Tyler Chen

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https://chen.pw

Academic Positions

New York University ..... *(2022-present)*
Assistant Professor / Courant Instructor

- Mathematics at Courant, Computer Science and Engineering at Tandon
- Sponsor: Christopher Musco

Education

University of Washington *2017-2022*
Ph.D. in Applied Mathematics

- Thesis: *Lanczos-based methods for matrix functions*
- Advisors: Anne Greenbaum, Thomas Trogdon

University of Washington *2017-2019*
M.Sc. in Applied Mathematics

Tufts University *2013-2017*
B.S. Summa Cum Laude in Mathematics and Physics; Minor in Studio Art

Research Interests

I'm particularly interested in incorporating probabilistic techniques into classical algorithms to develop methods which are fast and reliable, both in theory and in practice. Right now, I work mainly in the field of numerical linear algebra on Krylov subspace methods such as the conjugate gradient and Lanczos methods. I hope that my work will help to bridge the gaps between numerical analysis, theoretical computer science, and applied computational sciences such as quantum physics.

Mentoring

Robert Chen (NYU) ..... *2023 - present*
Typicality algorithms for partial trace estimation

Kevin Li (NYU) ..... *2022 - present*
Typicality algorithms for partial trace estimation

Skai Nzeuton (Stuyvesant High School) ..... *2022 - present*
Typicality algorithms for partial trace estimation

Yilu Pan (NYU) ..... *2022 - present*
Typicality algorithms for partial trace estimation

Last updated March 5, 2023

Yixin Wang (NYU) ..... *2023 - present*
Typicality algorithms for partial trace estimation

Qichen Xu (UW) ..... *2021 - present*
Error bounds for Krylov subspace methods

In submission

[7] Tyler Chen, Anne Greenbaum, and Thomas Trogdon. *GMRES, pseudospectra, and Crouzeix's conjecture for shifted and scaled Ginibre matrices*. 2023. arXiv: 2303.02042 [math.NA].

[6] Tyler Chen and Thomas Trogdon. *Stability of the Lanczos algorithm on matrices with regular spectral distributions*. 2023. arXiv: 2302.14842 [math.NA].

[5] Noah Amsel, Tyler Chen, Anne Greenbaum, Cameron Musco, and Christopher Musco. *Instance Near-Optimality Guarantees for Approximating Rational Matrix Functions by the Lanczos Method*.

[4] Qichen Xu and Tyler Chen. *A posteriori error bounds for the block-Lanczos method for matrix function approximation*. 2022. arXiv: 2211.15643 [math.NA].

[3] Raghu Bollapragada, Tyler Chen, and Rachel Ward. *On the fast convergence of minibatch heavy ball momentum*. 2022. arXiv: 2206.07553 [cs.LG].

[2] Tyler Chen and Eric Hallman. *Krylov-aware stochastic trace estimation*. 2022. arXiv: 2205.01736 [math.NA].

[1] Tyler Chen, Thomas Trogdon, and Shashanka Ubaru. *Randomized matrix-free quadrature for spectrum and spectral sum approximation*. 2022. arXiv: 2204.01941 [math.NA].

Publications

[7] Tyler Chen, Anne Greenbaum, Cameron Musco, and Christopher Musco. "Low-memory Krylov subspace methods for optimal rational matrix function approximation". In: *SIAM Journal on Matrix Analysis and Applications* (2023). to appear. arXiv: 2202.11251 [math.NA].

[6] Tyler Chen and Yu-Chen Cheng. "Numerical computation of the equilibrium-reduced density matrix for strongly coupled open quantum systems". In: *The Journal of Chemical Physics* 157.6 (Aug. 2022), p. 064106. arXiv: 2204.08147 [quant-ph]. URL: https://doi.org/10.1063/5.0099761.

[5] Tyler Chen, Anne Greenbaum, Cameron Musco, and Christopher Musco. "Error Bounds for Lanczos-Based Matrix Function Approximation". In: *SIAM Journal on Matrix Analysis and Applications* 43.2 (May 2022), pp. 787–811. arXiv: 2106.09806 [math.NA]. URL: https://doi.org/10.1137/21m1427784.

[4] Tyler Chen, Thomas Trogdon, and Shashanka Ubaru. "Analysis of stochastic Lanczos quadrature for spectrum approximation". In: *Proceedings of the 38th International Conference on Machine Learning*. Vol. 139. Proceedings of Machine Learning Research. PMLR, 18–24 Jul 2021, pp. 1728–1739. arXiv: 2105.06595 [cs.DS]. URL: http://proceedings.mlr.press/v139/chen21s.html.

- selected for long presentation (top 3%)

[3] Anne Greenbaum, Hexuan Liu, and Tyler Chen. "On the Convergence Rate of Variants of the Conjugate Gradient Algorithm in Finite Precision Arithmetic". In: *SIAM Journal on Scientific Computing* (July 2021), S496–S515. arXiv: 1905.05874 [cs.NA]. URL: https://doi.org/10.1137/20m1346249.

[2] Tyler Chen. "Non-asymptotic moment bounds for random variables rounded to non-uniformly spaced sets". In: *Stat* (June 2021), e395. arXiv: 2007.11041 [math.ST]. URL: https://onlinelibrary.wiley.com/doi/10.1002/sta4.395.

[1] Tyler Chen and Erin C. Carson. "Predict-and-recompute conjugate gradient variants". In: *SIAM Journal on Scientific Computing* 42.5 (Jan. 2020), A3084–A3108. arXiv: 1905.01549 [cs.NA]. URL: https://doi.org/10.1137/19m1276856.

- abridged version was Student Paper Competition winner at 16th Copper Mountain Conference on Iterative Methods

Teaching

Instructor, Numerical Analysis (NYU MATH-UA 252) ..... *spring 2023*
Instructor, Mathematical Statistics (NYU MATH-UA 234) ..... *fall 2022*
Instructor, Applied Linear Algebra and Numerical Analysis (UW AMATH 352) ..... *spring 2021*
Instructor, Interdisciplinary Writing/Natural Science (UW ENGL 199) ..... *winter 2021*
Instructor, Interdisciplinary Writing/Natural Science (UW ENGL 199) ..... *autumn 2020*
TA, Probability and Statistics for Computational Finance (UW CFRM 410) ..... *winter 2019*
TA, Calculus with Analytic Geometry I (UW MATH 124) ..... *autumn 2018*
TA, Calculus with Analytic Geometry II (UW MATH 12) ..... *winter 2018*
TA, Calculus with Analytic Geometry II (UW MATH 125) ..... *autumn 2017*
TA, Electronics (Tufts PHY 41) ..... *spring 2017*
TA, Electronics (Tufts PHY 41) ..... *spring 2016*
Grader, Discrete Mathematics (Tufts MATH 61) ..... *spring 2016*
Grader, Calculus III (Tufts MATH 42) ..... *fall 2015*
Grader, Differential Equations (Tufts MATH 51) ..... *spring 2015*
Grader, Calculus III (Tufts MATH 42) ..... *fall 2014*

Awards & Honors

Boeing Research Award (UW Department of Applied Mathematics) *2020*
Student Paper Competition Winner (Copper Mountain Conference on Iterative Methods) *2020*
Graduate Research Fellowship (NSF) *2019*
Top Scholars Fellowship (UW) *2017*
The Audrey Butvay Gruss Science Award (Tufts) *2017*
Phi Beta Kappa (Tufts) *2017*
Sigma Pi Sigma Physics Honors Society (Tufts) *2016*
The Howard Sample Prize Scholarship in Physics (Tufts) *2015*

Talks and Posters

[10] *Randomized matrix-free qudrature*. Presentation at Courant Numerical Analysis and Scientific Computing Seminar. Sept. 2022. [pdf]

[9] *GMRES, pseudospectra, and Crouzeix's conjecture for shifted and scaled Ginbre matrices*. Presentation at Conference on Random Matrix Theory and Numerical Linear Algebra. June 2022. [pdf]

[8] *Simple Algorithms for Spectral Sum and Spectrum Approximation*. Poster at Workshop on Algorithms for Large Data (Online). Aug. 2021. [pdf]

[7] *Analysis of stochastic Lanczos quadrature for spectrum approximation*. Oral at International Conference on Machine Learning. July 2021. [video]

[6] *Concentration in the Lanczos Algorithm*. Presentation at SIAM Linear Algebra 21. May 2021. [pdf]

[5] *Analysis of stochastic Lanczos quadrature for spectrum approximation*. Presentation at at Baidu Research. Mar. 2021. [pdf]

[4] *Analyzing the Effects of Local Roundoff Error on Predict-and-Recompute Conjugate Gradient Variants*. Poster at Householder Symposium (Cancelled). June 2020.

[3] *Predict-and-recompute conjugate gradient variants*. Presentation at Copper Mountain Student Paper Award Session (Cancelled). Mar. 2020.

[2] *Predict-and-recompute conjugate gradient variants*. Presentation at SIAM Parallel Processing. Feb. 2020. [pdf]

[1] *Symmetric Preconditioner Refinement Using Low Rank Approximations*. Presentation at Baidu Research. Feb. 2019.

Service and Outreach

Minisymposium Organizer ..... *may 2021*
Random matrices and numerical linear algebra (at SIAM Linear Algebra 21, co-organized with Thomas Trogdon) [program]

Graduate Student Representative ..... *2019 - 2020*
Represent interests of graduate students to the department

Minisymposium Organizer ..... *feb. 2020*
High performance Krylov subspace methods: Theory, Implementation, and Application (at SIAM Parallel Processing 20) [program]

Diversity Committee Departmental Climate Orientation ..... *oct. 2019*
Panelist for event focused on building an inclusive department culture

Numerical Analysis Research Club ..... *2019 - 2020*
Organize and plan weekly meetings for NARC

Washington Directed Reading Program ..... *autumn 2019*
Mentor for WDRP

SIAM UW Mental Health Conversation and Resources ..... *oct. 2018*

Organize and facilitate a discussion about mental health in grad school

Software

PETSc (https://www.mcs.anl.gov/petsc/)
Contribute PIPEPRCG. This method can be used by with the flag `-ksp_type pipeprcg`.

Research code (https://github.com/tchen-research)
Code to generate figures and experiments from my papers