Pierfrancesco Dionigi

PROFILE

BIRTHYEAR: 1994
NATIONALITY: Italian
GENDER: Male

CONTACTS

ADDRESSES

Temporary residence
Barcelona, Spain

EMAIL

me@pierfrancescodionigi.com
probablypier@outlook.com

WEBSITES

Personal Website
NETWORKS project profile
ResearchGate
LinkedIn

SKILLS

PROGRAMMING

Advanced:
Python • C++ • Mathematica
Good:
R • Shell (Bash) • Unix-like OS• LaTeX• Office
Intermediate:
ROOT
Familiar:
MATLAB • LabVIEW

LANGUAGE

- Italian (mother tongue)
- English (oral C1, written C1)
- Spanish (oral B2, written B2)
- Dutch (A2)
- French (A2)
- Hungarian (A1)

CURRENT POSITION

POSTDOCTORAL RESEARCHER | Mathematics

May 2026 — July 2026 | Barcelona School of Economics, Barcelona, Spain

With: Prof. Chiara Amorino. I am spending the summer visiting Chiara Amorino in Barcelona, working on extensions of non-exchangeable interacting particle systems using decorated graph limits (probability graphons).

SCIENTIFIC ADVISOR IN QUANTITATIVE MODELLING & MODEL GOVERNANCE | Advisory Board

Jan 2026 — ongoing | Proficiency s.r.l., Consulente360

About: Serving as a not-for-profit Scientific Advisor, with a focus on Fund Selection and Asset Allocation from an independent academic perspective on quantitative modelling, stochastic systems, complex networks, machine learning, AI, and model governance in financial-services contexts. Focused on methodological input around model assumptions, robustness, validation, interpretability, risk modelling, and the responsible use of quantitative, data-driven, and AI-based tools in applied financial research.

PAST POSITION

POSTDOCTORAL RESEARCHER | Mathematics

Jan 2024 — Dec 2025 | Alfréd Rényi Institute of Mathematics, Budapest, Hungary

Grant: ERC DYNASNET, Project Leader Prof. László Lovász (Alfréd Rényi Institute of Mathematics).

QUANTITATIVE RESEARCHER | Finance

Jan 2024 — Dec 2025 | Proficiency s.r.l., Italy

PHD | Mathematics

Oct 2019 — Dec 2023 | Leiden University, Leiden, the Netherlands
PhD defense: 19 June 2024 · Thesis: ``Spectral signatures of breaking of ensemble equivalence"

Supervisors: Prof. Dr. Frank den Hollander (Leiden University), Prof. Diego Garlaschelli (Leiden University, IMT Lucca) and Prof. Dr. Michel Mandjes (UvA).

QUANTITATIVE RESEARCH ACTIVITY

Since autumn 2023, I have collaborated with Alessandro Greppi, PhD, and Francesco Mercatelli on machine-learning models for portfolio allocation. We developed an LSTM-based model that forecasts the optimal Sharpe ratio over forward monthly windows with adjustable horizons for portfolios combining risk-off assets and sector equity ETFs. The model outperformed standard fixed-weight benchmarks such as 60/40 portfolios. Our approach combines sentiment analysis with a market-regime indicator based on the principal eigenvalue of the S&P 500 correlation matrix; asset interdependencies are quantified using O-information and transfer entropy.

Together with A. Greppi, I co-supervised Konstantinos Haitas (Università Bocconi) on a BSc thesis exploring graph neural networks (GNNs) for cryptocurrency market structures. The work resulted in the dissertation "ML and Crypto Price Predictions: A Novel Hybrid LSTM and Graph Convolutional Network" (2024, available upon request).
In 2024, I taught "Clustering Methods for Finance" within SIAT's Data Science for Asset Management course. Since that year, I have served as Lead Quantitative Researcher at Proficiency S.r.l. (CEO: Francesco Mercatelli), where we launched a mentorship programme for STEM students from Italian universities, offering company internships. Within this programme, I supervised Luca Manca (Università Cattolica, Milan) on extending OSBAP corporate-bond pricing models to European issuers by incorporating currency risk and sovereign-spread effects; this work formed the basis of his bachelor's thesis. I am currently

co-supervising additional projects with Saverio Lidonnici and Tobias Fontana Ceccato (both at the University of Bologna).

ACADEMIC RESEARCH ACTIVITY

At BSE, I work on non-exchangeable interacting particle systems whose interactions are generated through probability graphons. During my PhD, I specialised in random graph models, random matrix theory and large deviations, studying how spectral properties of *random graph ensembles* (canonical and microcanonical, in the terminology of statistical physics) relate to their large-deviation behaviour. During my postdoctoral position at the Alfréd Rényi Institute of Mathematics in Budapest, I continued my work in probability and discrete mathematics, focusing on graph-limit theory for weighted graphs and its large deviations, stochastic processes on graphs and their mean-field descriptions, large deviations for epidemic-spread models, preferential-attachment models and Glauber dynamics for spin systems. My research interests are:

- Graph limits (Graphon theory, Action Convergence, Local-Global convergence and Local Weak Limit *à la* Benjamini-Schramm);
- Large deviations, particularly for graph limits, graph ensembles and metastable states for epidemic spread;
- Stochastic processes on random graphs, their mean fields and their relations to graph limits;
- Statistical physics in general, Ising spin systems, spin glasses and related models;
- Preferential-attachment models with non-Markovian attachment mechanisms;
- Mixing times for Glauber dynamics on spin systems;
- Random matrix theory and its application to graph theory;
- Gibbs ensembles for random graph models (exponential random graph models).

My education in theoretical physics also informs my interest in applications of probability to physics and interdisciplinary fields such as economics and the social sciences, including the mathematical foundations and applications of data science and machine learning. See my research statement for more detail.

PUBLICATIONS

Published & Preprints:

- *A spectral signature of breaking of ensemble equivalence for constrained random graphs*, Electronic Communications in Probability 26 (2021): 1-15, DOI: 10.1214/21-ECP432. Joint work with D. Garlaschelli, F. den Hollander, M. Mandjes.
- *Central limit theorem for the principal eigenvalue and eigenvector of Chung-Lu random graphs*, Journal of Physics: Complexity (2022): 1-23, DOI 10.1088/2632-072X/acb8f7. Joint work with D. Garlaschelli, F. den Hollander, R. Hazra, M. Mandjes.
- *Largest eigenvalue of configuration model and breaking of ensemble equivalence*, arXiv:2312.07812. Joint work with D. Garlaschelli, F. den Hollander and R. Hazra.
- *The effects of initial conditions on the accuracy of mean-field approximations of Markov processes on large random graphs*, arXiv:2506.12872. Joint work with D. Keliger. (*Submitted*)
- *Large deviations for probability graphons* arXiv:2509.14204. Joint work with G. Zucal. (*Submitted*)
- *Quantum preferential attachment*, arXiv:2512.22542. Joint work with T. Zhao, B. Maga, G. Ódor, K. Soni, A. Salova, B. Hao, M. Abért, and I. Kovács. (*Submitted*)

In progress:

- *Exponential random weighted graphs with probability graphons*, together with G. Zucal.
- *Large Deviations for Village Model*, together with L. Andreis, J. Komyáthy, B. Rath.
- *Large deviation for subgraph counts in directed sparse random graphs*. Together with A. Arras.
- *Network methods applied to ceramic technology in archeology*, joint work with E. Kroon, A. Ferraro, D. Garlaschelli, T. Gili.

For other ongoing collaborations and research themes, see my research statement.

SELECTED TALKS AND POSTER SESSIONS

- 28 October 2025: Talk at the final NETWORKS conference, Soesterberg, the Netherlands
- 6 October 2025: Talk at the KUTSZEM seminar, Budapest, Hungary
- 24 June 2025: Talk at YEP XX "Interacting Particle Systems on Random Structures", Eindhoven, the Netherlands
- 19 November 2024: Talk at "Leiden Probability Seminar Day", Leiden, the Netherlands
- 1–7 July 2024: Talk at "Complex Systems from Economics to Biology and Brain", Lipari, Italy
- 13–16 September 2023: Talk at the "RandNET Workshop on Graph Limits and Networks", Prague, Czech Republic
- 30–31 August 2023: Contributed talk at the "Dutch NetSci Summer Symposium 2023", Delft, the Netherlands
- 5–9 June 2023: Poster presentation at "Random Matrices and Applications", RIMS, Kyoto University, Japan
- 27–31 March 2023: Invited speaker at the 18th YEP workshop, "Spectra of Random Graphs and Related Combinatorial Problems", EURANDOM, Eindhoven University of Technology, the Netherlands
- 6–8 February 2023: Talk at the 2023 Drafting Workshop, Rényi Institute, Budapest, Hungary
- 14 December 2022: NETWORKS Research Seminar at IMT Lucca, Italy
- 12 May 2022: NETWORKS training week, Asperen, NL
- 15–17 November 2021 (poster session): 49th Annual Meeting of the Dutch Probability and Statistics Community, Lunteren, the Netherlands
- 25 June 2021: LCN2 seminar
- 29 October 2020: NETWORKS training week
- 23 September 2020: iPod seminar, Leiden University Probability Group

- 2–13 April 2019 (poster session): "Nonlocal and Fractional Operators", Sapienza University of Rome, Italy

VISITING & GUEST SCHOLAR

- 29–31 October 2025: Guest at Leiden University, with Rajat Hazra and Frank den Hollander
- 26–30 May 2025: Focused Workshop on Random Graphs and Large Deviations, Budapest, Hungary
- 18–22 November 2024: Guest at Leiden University, with Rajat Hazra and Frank den Hollander
- 17–28 July 2023: Guest researcher at the Erdős Center, "Workshop on Networks and Their Limits"
- 12–22 December 2022: Visit to Diego Garlaschelli at IMT Lucca, Italy
- 29 May–25 June 2022: PIMS–CRM Summer School, UBC, Vancouver, Canada
- Oct 2021–Mar 2022: Guest scholar at IMT Lucca, Italy, hosted by Diego Garlaschelli
- 20–22 December 2019: Visit to Frank den Hollander in Erlangen, Germany
- 25–28 November 2019: Visit to Diego Garlaschelli at IMT Lucca, Italy

ORGANIZATION

- 2019 - 2024: Organizer and host of LCN2 seminars.

TEACHING ACTIVITY

- Contract lecturer for "Clustering Methods" within SIAT's "Data Science for Asset Management" course, Oct–Nov 2024.
- Teacher for "Mathematical Reasoning", Leiden University College (LUC), section E, second semester, block 4, 2023.
- Teaching assistant for Analysis 2, second semester, academic year 2021/2022.
- Teaching assistant for the Mastermath course "Random Walks" (taught by E. Verbitskiy and D. Valesin), first semester, academic year 2021/2022.
- Teacher for "Mathematical Reasoning", LUC, section E, second semester, block 4, 2020.
- Teaching assistant for the Mastermath course "Random Walks" (taught by E. Verbitskiy and D. Valesin), first semester, academic year 2019/2020.

SUPERVISED STUDENTS

Master students:

- Vincent Diringer, Rayan Suryadikara, Tamara Florijn and Xin Chen (Science Communication and Society, Leiden University): science-communication project on the small-world effect and its implications for the COVID-19 pandemic; co-supervised with Amber Bruynzeel, 2020;
- Saverio Lidonnici (University of Bologna): curricular internship with Proficiency s.r.l. on data-driven models for portfolio allocation, 2025;

Bachelor students:

- Luca Manca (Università Cattolica, Milan): thesis on "European Corporate Bond Pricing", 2025;
- Konstantinos Haitas (Università Bocconi): thesis "ML and Crypto Price Predictions: A Novel Hybrid LSTM and Graph Convolutional Network", 2024;
- Johan van der Marck (Mathematical Institute, Leiden University): simulation and coding for a thesis in probability theory under F. den Hollander, 2020.

High school students:

- Arpeeta Rao and Christopher Kusumo Adi: PRE-University project on the voter model, 2022.
- Kelsey Bozic and Kristian Nieuwenhuize: PRE-University project on random walks on polygons, hierarchical graphs and electrical networks; co-supervised with Rangel Baldasso, PhD, 2021.

OTHER INFORMATION

OTHER ROLES

- Volunteered for http://mathematics-in-europe.eu
- Contributed to the creation of Young KWG, youth branch of the Dutch Royal Mathematical Society. I was part of the board.
- Peer reviewer for academic journals.

HR COURSES & SOFT SKILLS

- TM204: Time management, taking control of and optimising your time and life (15 hrs).
- Analytical storytelling, taught by Marieke Drost through NETWORKS.
- HR course: Communication in Science. Teacher: Dominique Donato.
- HR course: Speed Reading. Teacher: Menno Pronker.
- HR course: Job orientation. Teacher: Marion Miezenbeek.

EDUCATION

MASTER DEGREE | Theoretical Physics

Sept 2016 — July 2019 | University of Bologna, Bologna, Italy

Final Mark: 110/110 Magna Cum Laude.

EXAMS: Statistical Mechanics 1, Statistical Mechanics 2, Theoretical Physics 1, Theoretical Physics 2, General Relativity, Advanced Mathematical Methods of Physics, Quantum Many Body Theory, Quantum Theory of Matter, Group Theory, Quantum Field Theory 1, Quantum Field Theory 2, Cosmology.

MASTER THESIS: "A Random Matrix Approach to Complex Networks"
Advisor: prof. Armando Bazzani
Summary: Using Random Matrix Theory (RMT), the thesis develops a formal mathematical approach to random walks on complex networks. It studies the empirical spectral distributions of adjacency matrices for Erdős–Rényi ($G(n,p)$) and d-regular ($G_{n,d}$) random graphs across connectivity regimes and in the thermodynamic limit ($n \to \infty$). In free probability, convergence to the Wigner semicircle distribution can be viewed as a non-commutative central limit theorem. The dependencies inherent in generating d-regular graphs break the classical central limit theorem and yield the McKay distribution at low d. The thesis then relates the spectra of weighted adjacency matrices to the dynamics of the corresponding random walks.

ACQUIRED SKILLS: I learned to use advanced tools for physical and mathematical modelling, particularly for physical systems. My thesis research strengthened my knowledge of probability theory applied to random networks and complex systems, as well as my Python and R programming for model simulation. I developed solid experience with NetworkX, graph-tool, SciPy, NumPy, Matplotlib and pandas.

BACHELOR DEGREE | Physics
Sept 2013 – Dec 2016 | University of Bologna, Bologna, Italy

FINAL MARK: 110/110 Magna Cum Laude.

SUBJECTS: Classical Physics, Quantum Mechanics, Relativity, Thermodynamics, Basic Matter Structure notions and related Statistical Physics, Physics of the Earth system, Chemistry, Programming (C++, LabVIEW, ROOT).

BACHELOR THESIS: "Symmetries and Relativity Principles" (In Italian)
Advisor: prof. Alexandre Kamenchtchik
Summary: The thesis studies the relationship between Galilean and Einsteinian relativity principles and their associated symmetries. It uses group theory and representation theory to incorporate these principles into physical laws, with particular attention to Poincaré-group representations in relativistic quantum theory.

SECONDARY SCHOOL DIPLOMA | Classical Studies
Sept 2008 – June 2013 | Liceo Classico Giulio Cesare, Rimini, Italy
SUBJECTS:
- Italian literature, and main developments in world literatures
- Classical Greek and Roman societies and literatures
- Ancient Greek and Latin
- History and Philosophy
- Art
- Chemistry and Biology

FINAL MARK: 100/100 Magna Cum Laude

PERSONAL SKILLS

COMMUNICATION SKILLS
- **Teamwork:** I have worked in research and laboratory teams and was a member of a competitive swimming team during secondary school.
- **Mediation:** I served as a class representative and on the student representative committee in secondary school.

ORGANIZATIONAL & MANAGERIAL SKILLS
- During my studies, many examinations required an original paper and presentation on a specialised topic, delivered in a seminar or private defence.
- Throughout my academic career, I have developed strong organisational skills in bibliographic research and project scheduling. When approaching a mathematical or physical problem, I can efficiently establish its foundations through the literature and develop original work.

CERTIFICATES & PRIZES

CERTIFICATES
- IELTS Academic certification, overall score 7, obtained in February 2018
- Driving licence B

PRIZES & ACKNOWLEDGMENTS

- Second place in the years III–IV category of the "Federica Del Magno" writing contest, Karis Foundation, 2012.
- Selected for a summer school for high-achieving students organised by Sant'Anna School of Advanced Studies, Volterra, 2012.
- MIUR prize for a secondary-school diploma awarded with 100/100 cum laude.
- Funded to attend the 2020 PIMS–CRM Summer School in Probability, UBC, Vancouver; postponed to 2022 because of the COVID-19 pandemic.

TRIVIA

HOBBIES & SPORTS

I swam competitively for 15 years at national and international level, ranking among the top 20 Italian swimmers in my age group in the 100 m backstroke. After so much time in the pool, I am now jokingly "water-repellent". I continue to enjoy the gym and other sports.

I enjoy reading historical essays and classic novels, especially Russian literature.

Before my console broke and I suddenly became an adult, I also played video games; Halo and Zelda are my favourite series.

I love music; you can follow me on *Spotify*. I prefer rock and jazz, with occasional classical music, and also enjoy electronic and experimental artists such as Moderat and Aphex Twin.

I am a film enthusiast, particularly interested in Italian political cinema about controversial twentieth-century themes, such as the work of Elio Petri, and in films that illuminate the complexity of human behaviour. My favourite living Italian director is Paolo Sorrentino; my overall favourites are the Coen brothers.

In keeping with the Italian stereotype, I enjoy good food and drink. I am interested in contemporary cocktail culture and enjoy mixing drinks. I wrote a column on Bologna's cocktail bars for an online magazine focused on local tourism and events; my Italian-language reviews are available here. My favourite is the *Martini cocktail*.