B. Tech Fourth Year End Semester Examination

Department: Computer Science and Engineering

Course Name: Artificial Intelligence Code: CS 461

Full Marks-100 Time: 3 hours

Answer any FIVE Questions.

Make reasonable assumptions as and whenever necessary. You can attempt the questions in any sequence. However answers to all the components of any particular question should appear together

1. (a). Describe about the relevance feedback architecture of information retrieval. Discuss the working principles of vector space model (***hints***: describe in terms of vector representations, term weights (i.e., tf-idf) and cosine similarity measurements).

   (b). Why is propositional logic monotonic? Define resolution theorem in propositional logic. Consider the following propositional logic knowledge base:

   $KB = (B_{1,1} \Leftrightarrow (P_{1,2} \vee P_{2,1})) \wedge \neg B_{1,1}$

   Use resolution algorithm to show whether $\alpha = \neg P_{1,2}$ can be concluded or not.

   (c). Define Modus Ponens in Propositional logic.

   (4+5) + (2+2+5) +2

2. (a). For propositional logic, why is entailment with horn clauses more efficient? Consider the following propositional logic knowledge base:

   $P \Rightarrow Q$
   $L \wedge M \Rightarrow P$
   $B \wedge L \Rightarrow M$
   $A \wedge P \rightarrow L$
   $A \wedge B \Rightarrow L$
   A
   B

   Show the various steps of backward chain resolution algorithm to derive the query Q (A and B are the facts). Why is backward chain more effective than forward chain?

   (b). Describe the working principles of K Nearest Neighbor algorithm with respect to document classification. Show its training and testing time complexities. Mention about the shortcomings of this approach and their possible remedies.

   (2+ 6+2) + 10

3. (a). Consider the weighted term vectors of two documents as:

$D_1 = 5T_1 + 3T_2 + 10T_3$ $D_2 = 5T_1 + 7T_2 + 3T_3$

For a query, $Q = 15T_1 + 5T_2 + 2T_3$, compute the similarities using *inner product* and *cosine similarity* metrics. With respect to this problem, which one is the better measurement?

(b). What are the different types of machine learning algorithms? Draw a decision tree for the problem of deciding whether to move forward at a road intersection, given that the light has just turned green.

(b). Suppose that an attribute splits the set of examples E into subsets Ei and that each subset has p_i positive examples and n_i negative examples. Show that the attribute has strictly positive information gain unless the ration $p_i /(p_i + n_i)$ is the same for all i.

(6+2) + (3+4+5)

4. (a). Distinguish between Multi-objective optimization and single objective optimization. Define Non-dominance and Pareto Optimality. Write down the different steps of NSGA-II.

(b) Let us assume the following: Universe U={X1, X2, X3, X4}; Fuzzy sets:

A={0.2/X1 , 0.7/X2 , 0.6/X3, 0.9/X4}
B={0.7/X1 ,0.3/X2 ,0.5/X3, 0.3/X4}

Compute the following functions: cardinality of A; d (A, B) and A U B.

(c) What is the fuzzy definition of subset-hood?

(3+4+5)+6+2

5. Mention the name of the algorithm that will result under each of the following conditions: (i). Local beam search with K (number of successors) =1; (ii). Local beam search with K (number of successors) =∞; (iii). Simulated annealing with T (temperature) = 0 at all times; (iv). Genetic algorithm with population size N=1.

(b). Write down the various steps of Genetic Algorithm. Why is it preferred over other local search techniques?

(c). Given a document, containing terms with given frequencies: A(20), B(30), C(40), D(10). Assume that collection contains 10,000 documents and document frequencies of these terms are: A (100), B (1200), C (2000), D(1000).

Compute the term *frequency-inverse document frequency* of the document collection.

4*2+ (5+2) + 5

6. (a). Construct by hand a neural network that computes the XOR function of two inputs. Specify number of layers, number of nodes in each layer, weight combination of each layer, function used etc.
(b). Define linearly separable functions with proper examples.
(c). Discuss about overfitting, underfitting and generalization with respect to machine learning.

12+3+5