

Giovanni Petri

PROFESSOR OF NETWORK SCIENCE · LONDON LEAD, NETWORK SCIENCE INSTITUTE · NETWORK SCIENCE LEAD, PROJECT CETI

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Summary

I study how the structure of a system constrains what it can represent, learn and do. My work combines information theory, algebraic topology and the statistical physics of networks with higher-order interactions, and tests the resulting laws in artificial neural networks, brains and animal societies. Recent results include closed-form limits on generalisation and identification under finite resolution (ICLR 2026), renormalisation methods for higher-order networks (*Nature Physics*, 2025) and the network analysis of cooperation during sperm whale birth (*Science*, 2026). I lead the ERC Consolidator Grant RUNES and NPLab, am London Lead of the Network Science Institute at Northeastern University London, and serve as Network Science Lead of Project CETI.

Professional Experience

- 2023 – **Professor of Network Science, PI of NPLab**, Network Science Institute, Northeastern University London
- 2026 – **London Lead**, Network Science Institute, Northeastern University London
- 2022 – **Network Science Lead; Scientific Advisory Board**, Project CETI
- 2025 – **Visiting Professor**, Politecnico di Torino
- 2026 – **Affiliated Researcher**, ISI Foundation
- 2025 – **Director + Founder**, Völrún Ltd
- 2022 – 2025 **Principal Researcher and PI**, CENTAI Institute, private AI research centre, Turin
- 2021 – 2024 **Guest Scholar, NETWORKS Unit**, IMT School for Advanced Studies Lucca
- 2021 – 2025 **Contract Professor, Physics Department**, University of Turin
- 2016 – 2022 **Senior Research Scientist**, ISI Foundation
- 2012 – 2015 **Junior Researcher**, ISI Foundation
- 2013 – 2014 **IMA Long-term visitor**, Institute for Mathematics and its applications, University of Minnesota
- 2010 – 2012 **Teaching assistant**, School of Business and Management, Queen Mary, University of London
- 2011 **HPC-Europe fellowship**, Complex Systems Lab, Scuola Normale Superiore di Catania
- 2011 **COST short-term fellowship**, Complex Systems Research Group, Medizinische Universität Wien
- 2010 **IDEA League fellowship**, ETH Zürich (group of D. Helbing)

Education

Imperial College London

PH.D. COMPLEX NETWORKS

- Ph.D. thesis on Information and Dynamics in Urban Traffic Networks
- Supervisors: H.J. Jensen and J.W. Polak (Imperial College London)

London, UK

2008 – 2012

University of Pisa

M.Sc. IN THEORETICAL PHYSICS

- M.Sc. dissertation focused on non-Gaussianity perturbations in Inflationary-Era Cosmic Microwave Background
- Supervisor: A. Riotto (University of Geneva)

Pisa, Italy

2005 – 2008

University of Pisa

B.Sc. IN GENERAL PHYSICS

- B.Sc. dissertation focused on analysis of pre-launch data from Fermi Tracker at Stanford Linear Accelerator Center
- Supervisor: E. do Couto e Silva (SLAC), R. Bellazzini (University of Pisa)

Pisa, Italy

2002 – 2005

BOOKS

F. Battiston, **G. Petri** (eds.) (2022). *Higher-Order Systems*. Springer, Understanding Complex Systems.

JOURNAL ARTICLES

- A. Santoro, M. Neri, S. Poetto, D. Orsenigo, M. Diano, M. Gatica, **G. Petri** (2026). Charting higher-order models of brain function beyond pairwise interactions. *Nature Communications* 17:9207.
- A. Abiad, A. Arenas, A. Backhausz, ..., **G. Petri**, ...(34 authors) (2026). Hypergraphs and simplicial complexes in focus: A roadmap for future research in higher-order interactions. *Journal of Physics: Complexity* 7:022501.
- A. Aleta, A. S. Teixeira, G. Ferraz de Arruda, ..., **G. Petri**, ...(17 authors) (2026). Multilayer network science: theory, methods, and applications. *Journal of Complex Networks* 14:cnag007.
- A. Maalouf, J. DelPreto, M. Lucas, S. Poetto, J. Andreas, A. Torralba, S. Gero, **G. Petri**, D. Rus, D. F. Gruber (2026). Cooperation by non-kin during birth underpins sperm whale social complexity. *Science* 391:1355–1360.
- Y. Aluma, Z. Baron, R. Barrett, ..., **G. Petri**, ...(47 authors) (2026). Description of a collaborative sperm whale birth and shifts in coda vocal styles during key events. *Scientific Reports* 16:9206.
- M. Gatica, C. Atkinson-Clement, C. Coronel-Oliveros, M. Alkhawashki, P. A. M. Mediano, E. Tagliazucchi, F. E. Rosas, M. Kaiser, **G. Petri** (2025). Understanding the high-order network plasticity mechanisms of ultrasound neuromodulation. *PLOS Computational Biology* 21:e1013514.
- M. Neri, A. Brovelli, S. Castro, F. Fraioli, M. Gatica, R. Herzog, P. A. Mediano, I. Mindlin, **G. Petri**, D. Bor, F. E. Rosas, A. Tramacere, M. Estarellas (2025). A taxonomy of neuroscientific strategies based on interaction orders. *European Journal of Neuroscience* 61:e16676.
- E. Combrisson, R. Basanisi, M. Neri, G. Auzias, **G. Petri**, D. Marinazzo, S. Panzeri, A. Brovelli (2025). Higher-order and distributed synergistic functional interactions encode information gain in goal-directed learning. *Nature Communications*.
- T. Robiglio, L. Di Gaetano, A. Altieri, **G. Petri**, F. Battiston (2025). Higher-order Ising model on hypergraphs. *Physical Review E*.
- M. Nurisso, M. Morandini, M. Lucas, F. Vaccarino, T. Gili, **G. Petri** (2025). Higher-order Laplacian renormalization. *Nature Physics* 21:661–668.
- T. Robiglio, M. Neri, D. Coppes, C. Agostinelli, F. Battiston, M. Lucas, **G. Petri** (2025). Synergistic Signatures of Group Mechanisms in Higher-Order Systems. *Physical Review Letters*.
- T. Lanciano, **G. Petri**, T. Gili, F. Bonchi (2025). Contrast subgraphs catch patterns of altered functional connectivity in autism spectrum disorder. *Scientific Reports* 15:24265.
- A. Leitao, M. Lucas, S. Poetto, T. A. Hersh, S. Gero, D. Gruber, M. Bronstein, **G. Petri** (2025). Evidence of social learning across symbolic cultural barriers in sperm whales. *eLife*. Published Reviewed Preprint, version 3.
- F. Saracco, **G. Petri**, R. Lambiotte, T. Squartini (2025). Entropy-based models to randomise real-world hypergraphs. *Communications Physics* 8:284.
- M. Nurisso, A. Arnaudon, M. Lucas, R. L. Peach, P. Expert, F. Vaccarino, **G. Petri** (2024). A unified framework for simplicial Kuramoto models. *Chaos: An Interdisciplinary Journal of Nonlinear Science*.
- Y. Zhang, P. S. Skardal, F. Battiston, **G. Petri**, M. Lucas (2024). Deeper but smaller: Higher-order interactions increase linear stability but shrink basins. *Science Advances* 10:eado8049.
- A. Santoro, F. Battiston, M. Lucas, **G. Petri**, E. Amico (2024). Higher-order connectomics of human brain function reveals local topological signatures of task decoding, individual identification, and behavior. *Nature Communications* 15:10244.
- G. Preti, A. Fazzone, **G. Petri**, G. De Francisci Morales (2024). Higher-Order Null Models as a Lens for Social Systems. *Physical Review X* 14:031032.
- D. Duong-Tran, R. Kaufmann, J. Chen, X. Wang, S. Garai, F. H. Xu, J. Bao, E. Amico, A. D. Kaplan, **G. Petri**, J. Goñi, Y. Zhao, L. Shen (2024). Homological Landscape of Human Brain Functional Sub-Circuits. *Mathematics* 12:455.
- M. Mancastroppa, I. Iacopini, **G. Petri**, A. Barrat (2024). The structural evolution of temporal hypergraphs through the lens of hyper-cores. *EPJ Data Science* 13:50.
- G. Petri**, S. Musslick, J. D. Cohen (2024). An Information-Theoretic Approach to Reward Rate Optimization in the Tradeoff Between Controlled and Automatic Processing in Neural Network Architectures. *eLife*. Published Reviewed Preprint, version 1.
- A. Celeghin, A. Borriero, D. Orsenigo, M. Diano, C. A. Méndez Guerrero, A. Perotti, **G. Petri**, M. Tamietto (2023). Convolutional neural networks for vision neuroscience: significance, developments, and outstanding issues. *Frontiers in Computational Neuroscience*.
- I. Akinrinade, K. Kareklas, M. C. Teles, T. K. Reis, M. Gliksberg, **G. Petri**, G. Levkowitz, R. F. Oliveira (2023). Evolutionarily conserved role of oxytocin in social fear contagion in zebrafish. *Science*.

- A. Santoro, F. Battiston, **G. Petri**, E. Amico (2023). Higher-order organization of multivariate time series. *Nature Physics* 19:221–229.
- M. Mancastroppa, I. Iacopini, **G. Petri**, A. Barrat (2023). Hyper-cores promote localization and efficient seeding in higher-order processes. *Nature Communications* 14:6223.
- G. Ferraz de Arruda, **G. Petri**, P. M. Rodriguez, Y. Moreno (2023). Multistability, intermittency, and hybrid transitions in social contagion models on hypergraphs. *Nature Communications*.
- M. Lucas, I. Iacopini, T. Robiglio, A. Barrat, **G. Petri** (2023). Simplicially driven simple contagion. *Physical Review Research*.
- J. S. Pinho, V. Cunliffe, K. Kareklas, **G. Petri**, R. F. Oliveira (2023). Social and asocial learning in zebrafish are encoded by a shared brain network that is differentially modulated by local activation. *Communications Biology*.
- N. W. Landry, M. Lucas, I. Iacopini, **G. Petri**, A. Schwarze, A. Patania, L. Torres (2023). XGI: A Python package for higher-order interaction networks. *Journal of Open Source Software*.
- A. Arnaudon, R. L. Peach, **G. Petri**, P. Expert (2022). Connecting Hodge and Sakaguchi-Kuramoto through a mathematical framework for coupled oscillators on simplicial complexes. *Communications Physics*.
- I. Iacopini, **G. Petri**, A. Baronchelli, A. Barrat (2022). Group interactions modulate critical mass dynamics in social convention. *Communications Physics* 5:64.
- G. St-Onge, I. Iacopini, V. Latora, A. Barrat, **G. Petri**, A. Allard, L. Hébert-Dufresne (2022). Influential groups for seeding and sustaining nonlinear contagion in heterogeneous hypergraphs. *Communications Physics*.
- M. F. Scaia, I. Akinrinade, **G. Petri**, R. F. Oliveira (2022). Sex Differences in Aggression Are Paralleled by Differential Activation of the Brain Social Decision-Making Network in Zebrafish. *Frontiers in Behavioral Neuroscience*.
- J. Billings, R. Tivadar, M. M. Murray, B. Franceschiello, **G. Petri** (2022). Topological Features of Electroencephalography are Robust to Re-referencing and Preprocessing. *Brain Topography* 35:79–95.
- J. Andreas, G. Beguš, M. M. Bronstein, ..., **G. Petri**, ...(20 authors) (2022). Toward understanding the communication in sperm whales. *iScience*.
- A. R. Nunes, M. Gliksberg, S. A. M. Varela, M. Teles, E. Wircer, J. Blechman, **G. Petri**, G. Levkowitz, R. F. Oliveira (2021). Developmental Effects of Oxytocin Neurons on Social Affiliation and Processing of Social Information. *The Journal of Neuroscience*.
- M. Guerra, A. De Gregorio, U. Fugacci, **G. Petri**, F. Vaccarino (2021). Homological scaffold via minimal homology bases. *Scientific Reports*.
- J.-G. Young, **G. Petri**, T. P. Peixoto (2021). Hypergraph reconstruction from network data. *Communications Physics*.
- G. Rho, A. L. Callara, **G. Petri**, M. Nardelli, E. P. Scilingo, A. Greco, V. De Pascalis (2021). Linear and Nonlinear Quantitative EEG Analysis during Neutral Hypnosis following an Opened/Closed Eye Paradigm. *Symmetry* 13:1423.
- J. Billings, M. Saggat, J. Hlinka, S. Keilholz, **G. Petri** (2021). Simplicial and topological descriptions of human brain dynamics. *Network Neuroscience* pp. 1–20.
- F. Battiston, E. Amico, A. Barrat, G. Bianconi, G. Ferraz de Arruda, B. Franceschiello, I. Iacopini, S. Kéfi, V. Latora, Y. Moreno, M. M. Murray, T. P. Peixoto, F. Vaccarino, **G. Petri** (2021). The physics of higher-order interactions in complex systems. *Nature Physics* 17:1093–1098.
- G. Petri**, S. Musslick, B. Dey, K. Özçimder, D. Turner, N. K. Ahmed, T. L. Willke, J. D. Cohen (2021). Topological limits to the parallel processing capability of network architectures. *Nature Physics* 17:646–651.
- G. Ferraz de Arruda, **G. Petri**, F. A. Rodrigues, Y. Moreno (2020). Impact of the distribution of recovery rates on disease spreading in complex networks. *Physical Review Research* 2:013046.
- F. Battiston, G. Cencetti, I. Iacopini, V. Latora, M. Lucas, A. Patania, J.-G. Young, **G. Petri** (2020). Networks beyond pairwise interactions: Structure and dynamics. *Physics Reports* 874:1–92.
- G. Ferraz de Arruda, **G. Petri**, Y. Moreno (2020). Social contagion models on hypergraphs. *Physical Review Research*.
- P. Expert, L.-D. Lord, M. L. Kringelbach, **G. Petri** (2019). Editorial: Topological Neuroscience. *Network Neuroscience* 3:653–655.
- C. Geniesse, O. Sporns, **G. Petri**, M. Saggat (2019). Generating dynamical neuroimaging spatiotemporal representations (DyNeuSR) using topological data analysis. *Network Neuroscience*.
- S. V. Scarpino, **G. Petri** (2019). On the predictability of infectious disease outbreaks. *Nature Communications*.
- I. Iacopini, **G. Petri**, A. Barrat, V. Latora (2019). Simplicial models of social contagion. *Nature Communications*.
- E. Ibáñez-Marcelo, L. Campioni, D. Manzoni, E. L. Santarcangelo, **G. Petri** (2019). Spectral and topological analyses of the cortical representation of the head position: Does hypnotizability matter?. *Brain and Behavior*.
- A. Patania, P. Selvaggi, M. Veronese, O. Di Pasquale, P. Expert, **G. Petri** (2019). Topological gene expression networks recapitulate brain anatomy and function. *Network Neuroscience*.

- E. Ibáñez-Marcelo, L. Campioni, A. Phinyomark, **G. Petri**, E. L. Santarcangelo (2019). Topology highlights mesoscopic functional equivalence between imagery and perception: The case of hypnotizability. *NeuroImage*.
- A. Phinyomark, **G. Petri**, E. Ibáñez-Marcelo, S. T. Osis, R. Ferber (2018). Analysis of Big Data in Gait Biomechanics: Current Trends and Future Directions. *Journal of Medical and Biological Engineering* 38:244-260.
- G. Petri**, A. Barrat (2018). Simplicial Activity Driven Model. *Physical Review Letters*.
- J.-G. Young, **G. Petri**, F. Vaccarino, A. Patania (2017). Construction of an efficient sampling from the simplicial configuration model. *Physical Review E*.
- A. Phinyomark, R. N. Khushaba, E. Ibáñez-Marcelo, A. Patania, E. Scheme, **G. Petri** (2017). Navigating features: a topologically informed chart of electromyographic features space. *Journal of the Royal Society Interface* 14:20170734.
- A. Patania, **G. Petri**, F. Vaccarino (2017). P-persistent homology of finite topological spaces. *Rendiconti del Seminario Matematico*.
- A. Phinyomark, E. Ibanez-Marcelo, **G. Petri** (2017). Resting-State fMRI Functional Connectivity: Big Data Preprocessing Pipelines and Topological Data Analysis. *IEEE Transactions on Big Data*.
- A. Patania, **G. Petri**, F. Vaccarino (2017). The shape of collaborations. *EPJ Data Science*.
- A. Patania, F. Vaccarino, **G. Petri** (2017). Topological analysis of data. *EPJ Data Science*.
- L.-D. Lord, P. Expert, H. M. Fernandes, **G. Petri**, T. J. Van Hartevelt, F. Vaccarino, G. Deco, F. Turkheimer, M. L. Kringelbach (2016). Insights into Brain Architectures from the Homological Scaffolds of Functional Connectivity Networks. *Frontiers in Systems Neuroscience*.
- I. Donato, M. Gori, M. Pettini, **G. Petri**, S. De Nigris, R. Franzosi, F. Vaccarino (2016). Persistent homology analysis of phase transitions. *Physical Review E* 93:052138.
- P. Bajardi, M. Delfino, A. Panisson, **G. Petri**, M. Tizzoni (2015). Unveiling patterns of international communities in a global city using mobile phone data. *EPJ Data Science*.
- A. Cardillo, **G. Petri**, V. Nicosia, R. Sinatra, J. Gómez-Gardeñes, V. Latora (2014). Evolutionary dynamics of time-resolved social interactions. *Physical Review E* 90:052825.
- G. Petri**, P. Expert, F. Turkheimer, R. Carhart-Harris, D. Nutt, P. J. Hellyer, F. Vaccarino (2014). Homological scaffolds of brain functional networks. *Journal of the Royal Society Interface* 11:20140873.
- J. Binchi, E. Merelli, M. Rucco, **G. Petri**, F. Vaccarino (2014). JHoles: A tool for understanding biological complex networks via clique weight rank persistent homology. *Electronic Notes in Theoretical Computer Science*.
- G. Petri**, P. Expert (2014). Temporal stability of network partitions. *Physical Review E - Statistical, Nonlinear, and Soft Matter Physics*.
- G. Petri**, P. Expert, H. J. Jensen, J. W. Polak (2013). Entangled communities and spatial synchronization lead to criticality in urban traffic. *Scientific Reports* 3:1798.
- G. Petri**, M. Scolamiero, I. Donato, F. Vaccarino (2013). Topological strata of weighted complex networks. *PLoS ONE* 8:e66506.
- M. Szell, R. Sinatra, **G. Petri**, S. Thurner, V. Latora (2012). Understanding mobility in a social petri dish. *Scientific Reports*.
- G. Petri**, H. J. Jensen, J. W. Polak (2009). Global and local information in traffic congestion. *EPL (Europhysics Letters)*.
- CONFERENCE PROCEEDINGS AND BOOK CHAPTERS
- D. Saviotto, D. Campbell, A. Panisson, M. Nurisso, **G. Petri**, J. D. Cohen, A. Perotti (2026). The Geometry of Representational Failures in Vision Language Models. *ICML 2026*.
- M. Nurisso, J. Fernando, R. Deshpande, A. Perotti, R. Marjeh, S. M. Frankland, R. L. Lewis, T. W. Webb, D. Campbell, F. Vaccarino, J. D. Cohen, **G. Petri** (2026). Bound by semanticity: universal laws governing the generalization-identification tradeoff. *ICLR*.
- M. Nurisso, P. Leroy, **G. Petri**, F. Vaccarino (2026). Topology and Geometry of the Learning Space of ReLU Networks: Connectivity and Singularities. *ICLR 2026*.
- G. D'Acunto, F. Bonchi, G. De Francisci Morales, **G. Petri** (2024). Extracting the Multiscale Causal Backbone of Brain Dynamics. *CLeaR, PMLR* 236:265–295.
- A. Brondetta, A. Bizyaeva, M. Lucas, **G. Petri**, S. Musslick (2024). On the Benefits of Heterogeneity in Cognitive Stability and Flexibility for Collaborative Task Switching. *Proceedings of the Annual Meeting of the Cognitive Science Society* 46.
- S. Piaggese, A. Panisson, **G. Petri** (2022). Effective Higher-order Link Prediction and Reconstruction from Simplicial Complex Embeddings. *Proceedings of Machine Learning Research* 198:55:1–55:17.
- P. Expert, **G. Petri** (2022). Higher-Order Description of Brain Function. *Understanding Complex Systems*.

- E. Campbell, A. Phinyomark, A. H. Al-Timemy, R. N. Khushaba, **G. Petri**, E. Scheme (2019). Differences in EMG Feature Space between Able-Bodied and Amputee Subjects for Myoelectric Control. *9th International IEEE/EMBS Conference on Neural Engineering (NER)*.
- K. Özçimder, B. Dey, S. Musslick, **G. Petri**, N. K. Ahmed, T. L. Willke, J. D. Cohen (2017). A Formal Approach to Modeling the Cost of Cognitive Control. *CogSci 2017 - Proceedings of the 39th Annual Meeting of the Cognitive Science Society: Computational Foundations of Cognition*.
- I. Donato, **G. Petri**, M. Scolamiero, L. Rondoni, F. Vaccarino (2013). Decimation of fast states and weak nodes: Topological variation via persistent homology. *Springer Proceedings in Complexity* pp. 295-301.
- G. Petri**, M. Scolamiero, I. Donato, F. Vaccarino (2013). Networks and cycles: A persistent homology approach to complex networks. *Springer Proceedings in Complexity*.

PREPRINTS

- L. Zaffina, C. Monti, S. Poetto, M. Lucas, H. J. M. Borges, R. Deshpande, P. Tønnesen, D. F. Gruber, S. Gero, A. Santoro, **G. Petri** (2026). Sperm whale foraging combines persistent search with flexible prey-capture tactics. *bioRxiv* Preprint.
- C. Siu, S. Pirzada, C. Glick, R. Betzel, **G. Petri**, J. R. Manning, L. Williams, M. Saggat (2026). Global topology of brain-wide co-fluctuations links task states, personality, and behavioral symptom dimensions. *bioRxiv* Preprint.
- F. M. Guadagnuolo, M. Nurisso, F. Galluzzi, A. Allard, **G. Petri** (2026). Harmonic morphisms and dynamical invariants in network renormalization. *arXiv* 2604.08386 (preprint).
- S. M. Frankland, R. Marjeh, M. Nurisso, J. Fluegemann, T. Webb, **G. Petri**, R. L. Lewis, J. D. Cohen (2026). Capacity Limits in Cognitive Processing Reflect the Curse of Generalization. *PsyArXiv, version 3* Preprint.
- M. Lucas, C. Bisot, **G. Petri**, S. Declerck, T. Carletti (2026). Minimal branching and fusion morphogenesis approaches biological multi-objective optimality. *arXiv* 2601.03877 (preprint).
- D. Orsenigo, F. Setti, M. Pagani, **G. Petri**, M. Tamietto, A. I. Luppi, E. Ricciardi (2025). Beyond Reorganization: Intrinsic cortical hierarchies constrain experience-dependent plasticity in sensory-deprived humans. *bioRxiv* Preprint.
- M. Wardynski, I. Iacopini, **G. Petri**, V. Latora, A. Crimi (2025). Modeling the Spread of Misfolded Proteins in Alzheimer's Disease using Higher-Order Simplicial Complex Contagion. *medRxiv* Preprint.
- S. Poetto, H. Merritt, A. Santoro, G. Rabuffo, K. Finc, D. A. Battaglia, F. Vaccarino, M. Saggat, A. Brovelli, **G. Petri** (2025). The Topological Architecture of Brain Identity. *bioRxiv* Preprint.
- B. Franceschiello, S. Rumatic, M. Leidi, ..., **G. Petri**, ...(18 authors) (2023). Hi-Fi fMRI: High-resolution, fast-sampled and sub-second whole-brain functional MRI at 3T in humans. *bioRxiv* Preprint.

Awards, Fellowships, & Grants

2025–2030	PI – Consolidator Grant – “RUNES: Reconstructing and Unifying Neural and Ecological Systems” , European Research Council	2M euros
2026–2027	Co-Investigator – “TOPO-LLM: Topologically-Informed Large Language Models for Innovation Intelligence” , EuroHPC JU, FFplus Second Open Call (Digital Europe Programme)	€100,000 share
2025–2027	CENTAI Supervisor of MSCA Fellowship – “TemporaHOI” , European Commission (Marie Skłodowska-Curie Actions)	Awarded to Andrea Santoro - CENTAI - 200k euros multiple phd fellowships
2024–2028	CENTAI PI – MSCA Doctoral Network – “BeyondTheEdge” , European Commission (Marie Skłodowska-Curie Actions)	(each 100k euros) \$35M total
2020–ongoing	Network Science Lead (from 2022) – “Project CETI (CEtacean Translation Initiative)” , TED Audacious 2020	project, \$1M CENTAI allowance
2021–2031	Italian National Abilitation as Associate Professor in Theoretical Physics and Condensed Matter , Italian Ministry of Education, University and Research	
2021–2023	Co-PI – “Mapping the higher-order dynamics of neurodegeneration human brain networks” , Swiss COST Action	CHF 314,964
2020–2021	Co-PI – “Topological Data Analysis of Adjuvant Data” , GSK Vaccines	€65,000
2020	OHBM Best Paper Award , Organization for Human Brain Mapping	\$1500

2015–2018	Co-PI - "ADnD: Algebraic-topological Detection of Neurodegenerative Diseases" , Compagnia San Paolo	€1,076,000
2013–2014	Fellowship – IMA long-term visitor , University of Minnesota	~\$20,000
2014	CCS Service Award , Complex Systems Society	-
2011	HPC-Europe fellowship – Complex Systems Lab, Scuola Normale Superiore di Catania , HPC Europe	~€5,000
2011	Short-term traveling award - Complex Systems Research Group, Medizinische Universität Wien , EU COST	~€5,000
2010	IDEA League fellowship – Computational Social Science group of D. Helbing, ETH Zürich , IDEA League	~€3,000

Teaching Experience

Feb 2022–2025	Complexity in social systems , MSc Physics of Complex Systems, Physics Department, University of Turin, Italy
Dec 2021	Network neuroscience , The Gulbenkian Integrative Biology and Biomedicine Ph.D. Program 2021 Neurobiology: Brain and Behavior, IGC, Lisbon
Dec 2021	TDA crash course: theory and practice for ML applications , Invited Lecturer, Complex Networks 2021, Madrid
Sep 2019	Workshop on Complex Networks and Topological Data Analysis , Invited Lecturer, UKM, Kuala Lumpur
Jun 2019	Complex72h , Invited Tutor
May 2019	Complex networks: theory, methods, and applications , Invited Lecturer, Lake Como School of Advanced Studies
Feb 2019	TDA crash course: theory and practice for ML applications , Lecturer, Applied Machine Learning Days 2019
2017 – 2018	Network theory - in MSc Physics of Complex Systems , Guest Lecturer, University of Turin
2017 – 2018	Topological Data Analysis - in MSc Engineering Math , Guest Lecturer, Polytechnic University of Turin
	Topological data science, doctoral course , PhD Programme in Mathematics, Polytechnic University of Turin

Mentoring

Postdoctoral and junior researchers

2024 – 2026	M. Gatica , Postdoctoral fellow, Network Science Institute, Northeastern University London; now Assistant Professor there
2025 –	A. Santoro , Marie-Curie Fellow, CENTAI Institute
2025 –	L. Zaffina , CETI researcher and PhD student in th Data Science PhD program, Sapienza University
2021 – 2023	A. Leitao , Junior Researcher, CENTAI Institute
2021 – 2024	A. Santoro , Postdoctoral fellow, EPFL (co-supervised with E. Amico under Swiss COSTs funds)
2021 – 2024	M. Lucas , Researcher, CENTAI Institute; then FNRS Fellow and now Assistant Professor, University of Namur
2020 – 2021	C. Sopegno , Junior Researcher, develop TDA methods for single-cell data (in collaboration with GSK Vaccines), ISI Foundation
2019 – 2020	J.C.W. Billings , Researcher, ISI Foundation
2019 – 2020	Y. Velaj , Researcher, ISI Foundation
2017 – 2018	A. Phinyomark , Researcher, ISI Foundation
2016 – 2018	E. Ibáñez-Marcelo , Researcher, ISI Foundation

PhD Students

from Oct 2026	D. Savietto , PhD Network Science, “Higher-order representational geometry in biological and artificial neural systems”, Northeastern University London (ERC RUNES)
from Oct 2026	M. Stevenson , PhD Network Science, “Higher-order coordination across cognitive ecosystems”, Northeastern University London (ERC RUNES)
2025 – current	L. Zaffina , PhD Data Science, “Higher-order signal processing”, CENTAI + Sapienza University (co-supervised with F. Bonchi)
2025 – current	X.C. Liu , PhD Network Science, “Bayesian inference for higher-order structures and dynamics”, Northeastern University London (co-supervised with S. Scarpino)
2024 – current	M.B. Guerreiro Pereira , PhD Network Science, “Data equivalence across higher-order dynamical systems”, CENTAI + Polytechnic University of Turin (co-supervised with F. Vaccarino)
2024 – current	R. Deshpande , PhD Network Science, “Symmetries in learning”, Northeastern University London (co-supervised with S. Scarpino)
2024 – current	H.J. Borges Machado , PhD Network Science, “Group decision making in human and non-human groups”, Northeastern University London (co-supervised with E. Moro)
2023 – current	D. Orsenigo , PhD Psychology, “Topological signature of consciousness in blindsight”, CENTAI + University of Turin (co-supervised with M. Tamietto)
2022 – 2026	M. Nurisso , PhD Mathematics, “Topological explainability in AI”, CENTAI + Polytechnic University of Turin (co-supervised with F. Vaccarino); now NAM Fellow, Princeton University
2021 – current	S. Poetto , PhD Physics, “Topological Neuroscience”, CENTAI + Nicolaus Copernicus University (co-supervised with K. Finc)
2018 – 2022	M. Guerra , PhD Applied Mathematics, “Computational techniques for persistent homology”, Polytechnic University of Turin
2014 – 2017	A. Patania , PhD Applied Mathematics, “Simplicial data analysis: theory, practice and algorithms”, Polytechnic University of Turin; now University of Vermont

Master Students

current	C. Agostinelli , MSc Physics of Complex Systems, “Renormalization of higher-order dynamical systems”, University of Turin (co-supervised with M. O)
current	M. Neri , MSc Physics of Complex Systems, “Higher-order information theory in cognitive neuroscience”, University of Turin (co-supervised with A. Brovelli)
current	S. Cavuoti Cabanillas , MSc Physics of Complex Systems, “Topology of higher-order information timeseries”, University of Turin (co-supervised with O. Sporns)
current	B. Aydin , MSc Physics, “Higher-order reconstruction from simulated dynamics”, Imperial College London (co-supervised with K. Christensen)
current	D. Ezaz , MSc Physics, “Inference from higher-order oscillator models”, Imperial College London (co-supervised with K. Christensen)
current	M. Ignat , MSc Physics, “Higher-order naming game in adaptive hypergraphs”, Imperial College London (co-supervised with K. Christensen)
current	T. Cowperthwaite , MSc Physics, “Disruption of minority norm emergence in higher-order opinion models”, Imperial College London (co-supervised with K. Christensen)
2022	A. Chung , MSc Physics, “Higher-order dynamics of polarization models”, Imperial College London (co-supervised with K. Christensen)
2022	N. Kiatjaroonlert , MSc Physics, “Temporal effects in higher-order models of social polarization”, Imperial College London (co-supervised with K. Christensen)
2022	M. Nurisso , MSc Mathematics, “Higher-order Sakaguchi-Kuramoto models”, Politechnic University of Turin (co-supervised with F. Vaccarino)
2022	M. Oria , MSc Physics of Complex Systems, “Single-cell topology of human organs”, University of Turin (co-supervised with M. Osella)
2022	A. Cassisa , MSc Mathematics for Data Science, “Topological explainability of neural networks”, University of Turin, (co-supervised with P. Bajardi)
2021	M. Marin , MSc Computer Science, “Colourings of random covers in networks”, ENS Lyon
2021	S. Poetto , MSc Physics of Complex Systems, “TDA for grid-cells analysis”, University of Turin, (co-supervised with F. Fariselli)

- 2020 **N. Pacella**, MSc Physics, “Topology of word-embedding models”, University of Turin (co-supervised with M. Osella)
- 2020 **A. Leita**, MSc Data Science, “Topology of Neural Networks”, NOVA University, (co-supervised with F. Pinheiro)
- 2017 **I. Iacopini**, MSc Physics of Complex Systems, “Urban traffic models”, University of Turin, (co-supervised with C. Cattuto); now Associate Professor, Northeastern University London
- 2014 **C. Nuzzo**, MSc Mathematics, “A comparison of persistent and expected random homology of complex networks”, University of Turin (co-supervised with F. Galluzzi)

BSc Students

- 2023 **N. Aime**, BSc Physics, “Topological analysis of EEG data under hypnosis”, University of Turin (co-supervised with M. Osella)
- 2021 **T. Robiglio**, BSc Physics, “Interacting higher-order contagion processes”, University of Turin (co-supervised with M. Osella)
- 2018 **G. Lerda**, BSc Mathematics, “Simplicial complexes: structural approach and decomposition”, University of Turin (co-supervised with F. Galluzzi)
- 2014 **D. Spalla**, BSc Physics, “Gene-based connectivity and entropy distribution in the human brain”, University of Turin, (co-supervised with M. Caselle)

Presentations

INVITED & KEYNOTE TALKS

- July 2026. *From individuals to social groups v2.0*, vision talk, Project CETI all-team meeting, Dominica.
- June 2026. *The cost of sharing*, invited talk, NSIA satellite, NetSci 2026, Boston, USA.
2026. Invited speaker, SYNAPSE 2026, India.
- October 2025. Keynote on topological functional equivalence in mental imagery under hypnosis, Hypnosis Research Summit, Budapest, Hungary.
- September 2025. *Trade-offs, Topology, and Intelligence: From Generalisation Limits to Higher-Order Brain Networks.*, keynote talk at Huawei “Science and Artificial Intelligence Summit 2025”, London, UK.
- August 2025. *Beyond LLMs: Intelligent Agents, Cognitive Limits & Trust-Tech*, invited talk at Cambridge Spark + Lloyds Bank AI training course for executives, Cambridge, UK
- July 2025. *Bound by semanticity: universal laws governing the generalization-identification tradeoff*, SafeAI retreat organized by PIBBS, Berkeley, USA
- July 2025. *Bound by semanticity: universal laws governing the generalization-identification tradeoff*, invited talk at “Progress of Non-linear Dynamics” workshop, IMT Lucca, Lucca, Italy/
- May 2025. *Simplicial Kuramoto models, brains, and renormalization*, invited talk at “dynamics of higher-order systems” at SIAM Dynamical Systems 2025, Denver, USA.
- April 2025, *Renormalization and Higher-Order Interactions: Bridging Structure and Dynamics in Complex Systems*, invited talk at Dutch Institute of Emergent Phenomena, Amsterdam, NL.
- February 2025, *Balancing Learning, Generalization, and Processing Efficiency*, keynote talk at Bunka AI kickoff meeting, Paris, France.
- February 2025. keynote speaker at SYNAPSE Conclave, Delhi, India.
- January 2025. *Higher-order brain connectivity*, invited speaker at NetSciX 2025 conference, Indore, India.
- November 2024. *Balancing Learning, Generalization, and Processing Efficiency*, invited talk at “Statistical Physics of Cognition”, IOP, London, UK
- November 2024. *Renormalization and Higher-Order Interactions: Bridging Structure and Dynamics in Complex Systems*, invited talk at “Future of Network Science” workshop, IAS, Seoul, South Korea.
- August 2024 *Informational and topological signatures of individuality and age*, invited talk at Newton Institute’s workshop on “Higher-order systems”, Turing Institute, London, UK
- July 2024. *Alien Translations*, invited talk at Berggruen event at American Academy of Arts, Rome, Italy.
- July 2024, *Social learning across symbolic cultural barriers in sperm whales*, invited talk at “Decoding non-human communication” workshop, Simons Institute, Berkley, USA

February 2024 *Informational and topological signatures of individuality and age*, invited talk at IPAM “Mathematics of Connectivity” workshop, UCLA, Los Angeles, USA

August 2023. *Social contagion and inference in higher-order dynamics*, invited talk at ICIAM 2023 conference, ‘Hypernetworks and their dynamics in theory and applications’ satellite, Tokyo, Japan

July 2023. *Topological Neuroscience*, invited lecture at Lipari AI Neuro Summer School 2023, Lipari, Italy

July 2023. *Higher-order dynamics and structure*, invited mini-course at the Netsci2023 Network School, Vienna, Austria

June 2023. *Higher-order dynamics and structure*, invited mini-course at the BIOMAT2023, Barcelona, Spain

March 2023. *Between higher-order mechanisms and phenomena*, invited speaker, ACCELNET seminar series, online

Oct 2022. *Between higher-order mechanisms and phenomena*, Brain connectivity workshop, Institut de Neurosciences de la Timone, Marseille, France

June 2022. *Between higher-order mechanisms and phenomena*, Critical and Collective Effects in Graphs and Networks (CCEGN-5), Cape Cod, USA

May 2022. *Between higher-order mechanisms and phenomena*, BrainNet Workshop, KTH Stockholm, Sweden

Dec 2021. *Social contagion models on simplicial complexes and hypergraph*, Canadian Mathematical Society Winter Workshop

Nov 2021. *The physics of higher-order interactions in complex systems*, Imperial College London Physics Colloquium Series

Jun 2021. *Simplicial and Topological Descriptions of Human Brain Dynamics*, Computational Neuroscience Conference 2021, online

Jun 2021 *The impact of higher-order descriptions on dynamical processes and learning systems*, Colloquium seminar, Physics Department, University of Turin

Jun 2021 *The impact of higher-order descriptions on dynamical processes and learning systems*, Twitter GraphML group

May 2021. *Social contagion models on simplicial complexes and hypergraph*. SIAM Dynamical Systems 2021, online conference

Mar 2021. *Social contagion models on simplicial complexes and hypergraph*. Models of Society Workshop, online conference

March 2021. *Bridging cognitive control and network theory*. Virtual Seminars in Complexity Center for Complexity & Biosystems, University of Milan

Mar 2021. *Social contagion models on simplicial complexes and hypergraph*. APS March Meeting 2021, session on higher-order networks.

Jul 2020. *Social contagion models on simplicial complexes and hypergraph*. Virtual Sunbelt 2020, session on higher-order networks.

Dec 2019. *The Impact of Higher Order Descriptions on Structural Analysis and Dynamical Processes*. Higher-Order Connectivity and Correlations in Complex Systems, CSH Vienna Workshop, Wien.

Sep 2019. *Introduction and applications of TDA*. Workshop on Complex Networks and Topological Data Analysis, UKM, Kuala Lumpur.

Aug 2019. *Brain Functional Shapes*. Advanced methods for neuroscience datasets workshop, Lille.

Jul 2019. *Random and configuration models for many-body interactions?*. Parnet2019, Max Planck Institute for Complex Systems, Dresden.

May 2019. *Network Geometry and Topological Data Analysis*. Lake Como School 2019, Como.

Apr 2019. *TDA/Networks for deciphering sperm whale speech*. Radcliffe Institute Exploratory Workshop “Novel Ways to Non-invasively Visualize/ Characterize/Decipher the Sonic Communication of Marine Mammals”, Harvard.

Dec 2018. *What’s the role of higher order topology*. International Workshop on Theoretical Perspectives on Network Science, Seoul.

Sep 2018. *Topology and Curvature of brain functional networks*. UMI-SIMAI-UPM 2018 joint mathematical societies’ conference, Wroclaw.

Sep 2018. *Topology highlights mesoscopic functional equivalence between imagery and perception*. IOP 2018, Lucca.

Aug 2018. *Topological data analysis for biology and neuroscience*. QMUL Institute for Applied Data Sciences Institute Series.

May 2018. *Structure and evolution of brain homological scaffolds*. EPFL applied topology seminar series, Lausanne.

Dec 2017. *Structure and evolution of brain homological scaffolds*. SISSA, Trieste.

Jul 2017. *Topological data analysis for complex systems*. SigmaPhi 2017 Workshop on Statistical Physics for the Digital Economy, Corfu.

Jun 2017. *Structure and evolution of brain homological scaffolds*. HONS satellite, NetSci 2017, Indianapolis.

Mar 2017. *Structure and evolution of brain homological scaffolds*. CompleNet 2017, Dubrovnik.

Jan 2017. *Topological brain ageing and cognitive limits*. School of Mathematical Sciences, Queen Mary's University.

Jan 2017. *Functional topology of brain altered states*. Institute of Psychiatry, King's College University.

Nov 2016. *Functional topology of brain altered states*. Center for Cancer Topology, Columbia University.

Sep 2016. *A computational topology paradigm for complex systems and neuroimaging*. "Complex networks: from socio-economic systems to biology and brain" Lipari.

Jun 2015. *Summarising robust features of complex networks with topological methods*. Toponets15 Satellite at NetSci 2015, Zaragoza.

Feb 2015. *Homological scaffolds of functional brain networks*. CAT & TDA workshop, University of Oxford.

Jun 2014. *Topological Data Analysis*. Hypathie Seminar, University of Marseille.

May 2014. *Computational topology for complex systems*. CNETS, University of Indiana.

Mat 2014. *Computational topology for complex systems*. MOBS lab, Northeastern University.

Sep 2013. *Topology and mechanical manifolds in classical Hamiltonian systems*. European Conference on Complex Systems 2013, "Topological methods for complex systems" satellite.

Feb 2013. *Computational topology approach to mesoscopic structure in complex networks*. King's College London, Neuroimaging Meetings, Institute of Psychiatry.

Jul 2012. *Persistent homology for complex networks*. Algebraic, geometrical and topological methods for complex systems, Politecnico di Torino.

CONTRIBUTED PRESENTATIONS

Sep 2018, *Topology highlights mesoscopic functional equivalence between imagery and perception*, CCS 2018, Thessaloniki.

Jun 2018, *Simplicial Activity Driven Model*, NetSci 2018, Paris.

Feb 2018, *Topology and curvature of brain functional networks under psychedelic drugs*, BIFI International Conference 2018, Zaragoza.

Feb 2018, *Construction of and efficient sampling from the simplicial configuration model*, BIFI International Conference 2018, Zaragoza.

Sep 2017, *Global topological conservation versus local reorganization of the psychedelic brain*, CCS2017, Cancun.

Sep 2017, *Universal limits to parallel processing capacity of neural systems*, CCS2017, Cancun.

Sep 2017, *Topological brain ageing and cognitive limits*, CCS2017, Cancun.

Jun 2017, *Diminishing returns with size for parallel computation capacity of neural architectures*, NetSci 2017, Indianapolis.

Jul 2016, *Homological features of brain functional connectomes show dynamical compensation of age-related structural brain connectomes changes*, "Complex Networks 2016", satellite workshop of StatMech2016, Marseille.

Feb 2015, *Homological scaffolds of functional brain networks*, XXIst Oporto Meeting on Geometry, Topology and Physics, Lisbon.

Jan 2015, *Topological methods for temporal networks*, NetSci X 2015, Rio de Janeiro.

Sep 2014, *Homological methods for complex networks*, European Conference on Complex Systems 2014, Lucca.

Sep 2013, *Temporal stability for network partitions*, European Conference on Complex Systems 2013, "Temporal networks" satellite.

Sep 2011, *Critical London: features of urban flow*, European Conference on Complex Systems 2011, Vienna.

Jul 2011, *Critical London: features of urban flow*, NetSci 2011, Budapest.

Jun 2009, *Congestion and information in traffic networks: dynamical percolation?*. NetSci 2009, Venice.

Outreach & Professional Development

SERVICE AND ORGANISATION

2026	“NeuroRenorm” workshop @ COSYNE 2026 , Co-organizer	
2025	CoBrain workshop @ CCS 2025 , Co-organizer	<i>Siena</i>
2025	“BeyondTheEdge+RUNES workshop and school on higher-order systems”, @Aix-Marseilles University , Organizer	<i>Marseilles</i>
2025	“Topology of natural and synthetic minds” workshop, @King’s College London , Organizer	<i>London</i>
2025	Erice School on higher-order systems, E. Majorana Institute , Organizer	<i>Erice</i>
2025	“Higher-order connectomics” session, Organization of Human Brain Mapping conference 2025 , Organizer	<i>Brisbane</i>
2025	TopoNets2025 satellite meeting @Netsci 2025 , Organizer	<i>Maastricht</i>
2024	TopoNets2024 satellite meeting @NetSci 2024 , Organizer	
2023	TopoNets2023 satellite meeting @Netsci 2023 , Organizer	<i>Vienna</i>
2022	TopoNets2022 satellite meeting @CCS 2022 , Organizer	<i>Lyon</i>
2022	”Higher-Order Interactions: The Next Frontier of Complex Systems” session @APS March Meeting 2022 , Organizer	
2021	”Topological and Geometrical Structures in Neurosciences” session @Geometric Science of Information 2021 , Organizer	<i>Paris</i>
2021	”Topological insights on brain function” workshop @Computational Neuroscience 2021 , Organizer	
2019-2022	Executive Committee of the Complex Systems Society , Member	–
2020	TopoNets2020 satellite meeting @Netsci2020 , Organizer	
2019	Complex Simplex: Topological and Network Data Science Workshop , Organizer	<i>Turin</i>
2019	TDA crash course: theory and practice for ML applications, @Applied Machine Learning Days 2019 , Organizer + Lecturer	<i>Lausanne</i>
2018	ATMCS7 Conference on Algebraic Topology: Methods, Computation and Science , Organizer	<i>Turin</i>
2018	Topological Neuroscience Workshop, @Princeton Neuroscience Institute , Chair	<i>Princeton</i>
2016	CCS Warm Up School, @CCS 2016 , Organizer	<i>Amsterdam</i>
2015–2018	CCS Steering Committee of the Complex Systems Society , Member	
2015–	Council of the Complex Systems Society , Member	
2014	NetSci Backstage satellite workshop @NetSci 2014 , Co-organizer	
2014–2019	Doctoral Committee for PhD Mathematics, Polytechnic University of Turin ,	

OUTREACH

2026	Biennale Tecnologia , Speaker	<i>Turin</i>
2025	SYNAPSE Conclave , Speaker	<i>Delhi</i>
2024	SONAR Podcast , Expert interviewee	<i>Il Post</i>
		<i>American</i>
2024	Alien Translations , Speaker	<i>Academy of</i>
		<i>Rome</i>
2023	Intesa AI and Neuroscience seminars , Speaker	<i>online</i>
2021	DataViz Lisboa , Speaker	<i>Lisbon</i>
2019	Brain Awareness Week Torino , Speaker	<i>Turin</i>
2017	BergamoScienza , Speaker	<i>Bergamo</i>
2016	Pint for Science , Speaker	<i>Turin</i>
2014-	Torino DataBeers , Founder	<i>Turin</i>

PEER REVIEW

Biological Psychiatry, Chaos, Chaos Solitons & Fractals, Communications Physics, EPJ Data Science, Europhysics Letters, Journal of Computational Neuroscience, Journal of Royal Society Interface, Journal of Statistical Physics, Molecular Psychiatry, Nature Physics, Nature Communications, Network Science, Neuron, PNAS, Physical Review E, Physical Review Letter, Physical Review X, PLoS Computational Biology, Proceedings of the Royal Society A, Science Advances, Scientific Reports, SIAM Journal on Applied Mathematics, SIAM Review, The Neuroscientist.

PROFESSIONAL MEMBERSHIPS

Organization for Human Brain Mapping, Complex Systems Society, Society for Neuroscience, Network Science Society

EXTRA-PROFESSIONAL

Capoeira Angola (instructor). Semi-professional acting training (method acting) at Central Saint Martins College of Art and Design and Caravanserai Productions, London, and previously in Pisa through programs promoted by Teatro Verdi, Pisa. Literature, gaming, roleplaying, photography, basketball and (out of patriotic reasons) football.