



# Recognition of Human Activities for Wellness Management Using a Smartphone and a Smartwatch: A Boosting Approach

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# Introduction

**Wellness Management:** Systematic management of daily activities to achieve health goals.

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graph TD; A[Wellness Management] --> B[Mobile Health]; B --> C[Problem]; C --> D[Research Question];
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**Mobile Health (mHealth):** Use of smart devices (smartphones, smartwatches) for health monitoring.

**Problem:** Human Activity Recognition (HAR) in natural settings is challenging due to noise and variability.

**Research Question:** How accurate are machine learning methods in identifying human activities using naturally used devices in natural settings?

# Research Objectives

Develop a HAR system using multimodal sensors in smartphones and smartwatches.

- Investigate the use of boosting algorithms for Human Activity Recognition (HAR).

- Compare performance of smartphones and smartwatches in activity detection.

# Methodology

- **Data Collection:** Used the publicly available Extrasensory dataset.
  - **Dataset:** 308,320 labelled examples from 60 users.
  - **Sensors:** Accelerometer, gyroscope, magnetometer (smartphone), and accelerometer, compass (smartwatch).
- **Activities:** Walking, standing, sitting, exercise, and sleeping.
- **Feature Extraction:** 138 features extracted from sensor data.
- **Classification Algorithms:** XgBoost, AdaBoost, Boosted C5.0

# Data Preprocessing

- **Data Cleaning:** Removed data points with missing sensor information.
- **Feature Scaling:** Normalized all features.
- **Data Partitioning:** 60% training, 40% testing.
- **Class Imbalance Handling:** Used undersampling to balance the dataset.



# Boosting Algorithms

## XgBoost:

- Gradient boosting framework.
- Implements system optimization and regularization.
- Prevents overfitting using shrinkage and feature subsampling.

## AdaBoost:

- Adaptive boosting with weighted decision trees.
- Adjusts weights based on misclassification rates.
- Combines weak learners to form a strong classifier.

## Boosted C5.0:

- Extension of C4.5 algorithm.
- Converts decision trees into rule sets.
- Adaptive boosting with iterative improvement.

# Feature Engineering

**Step 1:** Compare smartphone vs. smartwatch sensor features.



**Step 2:** Identify important features using Gini index and feature importance scores.



## Results:

Smartphone sensors (accelerometer, magnetometer) contributed more to HAR.

Smartwatch sensors were less effective but useful for specific activities (e.g., walking, exercise).

# Performance Metrics

## Metrics:

- **F1 Score:** Harmonic mean of precision and recall.
- **Accuracy:** Average of recall and specificity.

## Results:

- **AdaBoost** outperformed other algorithms for most activities.
- **Boosted C5.0** was best for detecting "sleeping."
- **XgBoost** showed competitive performance but was slightly less accurate than AdaBoost.



# Comparison with Standard ML Algorithms

- **Benchmark Algorithms:** Neural Networks, SVM, Logistic Regression, Multi-Layer Perceptron.
- **Results:**
  - Boosting algorithms (AdaBoost, XgBoost, Boosted C5.0) outperformed standard ML algorithms.
  - SVM performed relatively well among standard ML techniques but was less accurate than boosting methods.

# Feature Engineering Impact

- **Smartphone Sensors:**
  - Accelerometer and magnetometer were most important.
  - Improved accuracy for standing, sitting, and sleeping.
- **Smartwatch Sensors:**
  - Accelerometer was useful for walking and exercise.
  - Combined smartphone and smartwatch features improved accuracy for walking and exercise.



# Conclusion

- **Key Findings:**
  - Boosting algorithms (AdaBoost, XgBoost, Boosted C5.0) are highly effective for HAR in natural settings.
  - Smartphone sensors are more effective than smartwatch sensors for most activities.
  - Feature engineering significantly improves classification accuracy.
- **Future Research:**
  - Explore deep learning and bagging techniques for HAR.

# Reference

You can find the presented paper here

[https://www.sciencedirect.com/science/article/abs/pii/S0167923620301810?casa\\_token=qMi78D6VH7MAAAAAA:g6tso1VLj\\_JbqaWgUimtgV8DWAE7TgrpNSm6n-n8ilUkMrP8UHi2pdNMq4gnw\\_f7WgFm26o](https://www.sciencedirect.com/science/article/abs/pii/S0167923620301810?casa_token=qMi78D6VH7MAAAAAA:g6tso1VLj_JbqaWgUimtgV8DWAE7TgrpNSm6n-n8ilUkMrP8UHi2pdNMq4gnw_f7WgFm26o)



**Thank you**