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Education

B.A., MATHEMATICS, PRINCETON
September 1997 – June 2001

PH.D., APPLIED MATHEMATICS, YALE
September 2001 – June 2004

Employment

POSTDOCTORAL RESEARCHER
Yale University, Math Dept.
July 2004 – June 2008

VISITING ASSISTANT PROFESSOR
UCLA, Math Dept.
July 2008 – June 2009

ASSISTANT PROFESSOR
NYU Courant Institute, Math Dept.
September 2009 – August 2013

DIRECTOR
M.S. in Scientific Computing
NYU Courant Institute
September 2011 – August 2013

RESEARCH SCIENTIST
Yale University, Math Dept.
September 2013 – June 2014

RESEARCH SCIENTIST
Meta, Fundamental AI Research
July 2014 –

Honors

DARPA Young Faculty Award for “Computer-enabled metrics of statistical significance”

The 2010 U.S. National Academy of Sciences Award for Initiatives in Research

Sloan Research Fellowship

U.S. National Defense Science and Engineering Graduate Fellowship

Barry Goldwater, Robert Byrd, and National Merit Scholarships

Brown and Covington Prizes, the top awards to a junior and to a senior majoring in math at Princeton

Graduated summa cum laude and “with highest honors” from Princeton

2 Princeton President’s Awards for Academic Achievement

Valedictorian of the Schalmont High School class of 1997

Current research interests

Machine learning, statistics, and computational science and engineering, particularly numerical analysis

Long-term research vision

My research focuses on *compliance*, namely compliance with respect to government regulations or standards bodies, for instance. “Compliance” in general refers to the specification of best practices that are unlikely to be followed without explicit effort, and (critically) of means for validating adherence to those best practices. Best practices in machine learning and data science surely should include good calibration (or equitable calibration), assessed via tools akin to “reliability diagrams,” as well as the use of secure processors supporting remote attestation to their security (including confidentiality and possibly integrity, with a view toward protecting privacy).

Publications

32. AN EFFICIENT ALGORITHM FOR INTEGER LATTICE REDUCTION, *SIAM Journal on Matrix Analysis and Applications*, 45 (1): 353–367, 2024 (with François Charton, Kristin Lauter, and Cathy Li).
31. CALIBRATION OF P-VALUES FOR CALIBRATION AND FOR DEVIATION OF A SUBPOPULATION FROM THE FULL POPULATION, *Advances in Computational Mathematics*, 49 (70): 1–22, 2023.
30. METRICS OF CALIBRATION FOR PROBABILISTIC PREDICTIONS, *Journal of Machine Learning Research*, 23: 1–54, 2022 (with Imanol Arrieta Ibarra, Paman Gujral, Jonathan Tannen, and Cherie Xu).
29. COMPRESSED SENSING WITH A JACKKNIFE, A BOOTSTRAP, AND VISUALIZATION, *Journal of Data Science, Statistics, and Visualisation*, 2 (4): 1–29, 2022 (with Aaron Defazio, Rachel Ward, and Jure Zbontar).
28. A GRAPHICAL METHOD OF CUMULATIVE DIFFERENCES BETWEEN TWO SUBPOPULATIONS, *Journal of Big Data*, 8 (158): 1–29, 2021.
27. CUMULATIVE DEVIATION OF A SUBPOPULATION FROM THE FULL POPULATION, *Journal of Big Data*, 8 (117): 1–60, 2021.
26. SECURE MULTIPARTY COMPUTATIONS IN FLOATING-POINT ARITHMETIC, *Information and Inference: a Journal of the IMA*, iaaa038: 1–33, 2021 (with Chuan Guo, Awni Hannun, Brian Knott, Laurens van der Maaten, and Ruiyu Zhu).
25. SIMULATING SINGLE-COIL MRI FROM THE RESPONSES OF MULTIPLE COILS, *Communications in Applied Mathematics and Computational Science*, 15 (2): 115–127, 2020 (with Jure Zbontar).
24. A HIERARCHICAL LOSS AND ITS PROBLEMS WHEN CLASSIFYING NON-HIERARCHICALLY, *PLOS ONE*, 14 (12): 1–17, 2019 (with Cinna Wu and Yann LeCun).
23. REGRESSION-AWARE DECOMPOSITIONS, *Linear Algebra and Its Applications*, 565 (6): 208–224, 2019.
22. RANDOMIZED ALGORITHMS FOR DISTRIBUTED COMPUTATION OF PRINCIPAL COMPONENT ANALYSIS AND SINGULAR VALUE DECOMPOSITION, *Advances in Computational Mathematics*, 44 (5): 1651–1672, 2018 (with Huamin Li and Yuval Kluger).
21. ACCURATE LOW-RANK APPROXIMATIONS VIA A FEW ITERATIONS OF ALTERNATING LEAST SQUARES, *SIAM Journal on Matrix Analysis and Applications*, 38 (2): 425–433, 2017 (with Arthur Szlam and Andrew Tulloch).
20. SCALE-INVARIANT LEARNING AND CONVOLUTIONAL NETWORKS, *Applied and Computational Harmonic Analysis*, 42 (1): 154–166, 2017 (with Soumith Chintala, Marc’Aurelio Ranzato, Arthur Szlam, Yuandong Tian, and Wojciech Zaremba).
19. ALGORITHM 971: AN IMPLEMENTATION OF A RANDOMIZED ALGORITHM FOR PRINCIPAL COMPONENT ANALYSIS, *ACM Transactions on Mathematical Software*, 43 (3): 28:1–28:14, 2016 (with Huamin Li, George Linderman, Arthur Szlam, Kelly Stanton, and Yuval Kluger).
18. A MATHEMATICAL MOTIVATION FOR COMPLEX-VALUED CONVOLUTIONAL NETWORKS, *Neural Computation*, 28 (5): 815–825, 2016 (with Joan Bruna, Soumith Chintala, Yann LeCun, Serkan Piantino, and Arthur Szlam).
17. SOME DEFICIENCIES OF χ^2 AND CLASSICAL EXACT TESTS OF SIGNIFICANCE, *Applied and Computational Harmonic Analysis*, 36 (3): 361–386, 2014 (with William Perkins and Rachel Ward).
16. AN ALGORITHM FOR THE PRINCIPAL COMPONENT ANALYSIS OF LARGE DATA SETS, *SIAM Journal on Scientific Computing*, 33 (5): 2580–2594, 2011 (with Nathan Halko, Per-Gunnar Martinsson, and Yoel Shkolnisky).
15. COMPUTING THE CONFIDENCE LEVELS FOR A ROOT-MEAN-SQUARE TEST OF GOODNESS-OF-FIT, *Applied Mathematics and Computation*, 217 (22): 9072–9084, 2011 (with William Perkins and Rachel Ward).
14. A FAST RANDOMIZED ALGORITHM FOR ORTHOGONAL PROJECTION, *SIAM Journal on Scientific Computing*, 33 (2): 849–868, 2011 (with Edouard Coakley and Vladimir Rokhlin).

13. A RANDOMIZED ALGORITHM FOR THE DECOMPOSITION OF MATRICES, *Applied and Computational Harmonic Analysis*, 30 (1): 47–68, 2011 (with Per-Gunnar Martinsson and Vladimir Rokhlin).
12. STATISTICAL TESTS FOR WHETHER A GIVEN SET OF INDEPENDENT, IDENTICALLY DISTRIBUTED DRAWS COMES FROM A SPECIFIED PROBABILITY DENSITY, *Proceedings of the National Academy of Sciences (USA)*, 107 (38): 16471–16476, 2010.
11. FAST ALGORITHMS FOR SPHERICAL HARMONIC EXPANSIONS, III, *Journal of Computational Physics*, 229 (18): 6181–6192, 2010.
10. RECURRENCE RELATIONS AND FAST ALGORITHMS, *Applied and Computational Harmonic Analysis*, 28 (1): 121–128, 2010.
9. A RANDOMIZED ALGORITHM FOR PRINCIPAL COMPONENT ANALYSIS, *SIAM Journal on Matrix Analysis and Applications*, 31 (3): 1100–1124, 2009 (with Vladimir Rokhlin and Arthur Szlam).
8. FAST ALGORITHMS FOR SPHERICAL HARMONIC EXPANSIONS, II, *Journal of Computational Physics*, 227 (8): 4260–4279, 2008.
7. A FAST RANDOMIZED ALGORITHM FOR OVERDETERMINED LINEAR LEAST-SQUARES REGRESSION, *Proceedings of the National Academy of Sciences (USA)*, 105 (36): 13212–13217, 2008 (with Vladimir Rokhlin).
6. A FAST RANDOMIZED ALGORITHM FOR THE APPROXIMATION OF MATRICES, *Applied and Computational Harmonic Analysis*, 25 (3): 335–366, 2008 (with Franco Woolfe, Edo Liberty, and Vladimir Rokhlin).
5. RANDOMIZED ALGORITHMS FOR THE LOW-RANK APPROXIMATION OF MATRICES, *Proceedings of the National Academy of Sciences (USA)*, 104 (51): 20167–20172, 2007 (with Edo Liberty, Franco Woolfe, Per-Gunnar Martinsson, and Vladimir Rokhlin).
4. APPROXIMATION OF BANDLIMITED FUNCTIONS, *Applied and Computational Harmonic Analysis*, 21 (3): 413–420, 2006 (with Yoel Shkolnisky and Vladimir Rokhlin).
3. ON INTERPOLATION AND INTEGRATION IN FINITE-DIMENSIONAL SPACES OF BOUNDED FUNCTIONS, *Communications in Applied Mathematics and Computational Science*, 1: 133–142, 2006 (with Per-Gunnar Martinsson and Vladimir Rokhlin).
2. FAST ALGORITHMS FOR SPHERICAL HARMONIC EXPANSIONS, *SIAM Journal on Scientific Computing*, 27 (6): 1903–1928, 2006 (with Vladimir Rokhlin).
1. A FAST ALGORITHM FOR THE INVERSION OF GENERAL TOEPLITZ MATRICES, *Computers and Mathematics with Applications*, 50 (5–6): 741–752, 2005 (with Per-Gunnar Martinsson and Vladimir Rokhlin).

Preprints

12. GUARANTEES OF CONFIDENTIALITY VIA HAMMERSLEY-CHAPMAN-ROBBINS BOUNDS, *arXiv*, 2404.02866 (with Kamalika Chaudhuri, Chuan Guo, Laurens van der Maaten, and Saeed Mahloujifar).
11. CUMULATIVE DIFFERENCES BETWEEN PAIRED SAMPLES, *arXiv*, 2305.11323 (with Isabel Kloumann, Hannah Korevaar, Chris McConnell, and Jessica Zhao).
10. CONTROLLING FOR MULTIPLE COVARIATES, *arXiv*, 2112.00672.
9. AN OPTIMIZABLE SCALAR OBJECTIVE VALUE CANNOT BE OBJECTIVE AND SHOULD NOT BE THE SOLE OBJECTIVE, *arXiv*, 2006.02577 (with Isabel Kloumann).
8. POOR STARTING POINTS IN MACHINE LEARNING, *arXiv*, 1602.02823.
7. COMPUTER-ENABLED METRICS OF STATISTICAL SIGNIFICANCE FOR DISCRETE DATA, a 157-page monograph, available at <http://tygert.com/mono.pdf>, 2014 (with William Perkins and Rachel Ward).
6. TESTING GOODNESS-OF-FIT FOR LOGISTIC REGRESSION, *arXiv*, 1306.0959 (with Rachel Ward).
5. SIGNIFICANCE TESTING WITHOUT TRUTH, *arXiv*, 1301.1208 (with William Perkins and Rachel Ward).
4. A COMPARISON OF THE DISCRETE KOLMOGOROV-SMIRNOV STATISTIC AND THE EUCLIDEAN DISTANCE, *arXiv*, 1206.6367 (with Jacob Carruth and Rachel Ward).

3. COMPUTING THE ASYMPTOTIC POWER OF A EUCLIDEAN-DISTANCE TEST FOR GOODNESS-OF-FIT, *arXiv*, 1206.6378 (with William Perkins and Gary Simon).
2. TESTING THE SIGNIFICANCE OF ASSUMING HOMOGENEITY IN CONTINGENCY-TABLES/CROSS-TABS, *arXiv*, 1201.1421.
1. COMPUTING THE CONFIDENCE LEVELS FOR A ROOT-MEAN-SQUARE TEST OF GOODNESS-OF-FIT, II, *arXiv*, 1009.2260 (with William Perkins and Rachel Ward).

Courses taught

BASIC ANALYSIS IN FUNCTION SPACES Yale undergraduate MATH 260b Spring 2005	NUMERICAL METHODS WITH PROBABILITY NYU graduate MATH-GA-2012/CSCI-GA-2945 Spring 2010
MULTILEVEL COMPRESSION OF LINEAR OPERATORS Yale graduate AMTH 510a Fall 2005	REAL VARIABLES NYU graduate MATH-GA-2430 Fall 2010
DIFFERENTIAL CALCULUS Yale undergraduate MATH 112a Fall 2006	MATHEMATICAL STATISTICS NYU undergraduate MATH-UA-0234 Spring 2011
MULTILEVEL COMPRESSION OF LINEAR OPERATORS Yale graduate AMTH 510a Fall 2006	FAST MULTIPOLE METHODS NYU graduate MATH-GA-2011/CSCI-GA-2945 Fall 2011
INTRO. TO FUNCTIONS OF SEVERAL VARIABLES Yale undergraduate MATH 118a Fall 2007	MATHEMATICAL STATISTICS NYU undergraduate MATH-UA-0234 Spring 2012
EFFICIENT MATRIX COMPUTATIONS Yale graduate AMTH/CPSC 951a Fall 2007	MATHEMATICAL STATISTICS NYU graduate MATH-GA-2962 Spring 2012
OPTIMIZATION UCLA undergraduate MATH 164 Winter 2009	PROBABILITY THEORY NYU undergraduate MATH-UA-0233 Fall 2012
COMPUTATIONAL LINEAR ALGEBRA UCLA graduate MATH 270C Spring 2009	NUMERICAL COMPUTATION I NYU graduate MATH-GA-2010/CSCI-GA-2420 Fall 2012
COMPRESSION OF LINEAR OPERATORS NYU graduate MATH-GA-2011/CSCI-GA-2945 Fall 2009	MATHEMATICAL STATISTICS NYU graduate MATH-GA-2962 Spring 2013