Comparative Study of Convolutional Neural Networks for ECG Quality Assessment

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Background and Aim. Convolutional neural networks (CNNs) have recently become popular for ECG analysis, since they do not require pre-processing stages nor specific pre-training. However, their ability for ECG quality assessment has still not been thoroughly assessed. This challenging topic, aimed at identifying poor-quality ECG intervals, could facilitate more accurate decisions on cardiac disorders. This work introduces a comparative study about how several CNN algorithms discern between high and low-quality ECGs.

Methods. To take advantage of the concept of *transfer learning*, five common pre-trained CNNs were analyzed, such as VGG16, ResNet18, AlexNet, GoogleNet, and InceptionV3. They were fed with 2D images obtained by turning 5 s-length ECG segments into scalograms through a continuous Wavelet transform. The ECG intervals were selected from the training set proposed for the PhysioNet/CINC Challenge 2017. Although this database is composed of 8,528 recordings, only a minority of them were labeled as noisy signals. Thus, whereas all available noisy 5 s-length ECG intervals (1,168) formed the poor-quality group, 1,200 high-quality segments were selected from the remaining recordings. A total of 2,368 ECG intervals were then studied.

Results. Five learning-testing cycles were conducted with random 80/20 splits of the dataset. Whereas all algorithms provided mean values of accuracy between 89 and 91%, notable differences were seen in terms of computation time and CPU usage (see the table below). Thus, AlexNet was the fastest algorithm, moreover requiring 10% less of CPU usage. It should also be noted that the obtained values of accuracy were comparable or slightly better than those reported by other works introducing non-CNN-based techniques.

Conclusions. AlexNet has reported the best trade-off between poor quality ECG identification accuracy and computational load, and therefore it is the most convenient CNN-based approach for ECG quality assessment.

Feature	**Algorithm**				
	VGG16	ResNet18	AlexNet	GoogleNet	InceptionV3
Accuracy (%)	89.00	91.10	90.70	90.75	91.25
Computation time (s)	394.27	105.36	63.84	126.63	384.32
CPU usage (%)	39.27	41.65	30.40	37.03	32.51