February-June 2023 Semester
CS671: Deep Learning and Application
Programming Assignment 6

Date: May 01, 2023
Deadline for submission of code and report: **Sunday, May 14, 2023, 10:00 PM**

The objective of this programming assignment is to deepen your understanding of the **recurrent neural network (RNN)** and its variant, **long short-term memory (LSTM)**. The major task includes building a RNN for classification of sequential data.

The details of the datasets given are as follows:
1. **Handwritten character dataset**: This dataset consists of subset of handwritten characters from Kannada/Telugu script. Each character is seen as sequence of 2-dimensional points (*x* and *y* coordinates) of one stroke of character (pen down to pen up). Each group is given the data of 5 characters (5-class data). **Each group should refer to the `Mapping.txt` to know the character classes assigned to them.** Training and test data are separated and are provided inside the respective character folder. Test data is given in **dev** folder. Each data file is considered as one sample. Each file includes an array of elements. The numbers in each file should be read as follows:
    a. First element indicates the number of 2-d sequential points in that file.
    b. Second element onwards correspond to the 2-d sequential data points. They need to be considered in pairs as follows: first 2 numbers (i.e., 2nd and 3rd elements) are corresponding to first sequential point, next 2 numbers (i.e., 4th and 5th elements) are corresponding to second sequential point and so on.
    In order to ensure that all the characters are in same scale, *x* and *y* coordinates in each file should be normalized to the range of 0 to 1.

2. **Consonant Vowel (CV) segment dataset**: This dataset consists of subset of CV segments from a conversational speech data spoken in Hindi language. Every group is provided with the data for 5 CV segments (5-class data). **Each group should refer to the `Mapping_CV.txt` to know the CV segment classes assigned to them.** Training and test data are separated and are provided inside the respective CV segment folder. The 39-dimensional Mel frequency cepstral coefficient (MFCC) features extracted frame-wise from utterances of a particular CV segment uttered by multiple people are provided in separate files inside the respective folders corresponding to each class. Each data file is considered as one sample. Each row in a data file indicates one 39-dimensional MFCC feature vector. The number of such feature vectors (rows) depend on the duration of speech segment.

Build the RNN and LSTM for each of the datasets. Obtain the best RNN and LSTM models by tuning the different hyperparameters such as number of hidden layers, numbers of neurons in each hidden layer of the network at each timestep etc. You can also vary the number of RNN/LSTM layers. Use the *difference between average error of successive epochs falling below a threshold of 10^{-4}* as convergence criteria. Don't use a fixed number of epochs as convergence criteria.
    a. Present the plots of average training error (y-axis) vs. epochs (x-axis) for each of the different hyperparameter sets.
    b. Give the training accuracy and test accuracy for each of the hyperparameter sets.
    c. Give the training accuracy, test accuracy and confusion matrix for the model with best hyperparameter set.
    d. Your report should include at least 5 images (after normalization) from each of the handwritten character classes assigned to your group.

Each group of students must use the dataset identified for that group only.

You can use deep learning APIs (Tensorflow, PyTorch, Keras, etc.).

Report should be in PDF form and report by a team should also include the observations about the results of studies.

Instruction:
Upload in Moodle all your codes in a single zip file. Note that code(s) should be in a .py file, if you are coding in Python.
- **Give the name of the code folder as Group<*number*>_Assignment6_code**
  Example: Group01_Assignment6_code.
- **Give the name of the zip file as Group<*number*>_Assignment6_code.zip**
  Example: Group01_Assignment6_code.zip

Upload the report as PDF file.
- **Give the name to the report file as Group<*number*>_Assignment6_report.pdf**
  Example: Group01_Assignment6_report.pdf

We will not accept the submission if you don't follow the above instructions.