Deep Learning Based Classification of True/False Arrhythmia Alarms in the Intensive Care Unit

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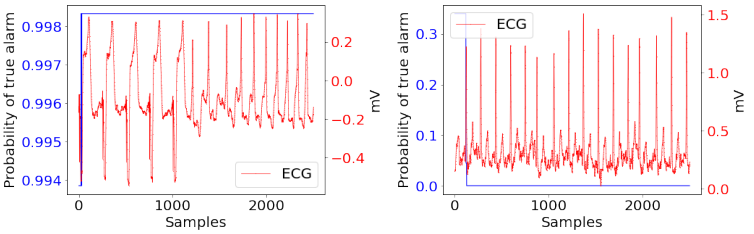
Once a cardiac alarm is triggered in the intensive care unit (ICU), accurately classifying whether the alarm is true of false is of critical importance. Incorrect classification may lead to patient's death if the alarm is true or to disruption in patient care if false. There has been a body of research, as signified by the 2015 PhysioNet/CinC Challenge; due accomplishments have been made in the relevant computational technology, and yet the highest accuracy known thus far is in the mid-80% range (85%). Our work achieved much higher accuracy and, additionally, very early classification almost at the onset of an arrhythmia alarm, by utilizing state of the art deep learning methods. The machine learning model used is a Residual Network (ResNet) and a Bi-directional Long Short Term Memory (BiLSTM) connected in tandem (see Figure 1). Using the PhysioNet dataset of 750 recorded ECG segments published with the challenge, our method performed the classification with 96% accuracy in 0.52 seconds from the onset of an alarm (see Figure 2) on average over all test ECG segments.

Figure 1: Deep learning model structure of ResNet+BiLSTM. ResNet is used to extract complex features from the ECG time series, and BiLSTM is used to build a prediction model based on the temporal order of features.



(a) Increase (true alarm). (b) Decrease (false alarm).

Figure 2: Early classification enabled by the deep learning model. The model's output is the probability of the alarm being true, which either increases or decreases quickly in about 125 ECG samples, amounting to 0.52 seconds, at the onset of an ECG segment after the alarm.