

Pierfrancesco Beneventano

Postdoc Researcher at MIT

Theoretical research on what neural networks learn, how optimizers shape them, and why training is unstable.

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Linkedin 
Google Scholar 
Website 

Academic Jobs

MIT
Fall '25 - on > [25th Anniversary McGovern Fellow \(POSTDOC\)](#).
Mentored by [Prof. Tomaso Poggio](#).

Education

Princeton University
2020 - 2025 > PHD IN [OPERATIONS RESEARCH AND FINANCIAL ENGINEERING](#).
Advised by [Prof. Boris Hanin](#) and [Prof. Jason D. Lee](#).
2020 - 2022 > MA IN [OPERATIONS RESEARCH AND FINANCIAL ENGINEERING](#).
Advised by [Prof. Boris Hanin](#) and [Prof. Jason D. Lee](#).
ETH Zurich
2018 - 2020 > MSC IN MATHEMATICS.
Advised by [Prof. Arnulf Jentzen](#) and [Prof. Patrick Cheridito](#).
Università di Pisa
2015 - 2018 > BSC IN MATHEMATICS, COMPUTATIONAL CURRICULUM.
Advised by [Prof. Dario A. Bini](#).

Other Research Experiences

AWS AI Labs
Fall '22 > APPLIED SCIENTIST INTERN (MACHINE LEARNING RESEARCH).
Developing explainability techniques for machine learning for time-series modeling and anomaly detection. Working with [Dr. Anoop Deoras](#), [Dr. Laurent Callot](#), [Dr. Baris Kurt](#), and [Dr. Youngsuk Park](#).
Inria
Summer '22 > VISITING PHD RESEARCHER / RESEARCH INTERN.
Working with [Dr. Blake Woodworth](#) in the group of [Prof. Francis Bach](#) on the stability of the training of neural networks.

Other Research Experiences (continued)

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Summer '20

➤ MACHINE LEARNING RESEARCH INTERN.

I worked on Explainability of AI and Theoretical Guarantees for Neural Networks. I mainly worked in the context of [Concepts of Design Assurance for Neural Networks in partnership with EASA](#), European Union Aviation Safety Agency, which will become the first guidelines for AI certification in safety-critical systems.

Publications and Preprints

- Jan. 2025 ➤ [Gradient Descent Converges Linearly to Flatter Minima than Gradient Flow in Shallow Linear Networks](#).
PB, Blake Woodworth; (arXiv preprint 2501.09137)
- Dec. 2024 ➤ [Edge of Stochastic Stability: Revisiting the Edge of Stability for SGD](#).
Arseniy Andreyev*, PB*; (arXiv preprint 2412.20553)
- Jun. 2024 ➤ [How Neural Networks Learn the Support is an Implicit Regularization Effect of SGD](#).
PB*, Andrea Pinto*, Tomaso Poggio; (arXiv preprint arXiv:2406.11110)
- Dec. 2023 ➤ [On the Trajectories of SGD Without Replacement](#).
PB; (arXiv preprint arXiv:2312.16143)
- Oct. 2022 ➤ [Models with higher effective dimensions tend to produce more uncertain estimates](#).
A Puy, PB, S A Levin, S Lo Piano, T Portaluri, A Saltelli; Science Advances, Vol 8, Issue 42.
- Dec. 2021 ➤ [Deep neural network approximation theory for high-dimensional functions](#).
PB, P Cheridito, R Graeber, A Jentzen, B Kuckuck; (arXiv preprint arXiv:2112.14523).
- Dec. 2020 ➤ [High-dimensional approximation spaces of artificial neural networks and applications to partial differential equations](#).
PB, P Cheridito, A Jentzen, P von Wurstemberger; (arXiv preprint arXiv:2012.04326).
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Selected Invited Talks

- Jul. 2025 ➤ [One World ML] One World Mathematics of Machine Learning. TBD.
- Jun. 2025 ➤ Max Planck + UCLA, Math Machine Learning seminar. "Where Does Mini-Batch SGD Converge?". [link to the video](#)
- Oct. 2024 ➤ INFORMS 2024, Promises and challenges in modern optimization theory. "On the Trajectories of SGD Without Replacement".
- Oct. 2024 ➤ NJIT, Data Science, Theory Workshop. Organized by CBMM@MIT. "On the Trajectories of SGD Without Replacement".
- Aug. 2024 ➤ Brains, Minds, and Machines Summer School 2024, Theory Workshop. Organized by CBMM@MIT. "On the Trajectories of SGD Without Replacement". [link to the video](#)
- Jul. 2024 ➤ ISMP 2024, Large-scale Optimization III session. "On the Trajectories of SGD Without Replacement".
- Jun. 2024 ➤ ETH Zurich, invited by Prof. Niao He. "On the Trajectories of SGD Without Replacement".
- Apr. 2024 ➤ Brown University, Applied Mathematics Department, invited by Prof. Govind Menon. "On the Trajectories of SGD Without Replacement".
- Mar. 2024 ➤ MIT, CBMM, invited by Prof. Tomaso Poggio. "On the Trajectories of SGD Without Replacement".
- Jan. 2024 ➤ Sapienza University, Physics Department, invited by Matteo Negri. "On the Trajectories of SGD Without Replacement".
- Jan. 2024 ➤ University of Genova, MALGA, invited by Prof. Lorenzo Rosasco. "On the Trajectories of SGD Without Replacement".
- Oct. 2022 ➤ Amazon Science & AWS: "Implicit Regularization of SGD: Possible explanations?".
- Jun. 2022 ➤ Inria Paris, SIERRA team, Invited by Prof. Blake Woodworth. "Implicit Regularization of SGD: Possible explanations?".
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Community Services

Organization of Scientific Events

- 2021 - 2022 ➤ Co-organizer of [CEST-UCL Seminar series on responsible modelling](#). Precisely, I chaired and organized the talk of [Prof. Bin Yu, Berkeley](#); I organized and was a panelist of the event with [Prof. Cynthia Rudin, Duke](#); and I have been a panelist at the event with [Prof. Mary Morgan, LSE](#).
- 2021 ➤ Co-organizer of the conference *Forecasting the future for sustainable development* at [OECD](#). I organized the session on Explainability in AI, managed the website, and I chaired and moderated some talks and one workshop.

Non-Scientific Academic Services

- 2022 - 2023 ➤ Social Media Chair and Co-founder of [Princeton AI Club \(PAIC\)](#). I mainly managed the [Twitter](#) and [YouTube](#) accounts.
- 2023 - 2024 ➤ Graduate Student Representative, ORFE Department, Princeton University.
- 2024 - 2025 ➤ Treasurer and Social Chair of Italian Society at Princeton University.

Media and Engagement in the Wider Community

- 2023 - 2024 ➤ I was guest at [Zapping, Radio 1](#) commenting on recent AI developments and their impacts on the society. Zapping is the single most listened Italian radio program with an average active audience ranging around 1 million.

Other

- 2024 ➤ Mentor at *Deep Learning Indaba*.
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Teaching and Advising

Co-Instructor and Head TA at MIT

- Fall '25 ➤ [STATISTICAL LEARNING THEORY AND APPLICATIONS - 9.520/6.7910](#).
Main instructor: Prof. Tomaso Poggio.

Guest Instructor at MIT

- Fall '24 ➤ [STATISTICAL LEARNING THEORY AND APPLICATIONS - 9.520/6.7910](#).
I taught the unit on Optimization for Deep Learning. Main instructor: Prof. Tomaso Poggio.

Teaching Assistant at Princeton University

- Spring '25 ➤ SENIOR THESIS - ORF 499.
Main instructor: Dan Rigobon, PhD.
I met weekly with 18 senior thesis student and guided them through every step of their research thesis, from the problem definition, to the literature review, to the actual completion of the thesis.
- Fall '24 ➤ SENIOR INDEPENDENT RESEARCH FOUNDATIONS - ORF 498.
Main instructor: Dan Rigobon, PhD.
I met weekly with 18 senior thesis student and guided them through every step of their research thesis, from the problem definition, to the literature review, to the actual completion of the thesis.
- Spring '24 ➤ OPTIMIZATION - ORF 307.
Main instructor: Prof. Bartolomeo Stellato.
- Fall '23 ➤ COMPUTING AND OPTIMIZATION FOR THE PHYSICAL AND SOCIAL SCIENCES - ORF 363.
Main instructor: Prof. Amir Ali Ahmadi.
- Spring '23 ➤ ANALYSIS OF BIG DATA - ORF 350.
Main instructor: Prof. Boris Hanin.
- Spring '22 ➤ ANALYSIS OF BIG DATA - ORF 350.
Main instructor: Prof. Boris Hanin.
- Fall '21 ➤ ENERGY AND COMMODITIES MARKETS - ORF 455.
Main instructor: Prof. Ronnie Sircar.

Teaching Assistant at ETH Zurich

- Spring '20 ➤ NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS - 401-0674-00.
Main instructor: Prof. Dr. Ralf Hiptmair.

Teaching and Advising (continued)

- Fall '19 ➤ COMPUTATIONAL METHODS IN ENGINEERING AND APPLICATIONS.
Main instructors: Dr. Kjetil Olsen Lye and [Prof. Dr. Siddhartha Mishra](#).
- Summer '19 ➤ PROOFREADER AND TRANSLATOR of a high school mathematics book, from German to Italian.
- Lecturer at Mini-Courses**
- Aug '24 ➤ TOWARDS UNDERSTANDING THE IMPLICIT REGULARIZATION EFFECT OF SGD.
Brain Minds and Machines Summer School 2024 by MIT, Woods Hole, MA.
Audience: MSc and PhD students in fields broadly ranging between ML, Physics, Computational Neuroscience.
- Bachelor Students Advised**
- 2024 - 2025 ➤ Guided 18 Senior Thesis students Class of 2025, Princeton University.
On many topics weakly related to applied mathematics, from mean field games, to machine learning or social sciences for the automotive, to sport analytics, etc.
- Spring '24 ➤ ALEXANDER KRAUEL, Princeton University.
Main Adviser, PACM Certificate thesis: Progressive Sharpening in Matrix Completion and Matrix Factorization.
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Awards and Scholarships

- Major Awards and Grants**
- 2025 - 2027 ➤ 25TH ANNIVERSARY POSTDOCTORAL FELLOWSHIP AT THE MCGOVERN INSTITUTE, 200 000\$ for salary, traveling, and research related expenses.
- 2020 - 2024 ➤ PRINCETON AWARD, 89 600\$ for university fees and stipend.
- Sep. 2015 ➤ INDAM SCHOLARSHIP FOR BACHELOR'S in Mathematics: best 40 freshmen in math all-over Italy, renewed for all the duration of the Bachelor (2015–2018), 12 000 EUR.
- Minor or Older Awards**
- 2021 - 2024 ➤ SEAS TRAVEL AWARDS, PRINCETON, Total ~ 2 000\$.
- Aug. 2023 ➤ BENNETT STUART '74 ORFE TRAVEL AWARD, Total ~ 1 500\$.
- Mar. 2021 ➤ INSTITUTE FOR NEW ECONOMIC THINKING, [CEST-UCL SEMINAR SERIES ON RESPONSIBLE MODELLING](#), 4 500\$.
- Mar. 2020 ➤ INSTITUTE FOR NEW ECONOMIC THINKING, FORECASTING THE FUTURE FOR SUSTAINABLE DEVELOPMENT AT [OECD](#), 3 500\$.
- March 2015 ➤ *Italian Statistics Olympiads* 1st place at the Semifinal, 4th at the Finals.
- 2013 - 2015 ➤ Finalist at the National (Individual) Finals of the *Italian Mathematics Olympiads* for 3 consecutive years.
- 2013 - 2015 ➤ Member (2013, 2014) and Captain (2015) of the team ranked 4th-4th-3rd all-over Italy at the Italian Mathematics Teams Olympiads.
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Selected Conferences and Workshops

- Aug. 2025 ➤ *Statistical Physics and Machine Learning: moving forward*, Cargese, France.
- Jan. 2025 ➤ *Towards a theory for typical-case algorithmic hardness*, Les Houches, France, ~ 40 selected candidates among more than 500 applicants.
- Nov. 2024 ➤ *Oberwolfach Seminar on Optimal Control and Machine Learning*, Oberwolfach, Germany.
- Oct. 2024 ➤ *INFORMS 2024*, Seattle, Invited Speaker.
- Aug. 2024 ➤ *Brain Minds and Machines Summer School*, MIT, Invited Lecturer.
- Aug. 2024 ➤ *Princeton Machine Learning Theory Summer School*, Princeton University (80 selected candidates among more than 500 applicants), with funding.
- Jul. 2024 ➤ *International Symposium of Mathematical Programming 2024*, Montreal, Invited Speaker.
- Aug. 2023 ➤ *Statistical Physics and Machine Learning back together again*, Cargese, France, ~ 40 selected candidates among more than 500 applicants.
- Aug. 2022 ➤ *Summer School of Scuola di Politiche*, Cesenatico, Italy, 200 selected candidates among Excellent Under 30 Italians.

Selected Conferences and Workshops (continued)

- Aug. 2022 ➤ *Princeton Machine Learning Theory Summer School*, Princeton University, 80 selected candidates among more than 500 applicants, with funding.
- Aug. 2021 ➤ *Princeton Deep Learning Theory Summer School*, Princeton University, 180 selected candidates among more than 500 applicants.
- Oct. 2020 ➤ *Conference on* .
- Oct. 2019 ➤ *Conference on tommy a torino*.
- Aug. 2017 ➤ *INdAM Summer school*, Perugia, Italy, ~ 30 participants, Top 40 out of Italian mathematics Bachelor Students, with funding.
- Aug. 2016 ➤ *INdAM Summer school*, Perugia, Italy, ~ 30 participants, Top 40 out of Italian mathematics Bachelor Students, with funding.

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