Total number of printed pages–7

53 (CS 711) ARIN

2021

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 ?

   (b) 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.

   Give a plan for all to cross the river. State: <M, C, B>

   - M : no of missionaries on the left bank,

Contd.

- C: no of cannibals on the left bank,
- B: position of the boat (one side of river) : L or R,

Initial state : < 3, 3, L >,

Goal state : < 0, 0, R >

Operators : < M, C >, M & C represent No. of missionaries and cannibals on the boat respectively.

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

5+15=20

2. *(a)* What is a grid-space world ?

(b) What is the role of monotone heuristic in A* algorithm, and how can check the heuristic value Successor ? How can be update heuristic value for the successor according this condition ?

(c) Write down the conditions for checking heuristic and updating same. What is key difference in between A* and IDA* ?

4+8+8=20

3. *(a)* 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 $w = 0$, $w = 1$ & $w = 2$?

(b) What is the problem reduction search? Describe the formulation using AND/OR graph with dimension and cost?

(c) Write down the AO* algorithm steps and also mention its cost revision steps. 6+6+8=20

4. *(a)* What is hill climbing search and describe the drawbacks of hill climbing?

(b) Define simulated annealing with probability formula and the temperature parameter.

(c) Explain the STRIPS and its representation with different predicate symbols. Give an example of Move operator. 6+6+8=20

5. *(a)* Explain standard procedure for canonical genetic algorithm with a diagram.

(b) Maximize the function $f(x) = x^2$ over the range of integers from 0...31. Apply a genetic algorithm to solve this problem. Show at least the possible solution (i.e. near to termination criteria).

(**Note :** x represents five-digit unsigned binary integers, $f(x)$ value itself a fitness solution. Coding in binary form having 5-bit string length (represent 32 numbers, Four chromosomes (01001, 10100, 00100, 10101) as initial populations. Decode individual for further evaluation (like fitness i.e. x^2 (01101=13; 13^2 = 169), probability, random number, crossover and mutation.)

8+12=20

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

4×5=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;

AI and DSIP: specific AI and DSIP courses, $x > y$: x is greater than y;

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

Student (x), course(x),

(a) Some students took AI in odd semester 2020.

(b) Every student who takes AI passes it.

(c) Only one student took DSIP in odd semester 2020.

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

(e) Students can pass some of the courses all the semesters, and they can pass all of the courses some of the semester, but they can't pass all of the courses in all the semesters.

7. (a) Define Skolemization process and also the role of Skolem function in CNF?

(b) Decide whether each of the following sentences is valid, unsatisfiable, or neither. Verify your decisions using truth tables or the equivalence rules. 8+12=20

(i) Smoke $\Rightarrow$ Smoke

(ii) Smoke $\Rightarrow$ Fire

(iii) (Smoke $\Rightarrow$ Fire) $\Rightarrow$ ($\neg$Smoke $\Rightarrow$ $\neg$Fire)

(iv) Smoke $\vee$ Fire $\vee$ $\neg$ Fire

(v) ((Smoke $\wedge$ Heat) $\Rightarrow$ Fire)

$\Rightarrow$ ((Smoke $\Rightarrow$ Fire) $\vee$ (Heat $\Rightarrow$ Fire))

(vi) (Smoke $\Rightarrow$ Fire) $\Rightarrow$ ((Smoke $\wedge$ Heat) $\Rightarrow$ Fire)

(vii) Big $\vee$ Dumb $\vee$ (Big $\Rightarrow$ Dumb)

(viii) (Big $\wedge$ Dumb) $\vee$ $\neg$ Dumb

(***Hint***: *Given Truth Table* (Standard logical equivalences). The symbols α, β, and γ stand for arbitrary sentences of propositional logic.)

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 $\vee$)

$\neg (\neg \alpha) \equiv \alpha$ (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 $\wedge$)