**Ideation Phase**

**Define the Problem Statements**

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| Date | 19 September 2022 |
| Team ID | PNT2022TMID41315 |
| Project Name | Classiﬁcation of Arrhythmia by Using Deep Learning with  2-D ECG Spectral Image Representation |
| Maximum Marks | 2 Marks |

**Customer Problem Statement Template:**

According to the World Health Organization (WHO), cardiovascular diseases (CVDs) are the number one cause of death today. Over 17.7 million people died from CVDs in the year 2017 all over the world which is about 31% of all deaths, and over 75% of these deaths occur in low and middle-income countries. Arrhythmia is a representative type of CVD that refers to any irregular change from the normal heart rhythms. There are several types of arrhythmia including atrial fibrillation, premature contraction, ventricular fibrillation, and tachycardia. Although a single arrhythmia heartbeat may not have a serious impact on life, continuous arrhythmia beats can result in fatal circumstances. In this project, we build an effective electrocardiogram (ECG) arrhythmia classification method using a convolutional neural network (CNN), in which we classify ECG into seven categories, one being normal and the other six being different types of arrhythmia using deep two-dimensional CNN with grayscale ECG images.

The one-dimensional ECG time series signals are transformed into 2-D spectrograms through short-time Fourier transform. The 2-D CNN model consisting of four convolutional layers and four pooling layers is designed for extracting robust features from the input spectrograms. Our proposed methodology is evaluated on a publicly available MIT-BIH arrhythmia dataset. We achieved a state-of-the-art average classification accuracy of 99.11%, which is better than those of recently reported results in classifying similar types of arrhythmias.

High-risk patients of cardiovascular disease can be provided with computerised electrocardiogram (ECG) devices to detect Arrhythmia. The CWT of the recordings is obtained and used to train the 2D convolutional neural network (CNN) for automatic arrhythmia detection. The proposed model is trained and tested to identify five types of heartbeats such as normal, left bundle branch block, right bundle branch block, atrial premature, and premature ventricular contraction. The model shows an average sensitivity, specificity, and accuracy to be 98.87%, 99.85%, and 99.65%, respectively.

Cardiac arrhythmia is a leading cause of cardiovascular disease, with a high fatality rate worldwide. The timely diagnosis of cardiac arrhythmias, determined by irregular and fast heart rate, may help lower the risk of strokes. Electrocardiogram signals have been widely used to identify arrhythmias due to their non-invasive approach. However, the manual process is error-prone and time-consuming. A better alternative is to utilize deep learning models for early automatic identification of cardiac arrhythmia, thereby enhancing diagnosis and treatment. In this article, a novel deep learning model, combining convolutional neural network and bi-directional long short-term memory, is proposed for arrhythmia classification. Specifically, the classification comprises five different classes: non-ectopic (N), supraventricular ectopic (S), ventricular ectopic (V), fusion (F), and unknown (Q) beats. The proposed model is trained, validated, and tested using MIT-BIH and St-Petersburg data sets separately. Also, the performance was measured in terms of precision, accuracy, recall, specificity, and f1-score. The results show that the proposed model achieves training, validation, and testing accuracies of 100%, 98%, and 98%, respectively with the MIT-BIH data set. Lower accuracies were shown for the St-Petersburg data set. The performance of the proposed model based on the MIT-BIH data set is also compared with the performance of existing models based on the MIT-BIH data set.

Electrocardiogram (ECG) is mostly used for the clinical diagnosis of cardiac arrhythmia due to its simplicity, non-invasiveness, and reliability. Recently, many models based on the deep neural networks have been applied to the automatic classification of cardiac arrhythmia with great success. However, most models independently extract the internal features of each lead in the 12-lead ECG during the training phase, resulting in a lack of inter-lead features. Here, we propose a general model based on the two-dimensional ECG and ResNet with detached squeeze-and-excitation modules (DSE-ResNet) to realize the automatic classification of normal rhythm and 8 cardiac arrhythmias. The original 12-lead ECG is spliced into a two-dimensional plane like a grayscale picture. DSE-ResNet is used to simultaneously extract the internal and inter-lead features of the two-dimensional ECG. Furthermore, an orthogonal experiment method is used to optimize the hyper-parameters of DSE-ResNet and a multi-model voting strategy is used to improve classification performance. Experimental results based on the test set of China Physiological Signal Challenge 2018 (CPSC2018) show that our model has average F1=0.817F1=0.817 for classifying normal rhythm and 8 cardiac arrhythmias. Meanwhile, compared with the state-of-art model in CPSC2018, our model achieved the best F1F1 in 2 sub-abnormal types. This shows that the model based on the two-dimensional ECG and DSE-ResNet has advantage in detecting some cardiac arrhythmias and has the potential to be used as an auxiliary tool to help doctors perform cardiac arrhythmias analysis. If our proposed model is trained and verified using more clinical data, we believe it can be used as an auxiliary device for diagnosing cardiac arrhythmias.

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