problem as a state space problem where the states of the problem are the contents of the register at any time. The operators (successor function) and the cost function are described in Table 1. Given the goal of having 9 in the register and the heuristic function h(n) = |9-n|, find the solution of the problem using:

(i) Best first Search

(ii) A* algorithm

Maintain OPEN and CLOSED at each step. Arrange the states with same evaluation function values in descending order of value of states (i.e. register contents).

Table 1: Successor and Cost Function

Instructions (Operators)	**Cost of Operators on the register containing number n**
ONE: Set the value of the register to 1	1
DOUBLE: Double the contents of the register	n
ADD: Add one to the contents of register	1
SUB: Subtract one from the contents of the register	1
DIVIDE: Divide the value of the register by 3	2n/3

(3+4)

Q.2 Consider a robotic arm that can perform five actions namely REACH, SLIDE, PUSH, PICK, PLACE. The agent architecture has 32- bit storage. How many agent functions are possible for the given robotic arm agent? (2)

Q.3 Consider a Nim game in which initially there is a single pile of *n* tokens placed between two opponents. The opponents play alternately and at each turn the player selects a pile and divides it into two piles of unequal number of tokens. The first player who is unable to make a move loses the game.

For instance, a pile of 8 tokens may be divided into two piles 7 and 1, 6 and 2, 5 and 3 but not 4 and 4. In the next move , another player can further divide the two piles containing 7 and 1 tokens into three piles containing 6,1,1 tokens or 5,2,1 tokens or 4,3,1 tokens.

(i) Generate the game tree for n=6.

(ii) If MAX starts the game, find the next move of MAX using Minimax algorithm. (3+2)

Q.4 Consider a finite search tree of depth d and branching factor b. Suppose the shallowest goal node is at depth g ≤ d. What is the minimum and maximum number of nodes that might be generated by a breadth-first search? (2)

Q.5 Prove the following properties of heuristics for the A* algorithm:

(i) If h_1 and h_2 are two admissible heuristics such that $h_1 \geq h_2$, then number of nodes expanded by first algorithm (which uses heuristic h_1) are also expanded by the second algorithm (which uses heuristic h_2).

(ii) A monotonic heuristic is always admissible i.e. it always underestimates the optimal values.

*Do not prove the properties by taking specific examples. (3+3)

Q.6 Consider the problem of decoding a secret word 'BANANA'. The probability of correctly identifying the secret word is quite less but not zero (specifically it is $1/(26)^6$ i.e. less than 1 in 308 million). Simulate this combinatorial explosive problem with Genetic Algorithm and output first two iterations.

Consider population size of 4 where each chromosome is represented as a six letter word ($X_1X_2X_3X_4X_5X_6$) where Xi ε {A,B,C…Z}. Let the initial population be BAHAMA, ABCDEF, IJKLMN, and CABANA. Generate the population for next iterations as follows:

Select the 1st and 2nd fittest individual as it is in the next iteration.

Apply 1-point crossover in the middle between 3rd and 4th fittest chromosome.

Apply single letter mutation of first offspring produced through crossover between 3rd and 4th fittest chromosome. Letter chosen for mutation follows this cyclic order {X_6,X_5,X_4,X_3,X_2,X_1} i.e. in the first iteration X_6 must be mutated, in the second X_5 must be mutated and so on. The letter to be mutated must be shifted two letters down i.e. A must be replaced with C and so on.

Use the following fitness function:

$$Fitness(Chromosome) = \sum_{n=1}^{6} |Guess(n) - Answer\ (n)|$$

Where Guess (n) and Answer (n) are the ASCII values of the letters at nth position in the guessed chromosome and the answer. Given that ASCII value of A is 65. (5)

Q.7 Consider ring and hook problem in which there are few rings in water which are to be put in hooks. Initially we randomly rotate the game to put as many rings as possible in the hooks. But when we have put larger number of rings, we rotate carefully so that rings which are in hooks do not come out.

Name the searching algorithm which works analogous to the solution strategy of ring and hook problem? Explain how such behaviour is controlled for the search algorithm? (1+2)