Cairo University **Final Exam**
Faculty of Computers & Information **Jan 2007**
Dept of Computer Science **Time 3 hrs**

Soft Computing

Answer ALL Qusetions:

1- Discuss the role of selection, crossover and mutation in genetic algorithms using schema theory.

2- Crossover and mutation are the main operators of a Genetic Algorithm.
a- Differentiate between single-point and multiple-point crossover, on both binary and floating point representations.
b- Show by example- using binary strings- how can a 2-point crossover be carried out.
c- Explain the operation of the mutation operator on both binary and floating point representations.
d- Discuss the mechanics of non-uniform mutation on floating point representation- Apply using the following function:

$$\Delta(t, y) = y.(1 - r^{(1-t/T)})$$

where r is a random number from [0..1].

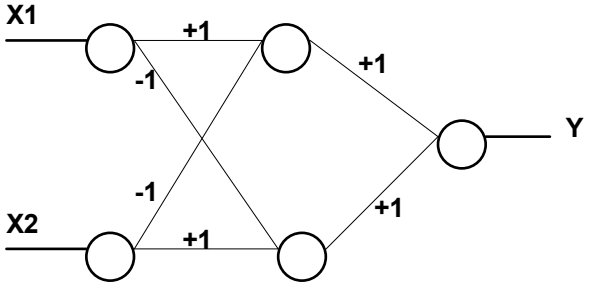
3- What is the total payoff after 10 cycles in the prisoner's dilemma of TIT for TAT (cooperate for cooperate, and defect for defect) playing against:
a- a strategy that always defects
b- a strategy that always cooperates
c- ANTI TIT for TAT (cooperate for defect, and defect for cooperate)
d- a strategy that makes random moves (what is the excpected average payoff?)

4- a- Prove that any string of length m is an instance of 2^m different schemas.
b- Define the fitness f of bit string x with length m = 4, to be the integer represented by the binary number x. (eg. f(0011)=3, f(1111)=15). What is the average fitness of the schema 1*** under f? What is the average fitness of schema 0*** under f?

5- Given a population of PopSize Individuals, which are bit-strings of length L. Let the frequency of allele 1 be 0.3 at position *i*, that is 30% of all individuals contains a 1 and 70% a 0. How does this allele frequency change after performing *k* crossover operations with one-point crossover?

6- Calculate the probability that a binary chromosome with length L will not be changed by applying the usual bit-flip mutation with Pm=1/L.

7- Given the following feedforward neural network with weights,



and applying the following activation function,

$$f(x) = \begin{cases} 1 & x > 0 \\ 0 & x \le 0 \end{cases}$$

Compute the outputs Y for inputs (X1, X2) equal to the following,
(0,0), (0,1), (1,0), (1,1).
What function do you think this network emulates.

8- Given the following exemplars to be encoded in a BAM,
X1 = (101010) Y1 = (1100)
X2 = (111000) Y2 = (1010)
a- Compute the weights matrix M.
b- Recall the output of the BAM when presented with X = (111010). Comment on the result.
c- Recall the output of the BAM when presented with X = (000111). Comment on the result.

9- Construct an autoassociative BAM with the following training vectors:
x1=(100101) and x2=(111000)
Determine the output using x= (111101) and x= (011010). Comment on the result.

10- Differentiate between linear and nonlinear activation functions in the performance of training feedforward neural networks.

11- Design a fuzzy controller with two input variables:
SPEED with range: 0 to 120 and 5 fuzzy sets: Stopped, Very Slow, Slow, Medium Fast and Fast.
And
DISTANCE with range:0 to 2500 and 5 fuzzy sets: At, Very Near, Near, Medium Far and Far.
The output variable is BRAKE with range: 0% to 100% and fuzzy sets: No, Very Slight, Slight, Medium and Full.
The following fuzzy rules govern the actions of the system:
IF SPEED=Very Slow and DISTANCE=At THEN BRAKE = Full.
IF SPEED= Slow and DISTANCE=At THEN BRAKE = Full.
IF SPEED=Very Slow and DISTANCE=Very Near THEN BRAKE = Medium.
IF SPEED= Slow and DISTANCE=Very Near THEN BRAKE = Medium.
Using a Mamdani approach, show how the output is computed.

12- Show how fuzzy rules that model a particular system can be evolved using genetic algorithms. (**Note: This question is bonus**!)