Preface

In many situations found both in Nature and in human-built systems, a set of mixed signals is observed (frequently also with noise), and it is of great scientific and technological relevance to be able to isolate or separate them so that the information in each of the signals can be utilized.

Blind source separation (BSS) research is one of the more interesting emerging fields nowadays in the field of signal processing. It deals with the algorithms that allow the recovery of the original sources from a set of mixtures only. The adjective "blind" is applied because the purpose is to estimate the original sources without any a priori knowledge about either the sources or the mixing system. Most of the models employed in BSS assume the hypothesis about the independence of the original sources. Under this hypothesis, a BSS problem can be considered as a particular case of independent component analysis (ICA), a linear transformation technique that, starting from a multivariate representation of the data, minimizes the statistical dependence between the components of the representation. It can be claimed that most of the advances in ICA have been motivated by the search for solutions to the BSS problem and, the other way around, advances in ICA have been immediately applied to BSS.

ICA and BSS algorithms start from a mixture model, whose parameters are estimated from the observed mixtures. Separation is achieved by applying the inverse mixture model to the observed signals (separating or unmixing model). Mixture models usually fall into three broad categories: instantaneous linear models, convolutive models and nonlinear models, the first one being the simplest but, in general, not near realistic applications. The development and test of the algorithms can be accomplished through synthetic data or with real-world data. Obviously, the most important aim (and most difficult) is the separation of real-world mixtures. BSS and ICA have strong relations also, apart from signal processing, with other fields such as statistics and artificial neural networks.

As long as we can find a system that emits signals propagated through a mean, and those signals are received by a set of sensors and there is an interest in recovering the original sources, we have a potential field of application for BSS and ICA. Inside that wide range of applications we can find, for instance: noise reduction applications, biomedical applications, audio systems, telecommunications, and many others.

This volume comes out just 20 years after the first contributions in ICA and BSS appeared[1]. Thereinafter, the number of research groups working in ICA and BSS has been constantly growing, so that nowadays we can estimate that far more than 100 groups are researching in these fields.

As proof of the recognition among the scientific community of ICA and BSS developments there have been numerous special sessions and special issues in several well-

[1] J. Herault, B. Ans, "Circuits neuronaux à synapses modifiables: décodage de messages composites para apprentissage non supervise", *C.R. de l'Académie des Sciences*, vol. 299, no. III-13, pp. 525–528, 1984.
Independently, two years before, although without the scientific impact of the previous reference, the following contribution was published:
J.W. Barness, Y. Carlin, and M.L. Steinberger, "Bootstrapping adaptive interference cancelers: some practical limitations", *Proc. of the Globecom Conference*, pp. 1251–1255, 1982.

known conferences and journals, such as GRETSI, NOLTA, ISCAS, EUSIPCO, NIPS, ESANN, IWANN, etc. An important landmark in the development of ICA was the organization of the first conference dedicated to ICA and BSS: the 1st International Workshop on Blind Source Separation and Independent Component Analysis (ICA 1999), which occurred in Aussois (France) in 1999. This workshop has been taking place since then about every 18 months, in Helsinki, Finland (ICA 2000), San Diego, California, USA (ICA 2001), and Nara, Japan (ICA 2003).

This volume of Lecture Notes in Computer Science encompasses the contributions to ICA 2004 which was held in Granada (Spain), presenting new ideas and challenges for ICA and BSS. This volume is composed of 156 contributions, selected after a peer-review process from 203 original contributions. The manuscripts were organized into the following eight sections:

1. Theory and fundamentals
2. Linear models
3. Convolutive models
4. Nonlinear models
5. Speech processing applications
6. Image processing applications
7. Biomedical applications
8. Other applications

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