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

Title:

Arrhythmia classification on ECG using Deep Learning

Published: IEEE – 2019

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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

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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-QRS-T 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:

Arrhythmia Classification using Deep Learning and Machine Learning with Features Extracted from Waveform-based Signal Processing

Published: IEEE – 2020

Link: https://ieeexplore.ieee.org/document/9176679

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Abstract:

Arrhythmia is a serious cardiovascular disease, and early diagnosis of arrhythmia is critical. In this study, we present a waveform-based signal processing (WBSP) method to produce state-of-the-art performance in arrhythmia classification. When performing WBSP, we first filtered ECG signals, searched local minima, and removed baseline wandering. Subsequently, we fit the processed ECG signals with Gaussians and extracted the parameters. Afterwards, we exploited the products of WBSP to accomplish arrhythmia classification with our proposed machine learning-based and deep learning-based classifiers. We utilized MIT-BIH Arrhythmia Database to validate WBSP. Our best classifier achieved 98.8% accuracy. Moreover, it reached 96.3% sensitivity in class V and 98.6% sensitivity in class Q, which both share one of the best among the related works. In addition, our machine learning-based classifier accomplished identifying four waveform components essential for automated arrhythmia classification: the similarity of QRS complex to a Gaussian curve, the sharpness of the QRS complex, the duration of and the area.

Title:

ECG Arrhythmia Classification on an Ultra-Low-Power Microcontroller

Published: IEEE - 13 June 2022

Link: https://ieeexplore.ieee.org/document/9795058

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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 single-channel 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 μm^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 fully-depleted 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:

Classification of Arrhythmia by Using Deep Learning with 2-D ECG Spectral Image Representation

Published: Cornell university on 14 May 2020

LINK:https://arxiv.org/abs/2005.06902

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Abstract:

The electrocardiogram (ECG) is one of the most extensively employed signals used in the diagnosis and prediction of cardiovascular diseases (CVDs). The ECG signals can capture the heart's rhythmic irregularities, commonly known as arrhythmias. A careful study of ECG signals is crucial for precise diagnoses of patients' acute and chronic heart conditions. In this study, we propose a two-dimensional (2-D) convolutional neural network (CNN) model for the classification of ECG signals into eight classes; namely, normal beat, premature ventricular contraction beat, paced beat, right bundle branch block beat, left bundle branch block beat, atrial premature contraction beat, ventricular flutter wave beat, and ventricular escape beat. 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.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 arrythmias.

Title:

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

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Link: https://ieeexplore.ieee.org/document/9492034

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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 learning-based 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 meta-classifier is then verified by another CNN-LSTM 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:

Detection and Classification of Cardiac Arrhythmias by Machine Learning: a Systematic Review

Published: IEEE - September 2020

Link: https://ieeexplore.ieee.org/document/9344180

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Abstract:

Machine learning (ML) techniques can perform as better as humans at key healthcare tasks. Recent advances make it possible to perform, using ML, automatic high-level feature extraction and classification of cardiac arrhythmia. In this work, we aimed through a systematic literature review to identify the principal methods, databases, and contributions of ML on cardiac arrhythmias classification. Electronic database including PubMed, Science Direct, IEEE, Scielo, Scopus, and Web of Science were searched, from 2014 to 2019, by combining the following keywords “ECG”, “heart signals”, “ar-rhythmia”, “classification” and “machine learning”. 28 studies were selected as eligible. Classifications classes ranged from 2 to 17, with prevalence of 2 classes (71.4% of the studies). The most frequent applied methods were Artificial Neural Network (13 articles), followed by Support Vector Machines and Mixed techniques (5 articles respectively). MIT-BIH Arrhythmia Database was used in 15 studies (54%), whereas 8 (28.5%) utilized their own data. The approach basis for evaluating the results is the confusion matrix, where up to 82% of the studies used accuracy, 67.8% precision, and 46% sensitivity/specificity.

Title:

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 13-layer 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:

Segment Origin Prediction: A Self-supervised Learning Method for 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 deep-learning-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 pre-training 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.

Title:

Automatic Concurrent Arrhythmia Classification Using Deep Residual Neural Networks

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Abstract:

This paper addresses the PhysioNetlComputing 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.