A robust CNN-based 12 lead ECG classifier for detecting cardiac abnormalities

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Introduction: The electrocardiogram (ECG) is the non-invasive technique of diagnosing heart condition. The standard 12-lead ECG signal can be used to diagnose different cardiac abnormalities. However, manual annotation of the ECG signal consumes more time and requires a skilful ECG signal interpreter. As a part of the CinC 2020 challenge, we aim to design a deep learning-based model that can automatically identify nine different cardiac abnormalities.

Methods: In this experiment, a modified VGG11 (Visual Geometry Group) model was considered (among a DenseNet and ResNet like structure) with configuration - [64, 'A', 128, 'A', 256, 'A', 512, 'A'] + GAP + Linear, where, 'A' is average pooling, GAP is global average pooling. The ECG signal from each lead is segmented to a 3-sec window with 2 sec overlapping. We have used all 12 lead signals for building the model. The modified VGG11 model is exhibiting superior performance among other types of deep-learning models. The validation follows the same segmentation approach where each lead, for a record, yields multiple labels from which the most frequent label is taken as a decision of that lead. Twelve leads provide twelve such decisions which are finally combined and by applying max voting, most probable label is retrieved. Existence of additional labels is searched by looking into a space very closer to a threshold (20% within the distance around the max voted label frequency), which may yield single or multiple labels in total.

Results: Using a 80/20 train/test splitting approaches on provided dataset, the proposed model showed F_2 score 0.759, G_2 score 0.528 and G_mean score 0.633. After submission, we received test score as follows: F_2 =0.730, G_2 = 0.487 and G_mean =0.596.

Conclusion: The study results show that CNN-based model can be used to effectively identify and interpret cardiac abnormalities using 12-lead ECGs.