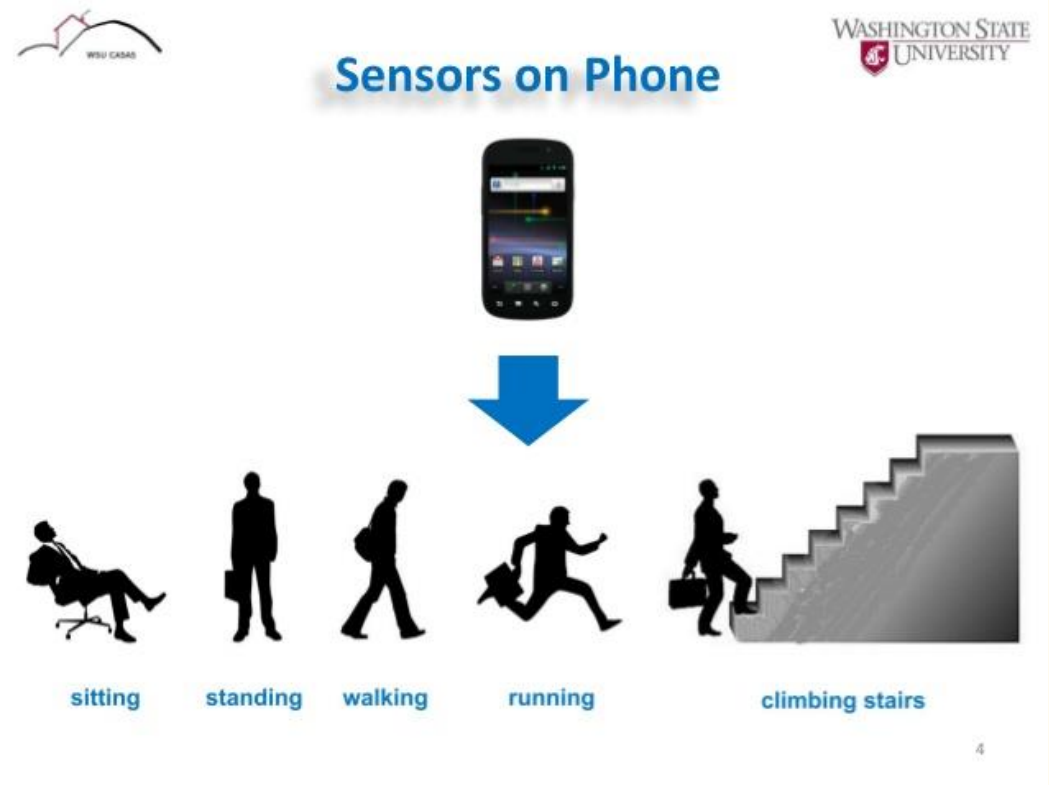
Activity Recognition Using Smartphone Sensors

—

Ravinder Dhesi

Motivation

- Human activity recognition is very useful for things such as elder care and healthcare
- Smartphones becoming able to do this would make it both more accessible and enable more freedom



Ways of analyzing the data

- Supervised learning
- Semi-supervised learning
- Incremental learning approaches
- Unsupervised
- Labels are available but can easily not be used

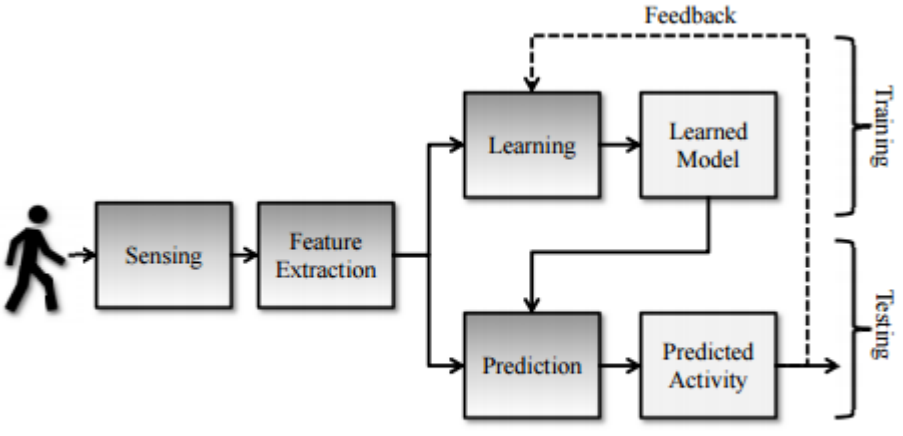


Fig. 1: The Human Activity Recognition Process Pipeline.

Small section of the data

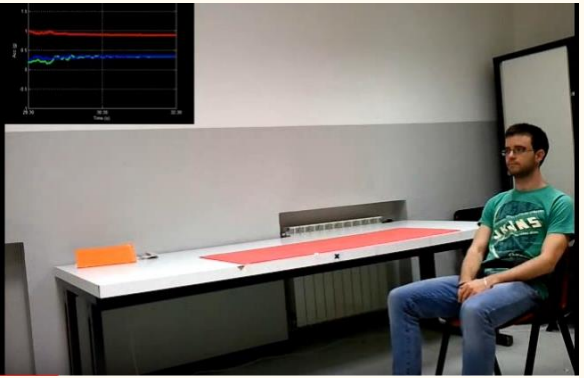
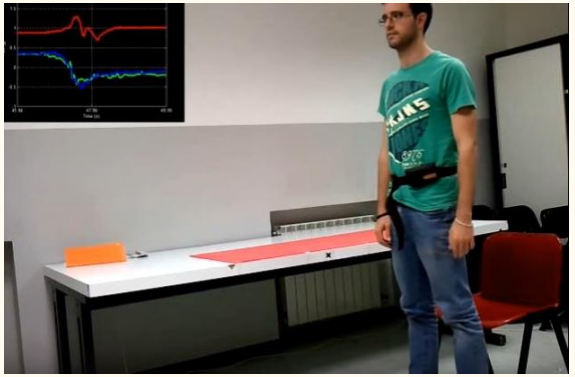
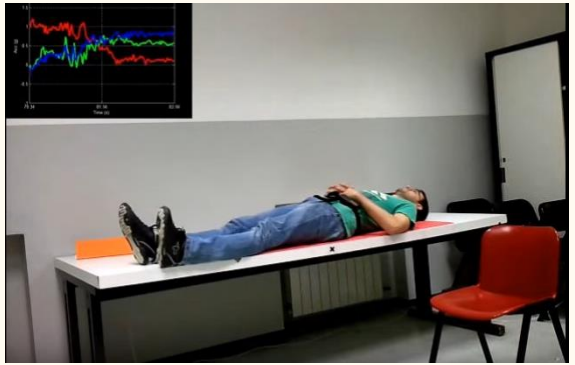
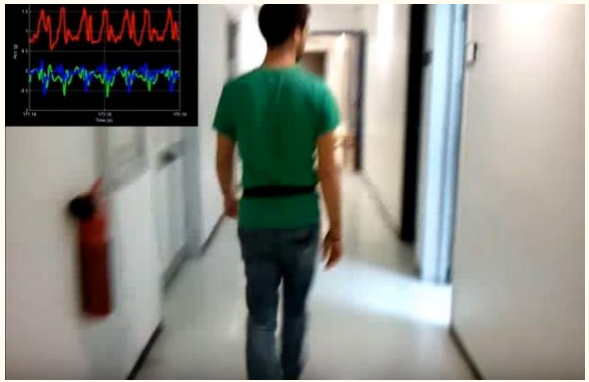
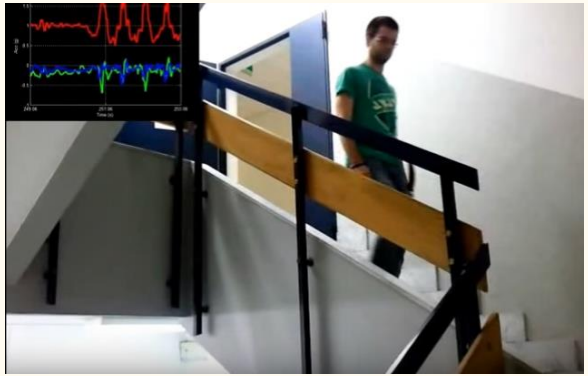
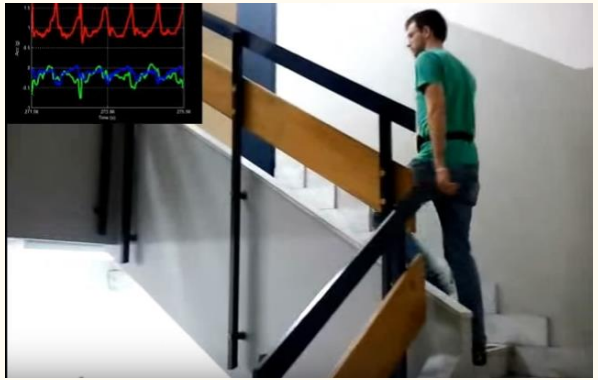
```
 2.8858451e-001 -2.0294171e-002 -1.3290514e-001 -9.9527860e-001 -9.8311061e-001 -9.1352645e-001 -9.9511208e-001
 1.1380614e-001 -5.9042500e-001  5.9114630e-001 -5.9177346e-001  5.9246928e-001 -7.4544878e-001  7.2086167e-001
-9.9236164e-001 -8.6704374e-001 -9.3378602e-001 -7.4756618e-001  8.4730796e-001  9.1489534e-001  8.3084054e-001
2.8225087e-001  9.2726984e-001 -5.7237001e-001  6.9161920e-001  4.6828982e-001 -1.3107697e-001 -8.7159695e-002
9.9348603e-001 -9.9424782e-001 -9.9994898e-001 -9.9454718e-001 -6.1976763e-001  2.9284049e-001 -1.7688920e-001
9.9973783e-001 -9.9973220e-001 -9.9949261e-001 -9.9981364e-001 -9.9968182e-001 -9.9983940e-001 -9.9973823e-001
9.9995513e-001 -9.9991861e-001 -9.9964011e-001 -9.9948330e-001 -9.9996087e-001 -9.9998227e-001 -9.9997072e-001
1.0000000e+000 -1.0000000e+000 -1.0000000e+000 -2.5754888e-001  9.7947109e-002  5.4715105e-001  3.7731121e-001
8.8436120e-002 -4.3647104e-001 -7.9684048e-001 -9.9372565e-001 -9.9375495e-001 -9.9197570e-001 -9.9336472e-001
 2.7841883e-001 -1.6410568e-002 -1.2352019e-001 -9.9824528e-001 -9.7530022e-001 -9.6032199e-001 -9.9880719e-001
-2.1049361e-001 -4.1005552e-001  4.1385634e-001 -4.1756716e-001  4.2132499e-001 -1.9635929e-001  1.2534464e-001
-9.8918458e-001 -8.6490382e-001 -9.5356049e-001 -7.4587000e-001  8.3372106e-001  9.0810964e-001  8.2893499e-001
2.7498054e-002  1.8270272e-001 -1.6745740e-001  2.5325103e-001  1.3233386e-001  2.9385535e-001 -1.8075169e-002
9.9200604e-001 -9.9512320e-001 -9.9996983e-001 -9.9481921e-001 -7.3072160e-001  2.0933413e-001 -1.7811256e-001
9.9954892e-001 -9.9973714e-001 -9.9956575e-001 -9.9990532e-001 -9.9947352e-001 -9.9955418e-001 -9.9960203e-001
9.9996834e-001 -9.9991010e-001 -9.9981369e-001 -9.9992027e-001 -9.9996071e-001 -9.9998672e-001 -9.9995600e-001
1.0000000e+000 -1.0000000e+000 -1.0000000e+000 -4.8167435e-002 -4.0160791e-001 -6.8178329e-002 -4.5855331e-001
4.4149887e-002 -1.2204037e-001 -4.4952188e-001 -9.9033549e-001 -9.9196029e-001 -9.8973198e-001 -9.9448884e-001
 2.7965306e-001 -1.9467156e-002 -1.1346169e-001 -9.9537956e-001 -9.6718701e-001 -9.7894396e-001 -9.9651994e-001
-9.2677626e-001  2.2341317e-003  2.7480687e-002 -5.6728165e-002  8.5533243e-002 -3.2902304e-001  2.7050025e-001
-9.8578618e-001 -8.6490382e-001 -9.5904912e-001 -7.4327710e-001  8.3372106e-001  9.0575280e-001  8.2893499e-001
2.5288704e-001  1.8164885e-001 -1.6930838e-001  1.3200906e-001  8.1973166e-003  1.9332856e-001  7.3717859e-002
9.9765184e-001 -9.9340322e-001 -9.9995494e-001 -9.9398834e-001 -6.6291363e-001  3.2803146e-001 -1.5456001e-001
9.9963593e-001 -9.9967885e-001 -9.9961574e-001 -9.9987958e-001 -9.9910845e-001 -9.9962404e-001 -9.9964327e-001
9.9984140e-001 -9.9992218e-001 -9.9990585e-001 -9.9987361e-001 -9.9999652e-001 -9.9996277e-001 -9.9980377e-001
1.0000000e+000 -8.7096774e-001 -1.0000000e+000 -2.1668507e-001 -1.7264171e-002 -1.1072029e-001  9.0519474e-002
```

Data

1. Inertial sensor data
   - Raw triaxial signals from the accelerometer and gyroscope of all the trials with with participants.
   - The labels of all the performed activities.

2. Records of activity windows. Each one composed of:
   - A 561-feature vector with time and frequency domain variables.
   - Its associated activity label (1-6).
   - An identifier of the subject who carried out the experiment.
   - 7352 labels for train and 2947 for test

Activity Data Collection

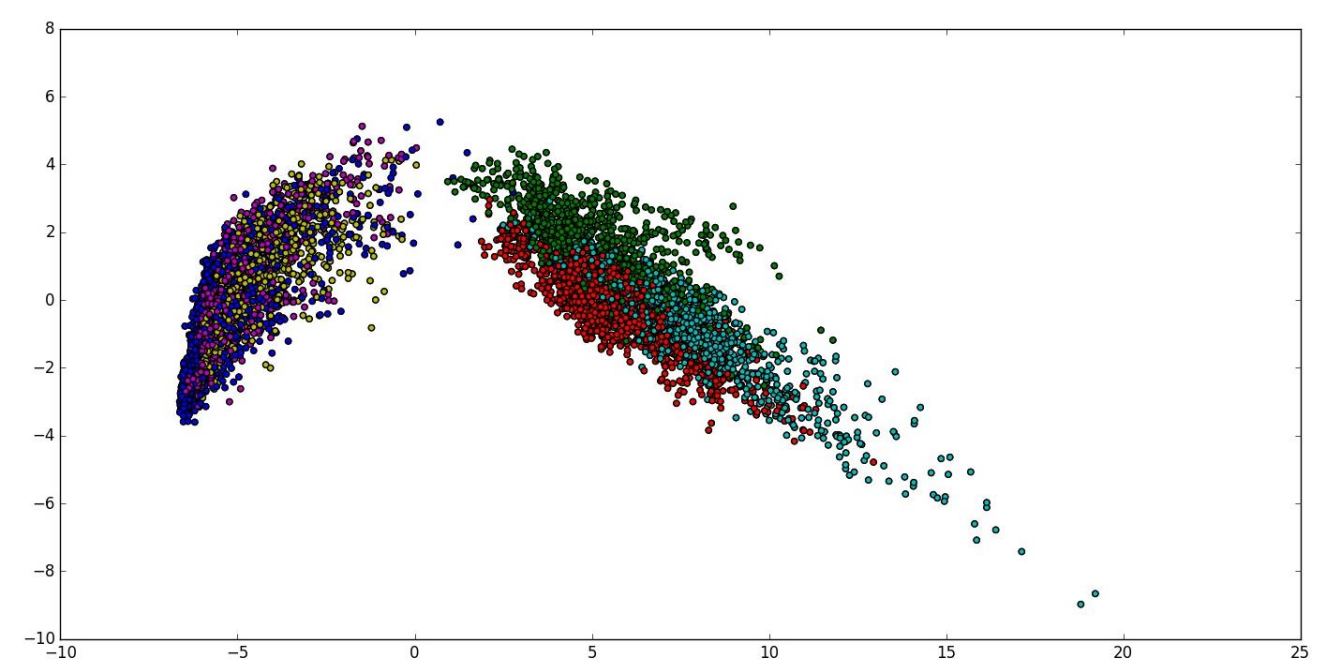







Activities monitored in data set
(https://www.youtube.com/watch?v=XOEN9W05_4A)

Methods

- PCA
- K-means
- 3D PCA
- More methods will probably be applied in the future

Results



PCA

R Walking

G Walking Upstairs

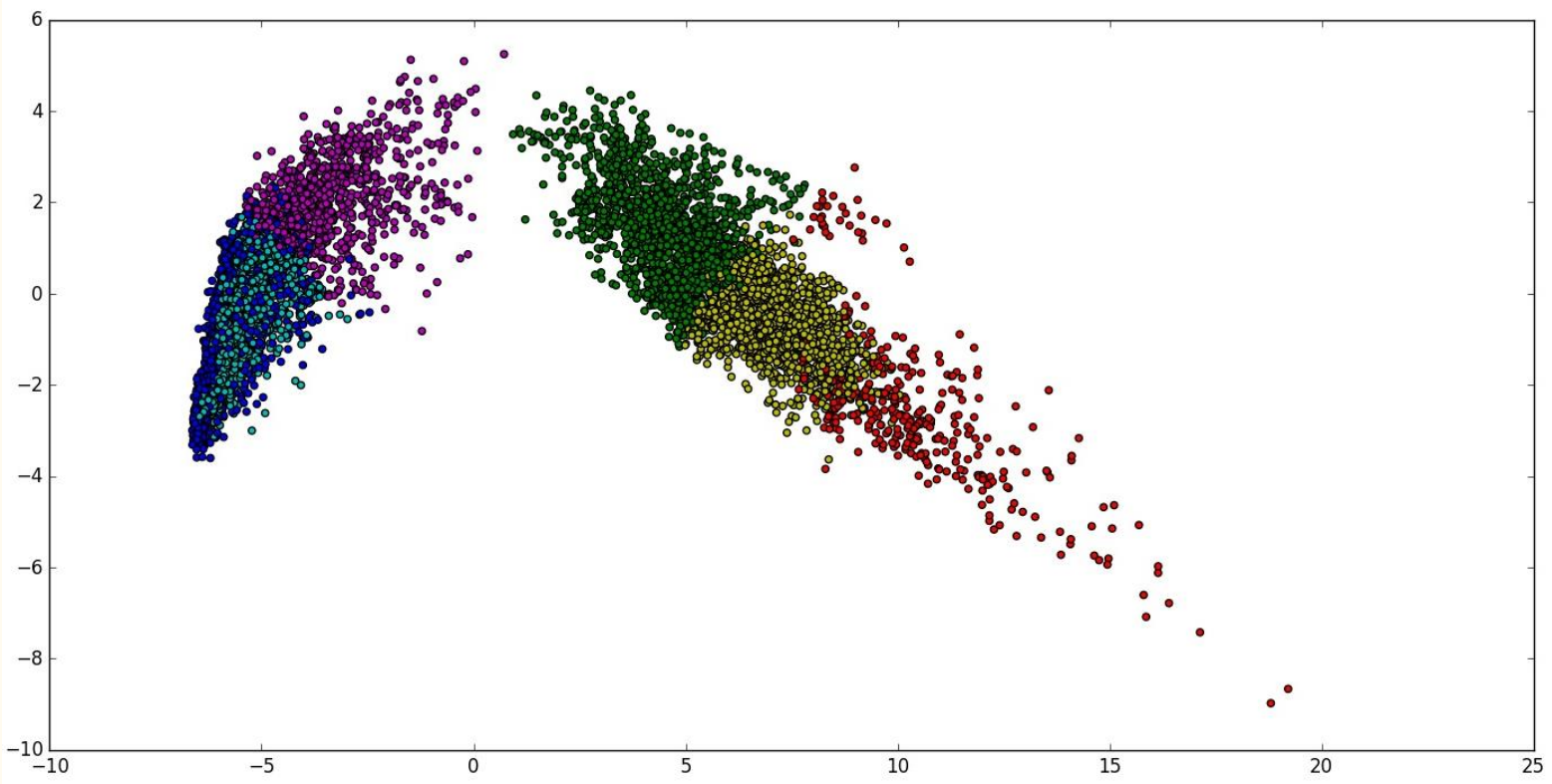
C Walking Downstairs

M Sitting

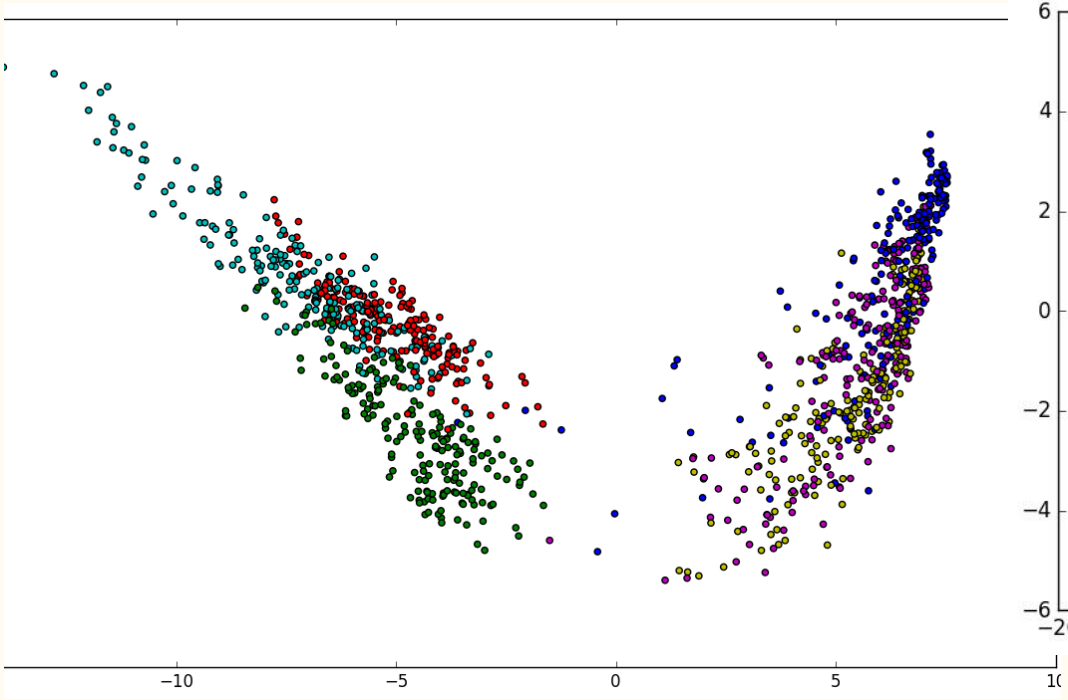
Y Standing

B Laying

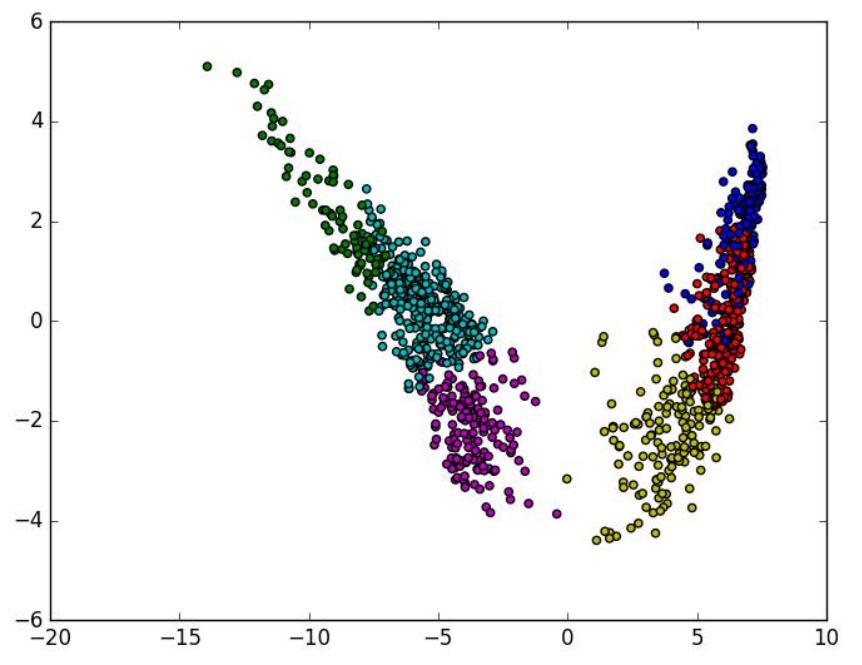
K-Means Attempt



Attempt at reducing data



PCA



K-Means

Current Interpretation and Future Work

- Data looks like it is easier for the sensors to discern movement
- Data overlaps a lot in PCA but uncertain as to whether or not this is due to 2D

Future Work

- Implementing 3D PCA
- Obtain a smaller section of the dataset
- Find more methods to use and compare

References

- Jorge-Luis Reyes-Ortiz, Luca Oneto, Alessandro Ghio, Albert SamÃ¡, Davide Anguita and Xavier Parra. Human Activity Recognition on Smartphones With Awareness of Basic Activities and Postural Transitions. Artificial Neural Networks and Machine Learning â€“ ICANN 2014. Lecture Notes in Computer Science. Springer. 2014.

- Davide Anguita, Alessandro Ghio, Luca Oneto, Xavier Parra and Jorge L. Reyes-Ortiz. A Public Domain Dataset for Human Activity Recognition Using Smartphones. 21th European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning, ESANN 2013. Bruges, Belgium 24-26 April 2013.

- Davide Anguita, Alessandro Ghio, Luca Oneto, Xavier Parra, Jorge L. Reyes-Ortiz. Energy Efficient Smartphone-Based Activity Recognition using Fixed-Point Arithmetic. Journal of Universal Computer Science. Special Issue in Ambient Assisted Living: Home Care. Volume 19, Issue 9. May 2013

- Davide Anguita, Alessandro Ghio, Luca Oneto, Xavier Parra and Jorge L. Reyes-Ortiz. Human Activity Recognition on Smartphones using a Multiclass Hardware-Friendly Support Vector Machine. 4th International Workshop of Ambient Assited Living, IWAAL 2012, Vitoria-Gasteiz, Spain, December 3-5, 2012. Proceedings. Lecture Notes in Computer Science 2012, pp 216-223.

- Jorge Luis Reyes-Ortiz, Alessandro Ghio, Xavier Parra-Llanas, Davide Anguita, Joan Cabestany, Andreu CatalÃ . Human Activity and Motion Disorder Recognition: Towards Smarter Interactive Cognitive Environments. 21th European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning, ESANN 2013. Bruges, Belgium 24-26 April 2013.

Questions? Comments?