Reconstruction of Missing Physiological Signals using Artificial Neural Networks

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Real-time monitoring of vital physiological signals is of significant clinical relevance. Disruptions in the signals are frequently encountered and make it difficult for precise diagnosis. Thus, the ability to accurately predict/recover the lost signals could greatly impact medical research and application. In response to the PhysioNet/CinC Challenge 2010: Mind the Gap, we develop an algorithm based on artificial neural networks to predict the missing signals in one channel using the measurements in other channels. An artificial neural network model is created for each record, which consists of 6, 7, or 8 signals acquired from bedside ICU patient monitors. We first train the network using data from the beginning 9.5 minutes of the record. Then, we reconstruct the missing data in the subsequent 30 seconds for a specific channel. A few techniques are utilized to improve the performance of the model. Principle component analysis is used to reduce complexity and computational cost. Noisy signals are smoothened using a wavelet-based de-noising algorithm before training and testing. We explored three different neural networks: focused time-delayed neural network, distributed time-delayed neural network, and nonlinear autoregressive network with exogenous inputs. The focused time-delayed neural network is more computationally efficient while the other two networks provide slightly more precise predictions. For highly correlated data sets, all three networks are able to produce accurate predictions; however, predictions of chaotic and highly noisy data sets are less satisfactory.