

# 12-lead Electrocardiogram Arrhythmia Detection using Deep Neural Networks

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**Aim:** This study aims to develop robust and high performance deep neural network models, more specifically convolutional recurrent neural networks (CRNNs), for the detection of cardiac arrhythmias from 12-lead electrocardiogram (ECG). This would help improving early detection and noninvasive monitoring of cardiovascular diseases (CVDs).

**Methods:** 12-lead ECGs are sliced into non-overlapping segments (of typical length 6 seconds). The models mainly consist of two sub-networks. The first part is a convolutional neural sub-network (CNN), which captures ECG features from coarser ones, like regularity of RR (R wave to R wave) intervals, to finer ones, like morphology of certain complex or even subtle shapes of specific waves in certain leads. Afterwards, feature tensors extracted from the CNN are fed into a recurrent neural sub-network (RNN), which is good at handling series data. A typical RNN used is composed by 3 bidirectional long short-time memory (LSTM) layers. Finally, a fully connected layer with sigmoid activation is applied to produce the predictions, which are probabilities of belonging to each type (one normal sinus rhythm type and eight abnormal types). A threshold of 0.5 is used to give the final judgement.

**Results:** In our experiments, considering the amount of the CPSC2018 data, we adopted VGGNet, simple yet comparably powerful, as the CNN feature extractor. Stratified train-validation-test split with ratio of 8:1:1 was made for training and evaluating models.  $F_\beta$  and  $G_\beta$  of the final model were 0.58 and 0.37 resp. on the test set, and these two scores provided by the CINC2020 Challenge submission system were 0.53 and 0.34 resp.

**Conclusion:** CRNNs offer a powerful and easily expandable framework of detecting cardiac arrhythmias for 12-lead ECGs. In order to better capture both local and global ECG features for improving the overall performance, more careful design of the convolutional sub-network should be made and tested.