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An Essay on Independent Component Analysis

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Measured signals are often mixtures of several source signals. Without enough prior information about the source signals or the mixing process, recovering the source signals is nontrivial. As one of the most popular blind source separation techniques, independent component analysis (ICA) provides a solution by expressing the observed variables (data) as a linear combination of statistically independent latent component variables (sources). An important application of ICA is to identify spatially or temporally independent patterns in functional Magnetic Resonance Imaging (fMRI) data. ICA decomposes the observed data matrix into a source matrix, which contains statistically independent spatial maps in its rows, and a mixing matrix whose associated columns (time-course) characterize the internally consistent temporal dynamic with each spatial map. Different activated brain maps associated with various bodily functions (breathing, reacting to stimulus, etc.) can be extracted from fMRI scans. The most commonly used group ICA methods can be categorized into two types—ad hoc post reconstruction and iterative EM algorithm. We use a simulation study to compare the efficiencies of existing group ICA methods.