Title: A Bio-toolkit for multi-cardiac abnormality diagnosis using 12-lead ECG signal and Deep Learning

Abstract: Early-stage clinical diagnosis of cardiac abnormalities can increase the chances of heart patient's survival by predicting cardiovascular morbidity and mortality. Cardiac screening modalities like the 12-lead electrocardiogram (ECG) signals are widely used to detect cardiac arrhythmias. However, manual interpretation of ECG is tedious and domain- expertise dependent. Therefore, automated cardiovascular disease (CVDs) detection from the ever-expanding number of ECG records can aid physicians and cardiac professionals in the prognosis of CVDs. In this work, we propose a bio-toolkit for multi-class arrhythmias classification.

We performed a first level signal quality assessment of three augmented limb leads (aVL, aVR, and aVF) using Goldberger's technique. Thereafter, The time-domain features like the RMSSD and pNN50 are extracted using Pan Tompkins algorithm and discrete wavelet-transform method. Statistical significance analysis using Student t-test and use of box-plots show intra-class discriminability. The majority of the features we calculated are motivated by the literature review done on the 2017 PhysioNet/CinC Challenge.

Further, we have explored an array of deep learning frameworks like the RNNs family, i.e., LSTM, Bi-LSTM and the convolutional neural networks (CNN) like 1D-CNN for deep cardiac feature learning and classification. Initially, we have developed a 1-Dimensional CNN based model with two convolutional layers, followed by one dropout layer, one pooling layer, and one fully connected layer. We trained our model with the extracted features from a subset of available training data to test its efficacy and used a stochastic gradient descent-based Adam optimizer to optimize the model. Preliminary results with our deep learning model give an overall F_2-score of 0.89 on the challenge dataset. A comparative study using the ECG time-domain features and hierarchical machine learning classifiers projects a standard class-specific accuracy of 96.43% and multi-classification accuracy of 33.69%. Attached block diagram shows the overall problem-solving approach