Arrhythmia detection based on patient-specific normal ECGs using deep learning

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Background: Most traditional studies on arrhythmia detection in ECG have proposed general methods applicable to various patients. Since patients have their own unique ECG patterns, it becomes possible to detect abnormalities that could not be found by the general methods if we could propose a new arrhythmia detection method tailored to each patient. Furthermore, the new method can effectively support doctors in their diagnosis if it could show the grounds for determining the abnormality.

Methods: In this study, we proposed a patient-specific method of arrhythmia analysis using autoencoder and Convolutional Neural Network, which are types of deep learning. Since the normal ECGs can be collected easily in a large amount, we used the autoencoder to learn them and acquired their features peculiar to individual patients. Our method detected arrhythmia by comparing the feature transition of the normal ECG data and that of the target ones to be judged. Furthermore, it was possible to show the basis for determining which parts of the ECG data are abnormal by showing and comparing the paths of the acquired features.

Results: To account for the abnormality over a relatively long period, ECG data corresponding to about three heartbeats were input to obtain their features. The performance was evaluated by the F-measure and the accuracy. As a result of the experiments on ECGs of five people with arrhythmia, the average of F-measures and that of accuracy values were 88.0% and 87.6%, respectively. Figure 1 shows the path of the features of a normal ECG and that of an abnormal ECG.

Conclusion: The proposed method could detect arrhythmia using only the ECG of each patient. It showed the possibility of the patient-specific diagnosis that was impossible in the conventional methods.

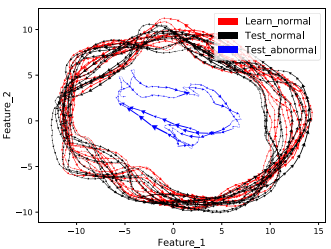

Figure 1: Feature paths of normal ECG for training(red), normal ECG for testing(black), and abnormal ECG for testing(blue).