école normale supérieure paris–saclay

CENTRE BORELLI

Mini-Project - ML for Time Series

L.Oudre & C.Truong

TSFEL: Time series feature extraction library

Barandas et. al, 2020

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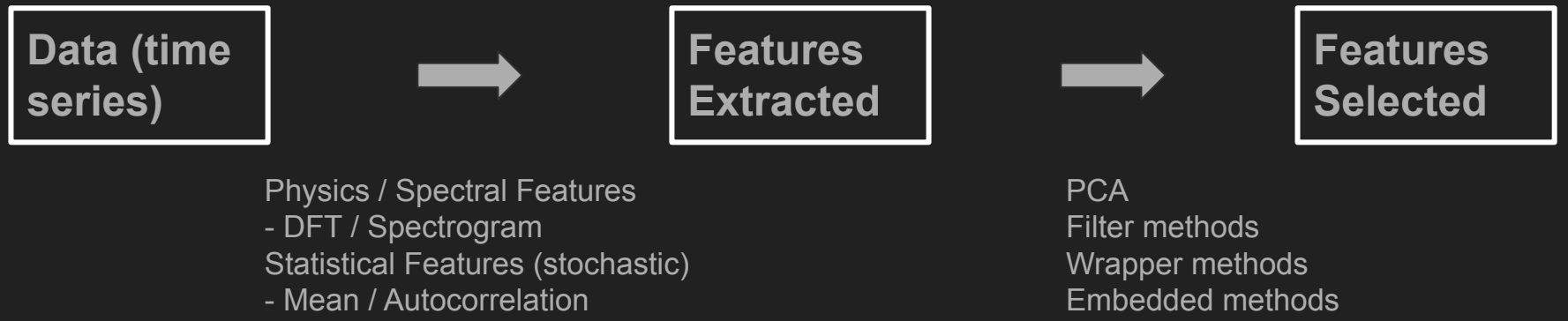
Feature Extraction; curse or challenge ?

→ 1) Extract a set of D features that characterizes the TS

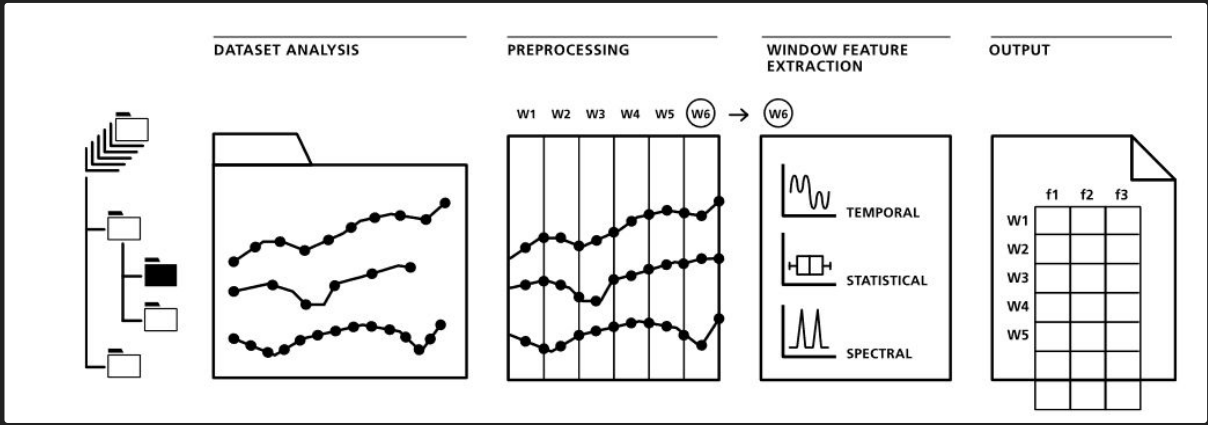
→ 2) Select the K<D features that are relevant for specific task



What is TSFEL ?

→ A Python Package

→ It computes over 60 different features across temporal, statistical and spectral domain.



To what extent can the extraction of generic features provide answers to a wide range of problems?

- Method
- Datasets
- Results
- Analysis

- **Method**
- Datasets
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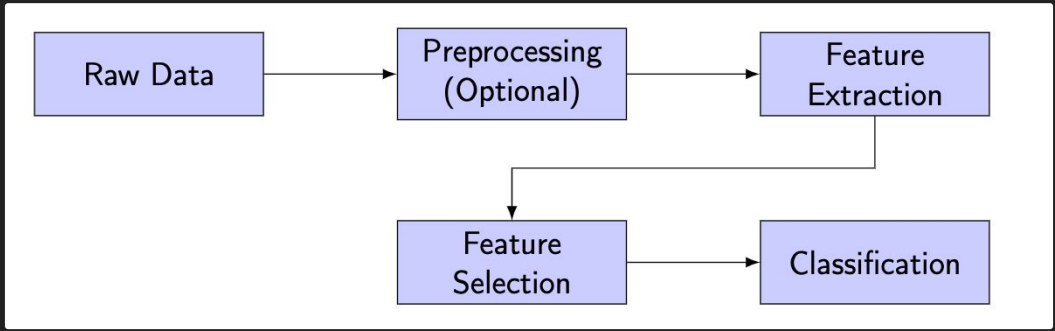
Method



Feature Extraction:

- Traditional method,using features specific to the dataset.
- TSFEL, TSFRESH and CESIUM libraries to extract generic features and select the most relevant ones.

Classification:

- Comparison of the quality of the features by computing classification accuracy.

- Method
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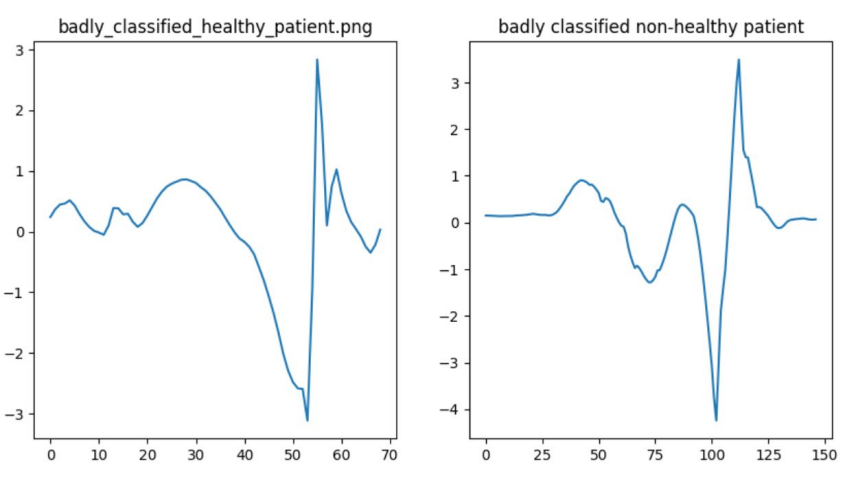
Dataset 1: Human Locomotion

Time series: Vertical acceleration from the left foot during 20 seconds

Objective: Classify footsteps in healthy/non-healthy

Personalized method : Train a kNN classifier based on the DTW distance with training data

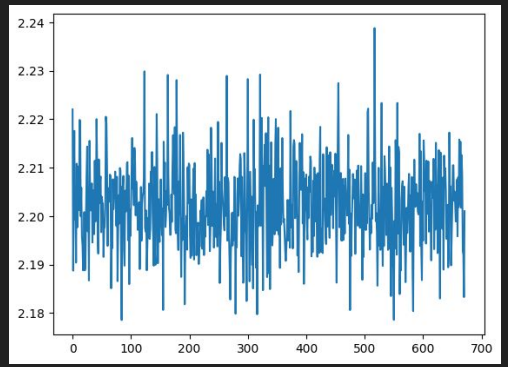


Dataset 2: Radars

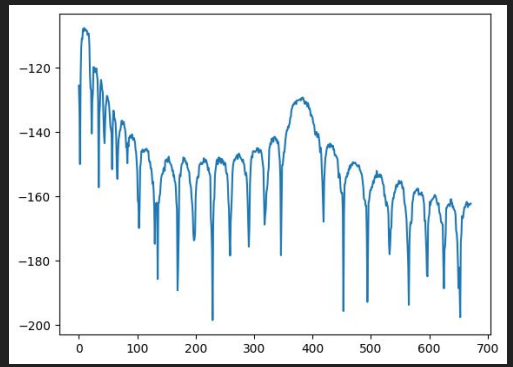
Time series: Pulse series described by its width, frequency, power and direction angle theta and phi.

Objective: Classifying radar as a ‘threat’ or ‘non-threat’ in a military context.

Personalized method : Specific features; weight and height of the largest lob in power, number of local minimum in power, estimation of the pulse sending frequency. Classifier → Random Forest.



← fréquence
puissance →

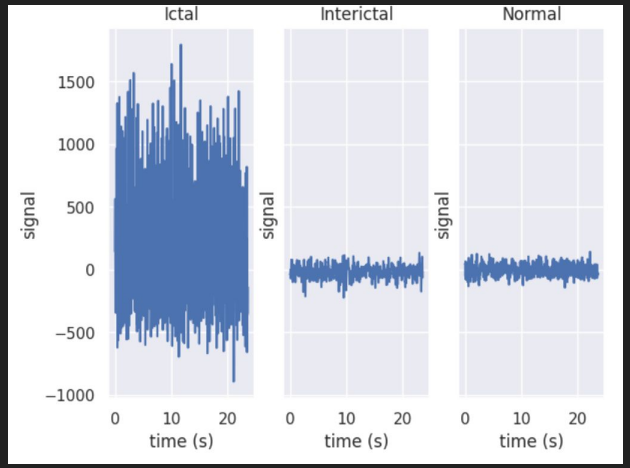


Dataset 3: EEG for epilepsy detection

Time series: EEG Time Series Dataset

Objective: Classify between three classes, normal, interictal, ictal.

Personalized method : Custom features / Multi Channel wavelet transforms from the literature

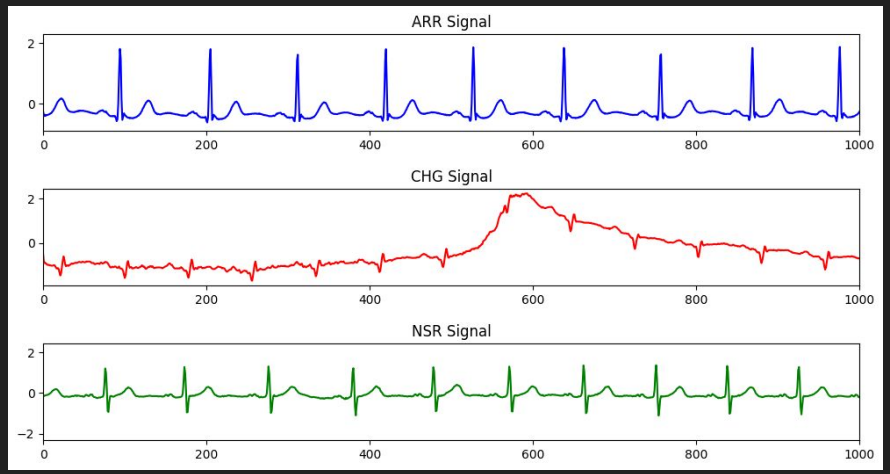


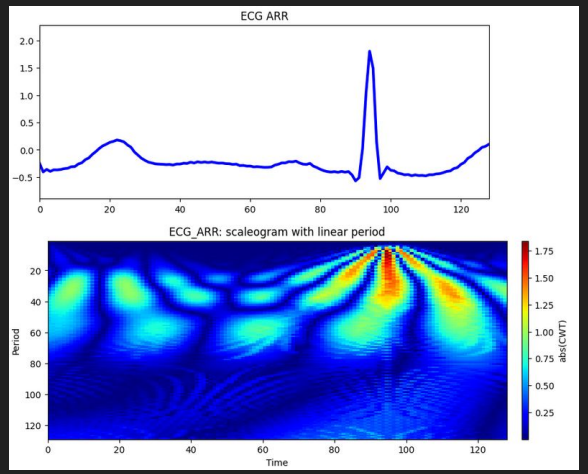
Dataset 4: ECG (Normal, Arrhythmia, CHG)

Time series: ECG dataset

Objective: Classify ECG in three classes; Normal, Arrhythmia and CHG

Personalized method : Frequency features (FFT), Time-Frequency domain features (Wavelet Transforms)





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Results

- **Human Locomotion**

Method	Accuracy
DTW	0.826923
TSFEL	0.711538
CESIUM	0.634615
TSFRESH MINI	0.596154
TSFRESH EFFICIENT	0.653846
TSFRESH COMPREHENSIVE	0.653846

- **Radars**

Method	Accuracy
personalized	0.88375
TSFEL	0.90250
CESIUM	0.89625
TSFRESH MINI	0.67000
TSFRESH EFFICIENT	0.77125

Results

- **EEG for epilepsy detection**

	Test Accuracy
Cesium	0.832
TSFEL	0.968
TSFresh	0.944
TSFresh Mini	0.760
Guo et al.	0.832
Wavelet Transform	0.952

- **ECG (Normal, Arrhythmia and CHR)**

	Test Accuracy
FFT / Wavelet + NN	0.9573
TSFEL + NN	0,3057
TSFEL (Full dataset) + NN	0.6038
TSFEL + RandomForest	0.856
Cesium + RandomForst	0.976

- Method
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Analysis & Conclusion

- Results depend largely on the dataset

- DTW performs better than TSFEL on DS 1
- TSFEL performs better than personalized features on DS 2
- TSFEL performs a slightly better than wavelet transforms on DS 3
- Wavelet + NN performs better than TSFEL on DS 4 (classifier !)

Analysis & Conclusion

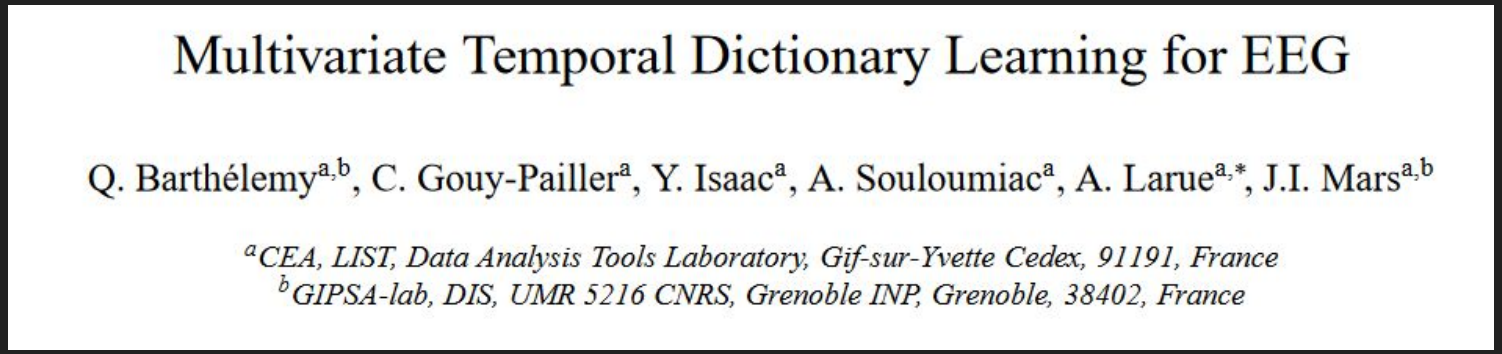
- TSFEL is a powerful tool for extracting predefined generic feature quickly and easily.

- TSFEL library should not replace the dataset analysis stage to give meaning to the data studied.

- TSFEL can be a powerful tool for obtaining initial results quickly on the dataset.

Outlooks

→ Dictionary Learning for Classification



Multivariate Temporal Dictionary Learning for EEG

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→ Other libraries should be studies (e.g sktime)


THANK YOU !