Team 17 Activity Detection using Biosignals from Wearable Devices

Tong Shan, Dushyanth Sirivolu, Fulya Tastan, Philip Barron, Larsen Linov, Ming Li

Github repository

Objective

- Creates machine learning models to recognize human daily activities from biosignals recorded by wearable devices.

Dataset

- We used the public dataset: ScientISST MOVE.
- There were 17 study participants, ≈1 hour of data per person (sampling frequency=500 Hz).
- The sensors recorded 14 raw biosignals in 6 categories: Electrocardiography (ECG), Electrodermal activity (EDA), Photoplethysmography (PPG), Acceleration (ACC), Electromyography (EMG), Skin temperature (TMP).
- Corresponding to 8 activities: Baseline, Lift, Greetings, Gesticulate, Jumps, Walk_before, Run, Walk_after.

Data processing

- Timepoints where the signal was missing or obviously incorrect were excluded.
- Continuous biosignal from each activity period in each subject was segmented into 10-second segments
- Features from time domain, frequency domain and statistical metrics were extracted using existing packages (BIOBSS, BioSPPy, Neurokit2) and custom functions.

Activity Classification ML Models

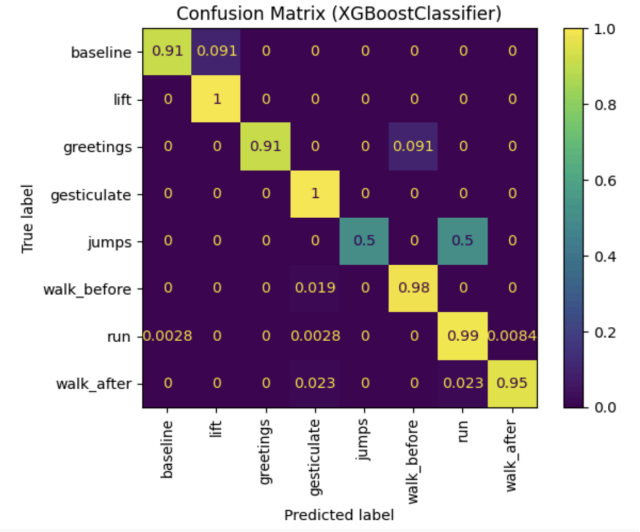
Hyperparameters were optimized through grid search by cross-validation in training set

- Random forest
- Support vector machine (SVM)
- Logistic/softmax regression
- XGBoost

Results

The models all did well on classification on the test set, here are the log loss scores of each model and the confusion matrix from XGBoostClassifier. It is also found that the most important features in recognizing human activities come from the Acceleration (ACC) biosignal.

Algorithms/Scores	Log Loss Score
Logistic/SoftMax Regression	0.1263
Support Vector Machine	0.1165
Random Forest Classifier	0.1399
XGBoostClassifier	0.0677



Future Iterations

- **Data**: Biosignal cleanings/processings, missing value imputation, different segmentation length, more sophisticated feature extractions, improvement on class imbalance
- **Algorithm**: In-depth hyperparameter tuning; Other non-feature based algorithms like convolutional neural network based time series classification

Application

- Our algorithms can be used for wearable devices to estimate user daily activities