Building normal ECG models to detect any arrhythmias using deep learning

Keiji Gyohten[1], Shota Hori[1], Hidehiro Ohki[1], Toshiya Takami[1], Noboru Sato[2]

[1]Oita University, Oita, Japan
[2]Keiwakai Healthcare Group, Oita, Japan

Background: In the studies of arrhythmias detection using deep learning, most methods train neural networks to categorize input ECGs to major arrhythmias using annotated training ECG data. Such methods can neither detect unknown arrhythmias nor explain why they are considered as arrhythmias. To detect any arrhythmias automatically, this study proposes a method that does not use annotated training data and can explain the reason for its judgment clearly.

Methods: Our method builds a model of normal ECGs using CNN (Convolutional Neural Network) and LSTM (Long Short-Term Memory), which are the types of deep learning. The model inputs normal ECGs and trains to predict the succeeding normal ECGs. If an abnormal ECG is given, our model predicts the succeeding ECG far from the actual one and can judge that the input is abnormal. This means that our method can judge any arrhythmias because it uses no prior knowledge about the annotations.

Results: To build the model, we used the parts of the normal ECGs in the MIT-BIH arrhythmia database as the training data. Using the other ECGs in the database as the test data, we evaluated our method with ROC curve where the average AUC score was 0.93. As shown in Figure 1, we also developed GUI for showing in which parts the predicted ECG does not fit the actual one.

Conclusion: We show that the proposed method can generate the normal ECG model without training annotated ECG training data and can identify any abnormal ECGs that do not fit the normal ones. In the future, we will investigate the possibility of the ECG analysis in a long period by adjusting the input size and of the classification of arrhythmias by clustering of the output results.

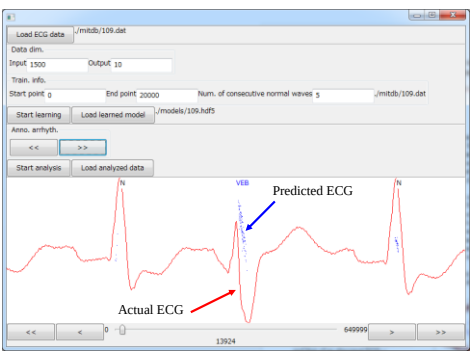

Figure 1: The developed GUI