LITERATURE SURVEY
CLASSIFICATION OF ARRHYTHMIA USING DEEP LEARNING WITH 2D ECG SPECTRAL IMAGE REPRESENTATION

Title:

Cardiac Arrhythmia Classification from 12-lead Electrocardiogram Using a Combination of Deep Learning Approaches
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Abstract:

Traditionally, electrocardiogram (ECG) signals are recorded and monitored over a period of time and finally analyzed by an expert. Automatic classification of cardiac arrhythmias has the potential to improve diagnostics. In this work, we explore the use of representation learning from ECG signals for cardiac arrhythmia classification. The dataset consisting of five cardiac rhythm types was created from the CPSC, CPSCExtra, and The Georgia 12-lead ECG Challenge databases. We use a sophisticated deep learning approach for representation learning and classification, namely a

combination of a Convolutional Auto-Encoder (CAE) and a Long Short-Term Memory (LSTM) classifier. CAE was used to compress the input signal that serves as input to the LSTM classifier. We also implemented a CAE-based data augmentation approach to balance the data distribution. The classification results reaching above 90% accuracy show that the use of the complex deep learning approach is suitable for addressing the problem.

Title:

Arrhythmia classification on ECG using Deep Learning

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Abstract:

In this paper, an intellectual based electrocardiogram (ECG) signal classification approach utilizing Deep Learning (DL) is being developed. ECG plays important role in diagnosing various Cardiac ailments. The ECG signal with irregular rhythm is known as Arrhythmia such as Atrial Fibrillation, Ventricular Tachycardia, Ventricular Fibrillation, and so on. The main aspire of this task is to screen and distinguish the patient with various cardio vascular arrhythmia. This examination encourages us to recognize diverse kinds of arrhythmia utilizing Deep Learning algorithm. Here we use Convolutional Neural Network (CNN) a DL algorithm which is efficient in classifying signals. Utilizing CNN, features are learned Automatically from the time domain ECG signals which are acquired from MIT-BIH Database from Physiobank.com. The feature adapted specifically replaces manually extracted features and this analysis will help the Cardiologists in screening the patient with Cardiac illness effectively. The CNN is trained, tested using ECG Dataset obtained from MIT-BIH Database and from the signal 7 of arrhythmia were classified. From the result obtained we came to know that ELU activation function gives better result with an accuracy of 93.6% and with a loss of 0.2.

Title:

Arrhythmia Classification System Using Deep Neural Network

Published: IEEE – 2019

Link:

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Abstract:

Previous studies on arrhythmia were used to diagnose the abnormally fast, slow, or irregular heart rhythm through ECG (Electrocardiogram), which is one of the biological signals. ECG has the form of P-QRS-T wave, and many studies have been done to extract the features of QRS-complex and R-R interval. However, in the conventional method, the P-QRS-T wave must be accurately detected, and the feature value is extracted through the P-QRS-T wave. If an error occurs in the peak detection or feature extraction process, the accuracy becomes very low. Therefore, in this paper, we implement a system that can perform PVC (Premature Ventricular Contraction) and PAC (Premature Atrial Contraction) classification by using P-QRST peak value without feature extraction process using deep neural network. The parameters were updated for PVC and PAC classification in the learning process using P-QRS-T peak without feature value. As a result of the performance evaluation, we could confirm higher accuracy than the previous studies and omit the process of feature extraction, and the time required for the pre-processing process to construct the input data set is relatively reduced.

Title:

ECG Arrhythmia Heartbeat Classification Using Deep Learning Networks

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Abstract:

The electrocardiogram (ECG) records the process of depolarization and repolarization of the heart and contains many important details related to the condition of the human heart. In this paper, we designed four deep learning network structures and three electrocardiogram signal preprocessing methods, under the same dataset, explored the impact and performance of different preprocessing methods and models on the ECG arrhythmia classification work. For a fairer comparison, we used intra-patient and inter-patient evaluation for the final classification evaluation. In the evaluation of the intra-patient, the proposed network structures can achieve an accuracy of more than 95%. In the evaluation of inter-patient, all classification models can achieve an accuracy rate of more than 81.7%. During our research, we found convolutional neural network (CNN) is good at capturing spatial features of ECG. Long short-term memory networks (LSTM) is suitable for processing time-series signals. The combination of the two has a better classification performance than the sole network. Besides, the Attention mechanism can help the model do better on focusing on abnormal heartbeats also improve the interpretability of the model. Residual neural Network (ResNet) has good behavior in intra-patient, but not suitable for the inter-patient classification due to the vanishing gradient problem. Compared to the different preprocessing methods, we recommended using the raw signal in future work.

Title:

ECG Arrhythmia Classification on an Ultra-Low-Power Microcontroller

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Link:

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Abstract:

Wearable biomedical systems allow doctors to continuously monitor their patients over longer periods, which is especially useful to detect rarely occurring events such as cardiac arrhythmias. Recent monitoring systems often embed signal processing capabilities to directly identify events and reduce the amount of data. This work is the first to document a complete beat-to-beat arrhythmia classification system implemented on a custom ultra-low-power microcontroller. It includes a singlechannel analog front-end (AFE) circuit for electrocardiogram (ECG) signal acquisition, and a digital back-end (DBE) processor to execute the support vector machine (SVM) classification software with a Cortex-M4 CPU. The low-noise instrumentation amplifier in the AFE consumes 1.4 μ W and has an input-referred noise of 0.9 μ V RMS. The all-digital time-based ADC achieves 10-bit effective resolution over a 250-Hz bandwidth with an area of only 900 μ m 2 . The classification software reaches a sensitivity of 82.6% and 88.9% for supraventricular and ventricular arrhythmias respectively on the MIT-BIH arrhythmia database. The proposed system has been prototyped on the SleepRider SoC, a 28-nm fullydepleted silicon on insulator (FD-SOI) 3.1-mm 2 chip. It consumes 13.1 μ W on average from a 1.8-V supply.

Title: Electrocardiogram heartbeat classification based on a deep convolutional neural network and focal loss

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Link:

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Abstract:

The electrocardiogram (ECG) is an effective tool for cardiovascular disease diagnosis and arrhythmia detection. Most methods proposed in the literature include the following steps: 1) denoizing, 2) segmentation into heartbeats, 3) feature extraction, and 4) classification. In this paper, we present a deep learning method based on a convolutional neural network (CNN) model. CNN models can perform feature extraction automatically and jointly with the classification step. In other words, our proposed method does not require a feature extraction step with hand-crafted techniques. Our proposed method is also based on an algorithm for heartbeat segmentation that is different from most existing methods. In particular, the segmentation algorithm defines each ECG heartbeat to start at an R-peak and end after 1.2 times the median RR time interval in a 10-s window. This method is simple and effective, as it does not use any form of filtering or processing that requires assumptions about the signal morphology or spectrum. Although enhanced ECG heartbeat classification algorithms have been proposed in the literature, they failed to achieve high performance in detecting some heartbeat categories, especially for imbalanced datasets. To overcome this challenge, we propose an optimization step for the deep CNN model using a novel loss function called focal loss. This function focuses on minority heartbeat classes by increasing their importance. We trained and evaluated our proposed model with the MIT–BIH and INCART datasets to identify five arrhythmia categories (N, S, V, Q, and F) based on the Association for Advancement of Medical Instrumentation (AAMI) standard. The evaluation results revealed that the focal loss function improved the classification accuracy for the minority classes as well as the overall metrics. Our proposed method achieved 98.41% overall accuracy, 98.38% overall F1-score, 98.37% overall precision, and 98.41% overall recall. In addition, our method achieved better performance than that of existing state-of-theart methods.

Title:

An Ensemble of Deep Learning-Based Multi-Model for ECG Heartbeats Arrhythmia Classification

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Abstract:

An automatic system for heart arrhythmia classification can perform a substantial role in managing and treating cardiovascular diseases. In this paper, a deep learningbased multi-model system is proposed for the classification of electrocardiogram (ECG) signals. Two different deep learning bagging models are introduced to classify heartbeats into different arrhythmias types. The first model (CNN-LSTM) is based on a combination of a convolutional neural network (CNN) and long short-term memory (LSTM) network to capture local features and temporal dynamics in the ECG data. The second model (RRHOS-LSTM) integrates some classical features, i.e. RR intervals and higher-order statistics (HOS), with LSTM model to effectively highlight abnormality heartbeats classes. We create a bagging model from the CNN-LSTM and RRHOS-LSTM networks by training each model on a different sub-sampling dataset to handle the high imbalance distribution of arrhythmias classes in the ECG data.These models are then combined using a meta-classifier to form a strong coherent model. The meta-classifier is a feedforward fully connected neural network that takes the different predictions of bagging models as an input and combines them into a final prediction. The result of the metaclassifier is then verified by another CNNLSTM model to decrease the false positive of the overall system.The proposed method achieves an

overall accuracy of 95.81% in the "subject-oriented" patient independent evaluation scheme.

Title:
Electrocardiogram Arrhythmia Classification

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Abstract:

The automatic arrhythmia classification system has made a significant contribution to reducing the mortality rate of cardiovascular diseases. Although the current deeplearning-based models have achieved ideal effects in arrhythmia classification, their performance still needs to be further improved due to the small scale of the dataset. In this paper, we propose a novel self-supervised pre-training method called Segment Origin Prediction (SOP) to improve the model's arrhythmia classification performance. We design a data reorganization module, which allows the model to learn ECG features by predicting whether two segments are from the same original signal without using annotations. Further, by adding a feed-forward layer to the pretraining stage, the model can achieve better performance when using labeled data for arrhythmia classification in the downstream stage. We apply the proposed SOP method to six representative models and evaluate the performances on the PhysioNet Challenge 2017 dataset. After using the SOP pre-training method, all baseline models gain significant improvement. The experimental results verify the effectiveness of the proposed SOP method.

Detection of Cardiac Arrhythmias From Varied Length Multichannel Electrocardiogram Recordings Using Deep Convolutional Neural Networks

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Abstract:

Automatic identification of different arrhythmias helps cardiologists better diagnose patients with cardiovascular diseases. Deep learning algorithms are used for the classification of multichannel ECG signals into different heart rhythms. The study dataset includes a cohort of 43101 12- lead ECG recordings with various lengths. Two options are tested to standardize the recordings length: zero padding and signal repetition. Downsampling the recordings to 100 Hz allow handling the problem of different sampling frequencies of data coming from different sources. We design a deep one-dimensional convolutional neural network (CNN) called VGG-ECG, a 13layer fully CNN for multilabel classification. Our team is called MIndS and our approach achieved a challenge validation score of 0.368, and full test score of - 0.128, placing us 38 out of 41 in the official ranking.

Title:

Title: Automatic Concurrent Arrhythmia Classification Using Deep Residual Neural Networks

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Abstract:

This paper addresses the PhysioNet|Computing in Cardiology Challenge 2020. The challenge presents a problem to classify 26 types of arrhythmias and normal sinus rhythm using 12-lead electrocardiogram data. We were able to successfully perform the classification task using an eight layer deep residual neural network (ResNet). The skip connections present in the ResNet allowed the model to train faster and produce better challenge score. We also investigated sixteen other models that included convolution and recurrent neural network based models along with interpretability based attention mechanism as all of them are well suited for time series classification problems. The results depicted that the 8 layer ResNet model outperformed other models in terms of challenge score consuming significantly less time during the training phase. We preferred batch wise training to avoid having all the data in memory during training thereby alleviating the problem of memory choking. Our team, deepzx987, obtained a challenge score of 0.305 on validation data, -0.035 on the full test set, and ranked 35 th in this year's challenge.