Tyler Chen

tyler.chen@nyu.edu
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. 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 with the ultimate goal of supporting the advancement of knowledge in the basic sciences.

Papers (in progress)

[9] Tyler Chen, Robert Chen, Kevin Li, Skai Nzeuton, Yilu Pan, and Yixin Wang. "Faster randomized partial trace estimation". 2023. arXiv: 2310.12364 [math.NA].

[8] David Persson, Tyler Chen, and Christopher Musco. "Randomized block Krylov subspace methods for low rank approximation of matrix functions". 2023.

[7] Tyler Chen, Anne Greenbaum, and Natalie Wellen. "Optimal Polynomial Approximation to Rational Matrix Functions Using the Arnoldi Algorithm". 2023. arXiv: 2306.17308 [math.NA].

[6] 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].

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

[4] Noah Amsel, Tyler Chen, Anne Greenbaum, Cameron Musco, and Chris Musco. "Near-Optimality Guarantees for Approximating Rational Matrix Functions by the Lanczos Method". 2023. arXiv: 2303.03358 [math.NA].

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

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

[1] Tyler Chen, Thomas Trogdon, and Shashanka Ubaru. "Randomized matrix-free quadrature for spectrum and spectral sum approximation". 2022. arXiv: 2204.01941 [math.NA]. INTRO: https://research/chen.pw/intros/randomized_quadrature.html

Papers (published)

[9] Tyler Chen. "A spectrum adaptive kernel polynomial method". In: *The Journal of Chemical Physics* 159.11 (Sept. 2023), p. 114101. arXiv: 2308.15683 [physics.comp-ph]. INTRO: https://research/chen.pw/intros/spectrum_adaptive_kpm.html

  – This approach is implemented in the spectral_density package

[8] Tyler Chen and Eric Hallman. "Krylov-Aware Stochastic Trace Estimation". In: *SIAM Journal on Matrix Analysis and Applications* 44.3 (Aug. 2023), pp. 1218–1244. arXiv: 2205.01736 [math.NA].

[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* 44.2 (May 2023), pp. 670–692. 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]. INTRO: https://research/chen.pw/intros/mean_force.html

[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]. INTRO: https://research/chen.pw/intros/lanczos_function_CIF.html

[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, July 2021, pp. 1728–1739. arXiv: 2105.06595 [cs.DS].

  – 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].

[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].

[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].

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

Student Mentoring

Research projects

Ismael Jiminez (NYU) .... 2023 - present
Robert Chen (NYU) .... 2023 - present
Kevin Li (NYU) .... 2022 - present
Skai Nzeuton (Stuyvesant High School) .... 2022 - present
Yilu Pan (NYU Shanghai) .... 2022 - present
Yixin Wang (NYU) .... 2023 - present
Qichen Xu (UW) .... 2021 - 2023

Independent studies/directed readings

Ismael Jiminez (NYU) .... summer 2023
Yue Geng (NYU) .... summer/fall 2023
Linda Zhao (NYU) .... summer/fall 2023
Aeron Langford (UW) .... autumn 2019

Teaching

Instructor, Numerical Analysis (NYU MATH-UA 252) .... fall 2023
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

Talks and Posters

[17] "Peering into the black box: Krylov-aware stochastic trace estimation". Presentation at SIAM New York, New Jersey, and Pennsylvania Annual Meeting. Newark, NJ, Oct. 2023.

[16] "Lanczos-based typicality methods for Quantum Thermodynamics". Presentation at Universität Bielefeld. Virtual, Oct. 2023.

[15] "Krylov subspace methods for matrix function trace approximation". Presentation at NYU Shanghai. Shanghai, China, Aug. 2023.

[14] "Krylov-aware low-rank approximation". Presentation at International Congress on Industrial and Applied Mathematics. Tokyo, Japan, Aug. 2023.

[13] "Randomized trace estimation". Presentation at Sampling Theory and Applications Conference. New Haven, CT, July 2023.

[12] "Randomized matrix-free quadrature". Presentation at Foundations of Computational Mathematics. Paris, France, June 2023.

[11] "Stochastic trace estimation and quantum typicality: a case study in interdisciplinary research". Presentation at Perspectives on Matrix Computations: Theoretical Computer Science Meets Numerical Analysis. Banff, AB, Mar. 2023.

[10] "Randomized matrix-free qudrature". Presentation at Courant Numerical Analysis and Scientific Computing Seminar. New York, NYU, Sept. 2022.

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

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

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

[6] "Concentration in the Lanczos Algorithm". Presentation at SIAM Linear Algebra 21. Virtual, May 2021.

[5] "Analysis of stochastic Lanczos quadrature for spectrum approximation". Presentation at at Baidu Research. Seattle, WA, Mar. 2021.

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

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

[2] "Predict-and-recompute conjugate gradient variants". Presentation at SIAM Parallel Processing. Seattle, WA, Feb. 2020.

[1] "Symmetric Preconditioner Refinement Using Low Rank Approximations". Presentation at Baidu Research. Seattle, WA, Feb. 2019.

Service and Outreach

Proud to Be First Faculty Connect 2023-2024

Serve as mentor for Proud to Be First Faculty Connect, which pairs second-year, first-generation students with faculty

NYU SIAM podcast .... oct. 2023

Discuss my path as a mathematician, and advice for students, etc.

NYU SIAM Grad School Info Session .... oct. 2022

Panelist for Q/A session for students interested in grad school

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

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

Organize and facilitate a discussion about mental health in grad school

Software

Research code (https://github.com/tchen-research)

Repositories with code to generate figures and experiments from my papers.

Spectral Density (https://pypi.org/project/spectral-density/)

Develop `spectral_density` package to efficiently produce spectrum adaptive KPM approximations.

PETSc (https://www.mcs.anl.gov/petsc/)

Contribute `PIPEPRCG`. This method can be used by with the flag `-ksp_type pipeprcg`.

mpmath (https://github.com/mpmath)

Update matrix multiplication driver to significantly improve performance for sparse matrices.

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