Automated Classification of Electrocardiogram Data With Machine Learning

Reyna Alam[1,2], Efe Sencan[2], Justin Li[2], Prof. Ayse Coskun[2]
Adlai E. Stevenson High School, 1 Stevenson Drive, Lincolnshire, IL 60069[1]; Boston University, Commonwealth Ave, Boston, MA 02215[2]

Electrocardiograms (ECGs) are among the most prevalent devices used in emergency rooms. With hospitals consistently overcrowded with patients, it is critical for patients to receive timely and accurate care, particularly for these electrocardiogram heart exams. One tool that can be implemented to accomplish this is a deep neural network (DNN) trained to classify ECG data at runtime in order to detect anomalies indicative of heart diseases like 1st degree AV block (1dAVb), right bundle branch block (RBBB), left bundle branch block (LBBB), sinus bradycardia (SB), atrial fibrillation (AF), and sinus tachycardia (ST). Research has already been done demonstrating effectiveness of a DNN with single-lead ECGs [1], however in clinical practice it is 12-lead ECGs that are most widespread. Therefore, in this work, we trained a DNN on time series data from 12-lead ECGs. First, we evaluated a pretrained model on its classifications for each anomaly and evaluated with F1-scores from a five fold cross validation on 15% of the CODE (Clinical Outcomes in Digital Electrocardiology) dataset as a baseline. We tested the pre-trained DNN through supervised learning, with labels derived from cardiologist analysis of the ECG exams in the CODE dataset. Next, we experimented with various other model frameworks like the Random Forest, Decision Tree, and AdaBoost classifiers to reassess performance and compare resulting F1-scores. We aim to test each model's performance on the entire CODE dataset to potentially reduce error further. Our model has the potential to especially aid areas with low medical resources and provide critical analysis of patients' heart health quickly if implemented in hospitals.

[1] Ribeiro, A.H., Ribeiro, M.H., Paixão, G.M.M. et al. Automatic diagnosis of the 12-lead ECG using a deep neural network. Nat Commun 11, 1760 (2020). https://doi.org/10.1038/s41467-020-15432-4