

Source Separation algorithms applied to cerebral signals

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Abstract

Physiological activity in the brain can be evaluated by means of non-invasive electrophysiological techniques like electroencephalogram, EEG, and magnetoencephalogram, MEG: such instruments are able to obtain cerebral processing measures with the optimal time resolution. The crucial problem is then to gain access to the inner neural code starting from the extra-cranial recordings: cerebral signals related to significant activity are mixed and embedded in unstructured noise and in other physiological artefacts, non relevant to the desired observation.

To deal with this problem, a statistical-based approach has been recently introduced, based on exploiting statistical properties of sources composed in the observed signals without any assumption about the biophysical model underlying the recorded signals. In particular, the “Independent Component Analysis” (ICA) model assumes that sources are statistically mutually independent; to extract them from the mixture a measure of non-gaussianity is maximized (i.e. kurtosis).

In this talk we discuss how the ICA assumptions fit with the complex and interconnected cerebral networks activity and we describe our newly proposed “Functional Source Separation” (FSS) algorithm, conceived as a generalization of the basic ICA model. Some physiological constraints, defined on the expected temporal behaviour of the cerebral sources of interest are added to the maximization of kurtosis producing a multi-objective cost function that exploits simultaneously global statistical features and functional source properties. Some of the ICA and FSS applications from our previous studies are revised and discussed in order to provide applications examples.

Our conclusions are that the ICA algorithm could be successfully applied for specific issues, in particular for artefacts removal, but the proposed multi-objective FSS cost-function provide a more general framework to estimate cerebral activity of interest.

References

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