Subject Code : COMP3010 Section No.: 1 Time Allowed: 3 Hour(s)

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Time allowed: 3 hours.
Answer **all** questions.
This is a closed book examination.

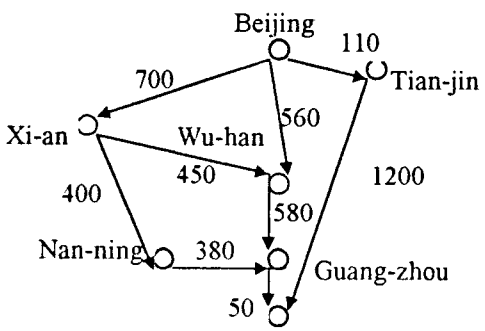
1a. Explain the criteria for evaluating a search strategy. (4 marks)
1b. Give the definitions of *iterative-deepening* and **A*** search. (4 marks)
1c. Use the criteria explained in 1a. to evaluate *iterative-deepening* and **A*** search. (4 marks)

2. Nine air-flights and their distances of an Airline-Company are shown in the following figure. Write a Prolog program to: (12 marks)

2a. find all routes from Beijing to H.K., calculate the distance of each route and list all the cities passed through by each route.

2b. find the shortest route from Beijing to H.K., calculate the distance of this route and list all the cities passed through by this route.

2c. find the shortest route from Beijing to H.K. without passing through Wu-Han because the airport of Wu-Han is closed for some reason.



3. Compare two iterative improvement algorithms, Hill-climbing and Simulate-Annealing, with respect to their abilities to search the optimal solution. (8 marks)

4. Explain why an inductive bias is needed in Inductive Learning. Describe the biases used in Decision-Tree learning and Version Space learning. (8 marks)

5. Suppose that we want to choose a day for the BBQ in the country-side. Each candidate day will be evaluated according to 4 attributes:
   (1) the Outlook of the sky,
   (2) the Temperature-degree,
   (3) the Humidity-degree, and
   (4) the Wind-strength.

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The possible values of each attribute are:

(1) the possible Outlook are Sunny, Overcast, Rain,
(2) the possible Temperature-degree are Hot, Mild, Cool,
(3) the possible Humidity-degree are Normal or High, and
(4) the possible Wind-strength are Middle or Strong.

The candidates are classified into two classes: Suitable or Non-suitable. The training examples are presented in the following table:

No.	Outlook	Temperature	Humidity	Wind	Class
1	Sunny	Mild	Normal	Middle	Suitable
2	Sunny	Mild	High	Middle	Suitable
3	Sunny	Hot	High	Strong	Suitable
4	Overcast	Mild	Normal	Middle	Suitable
5	Overcast	Hot	High	Middle	Non-suitable
6	Overcast	Cool	Normal	Middle	Suitable
7	Overcast	Cool	High	Middle	Non-suitable
8	Overcast	Mild	High	Middle	Non-suitable
9	Rain	Hot	Normal	Strong	Non-suitable
10	Rain	Mild	High	Strong	Non-suitable
11	Rain	Cool	Normal	Strong	Non-suitable
12	Rain	Cool	High	Middle	Non-suitable

5a. Calculate the Average Disorder of various attributes for each level of the decision tree. (6 marks)

5b. Construct a decision tree using the results of 5a. (4 marks)

5c. Predicate whether a candidate day is suitable. The information of the candidate is summarized in the following table: (2 marks)

Outlook	Temperature	Humidity	Wind
Overcast	Hot	Normal	Strong

5d. Discuss the overfitting phenomenon in Decision-Tree learning when adding the following incorrect example (noisy data) to the training set. (4 marks)

Outlook	Temperature	Humidity	Wind	Class
Overcast	Hot	Normal	Middle	Non-suitable

6. Consider a robot that collects TVs from the rooms of levels four and five in a building. The learning task is to derive rules that determines where a TV exists. The attributes and their features of the rooms are:

Department (History, Business),
Master (Faculty, Technician, Student),
Level (Four, Five).

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6a. The robot uses Candidate-Elimination algorithm to learn the rules. Explain, in general, how the most general boundary set G and the most specific boundary set S are updated when a new example (positive / negative) arrives. (6 marks)

6b. Give the most general boundary sets S and most specific boundary G of each version space produced when the following training examples are presented to the robot one by one. (6 marks)

No.	Department	Master	Level	Has a TV?
1	Business	Faculty	Four	yes
2	Business	Technician	Five	no
3	Business	Faculty	Five	yes
4	Business	Faculty	Four	no

6c. What are the rules produced? (2 marks)

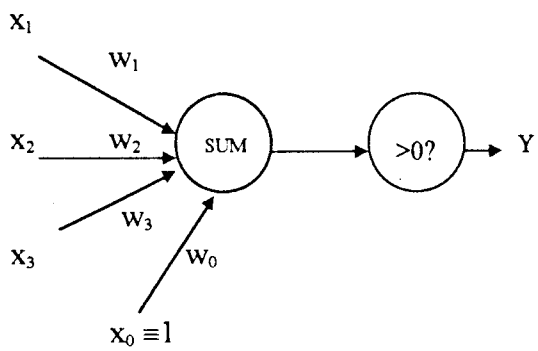
7a. Two sets of examples and a perceptron network are given as follows:

Set **A** of examples:

inputs:			outputs:
x_1	x_2	x_3	y
0	0	0	1
1	1	1	1
1	1	0	0
0	0	1	0

Set **B** of examples:

inputs:			outputs:
x_1	x_2	x_3	y
0	0	0	1
1	1	1	1
1	1	0	0
0	1	0	0



Execute the perceptron learning rule on the preceptron network by the two sets of examples respectively. Show the resulting weight vector if it is convergent; otherwise, explain why it is not convergent. Assume that the initial weight vector (w_0, w_1, w_2, w_3) is (1, -1, -1, -1) and the learning rate is 1. (12 marks)

7b. What type of problems (considering their attributes, noise, ...) are most appropriate for Neural-network learning? (6 marks)

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8a. Briefly state the key steps of Genetic algorithm. (6 marks)

8b. Consider the following two parental chromosomes,

0	1	1	0	1	0	0	1	1	0

1	0	0	1	1	1	1	0	0	1

i) what are the two offspring chromosomes generated by performing a single-point crossover with the following crossover mask: (1 marks)

1	1	1	0	0	0	0	0	0	0

ii) what are the two offspring chromosomes generated by performing a two-point crossover with the following crossover mask: (2 marks)

0	0	1	1	1	1	0	0	0	0

iii) what are the two offspring chromosomes generated by performing a uniform crossover with the following crossover mask: (3 marks)

0	1	1	0	0	1	1	0	0	1