	Utech
Name :	
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Invigilator's Signature :	

# ARTIFICIAL INTELLIGENCE & SOFT COMPUTING

Time Allotted: 3 Hours Full Marks: 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer Question No. 1 and any four from the rest.

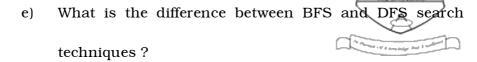
- 1. a) Give McCulloch-Pitts model for artificial neurons.
  - b) Give the *X*-projection and *Y*-projection of :

$$\mu_R (x, y) = \begin{pmatrix} 0.1 & 0.5 & 0.2 \\ 0.9 & 0.7 & 0.1 \\ 0.3 & 0.5 & 0.6 \end{pmatrix}$$

- c) Prove :  $p \to (q \to r) \Rightarrow (p \Rightarrow q) \Rightarrow r$  where p, q and r are three propositions.
- d) A box contains 10 screws, out of which 3 are defective. Two screws are drawn at random. Find the probability that name of the two screws are defective using:
  - i) Sampling with replacement
  - ii) Sampling without replacement.

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[ Turn over



- f) Solve for  $\left(X_1\,,\,X_2\,\right)$  with the help of 'problem-decomposition and constraint-satisfaction' approach. Given :  $X_1 \geq 2,\,X_2 \geq 3,\,X_1+X_2 \leq 6,\,X_1\,,\,X_2 \in I$  3+2+2+3+2+2
- 2. a) With reference to a typical production system, what is 'Recognise-Act Cycle'?
  - b) Why are conflict resolution strategies required in production systems ? Outline the various conflict resolution strategies.
  - c) Prove:

i) 
$$p \rightarrow q \equiv \neg p \vee q$$

ii) 
$$p \rightarrow q \Rightarrow \neg q \rightarrow \neg p$$
.  $3 + 6 + 5$ 

- 3. a) What is resolution theorem?
  - b) Prove the resolution theorem using Wang's algorithm.

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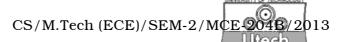


- c) Prove that Dog ( fido ) follows from the following statements by resolution theorem.
  - i)  $\forall X \text{ Barks } (X) \rightarrow \text{Dog } (X)$
  - ii)  $\forall X \forall Y \exists Z \text{ Has-master } (X, Y) \land \text{Likes } (X, Y) \land$  Unprecedented situation  $(Z) \rightarrow \text{Barks } (X)$
  - iii) Unrecedented-situation (noise)
  - iv) Likes (fido, jim)
  - v) Has-master (fido, jim).

- 2 + 5 + 7
- 4. a) Explain unsupervised learning with respect to artificial neural networks.
  - b) Briefly outline discrete hopfield net.
  - c) What is the difference between competitive leaning and Hebbian learning with respect to Artificial neural networks.
  - d) Outline two common topologies to be found in artificial neural networks. 5 + 5 + 2 + 2

- 5. a) Describe the process of genetic algorithm with the help of a simple schematic diagram.
  - b) Outline the optimization of function  $f(x) = x^2 25$  with the help of Genetic Algorithm using a population of 5 chromosomes and 2 iterations.
  - c) Describe the process of differential evolution with the help of its schematic diagram. 5+4+5
- 6. a) Describe the perceptron learning algorithm along with a simple schematic diagram.
  - b) Outline the method for translational-invariance and rotational-invariance (  $90^\circ$ ,  $180^\circ$ ,  $270^\circ$  ) given by Widrow-Hoff with ADALINE neurons.
  - c) Construct:
    - i) Logical AND gate
    - ii) Logical OR gate with McCulloch-Pitts neurons.

5 + 6 + 3



- 7. a) Why is Fuzzy production system better than traditional production system?
  - b) Outline any three Fuzzy implications rules.
  - c) For the given Fuzzy set:

$$A = \{x1/0.2, x2/0.4, x3/1, x4/0.7, x5/0.6, x6/0.5, x7/0.9, x8/0\}$$

Calculate the following :

- i) Core ( *A* )
- ii) Support (A)
- iii) Is A a 'normal' fuzzy-set?
- iv)  $\alpha$ -cut  $(A)|_{\alpha = 0.6}$
- v)  $\alpha$ -cut  $(A)^+ \mid_{\alpha = 0.6}$  (Strong  $\alpha$ -cut).

d) PR1: If age is YOUNG THEN digestion-rate is HIGH.

PR2: If digestion-rate is HIGH THEN speed is HIGH.

Find  $\boldsymbol{\mu}_{R}$  ( age, speed ) if :

digestion-rate →

$$\mu_R \text{ (age, digestion-rate = } \begin{bmatrix} 0.2 & 0.3 & 0.6 \\ 0.4 & 0.6 & 0.5 \\ 0.3 & 0.6 & 0.9 \end{bmatrix}$$

$$\mu_{R} \text{ ( digestion-rate, speed ) = } \begin{bmatrix} \psi & speed \rightarrow \\ \psi & 0.7 & 0.5 \\ \psi & 0.7 & 0.7 & 0.4 \\ 0.7 & 0.4 & 0.5 \end{bmatrix}$$

2 + 3 + 5 + 4

#### 8. a) Prove:

$$P\!\left(H_{j}/E_{1}\,,\,E_{2}\,,\,....\,,\,E_{m}\right) = \frac{\prod\limits_{i=1}^{m} P\!\left(E_{i}/H_{j}\right)P\!\left(H_{j}\right)}{\sum\limits_{k=1}^{n}\prod\limits_{i=1}^{m} P\left(E_{i}/H_{k}\right)P\left(H_{k}\right)}$$

for the Hypothesis space H consisting of  $H_j$ ;  $1 \le j \le n$  and evidence space consisting of  $E_i$ ;  $1 \le i \le m$ .

- b) Describe the process of Hill Climbing. What is the problem of 'trapping at local minima at a foothill' encountered in hill-climbing?
- c) Outline the process of simulated-annealing. How it overcomes the problem of 'trapping at local minima at a foothill' encountered in hill-climbing? 7 + 3 + 4