CMPE 442 Assignment #3

Due Thursday, May 14.

Note: The assignment is to be done individually. You are going to submit the report and code separately. Prepare separate code files for each question. Please do not include codes in the report. Your report should be self-contained, i.e. explain what you are doing, put the resulting graphs, the hyperparameters that you use, and write your observations. Do not write more than 4 pages!!! I will read only first 4 pages.

In this assignment you are going to implement a neural network with one hidden layer. First, you will implement a NeuralNetwork class and later on use that network to learn AND and XOR logic functions.

1) **[60 pts]** Implement a NeuralNetwork class according to the template that is provided to you (NN_template.ipynb). In this template you will find a class NeuralNetwork with a constructor and 4 methods. Some of the methods are partially filled. Feel free to add you own code where you think appropriate.
    a) **[20pts]** Fill the feedforward() method
    b) **[30pts]** Fill the backprop() method. Ignore the regularization part in the algorithm given in slides (i.e. λ=0).
    c) **[10pts]** Add a code that computes the error function after every 100 iteration in fit() method. The error is computed as the sum-of-squares difference between the network outputs and the targets.

2) **[20 pts]** Learn AND function with two variables using the implemented NN. Default number of units in the hidden layer is 2 (sl2=2).
    a. **[8pts]** Try different learning rates and iterations until the function is learnt. Report the final iteration number and learning rate. Report on the final predictions for all possible of inputs.
    b. **[6pts]** Plot the error as a function of number of iterations. Pick the hyperparameters you fixed in (a).
    c. **[8pts]** Try different values for $sl2 = 2, 3, 4, 5$, fixing iterations and learning rate hyperparameter and report on the effect of the number of units on the prediction. The learning rate should be fixed to the one that you selected as final in (a). To see the effect keep number of iterations small (ex. half of the one you fixed in (a)).
3) **[20 pts]** Learn XOR function with two variables using the implemented NN. Repeat all items in (2) (a, b, c) for XOR function.