CAIRO UNIVERSITY
INSTITUTE OF STATISTICAL
STUDIES & RESEARCH
JAN 2012
TIME: 3 HOURS

COMPUTER SCIENCE DEPARTMENT
MASTER OF COMPUTER SCIENCES
ARTIFICIAL NEURAL NETWORKS
(CS603)
DR. HESHAM A. HEFNY

ANSWER THE FOLLOWING QUESTIONS

Q1: Explain the following items: (12 points)

a) Neurocomputing is an approach to information processing systems.

b) A multi-layer layer perceptron network can solve the XOR problem while the single layer one can not.

c) There are some problems in the back propagation learning technique.

d) Adaptive Bkp technique may stabilize the convergence mechanism by adjusting the weight-update step.

Q2: A certain perceptron acts as a threshold logic unit (TLU), where $\underline{x} \in \{-1,1\}^3$ and $y \in \{-1,1\}$. The induced local field has the following formula: $v=(x_1-0.5)\ (x_2-0.5)\ (x_3-w)$. Obtain the output Boolean function for the following cases: $w = -1.5, 0, +1.5$. (12 points)

Q3: A certain perceptron has the following formulas:

$$y = \varphi(v) = \frac{1}{L-1}\sum_{k=1}^{L-1}\left(\frac{1}{1+e^{-\beta_k(v-\theta_k)}}\right) \quad , \quad \theta_{k+1} > \theta_k \, , \quad L > 1$$

$$v = \sum_{i=0}^{n} w_i\, x_i$$

3 i- Find the upper and lower bound of $\varphi(v)$.

10 ii- Derive the updating equations for the weights w_i, the slopes β_k, and the thresholds θ_k using the delta rule learning technique.

3 iii- Sketch the above activation function and show if it has any advantages over the classical logistic one (assume the cases of L=2, 3, 4). (16 points)

Q4: Four perceptrons units are connected as shown in figure (1). Assuming backpropagation learning technique and sigmoid activation functions, write down the weights updating

equations at each unit. (assume the biases connections). (15 points)

Q5: Assume two circles centered as shown in figure (2). The first circle has its center at point (6,4) with radius r_1=2. The second circle is centered at point (3,4) with radius r_2=1. Use a perceptron with a logistic activation function and an induced local field of the form $v = \sum_{i=1}^{n}(x_i - w_i)^2 - \theta$, to design a two-layer perceptron network that generates +1 for points located in the dashed area, otherwise it generates 0. (15 points)

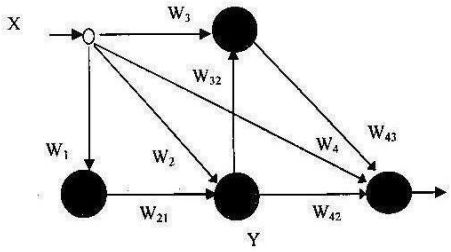

Figure (1)

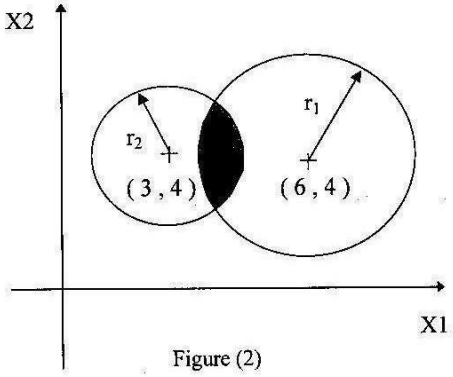

Figure (2)

Cairo University	Cairo University – Institute Of Statistical Studies And Researches	Cairo University Institute of Statistical Studies & Research
	Department: Computer Sciences	
	Academic Year: 2015/2016 Semester: 2nd	
	Date: 31/5/2016 Level: Master	

Course Title:	Course code:	Time:	Exam marks:	# Exam. Sheets:
Artificial Neural Networks	CS603	3 Hours	100	2

Exam. Instructions : Answer The Following Questions

Q1: Explain the following items: (16 points)

a) The main limitation of the perceptron model

b) The differences between perceptron learning technique and delta rule learning one.

c) The main problems of the back propagation learning technique.

d) Improving the convergence speed of back propagation learning technique.

Q2: A certain perceptron acts as a threshold logic unit (TLU), where $\underline{X} \in \{-1,1\}^3$ and $y \in \{-1,1\}$. The induced local field has the following formula: $v=(x_1-0.5)(x_2-w)(x_3-0.5)$. Obtain the output Boolean function for the following cases: $w = -1.5, 0, +1.5$.

(18 points)

Q3: The multilayer perceptron network shown in figure(1) consists of only two perceptrons. The perceptrons are illustrated as threshold logic units (TLU). This network can solve the XOR-problem. Derive the Boolean function for each node and show how the network output is exactly the XOR Boolean function. (10 points)

Q4: Write down the weights updating equations at each unit of a multilayer perceptron network with a structure of 2-1-2-1 assuming back propagation learning technique and logistic activation functions. (assume totally layered network). (20 points)

Q5: Derive the updating equations for the parameters β, c_i, and σ_i of a single perceptron using the delta rule learning technique. The used perceptron is governed by the following equations:

$$E=[1\ -e^{-(d-y)^2}],$$

$$y=\Phi(v)=\frac{1}{1+e^{-\beta v}}$$

$$v=\sum_{i=1}^{n}\left(\frac{x_i-c_i}{\sigma_i}\right)^2-1$$

(20 points)

Q6: Assume two circles centered as shown in figure (2). The first circle has its center at point (6,4) with radius r1=2. The second circle is centered at point (3,4) with radius r2=1. Use a perceptron with a logistic activation function and an induced local field of the form $v=\sum_{i=1}^{n}(x_i-w_i)^2-\theta$, to design a two-layer perceptron network that generates +1 for points located in the dashed area, otherwise it generates 0.

(16 points)

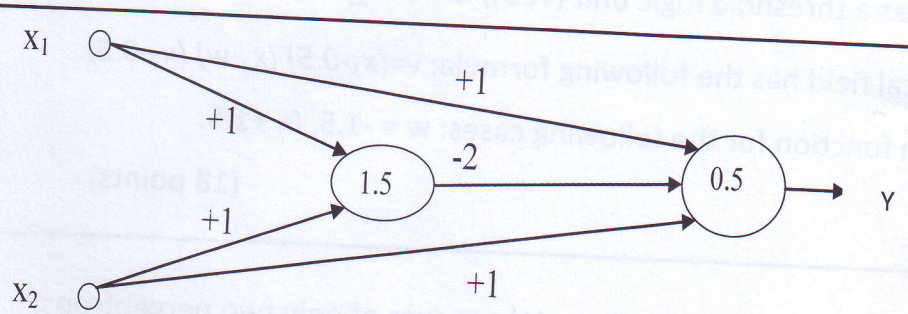

Figure (1)

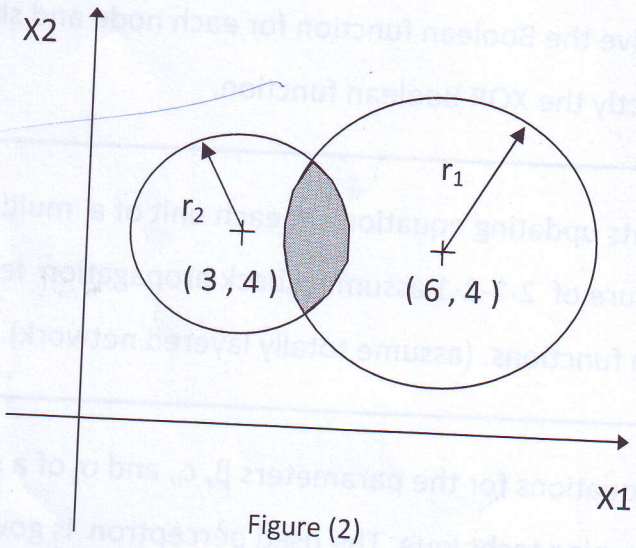

Figure (2)

Best Wishes **Prof./ Hesham A. Hefny**

Cairo University	Cairo University – Institute Of Statistical Studies And Researches	
	Department: Computer Sciences	
	Academic Year: 2016/2017 Semester: 1st	
	Date: 12/1/2017 Level: Master	

Course Title:	Course code:	Time:	Exam marks:	# Exam. Sheets:
Artificial Neural Networks	CS603	3 Hours	75	2

Exam. Instructions: Answer The Following Questions

Q1: Discuss the following items: (16 points)

a) Single layer perceptron network can not solve the XOR problem while the multiplayer perceptron network can solve it.

b) The differences between perceptron learning technique and delta rule learning one.

c) There are some problems with the back propagation learning technique.

d) Both of Adaptive back propagation and Quick propagation can be used to improve the convergence speed of back propagation learning technique.

Q2: Consider the following three-class problem in a 2-dimensional logic space $\{0, 1\}^2$: $C_1 = \{(0,0)\}$, $C_2 = \{(0,1)\}$, and $C_3 = \{(1,1)\}$. It is required to compute the switching functions of three Threshold Logic Units (TLUs) that linearly classifies the above logical points using the perceptron learning algorithms with the help of Kessler construction method. Use a unity learning parameter and assume the initial weight vector (Apply the perceptron learning for only one iteration) (16 points)

Q3: a- Find the minimum of the following error function:

$$E(\underline{w}) = \frac{1}{2}[(w_2 - w_1)^2 + (w_3 - w_2)^2 + (1 - w_1)^2]$$ (4 points)

b- Derive the updating equations for the design parameters α, β, w_i and b_i of a single perceptron using the delta rule learning technique. The used perceptron is governed by the following equations (try to simplify the output formulas):

$$E = tanh^2(\alpha\, k) \quad , \quad k = (d - y)$$

$$y = tanh(\beta\, v)$$

$$v = \prod_{i=1}^{n}(w_i\, x_i + b_i)$$ (12 points)

Q4: Six perceptrons units are connected as shown in figure (1). Assuming backpropagation learning technique and logistic activation functions, write down the weights updating equations at each unit. (Assume the biases connections). (16 points)

Q5: Assuming four circles as shown in figure (1), where $r_1=4$, $r_2=r_3=r_4=1$. Use perceptrons with a logistic activation function and an induced local field of the form $v = \sum_{i=1}^{n}(x_i - w_i)^2 - \theta$, to design a two-layer perceptron network that generates +1 for points located in the dashed area, otherwise it generates 0 (16 points)

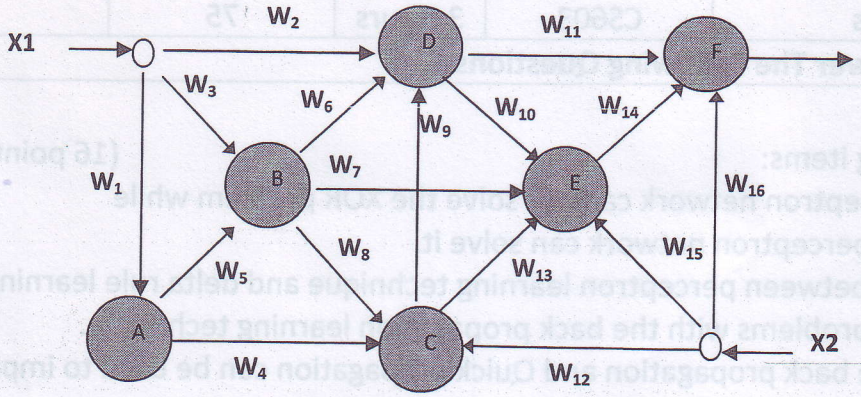

Figure (1)

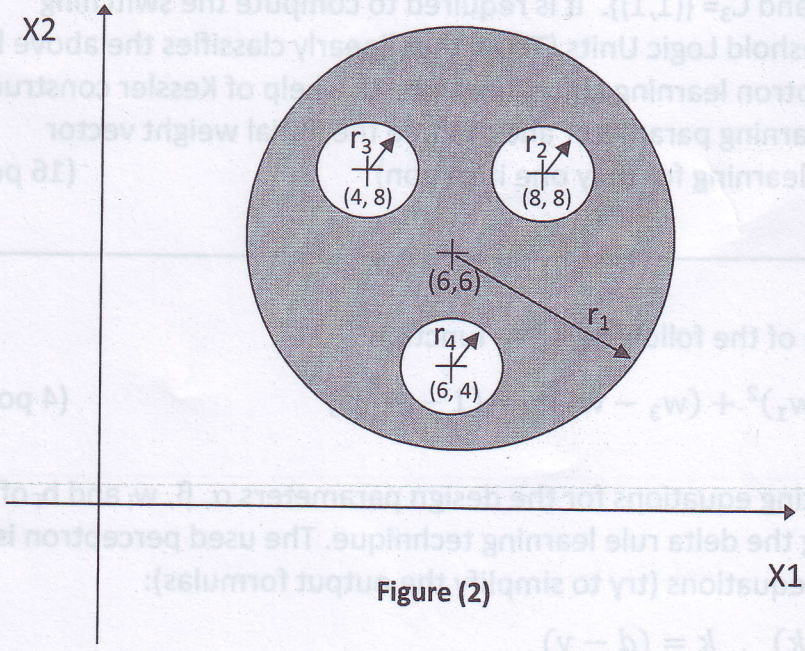

Figure (2)

Best Wishes **Prof./ Hesham A. Hefny**