ECG Signal Generation Using Feature Disentanglement Auto-encoder

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Aims: The lack of ECG dataset, particularly for rare classes, is challenging. Some generative models, such as GAN and VAE are being applied as standard solutions. However, this study aimed to propose a novel Auto-encoder to generate new samples, especially for rare classes like previous generative models.

Methods: We proposed Feature Disentanglement Auto-encoder (FDAe). The model comprises an encoder that learns person-independent representations and a decoder that learns to reconstruct the ECG signal of a designated person. With a raw signal from one person fed to the encoder, we concatenated the output of the encoder with the identity (like one-hot encoding) of the person instead of feeding it into the decoder directly. Then the concatenated result would be passed to the decoder, generating a new signal. Additionally, we trained FDAe as an ordinary Auto-encoder except for attaching a person's identity to the encoding result.

Results: We performed heartbeat classification experiments on the public MIT-BIH arrhythmia database to evaluate our proposed method. The baseline was a conventional classification task following intra-patient mode, and then we added new samples generated from FDAe to the train set in the baseline. The classifier was SVM and we selected overall accuracy (OAcc) and Macro-average F1 score (Macro-F1) as performance measurements. The evaluation result after our adding generated samples had OAcc 97.66% and Macro-F1 0.8471. For the baseline, it had OAcc 96.65% and Macro-F1 0.8187.

Conclusion: Owing to the experiment result that performance measurements are improved using our new approach, FDAe performs well in generating new samples.

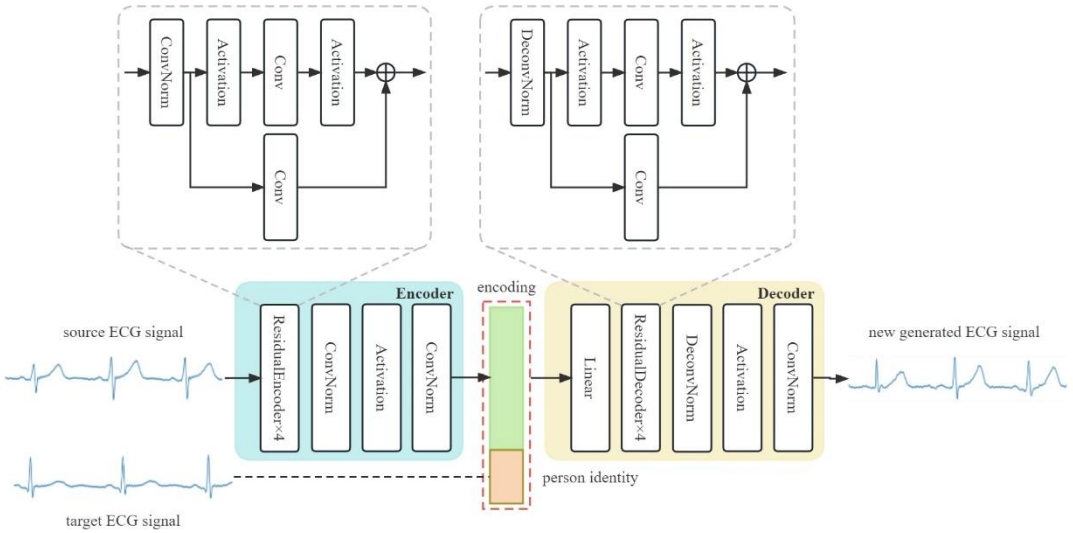

Figure 1. Our FDAe architecture. ConvNorm(DeconvNorm) denotes convolution(deconvolution) followed by batch normalization.