National University
of Computer & Emerging Sciences-Islamabad
Chiniot-Faisalabad Campus

Dr. Hashim Yasin
Department of Computer Science.

# CS4104 – Applied Machine Learning
# Assignment No. 4

**Instructions:**

1. Submit your assignment in **soft** as well as in **hard form (Report)** within the due date and time. Soft form does **not** mean the photos of the hard copy. Late submission will result in a deduction of marks.
2. Report should necessarily contain the discussion, comments, and conclusion about the solution. Without a report, you will not get full marks.
3. Mention your names and roll numbers clearly on your document.
4. Name your zip or other folder/file that you want to submit according to the following format: **AML_A4_RollNo_FirstName**
5. Try to solve each task of the assignment on your own.
6. No excuse or resubmission is permissible.
7. Do your assignment in a group of a maximum of two members.
8. There is no restriction of the language for the programming tasks.
9. **In programming tasks, you are NOT allowed to use any built-in function of any library for specific tasks.**

---

## Question No. 1: Artificial Neural Network (Backpropagation)

**(a)** Consider the Boolean function given below where $\mathbf{X_1}$, $\mathbf{X_2}$, $\mathbf{X_3}$, $\mathbf{X_4}$, and $\mathbf{X_5}$ are the attributes and **Y** is the class variable. Your task is to construct the architecture of the neural network and implement it for that Boolean function.

**(b)** Justify your architecture of the neural network in task (a), e.g., number of hidden layers, the number of neurons within hidden layers, etc.

| $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | Y |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 0 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 1 |
| 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 |

**(c)** In the above-mentioned task (a), apply different activation functions like (sigmoid, tanh, ReLU and its variant, Softmax) in the hidden layers and the output layer. At which combinations of activation functions, the accuracy is the highest. Justify your answer.

**Question No. 2: CNN**

There are two folders: a training set and a test set, you are supposed to train a classifier on the training set and test it on the test set. The training set has 225 images with 15 classes, while the test set has 150 images with the same 15 classes. Your task is to perform the following,

**a)** Design your own architecture and apply it directly to images without doing any pre-processing. Justify every step of your architecture.

**b)** Apply any two already developed convolutional neural networks like LeNet-5, AlexNet, VGG-16, etc.

**c)** Compare the accuracy of your architecture in part (a) with the accuracies of the other two implemented CNN models in part (b) and discuss it in detail.