FINAL EXAM
SECOND SEMESTER SESSION 2011/2012

COURSE CODE / NAME : STIN2053 NEURAL NETWORKS
DATE : 18 JUNE 2012 (MONDAY)
TIME : 9.00 A.M. – 11.30 A.M. (2 ½ HOURS)
VENUE : BK3 (FWB)

INSTRUCTION :
1. This question booklet contains FOURTEEN (14) QUESTIONS in SECTION A and FOUR (4) QUESTIONS in SECTION B in SIXTEEN (16) printed pages excluding the cover page.
2. Answer ALL questions in the answer sheet provided.
3. You are NOT ALLOWED to remove the exam paper from the examination hall.

MATRIC NO : ____________________________________ ( with word )

IDENTIFICATION CARD NO. :

LECTURER : DR. SHAHRUL AZMI BIN MOHD YUSOF

GROUP : A TABLE NO. : ____________

DO NOT OPEN THIS EXAMINATION PAPER UNTIL INSTRUCTED

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STIN2053 Neural Networks

SECTION A (45 MARKS)

1. Explain
   a) Draw a model of biological neuron. (1 mark)

   b) Draw a model of Artificial Neural Network. (1 mark)

   c) State TWO (2) differences between both models. (2 marks)
2. Explain **TWO (2)** characteristics of Neural Networks and give **ONE (1)** example for each characteristic explained.

(3 marks)

<table>
<thead>
<tr>
<th>No</th>
<th>Characteristic</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Explain about the functions of connection weight and bias.

(2 marks)
4. Momentum and learning rate are two major learning parameters used to control the training process of the Backpropagation network. Both parameters usually produce the most impact on the neural network training time and performance.

   a) Explain **ONE (1)** specific usage of momentum. **(1 mark)**

   b) Explain **ONE (1)** specific usage of learning rate. **(1 mark)**

5. State **ONE (1)** similarity and **TWO (2)** differences between the *Hebb* model and *Perceptron* model.

   a) Similarity. **(1 mark)**

   b) Difference 1. **(1 mark)**

   c) Difference 2. **(1 mark)**
6. Give **TWO (2)** differences between the *Perceptron* network and the *Multi Layer Perceptron* network.
   a) Difference 1. (1 mark)
   b) Difference 2. (1 mark)

7. Why is the *Single Layer Perceptron* not capable of solving the XOR problem? (2 marks)

8. Data cleaning is one of the steps in data preprocessing. List **THREE (3)** methods of data cleaning.
   a) Method 1: (1 mark)
   b) Method 2: (1 mark)
   c) Method 3: (1 mark)
9. For the purpose of developing a thumb print recognition system for the staff in the College of Arts and Sciences, an IT officer has developed the following *Multi Layer Perceptron (MLP)* network architecture:

![Diagram of MLP network](image)

**Input Layer**  **Hidden Layer**  **Output Layer**

a. There are FOUR (4) mistakes in the provided architecture. Identify **ALL** the mistakes by highlighting them in the architecture with labels M1, M2, M3 and M4. Please provide relevant explanations for the mistakes.

(6 marks)

<table>
<thead>
<tr>
<th>Mistakes</th>
<th>Explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td></td>
</tr>
<tr>
<td>M2</td>
<td></td>
</tr>
<tr>
<td>M3</td>
<td></td>
</tr>
<tr>
<td>M4</td>
<td></td>
</tr>
</tbody>
</table>
b. Based on your answer in 9 (a), redraw the refined architecture of the MLP for the system.

(2 marks)

10. There are several ways to terminate the learning process in the Backpropagation algorithm. State TWO (2) of them.

(1 mark)

11. Before you model the data, you need to study the distribution of the raw data. Please explain why this step is important.

(3 marks)
12. Raw data need to be normalized before we can use them in any neural network applications.
   a) What is the purpose of data normalization? (2 marks)

   b) Give ONE (1) technique of data normalization. (1 mark)

13. Explain TWO (2) methods that can be used to determine the winning unit in the Kohonen algorithm. Show the equations used. (4 marks)
14. Explain how you can build a better classifier by combining Particle Swarm Optimization and Neural Networks. (5 marks)
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SECTION B (55 MARKS)

1. Below is a part of the Perceptron training for leaves classification system from the University of Nottingham, United Kingdom database.
(Given threshold, threshold, θ = 0.2, learning rate, α = 0.5)

<table>
<thead>
<tr>
<th>Input</th>
<th>Net (Y)</th>
<th>Out</th>
<th>t</th>
<th>Weight Changes</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y_{in}</td>
<td>Y</td>
<td>t</td>
<td>Δw_1 Δw_2 Δw_0</td>
<td>w_1 w_2 b</td>
</tr>
<tr>
<td>X_1</td>
<td>X_2</td>
<td>b</td>
<td></td>
<td>Δw_1 Δw_2 Δw_0</td>
<td>w_1 w_2 b</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-1</td>
<td>1 1 1</td>
<td>2 3 -3</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>-1</td>
<td>0 0 0</td>
<td>2 3 -3</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0 -1 -1</td>
<td>2 2 -4</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>-4</td>
<td>0 0 0</td>
<td>2 2 -4</td>
</tr>
</tbody>
</table>

Based on the above table, answer these questions:

a) Continue the above learning process for ONE (1) epoch.

(5 marks)
b) Based on your answer in Section B Question 1 (a), draw the linear separability for the system. Show your calculation. (3 marks)

c) What can be concluded from your answers in Section B Question 1 (a) and (b)? (2 marks)
2. Given below is a *Multi Layer Perceptron* network that uses Backpropagation algorithm for data training, with target value, $t = 0.5$ and learning rate, $\alpha = 0.2$.

Based on the above figure, answer these questions based on first epoch:

a) For the feedforward phase, state the value for $Z_1$, $Z_2$ and $Y_1$. Show your calculation.  

(6 marks)
b) Give the error value for the output unit \( \delta_k \). Show your calculation. (3 marks)

c) Calculate the weight changes for each weight \([w]\). Show your calculation. (3 marks)

d) Show the calculation to get the error values for \( Z_1 (\delta_{I1}) \) and \( Z_2 (\delta_{I2}) \). (6 marks)
e) Calculate the weight changes for each weight \([v]\). Show your calculation  
(3 marks)

f) Update the weights for 

i. \(v_{ij}\)  
(3 marks)
3. Consider the following Kohonen Map model:

\[ W_{ij} \]

\[ [W_{ij}] = \begin{pmatrix}
0.1 & 0.3 & 0.5 & 0.7 & 0.9 & 0.2 & 0.4 & 0.6 \\
0.2 & 0.4 & 0.6 & 0.8 & 0.1 & 0.3 & 0.5 & 0.7
\end{pmatrix} \]

Based on the given Kohonen Map above, answer these questions based on first epoch:
a) By using the Euclidean Distance approach, determine the winning unit for the given Kohonen Map model. Show your calculation. (8 marks)

b) Calculate and update the new weights for the winning unit determined in Question 3 (a) (4 marks)
You are asked to build a prediction model using the data from the table below by a local hospital to predict high possibility of heart attacks in patients. After you have observed the data, you have some difficulties in building a good and accurate model. Please explain your difficulties and your recommendations in order to get a good prediction model.

<table>
<thead>
<tr>
<th>ID</th>
<th>Age</th>
<th>Gender</th>
<th>Sugar</th>
<th>Hypertension</th>
<th>Heart Attack</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>53</td>
<td>man</td>
<td>8 mg</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>456</td>
<td>23</td>
<td>woman</td>
<td>4 mg</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>453</td>
<td>78</td>
<td>man</td>
<td>9 mg</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>226</td>
<td>12</td>
<td>man</td>
<td>13 mg</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>194</td>
<td>15</td>
<td>woman</td>
<td>16 mg</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>112</td>
<td>17</td>
<td>woman</td>
<td>13 mg</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>122</td>
<td>22</td>
<td>woman</td>
<td>7 mg</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>789</td>
<td>66</td>
<td>man</td>
<td>8 mg</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>