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ECG QUALITY ASSESSMENT USING DEEP LEARNING

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Introduction: An electrocardiogram (ECG) is the most commonly used, fastest and easiest way to evaluate the condition of the heart. It enables us to measure the heart's electrical activity from the surface of the skin. Signal quality assessment became an important topic in the signal processing community, as different types of analyses are applied to signals of different qualities. Presently we observe an increased use of wearable devices, such as smartwatches, that collect a huge amount of information, but not always of the best quality.

Dataset: For this work, we used Brno University of Technology ECG Quality Database (BUT QDB) available on physionet [1]. This database consists of 18 long-term recordings of single-lead ECGs acquired with 1000Hz sampling frequency from fifteen subjects (six male, nine female) aged between 21 to 83 years. The recordings are minimum 24-hours long and they were made under “free-living conditions”, which means that the subjects were undertaking everyday activities. The signals are labeled in terms of quality in scale from 1 to 3, 1 being the highest quality.

Method: First, we divided the signal into 2000 sampled windows. To determine the R peaks (or QRS wave) we performed a series of operations following the method described in [2]. The algorithm consists of 1) Use of a low-pass filter (cut-off frequency app. 16 Hz); 2) Use of a high-pass filter (cut-off frequency app. 8 Hz); 3) Determination of the derivative of the obtained signal; 4) Determination of the signal module; 5) Use of a moving average window corresponding to 80 ms; 6) QRS detection - according to the rules described in [2]. Then we calculated a following set of features: distribution skewness (ssqi), kurtosis (ksqi), power spectrum (psqi), relative power to the isoline (bassqi), R-R - RR and RR interval variability (csqi), and the degree of matching of R peaks (qsqi) [3]. This feature vector was then used to train a feedforward neural network, which architecture was determined via random search with the help of keras-tuner library [4].

Results: The resulting network was two-layered, consisting of 16 nodes each. Besides the architecture tuning, the hyperparameters were tuned as well, resulting in a final network which was able to achieve the following results on the test set: accuracy - 81.92%, precision - 82.03%, recall - 81.84%, auc - 96.44%. The results on the training and validation sets were above 90% for all the above metrics.

References:

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