CS3630 – Deep Neural Networks
Assignment 3 – Recurrent Neural Networks for Sequence Modelling

Deadline – 15th October 2023, 11.59 PM.

In this assignment, you will develop three variations of Recurrent Neural Networks (RNNs) to predict human activities given the readings from a set of wearable sensors.

For this purpose, you are given the MHealth dataset, which consists of readings from 3 wearable sensors for ten voluntary participants performing 12 daily activities such as walking, climbing stairs, running, etc. (For more details, check the dataset repository). The three sensors were placed on the participants' chest, left ankle, and right wrist. Sensors placed on the left ankle and right wrist are used to take the readings of the embedded triple-axis: accelerometer, gyroscope, and magnetometer readings while performing the different activities. The sensor placed on the chest area has two embedded sensors, a tri-axis accelerometer to measure the acceleration and 2 ECG leads, which can be used to measure the basic heart rate. Each instance of the dataset has 23 distinct features and an activity label. Observations were recorded at 50 Hz. The dataset contains 344,116 samples altogether.

From each user from each activity, use 70% of randomly selected samples as the training data and the remaining 30% as the testing data. (This way, both training, and testing datasets will have activity). The activity label 0 corresponds to recordings in between the exercises. Thus, discard those instances.

Your tasks

Please work on this assignment in the same groups as in the sequence modelling in class assignment groups.

1. Using the MHealth dataset, develop the following three models.
    a. An activity recognition model based on RNN.
    b. An activity recognition model based on LSTM.
    c. An activity recognition model based on bidirectional GRU.
    d. An activity recognition model based on transformers.
2. For each of the 4 models in (1), create **three variants** by changing their architectures. For example, for RNN, LSTM and Bi-GRU, you can change the number of hidden layers, dimensions of the hidden state, how output is derived etc. whereas for the transformer you can change the number of encoders, number of decoders, number of heads in the multi-head attention etc. Altogether, you should develop **12 models**.
3. Submit a short report (maximum of 4 pages) renamed with your Group Name in PDF format (e.g., GroupB.pdf) in the top of the first page include index numbers of the group members.
   The report should contain the following.
    a. The description of each model variant (e.g., architecture, hyper-parameters used, etc.)
    b. Final training and testing accuracy for each of the model variant.
    c. A discussion explaining possible reasons for the differences in test accuracy values reported in (b).

Implementation guidelines

- You are encouraged to use the Pytorch framework and Google Colab for the implementations in this assignment.

- Ensure you are periodically saving your notebook (File -> Save) so that you don't lose your progress if you step away from the assignment and the Colab VM disconnects. Also, make sure you save your intermediate models following some criteria (e.g., save the best model so far) so that in case Colab VM disconnects, you can resume your training by using the weights of the saved model as the initial weights.