

Pay Attention and Watch Temporal Correlation: A Novel 1-D Convolutional Neural Network for ECG Record Classification

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Introduction: The mortality ration of cardiovascular disease (CVD) is much higher than other diseases. Electrocardiogram (ECG) which records changes in electrical activity, is a non-invasive and widely used CVD diagnostic tool. Analysis of the ECG is the first step in the treatment of CVD, but ECG analysis relies heavily on the doctor's experience. Therefore, develop a computer-aided diagnostic technique to automatic analysis ECG is significant. Currently, most of the researches on ECG analysis focus on the classification of heart beats, there are few studies on the classification of the entire ECG records. In fact, these two issues are completely different, record level classification is more challenge than beat level classification.

Methods: In this paper, we present a record level ECG classification method by combining 1-D deep convolutional neural network (CNN) and long short-term memory network (LSTM). The proposed method is an end-to-end deep learning approach which utilizes CNN to automatic extract features of ECG patches without complex data pre-processing or artificial feature scheme, and utilizes two layers LSTM to model the underlying temporal correlation relation among ECG patches. In order to alleviate vanishing gradient problem and enhance representation power of features (i.e., focusing on important features and suppressing unnecessary ones), we combine residual connection and attention mechanisms to build a residual attention module. Stacked residual attention module not only deepen the network, but also refine the feature map from both spatial and channel dimensions.

Results: We validate this method through the data provide by The China Physiological Signal Challenge 2018(6,877 ECG records, 9 classes), the cross-validation result has the average F1 score 0.78. Experiments on PhysioNet/CinC 2017 (8,528 ECG records, 4 classes) reveal that the mean F1 score is 0.807, increased by 1.5 percentage points over the best method of using the neural network method in this competition.