Michele Allegra's Curriculum Vitae

September 2022

Contents

Personal information

Personal data

Gender: Male. *Citizenship*: Italian. *Date of birth*: Nov. 7th, 1985. *Place of birth*: Moncalieri (Italy).

Contact

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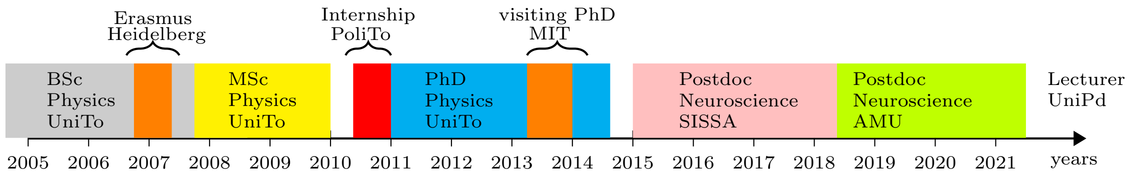
Cursus



Education

Main

09/1999-07/2004	**High school diploma**, Liceo Classico Vincenzo Gioberti, Torino. Final mark: 100/100 with honorable mention.
09/2004-12/2007	**Bachelor Degree in Physics**, University of Torino (Italy). Final mark: 110/110 *summa cum laude*.
09/2007-12/2009	**Master Degree in Physics of Fundamental Interactions**, University of Torino (Italy). Thesis advisors: Dr. Paolo Giorda and Prof. Matteo Paris (tutoring advisors) and Prof. Michele Caselle (official advisor). Thesis title: *Decoherence of non-Gaussian states in noisy channels.* Final mark: 110/110 *summa cum laude.*
01/2011-04/2014	**Ph.D in Physics**, University of Torino (Italy) and ISI Foundation, Torino. Thesis advisors: Dr. Paolo Giorda (tutoring advisor) and Prof. Lorenzo Magnea (official advisor). Thesis title: *Gain and loss of information by decoherence: quantum correlations and decoherent histories in diverse physical systems*

Visiting

09/2006-03/2007	**Visiting student** (Erasmus Program), University of Heidelberg (Germany).
03/2013-12/2013	**Visiting Student**, MIT, Cambridge (USA). Supervisor: Prof. Seth Lloyd.

Research Experience

06/2010-12/2010	**Research Internship** on quantum discord in fermionic systems, Politecnico di Torino (Italy). Supervisor: Prof. Arianna Montorsi.
01/2015-01/2018	**Postdoctoral researcher** on development of clustering analysis for fMRI, International School for Advanced Studies (SISSA), Trieste (Italy). Principal Investigator: Prof. Alessandro Laio.
05/2018-07/2021	**Postdoctoral researcher** on analysis of directional interactions in stroke, Institut de Neurosciences de la Timone, CNRS, Marseille (France). Principal Investigator: Dr. Andrea Brovelli.
09/2021-NOW	**Lecturer** Physics Department and Neuroscience Center, University of Padua (Italy).

Teaching

2021	Statistics and data analyisis course for physics bachelor students (16 hours)
2022	Statistics for Neuroscience course for neuroscience PhD students at SISSA, Trieste (16 hours)
2022	Data reduction course for neuroscience PhD students (8 hours)
2022	Information theory and Inference course for physics master students (48 hours)

Academic biography and overview of scientific interests

I am a physicist with a passion for neuroscience.

Since childhood I have been fascinated by all areas of science. Until the last minute before starting university, I was undecided between biology and physics. I finally opted for physics. I have got a bachelor in physics, a master in physics of fundamental interactions, and a PhD in physics (all from the University of Torino). My research activity began in the realm of theoretical physics, in particular, quantum information science: my doctoral work was centered on information-theoretical measures to characterize the effects of noise on quantum systems and the quantum-classical transition (Allegra et al., PRL 2010, IJQI 2010, PRL 2011, PRB 2011, PRA 2012).

As I went through my PhD, I progressively realized that I was more curious about living beings than quantum science, and I decided to re-orient my career. I then strove to enter an interdisciplinary field where I could use my skills a physicist to address new questions. Neuroscience was a natural candidate, as it attracts people with diverse backgrounds and competences. Furthermore, I looked for a rather data-intensive project, since I was well aware that I had gaps to fill on the data analysis side.

I was lucky enough to find a suitable opportunity. At SISSA, Trieste, Alessandro Laio was leading a group of physicists devoted to devising new data analysis methods, and he was interested in applying a recently developed clustering algorithm to neural data, in particular to fMRI analysis. In Trieste we developed CDPC (published article 12), an algorithm and pipeline to detect transient multi-voxel clusters of coherent activity in fMRI. Our goal was to link the functional response in a task with specific transient clusters of coherent activity. In particular, we demonstrated that CDPC is effective in detecting slow variations of the functional response occurring during learning. In article 13 we analyzed a task with two alternative strategies, identifying several slow changes in the clusters accompanying the optimization of a given strategy and the discovery of a new strategy.

During my Postdoc at SISSA, I gained experience in data analysis, acquired technical expertise with specific analysis methods such as clustering (Allegra et al., HBM 2017, NIMG 2020; Ilieva et al., Bioinf. 2020) and dimensionality reduction (Allegra et al., Sci. Rep. 2020), and got acquainted with the many subtleties and pitfalls of fMRI analysis. Yet, beyond these skills, the most important acquisition was certainly learning the basics of neuroscience. As I slowly got familiar with the literature, I was more and more fascinated by the large-scale organization of cortical activity, and the relation between structure and function in the brain. I thus became interested in applying advanced analysis techniques to intrinsic activity, which provides a window not only into the basic functioning of the brain (physiology), but also into its alterations bu disease (pathology). Accordingly, for my second Postdoc I looked for a laboratory where I could focus more directly on the resting state and its pathological malfunctions.

My research at the Timone Institute for Neuroscience in Marseille focused on the analysis of functional brain connectivity and its anomalies in stroke. In Marseille, I developed a pipeline for the computation of pairwise measures of directed and instantaneous connectivity from resting-state data. I applied this pipeline to characterize global anomalies in intra- and inter-hemispheric information flows in stroke patients (Allegra et al., NIMG 2021). Furthermore, I worked on the characterization of transient spontaneous activity patterns, and their anomalies in stroke (Favaretto et al., Nat. Comm. 2022).

My current research at the Laboratory for Interdisciplinary physics in Padua and the Padua Neuroscience Center focuses on combining data analysis and modeling to reconstruct and characterize brain connectivity at different scales.

Research

Areas of expertise

- fMRI data analysis, method development
- Information theory
- Bayesian statistics
- Network theory, dynamical processes on complex networks
- Unsupervised learning
- Signal processing
- Programming (C, Python)

Research achievements

Quantum physics

- **Robustness of entanglement in quantum optics.** In quantum optics it is important to create entangled states that are robust to noise and decoherence. While continuous-variable quantum optics usually focuses on Gaussian states, in Allegra et al., PRL 2010, IJQI 2010, PRL 2011, we considered for the first time a large class of non-Gaussian states, analysing the behavior of their entanglement under Markovian noise and comparing results with the case of entangled Gaussian states. Our evidence suggested that Gaussian entangled states may be generally more robust to noise then non-Gaussian ones. This result gave the spur to a debate with contributions from several Authors in the field.

- **Quantum discord in fermionic systems.** Cross-fertilisation between quantum information theory and condensed matter physics has highlighted strong ties between entanglement and physical properties of many-body ground states, especially at quantum critical points. This motivated a search for similar relations involving other types of quantum correlations, such as quantum discord. In Allegra et al., PRB 2011 we analysed the role of quantum discord in an integrable quantum many-body model (the extended Hubbard model), demonstrating a tie between long range correlations (off-diagonal long-range order) and quantum discord, pinpointing a general relation between discord and macroscopic quantum phenomena like superfluidity and superconductivity.

- **Quantum discord for non-Gaussian states.** The computation of quantum discord is in general very difficult, since an optimisation over all local measurements is required. In Giorda & Allegra, PRA 2012 we addressed this optimisation problem for an important class of continuous-variable states, that of Gaussian states. We found strong evidence that Gaussian measurements like homodyne detection (as opposed to non-Gaussian ones like photon counting) are optimal.

- **Quantum time-optimal control.** In quantum technology, time-optimal control is crucial to escape decoherence effects. Finding time-optimal solutions is a very challenging mathematical problem even for relatively simple cases. In Wang et al., PRL 2015 we analyzed time-optimal unitary gate generation for the case where the control Hamiltonian is restricted to a subspace of the full algebra. Under a general bound on the total energy of the system, we could elucidate a general asymptotic connection between geodesics of right-invariant metrics on the unitary group and time-optimal curves, paving the way for more efficient numerical solutions to the time-optimality problem. In Aiello et al., QIP 2015 we focused on time-optimal unitary control in two-level systems (qubits) where only a pair of non-orthogonal controls is allowed. We presented analytical results concerning the type and duration time-optimal control sequences. Our results are applicable to the control of several quantum systems including NV-centers in diamond.

- **Coherence in quantum transport.** While interference is a key feature of quantum dynamics, measures allowing to precisely quantify the amount of interference developed by a given dynamics are lacking. In Allegra et al., PRA 2016, we used the decoherent histories framework to define measures the amount of interference in dissipative (Markovian) quantum evolutions. We applied our measures to discuss the role of interference in exciton transport in photosynthetic complexes. Our analysis illustrates how the high efficiency of environmentally assisted transport depends on the capability of thermal noise to selectively kill the negative interference between different exciton pathways, while retaining the initial positive one.

- **Coherence in quantum estimation.** When a parameter is encoded in a family of quantum states, it can be estimated with greater-than-classical precision ("quantum estimation"). In the last years, there has been extensive discussion on what is the quantum property allowing for enhanced estimation precision in the quantum setting. In Giorda & Allegra, JPA 2017, we showed a relation between the statistical distance between infinitesimally close quantum states and the second order variation of the coherence of the optimal measurement basis with respect to the state of the probe, which led us to propose coherence as the relevant resource in quantum estimation protocols.

- **Classical correlations between quantum observables.** Correlations used in quantum communication protocols ultimately reduce to correlations between classical observables. In Giorda & Allegra, JPA 2017, we introduced a general measure of correlations for two-qubit states, based on the classical mutual information between local observables. By focusing on a simple yet paradigmatic example, the remote state preparation protocol, we introduced a method to systematically identify the correlations between observables that are useful for a given protocol.

Other physics

- **Exciton transport on complex networks.** In light-harvesting systems, excitons created by light absorption must converge to reaction centers where they are in turn absorbed, triggering a chemical reaction. Maximising the efficiency of excitonic trapping by reaction centers is essential for artificial light-harvesting devices. In Allegra & Giorda, PRE 2012 we addressed this problem by taking inspiration from biological light-harvesting membranes of purple bacteria and modelling the motion of excitons as dissipative and absorbing random walks over networks with a complex topology. We considered a wide range of possible artificial topologies, including both regular structures such as Cayley trees and random structures. As a result, we showed how network-theoretical centrality measures allow to identify efficient dispositions of the absorbing traps (reaction centers).

- **Clustering of force-extension curves in single-molecule force spectroscopy.** Recent experimental advances allow applying single-molecule force spectroscopy (SMFS) in previously inaccessible conditions, such as native cell membranes. While common SMFS analysis pipelines assume a homogeneous molecular sample, such new experiments pose the challenge of analyzing protein unfolding curves ("traces") coming from preparations with heterogeneous composition (e.g. where different proteins are present in the sample). In Ilieva et al., Bioinf. 2020, we developed an automated data analysis pipeline able to identify recurring unfolding patterns in large noisy data sets of unfolding curves.

Neuroscience

- **Identification of coherent activity clusters ion fMRI.** Task-based fMRI is aimed at characterizing the neural response to a given set of task stimuli. Usually, identifying the response requires averaging across several subjects and several repetitions of the same stimuli. A limitation of such an approach is that it is not suitable to characterize variability of the response across several trials of the task, or across different subjects. Another limitation is that it cannot be used to uncover the neural response to isolated cognitive events, which commonly occur in problem-solving, learning and decision-making. In Allegra et al., HBM 2017, we assumed that a task can evoke short-term multi-voxel clusters of coherent activity, and that identifying such clusters may help overcoming some of these limitations. Exploiting density peak clustering, we designed a method, called Coherence Density Peak Clustering (CDPC) to detect clusters of coherent activity by grouping together voxels with similar time-series within a short time window. CDPC can be applied to fMRI task data to: i) identify variations in the response, as characterized by the clusters, across different subjects and different trials/phases of a task; ii) identify a neural response to non-repeatable cognitive events. A Matlab GUI implementation of CDPC was made available as free software at https://github.com/micheleallegra/CDPC.

- **Coherent activity clusters and learning** When performing a task, humans can improve their performance by either optimizing a known strategy or discovering a novel, potentially more effective strategy. Neural mechanisms underlying strategy optimization and strategy discovery are not fully known. In Allegra et al., NIMG 2020, we addressed this issue by applying fMRI during a task with two possible alternative strategies. For analysis we combined multivariate pattern classification and CDPC (published article 12). Multivariate pattern classification allowed identifying areas encoding for relevant stimuli in the task. CDPC allowed revealing variations of the neural response in the course of the task. As subjects progressively improved the initial strategy or discovered a new strategy, we observed changes in the frequency with which neighboring and distant regions form transient clusters of coherent activity. Combining evidence from both methods, we showed that the precuneus and the angular gyrus have a central role in strategy optimization, while medial prefrontal cortex and the rostral portion of the fronto-parietal network are associated with strategy discovery. Overall, our findings shed light on the dynamic interactions between regions related to attention and cognitive control, underlying the balance between strategy exploration and exploitation.

- **Anomalous brain connectivity in stroke** Neuroimaging studies have suggested that stroke, beyond causing local structural damage, perturbs the functional organization of the brain at large. However, a complete understanding of how whole-brain dynamics is altered post-stroke is missing. In Allegra et al., NIMG 2021 we used resting-state fMRI and Granger causality analysis to quantify information transfer between brain areas, and its alteration in stroke. We developed a pipeline to compute covariance-based Granger causality from fMRI time series, which we made publicly available at https://github.com/micheleallegra/CovGC. Applying it to a large stroke database, we revealed two main large-scale dynamic anomalies in stroke. Overall our results provide key constraints for whole-brain models aimed at further characterizing brain dynamics in stroke and suggest that the lesioned hemisphere should be a privileged target for stimulation therapy. In Favaretto et al., Nat. Comm. 2022 we used resting-state fMRI and clustering analysis to analyze dynamical patterns in spontaneous brain activity and their anomalies in stroke. We observe that shifts in cortical patterns are temporally coincident with shifts in subcortical patterns, and that cortical regions flexibly synchronizing with either limbic regions (hippocampus/amygdala), or subcortical nuclei (thalamus/basal ganglia). Focal lesions induced by stroke, provoke anomalies in the patterns occurrence, causing a bias toward abnormal network integration. Anomalies observed two weeks after stroke recover in time and contribute to explaining neurological impairment and long-term outcome.

- **Information-based analysis of brain networks.** In the analysis of neurophysiological data, every study remains almost unique in its combination of analytical and statistical approaches, which impairs reproducibility. In Combrisson et al., 2022 we proposed a framework, based on information theory and non-parametric statistics, to perform group-level inferences about brain activity and brain connectivity in neurophysiology experiments. The framework supports both fixed- and random-effect models to adapt to inter-individuals and inter-sessions variability. We showed how the framework can be used to extract stereotypical task- and behavior-related effects across the population covering scales from the local level of brain regions, inter-areal functional connectivity to measures summarizing network properties. We also present an open-source Python toolbox called Frites implementing the proposed statistical pipeline.

Data analysis

- **The intrinsic dimension of data and its variability.** Commonly, a small number of variables is sufficient to describe high-dimensional data. The minimum number of variables required is called the intrinsic dimension (ID) of the data. Contrary to common intuition, there are cases where the ID varies within the same data set: different "portions" of the data require a different number of variables to be properly described. In Allegra et al., Sic. Rep. 2015 we developed a robust approach to discriminate regions with different local IDs and segment the data accordingly. Our approach rests on inversion of a Bayesian model that extends the

TWO-NN ID estimator to the case of a variable ID. Our method, termed Hidalgo (heterogeneous intrinsic dimension algorithm) reveals that many real-world data sets contain regions with widely heterogeneous dimensions. These regions host points differing in core properties: folded vs unfolded configurations in a protein molecular dynamics trajectory, active vs non-active regions in brain imaging data, and firms with different financial risk in company balance sheets. Matlab and Python implementations of Hidalgo were made available as free software at https://github.com/micheleallegra/Hidalgo.

Publications

Published articles

- M. Allegra, P. Giorda, and M.G.A. Paris, *Role of Initial Entanglement and Non-Gaussianity in the Decoherence of Photon-Number Entangled States Evolving in a Noisy Channel*, Phys. Rev. Lett. **105**, 100503 (2010).

- M. Allegra, M.G.A. Paris, and P. Giorda, *Robustness of Gaussian and non-Gaussian Entanglement in a Noisy Environment*, Int. J. Quant. Inf. **9**, 27 (2010).

- M. Allegra, M.G.A. Paris, and P. Giorda, *Allegra, Giorda, and Paris Reply*, Phys. Rev. Lett. **107**, 238902 (2011).

- M. Allegra, P. Giorda, and A. Montorsi, *Quantum discord and classical correlations in the bond-charge Hubbard model: Quantum phase transitions, off-diagonal long-range order, and violation of the monogamy property for discord*, Phys. Rev. B **84**, 245133 (2011).

- M. Allegra and P. Giorda, *Topology and energy transport in networks of interacting photosynthetic complexes*, Phys. Rev. E **85**, 051917 (2012).

- P. Giorda, M. Allegra and M.G.A. Paris, *Quantum discord for Gaussian states with non-Gaussian measurements*, Phys. Rev. A **86**, 052328 (2012).

- X. Wang, M. Allegra, K. Jacobs, S. Lloyd, C. Lupo, M. Mohseni, *Quantum Brachistochrone Curves as Geodesics: Obtaining Accurate Minimum-Time Protocols for the Control of Quantum Systems*, Phys. Rev. Lett. **114**, 170501 (2015).

- C. D. Aiello, M. Allegra, B. Hemmerling, X. Wang, P. Cappellaro, *Algebraic synthesis of time-optimal unitaries in SU (2) with alternating controls*, Quant. Inf. Proc. **14**, 3233 (2015)

- M. Allegra, P. Giorda, S. Lloyd, *Global coherence of quantum evolutions based on decoherent histories: theory and application to photosynthetic quantum energy transport*, Phys. Rev. A **93**, 042312 (2016).

- P. Giorda, M. Allegra, *Coherence in quantum estimation*, J. Phys. A **51(2)**, 025302 (2017).

- P. Giorda, M. Allegra, *Two-qubit correlations revisited: average mutual information, relevant (and useful) observables and an application to remote state preparation*, J. Phys. A **50(29)**, 295302 (2017).

- M. Allegra, S. Seyed-Allaei, F. Pizzagalli, F. Baftizadeh, M. Maieron, C. Reverberi, A. Laio, and D. Amati, *fMRI single trial discovery of spatio-temporal brain activity patterns*, Hum. Brain Mapp. **38**, 1421 (2017).

- M. Allegra, S. Seyed-Allaei, N. W. Shuck, D. Amati, A. Laio, and C. Reverberi, *Brain network dynamics during spontaneous strategy shifts and incremental task optimization*, NeuroImage, 116854 (2020).

- N. I. Ilieva, N. Galvanetto, M. Allegra, M. Brucale, and A. Laio, *Automatic classification of single-molecule force spectroscopy traces from heterogeneous samples*, Bioinformatics, btaa626 (2020).
- M. Allegra, E. Facco, F. Denti, A. Laio, and A. Mira, *Data segmentation based on the local intrinsic dimension*, Scientific Reports, Scientific reports, 10(1), 1-12 (2020).
- D. Mouillot, N. Loiseau, M. Grenié, A. C. Algar, M. Allegra, M. W. Cadotte, N. Casajus, P. Denelle, M. Guéguen, A. Maire, B. Maitner, B. J. McGill, M. McLean, N. Mouquet, F. Munoz, W. Thuiller, S. Villéger, C. Violle, A. Auber The dimensionality and structure of species trait spaces. Ecology Letters, 24(9), 1988-2009 (2021).
- M. Allegra, C. Favaretto, N. Metcalf, M. Corbetta, and A. Brovelli, *Stroke-related alterations in inter-areal communication revealed via Granger causality analysis*, NeuroImage: Clinical, 32, 102812 (2021)
- E. Combrisson, M. Allegra, M., R. Basanisi, R.A. Ince, B. Giordano, J. Bastin, A. Brovelli, *Group-level inference of information-based measures for the analyses of cognitive brain networks from neurophysiological data.* NeuroImage, 258, 119347. (2022).
- C. Favaretto, M. Allegra, G. Deco, N. V. Metcalf, J. C. Griffis, G. L. Shulman, A. Brovelli, M. Corbetta, *E. Subcortical-cortical dynamical states of the human brain and their breakdown in stroke*, Nature communications 13(1), 1-17 (2022).

PhD thesis

Michele Allegra, *Gain and loss of information by decoherence*, PhD thesis, Universitá di Torino (2014).

Conference articles

- X. Wang, M. Allegra, K. Jacobs, S. Lloyd, C. Lupo, M. Mohseni, *Time-Optimal Quantum Control via Differential Geometry*, Proceedings Volume 10118, Advances in Photonics of Quantum Computing, Memory, and Communication X (2017)
- M. Allegra, M. d'Errico, E. Facco, A. Laio, A. Rodriguez, *Reconstructing the topography of multidimensional probability landscapes*, 49th Scientific meeting of the Italian Statistical Society (2018)

Presentations

Invited Talks

- 07/1/2013: invited talk at the Aspuru-Guzik group meeting, Chemistry Department, Harvard University, Cambridge, Massachusetts (USA)
- 01/25/2018: invited talk at the Monthly Neuroimaging Meeting, Aix-Marseille Université, Marseille (France)
- 04/17/2018: invited talk at the Institute for Computational Science, Università della Svizzera Italiana, Lugano (Switzerland)
- 06/08/2018: invited talk at the CECAM Workshop on Machine Learning at Interfaces, CECAM-HQ-EPFL, Lausanne (Switzerland)
- 6/22/2018: invited talk at the 49. Meeting of the Italian Statistical Society, Palermo (Italy)

- 04/09/2019: invited talk at TNG group meeting, Institut de Neurosciences des Systémes, Aix-Marseille Université, Marseille (France)
- 05/09/2019: invited talk at the Young Researcher's Workshop on Machine Learning for Materials Science 2019, Helsinki (Finland)
- 11/05/2019: invited talk at the TSN group meeting, Centre Interdisciplinaire de Nanosciences de Marseille, Aix-Marseille Université, Marseille (France)
- 05/20/2020: invited talk at the Physics Department, Università di Padova (Italy)
- 05/20/2020: invited talk at the Physics Department, Università di Padova (Italy)
- 05/20/2020: invited talk at the Physics Department, Università di Padova (Italy)
- 05/20/2020: invited talk at the Physics Department, Università di Padova (Italy)
- 02/02/2022 invited (virtual) talk at Institute for Research in Fundamental Sciences, (IPM), Tehran (Iran)
- 03/03/2021 Invited talk within the Padua Neuroscience Center Seminar Series, Padua (Italy)
- 06/06/2022 Invited talk at Neuroscience & statistical physics workshop, SISSA, Trieste (Italy)

Other

- 05/25/2010: poster presentation at Quantum 2010, INRIM, Torino (Italy)
- 06/17/2011: talk at Quantum Information 2011, Centro de ciencias Benasque (Spain)
- 05/24/2012: talk at Quantum 2012, INRIM, Torino (Italy)
- 11/7/2012: talk at the Workshop on tensor network states, ISI, Torino (Italy)
- 11/14/2013: poster presentation at the MURI Review Meeting, M.I.T., Cambridge, Massachusetts (USA)
- 06/27/2016: poster presentation at the 22nd Annual Meeting of the Organization for Human Brain Mapping, Geneve (Switzerland)
- 09/29/2017: poster presentation at the International Conference Cognitive Neuroscience of Executive Functions, Padova (Italy)
- 10/17/2018: poster presentation at the 2018 HBP Summit in Maastricht (Netherlands)
- 05/22/2019: poster presentation at Neurofrance 2019, Marseille (France)
- 02/05/2020: poster presentation at the 2020 HBP Summit in Athens (Greece)

Grants and awards

- 05/2006: I was awarded an Erasmus scholarship at the University of Heidelberg (Heidelberg, Germany)
- 06/2010: I was awarded an internship scholarship at the Politecnico di Torino (Torino, Italy)
- 11/2010: I was awarded a PhD scholarship at the Università di Torino (Torino, Italy), ranking 1^{st} among all applicants

- 11/2015: I won the public competition for a PostDoc position at the Molecular and Biophysical Physics Sector at SISSA, Trieste (Italy)
- 03/2018: I won the public competition for a PostDoc position at the Institut de Neurosciences de la Timone, Aix-Marseille Université, Marseille (France)

Reviewer activity

I am reviewer for Physical Review A, Physical Review Letters, Journal of Physics A, Nature Scientific Reports, Pattern Recognition, Frontiers in Neuroscience, Brain Communications.

Public code

- Matlab implementation of Coherence Density Peak Clustering (published article 12): https://github.com/micheleallegra/CDPC.
- Matlab and Python implementations of Heterogeneous Intrinsic Dimension Algorithm (published article 15): https://github.com/micheleallegra/Hidalgo.
- Python implementation of covariance-based Granger causality (article 16): https://github.com/micheleallegra/CovGC.
- C++ implementation of clustering for force-extension curves in single-molecule force spectroscopy (published article 14): https://github.com/ninailieva/SMFS_clustering

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Skills

Language skills

Italian (mother tongue), English (fluent, FCE 2002), German (fluent, KDS 2008), French (fluent), Spanish (basic).

Computational skills

Programming languages: Python, Matlab, R, C/C++, Mathematica, Bash, Fortran.

Referees

- Andrea Brovelli, CNRS, Marseille, France (andrea.brovelli@univ-amu.fr)
- Maurizio Corbetta, Università di Padova, Padova, Italy (maurizio.corbetta@unipd.it)
- Alessandro Laio, SISSA, Trieste, Italy (laio@sissa.it)
- Daniele Amati, SISSA, Trieste, Italy (amati@sissa.it)
- Seth Lloyd, MIT, Cambridge, USA (slloyd@mit.edu)
- Carlo Reverberi, Università di Milano Bicocca, Milan, Italy (carloreve@gmail.com)

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- Paola Cappellaro, MIT, Cambridge, USA (pcappell@mit.edu)
- Matteo Paris, Università di Milano, Milan, Italy (matteo.paris@fisica.unimi.it)
- Paolo Giorda, CNISM, Italy (magpaolo16@gmail.com)