PhysioNet 2010 Challenge: A Robust Multi-Channel Adaptive Filtering Approach to the Estimation of Physiological Recordings

Ikaro Silva*

Laboratory for Computational Physiology, MIT, Cambridge, MA, United States

The 2010 PhysioNet Challenge was to predict the last 30 seconds (the g̈ap) of a physiological waveform given 9 minutes and 30 seconds of its previous history and 10 minutes of N different concurrent physiological recordings (sampled at 125 Hz). A robust approach was implemented by using a set of adaptive filters to predict the desired channel. In all, N+2 channels (the N original signals, and 2 signals derived from the first 9 minutes and 30 seconds of the signal preceding the gap) were used to estimate the missing data. For each of the N+2 individual channels, a gradient adaptive lattice Laguerre filter (GALL) was trained to estimate the desired channel. The GALL filter was chosen because of its fast convergence, numerical robustness, stability, and ability to model a very long response using relatively few parameters. A learning factor was applied to each GALL in order to account for changes in the environment and/or in the relationship between the channels. The prediction of each of the N+2 channels (the output of each of the N+2 GALL filters) was then linearly combined using time-varying weights determined through a Kalman filter with a learning factor optimized over a training region. At the time of this writing, an average score of 80% on Set B (Event 2) was obtained. The performance of the procedure was found to be roughly dependent on the type of recording, number of channels available, and the ranking of the final weights given by the Kalman filter. This suggests that the tracking of the Kalman weights might provide further insight into how specific changes in a physiological state affect the selected recording. The approach is extensible to recordings with any number of signals, other types of signals, and other problem domains.