**Machine Learning**

MET CS767

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**(5 points) Question 1**

Read Keras.io and list five important facts that you learn about Keras API. Add reference to the document that you used to identify each important fact.

Post them on Blackboard under discussion tab.

**(20 points) Question 2**

Design an MLP – Multilayer Perceptron neural network using Keras sequential API to classify MNIST fashion dataset.

1. The input is MNIST fashion database, which is part of Keras.

Load the data as follows:

* 1. fashion\_mnist = keras.datasets.fashion\_mnist
  2. (X\_train\_full, Y\_train\_full), (X\_test, Y\_test) = fashion\_mnist.load\_data()
  3. class\_names = ["T-shirt/top", "Trouser", "pullover", "Dress", "Coat",

"Sandal", "Shirt", "Sneaker", "Bag", "Ankle\_boot"]

1. Put aside 10% of the samples for validation
2. Add comments to the code to make it clear

Questions:

1. Implement the best MLP neural network with following options. Provide the best set of parameters () , train your model with the best set of parameters, and plot the learning curve (error of training and test set as a function of epochs) (5 points)
   1. Normalize the data using min-max method
   2. Optimizer – Nesterov, Adam and RMSProp.
   3. Activation function: ReLU
   4. Learning rate between 0.001 and 0.1
   5. Number of hidden layers: 1, 3 and 5.
   6. Number of neurons between 50 and 500.

**(15 points) Question 3**

1. Find the best model for the question 2 which gives you the best performance in ten epochs using random search. (10 points)

Bonus point: Top 5 performances will get an extra 5 points. (5 points)

**(30 points) Question 3**

Train a DNN on MNIST data set (hand written number from 0 to 9)

* + The network consists of three hidden layers
  + Each hidden layer has 100 neurons
  + Use ELU activation function.
  + Use early stopping
  + Train your model ONLY with digits 0 to 4. NOTE: input is ONLY digits 0 to 4. Therefore, the output layer will be a Softmax layer with five neurons.

Questions:

* + 1. For the parameters that are not mentioned, choose the best set of parameters to get the best performance. For example, choose the best learning rate and optimization.
    2. Save checkpoints at the end of each Epoch, save the final model, and also the best model.
    3. Adjust See what precision you can achieve with different parameters.
    4. Is the model overfitting the training set?

**(30 points) Question 4**

1. Use the model in the previous question
   * The inputs are only digits 0 to 4.
   * Split data (80%, 20%) for training and testing, respectively.
   * Train the model for 10 Epochs.

Save the weights using following command:

yourModel.save\_weights("yourKerasWeights.ckpt")

1. Use the exact model as in the previous question.
   * This time the inputs are ONLY digits 5 to 9
   * Transfer the weights from part (a)
   * Use ONLY 100 images per digit as the training set.
   * Split data (80%, 20%) for training and testing, respectively.

Questions:

1. How much time does it take to train the model in part a
2. How much time does it take to train the model in part (b) for 2 Epochs.
3. Report the accuracy of part (b) after 2 Epochs.
4. How much time does it take to train the model in part (b) for 20 Epochs.
5. What is the accuracy of the model (b) after 10 Epochs?
6. Plot training and testing set accuracy for part (a) and part (b) for 20 Epochs.

**Submission:**

* You must work on your assignments individually. You are not allowed to copy the answers from the others.
* Each assignment has a strict deadline.
* When the term *lastName* is referenced, please replace it with your last name. Create files with preface **CS767\_HW5\_lastName**. Clearly mark each subpart of each question.  Provide the corresponding code and outputs from the code in a single Word document, CS767\_HW5\_lastName.doc.