Presentation:
Human Activity Recognition using Smartphone Sensor Data

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Project Introduction

We intend to classify the physical activities performed by a user based on accelerometer and gyroscope sensor data collected by a smartphone in the user's pocket.

To implement the above, we will be using a number of machine learning concepts and use a variety of classifying techniques to figure out which methods will best classify our data.

Motivation

Phone applications nowadays can show you how many steps you have walked, ran, flights of stairs you have climbed, calories burnt, etc. On a similar line, we also intend to build such a classifier from scratch which based on data from sensors already present in smartphones is able to identify the activity the user is currently participating in. By doing this project we intend to gain practical knowledge of building classifiers and learn & implement machine learning concepts.

Currently the accuracy of these human activity classifiers are about 85% and improving them has many hurdles. Some of these being:

- High sampling rate of data is required, so more data needs to be processed every second.
- Also since the physical attributes of users, the sensors used in the smartphones vary greatly, a bias creeps in which decreases accuracy

If we can discover a novel method to handle this data or to decrease user bias or something else which can potentially increase accuracy, it would be a great step forward :D

Review of Literature

1] **Smart Devices are Different: Assessing and Mitigating Mobile Sensing Heterogeneities for Activity** -Research paper (http://userpages.umbc.edu/~nroy/courses/spring2016/cmisr/papers/Smart_Devices_Different_SenSys15.pdf)

This research was conducted on the same dataset we are using. They have implemented different types of classifiers and cross validation techniques and also tried to minimize the device and user bias.

2] **Using Machine Learning on Sensor Data** -Research Paper (Journal of Computing and Information Technology - CIT 18, 2010, 4, 341–347 doi:10.2498/cit.1001913)

This research is unrelated to smartphone activity classification. But it gave us an idea as to how we can use sensor data and train our neural network with it.

Our DataSet

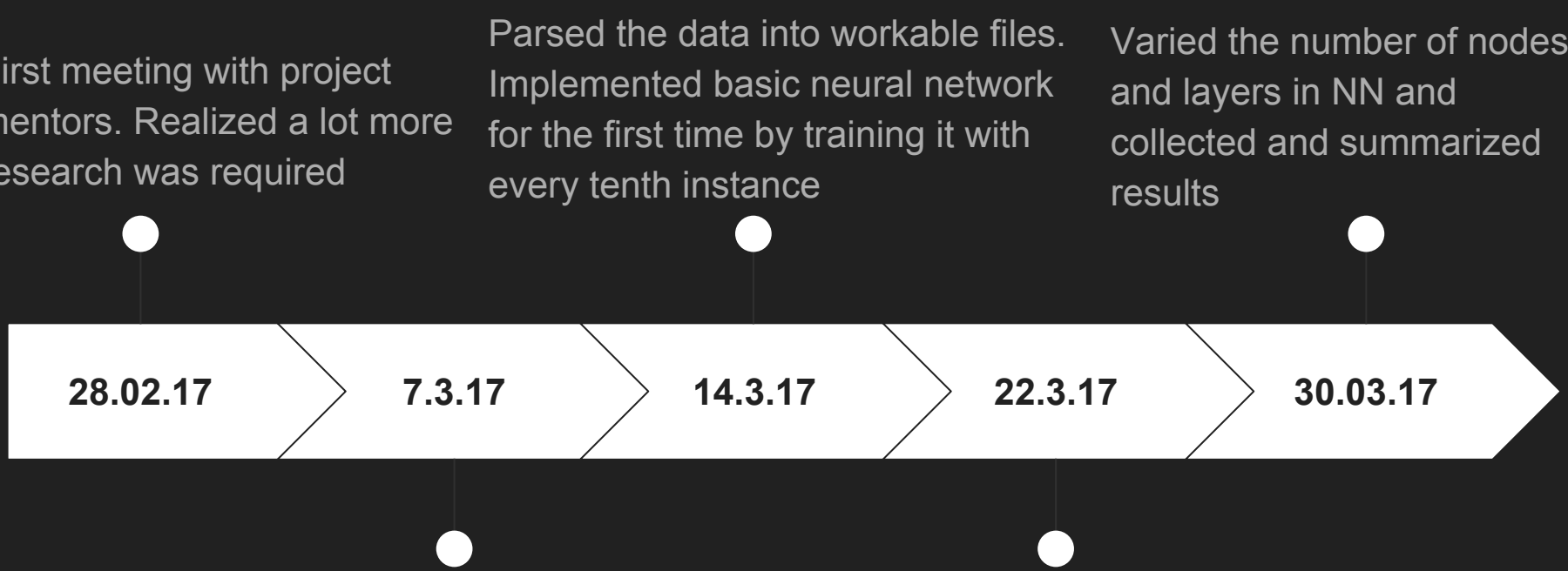
We have used the “Heterogeneity Human Activity Recognition Dataset” which can be obtained from:

https://archive.ics.uci.edu/ml/datasets/Heterogeneity+Activity+Recognition

Data Set Information:

- **The Heterogeneity Dataset for Human Activity Recognition from Smartphone and Smartwatch sensors consists of two datasets (one containing accelerometer readings, the other containing gyroscope readings)**
- **Number of Attributes : 16 Number of Instances: 26,000,000+**
- **Users executed activities scripted in no specific order while carrying smartphones.**
- **Activities: ‘Biking’, ‘Sitting’, ‘Standing’, ‘Walking’, ‘Stairs Up’ and ‘Stairs down’.**
- **Sensors: Sensors: Two embedded sensors, i.e., Accelerometer and Gyroscope, sampled at the highest frequency the respective device allows (100 Hz)**
- **Recordings: 9 users and 8 smartphones (2 Samsung Galaxy S3 mini, 2 Samsung Galaxy S3, 2 LG Nexus 4, 2 Samsung Galaxy S+)**

Project Timeline



What we have Done so Far

Since the number of instances was extremely large (> 26 million), first we split the dataset into 13 separate files. Took every tenth value from these files and stored them into 13 smaller files and then appended these smaller files to get a new dataset which was one-tenth the size of original dataset which is now workable.

We have used the data from 8 users for training and then we are testing our classifier on the data from the 9th user.

We are taking every tenth instance from original dataset and the sensor readings of accelerometer at an instance is a point being given to neural network for training.

What we have Done so Far

First we implemented a neural network with 1 layer having 20 nodes.

Later on we changed the number of hidden layers to 3 with each layer having 5 nodes. We implemented this type of neural network, gradually increasing the number of nodes and observed the variation in test data results.

We also tried implementing svm and random forest. However both these methods failed to converge in a good amount of time because of size of dataset.

Scales to Measure Success

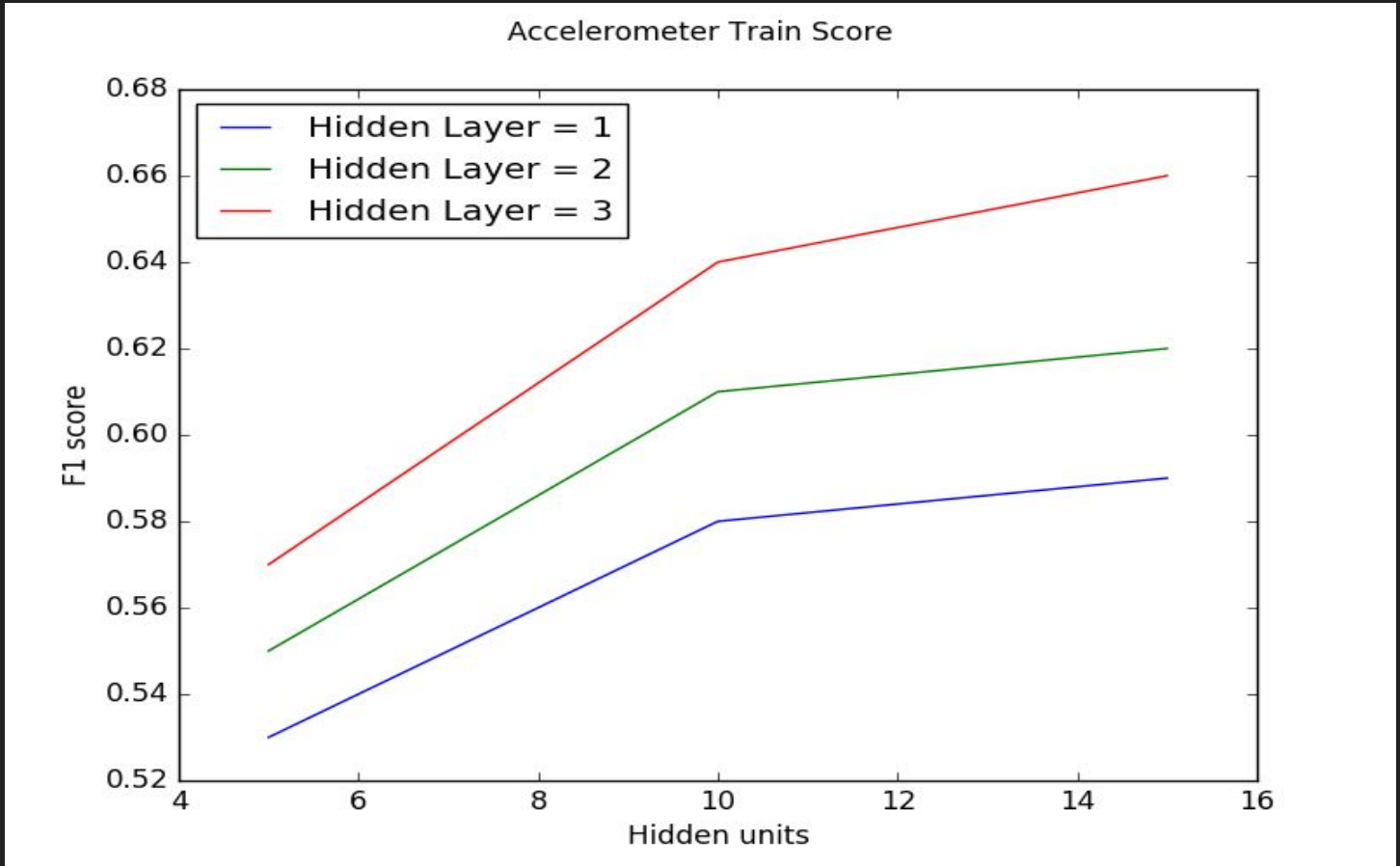
To measure the accuracy of our classifier on test data, an indicator called the F-1 score helps a great deal.

F-1 score is calculated in the range 0-1. With 1 being 100% accuracy on test data.

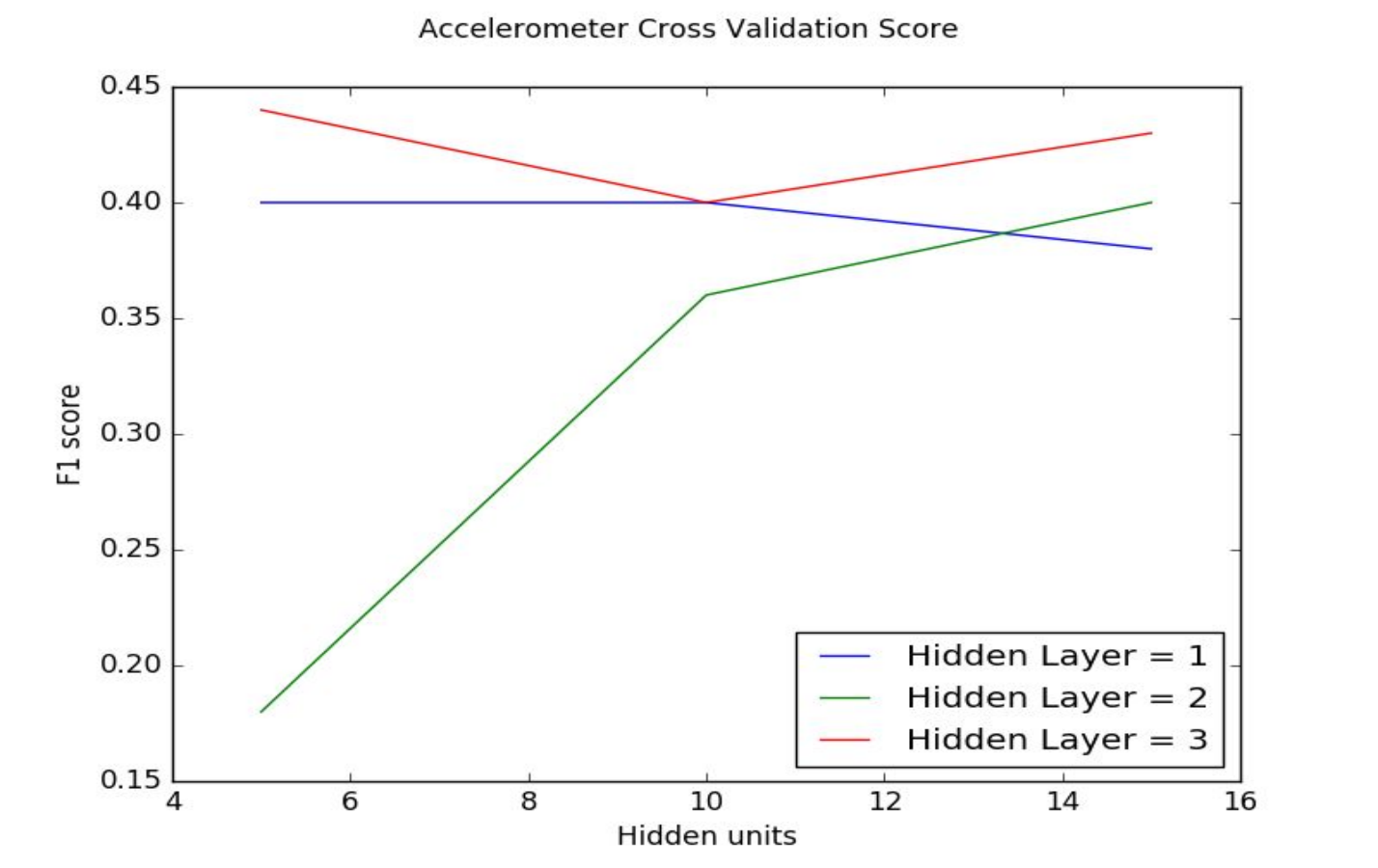
We have plotted graphs of F1-score vs number of nodes in hidden layer to figure out what structure of neural network produces the best results.

The graphs are coming up in the following slides……..

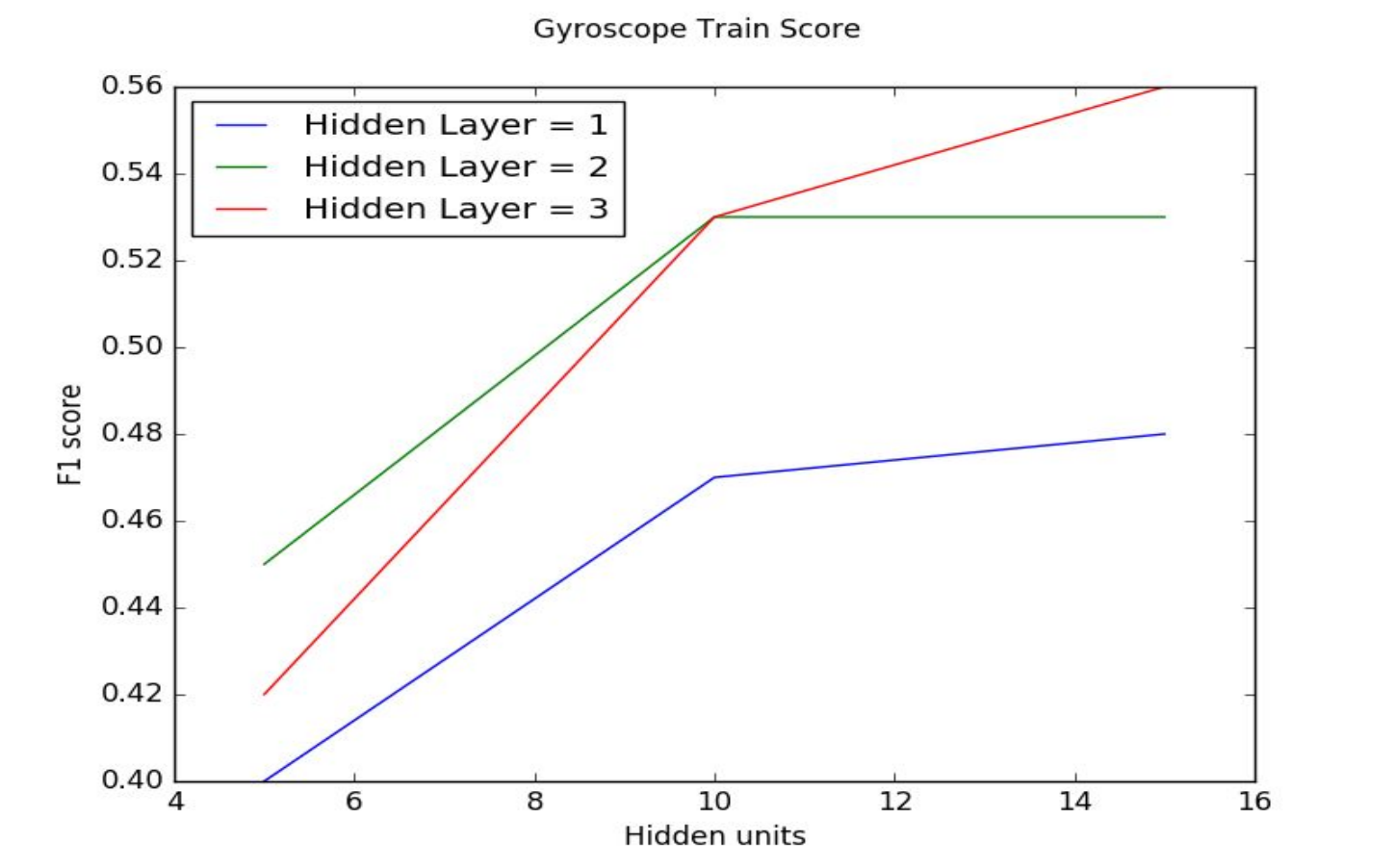
Accelerometer Train Results



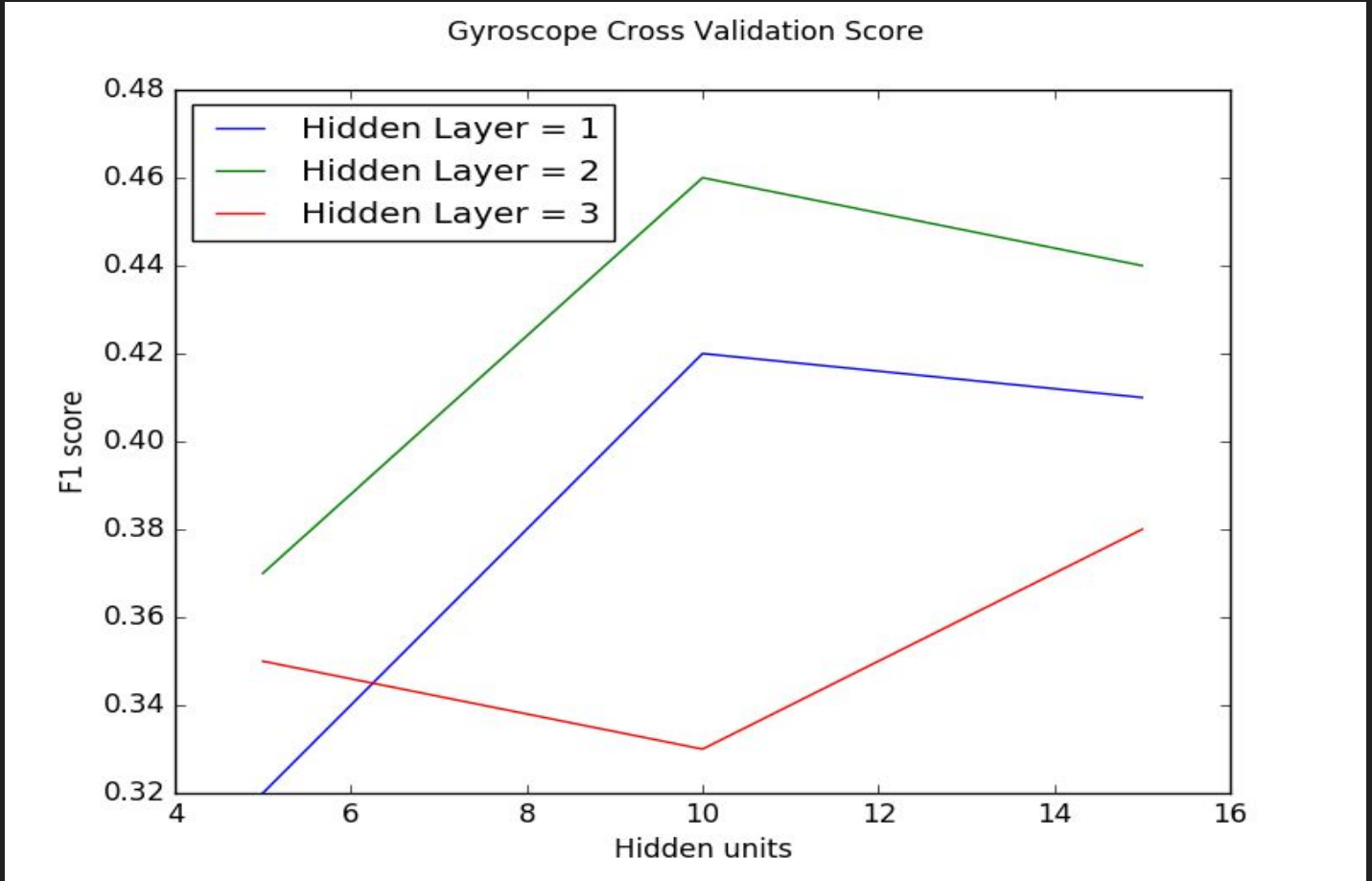
Accelerometer Test Results



Gyroscope Train Results



Gyroscope Test Results



Next steps to Improve our Classifier

Till now we have been able to train a neural network using accelerometer readings and gyroscope readings separately. But we haven’t been able to combine both the gyroscope and accelerometer readings at time t into 1 data point due to unsynchronised data in the datasets.

We will get this working in the next week.

Also another problem is that we have taken discrete data points which will not be able to convey many of the features which will help in classification.

Eg- In stairs down activity, if you take instances when the smartphone leg is grounded, then neural network doesn’t have much to differentiate this activity from standing.

Next steps to Improve our Classifier

Since any physical activity can not be well characterized by the readings at a particular instance during the activity, we intend to club together instances across 1 second and include this window as a single entry in our new dataset. Then we slide the window by 1 instance and add this new window into the new dataset.

Extracting features from the discrete data points in this window is currently a challenge. Some of the features we intend to extract and utilize is number of maxima/minima, distance between adjacent peaks and the readings at these points of peaks. Figuring out features which will help in best characterizing these basic activities will be an integral part of this project.

THANK YOU..!!!!!!!