Programming Assignment

Submission Guidelines:

- Download the file `skeleton_perceptron.py` from Moodle. In each of the following questions you should only implement the algorithm at each of the skeleton files. Plots, tables and any other artifact should be submitted with the theoretical section.
- In the file `skeleton_perceptron.py` there is an helper function. The function reads the examples labelled 0, 8 and returns them with 0-1 labels. If you are unable to read the MNIST data with the provided script, you can download the file from here: `https://github.com/amplab/datasciencesp14/blob/master/lab7/mldata/mnist-original.mat`.
- Your code should be written with Python 3.
- Make sure to comment out / remove any code which halts the code execution, such as matplotlib popup.
- Your submission should include exactly one file: `perceptron.py`.

1. **(20 points) Perceptron.** Implement the Perceptron algorithm (in the file name `perceptron.py`). Do not forget to normalize the samples to have unit length (i.e., $\|x_i\| = 1$).

   (a) **(8 points)** Use only the first $n = 5, 10, 50, 100, 500, 1000, 5000$ samples as an input to Perceptron. For each n, run Perceptron 100 times, each time with a different random order of inputs, and calculate the accuracy of the classifier on the test set of each run. You should therefore have 100 accuracy measurement per n. Print a table showing, for each n, the mean accuracy across the 100 runs, as well as the 5% and 95% percentiles of the accuracies obtained.

   (b) **(4 points)** The weight vector w, returned by Percepton, can be viewed as a matrix of weights, with which we multiply each respective pixel in the input image. Run Perceptron on the entire training set, and show w, as a 28×28 image, for example with `imshow(reshape(image, (28, 28)), interpolation='nearest')`. Give an intuitive interpretation of this image.

   (c) **(4 points)** Calculate the accuracy of the classifier trained on the full training set, applied on the test set.

   (d) **(4 points)** Choose one (or two) of the samples in the test set that was misclassified by Perceptron (with the full training set) and show it as an image (show the unscaled images). Can you explain why it was misclassified?