Source density driven fast independent component approach for EEG recordings analysis

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Abstract

Independent Component Analysis (ICA) has been widely applied to blind separation of statistically independent processes in time-varying event-related response data including electroencephalographic (EEG) and magnetoencephalography (MEG) signals, without making use of *a priori* knowledge of the temporal properties of the processes contributing to the responses [Makeig *et al.*, 1996, 1997; Hyvärinen, 1999, Vigario *et al.*, 2000]. Aware of the issue of the probability density functions of the latent sources, a large number of parametric density models have been made available in recent literature. By performing blind source separation on linear mixtures of independent source signals with either sub-Gaussian or super-Gaussian distributions, the extended infomax algorithm of ICA [Lee and Sejnowski, 1997] has been found to be more effective than previous version [Bell and Sejnowski, 1995] for removing a wide variety of artifacts from EEG records [Jung *et al.*, 1998; Lee *et al.*, 1999]. A skewed probability density function with long tails instead of symmetric heavy tails has also been introduced to describe sources which consist of spatially localized features surrounded by an homogeneous background [Stone *et al.*, 2002]. Since the probability density functions of the underlying sources are often unknown, unrealistic assumptions about the distribution family may seriously compromise the performance and convergence properties of the algorithms.

In this talk, a novel approach to the blind signal separation (BSS) problem is introduced that is capable of jointly estimating the probability density function (pdf) of the source signals and the unmixing matrix. By using a hyperbolic power transformation, it is possible to extract not only mixtures of sub-Gaussian, super-Gaussian, and skewed source signals, but also bimodal and/or near Gaussian signals, which are common in some key application areas, such as biomedical signal processing. The simulation results and real EEG recordings decomposition illustrate the effectiveness and

performance of the proposed method.