Total number of printed pages–8

53 (CS 711) ARIN

2021

(Held in 2022)

ARTIFICIAL INTELLIGENCE

Paper : CS–711

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. *(a)* What is the difference between artificial and natural intelligence ? 5

   (b) What was key motivation for doing Turing test and also the problems identified during Turing test ? 5

Contd.

(c) Three missionaries (M) and three cannibals (C) are on one side of a river along with a boat that can hold one or two people. Missionaries must never be outnumbered by cannibals. Find a way to get everyone to the other side, without ever leaving a group of missionaries outnumbered by cannibals. Draw state diagram for all to cross the river. 10

State is <M, C, B> where, M, C and B are no. of missionaries on the left bank, no. of cannibals on the left bank and position of the boat (one side of river, i.e., left (L) or right (R) respectively.

Initial state : <3, 3, L>;

Goal state : <0, 0, R>;

Operators : <M, C>,

Valid operators : <1,0>, <2,0>, <1,1>, <0,1>, <0,2>.

2. (a) What is a grid-space world ? Define production system. Describe the production system for agent boundary using Boolean notation. 5

(b) What is the role of monotone heuristic in A* algorithm, and how be can checked the heuristic value successor ? How can be updated heuristic value for the successor be according to this condition ? 5

(c) What are the conditions for checking heuristic values and also updating the same ? What are the key differences in between A* and IDA* ? 5

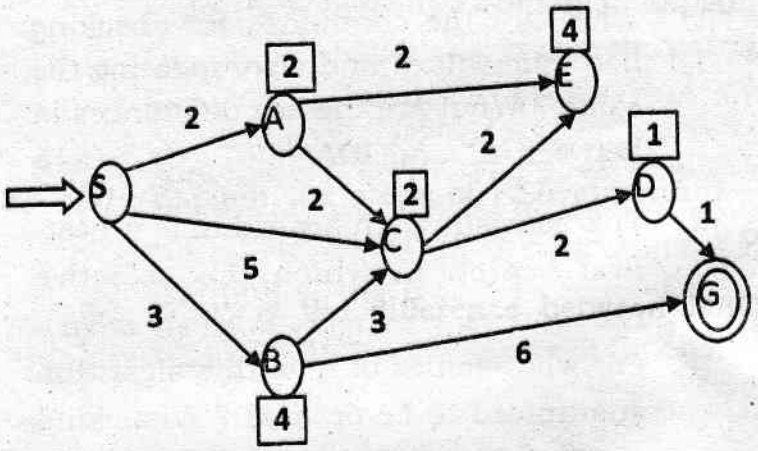
(d) The heuristic path algorithm is a best-first search in which the objective function is $f(n) = (2 - w)g(n) + wh(n)$. For what values of w is this algorithm guaranteed to be optimal ? What kind of search does this perform when $w = 0, w = 1$ and $w = 2$? 5

3. (a) What is the problem reduction search ? Write down the formulation of dimension and cost in using AND/OR graph search. 6

(b) Describe A* algorithm which estimates the cost of goal. 6

(c) Apply A* algorithm which is based on the path cost and heuristics values, are as follows and also shown in the figure below : 8

$A=2,\ B=4,\ C=2,\ D=1,\ E=5,\ G=0$



4. (a) Explain the hill climbing search with its drawbacks. 5

(b) Describe standard procedure for canonical genetic algorithm with a diagram. 5

(c) Maximize the function $f(x) = x^2$ over the range of integers from 0...7. Apply a genetic algorithm to solve this problem. Show at least the possible solution. 10

(Note : x represent five-digit unsigned binary integers, $f(x)$ value itself a fitness solution, coding in binary form having 3-bit string length (represent 8 numbers, four chromosomes (001, 101, 110, 011) as initial populations. Decode individual for further evaluation (like fitness, i.e., $x^2(110 = 6;\ 6^2 = 36)$, probability, random number, crossover and mutation.)

5. Decide whether each of the following sentences is 'VALID' or 'SATISFIABLE' : Verify your decisions using truth tables or the equivalence rules. 20

(i) Light $\Rightarrow$ Light

(ii) Light $\Rightarrow$ Electricity

(iii) Light Electricity

(iv) Light $\vee$ Light $\Rightarrow$ Electricity

(v) (Light $\Rightarrow$ Electricity) $\Rightarrow$
(Light $\Rightarrow$ Electricity)

(vi) Light $\vee$ Electricity $\vee$ Electricity

(vii) ((Light Topper) $\Rightarrow$ Electricity
((Light $\Rightarrow$ Electricity)
(Topper $\Rightarrow$ Elecrticity))

(viii) (Light $\Rightarrow$ Electricity) $\Rightarrow$ ((Light Topper) $\Rightarrow$ Electricity))

Hint: *Given Truth Table* (Standard logical equivalences.)

Standard logical equivalences :

$(\alpha \wedge \beta) \equiv (\beta \wedge \alpha)$ (commutativity of $\wedge$)

$(\alpha \vee \beta) \equiv (\beta \vee \alpha)$ (commutativity of $\vee$)

$((\alpha \wedge \beta) \wedge \gamma) \equiv (\alpha \wedge (\beta \wedge \gamma))$ (associativity of $\wedge$)

$((\alpha \vee \beta) \vee \gamma) \equiv (\alpha \vee (\beta \vee \gamma))$ (associativity of $\vee$)

$(\neg \alpha) \equiv \alpha$ (double negation elimination)

$(\alpha \Rightarrow \beta) \equiv (\neg \beta \Rightarrow \neg \alpha)$ (contraposition)

$(\alpha \Rightarrow \beta) \equiv (\neg \alpha \vee \beta)$ (implication elimination)

$(\alpha \Leftrightarrow \beta) \equiv ((\alpha \Rightarrow \beta) \wedge (\beta \Rightarrow \alpha))$ (biconditional elimination)

$\neg(\alpha \wedge \beta) \equiv (\neg\alpha \vee \neg\beta)$ (De Morgan's law)

$\neg(\alpha \vee \beta) \equiv (\neg\alpha \wedge \neg\beta)$ (De Morgan's law)

$(\alpha \wedge (\beta \vee \gamma)) \equiv ((\alpha \wedge \beta) \vee (\alpha \wedge \gamma))$ (distributivity of $\wedge$ over $\vee$)

$(\alpha \vee (\beta \wedge \gamma)) \equiv ((\alpha \vee \beta) \wedge (\alpha \vee \gamma))$ (distributivity of $\vee$ over $\wedge$)

6. Represent the following sentences in first-order logic using the predicates : 20

Takes (x,c,s) : student x takes course c in semester s;

Passes (x,c,s) : student x passes course c in semester s;

Grade (x,c,s) : the grade obtained by student x in course c in semester s;

DM and AI : specific DM and AI courses

$x > y$: x is greater than y;

Student (x) : Predicates satisfies by members of the corresponding categories.

Student (x), course (c), and semester (s)

(a) Some students took DIP in odd semester 2017.

(b) Every student who takes DIP passes it.

(c) Only one student took DM in odd semester 2017.

(d) The best grade in DM is always higher than the best grade in DM.

7. (a) Write short notes on : ***(any two)*** 10

(i) Simulated annealing

(ii) Strips

(iii) Skolemization

(b) Differentiate between : ***(any two)*** 10

(i) Uniform search and Best first search

(ii) Universal quantifier and Existential quantifire

(iii) Crossover and Mutation