

# Human Activity Recognition: A method combining smartphone and wearable device signals analysis

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## DATA

Accelerometer data on waist, left thigh, right ankle, right upper arm, from 4 users and 5 motion categories\*

Motion	Occurrences
Sitting	50631
Sit down	11827
Standing	47370
Stand up	12415
Walking	43390

Table 1. Motion occurrences in dataset

## DATA PROCESS

### Zscore Scaling:

$$Zscore(x_i) = \frac{x_i - \mu}{\sigma}$$

$\mu$ : mean

$\sigma$ : standard deviation

### 0-1 Normalization:

$$Normalization(x_i) = \frac{x_i - x_{min}}{x_{max} - x_{min}}$$

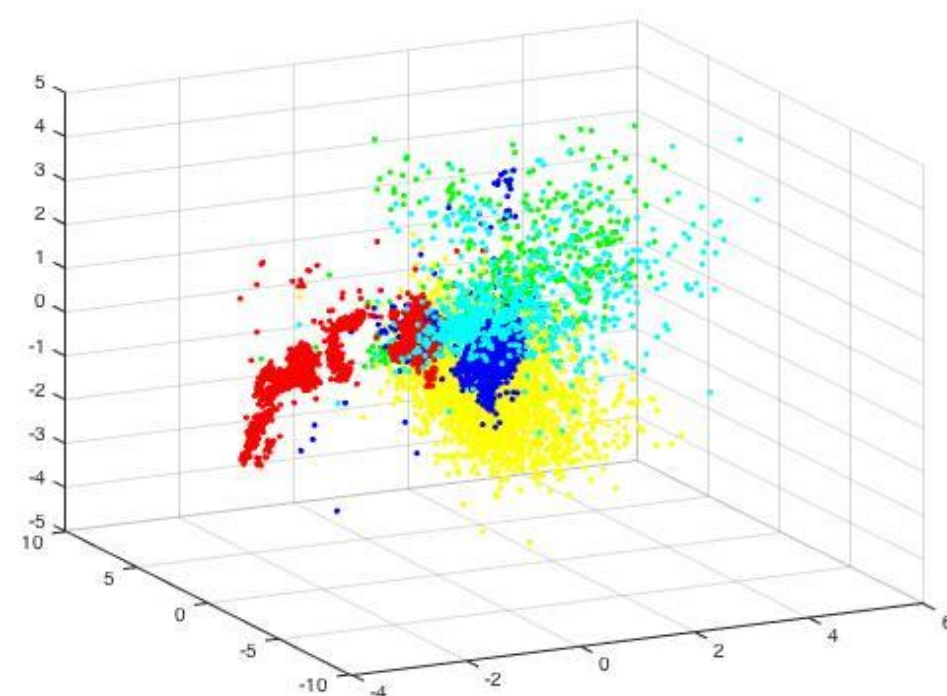


Figure 1. PCA Visualization of 10,000 Zscore data

## GDA

### Gaussian Discriminant Analysis

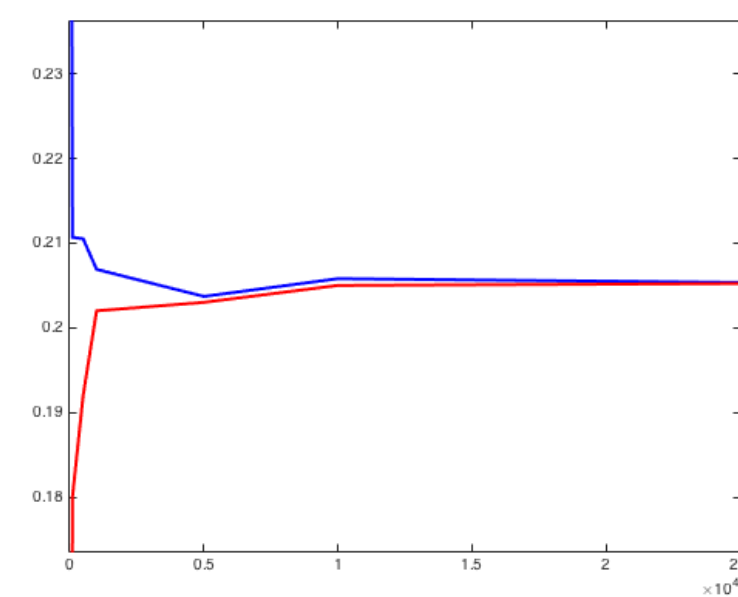


Figure 2. GDA same covariance matrix error vs training set size

Training Accuracy %	Generalization Accuracy %
79.29	79.59

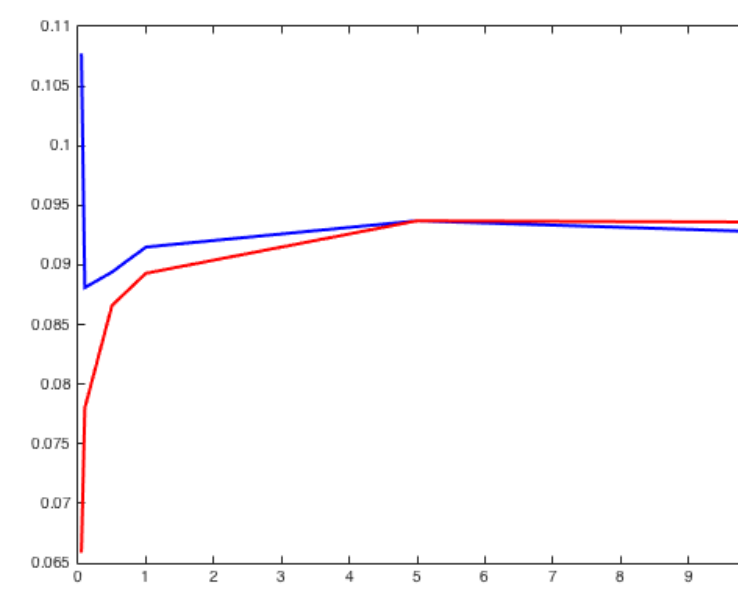


Figure 3. GDA different covariance matrix error vs training set size

Training Accuracy %	Generalization Accuracy %
90.64	90.72

### GDA Using Scaled data

GDA (different covariance matrix)	Unscaled	0-1 Normalized	Zscore
Training Accuracy %	90.64	90.64	90.63
Generalization Accuracy %	90.72	90.87	90.71

Table 2. Accuracy vs data-scaling

## SVM – All Sensors

### Support Vector Machines

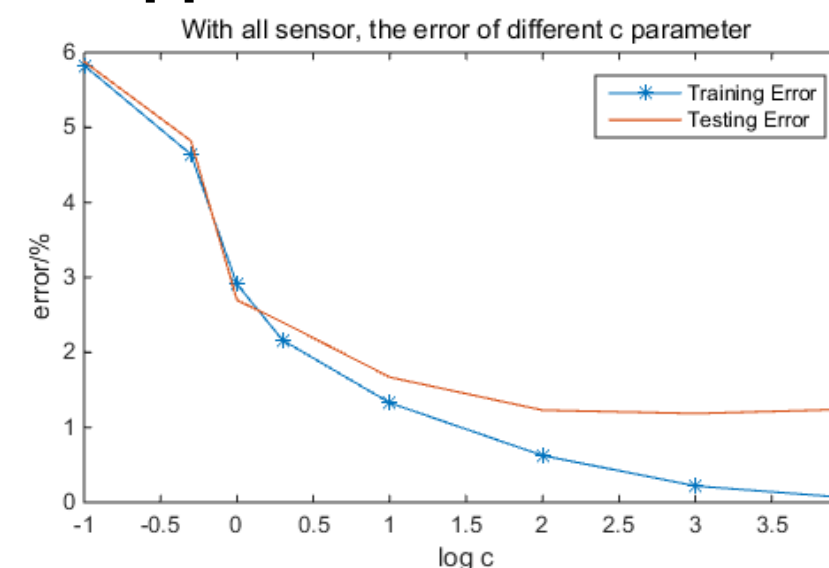


Figure 4. Error vs logC Kernel RBF Training Data Size: 100,000

	sitting	sitting down	standing	standing up	walking	all
Training Accuracy %	100.00	99.61	99.85	99.54	99.56	99.78
Generalization Accuracy %	99.86	96.69	99.38	96.62	98.19	98.81

Table 3. Accuracy of different classes Kernel: RBF, C=1000, Training Data Size: 100,000

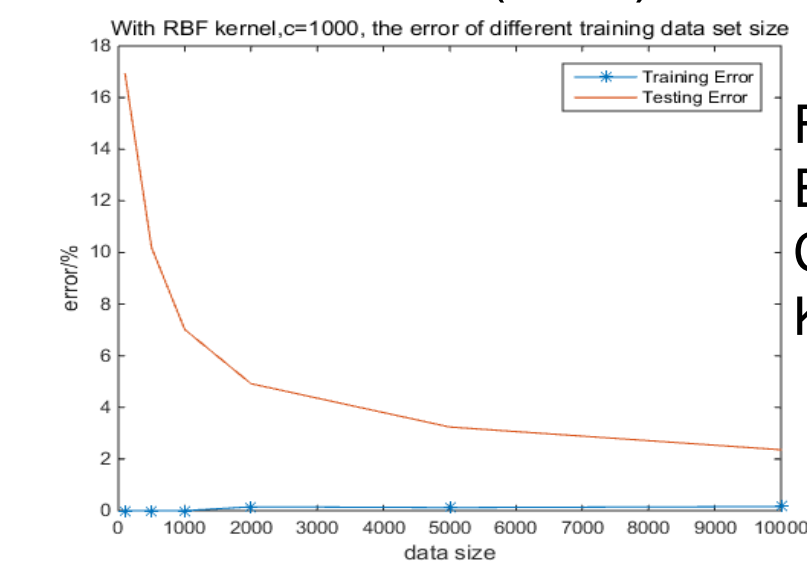


Figure 5. Error vs training set size C = 1000 Kernel RBF

## SVM – Two Sensors

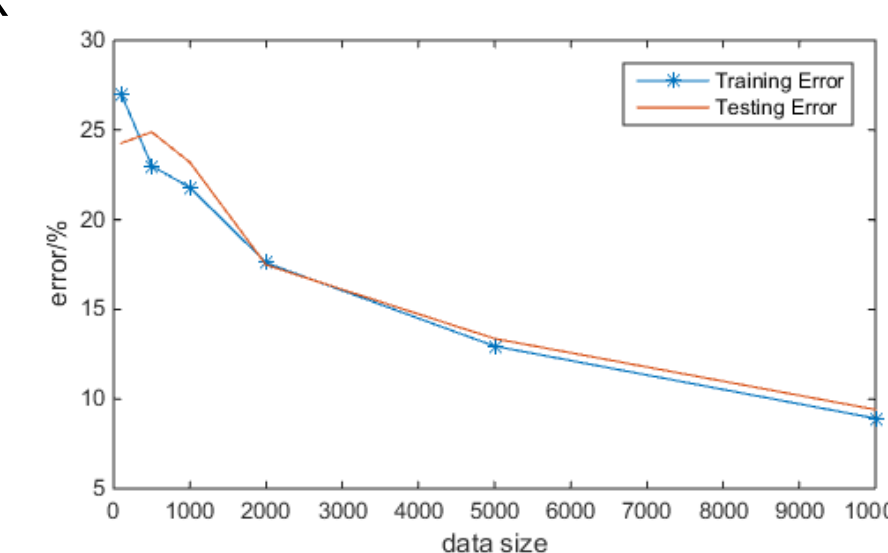


Figure 6. Error vs training set size C = 0.1 Kernel RBF

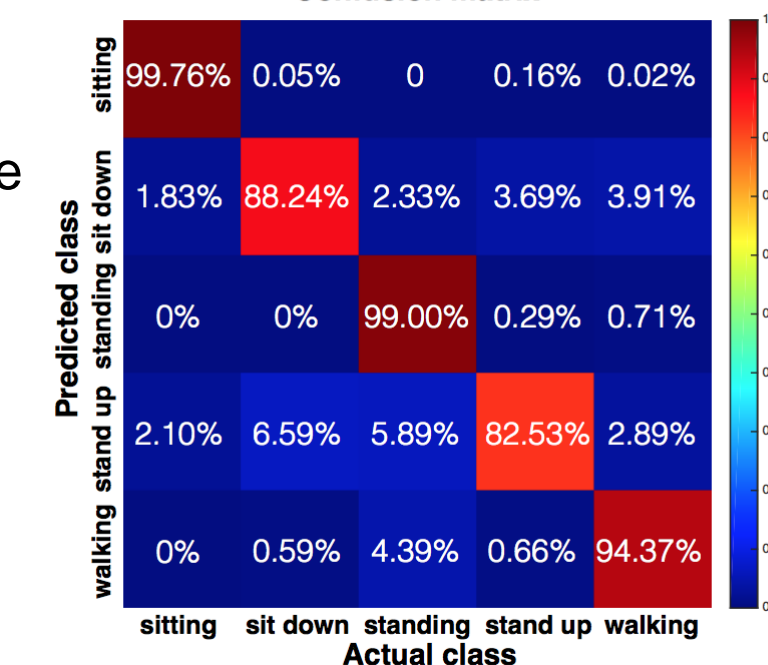


Figure 7. Confusion Matrix C = 2000 Kernel RBF

	sitting	sitting down	standing	standing up	walking	all
waist and left thigh	99.81	89.53	99.24	83.90	94.84	96.41
Training Accuracy %	99.76	88.24	99.00	82.53	94.37	96.04
Generalization Accuracy %						
waist and right upper arm	99.66	90.75	98.16	77.39	90.24	94.44
Training Accuracy %	99.51	87.74	98.04	76.62	89.26	93.90
Generalization Accuracy %						
waist and ankle	99.64	82.07	98.51	72.42	93.02	94.23
Training Accuracy %	99.65	80.30	98.48	70.68	92.35	93.88
Generalization Accuracy %						

Table 3. Accuracy of different classes Kernel: RBF, C=2000, Training Data Size: 100,000

\* Wearable Computing: Classification of Body Postures and Movements (PUC-Rio) Data Set [https://archive.ics.uci.edu/ml/datasets/Wearable+Computing%3A+Classification+of+Body+Postures+and+Movements+\(PUC-Rio\)](https://archive.ics.uci.edu/ml/datasets/Wearable+Computing%3A+Classification+of+Body+Postures+and+Movements+(PUC-Rio))