Enabling ECG Digitization and Classification with Hierachical End-To-End Training

Tizian C. Dege*[1], Maurice Rohr[1], Christoph Hoog Antink[1]
[1]KIS*MED - AI Systems in Medicine,
Technische Universität Darmstadt, Darmstadt, Germany

Despite its age, the electrocardiogram (ECG) remains the primary diagnostic tool for detecting abnormal heart behaviour. Traditionally, ECGs were printed on paper to be diagnosed by cardiologists. Moreover, recent advancements in deep learning have shown to be capable of detecting abnormalities of the heart with high precision, from digitized signals, thus enabling an accessible tool for self-diagnosis and reducing the number of preventable deaths.

In our work, we present a novel hierarchical approach to ECG classification and digitization from images. We base our solution on a recently published convolutional neural network (CNN) architecture for ECG image classification and use it as a backbone for feature extraction.

Before training, we generate realistic ECG images from openly available ECG datasets. The classification (1) is trained on low-resolution images, while the digitization (2) relies on a clipped image, that use a predicted region-of-interests where the ECG signal is. We assume that the digitization is prone to artefacts shown, and therefore reduce the noise of the input. Additionally, we combine classification and digitization in a single architecture (3) since we believe that classification comprises important features for digitization and makes the approach robust to noise. After training classification and digitization models separately, we stack a 1D CNN for classification on top of the digitization model, combine the output of both classification models, and finetune all components with end-to-end training (4). We assume that the hierarchical structure of the model increases both accuracy and allows for improved digitization of the input. Our current solution for classification (1) has achieved an F1-score of 0.66 on the hidden set of PhysioNet2024, while our digitization model (2) still needs to be implemented.

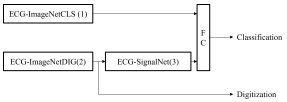

Figure 1. Complete architecture for classification and digitization (4).