

Components in Data Analysis

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Introduction

Independent Component Analysis

Algorithm

Preprocessing

Usage

Summary

Literature

Questions

Introduction

- ▶ Mixed independent signals
 - ▶ $x_1 = a_{11}s_1 + a_{12}s_2$
 - ▶ $x_2 = a_{21}s_1 + a_{22}s_2$
- ▶ Ambiguities

Independent Component Analysis

- ▶ Independent variables
- ▶ Only nongaussian random variables
- ▶ Heuristic, estimation

Nongaussianity

- ▶ Nongaussianity measure
 - ▶ Kurtosis
 - ▶ Negentropy
 - ▶ Negentropy approximation
- ▶ Minimization of mutual information (dependence)

Preprocessing

- ▶ Centering
- ▶ Whitening (uncorrelated, variance=1)
- ▶ Application specific preprocessing

FastICA

- ▶ Neural network learn to find direction
- ▶ Maximize nongaussianity
- ▶ Decorrelate outputs if several output units

FastICA - properties

- ▶ Neural network, parallelizable
- ▶ Fast convergence
- ▶ No step parameters
- ▶ Finds components one by one

Usage - Signal separation

- ▶ Blind signal separation
- ▶ Separate independent signals
 - ▶ or signal from artifacts
- ▶ Separate parts of one signal

Usage - Noise reduction

- ▶ Images corrupted with additive Gaussian noise
- ▶ Separate image from one gaussian component (noise)
- ▶ Sparse code shrinkage

Usage - Telecommunications

- ▶ Separate signal from interfering signals
- ▶ Error correction algorithms
- ▶ Maximize data throughput on given channel

Literature

- ▶ Independent Component Analysis: Algorithms and Applications, *Aapo Hyvärinen and Erkki Oja*
- ▶ Pattern Recognition, Third Edition, *Sergios Theodoridis and Konstantinos Koutroumbas*
- ▶ An Information-Maximization Approach to Blind Separation and Blind Deconvolution, *Bell, Sejnowski*
- ▶ Sparse code shrinkage: Denoising of nongaussian data by maximum likelihood estimation, *Hyvarinen*

Questions

Questions?