Theodor Misiakiewicz

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Education

- **Stanford University**   **Stanford, CA, USA**
  Ph.D Candidate, Department of Statistics.   09/2017 – 06/2023
  PhD Advisor: Prof. Andrea Montanari.
  Title: *"Statistical and computational aspects of learning with NNs in high-dimension".*

  M.Sc. in Statistics, Department of Statistics.   09/2017 – 06/2020

- **École Normale Supérieure de Paris**   **Paris, France**
  M.Sc. in Theoretical Physics, International Center of Fundamental Physics.   09/2014 – 07/2016
  B.Sc. in Mathematics, Department of Mathematics.   09/2013 – 09/2014
  B.Sc. in Physics, Department of Physics.   09/2013 – 09/2014

Internships

- **EPFL**, Lausanne, Switzerland   06/2022 – 09/2022
  Visiting student at the Mathematics Department.
  Advisor: Prof. Emmanuel Abbe.

- **G-Research**, London, UK   07/2019 – 09/2019
  Summer intern (quant intern).

- **MIT**, Cambridge, MA   02/2017 – 07/2017
  Visiting student at the Laboratory for Information and Decision Systems (LIDS) and
  Institute for Data, Systems and Society (IDSS), EECS Department.
  Advisor: Prof. Guy Bresler.

- **Los Alamos National Laboratory**, Los Alamos, NM
  Visiting student at the Center for Non-Linear Studies.
    - Funded by D-Wave Quantum Computing grant.   06/2016 – 09/2016
      Advisor: Sct. Marc Vuffray.
    - Power Grid Spectroscopy project, NMC, sponsored by the NSF.   02/2015 – 07/2015
      Advisor: Sct. Michael Chertkov.

- **École Polytechnique**, Palaiseau, France   01/2016 – 03/2016
  Intern at the Laboratoire Leprince-Ringuet, joint position CNRS and CERN.
  CMS experiment at Large Hadron Collider (LHC), CERN, Geneva.
  Advisor: Sct. Christophe Ochando.

- **Paris-Diderot University (Paris VII)**, Paris, France   06/2014 – 08/2014
  Summer intern at the Astroparticle and Cosmology Laboratory (APC).
  Cosmology and Gravitation theory group.
  Advisor: Prof. Daniele Steer.

Research Interests

- Theory of Deep Learning: mean-field description and neural tangent kernel.

- Kernel and random feature methods in high-dimension (benign overfitting, multiple descent...).

- Non-convex optimization, implicit regularization, landscape analysis.

- Computational limits of learning with neural networks.

- Random matrix theory, high-dimensional probability.

Awards & Honors

- **Silver medal** at the 43rd International Physics Olympiads, Tallinn, Estonia   07/2012

- **2nd Prize Physics** and **Honors Maths**, Concours General (National Competition)   07/2011

- **1st Prize**, French National Physics Olympiads   12/2010

Teaching Experience

- **Teaching Assistant**, Stanford University   06/2017 – 06/2023
  - STATS 310A: Theory of Probability I (Fall 2021).
  - MATH 20: Introduction to calculus (Summer 2021).
  - STATS 375: Mathematical problems in Machine Learning (Spring 2021).
  - STATS 300C: Theory of statistics III (Spring 2021).
  - STATS 216: Introduction to Statistical Learning (Winter 2021).
  - STATS 200: Introduction to Statistical Inference (Fall 2020, Winter 2018).
  - STATS 116: Theory of Probability (Spring 2020, Fall 2018).
  - STATS 221: Random Processes on Graphs and Lattices (Winter 2020).
  - STATS 110: Statistical Methods in Engineering and the Physical Sciences (Fall 2019).
  - STATS 310C: Theory of Probability III (Spring 2019).
  - STATS 202: Data Mining and Analysis (Summer 2018).
  - STATS 101: Data Science 101 (Fall 2017).

- **Teaching Assistant**, Deep Learning Theory Summer School, Princeton   08/2021

Conference Proceedings:

(C1) "Precise Learning Curves and Higher-Order Scalings for Dot-product Kernel Regression."
Hong Hu, Yue M. Lu, Theodor Misiakiewicz, Jeffrey Pennington, Lechao Xiao.
Neural Information Processing Systems Conference, 2022.

(C2) "Learning with convolution and pooling operations in kernel methods."
Theodor Misiakiewicz, Song Mei.
Neural Information Processing Systems Conference, 2022.

(C3) "The merged-staircase property: a necessary and nearly sufficient condition for sgd learning of sparse functions on two-layer neural networks."
Emmanuel Abbe, Enric Boix-Adsera, Theodor Misiakiewicz.
In *Conference on Learning Theory*, pp. 4782–4887. PMLR, 2022.

(C4) "Learning with invariances in random features and kernel models."
Song Mei, Theodor Misiakiewicz, Andrea Montanari.
In *Conference on Learning Theory*, pp. 3351–3418. PMLR, 2021.

(C5) "When do neural networks outperform kernel methods?"
Behrooz Ghorbani, Song Mei, Theodor Misiakiewicz, Andrea Montanari.
Advances in Neural Information Processing Systems, 33, pp. 14820–14830, 2020.

(C6) "Mean-field theory of two-layers neural networks: dimension-free bounds and kernel limit."
Song Mei, Theodor Misiakiewicz, Andrea Montanari.
In *Conference on Learning Theory*, pp. 2388–2464. PMLR, 2019.

(C7) "Limitations of Lazy Training of Two-layers Neural Networks."
Behrooz Ghorbani, Song Mei, Theodor Misiakiewicz, Andrea Montanari.
Advances in Neural Information Processing Systems, 32, 2019.

(C8) "Solving SDPs for synchronization and MaxCut problems via the Grothendieck inequality."
Song Mei, Theodor Misiakiewicz, Andrea Montanari, Roberto Imbuzeiro Oliveira.
In *Conference on learning theory*, pp. 1476–1515. PMLR, 2017.

(C9) "Concentration to zero bit-error probability for regular LDPC codes on the binary symmetric channel: Proof by loop calculus."
Marc Vuffray, Theodor Misiakiewicz.
In *53rd Annual Allerton Conference on Communication, Control, and Computing (Allerton)*,
pp. 115–124. IEEE, 2015.

Journal Papers:

(J1) "Generalization error of random feature and kernel methods: hypercontractivity and kernel matrix concentration."
Song Mei, Theodor Misiakiewicz, Andrea Montanari.
Applied and Computational Harmonic Analysis, 59, 3–84, 2022.

(J2) "When do Neural Networks Outperform Kernel Methods?"
Behrooz Ghorbani, Song Mei, Theodor Misiakiewicz, Andrea Montanari.
Journal of Statistical Mechanics: Theory and Experiment 2021, no. 12, 124009, 2021.

(J3) "Linearized two-layers neural networks in high dimension."
Behrooz Ghorbani, Song Mei, Theodor Misiakiewicz, Andrea Montanari.
The Annals of Statistics, 49(2), pp. 1029–1054, 2021.

Discussions/Expository Writings:

(D1) Discussion of: "Nonparametric regression using deep neural networks with ReLU activation function".
Behrooz Ghorbani, Song Mei, Theodor Misiakiewicz, Andrea Montanari.
The Annals of Statistics, 48(4), pp. 1898–1901, 2020.

Preprints/In Sumbission Papers:

(P1) "Spectrum of inner-product kernel matrices in the polynomial regime and multiple descent phenomenon in kernel ridge regression."
Theodor Misiakiewicz.
Preprint arXiv:2204.10425, 2022.

(P2) "Minimum complexity interpolation in random features models."
Michael Celentano, Theodor Misiakiewicz, Andrea Montanari.
Preprint arXiv:2103.15996, 2021.

Invited Talks

(T1)	*Optimal Transport, Mean-Field Models, and Machine Learning* TUM Institute for Advanced Study, Munich, Germany.	04/2023
(T2)	*Mathematics and Data Science seminar* Center for Data Science and Courant Institute, NYU.	11/2022
(T3)	*ML theory seminar (alg-ml)*, Princeton	11/2022
(T4)	*Topics in Theory of Neural Networks*, INFORMS	10/2022
(T5)	*Information Systems Laboratory (ISL) Colloquium*, Stanford	10/2022
(T6)	*External FLAIR seminar*, EPFL	09/2022
(T7)	*Learning: Optimization and Stochastics (Summer Research Institute 2022)*, EPFL	06/2022
(T8)	*Mathematics of Deep Learning*, ELLIS	06/2022
(T9)	*New Interactions Between Statistics and Optimization workshop*, BIRS, Banff	05/2022
(T10)	*Deep Learning Theory Symposium workshop*, Simons Institute, Berkeley	12/2021
(T11)	*Geometric Methods in Optimization and Sampling*, Simons Institute, Berkeley	10/2021

(T12)	*Youth in High-Dimensions*, ICTP, Trieste	06/2021
(T13)	*NSF-Simons Journal Club*	04/2021
(T14)	*External Seminar*, G-Research	02/2021
(T15)	*ML Foundations seminar*, Microsoft Research	11/2020
(T16)	*MoDL (NSF collaboration)*	10/2020

Service & Leadership

- **Organizer:** reading group on the *Mean-Field description of neural networks* Fall 2021
  Geometric Methods in Optimization and Sampling program, Simons Institute, Berkeley.

- **Consulting in Statistics**, Department of Statistics, Stanford University 2017 − 2023
  Free consulting service offered to the broader Stanford research community.
  Experimental design, data exploration, modeling, statistical inference, etc.

- **Area Chair:** ICML 2021 Workshop on Information-Theoretic Methods for Rigorous,
  Responsible, and Reliable Machine Learning.

- **Reviewer:** SIAM Journal on Mathematics of Data Science (SIMODS), Journal of
  Machine Learning Research (JMLR), Neural Information Processing Systems
  (NeurIPS), International Conference on Machine Learning (ICML), Conference on
  Learning Theory (COLT), Symposium on Foundations of Computer Science (FOCS),
  IEEE Transactions on Information Theory, Journal of the Royal Statistical Society:
  Series B (Statistical Methodology), Proceedings of the National Academy of Sciences
  (PNAS), International Conference on Learning Representations (ICLR), Conference on
  Artificial Intelligence and Statistics (AISTATS).