

## ECE 492-45 Homework 10

### Material Covered: Python Basics, Neural Network

**Problem 1** (20 points) [Python Basics] Python is a popular programming language used by the machine learning community. In this problem, you will go through a Python tutorial to quickly learn its syntax in order to work on subsequent neural network problems. Note that this process is very different from learning a programming language for the first time: you learn it by focusing on the special syntax that the “baseline” programming language you are good at does not have. Limit the time spend on this problem to one hour.

In this assignment, we will use Google Colab to execute Python code. An introduction on how to get started with the Colab environment can be found [here](#). After opening the above link in your browser, click “Copy to Drive” to play the code in your own Google Drive. [If you prefer to run Python code locally, you need to take some time to set up the Python and an editor or integrated development environment (IDE).] Below is [a quick tutorial](#) on using Python that includes examples on using common Python libraries such as numpy and matplotlib. (If you feel like to learn from another Python tutorial, feel free to follow that tutorial.) While going over the tutorial, you should note the following unique features in Python:

- Syntax wise: no “end” or “}”; use indent.
- List/set comprehension
- Built-in data structures such as list and dictionary
- The absence of ++, --, &&, || operators
- range() function
- Exponentiation operator

*What to submit:* A self-designed Python coding cheat sheet of no more than 1 page that is tailored to yourself.

**Problem 2** (20 points) [Simple Neural Network for Data with Nonlinear Decision Boundaries] You are going to play with the code of a simple neural network that does binary classification. Open the Colab notebook file [HW10-2.ipynb](#) using Google Drive. Quickly scan through the whole

document to get a high-level idea, and then sequentially run the code blocks by clicking the play button on the top left corner of each code block. Answer the following questions:

1. How is the structure of this classifier different from a logistic regression classifier?
2. Draw three convergence curves in one plot for  $\text{learning\_rate} = 10^{-3}$ ,  $10^{-4}$ , and  $10^{-5}$ . The  $x$ -axis should be the iteration number and the  $y$ -axis should be the loss/training error. For smaller learning rates/step size, you may want to increase `num_of_iter` to allow the curve to flatten out.

**Problem 3** (20 points) [Neural Network for Classifying Digits] Open the Colab notebook file [HW10-3.ipynb](#) using Google Drive. Quickly scan through the whole document to get a high-level idea, and then sequentially run the code blocks by clicking the play button on the top left corner of each code block. Examine how the following factors affect the convergence rate and test accuracy:

1. Learning rate
2. Number of epochs
3. Batch size
4. Number of hidden units

In your opinion, what is the best combination of the parameters that leads to a reasonable tradeoff between accuracy and convergence time? To speed up the computation, go to Edit → Notebook settings and select GPU as the hardware accelerator.