Ilias Zadik, PhD

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Current Appointment

- **Yale University** **New Haven, CT, USA**
  Assistant Professor, Department of Statistics and Data Science *09/2023 – Present*

Past Academic Appointments

- **Massachusetts Institute of Technology (MIT)** **Cambridge, MA, USA**
  Postdoctoral Associate, Department of Mathematics *09/2021 – 08/2023*
  Postdoctoral mentors: Elchanan Mossel and Nike Sun
- **New York University (NYU)** **New York, NY, USA**
  CDS Moore-Sloan Postdoctoral Fellow (Faculty Fellow), Center for Data Science (CDS) *09/2019 – 08/2021*
  Conducted independent research.
  Co-instructed two graduate level classes in Data Science.

Research Interests

- High dimensional statistics, foundations of data science/machine learning, probability theory, algorithms, differential privacy.

Education

- **Massachusetts Institute of Technology (MIT)** **Cambridge, MA, USA**
  PhD, Operations Research. GPA: 5.0/5.0 *09/2014 – 09/2019*
  PhD advisor: David Gamarnik.
  Thesis: *"Computational and Statistical Challenges in High Dimensional Statistical Models"*
- **Trinity College, Cambridge University** **Cambridge, UK**
  M.A.St. in Mathematics, Part III, with Distinction (ranked 13th out of 247 students) *09/2013 – 07/2014*
  Part III Essay: *"Noise Sensitivity with applications to Percolation and Social Choice Theory"*
  Part III Essay advisor: Béla Bollobás
- **University of Athens** **Athens, Greece**
  B.A. in Mathematics, Graduated with GPA 10.0/10.0 *09/2009 – 02/2013*
  First known *perfect GPA* achieved in the recorded history of the department.
  Undergraduate research advisor: Vassili Nestoridis. Research area: Complex Analysis.

Industry Experience

- **Microsoft Research New England** **Cambridge, MA, USA**
  Summer Internship *06/2017 – 08/2017*

  Mentored by Jennifer Chayes and Christian Borgs.
  Performed research on differential privacy and large networks (led to conference paper (C18)).

  Also collaborated with Lester Mackey and Vasilis Syrgkanis (led to conference paper (C19)).)

Research

Note: As customary in my field, the order of the authors is **alphabetical**.
Few exceptions are denoted by (*).

Journal Papers (Accepted or In Press)

(J1) “Stationary Points of Shallow Neural Networks with Quadratic Activation Function";
David Gamarnik, Eren Kizildag, Ilias Zadik
Mathematics of Operations Research (accepted, 2024)
Preprint available at https://arxiv.org/abs/1912.01599.

(J2) "The Landscape of the Planted Clique Problem: Dense Subgraphs and the Overlap Gap Property";
David Gamarnik, Ilias Zadik.
Annals of Applied Probability (accepted, 2024)
Preprint available at https://arxiv.org/abs/1904.07174.

(J3) “Shapes and recession cones in mixed-integer convex representability”
Ilias Zadik, Miles Lubin, Juan Pablo Vielma (*)
Mathematical Programming, 2024, Volume 204, pages 739–752
Preprint available at https://arxiv.org/abs/2103.03379.

(J4) “Free Energy Wells and the Overlap Gap Property in Sparse PCA" ;
Gérard Ben Arous, Alexander Wein, Ilias Zadik.
Communications on Pure and Applied Mathematics 2023
Preprint available at https://arxiv.org/abs/2006.10689.
Journal version of conference paper (C12).

(J5) " It was "all" for “nothing": sharp phase transition for noiseless discrete channels. ";
Jonathan Niles-Weed, Ilias Zadik.
IEEE Transactions of Information Theory , 2023
Preprint available at https://arxiv.org/abs/2102.12422.
Journal version of conference paper (C7).

(J6) "Sparse High-Dimensional Regression. Algorithmic Barriers and a Local Search Algorithm";
David Gamarnik, Ilias Zadik.
The Annals of Statistics, 2022, Vol. 50(2), pp 880-903
Journal version of conference paper (C20).

(J7) "Mixed integer convex representability";
Miles Lubin, Juan Pablo Vielma and Ilias Zadik
Mathematics of Operations Research, 2021 Vol. 47(1), pp720-749.
Journal version of conference paper (C21).

(J8) "The All-or-Nothing Phenomenon in Sparse Linear Regression";
Galen Reeves, Jiaming Xu, Ilias Zadik.
Mathematical Statistics and Learning, 2021, Vol. 3, pp 259-313
Journal version of conference paper (C14).

(J9) "Inference in High-Dimensional Linear Regression via Lattice Basis Reduction and Integer Relation Detection";
David Gamarnik, Eren C. Kizildag, IIias Zadik
IEEE Transactions of Information Theory , 2019, Vol 67, pp 8109 - 8139.
Journal version of conference paper (C17).

(J10) "Self-Regularity of Non-Negative Output Weights for Overparameterized Two-Layer Neural Networks"
David Gamarnik, Eren C. Kızıldağ, Ilias Zadik
IEEE Transactions on Signal Processing, 2022, Vol. 70, pp 1310–1319.
Journal version of conference paper (C9).

(J11) "Universal Padé Approximants and their behaviour on the boundary"
Ilias Zadik
Monatshefte für Mathematik, 2017, Vol. 182, pp 173–193.

(J12) "Pade approximants, density of rational functions in $A^{\infty}(V)$ and smoothness of the integration operator";
Vassili Nestoridis, Ilias Zadik
Journal of Mathematical Analysis and Applications, 2015, Vol. 423, pp 1514-1539.

Peer-reviewed Conference Papers

(C1) "Sharp thresholds in inference of planted subgraphs";
Elchanan Mossel, Jonathan Niles-Weed, Youngtak Sohn, Nike Sun, Ilias Zadik.
In Proceedings of the *Conference on Learning Theory* (COLT), 2023.

(C2) "Almost-Linear Planted Cliques Elude the Metropolis Process";
Zongchen Chen, Elchanan Mossel, Ilias Zadik
In Proceedings of the *Symposium on Discrete Algorithms* (SODA), 2023.

(C3) "Archimedes Meets Privacy: On Privately Estimating Quantiles in High Dimensions Under Minimal Assumptions";
Omri Ben-Eliezer, Dan Mikulincer, Ilias Zadik
In Advances of the 35th *Neural Information Processing Systems* (NeurIPS), 2022.

(C4) "The Franz-Parisi Criterion and Computational Trade-offs in High Dimensional Statistics";
Afonso Bandeira, Ahmed El Alaoui, Sam Hopkins, Tselil Schramm, Alexander S Wein, Ilias Zadik
In Advances of the 35th *Neural Information Processing Systems* (NeurIPS), 2022 **(Oral presentation)**.

(C5) "Lattice-based methods surpass sum-of-squares in clustering" ;
Ilias Zadik, Min Jae Song, Alexander S. Wein, Joan Bruna (*)
In Proceedings of the 35th *Conference in Learning Theory* (COLT), 2022, pp1247-1248.

(C6) "Statistical and Computational Phase Transitions in Group Testing";
Amin Coja-Oghlan, Oliver Gebhard, Maz Hahn-Klimroth, Alexander S Wein, Ilias Zadik
In Proceedings of the 35th *Conference in Learning Theory* (COLT), 2022, pp 4764-4781.

(C7) "On the cryptographic hardness of learning single periodic neurons";
Min Jae Song, Ilias Zadik, Joan Bruna (*)
In Advances of the 34th *Neural Information Processing Systems* (NeurIPS), 2021, pp 29602-29615

(C8) " It was "all" for "nothing": sharp phase transition for noiseless discrete channels. ";
Jonathan Niles-Weed, Ilias Zadik.
In Proceedings of the 34th *Conference in Learning Theory* (COLT), 2021, pp 3546-3547.

(C9) "Group testing and local search: is there a computational-statistical gap?";
Fotis Iliopoulos, Ilias Zadik.
In Proceedings of the 34th *Conference in Learning Theory* (COLT), 2021 pages 2499-2551.

(C10) "Self-Regularity of Non-Negative Output Weights for
Overparameterized Two-Layer Neural Networks";
David Gamarnik, Eren Kizildag, Ilias Zadik
In Proceedings of the IEEE *International Symposium of Information Theory* (ISIT), 2021, pages 819-824.

(C11) "The All-or-Nothing Phenomenon in Sparse Tensor PCA ";
Jonathan Niles-Weed, Ilias Zadik.
In Advances of the 34th *Neural Information Processing Systems* (NeurIPS) 2020

(C12) "Optimal Private Median Estimation under Minimal Distributional Assumptions ";
Christos Tzamos, Emmanouil Vlatakis, Ilias Zadik.
In Advances of the 34th *Neural Information Processing Systems* (NeurIPS) 2020 **(Spotlight)**

(C13) "Free Energy Wells and the Overlap Gap Property in Sparse PCA" ;
Gérard Ben Arous, Alexander Wein, Ilias Zadik.
In Proceedings of the 33rd *Conference on Learning Theory* (COLT) 2020, pages 479-482.

(C14) "All-or-Nothing Phenomena: From Single-Letter to High Dimensions";
Galen Reeves, Jiaming Xu, Ilias Zadik.
In Proceedings of the 8th IEEE *International Workshop on Computational Advances in Multi-Sensor Adaptive Processing,* (CAMSAP) 2019, pages 654-658.

(C15) "The All-or-Nothing Phenomenon in Sparse Linear Regression";
Galen Reeves, Jiaming Xu, Ilias Zadik
In Proceedings of the 32nd *Conference on Learning Theory* (COLT) 2019, pages 2652-2663.

(C16) "Improved bounds on Gaussian MAC and sparse regression via Gaussian inequalities";
Ilias Zadik, Christos Thrampoulidis, Yury Polyanskiy (*)
In Proceedings of the IEEE *International Symposium of Information Theory* (ISIT) 2019, pages 430-434.

(C17) "A Simple Bound On The BER Of The MAP Decoder For Massive MIMO System";
Christos Thrampoulidis, Ilias Zadik, Yury Polyanskiy (*)
In Proceedings of the 44th *International Conference on Acoustics, Speech, and Signal Processing* (ICASSP) 2019, pages 4544-4548.

(C18) " High-Dimensional Linear Regression using Lattice Basis Reduction"
David Gamarnik, Ilias Zadik
In Advances of the 32nd *Neural Information Processing Systems* (NeurIPS) 2018, pages 1842–1852.

(C19) " Revealing Network Structure Confidentially: Improved Rates for Node-Private Graphon Estimation";
Christian Borgs, Jennifer Chayes, Adam Smith, Ilias Zadik.
In Proceedings of the 59th IEEE Annual Symposium on *Foundations of Computer Science* (FOCS) 2018, pages 533–543.

(C20) "Orthogonal Machine Learning: Power and Limitations";
Lester Mackey, Vasilis Sygrkanis, Ilias Zadik.
In Proceedings of the 35th *International Conference of Machine Learning* (ICML) 2018, pages 5723–5731.

(C21) "High-dimensional Regression with Binary Coefficients. Estimating Squared error and the Phase Transition Property" ;
David Gamarnik, Ilias Zadik.
In Proceedings of the 30th *Conference on Learning Theory* (COLT) 2017, pages 948–953.

(C22) "Mixed integer convex representability";
Miles Lubin, Ilias Zadik, Juan Pablo Vielma (*)
In Proceedings of the 19th *Integer Programming and Combinatorial Optimization* conference (IPCO) 2017, pages 392–404.

Preprints/In Sumbission Papers

(P1) "Sharp Thresholds Imply Circuit Lower Bounds";
David Gamarnik, Elchanan Mossel, Ilias Zadik
Preprint available at https://arxiv.org/abs/2311.04204.

(P2) "A Second Moment Proof of the Spread Lemma";
Elchanan Mossel, Jonathan Niles-Weed, Nike Sun, Ilias Zadik
Preprint available at https://arxiv.org/abs/2209.11347.

(P3) "On the Second Kahn-Kalai Conjecture";
Elchanan Mossel, Jonathan Niles-Weed, Nike Sun, Ilias Zadik
Preprint available at https://arxiv.org/abs/2209.03326.

Invited Talks

(T42) New York University (Courant), Discrete Mathematics Seminar, February 2024

(T41) Leigh University and University of Minnesota, joint probability seminar, November 2023

(T40) University of Athens, Department of Mathematics seminar, November 2023

(T39) University of Texas, Austin, Institute for Foundations of Machine Learning seminar, November 2023

(T38) John Hopkins University, Applied Mathematics and Statistics seminar, October 2023

(T37) Workshop "Statistical Physics & Machine Learning back together again", Cargese, August 2023

(T36) Workshop "Connecting Physics, Geometry, and Algebraic Hardness", Santa Fe Institute, July 2023

(T35) Workshop on "Graphical Models, Statistical Inference and Applications", Harvard, May 2023

(T34) AMS meeting on "High-dimensional Convexity and Probability", Georgia Tech, March 2023

(T33) BIRS workshop on "Learning in Networks: Performance Limits and Algorithms", November 2022

(T32) Cornell University, Statistics Seminar, November 2022

(T31) Worcester Polytechnic Institute, Computer Science Colloquium, November 2022

(T30) UC Davis, Probability Seminar, October 2022

(T29) INFORMS Annual Meeting, October 2022

(T28) New York University, Mathematics, Information and Computation (MIC) Seminar, October 2022

(T27) Simons workshop on "Graph Limits, Nonparametric Models, and Estimation", September 2022

(T26) MIT, IDSS Statistics Seminar, February 2022

(T25) Simons workshop on "Cryptography and Learning", November 2021

(T24) Joint Simons/IFML workshop, Berkeley, October 2021

(T23) INFORMS Annual Meeting, October 2021

(T22) Simons workshop on “Rigorous Evidence for Computational-Statistical Trade-offs", September 2021

(T21) BIRS workshop on "Random Graphs and Statistical Inference", August 2021

(T20) New York Colloquium on Algorithms and Complexity (NYCAC), March 2021

(T19) 19th Northeast Probability Seminar, November 2020

(T18) INFORMS Annual Meeting, November 2020

(T17) Simons workshop on “Computational Phase Transitions", September 2020

(T16) IBM Thomas J Watson Research Center, February 2020

(T15) Google Research Algorithm’s Seminar, NYC, February 2019

(T14) New York University, Mathematics, Information and Computation (MIC) Seminar, February 2019

(T13) Stanford, Theory of Computer Science Seminar, January 2019

(T12) Northeastern University, Theory of Computer Science Seminar, November 2018

(T11) Microsoft Research New England, Machine Learning (ML) Ideas Lunch, November 2018

(T10) Cornell University, workshop for young Operations Research researhers, October 2018

(T9) MIT LIDS and Statistics Tea talk, April 2018

(T8) Oberwolfach’s workshop on "Network Models: Structure and Functions", December 2017

(T7) INFORMS Annual Meeting, November 2017

(T6) INFORMS Applied Probability Society Conference, July 2017

(T5) Integer Programming and Combinatorial Optimization Conference, July 2017

(T4) MIT LIDS and Statistics Tea talk, March 2017

(T3) MIT LIDS student seminar, January 2017

(T2) University of Athens Probability and Statistics Seminar, January 2017

(T1) MIT Operations Research Center Student Seminar, November 2016

Mentoring Experience

During my postdoctoral years, I had the pleasure to collaborate with the following graduate students:

- Min Jae Song (graduate student at NYU, Courant Institute of Mathematical Sciences).
  Collaborated in papers (C4), (C6).
- Eren Kizildag (graduate student at MIT, EECS).
  Collaborated in papers (J6), (J7), (C9).
  Now, he is a postdoctoral fellow in the Statistics Department of Columbia University.
- Emmanouil Vlatakis (graduate student at Columbia University, CS)
  Collaborated in paper (C11).
  Now, he is a postdoctoral researcher in Michael Jordan’s group, at UC Berkeley.

Teaching Experience

- Spring 2024: S&DS 351 (Yale), “Stochastic Processes"
  Undergraduate andgGraduate-level class on topics such as:
  Markov chains, martingales, Brownian motion
- Fall 2023: S&DS 688 01 (Yale), “Computational-Statistical Trade-offs."
  Newly designed research-level class.
  On recent research topics such as:
  replica-symmetric predictions, low-degree lower bounds, SQ lower bounds, MCMC lower bounds.
- Fall 2020: DS-GA 1005 (NYU), “Inference and Representation."
  Co-instructor with Joan Bruna. We redesigned together the class this year.
  Graduate-level advanced class on topics such as:
  graphical models, variational inference, MCMC sampling and optimal transport.
- Fall 2019, DS-GA 1002 (NYU), “Probability and Statistics for Data Science."
  Co-instructor with Carlos Fernandez-Granda.
  Graduate-level introductory class on probability and statistics.
- Spring 2017, 15.070J/6.265J (MIT),“Modern Discrete Probability."
  Teaching assistant
  Duties included: weekly office hours, assignment preparation and grading.
  Graduate-level class taught by Yury Polyanskiy and Guy Bresler.
- Fall 2016, 15.085J/6.436J (MIT), “Fundamentals of Probability."
  Teaching assistant.
  Duties included: weekly office hours, recitations, assignment preparation and grading.
  Graduate-level class taught by David Gamarnik.

Awards and Honors

- CDS Moore-Sloan *Postdoctoral Fellowship* at NYU, 2019-2021.
- Top 400 Reviewers Award, for reviewing for Neural Information Processing Systems (NeurIPS), 2019.
- *Honorable Mention* for MIT Operations Research Center Best Student Paper Award, 2017
  Awarded for paper (J3), now published in the Annals of Statistics, 2022.
- *Senior scholarship* from Trinity College, Cambridge University, 2014.
  Awarded for achieving “Distinction” in Part III examination.
- The Onassis Foundation Scholarship for my Master’s studies, 2013-2014.
- The Cambridge Home and European Scholarship Scheme (CHESS) award for my Master’s studies, 2013-2014.
- IKY scholarship for top academic performance in *each year* of my undergraduate studies, 2009-2012.
- International Mathematics Competition for university students (IMC):
  First Prize, 2011; Second Prize, 2010.
- South Eastern European Mathematical Olympiad for University students (SEEMOUS):
  Gold Medal **(scored 39.5/40 and ranked 1st)**, 2011 ; *Silver Medal*, 2010.
- International Mathematical Olympiad (IMO): *Honorable Mention*, 2009.

Service and Outreach

- Co-organized the *(virtual and open to the public) "Math and Data (MaD) +" seminar*.
  The MaD+ seminar took place from Spring 2020 to Spring 2021.
  Our goal was to assist research on the foundations of data science during the COVID-19 pandemic.
  For more information, please see the seminar's website.
- Served in the program committee for COLT 2021, 2022.
- Served (multiple times) as a reviewer for Annals of Statistics, Probability Theory and Related Fields, Mathematical Programming, SIAM Journal of Discrete Mathematics, SIAM Journal of Optimization, Combinatorica, Operations Research, Journal of Machine Learning Research, IEEE Journal on Selected Areas in Information Theory.
- Served as a reviewer/sub-reviewer for COLT, NeurIPS, FOCS, STOC, ITCS, ISIT, ICALP and SODA.
- Co-ordinated MIT Operations Research Seminar during Fall 2018.
- Proctored 2017 Qualifying Exams in Probability Theory for MIT Operations Research Center.

References (upon request)

- Dr. David Gamarnik
  Professor of Operations Research
  Massachusetts Institute of Technology.
  Email: gamarnik@mit.edu
- Dr. Elchanan Mossel
  Professor of Mathematics
  Massachusetts Institute of Technology.
  Email: aldixon@mit.edu
- Dr. Nike Sun
  Associate Professor of Mathematics
  Massachusetts Institute of Technology.
  Email: nsun@mit.edu
- Dr. Joan Bruna
  Associate Professor of Computer Science, Data Science and Mathematics,
  New York University.
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- Dr. Guy Bresler
  Associate Professor of Electrical Engineering and Computer Science,
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