

Neural Network-Based Matrix Completion for Minimal Configuration of Body Surface Potential Mapping

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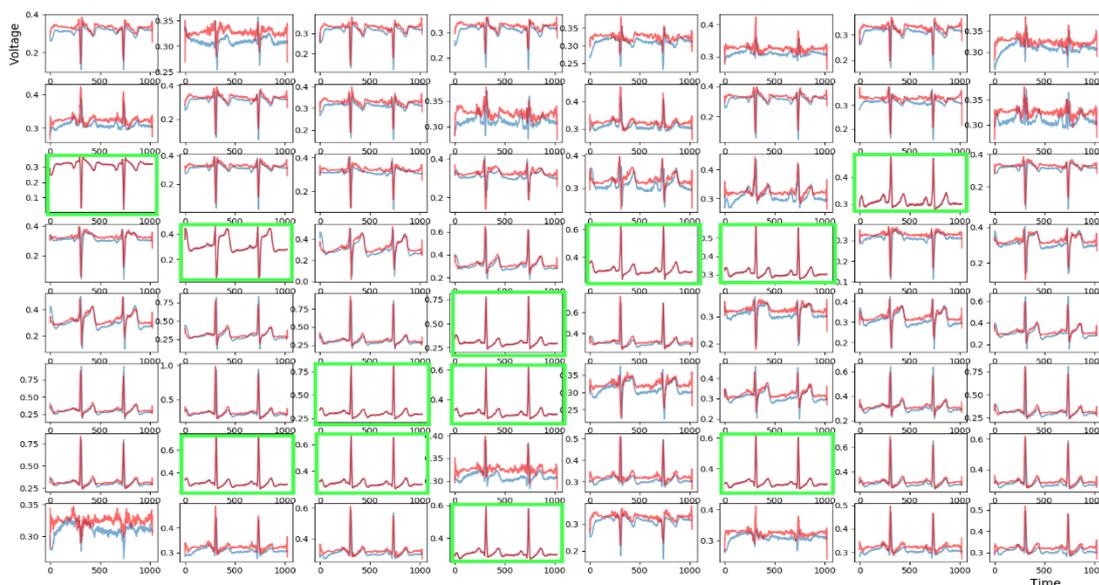
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Aims: Body surface potential mapping (BSPM) can involve up to 200 electrodes, in contrast to standard 12-lead ECG. The costs and complexity of a BSPM procedure are a limiting factor to its use in clinical practice. Both can be reduced by using less electrodes and reconstructing signals from the missing electrodes with a neural network. The minimal configuration consists of the electrodes that are most relevant for reliable reconstruction.

Methods: A variational autoencoder was trained on BSPM recordings from the Nijmegen-2004-12-09 dataset available on EDGAR (BSPM system with 65 channels; 14 different procedures from 1 subject) and used to reconstruct the signals of all 65 channels from a reduced number of input channels. The autoencoder was trained on a procedure, and accuracy was assessed by computing reconstruction errors on data from a different procedure. Additionally, the effect of systematically increasing numbers of missing electrodes and the corresponding reconstruction errors was studied. Finally, a qualitative comparison with the 12-lead ECG was made, by selecting the 12 most important leads and mapping their locations on the upper torso.

Results: The optimal settings for the autoencoder was 2 seconds rolling window and a latent dimension of 24. The variational autoencoder could reconstruct sufficiently well BSPM signals from the test set using as few as 12 electrodes (average mean square error 11.210 ± 0.408 over 100 predictions). Minimal configuration electrode positions coincided well with those of precordial leads from the 12-lead ECG, with additional positions appearing on the lower back.

Conclusion: Results shows that by using an autoencoder it is possible to achieve accurate reconstruction of 65-BSPM channels from a minimal configuration of 12 electrodes on the body surface. The positions of these electrodes overlap well with the standard 12-lead ECG, with the addition of 2 electrodes on the lower back.



Ground Truth signal (blue) and network reconstruction (red) for data the network was not trained on, after n=12 reconstructions using 12 best leads marked by green frames.