

NAME: **SOLUTION**  
 Signature:

Student Nr.



**EASTERN MEDITERRANEAN UNIVERSITY**  
**COMPUTER ENGINEERING DEPARTMENT**  
**CMPE 535 - Knowledge Engineering**  
**Final Exam**

Spring 2006-07

Q	1	2	3	4	5	total
pts	10	20	30	20	20	100

1) a- [6p] Write two different kind of generic AI problems, and for each of the generic problem give an example of two specific problem

generic problem -1 ..... optimization  
 specific problem-1: ..... (combinatorial) traveling salesman problem  
 specific problem-2: ..... (scalar) credit card worthiness  
 generic problem-2..... diagnosis  
 specific problem-1..... car diagnosis  
 specific problem-2: ..... breast cancer

b- [2p] Write the names of two heuristic optimization methods which may be used to solve the Traveling Salesman Problem.

..... Genetic,, Monte-Carlo,  
 ..... Extensive Search (Depth, or Breath)

c- [2p] Explain the genetic algorithm by listing its main components, and why each component is needed? An offspring population of solutions is obtained by Crossover and Mutation operations from the selected members according to a fitness criteria. Crossover combines partial solutions on an offspring member. Mutation generates new and better partial solutions. Selection provides continuation of the best solutions on the offsprings.

2) a- [5p] What is the main difference between the imperative computer languages and the descriptive computer languages regarding where the knowledge is stored, and how the knowledge is processed?

imperative languages keep the knowledge in program code, and apply forward chaining

descriptive languages keep the knowledge as data, and apply backward chaining inference.

b- [5p] Explain what does **the adequateness of data representation** mean, and list the other two main requirements of a good data representation. Adequateness of data representation means the method is suitable for representation for a computerized problem solving. Other main requirements are simplicity and accuracy.

c- [3p] Is the graphical data representation a good data representation format in order to solve optimization problems by AI methods? Why? no, graphical data representation does not satisfy adequateness.

c- [5p] List five of the dynamic data structures commonly used in Knowledge Engineering.

sets, stacks, queues, linked-lists, graphs, frames, schemata, ....

d- [2p] For each tool listed below state the mostly used inference type: forward or backward chaining inference.

Prolog: ..... backward      Simple Artificial Neural Nets: .....forward  
 Production Languages:..... forward      Simple Fuzzy Approximators:..... forward

3) [30p] The following observations are taken by star-rent-a-car on the preference of clients.

age	gender	education	car-type
23	M	U	Sedan
38	M	-	Sedan
25	F	-	Coupe
34	F	U	Coupe
46	M	U	Sedan
42	F	U	Coupe
58	F	U	SUV
64	F	-	SUV

} Y (=young)

Sedan  
 YMU  
 YM~U  
 ~YMU

SUV  
 ~Y~MU  
 ~Y~M~U

Some observations:  
Coupe ~YM~U = x  
 Y~MU (it is not described).  
 Y~M~U ~Y~MU is both Sedan  
 ~Y~MU and Coupe.

where **M** denotes male, **F** is female, **U** is University-graduate.

a) Discretize **age** into two groups, denoting the range of **age < 40** with Y=young, and **age ≥ 40** with ~Y= not young. Construct truth table for preferring Sedan, Coupe and SUV in terms of Y, M, U.

Y	M	U	Sedan
0	0	0	
0	0	1	
0	1	0	x
0	1	1	1
1	0	0	
1	0	1	
1	1	0	1
1	1	1	1

Y	M	U	Coupe
0	0	0	
0	0	1	1a
0	1	0	x
0	1	1	
1	0	0	1
1	0	1	1
1	1	0	
1	1	1	

Y	M	U	SUV
0	0	0	1
0	0	1	1a
0	1	0	x
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

a stands for the ambiguity between coupe and SUV selection.

x stands for the not-available information, which also may mean invalid input combination.

b) Construct three individual Karnaugh Maps for **Sedan**, **Coupe** and **SUV** preference depending on attributes **Y/~Y**, **M/~M**, and **U/~U**.

K-map for Sedan

	~M~U	~MU	MU	M~U
~Y			1	x
Y			1	1

K-map for Coupe

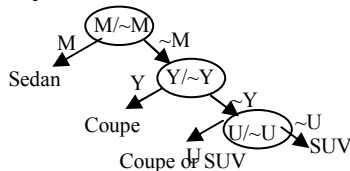
	~M~U	~MU	MU	M~U
~Y		1a		x
Y	1	1		

K-map for SUV

	~M~U	~MU	MU	M~U
~Y	1	1a		x
Y				

c) From K-maps, construct the simplest possible decision trees based on discretized age Y.

Sedan = M; Coupe=Y~M + ~Y~MU SUV=~Y~M  
 M is the most significant attribute since M determines all consequences., Next significant is Y since it appears both in Coupe and SUV, U is the least significant attribute.



d) Your chief engineer claims that choosing **age < 45** to be **Young'** will give a different decision tree. Denote **age < 45** by **Y'**, and construct the K-maps for the attributes **~Y'/Y'**, **~M/M**, and **~U/U**.

K-map for Sedan

	~M~U	~MU	MU	M~U
~Y'			1	x
Y'			1	1

K-map for Coupe

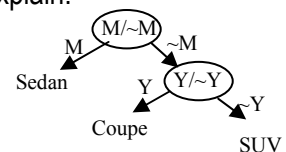
	~M~U	~MU	MU	M~U
~Y'				x
Y'	1	1		

K-map for SUV

	~M~U	~MU	MU	M~U
Y'	1	1		x
~Y'				

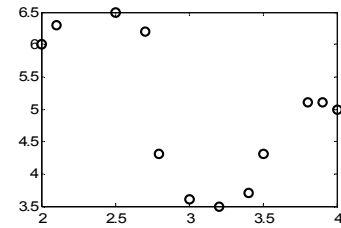
e) Which of the two discretizations (Y or Y') yields a better representation in terms of Knowledge Engineering concepts (i.e., information loss, simplicity, and adequacy). Explain.

Y' gives a simpler representation and also solves the ambiguity between SUV and Coupe. Thus, it is definitely a better representation.



4) [20p] Consider the following data and its plot.

X	2	2.1	2.5	2.7	2.8	3.0	3.2	3.4	3.5	3.8	3.9	4.0
Y	6	6.3	6.5	6.2	4.3	3.6	3.5	3.7	4.3	5.1	5.1	5.0

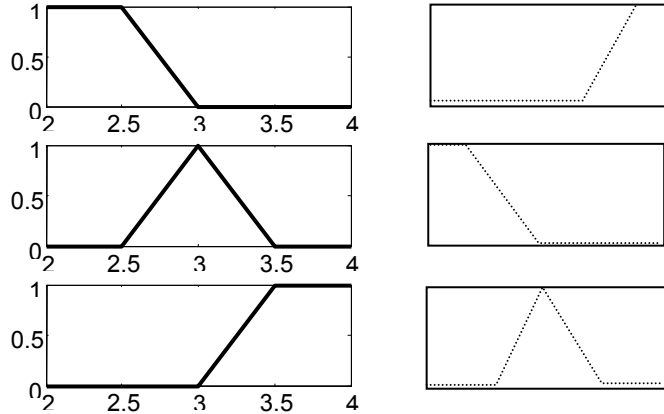
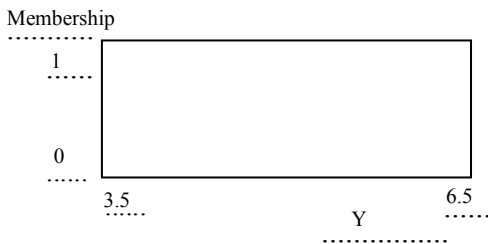


a) [4p] Write the universe of discourse of the X and Y axis.

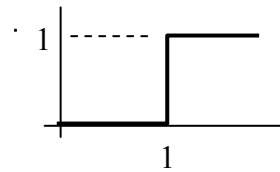
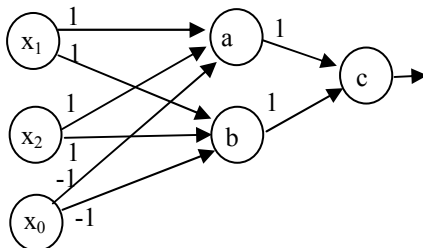
..... from 2 to 4  
 ..... from 3.5 to 6.5

b) [10] For the following fuzzy granulation of X, apply Extension Principle to find the consequent fuzzy sets of the three antecedent fuzzy sets to approximate the function.

c) [6p] Label the axis of the consequent fuzzy sets with proper symbols. Indicate the maximum and minimum of each axis.



5) Consider the following artificial neural net with an activation function shown below.



The binary inputs  $x_1$  and  $x_2$  takes the binary values either 0 or 1, and  $x_0=1$  is biasing the network. Each neuron sums the weighted inputs ( $s = \sum w_i x_i$ ). The neuron outputs 0 if  $s < 1$ , and 1 otherwise.

a) [10] Find the output of the ANN (output of neuron-c) for all four combination of inputs ( $x_1, x_2$ ) and construct its truth table.

$x_0$	$x_1$	$x_2$	$\sum_a w_i x_i$	$O_a$	$\sum_b w_i x_i$	$O_b$	$\sum_c w_i x_i$	$O_c$
1	0	0						0
1	0	1						0
1	1	0						0
1	1	1						1

b) [4p] Is it a well-known boolean function? Identify the implemented function.

The implemented function is ..... AND gate

b) [6p] Write the structure of the neural network

How many layer does it employ? # of layers: .....3

How many intermediate neurons does it employ? # of intermediate neurons: .....2

Type of this ANN is : ..... Binary Multilayer Perceptron Network