

# Applied AI in Biomedicine Project Report - Development of H.T.F. Deep-Learning Peak Classifier

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## I. CONTEXT

The goal of this project is to build a classification model that properly annotates each peaks as Normal, PAC (supraventricular beats) or PVC (ventricular beats). The available dataset is composed of 2-lead ECG signal and R peaks position of 105 patient recordings.

## II. INTRODUCTION

Electrocardiogram (ECG) signals records the electrical activity of the human hearts and consist of several waveforms (P, QRS, and T). The duration and shape of each waveform and the distances between different peaks are used to diagnose cardiovascular heart diseases (CVD). Premature atrial contractions (PAC) and premature ventricular contractions (PVC) are among the most common forms of arrhythmias; the first results from premature electrical activation originating in the atria of the heart, while the second one is caused by a premature electrical activation originating in the ventricles. As the presence of frequent PACs and PVCs are associated with a higher risk of unfavorable prognosis[1][2], the accurate recognition of these abnormal beats is strictly required. The aim of the this work is to design a deep-learning ensemble model that properly classifies all the peaks in a recording, without requiring the extraction of ECG features. The History-Time-Frequency Classifier analyzes each samples in both the time and frequency domain, and take as input also the labels assigned to the previous two samples. The miss-classification error on the test set was around 3%, highlighting the potential of our classifier.

### A. Data Loading

scegli il meglio

### B. Splitting

scegli eccampus

### C. Preprocessing

ti aspetto

## III. THE H.T.F. MODEL

1. Parlare del class imbalance? Undersampling? 2. Mettere il graphviz del modello?

hist\_plot.png

Fig. 1. Pathological interpeak distances over the 105 recordings. rca troia non si legge niente

### A. *H as History*

During a first inspection phase, an analysis on the distribution of pathological beats has been performed. In fig. 1a, the histogram reports the abnormal interpeak distances computed over all the recordings, confirming that PACs and PVCs often occurs in repeated patterns[3][4]. For these reasons, the involvement of the labels assigned to the previous peak could help in predicting more precisely the current peak. Considering the interpeak distances distributions, in this classifier the two previous labels has been added as further inputs of the ensemble model. ??

### B. *T as Time*

### C. *F as Frequency*

The last branch of this model consists in a frequency-domain classifier by a proper Fourier Transformation of the

inputs. In order to apply the Fourier Transform, the stationarity hypothesis has been assumed for each window. This is not an heavy assumption, since the inputs length is very short and most part of the window consists in the peak recorded. The classifier consist of multiple CNN-ReLU-MaxPooling stacks. A low filter size has been chosen to get useful features in a few amount of samples at a time. After the application of the FFT on the input signal, the output of the CNN layer is concatenated with the two history-labels as in the time model. Finally, a dense layer with a softmax AF provides the probability assigned to the three labels.

#### IV. TRAINING

<https://www.youtube.com/watch?v=dQw4w9WgXcQ>

#### V. RESULTS