Brief CV of Christian Jutten
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Emeritus Prof. of Statistical Signal Processing, Univ. Grenoble Alpes, Grenoble, France
Senior Member of Institut Universitaire de France since 2008,
Felllow IEEE (2008) and Fellow EURASIP (2013)
PI of the 2012 ERC Advanced Grant CHESS

JUTTEN Christian, born April 19th, 1954 in Epernay, France. French nationality

1 - Diploma

- MSc in Electrical Engineering at Institut National Polytechnique of Grenoble (INPG, now Grenoble Institute of Technology), Research MSc (DEA) in electronics and signal processing, Grenoble 1977
- PhD, Institut National Polytechnique de Grenoble (INPG), 1981 (with ***highest honors***). *In my PhD, I investigated properties of artificial neural networks as information processing systems.*
- Docteur ès Sciences physiques, INPG and Univ. J. Fourier (now Univ. Grenoble Alpes), Grenoble, 1987. *My dissertation for this degree contains pioneer works (done from 1982 to 1987) on source separation and independent component analysis, inspired by the motion coding in vertebrates.*

2 - Successive positions

- ***Associate professor (1982-89)*** at Grenoble INP
- ***Invited professor at EPFL (Swirzerland)*** in Prof. Nicoud's lab during 6 months in 1989
- ***Full professor*** since 1989 at University Joseph Fourier of Grenoble (now Univ. Grenoble Alpes), "exceptional class" professor (**2nd and highest level**) since 2008.
- ***Director*** of the Images Processing and Pattern Recognition lab (35 people) from 1993 to 1997.
- ***Scientific advisor*** for signal and image processing, French Ministry of Research, from1996 to 1998.
- ***Invited researcher in Riken lab (Japan),*** with Prof. Cichocki during one month in spring 1999
- ***Deputy director*** of Images and Signals lab (CNRS joint unit, 100 people), 1999-2006 and of GIPSA-lab (CNRS joint unit, 300 people), head of the Images and Signal Dept. (DIS, 120 people), 2007-10,
- ***Scientific advisor*** for signal/image processing at CNRS (STIC department), from 2003 to 2006.
- ***Invited professor in Campinas Univ.,*** with Prof. Romano during one month in summer 2010
- ***Scientific Deputy Director*** (May 2012 up to September 2014) and then ***Scientific Advisor*** (up to Sept. 2019) for Signal and Image Processing and coordinator of the ERC support team at Institute for Information Sciences and its Interactions (INS2I) at CNRS.
- ***Scientific advisor*** for the president of CNRS, in the Office for Scientific Integrity, from May 2019.
- ***Emeritus Professor*** in Univ. Grenoble Alpes, from September 2019.

3 - Honors, Awards and Invitations

- ***Best paper award*s: Signal Processing** in 1991 (paper ***cited more than 3400 times***) and ***IEEE GRSS 2012 Transactions Prize paper award.***
- ***Invited professor: Ecole Polytechnique Fédérale de Lausanne*** (6 months in 1989), ***RIKEN*** Lab. (Wako Chi, Japan, 1 month in 1996), ***Univ. of Campinas*** (Brazil, 1 month in 2010).
- ***Medal Blondel*** awarded by the French Society of Electrical and Electronical Engineer (1997).
- Elevation to the grade of ***IEEE Fellow*** (2008) and ***EURASIP Fellow*** (2013).
- Senior member of ***Institut Universitaire de France*** (2008), with renewal for 5 years in 2013.
- ***Award a prestigious Advanced ERC Grant*** in 2012, for the CHESS (CHallenge in Extraction and Separation of Sources) project, 2012-ERC-AdG-320684.
- ***Grand Prix 2016 "Science et Innovation"*** *of the French* ***Académie des Sciences.***

4 - International responsabilities

- ***Associate editor*** for the journals IEEE Trans. on Circuits and Systems (1993-95), and Signal Processing (2013-17)
- ***Guest co-editor*** of a special issue of IEEE Signal Proc. Magazine (2014) *on source separation* and of Proceedings of the IEEE (2015) on *data fusion*.
- ***Reviewer and/or member of program committees*** in main international journals and conferences in Signal Processing and Machine Learning,
- ***Scientific reviewer*** for EU, and other research institutes in Belgium, Germany, Switzerland, Austria and Israel.
- ***Member of panel SEN3 of FNRS*** (Belgium) since Mai 2016.
- ***Member of IEEE Technical Committees:*** Blind Signal Processing (IEEE Circuits and Systems Society, 2002-10), Machine Learning for Signal Processing (IEEE Signal Processing Society, from 2006-11), Signal Processing Theory and Methods (IEEE Signal Processing Society, since 2014).

5 - Research activities

Since 1981, my research activities are focused on statistical signal processing issues strongly related with machine learning. Very early, I investigated artificial neural networks, how they process information. For understanding how vertebrate brain are able to code/decode their own motions, I developed the concept of source separation and contributed in its theoretical foundations, and in many applications, especially in audio-visual source separation, in biomedical engineering (ECG, EEG, etc.), hyperspectral imaging, chemical sensing. More recently, I investigated sparse representations, dictionary learning, and data fusion from a theoretical perspective in the framework of Big Data, which are typically multimodal, heterogeneous, high-dimension, with again applications in brain imaging, remote sensing, chemical sensor array, etc.

In the following, I propose a short summary of my last contributions, where number between square braces correspond to a selection of 12 recent papers listed at the end of this document (Section 6).

5.1. Summary of main recent contributions

During the last 5 years, as the Prime Investigator of the ERC project (2012-ERC-AdG-320684) Challenges for Extraction and Separation of Sources (CHESS), with my team, collaborators, post-doc and PhD students, I worked mainly about 3 challenges in extraction and separation of sources.

The first challenge concerns source separation for multimodal recordings. In fact, multimodal recordings can be due to different devices (e.g. EEG and MEG in brain imaging), different time (space) windows for studying dynamics of data along time (space), or different subjects (e.g. patients) recorded by the same device. Although these situations are very different, from a theoretical point of view, they require to jointly process multiple datasets (one per modality) with interactions between them [12]. This challenge relates to data fusion, but the main goal in CHESS is to develop comprehensive foundations and generic methods for multimodal processing instead of designing ad hoc algorithms.

- We propose a new source separation model assuming multidimensional sources and multimodal recordings. This model extends independent component analysis (ICA), independent vector analysis (IVA) and independent subspace analysis (ISA). Results, some of them based on generalization of Schur's Lemma, show that multimodality, provided that hard or soft interactions exist between datasets, leads to relaxed conditions for source identifiability and uniqueness [2, 10]. The core of multimodal models is the interaction between datasets.
- For multi-devices or multi-temporal data sets, we develop a general and flexible framework suited to a vast class of models with interaction, e.g. when datasets share common, correlated or weakly related factors, or with factors varying along data sets [8]. This leads to algorithmic implementations, based on non convex optimization with constraints: the cost function contains a classical data fit term, completed by regularization terms, modeling interactions between the datasets.
- More generally, performance in joint processing of multimodal recordings is usually assumed better than that achieved using only one recording coming from a unique modality. But, in the literature, there are results in contradiction with this claim. We then studied, in an information

theoretic approach, the benefits or disadvantages of using two or more modalities. Our results explain how different sampling rates, SNRs in each modality and correlation between modalities influence estimation performance [5]. These results are currently used for optimal selection of data (images, pixels, frequency bands, etc.) in multimodal fusion in remote sensing, in cooperation with A. Marinori and S. Chlaily in UiT the Artic Univ. of Norway at Tromso.

The second challenge focuses on source separation in nonlinear mixtures. A new generic approach consists in replacing the time-invariant nonlinear mixture of sources by a time-varying linear mixture of the derivatives of the sources. This idea only requires mild conditions, i.e. the nonlinear model to be differentiable and sources to be smooth enough. It leads to theoretical proof of identifiability and new algorithms [4]. Moreover, we showed the theoretical relationship with nonlinear unmixing and local linear unmixing [7], e.g. used in hyperspectral unmixing for taking into account the spectral variability [9]. A second, very generic approach too, is based on the fact that the Gaussian process property is lost when mixed nonlinearly with polynomial. Thus, Gaussian process can be used as a criterion for separating colored sources satisfying Gaussian process model, using simple second-order statistics. Main applications are focused on processing signals coming from ion-sensitive or gas sensor arrays.

The third challenge - extraction of sources in high- or low-dimension data - has been explored in three multimodal applicative frameworks: IRM/EEG [11], PCG/ECG based non-invasive fetal heart extraction, audio-video speech separation [6], gaze-EEG recordings, and hyperscanning. Typically, we design methods, which exploit simple hints of the sources of interest: hints can be properties like quasi-periodicity or simple binary information coming from one modality. For hyperscanning, we show that approximate joint diagonalizer of a set of matrices is related to the geometric mean of those matrices. This finding links blind source separation to classification on Riemannian manifold.
With P. Zanini, P. Rodrigues, M. Congedo, S. Salem and Y. Berthoumieu, we also considered the problem of transfer learning on the Riemannian manifold. Originally developed for brain-computer interfaces, our results provide a general and efficient answer for an ecological approach of machine learning, in the sense that they propose simple and efficient methods for re-using previous results [1, 3] which can thus avoid additional computationally costly learning steps.

More details can be found on the open-access site HAL: https://hal.archives-ouvertes.fr/ with my name as author for getting all my publications, and using the acronym CHESS in "European project" topics for selecting the CHESS publications, only.

5.2. Content and impact of major scientific contributions : for details see my Google Scholar page.

- ***h-index equal to 60***, ***with +20900 citations*** (Google Scholar Citation, March 2020):
- ***More than 115 papers in international journals*** *(IEEE Trans. on SP, on BME, IEEE SPL, etc.)*
- ***250+ communications*** *in international conferences with reviewing committees and proceedings.*
- In addition to papers in journals and conferences, I am co-author of a ***book on neural networks for signal processing*** (1994, in French), 2 books (in French) on source separation and applications (2007), and I co-edited the ***Handbook on Blind Source Separation*** (Academic Press, 2010, +***3470 citations***).

5.3. International recognition

- ***Coordinator of two European projects***: Elena-Nerves 2 (Esprit Basic Research n°6891, 1992-1995) on incremental neural networks ; BLISS (IST-1999-14190, 2000-2003) on blind source separation
- ***PI of the ERC Advanced project CHESS (2013-2018)***: 2012-ERC-AdG-320684.
- ***General chair*** of the 1st Int. workshop on Source separation and independent component analysis (ICA 1999, Aussois, France), which was the first of a serie of biennal conferences; member of the international steering committee of ICA conferences
- ***General chair*** of the 18th Int. IEEE Workshop on Machine Learning for Signal Processing, MLSP 2009
- ***Program chair of ICA'2009 and ICASSP 2020***
- ***Organization of 10 special (invited) sessions in international conferences*** during the last 15 years (especially 1 in ICASSP in 2013, 2 in EUSIPCO in 2013 and 2014, 1 in LVA-ICA 2017)
- ***29 invited plenary talks*** in international conferences and workshops
- ***Tutorial*** (3 hours) in IEEE Int. Conference ISCAS 2002 (Phoenix, Arizona) on source separation

- ***Tutorial*** (3 hours) in EUSIPCO 2016 (Budapest) with T. Adali and D. Lahat on data fusion
- ***Participation in more than 340 PhD defenses*** among which **42 out of France** (Belgium, Germany, Finland, Denmark, Spain, Switzerland, Australia, India and Israel).

5.4. Inspiration for younger researchers

- Supervisor of ***50 PhD students***, with 23 (22 defended, 1 in progress) during the last 10 years.
- Most of these 22 PhD students (who already defended) have now activities in research: 5 are associate professors (1 in France, 2 in Iran, 1 in Brazil, 1 in Burkina Faso), 11 are senior scientists in private or public research institutes (1 in Italy, 1 in Belgium, 1 in UK, 1 in USA, 5 in France, 2 in Iran), 2 are founders of a start-up (1 in France, 1 in Iran), 4 are post-doc researchers (2 in France, 1 in Canada, 1 in Norway).

6. Twelve relevant publications since 2015

1. P. L. Coelho Rodrigues, **C. Jutten**, and M. Congedo. Riemannian Procrustes Analysis: Transfer Learning for Brain-Computer Interfaces. *IEEE Transactions on Biomedical Engineering*, 66 (8) :2390-2401, August 2019.
2. D. Lahat and **C. Jutten**. Joint Independent Subspace Analysis: Uniqueness and Identifiability. *IEEE Transactions on Signal Processing*, 67(3):684-699, February 2019.
3. P. Zanini, M. Congedo, **C. Jutten**, S. Said, and Y. Berthoumieu. Transfer learning: a Riemannian geometry framework with applications to Brain-Computer Interfaces. *IEEE Transactions on Biomedical Engineering*, 65(5):1107-1116, 2018.
4. B. Ehsandoust, M. Babaie-Zadeh, B. Rivet, and **C. Jutten**. Blind Source Separation in Nonlinear Mixtures: Separability and a Basic Algorithm. *IEEE Transactions on Signal Processing*, 65(16):4339-4352, May 2017.
5. S. Chlaily, C. Ren, P.-O. Amblard, O. Michel, P. Comon, and **C. Jutten**. Information-Estimation relationship in mismatched Gaussian channels. *IEEE Signal Processing Letters*, 24(5):688-692, May 2017.
6. F. Sedighin, M. Babaie-Zadeh, B. Rivet, and **C. Jutten**. Multimodal Soft Nonnegative Matrix Co-Factorization for Convolutive Source Separation. *IEEE Transactions on Signal Processing*, 65(12):3179-3190, 2017.
7. L. Drumetz, B. Ehsandoust, J. Chanussot, B. Rivet, M. Babaie-Zadeh, and **C. Jutten**. Relationships between nonlinear and space-variant linear models in hyperspectral image unmixing. *IEEE Signal Processing Letters*, 24(10):1567-1571, 2017.
8. S. Henrot, J. Chanussot, and **C. Jutten**. Dynamical Spectral Unmixing of Multitemporal Hyperspectral Images. *IEEE Transactions on Image Processing*, 25(7):3219-3232, July 2016.
9. L. Drumetz, M.-A. Veganzones, S. Henrot, R. Phlypo, J. Chanussot, and **C. Jutten**. Blind hyperspectral unmixing using an Extended Linear Mixing Model to address spectral variability. *IEEE Transactions on Image Processing*, 25(8):3890-3905, 2016.
10. D. Lahat and **C. Jutten**. Joint Independent Subspace Analysis Using Second-Order Statistics. *IEEE Transactions on Signal Processing*, 64(18):4891-4904, September 2016.
11. S. Samadi, H. Soltanian-Zadeh, and **C. Jutten**. Integrated Analysis of EEG and fMRI Using Sparsity of Spatial Maps. *Brain Topography*, 29(5):661-678, 2016.
12. D. Lahat, T. Adali, and **C. Jutten**. Multimodal Data Fusion: An Overview of Methods, Challenges and Prospects. *Proceedings of the IEEE*, 103(9):1449-1477, August 2015.