Diagnosis of Reduced-lead Electrocardiograms using Autoencoders with a Shared Latent Space

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Aims This study is part of the PhysioNet/Computing in Cardiology Challenge 2021 and aims to perform automatic diagnosis of a reduced-lead electrocardiograms (ECGs) using autoencoders with a shared latent space.

Methods A deep neural network architecture using four separate encoders, one for every 12-, 6-, 3- and 2-lead dataset, was used to compress the ECGs into a latent space of 64 variables. The network consisted of 7 layers with 1-dimensional dilated causal convolutional layers. As a baseline, these four latent spaces were used as an input to a multilayer perceptron classifier for prediction of 85 diagnostic ECG statements. The networks were pre-trained on a dataset of 254.044 physician annotated 12-lead ECGs from the University Medical Center Utrecht. Training was performed on the challenge dataset and 10-fold cross validation was used for internal validation. Performance was evaluated using the area under the receiver operating curve (AUROC) and challenge score.

Results For the 12-, 6-, 3- and 2-lead datasets, the baseline cross-validated AUROC scores are 0.915, 0.908, 0.907, 0.864 and challenge scores 0.238, 0.235, 0.237 and 0.160, respectively. The official challenge scores were all -0.41 (team UMCU).

Conclusion Dilated causal convolutional encoders show good baseline performance for diagnosis of reduced lead-set ECGs. Results are comparable for 12-, 6- and 3-lead ECG, but decline with 2-lead ECGs. This approach will be further improved by introducing a single shared decoder to map the 2-, 3-, 6- and 12-lead ECGs to their corresponding 12-lead representation. By using a shared decoder, the different encoders transform the different reduced-lead input ECGs to a shared latent space. A single classifier will then be trained on this shared latent space. Assuming perfect reconstruction, this approach does not harm the 12-lead reconstruction but improves performance on the reduced-lead datasets.