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Extended Abstract

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An ECG based classification for automated detection system of ventricular arrhythmias using deep learning approach

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Heart disease is one of the deadliest diseases in the universe. Generally heart disease occurs due to the disorders in heart beat called arrhythmias which affect the rate and rhythm of the heart. There are several arrhythmias affect normal functioning of the heart. Among all, Ventricular Tachycardia (VT), Ventricular Fibrillation (Vfib), Premature Ventricular Complex (PVC) is the life-threatening arrhythmias that affect young adults. Electrocardiogram (ECG) is the leading diagnostic tool to record the heart rate and rhythm. It is tough for physician to interpret an ECG signal manually. Hence, an Automated Diagnosis System (ADS) is proposed. It uses Convolutional Neural Network (CNN) classifier which automatically diagnoses the irregular ECG signals from huge volume of ECG datasets. CNN designed with eleven hidden layer and four output layers (neurons) represents all the four classes (normal sinus rhythm (Nsr), VT, Vfib, and PVC) of heart conditions. MIT-BIH database samples are used for validating and testing the model. To validate the model, bootstrap aggregation applied on the dataset to train the model with enough trained data samples so that it produces robust classification result. The performance of the model is tested with calculating some statistical measures like accuracy, sensitivity, specificity. The proposed neural network helps the clinicians to diagnose ECG signal with improvised accuracy with robustness in result since the model uses Data Augmentation. Deep Learning (DL) has recently become a topic of study in different applications including healthcare, in which timely detection of anomalies on Electrocardiogram (ECG) can play a vital role in patient monitoring. This paper presents a comprehensive review study on the recent DL methods applied to the ECG signal for the classification purposes. This study considers various types of the DL methods such as Convolutional Neural Network (CNN), Deep Belief Network (DBN), Recurrent Neural Network (RNN), Long Short-Term Memory (LSTM), and Gated Recurrent Unit (GRU). From the 75 studies reported within 2017 and 2018, CNN is dominantly observed as the suitable technique for feature extraction, seen in 52% of the studies. DL methods showed high accuracy in correct classification of Atrial Fibrillation (AF) (100%), Supraventricular Ectopic Beats (SVEB) (99.8%), and Ventricular Ectopic Beats (VEB) (99.7%) using the GRU/LSTM, CNN, and LSTM, respectively. In many cases, the traditional rule-based diagnosis paradigm is inefficient due to dealing with large amount of heterogeneous data, and requires significant analysis and medical expertise to achieve adequate accuracy in diagnosis. The problem will become more pronounced in places, where there is a lack of medical experts and clinical equipment, especially in developing countries. This motivates the requirement for a reliable, automatic, and low-cost system for monitoring and diagnosis. This requirement is becoming more demanded by the healthcare providers, such that appropriate medical assessments can be linked to utilizing Compute Aided Diagnosis Systems Computer-Aided Diagnosis (CADS). A CADS is composed of automatic monitoring procedures of health conditions working based on analysis of physiological signals for monitoring and evaluating functionality of the corresponding organ. CADSs provide individuals with portable and straightforward solutions to make them informed about their diseases. Electrocardiogram (ECG) is a non-stationary physiological signal, representing electrical activity of heart. It is not only used to look for pathological patterns among the heartbeats, but also used to measure the beats' regularity as well as other conditions like mental stress. Deep Neural Network (DNN) has been widely used for classification and prediction purposes in different domains. Recently, it has been noticed that DNNs are being developed sharply with a significant effect on the accuracy in classification for a wide range of medical tasks. Modern CADS systems leverage DNNs to detect arrhythmia of captured ECG signal leading to decrease the cost of continuous heart monitoring and improving the quality of predictions. However, an ECG-based automatic arrhythmia classification is typically faced with several important challenges. The topic of Deep Learning (DL) refers to the studies on knowledge extraction, predictions, intelligent decision making, or in another term recognizing intricate patterns using a set of the data, so called training data. Comparing to the traditional learning techniques, DNNs are more scalable since higher accuracy is usually achieved by increasing the size of the network or the training dataset. Shallow learning models such as decision trees and Support Vector Machine (SVMs) are inefficient for many modern applications, meaning that they require a large number of observations for achieving generalizability, and imposing significant human labour to specify prior knowledge in the model. In the recent years, several Deep Learning (DL) models have been proposed to improve the accuracy of different learning tasks, including Multilayer Perceptron (MLP), Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), Long Short-Term Memory (LSTM), and Deep Belief Network (DBN). Time-growing neural network is an elaboration of time-delayed neural network, recently introduced to the context of learning theory. Although the idea of deep time growing neural network is well-tailored for biological signals, especially those with cyclic characteristics application of this powerful method has not been studied for ECG classification, yet.

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