Complex Independent Component Analysis of Frequency-Domain Electroencephalographic Data

Jörn Anemüller, Terrence J. Sejnowski and Scott Makeig

Swartz Center for Computational Neuroscience
University of California San Diego
La Jolla, California
and
Computational Neurobiology Laboratory
The Salk Institute for Biological Studies
La Jolla, California
{jorn,terry,scott}@salk.edu

Independent component analysis (ICA) is highly useful for modeling brain and electroencephalographic (EEG) data. Here, we present a new method that may better capture the dynamics of brain signals than previous ICA algorithms. We assume that a brief, impulse-like activation of an effective signal source elicits a short sequence of spatio-temporal activations in the measured signals. This leads to a model of convolutive signal superposition, in contrast to the commonly used instantaneous mixing model. In the frequency-domain, convolutive mixing is equivalent to multiplicative mixing of complex signal sources within distinct spectral bands. We decompose the recorded complex signals into independent components (ICs) by a complex infomax ICA algorithm. We compare the complex ICs in distinct spectral bands to group together components generated by common EEG processes. Results from a visual attention EEG experiment illustrate differences between real time-domain and complex spectral-domain ICA, and highlight properties of complex ICs.