

# Automated Detection of Cardiovascular Anomalies in Electrocardiograms Using Feature Extraction Ensembles

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The constant demographic transition together with a rising access to medical treatments result in a constantly growing number of performed diagnostic methods. Electrocardiograms (ECGs) are a basic, non-invasive source for diagnosis in order to detect a majority of cardiovascular deceases and thus, is applied to patients worldwide. This results in an constantly increasing quantity of ECG signal, that need to be reviewed by medical experts - a time consuming and tedious task. Therefore, significant effort was made to provide support and automation by detection and classification of cardiac abnormalities based on ECG signals.

However, to correctly classify a broad range of anomalies in cardiac signals is challenging. Some pathologies like the atrioventricular block manifest themselves in particular morphologies observable in different leads, some occur as a shift over multiple leads and some are of arrhythmical nature. Different algorithms were proposed to detect anomalies of each respective category but they usually fail to provide a general solution for all of them.

To overcome this limitation, we propose an ensemble method that consists of two parts. First, diverse convolutional and autoregressive feature extraction methods, each aiming at extraction of information from a respective pathology type, are applied. Second, we utilize an attention based classification trained on multiple one-vs-all binary objectives, which enables the detection of multiple anomalies in an ECG recording. Thereby, the autoregressive models are trained on the ECG time series data of every abnormality class to adapt to its inherent morphology. After that, the average out-of-sample prediction residuals are extracted and used as features. Additionally, a convolutional neural network is used as a second feature extractor by applying multiple features on single and jointly on all leads.

Combining these two techniques, the proposed approach achieved a preliminary  $F_2$ -score,  $G_2$ -score and geometric mean of 0.314, 0.146 and 0.214.