Lorenzo Giambagli

Curriculum Vitae

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DoB 15/02/1996

Academic Jobs

2023-2024 **PostDoc** at the **Department of Physics and Astronomy, *Università degli Studi di Firenze***
Supervisor: **Prof. Duccio Fanelli**
Research Topic: **Graph Spectral Theory applied to Deep Artificial Neural Networks**

Education

2020 - 2024 **PhD in "cotutelle"** at the **Department of Physics and Astronomy** , *Università degli Studi di Firenze*
Supervisor: **Prof. Duccio Fanelli**
Research Topic: **Artificial and Biological Neural Networks Dynamics**
Final mark: **Excellent with Honors** awarded the 17/02/2024

2020 - 2024 **PhD in "cotutelle"** at the **Department of Mathematics**, *Université de Namur, Belgium*
Supervisor: **Prof. Timoteo Carletti**
Research Topic: **Artificial and Biological Neural Networks Dynamics**

2018–2020 **Master's Degree (LM-17)** in **Theoretical Physics**, *Università degli Studi di Firenze*, Italy
Supervisors: **Prof. Duccio Fanelli**
Research Topic: **Deep Learning and Network Science**
Thesis title: *Spectral Learning for Neural Networks*
Final mark: **110/110 with Honors** awarded the 18/10/2020

2015–2018 **Bachelor's Degree (L-30)** in **Physics and Astrophysics**, *Università degli Studi di Firenze*, Italy
Supervisors: **Prof. Duccio Fanelli**
Research Topic: **Biological Neural Networks Dynamics**
Thesis title: *Diffusive model for hallucination pattern in primary visual cortex*
Final mark: **110/110 with Honors** awarded the 15/09/2018

2010–2015 **High School Diploma**, *Liceo Scientifico*, Istituto di istruzione superiore "F. Redi", Arezzo, AR, Italy
Final mark: **100/100 with Honors** achieved on 08/07/2015

Teaching Experiences

2024 **Mini Course** *12h* at the **Several High Schools**, Italy
Course: **Modeling and Data Analysis Basics** (Under the Italian national project 'Percorso Competenze Trasversali e Orientamento' - PCTO)

April 2023 **Mini Course** *4h*, *Universidade Federal do Rio de Janeiro*, Brasil
Course: **Spectral Analysis of Deep Neural Networks**, `https://sites.google.com/matematica.ufrj.br/internationalschool-dynamicals/home`

2021 **Mini Course** *4h* at the **Varchi Institute**, *High School, Montevarchi*, Italy
Course: **Modeling and Data Analysis Basics** (Under the Italian national project 'Percorso Competenze Trasversali e Orientamento' - PCTO)

2021 **Teaching Tutor** *150h* at the **Department of Physics**, *Università degli Studi di Firenze*, Italy
Course: **Physics I** (Classical Mechanics)

Publications

2024 L. Chicchi, L. Giambagli, L. Buffoni, R. Marino, D. Fanelli, Complex Recurrent Spectral Network, (Under Review) Chaos Solitons & Fractals, `https://doi.org/10.48550/arXiv.2312.07296`

2023 R. Marino, L. Buffoni, L. Chicchi, L. Giambagli, D. Fanelli Engineered Ordinary Differential Equations as Classification Algorithm (EODECA): thorough characterization and testing, *(Under Review) Chaos Solitons & Fractals*, `https://doi.org/10.48550/arXiv.2312.14681`

2023 R. Marino, L. Giambagli, L. Chicchi, L. Buffoni, D. Fanelli, A Bridge between Dynamical Systems and Machine Learning: Engineered Ordinary Differential Equations as Classification Algorithm (EODECA), *Physical Review Letters (under review)*, `https://doi.org/10.48550/arXiv.2311.10387`

2023 L. Giambagli, L. Buffoni, L. Chicchi, D. Fanelli, How a student becomes a teacher: learning and forgetting through Spectral methods, *Journal of Statistical Mechanics: Theory and Experiment, Special Issue*

2023 L. Giambagli, L. Buffoni, L. Chicchi, D. Fanelli, How a student becomes a teacher: learning and forgetting through Spectral methods, *Advances in Neural Information Processing Systems, 2023*. `https://openreview.net/forum?id=1FVmMlifl7`

2023 L. Giambagli, D. Fanelli, G. Risaliti, M. Signorini, Non-parametric analysis of the Hubble Diagram with Neural Networks, *Astronomy & Astrophysics, 678, A13*, `https://doi.org/10.1051/0004-6361/202346236`

2023 T. Carletti, L. Giambagli, G. Bianconi, Global topological synchronization on simplicial and cell complexes, *Physical Review Letters, 130, 187401*, `https://doi.org/10.1103/PhysRevLett.130.187401`

2022 L. Buffoni, E Civitelli, L. Giambagli, L. Chicchi, D. Fanelli, Spectral pruning of fully connected layers: ranking the nodes based on the eigenvalues, *Scientific Reports 12 (1), 1-9*, `https://doi.org/10.1038/s41598-022-14805-7`

2022 L. Giambagli, L. Calmon, R. Muolo, T. Carletti, G. Bianconi, Diffusion-driven instability of topological signals coupled by the Dirac operator, *Physical Review E 106, 064314*, `https://doi.org/10.1103/PhysRevE.106.064314`

2022 L. Chicchi, D. Fanelli, L. Giambagli, L. Buffoni, T. Carletti, Recurrent Spectral Network (RSN): shaping the basin of attraction of a discrete map to reach automated classification, *Chaos, Solitons and Fractals 168, 113128*, `https://doi.org/10.1016/j.chaos.2023.113128`

2021 L. Chicchi, L. Giambagli, L. Buffoni, T. Carletti, M. Ciavarella, D. Fanelli, Training of sparse and dense deep neural networks: Fewer parameters, same performance, *Physical Review E 104 (5)*, `https://doi.org/10.1103/PhysRevE.104.054312`

2021 L. Giambagli, L. Buffoni, T. Carletti, W. Nocentini, D. Fanelli, Machine learning in spectral domain, *Nature Communications 12 (1), 1-9*, `https://doi.org/10.1038/s41467-021-21481-0`

2021 L. Chicchi, L. Giambagli, L. Buffoni, D. Fanelli, Mobility-based prediction of SARS-CoV-2 spreading, *arXiv:2102.08253*, `https://doi.org/10.48550/arXiv.2102.08253`

Invited Talks and Seminars

29 Feb 2024 **Invited Seminar**, *Freie Universität*, Berlin (Germany)
Spectral Graph Decomposition of Deep Neural Networks

22 Feb 2023 **Invited Talk**, *Florence Theory Group Day at Galileo Galilei Institute for Theoretical Physics*, Florence (Italy)
Learning with the spectrum in Neural Networks

16 Sep 2022 **Invited Talk**, *Machine Learning at Galileo Galilei Institute for Theoretical Physics, Workshop*, Florence (Italy)
Spectral Feed-Forward Neural Networks

25 Aug 2022 **Invited Talk**, *Machine Learning at Galileo Galilei Institute for Theoretical Physics, Workshop*, Florence (Italy)
Hubble Diagram Regression with Neural Networks

13-14 Jul 2022 **Invited Seminar**, *Gatsby Computational Neuroscience Unit - UCL*, London (England)
Spectral Feedforward Neural Network

24-25 May 2022 **Invited Seminar**, *Università degli Studi dell'Insubria*, Como (Italy)
Spectral Learning in Feed-Forward and Recurrent Neural Networks

12 May 2022 **Invited Seminar**, *ICHEC*, Bruxelles (Belgium)
Spectral Learning for Deep Neural Networks

Conference contributions

10 Dec - 16 Dec 2023 **Poster**, *Conference on Neural Information Processing Systems*, New Orleans (Louisiana, US)
How a Student becomes a Teacher: learning and forgetting through spectral methods

21 Jun - 24 Jun 2023 **Talk**, *National Conference on Statistical Physics*, University of Parma, Parma (Italy)
How a Student becomes a Teacher: learning and forgetting through spectral methods

29 May - 2 Jun 2023 **Poster**, *Youth In High Dimensions*, ICTP Institute of Theoretical Physics, Trieste (Italy)
How a Student becomes a Teacher: learning and forgetting through spectral methods

12-14 Apr 2023 **Talk**, *Conference Summer Solstice 2023*, Galileo Galilei Institute of Theoretical Physics, Florence (Italy)
Diffusion-driven instability of topological signals coupled by the Dirac operator

23-27 Jan 2023 **Talk**, *Workshop on the Mathematics of Machine Learning*, Scuola Normale Superiore Pisa (Italy)
Spectral analysis of Feed-Forward Neural Networks

17-21 Sep 2022 **Talk**, *Conference on Complex Systems*, Palma de Mallorca (Spain)
Spectral Pruning of Feed-Forward Neural Networks

17-21 Sep 2022 **Talk**, *Conference on Complex Systems*, Palma de Mallorca (Spain)
Diffusion Driven Instability of Topological Signals

5 Sep 2022 **Talk**, *Machine Learning at Galileo Galilei Institute for Theoretical Physics, Conference*, Florence (Italy)
Spectral Pruning of Feed-Forward Neural Networks

20-22 May 2022 **Poster**, *Conference of the Italian Society of Statistical Physics*, Parma (Italy)
Spectral Learning in Feed-Forward Neural Networks

17 Jun 2022 **Poster**, *School of Statistical Physics and Deep Learning*, Como (Italy)
Spectral Tools in Feed-Forward Neural Networks

30 Nov 2021 **Talk**, *Complex Network*, Madrid (Spain)
Spectral Pruning of Fully Connected Layers: Ranking the Nodes Based on the Eigenvalues

18 Nov 2021 **Talk**, *Belgian Network Research Meeting (BENet)*, Namur (Belgium)
Spectral Pruning of Fully Connected Layers: Ranking the Nodes Based on the Eigenvalues

Schools, Courses, Workshops

15-16 Dec 2023 **Workshop UniReps and NeurReps**, *Neural Information Processing Systems, New Orleans (Louisiana, USA)*, Topics: Symmetry and Geometry in Neural Representations

5-17 Jun 2023 **Statistical Physics of Complex Systems**, *The Beg Rohu Summer School*, Topics: Statistical Physics (SP) of Inference and Computation, SP Applied to Climate Dynamics, SuSy approach to random matrices, Extreme Statistics of Strongly Correlated Variables

16-27 Jan 2023 **School and Workshop The Mathematics of Machine Learning**, *Scuola Normale Superiore, Pisa (Italy)*, Topics: Gradient flows, Optimal Transport and Metric Measure Structures, Optimization

2022 **Percorso Formativo 24 CFU**, *University of Florence*, Topics: Anthropology, Psychology, Pedagogy, Teaching Methodologies

22 Aug - 30 Sep 2022 **Workshop Machine Learning at Galileo Galilei Institute of Theoretical Physics**, *GGI Arcetri Institute, Florence (Italy)*, Topics: Monte Carlo integration and simulation, anomaly detection, time series analysis, clustering and multi-dimensional visualization, Equation solving, Statistical physics algorithms for optimization and learning problems, Quantum machine learning

13-17 Jun 2022 **Statistical Physics of Deep Learning**, *Lake Como School for Advanced Studies, Como (Italy)*, Topics: Introduction to deep neural network rooted in a statistical physics perspective. Restricted Boltzmann Machines, Deep Linear Networks, Analysis of training and inference of Deep Neural Networks

2021 **Coursera**, *TensorFlow: Advanced Techniques Specialization*

2021 **Out of Curriculum Courses**, *Behavioural Biology (Online Stanford), Anatomy of Nervous System (University of Florence)*

Fellowships, Awards, Funding & Honors

22 Jul 2018 **Conference Prize: Best Poster**, *Conference of the Italian Society of Statistical Physics*, Parma (Italy)

Jul 2018 **Graduation Prize 2018**, *Bachelor's Degree, Università degli Studi di Firenze*, Florence (Italy)

Supervisor experiences

2023 **Master Degree Thesis - Physics**, *Università degli Studi di Firenze*
Gianluca Peri - *Spectral Residual Networks (ongoing)*

2023 **Master Degree Thesis - Physics**, *Università degli Studi di Firenze*
Matteo Pinzauti - *Spectral Pruning Benchmark (ongoing)*

2021 **Bachelor's Degree Thesis - Physics**, *Università degli Studi di Firenze*
Benedetta Noferi - *Regression with Spectral Learning*

2021 **Bachelor's Degree Thesis - Physics**, *Università degli Studi di Firenze*
Giovanni Abati - *Neural Network and Spectral Learning*

2021 **Bachelor's Degree Thesis - Physics**, *Università degli Studi di Firenze*
Matteo Pinzauti - *Generative fractals and inverse problem*

Event Organization

18-20 Jul 2022 **Organizing committee**, *IEEE Complexity in Engineering - COMPENG 2022*, Florence (Italy)

18 Nov 2021 **Organizing committee**, *Belgian Network Research Meeting (BENet)*, Namur (Belgium)

Languages

Italian: Native

English: Upper Intermediate, level C1

French: Intermediate

Spanish: Intermediate

Programming Skills

Operating system: Windows, Linux

Software and programming language known: Python, Tensorflow, PyTorch, C (basic), MATLAB, LaTeX, Blender and Cinema4D (amateur)

General Skills: Supervised and Reinforced Learning, Data Mining

Miscellaneous

2017–2018 **Student Representative**, *SIAF (Informatic System University of Florence)*

2016–2018 **Student Representative**, *Scuola di Scienze (STEM departments council)*

2020–present **Member of**, *Italian Society of Statistical Physics*

Academic References

Prof. Duccio Fanelli, University of Florence duccio.fanelli@unifi.it

Prof. Timoteo Carletti, University of Namur timoteo.carletti@unamur.be

Prof. Ginestra Bianconi, Queen Mary Univesity of London

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