A Deep Learning Solution for Automatized Interpretation of 12-Lead ECGs

Álvaro Huerta, Arturo Martínez-Rodrigo, José J Rieta, Raúl Alcaraz

Research Group in Electronic, Biomedical and Telecommunication Engineering, University of Castilla-La Mancha Cuenca, Spain

Background and Aim. A broad variety of algorithms for detection and classification of rhythm and morphology abnormalities in ECG recordings have been proposed in the last years. Although some of them have reported very promising results, they have been mostly validated on short and nonpublic datasets, thus making their comparison extremely difficult. Interestingly, PhysioNet/CINC Challenge 2020 provides an opportunity to compare these and other algorithms on a wide set of ECG recordings. The goal of this work is to introduce a novel method based on deep learning and beat-to-beat classification to participate in this competition.

Methods. Beats in all ECG recordings from the learning set were firstly segmented. Thus, R-peaks were detected from lead I and the mean RR interval was computed to define a time window in which every single beat was get. Next, this time window was applied to the remaining available leads, consecutively concatenating single beats to generate a new signal, which was next transformed into a 2-D image through a continuous Wavelet transform. In this way, more than 130,000 images were obtained, which were used to train an 8-layer convolutional neural network (CNN) specifically designed to discern 9 different rhythms or morphology abnormalities. For an ECG-based validation, the probabilities of belonging to each class obtained by the CNN were averaged for all beats found in the recording. Finally, those classes presenting an average probability larger than 10% were assigned to the ECG.

Results. According to the Challenge guidelines, the proposed algorithm was evaluated in terms of a class-weighted F-score (F_β) and a generalization of the Jaccard measure (G_β). In average for all training signals, these metrics were 0.933 and 0.811, respectively. Regarding validation on the testing set, mean values for both performance indices were 0.654 and 0.372, respectively.

Conclusions. Although the proposed method has reported a notable ability to associate the dominant class to each ECG, detection of secondary abnormal rhythms in the recording should be improved.