Relevance of Pre-Training in the Development of a Light Convolutional Neural Network for ECG Quality Assessment

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Background and Aim. Long-term cardiac monitoring with conventional technology requires high economic cost. An interesting alternative is the use of modern wearable devices. However, they acquire ECGs hardly disturbed by noise and accurate quality assessment of these signals is of paramount importance. Recently, pre-trained convolutional neural networks (CNNs) have reported promising performance in that context, but they are composed of millions of parameters and require a high computational cost, which limites their incorporation in portable systems with technical restrictions. Hence, this work aims to explore the ability of a light CNN, with far fewer parameters than well-known pre-trained CNNs, to discern between clean or noisy ECG recordings.

Methodology. The analyzed network received a 2-D image as input, which was obtained by applying a Continuous Wavelet Transform to every 5 second-length ECG interval, and was composed of 4 layers (3 convolutional and one fully connected) and 1,221,574 parameters. Having in mind the relevance of the transfer learning approach in many classification tasks, the performance of the network was compared when trained from scratch and when pre-trained on a freely available set of natural images, such as *ImageNet 70*. The well-known GoogLeNet was also considered for comparison. This CNN presents a structure with a deep of 22 layers and about 7 million of parameters.

Results. All networks were trained with 20,000 5 second-length ECG intervals (50% clean and 50% noisy) and validated on a freely available database. The table below shows that GoogLeNet presented a slightly better performance than the light CNN pre-trained on *ImageNet 70*, in terms of accuracy (Ac), sensitivity (Se), and specificity (Sp). However, this last network was about 12 times faster to classify each ECG interval in the testing stage. The light CNN without pre-training also reported a great speed, but the poorest performance.

Significance. The use of pre-training on natural images is useful to develop light CNNs able to maintain a comparable performance in ECG quality assessment to much deeper networks, but reducing notably the computational cost.

Network	Se	Sp	Acc	Time/ECG interval (ms)
Light CNN (empty weights)	0.776	0.934	0.780	0.65
Light CNN (Pre-trained on ImageNet 70)	0.836	0.884	0.836	0.64
GoogLeNet (ImageNet)	0.887	0.841	0.886	7.94