Ex/PG/ETCE/T/114A/16/2017

MASTER OF ENGINEERING FIRST SEMESTER EXAMINATION, 2017

(Bio-Medical, Control, Electrical, ETCE, Illumination)

ARTIFICIAL INTELLIGENCE AND SOFT COMPUTING

Time: 3 hours **Full Marks: 100**

Answer any FOUR questions

Q 1: A farmer wants to transfer his three belongings – a wolf, a goat and a cabbage, by boat from the left bank of the river to the right bank. The boat can carry at most two items including the farmer. If unattended, the wolf may eat up the goat and the goat may eat up the cabbage. How should the farmer plan to transfer the items?

(a) Design the rules to solve the above problem.
(b) Define the starting state and the goal state.
(c) Use forward or backward reasoning to solve the problem.
(d) Give your views on the choice of forward/backward reasoning approach to solve the present problem. Which would be efficient for the present search? 8+4+8+5

Q 2: Answer the following with respect to the A* algorithm.

(a) Define g-cost and h-cost.
(b) Define nodes, open and closed set of nodes.
(c) How will you select a promising solution from the open set of nodes?
(d) In the process of expanding a node, what steps will you follow if the node selected for expansion is a (i) new node, (ii) existing open node (iii) existing closed node. Discuss each case with diagrams.
(e) Which of the following two heuristic functions would be a better choice for the water jug problem?
   i) $h_1 = |x-2|.|y-2|$
   ii) $h_2 = \text{Min}(|x-2|, |y-2|)$

where x and y denote the contents of the 4 litre jug and the 3 litre jug respectively.

4+4+4+9+4

Q 3: (a) Distinguish between proposition and predicates.

(b) With respect to Wang's Algorithm

i) Explain and illustrate the negation removal, and the AND/ OR removal steps.

ii) What is theorem splitting? Explain when theorem splitting is performed.

iii) State the stopping conditions of Wang's algorithm.

(c) Using Wang's algorithm, prove or disprove the following logical statement:

$P \leftrightarrow q \Rightarrow (p \wedge q) \vee (\neg p \wedge \neg q)$,

where the symbols have usual meaning. 4+ 12+9

Q 4: (a) State the resolution theorem of proposition and predicate logics.

(b)What is resolution by refutation? Give an illustration to explain the definition.

(c)Design the knowledge base and then by using the resolution theorem of predicate logic prove the statement: "The external angle of a triangle is equal to the sum of the opposite inner angles." 6+4+15

Q 5: (a) Given the evidential space E = E1 U E2 U E3 and hypothesis space H = H1 U H2,

obtain P(H2 | E1, E2, E3). Assume that the evidences are independent.

(b) Given P(A) = 0.5, P(¬B) = 0.4, P(A ∩ ¬B) = 0.3, and P(¬A ∩ B) = 0.4. Evaluate P(A∩B),

P(¬A∩¬B) and by definition of conditional probability, obtain P(¬B∩¬A).

(c) Given P(B if A is true) = P(B|A), then find P(A). What does the answer physically mean?

(d) Illustrate Dempster-Shafer theory to demonstrate the importance of orthogonal summation of belief. 6+6+4+9

Q 6: With respect to Widrow-Hoff's neural net, answer the following:

(a) Draw a structure of an ADALINE neuron and express its output in terms of inputs.

(b) What is delta learning? Derive the condition for convergence of the delta learning rule?

(c) What is meant by translation and rotation invariant pattern recognition?

(d) How will you set the weights in the planes of ADALINES for translation invariance and rotation invariance? 6+6+4+9

Q 7: With respect to Back-propagation neural learning, answer the following.

(a) Show that the steepest descent learning always converges to an optimum in a given energy surface irrespective of initialization.

(b) Draw a 3-layer feed-forward neural network, and develop the weight adjustment policy in the last layer and last-but-one layer following steepest descent learning.

(c) How would you adjust the weights when a set of input-output training instances are provided?

(d) Identify a suitable problem from your own domain to illustrate non-linear functional mapping from measured inputs to required outputs. Justify why such non-linear mapping is useful. Also indicate why a back propagation neural network may be useful for solving the mapping problem. 4+8+6+7

Q 8: (a) Let 'x' denote the age of a person in [0, 120] years.

We define $\mu_{OLD}(x) = (1 + e^{-kx})^{-1}$. What is the limitation of the above function to describe membership of oldness? Does the problem persist if $\mu_{OLD}(x) = 1 - e^{-kx}$?

(b) What would happen in the membership if 'k' is increased in $\mu_A(x) = 1 - e^{-kx}$? Draw graphically to illustrate the same.

(c) Given

$$\mu_A(x) = \frac{1}{\sqrt{2\pi}} e^{(-(x-25)^2)}$$

$$\mu_B(y) = \frac{1}{\sqrt{2\pi}} e^{(-(y-10)^2)}$$

where the rule indicates *if age x is YOUNG, then speed y is AROUND 10m/s.* Construct a fuzzy implication relation R(x, y) for the rule.

(d) $\mu_A(x) = [0.4 \quad 0.7 \quad 0.9]$, where $x = [22 \quad 25 \quad 28]$, determine $\mu_B(y)$ by max-min composition operation for the problem in part (c).

(e) State one application from your domain, where approximate reasoning characteristic of fuzzy logic can be used. Be specific in your answer. 6+4+5+5+5