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Integration of Prior Information in Learning Algorithms for Adaptive Signal Processing

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Diskussionsleitung: Prof. Dr.-Ing. R. Müller

The subject of adaptive filtering and the development of suitable machine learning algorithms constitutes an important part of statistical signal processing. A prominent example and a driving force for the development of powerful and efficient adaptation algorithms is adaptive filtering for scene analysis using sensor arrays and the related task of signal enhancement in human-machine interfaces, such as acoustic interfaces (e.g., teleconferencing, hands-free automatic speech recognition, hearing aids) or for biomedical signal processing. One of the challenges in these applications lies in the broadband nature of the signals and the generality of the stochastic signal properties. These characteristics are often contradictory to the assumptions of traditional algorithms. Furthermore, especially in blind adaptive signal processing problems, i.e., adaptation without access to a reference signal, it is even a necessity to exploit the nonstationarity or the non-gaussianity, combined with the nonwhiteness of the signals. As a result of the various possible adaptive signal processing configurations and constraints, a large and diverse set of seemingly unrelated algorithms has been proposed in the literature.

This talk consists of two major parts. In the first part, we review a framework, called TRINICON, which allows for a unified treatment of broadband adaptive adaptive signal processing algorithms, including blind and supervised multiple-input and multiple-output (MIMO) systems. Based on first principles of estimation theory and information theory, this framework allows to simultaneously exploit all the stochastic signal properties mentioned above in a rigorous way, and we will also report on some recent novel results made possible by the integration of prior information on the signal characteristics.

The second part will go beyond the integration of prior information on the signals, and we will outline how the framework can be extended in its full generality in order to integrate prior information on the dynamical systems as well. This includes aspects from some highly active research areas in machine learning and signal processing, such as Bayesian signal processing, manifold learning, and compressed sensing. Finally, we will conclude with a brief discussion of some interesting future research directions based on this framework.