WAYAMBA UNIVERSITY OF SRI LANKA

FACULTY OF APPLIED SCIENCES

Department of Computing and Information Systems

CMIS 4114 – Artificial Intelligence
Assignment - 2020

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1. (a) Define the term 'rational agent' in AI. Is a human being an ideal rational agent? Justify your answer.

   (b) What is a utility function? With the aid of a diagram describe how a utility based agent operates.

   (c) Briefly describe and compare the four types of rational agents which are commonly developed in the field of intelligent systems. Identify the most suitable agent type for a taxi driving agent.

   (d) State and describe four types of environment pairs an agent can operate in.

   (e) To what extend are the following computer systems instances of artificial intelligence:

      (i) Supermarket bar code scanners
      (ii) Web search engines
      (iii) Voice-activated telephone menus
      (iv) Internet routing algorithms that respond dynamically to the state of the network.

2. (a) (i) Briefly explain four different criteria used for evaluating searching strategies.

      (ii) Compare the depth-first search and breadth-first search algorithms by writing out their advantages and disadvantages.

   (b) Consider the map of distances between some cities given in Figure 1. Suppose it is necessary to travel from City **S** to City **G.** The straight line distances to City **G** from other cities are given in Figure 2, describe a simple best–first search strategy known as greedy search to reach City **G**. Give the total distance traveled by using this algorithm.

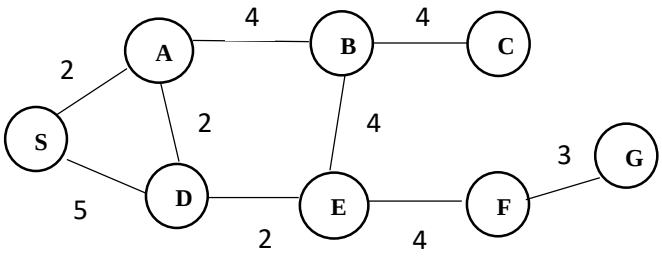


Figure 1

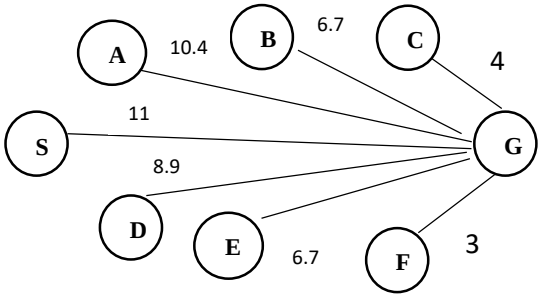
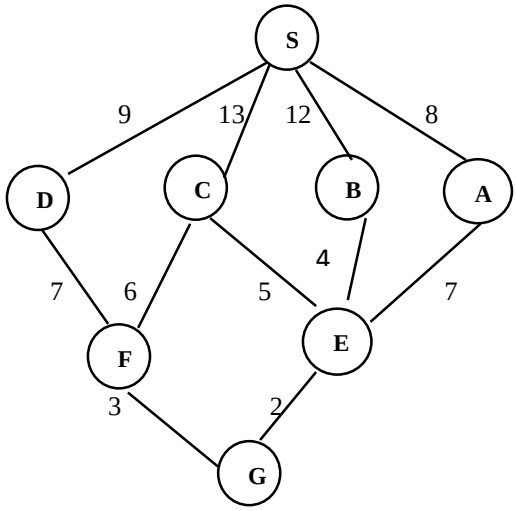


Figure 2

Explain whether the heuristic function in the answer to (b) above can identify the shortest path between City S and City G. Describe how this heuristic function can be improved to make it optimal and complete. What is the optimal path given by this modified algorithm?

(c) Consider the graph given below starting at S and ending at G. Costs of travelling between the states are shown on arcs. Perform bread-first, depth-first and uniform cost search and give the search path.



3. (a) Express the following natural language sentences (i) and (ii) in first order logic and first order logic sentences (iii) and (iv) in natural language.

(i) Computers can never be intelligent.
(ii) Everyone loves everyone who loves them.
(iii) ∀ X (human (X) ^ (male(X) V female (X))).
(iv) [∀ X(god(Y) ^ loves (Y, X))] ^ [∃ X (god(Y) ^ ¬ loves (X,Y))].

(b) Consider the following Rules and Facts and infer whether to switch on the sprinklers using backward chaining.

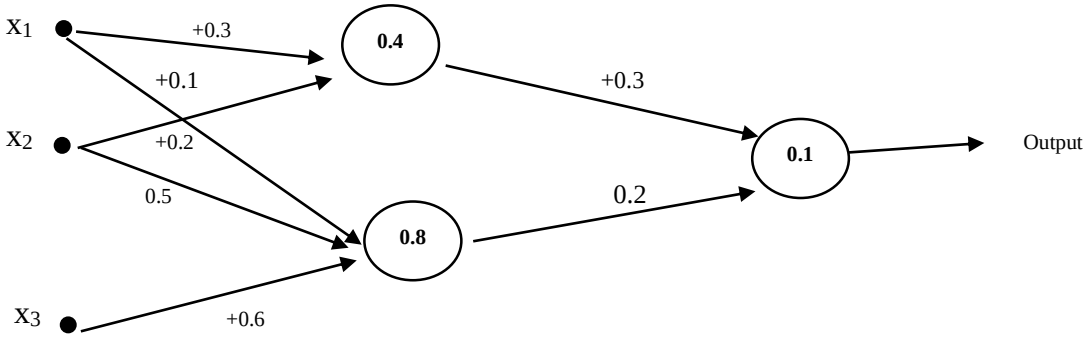
Rules:
R1: IF hot AND smoky THEN fire
R2: IF alarm beeps THEN smoky
R3: IF fire THEN switch_on_sprinklers

Facts:
F1: hot
F2: alarm beeps

4. (a) What are the differences between the supervised learning, unsupervised learning and reinforcement learning?

(b) Using XOR problem discuss the limitations of simple perceptions.

(c) The figure below depicts an artificial neural network elements are linear threshold units (i.e. if $\sum_i \ w_i x_i > t$ then Output =1, else Output = 0) . The numerical value within each unit is the unit's threshold value (t). The numerical values alongside each arrow indicate the network's weight values (w_i).



If the inputs x_z,x_2 and x_3 are restricted to binary values, the network implements a Boolean function. What is this Boolean function? Show the calculations clearly.

5. (a) What is fuzzy set theory? Using examples discuss how fuzzy sets differ from crisp sets.

(b) For the two fuzzy sets A and B find the following properties graphically.

$$\mu_A(x) = \begin{cases} \frac{1}{1+\left(\frac{1}{5}x-5\right)^2} & 25 < x \\ 0 & \text{otherwise} \end{cases} \quad \text{and} \quad \mu_B(x) = \begin{cases} \frac{1}{1+\left(\frac{13}{2}-\frac{1}{10}x\right)^2} & x < 65 \\ 0 & \text{otherwise} \end{cases}$$

(i) $\bar{A}$ (ii) $\bar{B}$ (iii) $A \cup B$ (iv) $A \cap B$

(c) Consider the following fuzzy sets

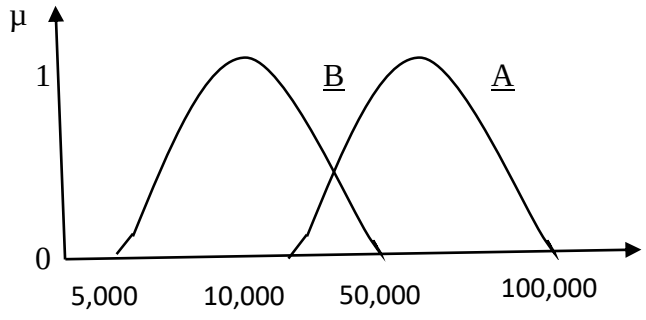
X = {(8, 0.1), (9, 0.5), (10, 1), (11, 0.3), (12, 0.1)}
Y = {(4, 0.1), (5, 0.3), (6, 1), (7, 0.9), (8, 0.2)}
Z = {(8, 0.5), (9, 1), (10, 0.9), (11, 0.4), (12, 0)}

Compute

(i) R = X × Y and S = Y × Z.
(ii) $P = R \circ S$ by max-min composition.

(d) For the two fuzzy sets shown in the figure find the following properties graphically.

(Not to scale)



(i) $\bar{A}$ (ii) $\bar{B}$ (iii) $A \cup B$

6. (a) Consider the following set of FOL expressions:

$$Student(p) \wedge Subject(q) \wedge Eligible(p,q) \rightarrow Sit\_exam(p,q).$$
$$Pass\_assignment(x,y) \rightarrow Eligible(x,y).$$
$$Pass\_assignment(Sarath, Maths).$$
$$Pass\_assignment(Nimal, Maths).$$
$$Pass\_assignment(Sarath, Biology).$$
$$Subject(Maths).$$
$$Subject(Biology).$$
$$Student(Sarath).$$

(i) Explain how you conclude that sitexam(sarath, maths) is true with the use of

(1) forward chaining (2) backward chaining

(ii) From the above information which of the following can be concluded. In each case, give reasons for your answer.

(1) $Eligible(Sarath, Biology)$

(2) $Sit\_exam(Nimal, Maths)$

(b) Describe briefly the method of problem solving using resolution.

(c) Consider the following argument:

Nimal plays all kinds of sports. Cricket is a sport. Football is a sport. Anything anyone plays is a sport. Ranil plays Basketball. Amal plays everything Nimal plays. Therefore, Nimal plays Basketball.

(i) Formalize the hypotheses and conclusion of the above argument as expressions in First Order Logic (FOL).

(ii) Convert the above First order Logic (FOL) expression for hypotheses into Conjunctive Normal Form (CNF).

(iii) Show that the above argument is valid using resolution.

Submit on or before 22nd November 2020.