Manarat International University (MIU)

Department of Computer Science and Engineering
Mid-term Examination (Fall 2019)
Neural Network and Fuzzy Systems(CSE-433)

Full Marks: 20 Time: 1.5 Hour

Answer any 4 (Four) questions. All questions are of equal value.

1 Show the gradient of the loss function at k^{th} layer of hidden layer activation is 5

$$\nabla_{h^{(k)}(\mathbf{x})} - \log f(\mathbf{x})_{\mathbf{y}} = \mathbf{W}^{(\mathbf{k+1})^{\mathbf{T}}} (\nabla_{\mathbf{a}^{(\mathbf{k+1})}(\mathbf{x})} - \log \mathbf{f}(\mathbf{x})_{\mathbf{y}})$$

Where

$\mathbf{a}^{(k+1)}(\mathbf{x})$ is the preactivation of the $(k+1)^{th}$ hidden layer

$-\log \mathbf{f}(\mathbf{x})_y$ Negative log-likelihood loss of the $\mathbf{x}$ input vector in y^{th} class

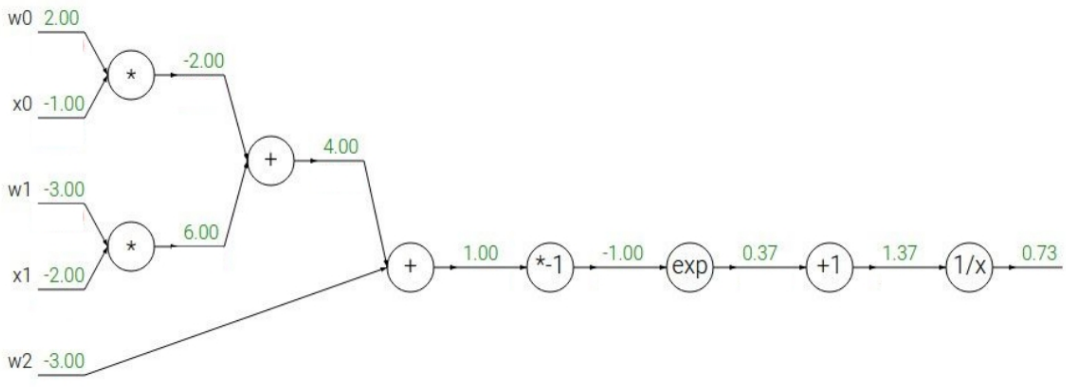
2 a. How **Multilayer Perceptron** network solves XOR problem. 2+2+1

b. Explain different types of **activation functions** in NN.

c. Find the derivative of a sigmoid activation function.

3 a. Fill in the missing gradients underneath the forward pass activations in the following computational graph. 5

$$f(\mathbf{w}, \mathbf{x}) = \frac{\mathbf{1}}{\mathbf{1} + \exp^{-(\mathbf{w_0 x_0} + \mathbf{w_1 x_1} + \mathbf{w_2})}}$$



4 a. Why training a neural network is considered as a optimization problem? 2+2+1

b. Explain Newtons second order optimization method for neural network.

c. What is **L1** and **L2** regularization in machine learning ?

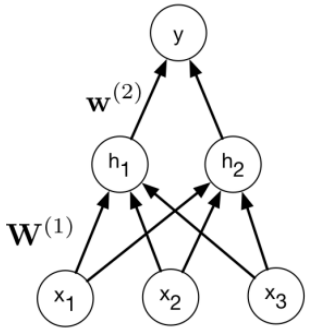
5 a. Riadul Islam designs a multi-layer perceptron which receives three binary-valued (i.e. 0 or 1) inputs x_1, x_2, x_3, and outputs 1 if exactly two of the inputs are 1, and outputs 0 otherwise. He uses following activation function for all of the units. 5

$$\mathbf{W}^{(1)} = \underbrace{\left(\qquad\qquad\right)}_{2\times 3 \text{ matrix}}$$

$$\mathbf{b}^{(1)} = \left(\qquad\qquad\right)$$

$$\mathbf{w}^{(2)} = \left(\qquad\qquad\right)$$

$$b^{(2)} =$$



$$z = \begin{cases} 1 & \text{if } z \geq 0 \\ 0 & \text{if } z < 0 \end{cases}$$

Now, specify weights and biases which correctly implement his network.

Note: You do not need to explain your solution.

Hint: One of the hidden units should activate if 2 or more inputs are on, and the other should activate if all of the inputs are on.