

What is Independent Components Analysis

- ICA is a family of techniques used to extract independent signals from some source signal.
 - Solves Cocktail Party Problem
 - Major technique for Blind Signal Separation
 - Has advantages from other multivariate techniques like PCA
 - Applications in EEG, fMRI

Cocktail Party Problem

- Problems Specification

- 2 people talking simultaneously($s_1(t)$ $s_2(t)$)

- 2 microphones in different locations(gives us two time signals $x_1(t)$ $x_2(t)$)

$$x_1 = a_{11} * s_1 + a_{12} * s_2$$

$$x_2 = a_{21} * s_1 + a_{22} * s_2$$

- a_{ij} are values depending on distance of mic from speakers.

- Want to estimate s_1 and s_2 using only x_1 and x_2

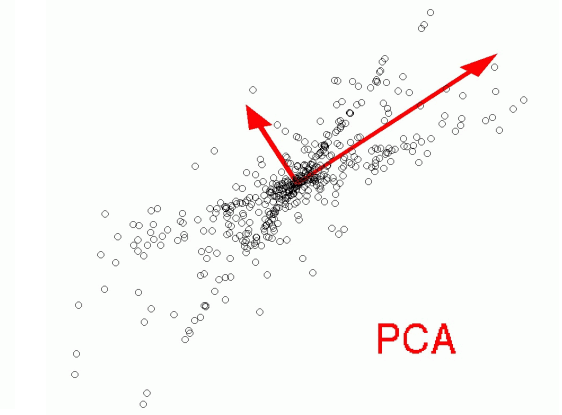
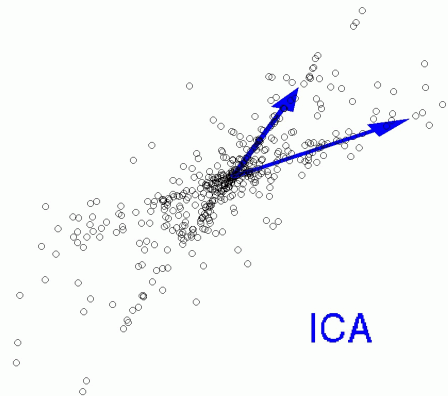
- ICA solves this problem without knowing a_{ij} , the major assumption is that $s_1(t)$ and $s_2(t)$ are independent.

More Details on ICA

- Interested in solving $x=As$
 - A is mixing matrix, s is source vector, x is mixtures
 - Generative model: describes how observed data are generated by a process of mixing components of s .
- Two major assumptions
 - Components s_i are statistically independent
 - Independent component must have nongaussian distributions
- Part of Larger Problem Blind Source Separation (BSS)
 - Little known about mixing matrix
 - Little assumed about source signals

PCA vs ICA

- Use ICA or PCA when you want multivariate analysis
 - Definition: methodologies used in the analysis of data taken simultaneously on many variables
- PCA: finds directions of maximal variance in **gaussian** data
- ICA: finds directions of maximal independence in **nongaussian** data“Maximizes joint entropy and minimizes mutual information between output channels”(Bell & Sejnowski, 1995).



Applications of ICA

- EEG
 - Separates brain signals from artifacts
 - Allows study of brain activation in noisy conditions
- fMRI
 - Identifies concurrent hemodynamic processes
 - One measure of functional connectivity

