Assignment 4

This assignment may be completed individually or in groups of 2 or 3.
You are recommended to use your project groups. If you are in a group, **one student** will submit all necessary files and the **other student(s) will submit a text file** specifying members of the group and who is submitting. The report must have **all students' names and IDs**.

In this assignment, you will develop implementations for self-organizing maps and Hopfield neural networks for the handwritten digit recognition problem.

Description

You may use any and all functionalities found in `scikit-learn` and `tensorflow`. You may find K-means on MNIST useful too.

Note

In any K-fold experimentation performed ensure that you document mean and standard deviation of performance measures obtained (e.g., accuracy).

Question 1

[30 marks]

Using the `scikit-learn` utilities to load the MNIST data, implement a Hopfield network that can classify the image data for a subset of the handwritten digits. Subsample the data to only include images of '1' and '5'. Here, correct classification means that if we present an image of a '1' an image of a '1' will be recovered; however, it may not be the original image owing to the degenerate property of this type of network. You are expected to document classification accuracy as a function of the number of images used to train the network. Remember, a Hopfield network can only store approximately 0.15N patterns with the "one shot" learning described in Lecture 13.

Question 2

[30 marks]

Develop a feed forward RBF neural network in python that classifies the complete set of images found in the MNIST dataset. You are to train your neural network using backpropagation. You should use gaussian functions as your radial basis functions. You must show that you have:

1. Used K-means to design the hidden layer in your network. You may use any existing code for running K-means (you do not need to code your own), but you must cite your sources in the report.
2. Performed K-fold cross correlation.
3. Investigated the performance of your neural network for different sizes of hidden layer.

4. Investigated the performance of your neural network when using dropout in the hidden layer. A paper on dropout is here.

Question 3

[30 marks]

We can use self organizing maps as a substitute for K-means.

In Question 2, K-means was used to compute the number of hidden layer neurons to be used in an RBF network. Using a 2D self-organizing map compare the clusters when compared to K-means for the MNIST data. Sample the data to include only images of '1' and '5'. Use the `scikit-learn` utilities to load the data. You are expected to (a) document the dimensions of the SOM computed and the learning parameters used to generate it (b) provide 2D plots of the regions for '1' and '5' for both the SOM and K-means solutions. You may project your K-means data using SVD to 2 dimensions for display purposes.