Reading Between the Leads: Local Lead-Attention Based Classification of ECG Signals

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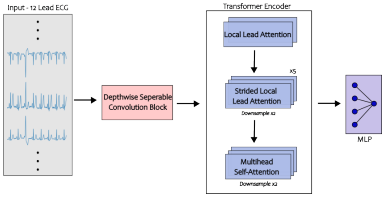
Self-Attention based models have been dominating both computer vision and NLP areas, but very few works have tried to implement them in time-domain ECG signal processing, mainly due to the fact that there is not much need for global receptive fields. In this work, we implement a network using local self-attention to solve the task of multi-class classification on the PhysioNet/Computing in Cardiology Challenge 2021 dataset which comprises of 26 different classes over 6 different datasets combined and compare the performance of out model with the winning solution of the challenge.

We introduce a novel local lead-attention to learn features across a single lead as well as multiple leads. We project the signals using a shallow strided depthwise seperable convolution block without overlap between the leads. The use of depthwise convolutional layers and local lead-attention makes the model efficient and light-weight with only 2.4M parameters.

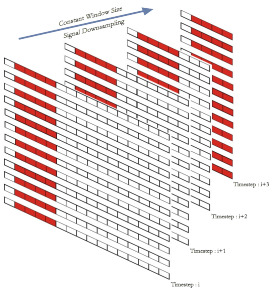


Model Architecture

Given $\mathbf{Z} \in \mathbb{R}^{L \times T \times D}$, where L is the number of leads, T is the time step and D is the dimension of the feature in an intermediate layer, $\mathbf{Z}$ is projected using $W_Q \in \mathbb{R}^{D \times D_q \times L}$, $W_K \in \mathbb{R}^{D \times D_k \times L}$, $W_V \in \mathbb{R}^{D \times D_v \times L}$ to get feature matrices $\mathbf{Q}$, $\mathbf{K}$ and $\mathbf{V}$.

The output of this local self attention is as follows:

$$S = softmax(\frac{QK^T}{\sqrt{D_q}})V \qquad (1)$$



Local-Lead Attention with fixed window size

Results of the Challenge

Method	AUPRC	AUROC	F-Measure	Model Size
ISIBrno	0.901	0.514	0.493	6.5M
Local Lead-Attention	**0.949**	**0.548**	**0.521**	**2.4M**