



Sensor-Based Single-User Activity Recognition

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Motivation

- Improving Smartphone Technology
- Better Build-In Sensors
- Motion Co-Processor

Apple M7

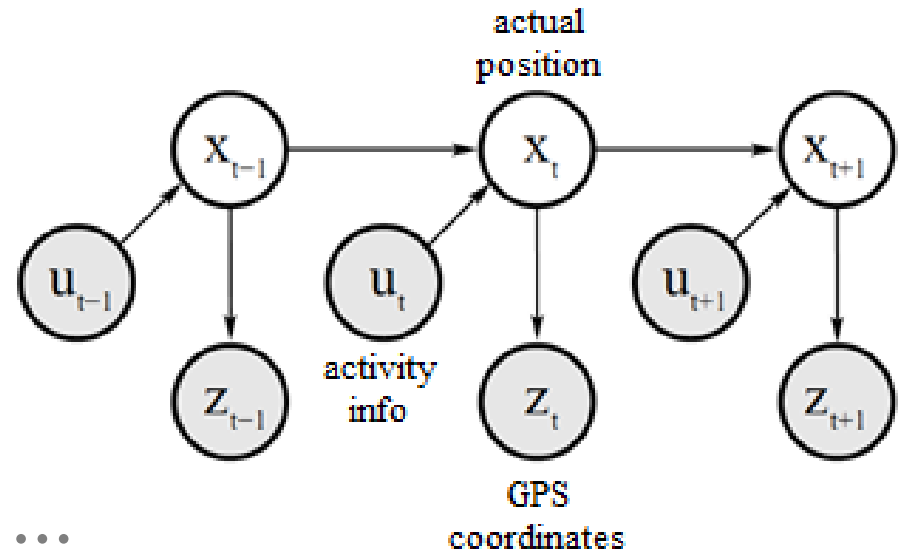


The NXP LPC18A1, also known as the M7 motion co-processor.

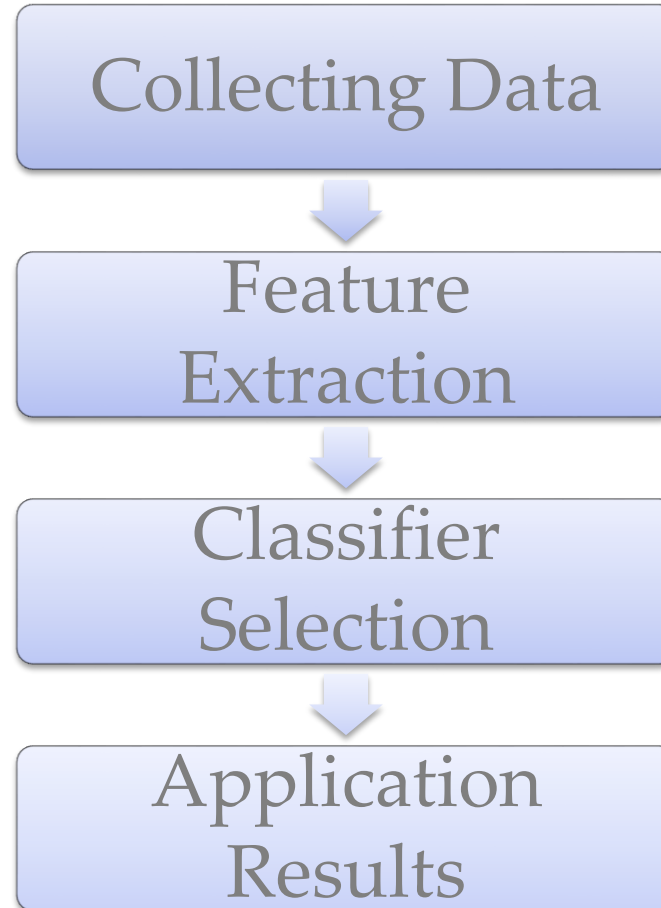
Produced	From September 2013 to present
Designed by	Apple Inc.
Common manufacturer(s)	NXP Semiconductors ^[1]
Max. CPU clock rate	0.150 ^[2] GHz
Min. feature size	90 nm ^[2]
Instruction set	ARMv7-M ^[2]
Microarchitecture	Cortex-M3 ^[2]
Product code	LPC18A1 ^[1]
Cores	1 ^[2]

Possible Applications

- Healthcare
- Bussines
- Transportation, ...

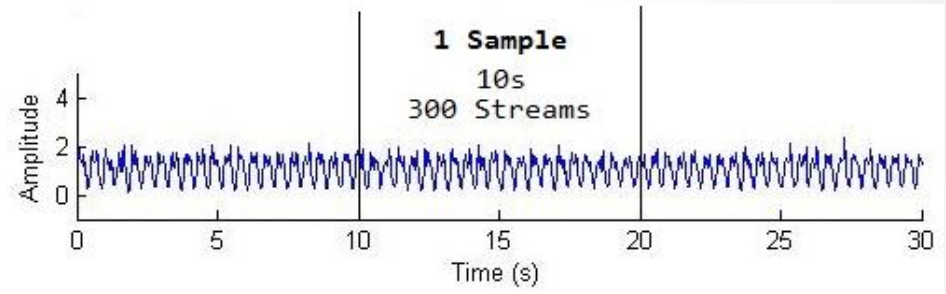


Outline – Workflow



Collecting Data

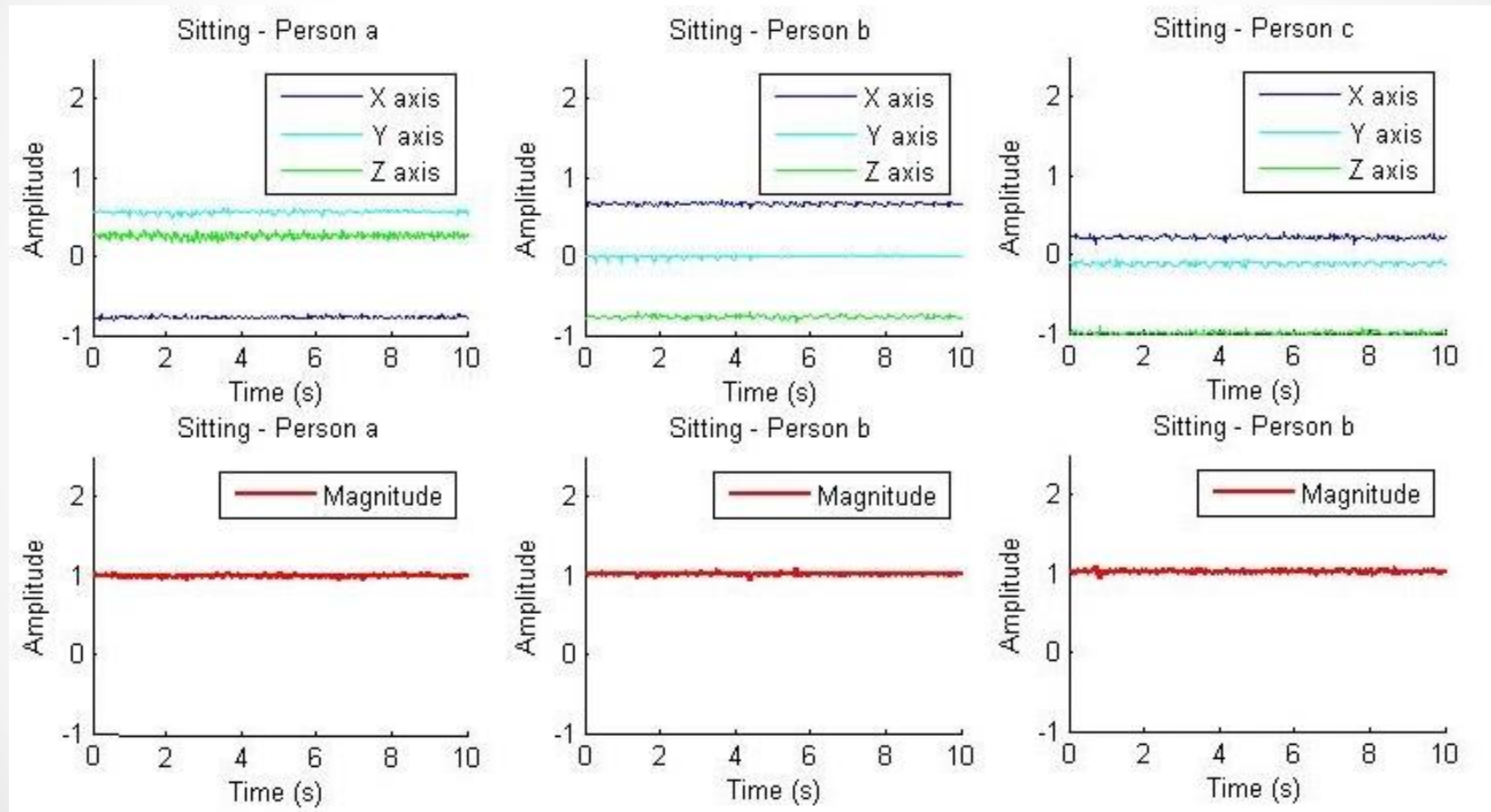
- Mobile App
 - SensorLogger
- Extracting Data
 - 30Hz
- Sample
 - 10s
- Training Data Set
 - 1750 samples (5h)



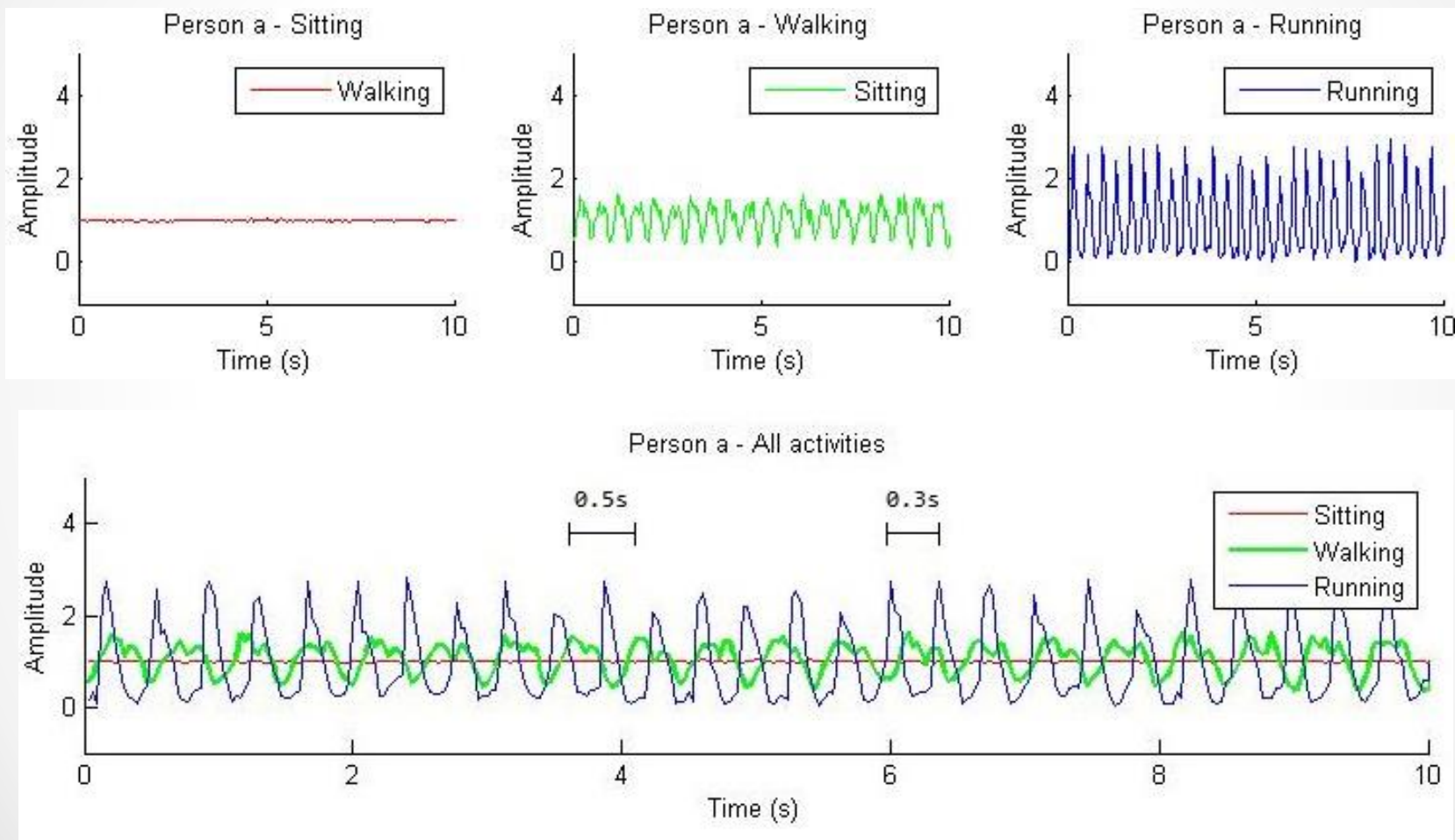
Person	Standing	Walking	Running
a	80	77	80
b	79	116	94
c	79	78	59
d	92	86	68
e	68	92	86
f	166	79	78
g	68	63	62
Sum	632	591	527

Table: *Training data set*

Orientation Problem



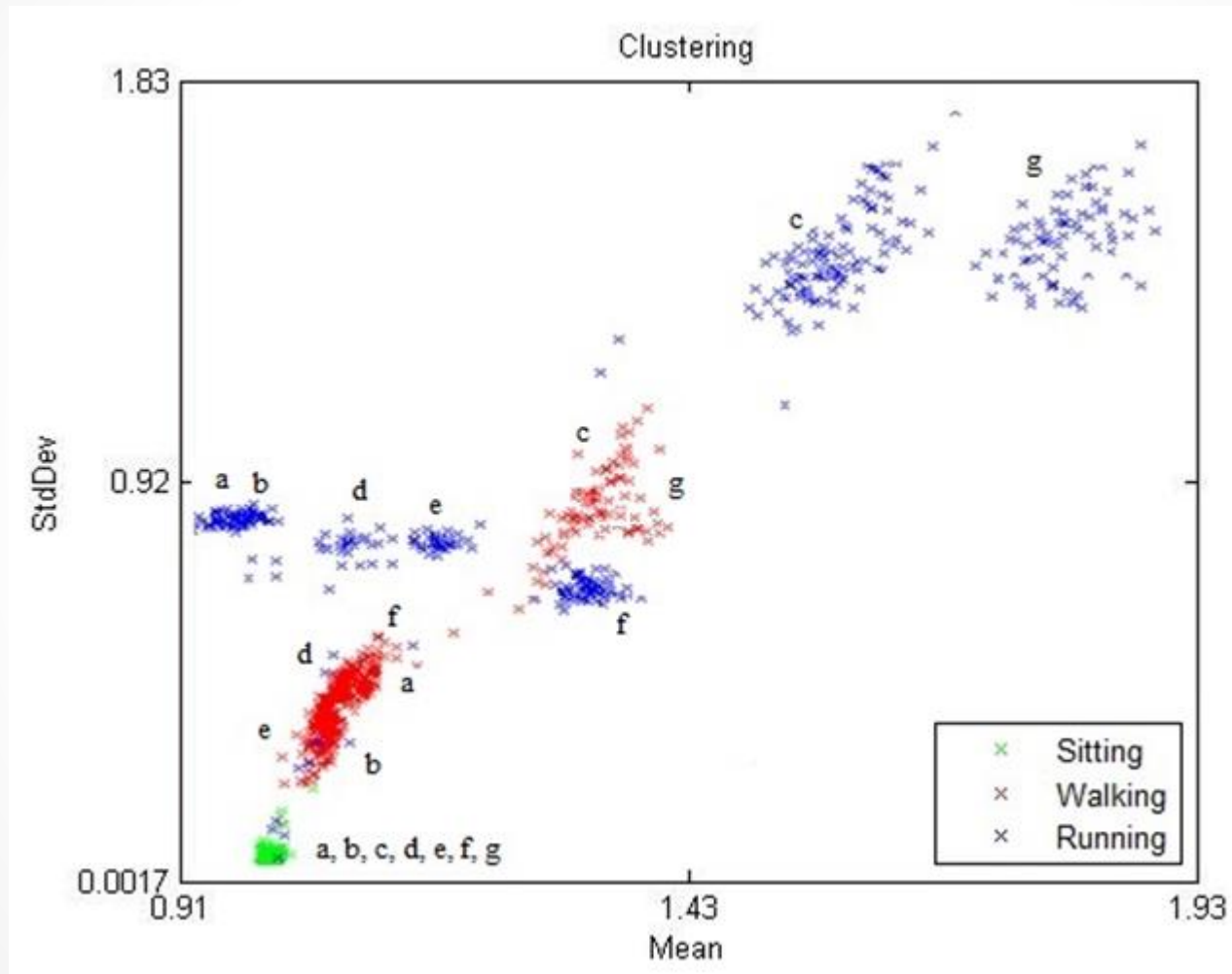
Raw Accelerometer Data



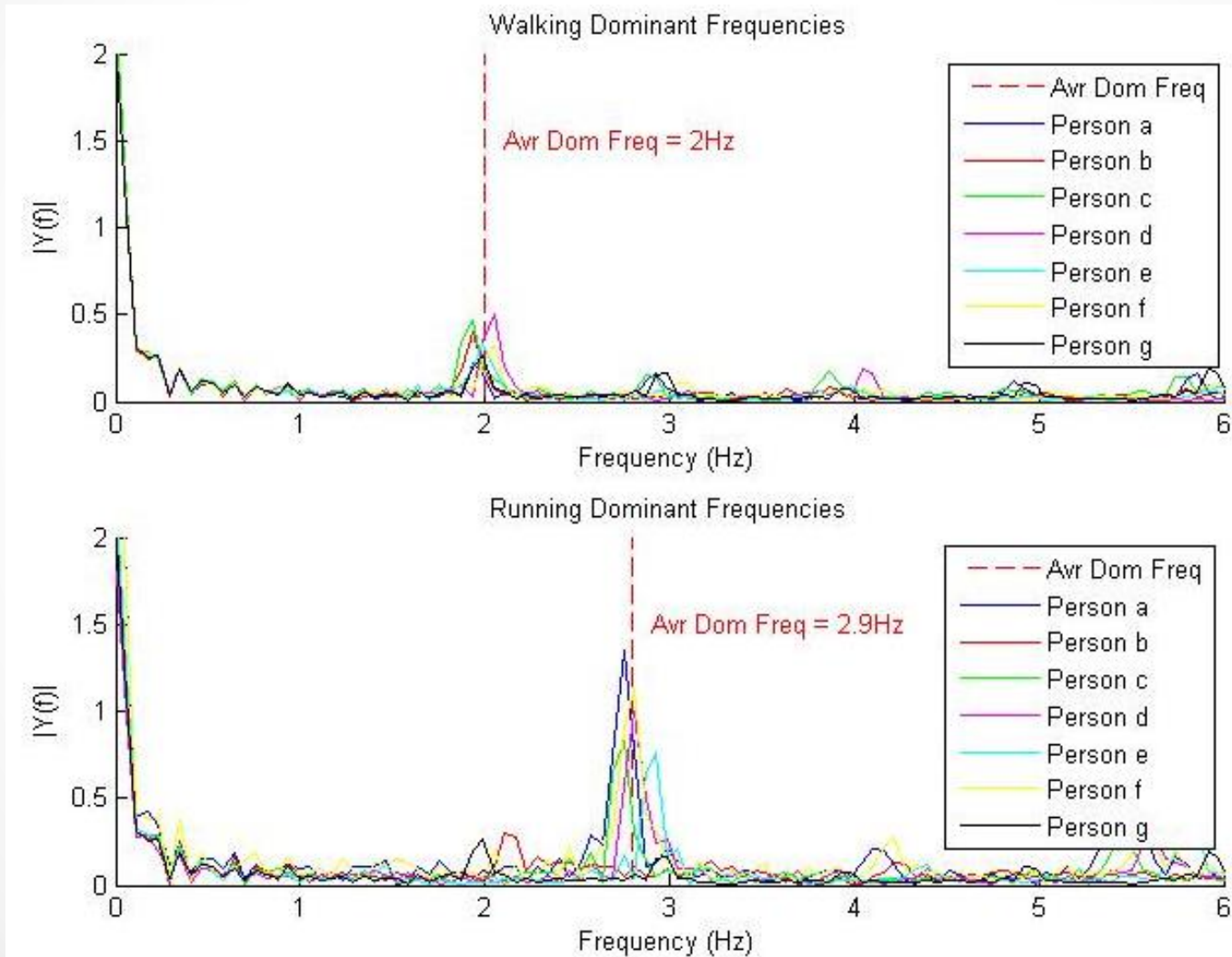
Extracting Features

- All Features Set
 - {mean, standard deviation, variance, median, root mean square, skewness, kurtosis, 25th percentile, 75th percentile, inter-quartile, mean crossing rate, dominant frequency, DFTs energy, spectral entropy, xy correlations, xz correlation, yz correlation}
- Simplified Features Set
 - {mean, standard deviation, 75th percentile, dominant frequency, xy correlation}
- Mean & StdDev Set
 - {mean, standard deviation}

Mean & StdDev



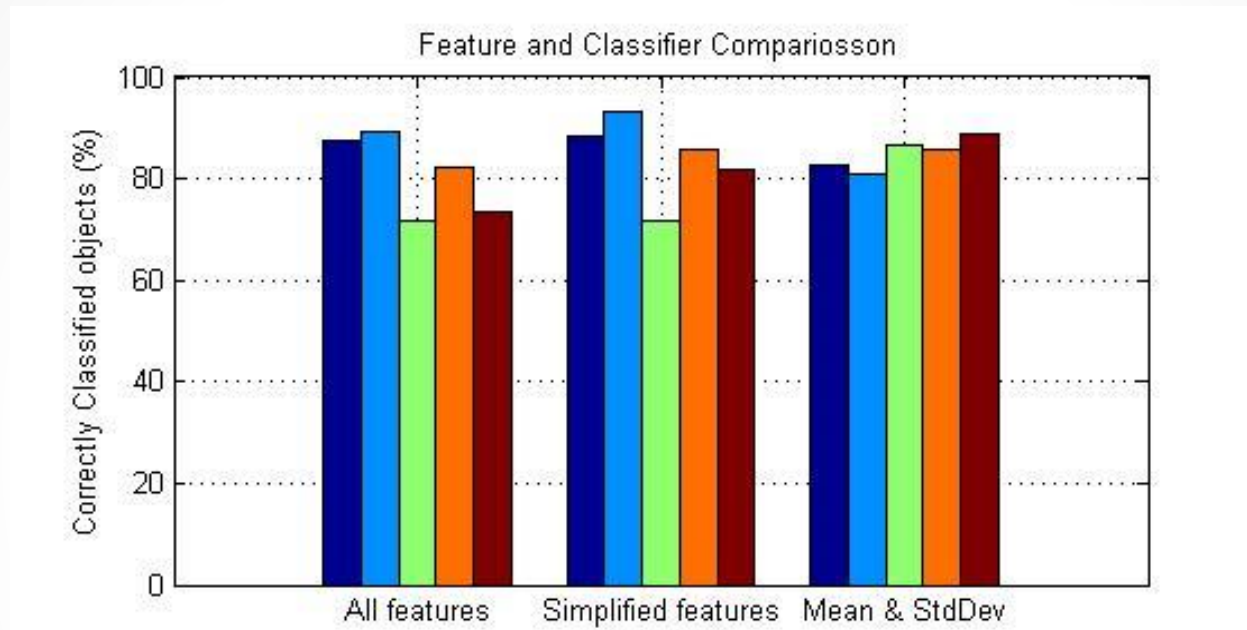
Dominant Frequency



Classifier Seleciton

- Weka Toolkit
 - Open Source Machine learning Software
 - Collection of machine learning algorithms for data mining tasks
 - ARFF (Attribute Relationship File Format)
- Tested Machine Learning algorithms
 - Desicion Tree (J.48)
 - Naive Bayes (NB)
 - K-Neares Neighbor (IBK)
 - Support Vector Machine (SMO)
 - Neural Network (Mulitlayer Perceptron)

Classifier Evaluation



Classifier	All features	Simplified features	Mean & StdDev
Decision Tree (J.48)	87,3%	88,2%	82,7%
Naive Bayes (NB)	89,2%	93,2%	80,9%
k-Nearest Neighbor (IBK)	71,9%	71,6%	86,7%
Support Vector Machine (SMO)	82,1%	85,9%	85,9%
Neural Network (Multilayer Perceptron)	73,3%	82%	88,6%

Naive Bayes Classifier

- Experiment
 - Learning set: 1750 Labeled Samples
 - Input: 294 New Labeled Samples
 - Result: 283 Correctly Classified (96%)

Labeled input data	Recognized activity		
	Running	Walking	Sitting
Running	92	2	0
Walking	0	116	5
Sitting	0	4	75

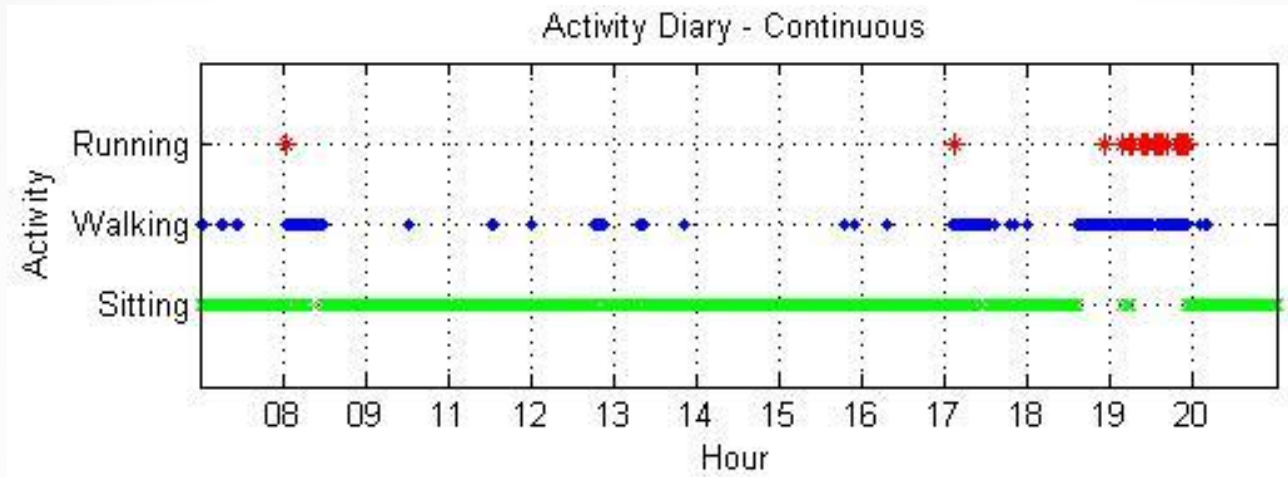
Table 2: *Confusion matrix*

Practical Application

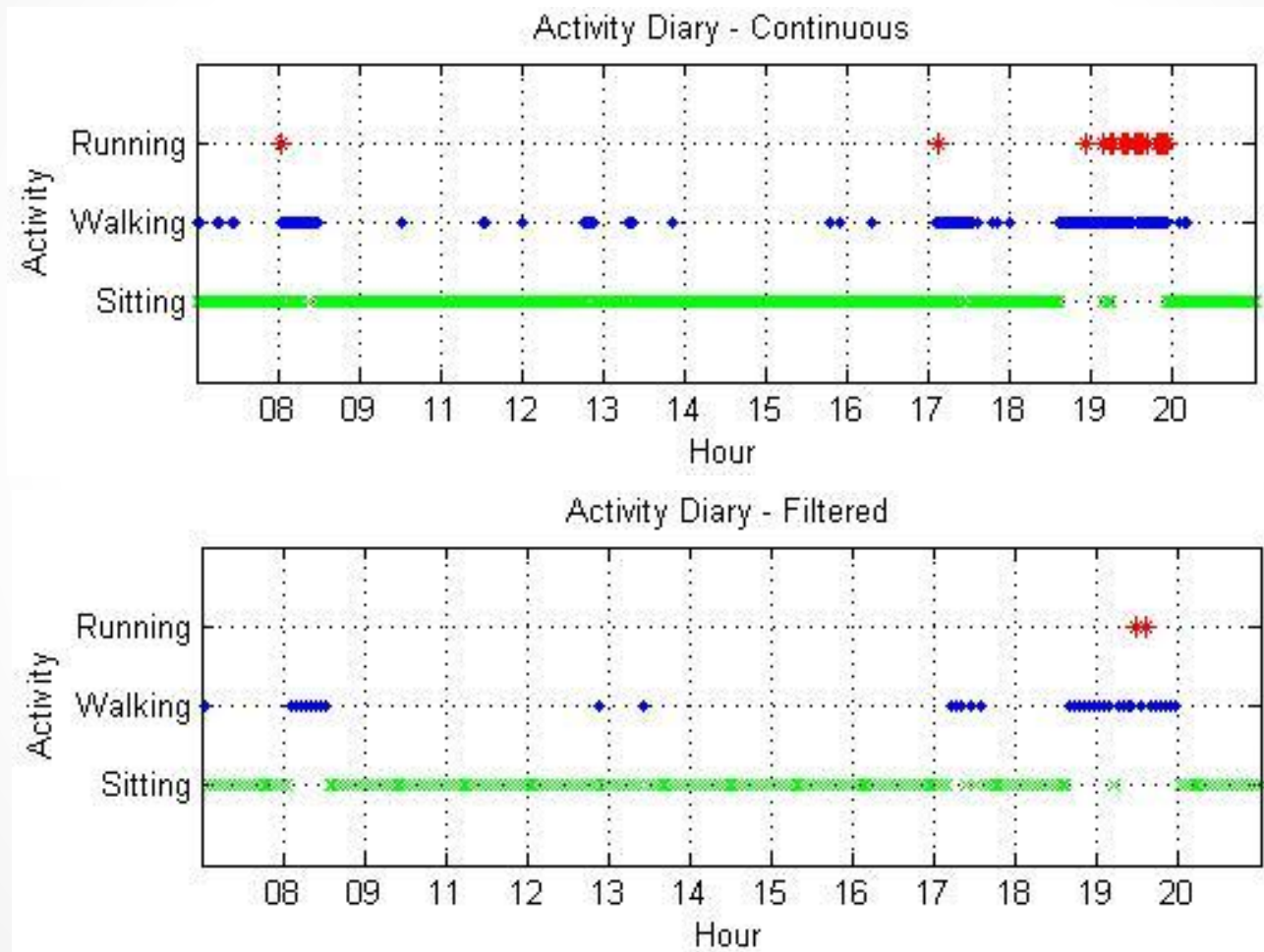
- Activity Diary
- Twelve hours of data recorded
- Filtering data



Results



Results



Future Work

- Increase number of recognizable activities
 - Sitting, walking, running, standing, hiking, cycling driving, shopping...
- Include more sensors
 - GPS, gyroscope, compass, ...
- Larger training set, larger testing set
- Sampling frequency, window sizes

Thank You for Your
Attention