Assignment 4

The classification was done for 10 participants performing the following 7 activities

Activity ID	Activity
1	Drinking
2	Opening the Door
3	Sitting Down
4	Standing Up
5	Stationary
6	Walking Fast
7	Walking Slow

Localize the Human Body – Scan Number vs. Range Plots
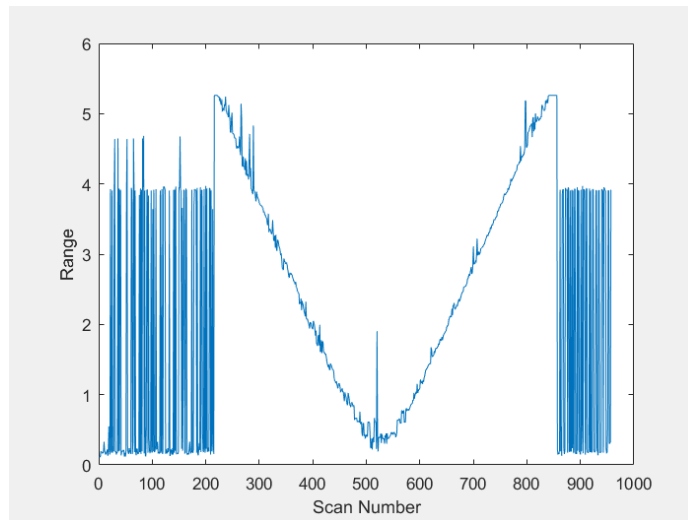
Figure 1: Walk Slow
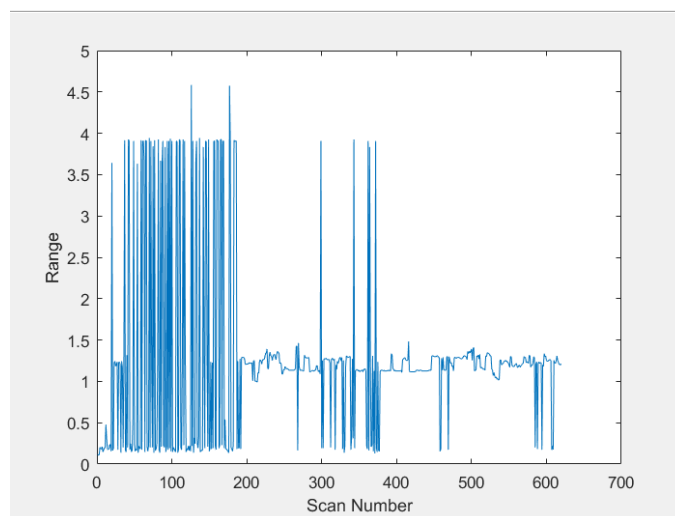
Figure 2: Drinking

Features

Time Domain Features	Frequency Domain Features
Mean	Mean of FFT
Minimum	Min of FFT
Maximum	Max of FFT
	Variance of FFT
	Standard Deviation of FFT
	Median of FFT

The person was localized by finding the location of the first and the last peak along the range. For all values of the range, where no peaks were detected (i.e. before the first peak and after the last peak), the value of the signal was replaced as zero. These features were extracted for every window of 25 scans across all values of the range.

The time domain features mean, minimum and maximum of all the scans in the window for every value of range would tell us how the signal varied as the person moved in front of the radar. So, this can help detect the spatial change in the person's position as we can see how the value of these features change for the person's movement in the range of the radar.

The frequency domain features would give a peak at different positions for different types of movements in front of the radar. So, different activities, depending on their nature, would have a peak at different positions and will have a different magnitude and the curve will have a different spread. To account for these, various statistical measures namely mean, median, variance, standard deviation, minimum and maximum have been used.

Confusion Matrices, Recall, Precision, F-Score for each activity

Leave One Subject Out Cross Validation was performed between 10 subjects to classify 7 activities, using 9 features and Decision Tree Classifier.

Some experiments were performed to see which activities get better classified than others, by excluding some activities from classification.

It was found that stationary vs. walking slow were the easiest to discern from the features extracted as expected.

Also, excluding activities drinking and sitting down improved the classification accuracy, since they were creating a lot of confusion in the classifier.

Results for all activities using all features in the classifier is also shown.

For every experiment, the precision, recall and f1 score for every activity is also given.
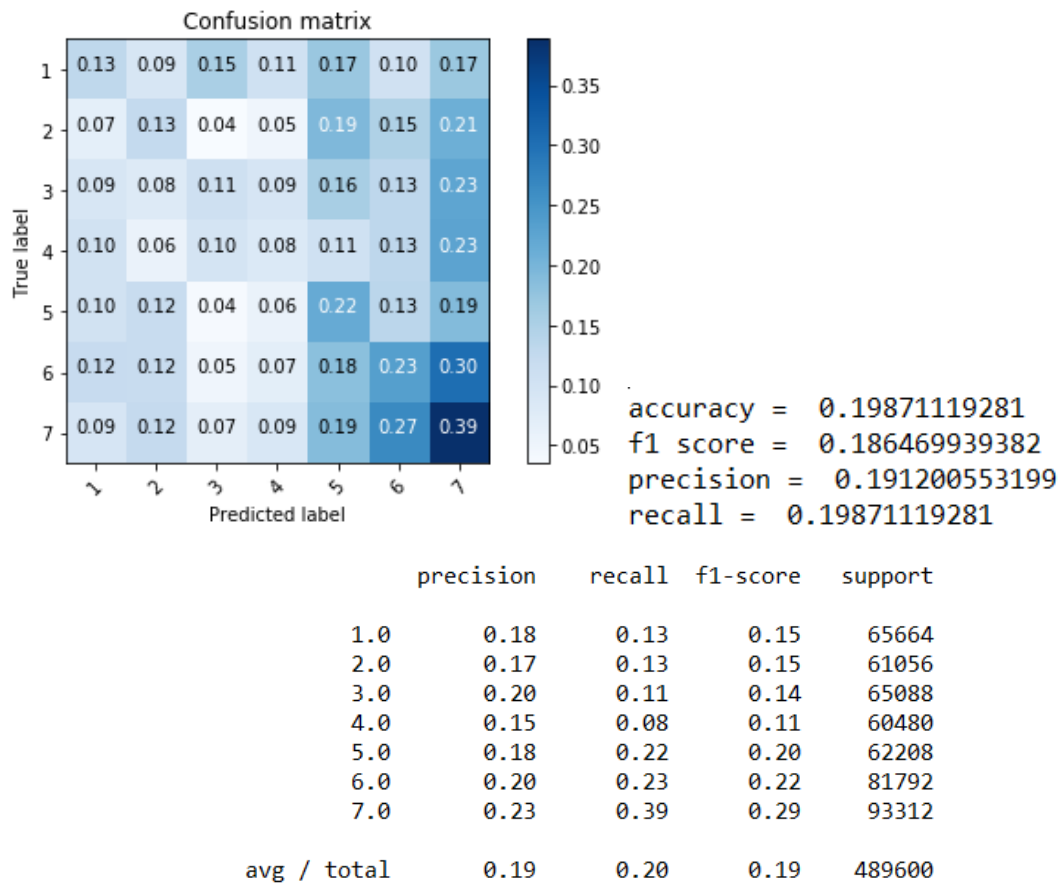
Confusion matrix


```
accuracy  =  0.19871119281
f1 score  =  0.186469939382
precision =  0.191200553199
recall    =  0.19871119281
```

	precision	recall	f1-score	support
1.0	0.18	0.13	0.15	65664
2.0	0.17	0.13	0.15	61056
3.0	0.20	0.11	0.14	65088
4.0	0.15	0.08	0.11	60480
5.0	0.18	0.22	0.20	62208
6.0	0.20	0.23	0.22	81792
7.0	0.23	0.39	0.29	93312
avg / total	0.19	0.20	0.19	489600

Figure 3: Classifying All Activities

Confusion matrix


```
accuracy  =  0.308141252955
f1 score  =  0.301911968294
precision =  0.302107604452
recall    =  0.308141252955
```

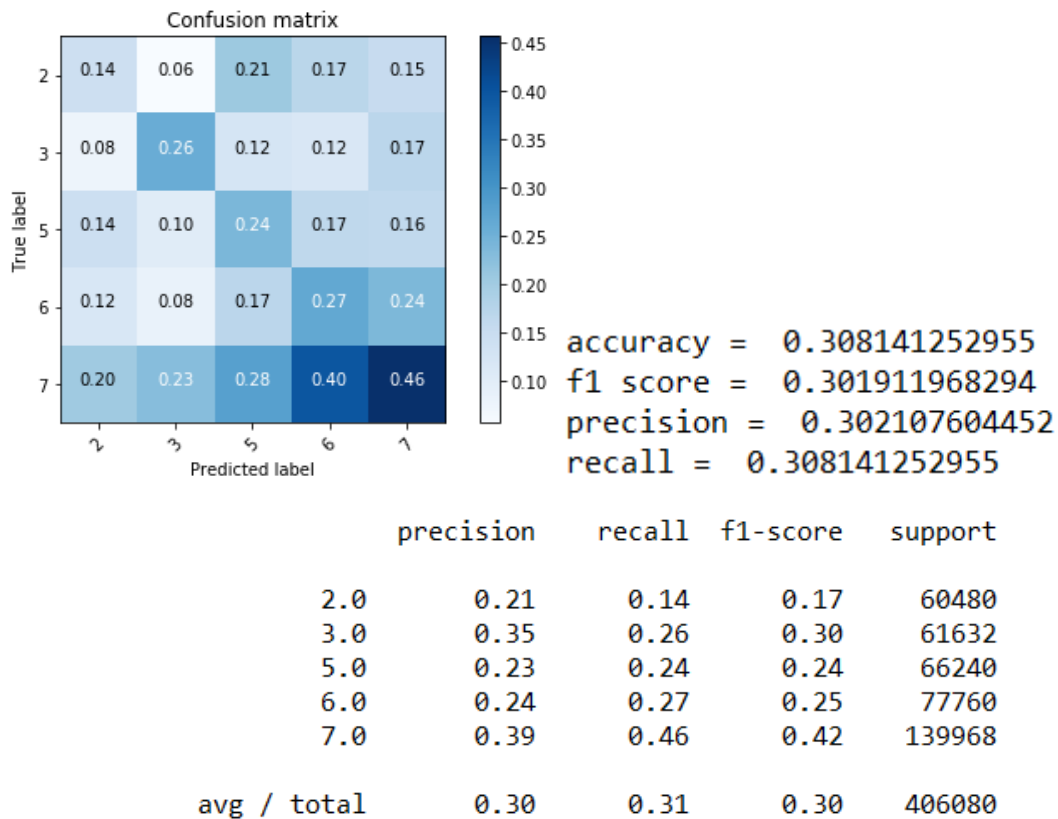|	precision	recall	f1-score	support
2.0	0.21	0.14	0.17	60480
3.0	0.35	0.26	0.30	61632
5.0	0.23	0.24	0.24	66240
6.0	0.24	0.27	0.25	77760
7.0	0.39	0.46	0.42	139968
avg / total	0.30	0.31	0.30	406080

Figure 4: Classification between Drinking, Opening the Door, Standing Up, Sitting Down, Walk Fast and Walk Slow
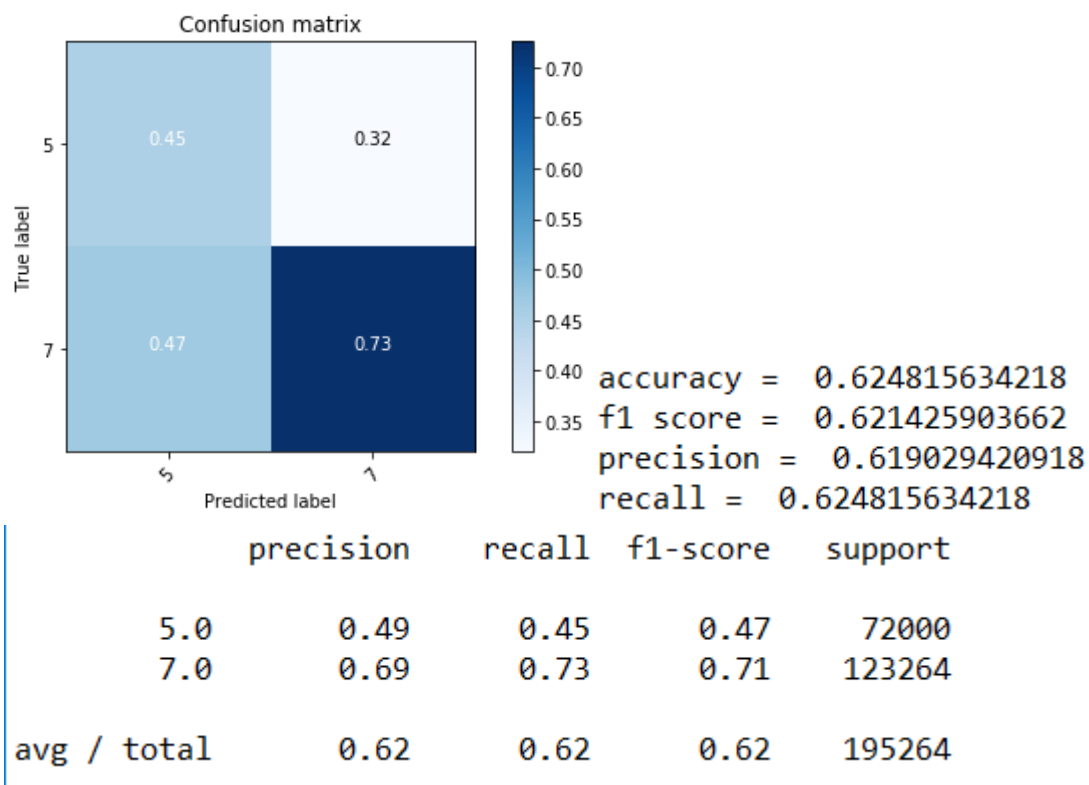
Figure 5: Classification between Stationary and Walk Slow

Explanation of Results

The results clearly show that the classifier fails to discern between similar activities in an extremely decisive way. Activities like sitting down, standing up, drinking and stationary are the classes with the highest amount of confusion due to their similar nature. What distinguishes opening the door from these classes is the fact that this activity was done at a different distance as compared to other activities. Walking and being stationary is also discerned efficiently because there is a spatial variation in the signal across a range when the person is walking vs. when the person is in one position. Thus, time domain features can efficiently distinguish between such activities. Frequency domain features are used to discern between these activities, but can also help in discerning between similar activities, since the variation of the signal represented in the frequency domain for similar activities looks different, thus various statistical measures of the signal in the frequency domain can be used as features.

The overall accuracy of the classifier is low because of the fact that some of the activities are extremely similar, so it is hard for the classifier to distinguish between activities. The values of the evaluation metrics are shown to improve when certain activities are not being used for classification, since they were seen to cause the most amount of confusion in the classifier. The best results were obtained when a binary classification was performed to determine if the person was stationary or walking slow.