CS454-554 Homework 3: Single-and Multi-Layer Perceptrons for Binary Classification
Fall 2022/2023

In this homework, you will implement single- and multi-layer perceptrons for binary classification. As usual, you are provided with two dataset files and **train.csv** file will be used for training and **test.csv** file will be used for testing. Each row of the files corresponds to one input instance and its desired output. Each input is two-dimensional and there are two classes. You have 200 instances for training and 200 instances for testing.

You should implement the back-propagation algorithm (without using any machine-learning library (such as PyTorch, Scikit-learn, and so on) to train the following four networks:

a) Single-layer perceptron
b) Multi-layer perceptron with one hidden layer of 2 hidden units,
c) Multi-layer perceptron with one hidden layer of 4 hidden units,
d) Multi-layer perceptron with one hidden layer of 8 hidden units.

You will have to do some trial-and-error to adjust the number of epochs and the learning rate. Don't forget to include the bias nodes in the input layer and the hidden layer! You can implement online, minibatch, or batch learning.

Your output and report should contain:

a) Four figures for each network's output after convergence, plotted together with the training data. The output of the network should be shown as a contour plot in the two-dimensional input space.
b) A figure of learning epochs vs error. The *y* axis should correspond to the binary cross-entropy and the *x* axis corresponds to epochs. You can have different figures for each network or have one figure with four plots.
c) A figure of network complexity vs error. The *y* axis should correspond to the training/test binary cross-entropy where the *x* axis corresponds the number of hidden units, with *x*=0 for the single-layer perceptron.

As in the previous homework, you can use pandas for **loading the data** and the numpy array as a **data structure** but you are not allowed to use pandas or numpy functions for calculations (np.dot, etc).

This homework is due **December 14th (Thursday), 23:00**.
Your submission should include a short report of your findings, the plots, and your source code.
Upload your report **as a pdf file** to LMS alongside your .py/.m code file.