Optimization problems in signal compression

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Real-world applications, e.g., telecommunication, e-health, produce a vast amount of signals (sounds, electrocardiograms, etc.), thus their compression is inevitable. These methods are based on dimensionality reduction of the original data. Hence, they can also be used as a feature extraction step in classification tasks. The main scope of this talk is to examine adaptive signal representations, which depend on a certain parameter vector $\mathbf{a}$. In order to minimize the ℓ^2 error between the original discrete time series $f \in \mathbb{R}^N$ and the approximation $\widetilde{f}^{\mathbf{a}} \in \mathbb{R}^N$, we should solve the following optimization problem

$$\min_{\mathbf{a}} \left\| f - \widetilde{f}^{\mathbf{a}} \right\|_2$$

We are looking for the solution in the form

$$\widetilde{f}^{\mathbf{a}}[k] = \sum_{i=1}^{n} c_i \Theta_i^{\mathbf{a}}[k] \qquad (k = 1, \ldots, N),$$

where the coefficients c_i of the representation can be calculated via scalar products, least squares methods, etc. Generally, $n \ll N$, thus the length N of the original series is reduced to n. The set of the base functions $\{\Theta_i^{\mathbf{a}} : i = 1, \ldots, n\}$ should be chosen carefully according to the problem. For instance, rational function systems proved to be very useful in ECG and EEG signal processing tasks [1, 2]. We review these compression and optimization techniques including rational functions [3], orthogonal polynomials [4] and B-splines [5].

References

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