

# Preface

Blind source separation (BSS) methods have received extensive attention over the past two decades; thanks to its wide applicability in a number of areas such as biomedical engineering, audio signal processing, and telecommunications. The problem of source separation is an inductive inference problem, as only limited information, e.g., the sensor observations, is available to infer the most probable source estimates. The aim of BSS is to process these observations (acquired by sensors or sensor arrays) in such a way that the original unknown source signals are extracted by, e.g., an adaptive system, or separated simultaneously using, e.g., a block (or batch)-based algorithm, without knowing or with very limited information about the characteristics of the transmission channels through which the sources propagate to the sensors. Independent component analysis (ICA) is one of the early and most widely used techniques for BSS by revealing the hidden factors that underlie the sets of measurements or the observed signals. Recently, a number of new techniques have been emerging in BSS, such as latent variable analysis, non-negative matrix/tensor factorization (NMF/NTF), sparse component analysis, dictionary learning, independent vector analysis, factor analysis, matrix completion, compressed sensing, empirical mode decomposition, and complex-valued adaptive methods. At the same time, the applications of BSS continue to grow and prosper in a number of areas, such as audio, speech, music, image, biomedical, communication, and financial data analysis and processing.

This book aims to disseminate timely to the scientific community the new developments in BSS spanning from theoretical frameworks, algorithmic developments, to a variety of applications. The book covers some emerging techniques in BSS, especially those developed recently, offering academic researchers and practitioners a comprehensive update about the new development in this field. The book provides a forum for researchers to exchange their ideas, and to foster a better understanding of the state of the art of the subject. We envisage that the publication of this book will motivate new ideas and more cutting-edge research activities in this area.

This book is intended for computer science and electronics engineers (researchers and graduate students) who wish to get novel research ideas and some training in BSS, ICA, machine learning, artificial intelligence, and signal processing applications. Furthermore, the research results previously scattered in many scientific articles worldwide are methodically collected and presented in the

book in a unified form. As a result of its twofold character, the book is likely to be of interest to researchers, engineers, and graduates who wish to learn the core principles, methods, algorithms, and applications of BSS. Furthermore, the book may also be of broader interest to researchers working in other areas of science and engineering, due to the multidisciplinary nature of this book.

The book is organized into two parts. Part I is devoted to recent developments in theories, algorithms, and extensions of BSS. In this part, we have collected nine chapters with several novel contributions, namely, the idea of quantum ICA by Yannick Deville and Alain Deville, the singularity-aware dictionary learning approach for BSS by Xiaochen Zhao, Guangyu Zhou, Wenwu Wang, and Wei Dai, the theoretical results on the performance of complex ICA by Benedikt Loesch and Bin Yang, sub-band based BSS by Bo Peng and Wei Liu, independent vector analysis for frequency domain BSS by Yanfeng Liang, Syed Mohsen Naqvi, Wenwu Wang, and Jonathon A. Chambers, sparse component analysis by Yannick Deville, underdetermined source separation by Nikolaos Mitianoudis, NMF based source separation by Bin Gao and Wai Lok Woo, and a BSS related topic of source localisation and tracking by Md Mashud Hyder and Kaushik Mahata. Part II focuses on the various applications of BSS and its links to other relevant areas, such as computational auditory scene analysis (CASA). We have gathered 10 chapters in this part. They are respectively, blind speech extraction algorithms by Hiroshi Saruwatari and Ryoichi Miyazaki, combining superdirective beamforming and BSS for speech separation by Lin Wang, Heping Ding, and Fuliang Yin, ideal ratio mask for CASA by Christopher Hummersone, Toby Stokes, and Tim Brookes, monaural speech enhancement by Masoud Geravanchizadeh and Reza Ahmadnia, background/foreground separation by Zafar Rafii, Antoine Liutkus, and Bryan Pardo, NMF-based sparse coding for cochlear implants by Hongmei Hu, Guoping Li, Mark E. Lutman, and Stefan Bleeck, brain signal analysis using ICA by Ruben Martin-Clemente, BSS for the analysis of large-scale omic datasets by Andrew E. Teschendorff, Emilie Renard, and Pierre A. Absil, ICA for complex domain source separation of communication signals by Ajay K. Kattapur and Farook Sattar, and semi-blind source separation algorithms from non-invasive electrophysiology to neuro-imaging by Camillo Porcaro and Franca Tecchio.

We would like to thank the authors for their excellent submissions (chapters) to this book, and their significant contributions to the review process, which have helped to ensure the high quality of this publication. Without their contributions, it would have not been possible for the book to come successfully into existence.

January 2014

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<http://www.springer.com/978-3-642-55015-7>

Blind Source Separation

Advances in Theory, Algorithms and Applications

Naik, G.R.; Wang, W. (Eds.)

2014, IX, 551 p. 189 illus., Hardcover

ISBN: 978-3-642-55015-7