Filling in the Gap: a General Method using Neural Networks

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When a set of medical signals has redundant information it is sometimes possible to recover one signal from its past and the information provide by the other signals. In this work we present a general method to accomplish this task. For a long time it was known that multilayered networks are universal approximators but, even with the backprop algorithm, it was not possible to train in a reasonable amount of time such a network to realize complex real life tasks. In the last years Geoffrey Hinton proposed a training method that is able to overcome the previous difficulties. Pretraining a multilayered perceptron, layer by layer as a restricted boltzmann machine first and then as an autoencoder enables the backprop algorithm to find satisfactory weights for a complex neural network. So, if ecg leads II and V are available and lead AVR is missing for a while, we first train, using past information, an autoencoder on leads II and V and another on lead AVR. The higher layer of the first autoencoder will provide features that will allow, with an extra perceptron, to match the higher layer of the second autoencoder. Now this higher layer of the second autoencoder can be seen as a code that enables us to reconstruct lead AVR. We applied the same procedure to reconstruct, for example, missing intracranial pressure signal when pleth, abp and respiration signals are available or missing CVP when pleth, respiration and some ecg leads are present. Moreover, the autoencoder we train sucessfully on the past of a signal can be used to judge if present signal suffered significant changes: when the autoencoder reconstruction error is big on the the present time signal, something changed on the signal and that might be for example noise degradation or alteration in the heart rate.