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 parts of any particular question should appear together.

1. (a). When and under what conditions local search performs well? Show the various steps of hill climbing algorithm for the following 8-puzzle problem. Assume the heuristic function to be the number of misplaced tiles. **3+10**

8	2	3
1	6	4
7		5

Start Sate

1	2	3
8		4
7	6	5

Goal State

(b). What are the merits and demerits of hill climbing search? How does simulated annealing address the problems of hill climbing? How is local beam search different from hill climbing and simulated annealing? **7**

2. Consider the following examples for binary classification in decision tree. **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. What is the best split (among a1, a2, a3) according to the information gain? (*show each step with proper justification*)

c. What is the best split (among a1 and a2) according to the classification error rate? ((*show each step with proper justification*)

3. Based on the data given in the following table, (i). estimate a multinomial naïve Bayes classifier; (ii). Apply classifier to the test document (***Show each step with proper explanation***)

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	docID	Words in document			In c= Computer Sc.?
Training set	1	Programming	Language	Computers	yes
	2	Architecture	Database	OS	yes
	3	Language	AI	OS	yes
	4	Cricket	Football	Hockey	no
Test set	5	Language Architecture Cricket			?

4. (a). If A* knows the ACTUAL cost of the optimal path of any node to the goal, then no useless node is expanded. Prove or disprove this statement rigorously. **5**

(b). In backpropagation algorithm we start with random initialization of the weights and threshold values. Prove that if the initial weights are all equal then the algorithm will never converge to the correct set of weights which are in general different from one another.

The above problem is called "symmetry breaking". Give the weakest "symmetry" condition. Equality of all weights is the strongest symmetry condition.

4+6

(c). Prove that XOR cannot be computed by a single sigmoid neuron. Sigmoid function is defined by y=1/(1+e^-x). 'y' is the o/p of the neuron and 'x'' is the net input to the neuron.

5

5. (a). For each pair of atomic sentences, give the most general unifier if it exists:
(i). P (A, B, B), P(x, y, z)
(ii). Q(y, G(A, B)), Q(G(x,x),y)
(b). Suppose a knowledge base contains just the following first-order Horn clauses: **8**
Ancestor (Mother(x), x)
Ancestor (x,y) ∧ Ancestor (y,z) ==>Ancestor (x,z)

Consider a forward chaining algorithm, that on the jth iteration, terminates if the KB contains a sentence that unifies with the query, else adds to the KB every atomic sentence that can be inferred from the sentences already in the KB after iteration j-1.

(i). Can a resolution algorithm prove the sentence ~Ancestor (John, John) from the original knowledge base? Explain how, or why not?

(ii). Suppose we add the assertion that ~(Mother(x)=x) and augment the resolution algorithm with inference rules for equality. Now what is the answer of (i).

(c). Here are two sentences in the language of first-order logic: **7**
∀x ∃y (x>=y) and ∃y∀x(x>=y)
Assume that the variables range over all the natural numbers 0,1,2..... and that the ">=" predicate means "is greater than or equal to". Does A logically entail B? Does B logically entail A? Using resolution try to prove that A follows from B. Do this even if you think that B does not logically entail A.