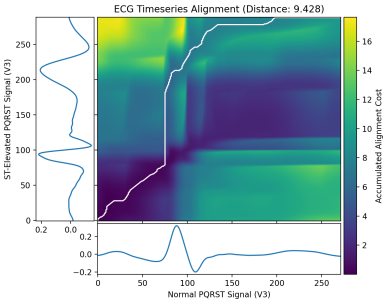
Dynamic Time Warping with Gradient Boosting Tree Ensemble for 12-Lead ECG Multilabel Classification

Alexander W. Wong, Weijie Sun, Sunil V. Kalmady, Padma Kaul, Abram Hindle

University of Alberta
Edmonton, Alberta, Canada

Standard 12-lead electrocardiograms (ECGs) are commonly used to detect cardiac irregularities such as atrial fibrillation, blocks and irregular complexes. For the *Physionet/CinC 2020 Challenge*, we built an algorithm using gradient boosted tree ensembles fitted on morphology and signal processing features.

We used the *ecgpuwave* implementation of the Pan Tompkins method to detect the P-wave, QRS complex, and T-wave. We selected templates that exhibited maximum similarity with the rest of the ECG records in the same class using minimum distance criteria to isolate candidate templates for each cardiac abnormality. We leveraged these templates using Dynamic Time Warping (DTW), an algorithm used for measuring similarity between temporal sequences of varying speeds. From the annotated signals we derived the morphology related durations, amplitudes, and intervals. Additional signal representation techniques, including discrete Fourier transformations and polynomial function fitting, were also used to extract features.



DTW alignment between a normal and ST-Elevation V3 PQRST.

We concatenate the features for all 12 leads and fit an ensemble of gradient boosting trees to predict probabilities of ECG instances belonging to each class. We evaluated using a 5-fold cross validation split of the provided dataset.

Initial results show that ST elevation is the most difficult label to classify. Averaging our validation set results, our model shows an F_2 score of 0.7199 and a G_2 score of 0.5296. Our Physionet preliminary leaderboard results shows our team CVC, at an F_2 Score of 0.681 and G_2 Score of 0.469. These scores were obtained before the inclusion of DTW features, which according to our internal validation shows an improvement in the classification scoring metrics. Therefore the preliminary scores may not accurately reflect the latest methodology described in this abstract.