Mobile Sensing and Human Activity Recognition

Final Presentation

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CSL 7460 Mobile and Pervasive Computing

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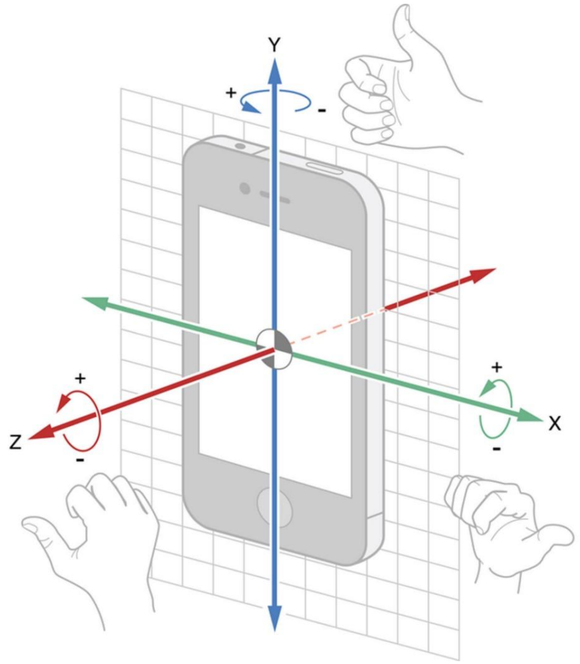
Objectives

- Study methodologies used to recognize Human Activity from obtained data from sensors like : **Accelerometer and Gyroscope** and classify activities into one of the five activities:

  Sitting, Standing, Walking, Walking Upstairs, Walking Downstairs

- To determine the best effective method of activity recognition



Mid-Semester Progress

1. **Studying Related Papers**

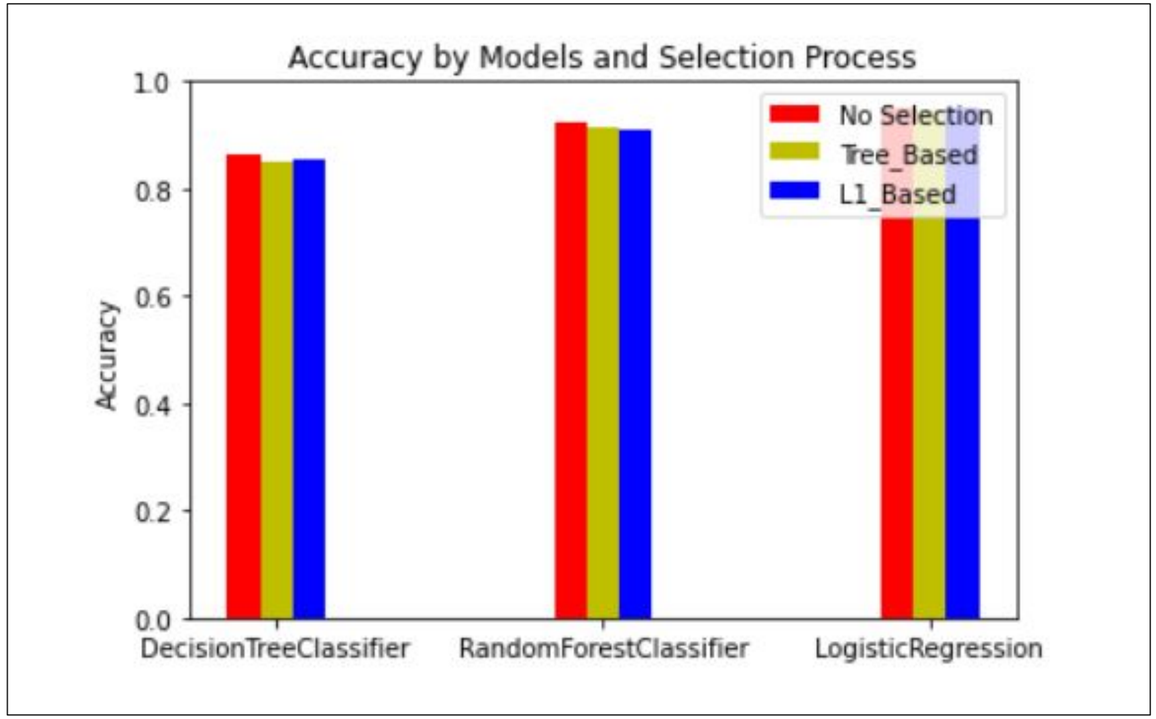
   (Approaches include **Decision Tree, Random Forest** and **Logistic Regression classifiers, Two Stage CHMM - Continuous Hidden Markov Model**)

2. **Implementation of**
   a. Decision Tree Classifier
   b. Random Forest Classification
   c. Logistic Regression Classifier

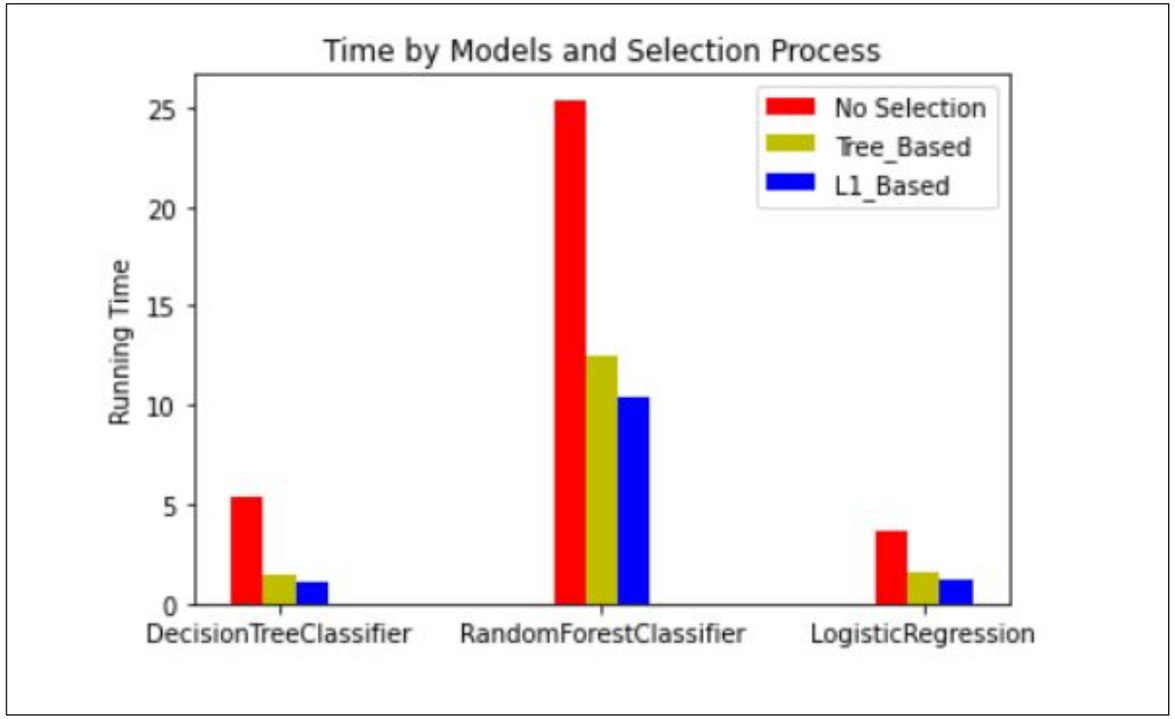
- **Implementation steps**
  a. Data Visualization
  b. Pre-processing
  c. Feature Extraction
  d. Classifier Training & Validation Strategy

- **DataSet used for testing**
- Dataset built from recordings of 30 study participants within an age bracket of 19-48 years performing **activities of daily living (ADL)** while carrying a waist-mounted smartphone with embedded inertial sensors. Using its embedded accelerometer and gyroscope, 3-axial linear acceleration and 3-axial angular velocity at a constant rate of 50Hz is captures.
- The obtained dataset was randomly partitioned into two sets, where 70% of the volunteers was selected for generating the training data and 30% the test data.
- The sensor signals (**accelerometer and gyroscope**) were pre-processed by applying noise filters and then sampled in fixed-width sliding windows of 2.56 sec and 50% overlap (128 readings/window).
- The objective is to classify activities into one of the six activities performed.

Accuracy & Feature Selection Comparison



Running Time & Feature Selection Comparison



Observations

- Decision Tree Classifier with L1-based feature selection takes the least time to run, 1.05 seconds. Next, Logistic Regression Classifier with L1-based feature selection takes 1.21 seconds to run.
- Logistic Regression Classifier without any feature selection applied gives the most accurate results with an accuracy of **95.24%**
- Thus, Out of the three methodologies studied, Logistic Regression Classifier with L1-Based Feature Selection process appears to be the best choice for the application of Human Activity Recognition.

Logistic Regression Classifier	Running Time	Accuracy
Without Feature Selection	**3.7050**	**95.24 %**
With Tree based Feature Selection	**1.5546**	**94.77 %**
With L1-Based Feature Selection	**1.2134**	**95.18 %**

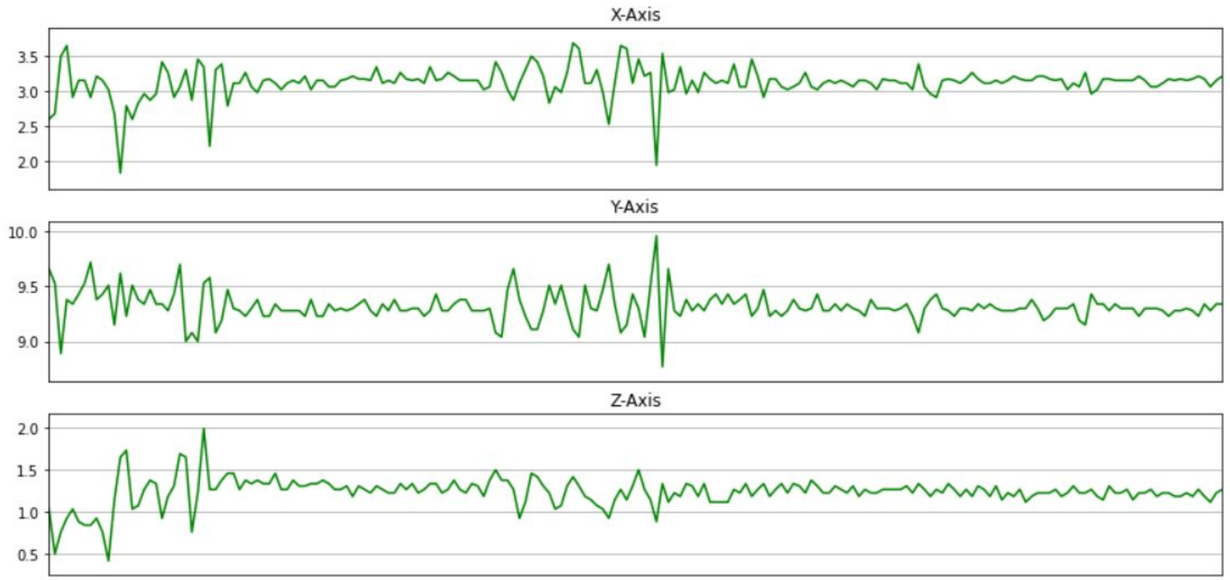
Distinguish between the activities **- Sitting** and **Standing**

Dataset Description

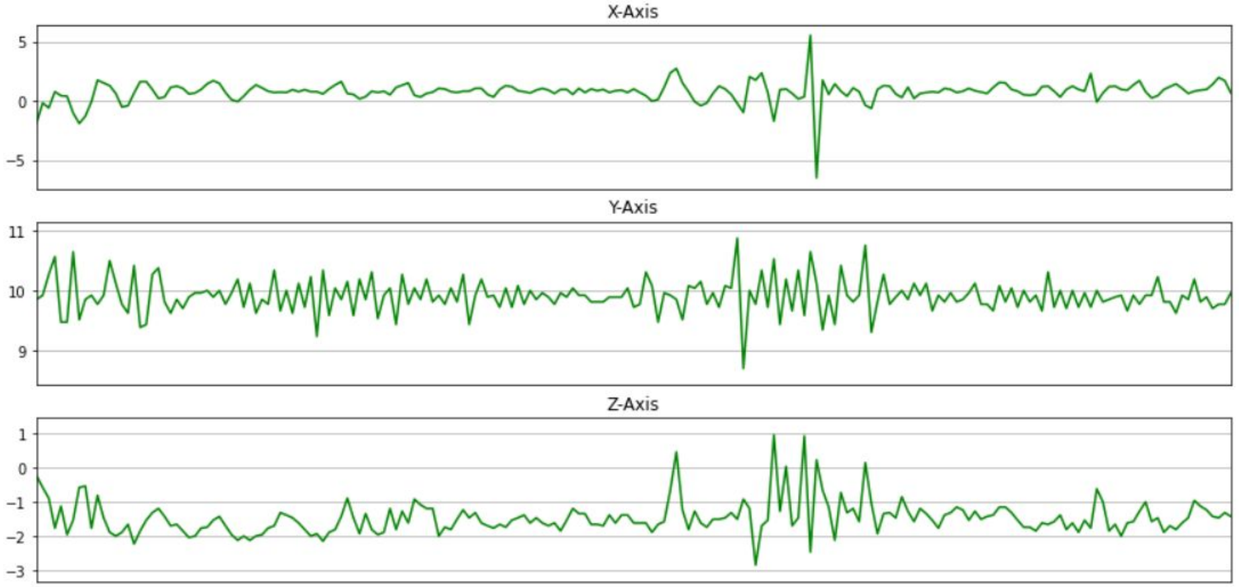
WISDM – Wireless Sensor Data Mining

- Number of examples: 1,098,207
- Number of attributes: 6
- Missing attribute values: None
- Class Distribution
  - Walking: 424,400 (38.6%)
  - Jogging: 342,177 (31.2%)
  - Upstairs: 122,869 (11.2%)
  - Downstairs: 100,427 (9.1%)
  - Sitting: 59,939 (5.5%)
  - Standing: 48,395 (4.4%)

Sitting

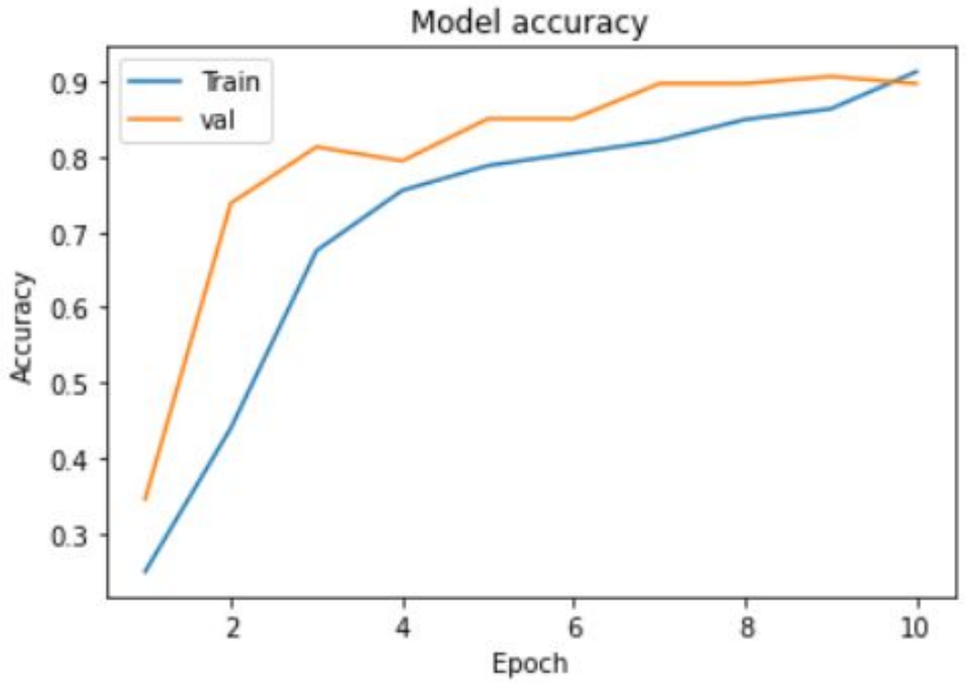


Standing



Implementation Steps:

- Standardize data
- Frame Preparation
- 2D CNN Model



Model's Learning Curve

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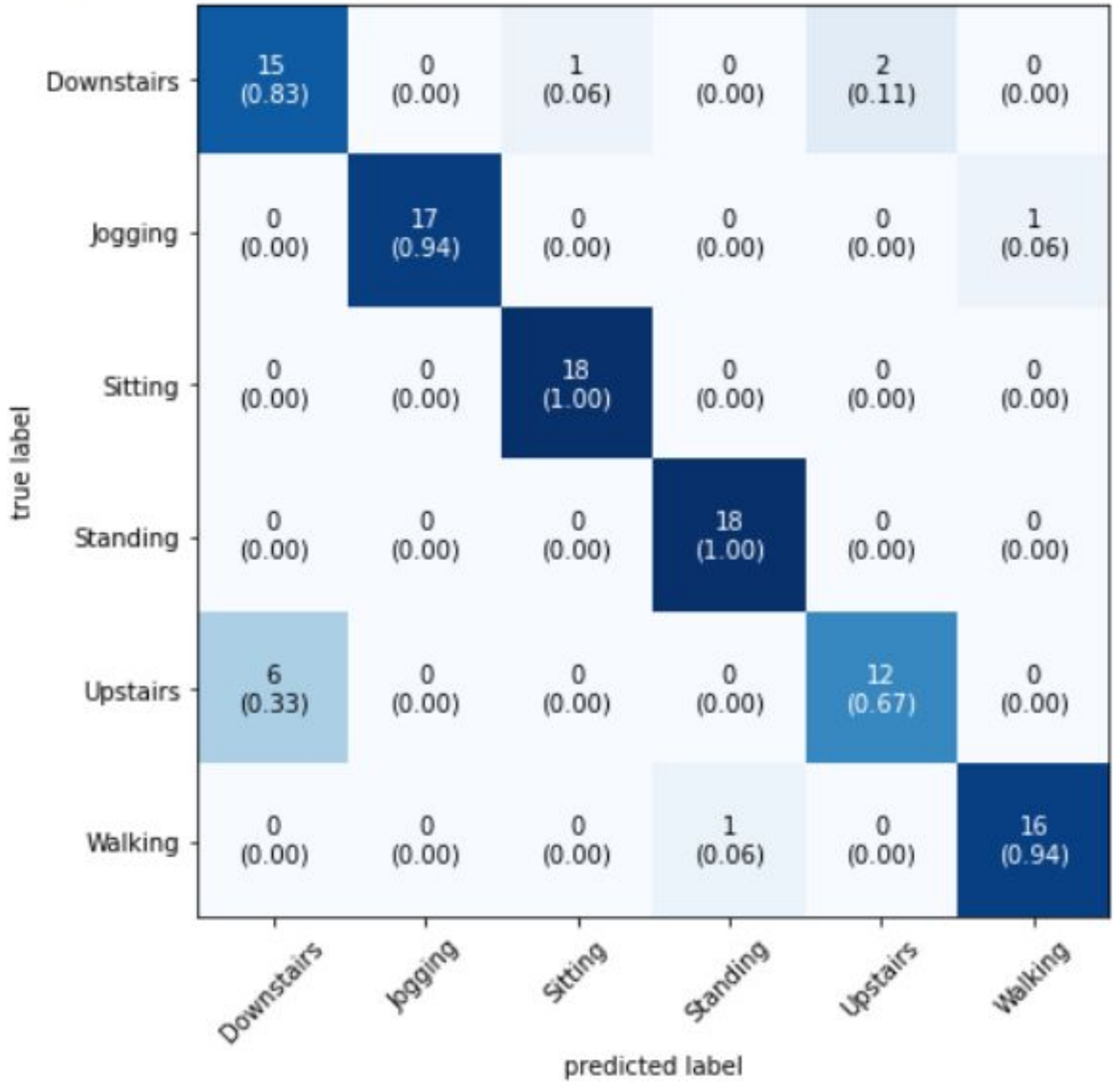

Conclusion

- Studied multiple papers related to Human Activity Recognition to find out the most suitable methodology
- Compared multiple models to find out the best method, tested multiple models on two different datasets
- Analysed the best method for classification of Human Activity with different feature selection techniques - Logistic Regression Classifier
- Successfully distinguished between hard-to-distinguish activities like Sitting and Standing with 100% accuracy using 2D CNN Model

References

- **Paper 1** - Human activity recognition using smartphone sensors
- **Paper 2** - Human activity recognition using smartphone sensors with two-stage continuous hidden Markov models
- **Dataset 1 -** https://www.kaggle.com/datasets/uciml/human-activity-recognition-with-smartphones
- **Dataset 2 -** https://www.cis.fordham.edu/wisdm/dataset.php

Thank You