End Semester Examination

Course Name: Artificial Intelligence **Code: CS 561**

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

Answer ALL the questions

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

1. (a). Define subsethood in Fuzzy logic. Let Universe $U=\{X_1, X_2, X_3, X_4\}$ Fuzzy sets $A=\{0.5/X_1, 0.9/X_2, 0.2/X_3, 0.8/X_4\}$ and $B=\{0.7/X_1, 0.3/X_2, 0.7/X_3, 0.5/X_4\}$ Then define AUB, $A \cap B$, Cardinality of A, Cardinality of B, distance between A and B, A^c

   (b). 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?

   (3+1.5*6)+8

2. (a). Formulate naïve Bayes classifier for text classification (Mention about representations of documents, calculations of necessary probabilities etc.?). What is time complexity of multinomial naïve Bayes model?

   (b). Construct a decision tree for the function $f(A, B)=AB + A'B'$, where A and B are the boolean variables and A' and B' are the complements of A and B, respectively. Describe the information gain metric with respect to the choice of attributes in decision tree.

   10+10

3. Based on the data given in the following table, (i). estimate a multinomial Naïve Bayes classifier; (ii). apply classifier to the test document; (iii). estimate a Bernoulli NB classifier; (iv). apply a classifier to the test document. You need not estimate parameters that you don't need for classifying test document.

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	docID	Words in document	In c= India?
Training set	1	Kolkata Delhi	yes
	2	Kolkata Chennai Patna	yes
	3	Trento Milan	no
	4	Sapporo Osaka Taiwan	no
Test set	5	Kolkata Kolkata Milan	?

4. Consider the following examples for binary classification. **20**

Instance	a1	a2	a3	Target class
1	T	T	1.0	+
2	T	T	6.0	+
3	T	F	5.0	-
4	F	T	4.0	+
5	F	T	7.0	-
6	F	T	3.0	-
7	F	F	8.0	-
8	T	F	7.0	+
9	F	T	5.0	-

a. Determine the entropy of the above records with respect to the positive class?

b. Find out the information gains of a1 and a2 relative to these training examples.

c. What is the best split (among a1 and a2) according to the classification error rate?

d. What is the best split (between a1 and a2) according to the Gini index?

5. Write short notes on the following topics (Any **FOUR**) **4*5=20**

(a). Definition of sets using first order predicate logic

(b). Fuzzy sets vs. Crisp sets

(c). Overfitting and underfitting in machine learning

(d). Multilayer perceptron model

(e). Supervised vs. Unsupervised vs. Re-enforcement learning

(f). K-NN algorithm

(g) Universal quantification vs. Existential quantification in First order logic