

Michel Besserve

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Professional experience

- 2014–present **Senior research scientist and project leader**, *Max Planck Institute for Intelligent Systems and Max Planck Institute for Biological Cybernetics*, Tübingen, Germany.
Project : Multiscale analysis and modeling of representations in neural networks.
- Developed causality-based tools to analyze generative models and neural networks,
 - Developed computational models of brain activity, primarily for sleep and long-term memory,
 - Developed unsupervised learning algorithms to analyze large-scale multivariate neural data.
- 2008–2014 **Research scientist**, *Departments of Empirical Inference and Cognitive Neurophysiology, Max Planck Institute for Biological Cybernetics*, Tübingen, Germany.
Project : Statistical and causal dependency measures for neurophysiology signals.
- Developed statistical tools for the analysis of non-linear time series.
 - Investigated coordination mechanisms in neural networks.
- 2007–2008 **Consultant**, Paris, France.
Subject : Prediction of mental fatigue from electroencephalography signals.

Skills

- Causality Invariance-based inference of direction of causation, counterfactuals and latent model parameters
- Machine learning Unsupervised learning, deep neural networks, kernel methods, data mining.
- Computational modeling Large scale simulation of dynamical systems, biologically realistic neural networks.
- Statistics Causal inference, time series analysis, independence tests, information theory, random matrix theory.
- Data analysis Point processes, large scale multivariate neural time series (Local Field Potentials, electroencephalography, magnetoencephalography, functional Magnetic Resonance Imaging).
- Programming Python (expert ; Numpy, Scipy, Tensorflow), Matlab (expert), C-C++ (intermediate).

Interests

- Collective systems Homeostasis, distributed information processing, collective dynamics, transient phenomena, game theory/mechanism design.
- Causality Counterfactuals, extrapolation, interpretability, generative models.
- Neuroscience Learning and memory, distributed representations, systems neuroscience.

Education

- 2004–2008 **Doctorate in Signal Processing**, *Université Paris-Sud*, France.
Title : Analysis of neural dynamics for Brain-Machine Interfaces : back to the sources.
- Fully designed a setup for real-time brain-computer interfacing using high density human EEG.
 - Developed machine learning and source separation algorithms for the classification of brain states from ongoing EEG signals.
- Passed with high honors.*
- 2003–2004 **MSc. Mathematics of Vision and Learning**, *École Normale Supérieure (ENS)*, Paris, France.
Passed with high honors.
- 2000–2004 **BSc./MSc. in Applied Physics and Electrical Engineering**, *École Normale Supérieure*.
Passed with high honors.

Titles, awards, fellowships

- 2015–2017 **Associate fellow of the Max Planck ETH Center for Learning Systems, MPI for Intelligent Systems-ETH Zürich.**
- 2008 **Qualification to the function of assistant professor by the French National Board of Universities, for the following sections : signal processing, neuroscience and physics.**
- 2004 **Awarded a joint Doctoral and Junior Lecturer scholarship, from the French Ministry of Research and Higher Education.**
- 2003 **“Professeur Agrégé” in Applied Physics, highly selective french competitive exam. Ranked 3rd/300.**

Selected publications

- M. Besserve**, R. Sun & B. Schölkopf, Counterfactuals uncover the modular structure of deep generative models, *ICLR 2020*.
- P. Geiger, **M. Besserve**, J. Winkelmann, C. Proissl & B. Schölkopf, Coordination via predictive assistants : time series algorithms and game-theoretic analysis, *UAI 2019*.
- M Besserve**, N. Shajarisales, B. Schölkopf and D. Janzing, Group invariance principles for causal generative models, *AISTATS 2018*.
- J. F. Ramirez-Villegas, K. F. Willeke, N. K. Logothetis and **M. Besserve**, Dissecting the synapse- and frequency-dependent network mechanisms of in vivo hippocampal sharp wave-ripples, *Neuron* 2018.
- J. F. Ramirez-Villegas, N. K. Logothetis & **M. Besserve**, Diversity of sharp wave-ripple LFP signatures reveals differentiated brain-wide dynamical events, *PNAS* 2015.
- M. Besserve**, S. C. Lowe, N. K. Logothetis, B. Schölkopf & S. Panzeri, Shifts of Gamma Phase across Primary Visual Cortical Sites Reflect Dynamic Stimulus-Modulated Information Transfer, *PLOS Biology* 2015.
- N. Shajarisales, D. Janzing, B. Schölkopf & **M. Besserve**, Telling cause from effect in deterministic linear dynamical systems, *ICML* 2015.
- M. Besserve**, N. Logothetis & B. Schölkopf, Statistical analysis of coupled time series with Kernel Cross-Spectral Density operators, *NIPS* 2013.
- N. K. Logothetis, O. Eschenko, Y. Murayama, M. Augath, T. Steudel, H. C. Evrard, **M. Besserve** et al., Hippocampal-Cortical Interaction during Periods of Subcortical Silence, *Nature* 2012.

Professional service

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| Journal reviewing | Proceedings of the National Academy of Sciences
ACM Trans. on Intelligent Systems and Technology
IEEE Trans. on Pattern Analysis and Machine Intelligence
IEEE Trans. on Biomedical Engineering
IEEE Trans. on Systems, Man, and Cybernetics, Part B
Journal of Machine Learning Research | PLoS Biology
Journal of Neuroscience Methods
Journal of Neuroscience
Journal of Comput. Neuroscience
Journal of Bifurcation and Chaos |
| Conference reviewing | Uncertainty in Artificial Intelligence (UAI) 2016-2019 (program committee/senior program chair)
International Conference on Machine Learning (ICML) 2016-2019 (reviewer)
Neural Information Processing Systems (NIPS) 2010-2018 (reviewer)
Artificial Intelligence and Statistics (AISTATS) 2014, 2016, 2017, 2018 (reviewer)
Association for Advancement of Artificial Intelligence conference (AAAI) 2017-2018 (reviewer)
International Conference on Learning Representations (ICLR) 2017-2018 (reviewer) | |
| Workshop organization | Signal propagation, <i>nanosymposium at the Society for Neuroscience annual meeting (SfN)</i> , New Orleans, LA, November 2012.
Uncovering the structure of complex data : progresses in machine learning and causal inference, <i>workshop at the Data Learning and Inference meeting (DALI)</i> , Tenerife, Spain, April 2017. | |

Student supervision

- 2017– **Kaidi Shao**, *Master/PhD student, Graduate School of Neuroscience, University of Tübingen.*
Project : Neural mass modeling of Ponto-Geniculo-Occipital waves.
- 2016 **Maryam Faramarzi**, *Master student, Graduate School of Neuroscience, University of Tübingen.*
Project : Analysis of multi-structure neural events using multichannel Non-negative Matrix Factorization.
- 2017– **Shervin Safavi**, *PhD student, Graduate School of Neuroscience, University of Tübingen.*
Project : Multiscale analysis of neural signals.
- 2014–2018 **Juan F. Ramirez-Villegas**, *PhD student, Graduate School of Neuroscience, University of Tübingen.*
Project : Analysis and modeling of hippocampal neural events.
- 2016 **Yiling Yang**, *Master student, Graduate School of Neuroscience, University of Tübingen.*
Project : Estimation of the hemodynamic response function across multiple brain regions.
- 2015 **Fariborz Mafakheri**, *Internship (3 months).*
Project : Denoising methods for causal inference.
- 2014 **Naji Shajarisales**, *Master student, Graduate School of Neuroscience, University of Tübingen.*
Project : Causal inference for time series and applications to Neuroscience.
- 2008 **Antoine Dufour**, *Master student, ENSEA (electrical engineering school), Cergy.*
Project : Graphical User Interface for Brain Computer Interfacing.
- 2008 **Iona Ocnarescu**, *Master student, École Polytechnique, Palaiseau.*
Project : Joint EEG/fMRI functional network analysis.

Teaching experience

- 2016-2020 **Signal Processing Lectures**, *Graduate Training Center for Neuroscience, Tuebingen, Germany.*
26 hours/year.
- 2019 **Machine learning and Neuroscience Lectures**, *Machine Learning Summer School (MLSS), Moscow, Russia, September 2019.*
- 2016 **Machine learning for Neuroscience practical**, *Machine Learning Summer School (MLSS), Cadiz, Spain, 20 May 2016.*
- 2014 **Quantifying statistical dependency : lecture and practical**, *Research Network on Learning Systems Summer School, ETH Zurich, Switzerland, 19 June 2014.*
- 2011 **Introduction to real time neuroimaging**, *Grenoble Autumn School in Neuroimaging, Grenoble, France, 16 October 2011.*
- 2007–2008 **Part time Lecturer in Physics (BSc. Level)**, *University Pierre et Marie Curie, Paris, France.*
96 hours/year
- 2004–2007 **Junior Lecturer in Electrical Engineering**, *University Marne-la-Vallée, Paris, France.*
BSc. : Electrical Engineering, Mathematical Analysis ; MSc. : Control, Digital Communications, Speech Signal Processing ; 64 hours/year.

Publications

Preprints

S. Safavi, N. K. Logothetis & **M. Besserve** From univariate to multivariate coupling between continuous signals and point processes : a mathematical framework, *ArXiv preprint*.

M. Besserve, R. Sun, D. Janzing & B. Schölkopf A theory of independent mechanisms for extrapolation in generative models, *ArXiv preprint*.

Journal papers

J. F. Ramirez-Villegas, K. F. Willeke, N. K. Logothetis & **M. Besserve**, Dissection of frequency-dependent spiking and synaptic contributions to in-vivo hippocampal Sharp Wave Ripples, *Neuron* 2018 ; 100 :1016-19.

V. Kapoor, M. Besserve, N.K. Logothetis & F. Panagiotaropoulos, Parallel and functionally segregated processing of task phase and conscious content in the prefrontal cortex, *Communications Biology* 2018 ; 1.

R. Hindriks, X. D. Arsiwalla, T. Panagiotaropoulos, **M. Besserve**, P. F. M. J. Vershure, N. K. Logothetis & G. Deco, Discrepancies between Multi-Electrode LFP and CSD Phase-Patterns : A Forward Modeling Study, *Frontiers in Neural Circuits* 2016.

J. F. Ramirez-Villegas, N. K. Logothetis & **M. Besserve**, Diversity of sharp wave-ripple LFP signatures reveals differentiated brain-wide dynamical events, *Proceedings of the National Academy of Sciences U.S.A* 2015 ; 112 (46), E6379-E6387.

M. Besserve, S. C. Lowe, N. K. Logothetis, B. Schölkopf & S. Panzeri, Shifts of Gamma Phase across Primary Visual Cortical Sites Reflect Dynamic Stimulus-Modulated Information Transfer, *PLOS Biology* 2015 ; 13, e1002257.

F. Laurent, M. Valderrama, **M. Besserve**, M. Guillard, J-P. Lachaux, J. Martinerie & G. Florence, Multimodal information improves the rapid detection of mental fatigue, *Biomedical Signal Processing and Control* 2013 ; 8, (4), 400-408.

D. Balduzzi, PA. Ortega & **M. Besserve**, Metabolic cost as an organizing principle for cooperative learning, *Advances in Complex Systems* 2013 ; 16 :1350012.

NK. Logothetis, O. Eschenko, Y. Murayama, M. Augath, T. Steudel, HC. Evrard, **M. Besserve** & A. Oeltermann, Hippocampal-Cortical Interaction during Periods of Subcortical Silence, *Nature* 2012 ; 491, 547-553.

M. Besserve, J. Martinerie & L. Garnero, Improving quantification of functional networks with EEG inverse problem : evidence from a decoding point of view, *Neuroimage* 2011 ; 55 :1536-1547.

M. Besserve & J. Martinerie, Extraction of functional information from brain electrical activity, *BioMedical Engineering and Research* 2011 ; 32 :27-34.

M. Chavez, **M. Besserve** & M. Le Van Quyen, Dynamics of excitable neural networks with heterogeneous connectivity, *Progress in Biophysics and Molecular Biology* 2011 ; 105 :29-33.

M. Besserve, B. Schölkopf, N. K. Logothetis & S. Panzeri. Causal relationships between frequency bands of extracellular signals in visual cortex revealed by an information theoretic analysis, *Journal of Computational Neuroscience* 2010 ; 29 :547-66.

F. Laurent, **M. Besserve**, L. Garnero, M. Philippe, G. Florence & J. Martinerie, Source reconstruction and synchrony measurements for revealing functional brain networks and classifying mental states, *International Journal of Bifurcation and Chaos* 2010 ; 20 :1703-1721.

M. Besserve, M. Phillippe, G. Florence, L. Garnero & J. Martinerie, Prediction of performance level during a cognitive task from ongoing EEG oscillatory activities, *Clinical Neurophysiology* 2008 ; 119 :897-908.

M. Besserve, K. Jerbi, F. Laurent, L. Garnero & J. Martinerie, Classification methods for ongoing EEG and MEG signals, *Biological Research* 2007 ;40 :415-437.

M. Chavez, **M. Besserve**, C. Adam & J. Martinerie, Towards a proper estimation of phase synchronization from time series, *Journal of Neuroscience Methods* 2006 ;154 :149-160.

Conference papers

M. Besserve, R. Sun & B. Schölkopf, Counterfactuals uncover the modular structure of deep generative models, *ICLR 2020*.

P. Geiger, **M. Besserve**, J. Winkelmann, C. Proissl & B. Schölkopf, Coordinating users of shared facilities via data-driven predictive assistants and game theory, *UAI 2019*.

M. Besserve, R. Sun & B. Schölkopf, Intrinsic disentanglement : an invariance view for deep generative models, *Workshop on Theoretical Foundations and Applications of Deep Generative Models at ICML 2018*.

M Besserve, N. Shajarisales, B. Schölkopf and D. Janzing, Group invariance principles for causal generative models, *AISTATS 2018*.

N. Shajarisales, D. Janzing, B. Schölkopf & **M. Besserve**, Telling cause from effect in deterministic linear dynamical systems, *32nd International Conference on Machine Learning 2015 (ICML 2015)*.

M. Besserve, N. Logothetis & B. Schölkopf, Statistical analysis of coupled time series with Kernel Cross-Spectral Density operators, *In : Advances in Neural Information Processing Systems 26, 2535–2543, 27th Annual Conference on Neural Information Processing Systems 2013 (NIPS 2013)*.

D. Balduzzi & **M. Besserve**, Towards a learning-theoretic analysis of spike-timing dependent plasticity, *In : Advances in Neural Information Processing Systems 25, 2465–2473, 26th Annual Conference on Neural Information Processing Systems 2012 (NIPS 2012)*.

M. Besserve, N. K. Logothetis, D. Janzing & B. Schölkopf, Finding dependencies between frequencies with the kernel cross-spectral density, *International Conference on Acoustics, Speech and Signal Processing 2011 (ICASSP 2011)*.

M. Besserve, J. Martinerie & L. Garnero, Reconstructing the cortical functional network during imagery tasks for boosting asynchronous BCI, *Deuxième conférence française de Neurosciences Computationnelles 2008*.

M. Besserve, J. Martinerie & L. Garnero, Non-invasive classification of cortical activities for Brain Computer Interface : A variable selection approach, *5th IEEE International Symposium on Biomedical Imaging 2008 (ISBI 2008)*.

M. Besserve, L. Garnero & J. Martinerie, De l'estimation à la classification des activités corticales pour les Interfaces Cerveau Machines, *21ème colloque GRETSI sur le traitement du signal et des images 2007*.

F. Laurent, **M. Besserve**, G. Florence & J. Martinerie, Apport de la reconstruction de sources en EEG pour la détection d'états de fatigue mentale, *21ème colloque GRETSI sur le traitement du signal et des images 2007*.

M. Besserve, K. Jerbi, L. Garnero & J. Martinerie, Prediction of cognitive states using MEG and Blind Source Separation, *Proceedings of the 15th International Conference on Biomagnetism, Vancouver, BC Canada, International Congress Series 2007*.

M. Besserve, L. Garnero & J. Martinerie, Cross-spectral discriminant analysis for the classification of Brain Computer Interfaces, *3rd International IEEE/EMBS Conference on Neural Engineering 2007*.

Conference talks

M. Besserve, B. Schölkopf & N. K. Logothetis, Unsupervised identification of neural events in local field potentials, *44th Annual Meeting of the Society for Neuroscience 2014 (Neuroscience 2014)*.

NK. Logothetis, O. Eschenko, Y. Murayama, M. Augath, T. Steudel, HC. Evrard, **M. Besserve** & A. Oeltermann, Studying large-scale brain networks : electrical stimulation and neural-event-triggered fMRI, Keynote Lecture, *22nd Annual Computational Neuroscience Meeting 2013 (CNS 2013)*.

T. Panagiotaropoulos, **M. Besserve** & NK. Logothetis, Beta oscillations propagate as traveling waves in the macaque prefrontal cortex, *42nd Annual Meeting of the Society for Neuroscience 2012 (Neuroscience 2012)*.

Invited talks

Causal inference from a group invariance perspective, *DALI workshop “Causality : Dialogues between Machine Learning and Psychology”*, Tenerife, Spain, 18 April 2017.

Causal Inference for Empirical Time Series Based on the Postulate of Independence of Cause and Mechanism, *53rd Annual Allerton Conference on Communication, Control, and Computing*, Allerton Retreat Center, Monticello, IL, USA, 31 September 2015.

Independence of cause and mechanism in brain networks, *DALI workshop “Networks : Processes and Causality”*, La Palma, Spain, 10 April 2015.

Quantifying statistical dependency, *Research Network on Learning Systems Summer School*, ETH Zurich, Switzerland, 19 June 2014.

Assessing the organization of functional brain networks, *Workshop on Networks – Processes and Causality*, Menorca, Spain, 4 September, 2012.

Gamma oscillations and causal information transfer in the primary visual cortex, *NeFF-Workshop on Non-linear and model-free Interdependence Measures in Neuroscience*, Goethe University, Frankfurt, Germany, 26 April 2012.

Quantifying non-linear brain dynamics : towards better Brain-Computer Interfaces, *Colloquium of the Signal and Image Processing department, Telecom ParisTech*, Paris, 18 January 2012.

Centrality of the mammalian functional network : an fMRI study across species, *Colloquium of the Laboratory of Psychology and Neurocognition*, Grenoble, France, 17 October 2011.

Introduction to real time neuroimaging, *Grenoble Autumn School in Neuroimaging*, Grenoble, France, 16 October 2011.

Functional interactions across space and frequency in the primary visual cortex, *Colloquium of the Neuroscience Research Center*, Lyon, France, 14 October 2011.

Finding dependencies between frequencies with the kernel cross-spectral density, *Colloquium of the Gipsa Lab*, Grenoble, France, 18 October 2011.

Functional interactions across space and frequency in the primary visual cortex, *Colloquium of the System Neuroscience Institute*, Marseille, France, 2011.

Brain computer interfaces and interactions between brain rhythms, *Journée Line Garnero, L'imagerie cérébrale dans tous ces états*, Paris 2010.

The desynchronisation/synchronisation paradigm, *Workshop on Medical Applications of Computer Science, Novel Approaches*, Monastir, Tunisia, 2008.

Asynchronous classification of neuronal network dynamics from EEG signals, *Departement of Empirical Inference, Max Planck Institute for Biological Cybernetics*, Tübingen, 2008.

Classification of neural network dynamics in Asynchronous Brain Computer interfaces, *Colloquium of the Behavior, Brain and Cognition Federation*, University of Provence, Marseille, 2008.

Introduction to Brain Machine Interfaces, *GRAMAGICOM colloquium*, Brest, 2007.

Source separation and inverse problem, towards realistic mental state classification, *Colloquium of the Handicap Research Group*, Paris, 2006.

Conference posters

S. Safavi, T. Panagiotaropoulos, V. Kapoor, N. K. Logothetis & **M. Besserve**, Generalized phase locking analysis of electrophysiology data, *ESI Systems Neuroscience Conference : Principles of Structural and Functional Connectivity*, Frankfurt, Germany, 2017. (ESI-SyNC 2017).

M. Besserve & N. K. Logothetis, Hippocampal neural evnets predict ongoing brain-wide BOLD activity, *46th Annual Meeting of the Society for Neuroscience 2016* (Neuroscience 2016).

J. F. Ramirez-Villegas, N. K. Logothetis & **M. Besserve**, Statistical source separation of rhythmic LFP patterns during sharp wave ripples in the macaque hippocampus, *46th Annual Meeting of the Society for Neuroscience 2016* (Neuroscience 2016)

J. F. Ramirez-Villegas, N. K. Logothetis & **M. Besserve**, Dynamical source analysis of hippocampal sharp-wave ripple episodes, *Bernstein Conference*, Göttingen, 2014.

J. F. Ramirez-Villegas, N. K. Logothetis & **M. Besserve**, Cluster analysis of sharp-wave ripple field potential signatures in the macaque hippocampus, *Computational and Systems Neuroscience Meeting 2014* (Cosyne 2014).

S. Safavi, T. Panagiotaropoulos, V. Kapoor, NK. Logothetis & **M. Besserve**, Analyzing locking of spikes to spatio-temporal patterns in the macaque prefrontal cortex, *Bernstein Conference*, Tübingen, 2013.

JF. Ramirez-Villegas, NK. Logothetis & **M. Besserve**, Characterization of different types of sharp-wave ripple signatures in the CA1 of the macaque hippocampus, *4th German Neurophysiology PhD Meeting Networks*, Tübingen, 2013.

S. Safavi, T. Panagiotaropoulos, V. Kapoor, NK. Logothetis & **M. Besserve**, Coupling between spiking activity and beta band spatio-temporal patterns in the macaque PFC, *43rd Annual Meeting of the Society for Neuroscience 2013* (Neuroscience 2013).

M. Besserve, A. Bartels, Y. Murayama & NK. Logothetis, Centrality of the Mammalian Functional Brain Network, *42nd Annual Meeting of the Society for Neuroscience 2012* (Neuroscience 2012).

M. Besserve, T. Panagiotaropoulos, B. Crocker, V. Kapoor, A. Tolia, S. Panzeri, NK. Logothetis, Identifying endogenous rhythmic spatio-temporal patterns in micro-electrode array recordings, *9th annual Computational and Systems Neuroscience meeting 2012* (Cosyne 2012).

M. Besserve, Y. Murayama, B. Schölkopf, N. K. Logothetis, S. Panzeri, High frequency phase-spike synchronization of extracellular signals modulates causal interactions in monkey primary visual cortex, *Society for Neuroscience Annual Meeting*, 2010 (Neuroscience 2010).

M. Besserve, L. Garnero & J. Martinerie, Second order blind identification in the asynchronous BCI context, *Brain Computer Interface Workshop, Challenging Brain Computer Interfaces : Neural Engineering Meets Clinical Needs in Neurorehabilitation*, Rome, 2006.

M. Besserve, M. Phillipe, G. Florence, L. Garnero & J. Martinerie, A voting approach for the classification of performance level using EEG, *10th International Conference on Human Brain Mapping*, 2006 (HBM 2006).

M. Besserve, L. Garnero & J. Martinerie, Second order Blind identification for Brain Computer Interfacing, *6th International Congress of Neurorecovery : to overcome the deficiency through the optimization of undamaged neuronal networks*, Paris, 2005.