Machine learning approach and waves synchronization improvement for the localization of Atrial Flutter circuit based on the 12-leads ECG

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The localization of the Atrial flutter (AFL) is of great interest for ablation planification. Regardless the direction of rotation of the corresponding reentry loop, its left or right atrium origin needs to be known beforehand. This localization is usually performed by using visual inspection of the 12-leads standard ECG that could be computerized. The aim of the study is to automatically classify the corresponding averaged F-waves by using one to five simple features. The averaged F-wave is computed by introducing a new multi-lead extension of a SVD based method for the wave resynchronization.

A dataset of ECG recorded from 56 subjects and comprising 25 left AFL and 31 right AFL will train the classifier. It is shown that the single lead SVD based wave synchronization is efficiently extended to 12 leads by computing the SVD of each group of waves for each lead and optimally combining the corresponding first singular values. From the subsequent averaged 12 leads F-wave, 3 groups (Gi) of features were extracted: G1-(min, max), G2-(integral of the negative, of the positive part), G3-(integral of the absolute value of the wave). A wrapper approach using an exhaustive search for feature selection is applied to maximize the mean classification accuracy computed over one to five features for each group (Gi) applied to the 12 leads. The logistic regression (LR) model is used for the supervised classifications.

The mean accuracy ranges for the three groups are G1:[0.68-0.83], G2:[0.68-0.81], G3:[0.65-0.76] for one feature up to five. The maximum accuracy comes from G1 with five features and is equal to 93%. The corresponding selected features are [max(I), max(III), max(V3), min(aVL), min(V5)]. In order to check for the risk of model overfitting, a leave one out cross-validation is performed with these five features and gives 86% for the accuracy.
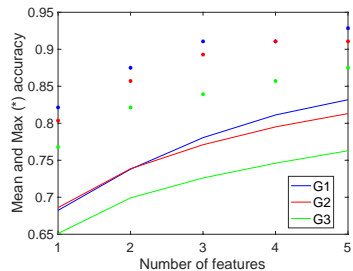
Mean and Max accuracy for the Gi's.