HAIZHAO YANG

Department of Mathematics
Purdue Universify
United States

Phone: +1 (984) 218-7016
Email: haizhao@purdue.edu
Homepage: http://haizhaoyang.github.io

CURRENT POSITION

Assistant Professor 2019.8 - Now
Department of Mathematics
Purdue University, US

Assistant Professor 2017.10 - 2019.8
Department of Mathematics
Affiliate, Institute of Data Science 2019.1-2019.8
National University of Singapore, Singapore

PREVIOUS POSITION

Visiting Assistant Professor, Duke University, US 2015 - 2017
Mentors: Ingrid Daubechies and Jianfeng Lu

EDUCATION

Ph.D. in Mathematics, Stanford University, US 2015
Advisor: Lexing Ying
M.S. in Mathematics, University of Texas at Austin, US 2012
B.S. in Mathematics, Shanghai Jiao Tong University, China 2010

HONORS

NSF CAREER Award. 2020-2015
PRF International Travel Grant, USD 2,033. 2020
AMS Simons Travel Award, USD 4,000. 2015-2017
Duke Faculty Travel Support, USD 2,000. 2015-2017
SIAM Early Career Travel Award 2015
SIAM Student Travel Award 2013-15
Shanghai Outstanding Graduate, Shanghai Government 2010
First prize of senior thesis, Department of Mathematics, Shanghai Jiao Tong University 2010
National scholarship, Chinese Ministry of Education 2009
Scholarship of Chinese Academy of Sciences 2008

PUBLICATIONS

Preprints

1. Qiyuan Pang[+†], Yihui Tu[+†], Zhenli Xu, **Haizhao Yang**. Solving fluctuation-enhanced PoissonBoltzmann Equations Based on Selected Inversion via Hierarchical Interpolative Factorization. In preparation.

2. Jianfeng Lu[+*], Zuowei Shen[+], **Haizhao Yang**[+], Shijun Zhang[+†]. Deep Network Approximation for Smooth Functions. Submitted to Duke Mathematical Journal.
3. Yiqi Gu[†], **Haizhao Yang**[*], Chao Zhou. SelectNet: Self-Paced Learning for High-Dimensional Partial Differential Equations. Submitted to SIAM Journal of Scientific Computing.
4. John Harlim[+*], Shixiao Jiang[+], Senwei Liang[+†], **Haizhao Yang**[+]. Machine Learning for Prediction with Missing Dynamics. arXiv:1910.05861 [math.NA]. Submitted to Journal of Computational Physics.
5. Jianguo Huang[+], Haoqin Wang[+], **Haizhao Yang**[+*], Int-Deep: A Deep Learning Initialized Iterative Method For Nonlinear Problems. arXiv:1910.01594 [math.NA]. Submitted to Journal of Computational Physics.
6. Ze Chen[†], Juan Zhang, Kenneth L. Ho, **Haizhao Yang**[*], Multidimensional Phase Recovery and IDBF for Fast Oscillatory Integral Transforms. arXiv:1908.09376 [math.NA]. Submitted to Journal of Computational Physics.
7. Zuowei Shen[+], **Haizhao Yang**[+*], Shijun Zhang[+†]. Deep Network Approximation Characterized by Number of Neurons. arXiv:1906.05497 [math.NA]. Submitted to JMLR.
8. Yunru Liu[†], Tingran Gao, **Haizhao Yang**[*], SelectNet: Learning to Sample from the Wild for Imbalanced Data Training. arXiv:1905.09872 [cs.LG]. Submitted to MSML.
9. Yong-Zheng Ong[†], Charles K. Chui, **Haizhao Yang**[*], CASS: Cross Adversarial Source Separation via Autoencoder. arXiv:1905.09877 [cs.LG]. Submitted to IEEE Signal Processing Letters.
10. Lin Chen[†], **Haizhao Yang**[*], Generative Imaging and Image Processing via Generative Encoder. arXiv:1905.13300 [eess.IV]. Submitted to NeurIPS.
11. Hadrien Montanelli, **Haizhao Yang**[*], Qiang Du, Deep ReLU Networks Overcome the Curse of Dimensionality for Bandlimited Functions. arXiv:1903.00735 [math.NA]. Submitted to Journal of Computational Mathematics.
12. Senwei Liang[†], Yuehaw Kwoo, **Haizhao Yang**[*]. Drop-Activation: Implicit Parameter Reduction and Harmonic Regularization. arXiv:1811.05850 [cs.LG]. Submitted to Communication on Applied Mathematics and Computation.
13. James Bremer[+], Qiyuan Pang[+†], **Haizhao Yang**[+*]. Fast Algorithms for Multi-Dimensional Jacobi Polynomial Transformations. arXiv:1901.07275 [math.NA]. Minor revision, Applied and Computational Harmonic Analysis.
14. Qiyuan Pang[†], Kenneth L. Ho, **Haizhao Yang**[*]. Interpolative Decomposition Butterfly Factorization. arXiv:1809.10573 [math.NA]. Submitted to SIAM Journal of Scientific Computing.
15. Jieren Xu, Yitong Li, David Dunson, Ingrid Daubechies, **Haizhao Yang**[*]. Non-Oscillatory Pattern Learning for Non-Stationary Signals. arXiv:1805.08102 [stat.ML]. Submitted to NIPS.
16. Gao Tang[†], **Haizhao Yang**[*], A Fast Algorithm for Multiresolution Mode Decomposition. arXiv:1712.09338 [math.NA]. Minor revision, SIAM Multiscale Modeling and Simulation.
17. Ling Li, **Haizhao Yang**, Jinjin Zhong, Katherine R. Phillips, Jianfeng Lu, Joanna Aizenberg. Microscopic Origins of the Crystallographic Growth in Colloidal Self-assemblies. Submitted to Nature.
18. Yingzhou Li[+], **Haizhao Yang**[+*], Interior Eigensolver for Sparse Hermitian Definite Matrices Based on Zolotarevs Functions. arXiv:1701.08935v1 [math.NA]. Submitted to Communication of Mathematical Sciences.

Journal Publications

19. Hadrien Montanelli[+*], **Haizhao Yang**[+], Error Bounds for Deep ReLU Networks using the Kolmogorov–Arnold Superposition Theorem. arXiv:1906.11945 [math.NA]. To appear, Neural Networks.
20. Tao Zhang[†], Ling Li, **Haizhao Yang**[*]. 3D Atomic Crystal Analysis via Fast Synchrosqueezed Transform. arXiv:1811.05186 [math.NA]. To appear, Communication of Mathematical Sciences.

21. **Haizhao Yang***. Multiresolution Mode Decomposition for Adaptive Time Series Analysis. arXiv:1709.06880 [math.NA]. In press, Applied and Computational Harmonic Analysis. https://doi.org/10.1016/j.acha.2019.09.006

22. Yang Liu^{+}, **Haizhao Yang**$^{+*}$. A Hierarchical Butterfly LU Preconditioner for Two-Dimensional Electromagnetic Scattering Problems Involving Open Surfaces. Journal of Computational Physics, al of Computational Physics, Volume 401, 15 January 2020, Pages 109-014.

23. Katherine R. Phillips, Cathy T. Zhang, Ting Yang, Theresa Kay, Chao Gao, Soren Brandt, Lei Liu, **Haizhao Yang**, Yaning Li, Joanna Aizenberg, Ling Li*. Fabrication of Photonic Microbricks via Crack Engineering of Colloidal Crystals. Advanced Functional Materials, 2019. https://doi.org/10.1002/adfm.201908242

24. Zuowei Shen^{+}, **Haizhao Yang**$^{+*}$, Shijun Zhang$^{+\dagger}$. Nonlinear Approximation via Compositions. Neural Networks, Volume 119, November 2019, Pages 74-84.

25. James Bremer^{+*}, **Haizhao Yang**$^{+}$, Fast algorithms for Jacobi expansions via nonoscillatory phase functions. IMA Journal of Numerical Analysis, 04, 2019. ISSN 0272-4979.

26. **Haizhao Yang***, A Unified Framework for Oscillatory Integral Transforms: When to Use NUFFT or Butterfly factorization? Journal of Computational Physics, Volume 388, 1 July 2019, Pages 103-122.

27. Jianfeng Lu^{+}, **Haizhao Yang**$^{+*}$. Phase Space Sketching for Crystal Image Analysis Based on Synchrosqueezed Transforms. SIAM Journal on Imaging Science, 11(3), 1954-1978, 2018.

28. Victor Wen-zhe Yu, Fabiano Corsetti, Alberto García, William P. Huhn, Mathias Jacquelin, Weile Jia, Björn Lange, Lin Lin, Jianfeng Lu, Wenhui Mi, Ali Seifitokaldani, Álvaro Vázquez-Mayagoitia, Chao Yang, **Haizhao Yang**, Volker Blum*, ELSI: A Unified Software Interface for Kohn-Sham Electronic Structure Solvers. Compute Physics Communications, Volume 222, January 2018, Pages 267-285.

29. Jieren Xu, **Haizhao Yang***, and Ingrid Daubechies, Recursive Diffeomorphism-Based Regression for Shape Functions. SIAM Journal on Mathematical Analysis, 50(1), 5-32, 2018.

30. Yingzhou Li^{+}, **Haizhao Yang**$^{+*}$ and Lexing Ying. Multidimensional Butterfly Factorization. Applied and Computational Harmonic Analysis, Volume 44, Issue 3, May 2018, Pages 737-758.

31. John Harlim^{+*}, **Haizhao Yang**$^{+}$. Diffusion Forecasting Model with Basis Functions from QR Decomposition. Journal of Nonlinear Science, 2017. https://doi.org/10.1007/s00332-017-9430-1.

32. Jianfeng Lu^{+} and **Haizhao Yang**$^{+*}$. A Cubic Scaling Algorithm for Excited States Calculations in Particle-Particle Random Phase Approximation. Journal of Computational Physics, Volume 340, 1 July 2017, Pages 297-308.

33. **Haizhao Yang***. Statistical Analysis of Synchrosqueezed Transforms. Applied and Computational Harmonic Analysis, Volume 45, Issue 3, November 2018, Pages 526-550.

34. Yingzhou Li^{+}, and **Haizhao Yang**$^{+*}$. Interpolative Butterfly Factorization. SIAM Journal on Scientific Computing, 39(2), A503-A531, 2017.

35. Jianfeng Lu^{+} and **Haizhao Yang**$^{+*}$. Preconditioning Orbital Minimization Method for Planewave Discretization. SIAM Multiscale Modeling and Simulation, 15(1), 254-273, 2017.

36. Bruno Cornelis, **Haizhao Yang***, Alex Goodfriend, Noelle Ocon, Jianfeng Lu, and Ingrid Daubechies, Removal of Canvas Patterns in Digital Acquisitions of Painting. IEEE Transactions on Image Processing, 26(1):160-171, 2017.

37. Jianfeng Lu^{+}, Benedikt Wirth^{+} and **Haizhao Yang**$^{+*}$. Combining 2D Synchrosqueezed Wave Packet Transform with Optimization for Crystal Image Analysis. Journal of the Mechanics and Physics of Solids, 89:194-210, 2016.

38. **Haizhao Yang***, Jianfeng Lu and Lexing Ying. Crystal Image Analysis Using 2D Synchrosqueezed Transforms. SIAM Multiscale Modeling and Simulation, 13(4), 1542-1572, 2015.

39. Yingzhou Li, **Haizhao Yang**, Eileen Martin, Kenneth L. Ho and Lexing Ying*. Butterfly factorization. SIAM Multiscale Modeling and Simulation, 13(2), 714-732, 2015.

40. Yingzhou Li[+], **Haizhao Yang**[+*] and Lexing Ying[+]. A Multiscale Butterfly Algorithm for Multidimensional Fourier Integral Operators. SIAM Multiscale Modeling and Simulation, 13(2), 614-631, 2015.
41. **Haizhao Yang**, Jianfeng Lu[*], William P. Brown, Ingrid Daubechies, and Lexing Ying, Quantitative Canvas Weave Analysis Using 2D Synchrosqueezed Transforms: Application of Time-Frequency Analysis to Art Investigation. Signal Processing Magazine, IEEE, 32(4):55-63, July 2015.
42. **Haizhao Yang**[*]. Synchrosqueezed Wave Packet Transforms and Diffeomorphism Based Spectral Analysis for 1D General Mode Decompositions, Applied and Computational Harmonic Analysis, 39(1):33-66, 2015.
43. **Haizhao Yang**[+*] and Lexing Ying[+]. Synchrosqueezed Curvelet Transform for Two-Dimensional Mode Decomposition, SIAM Journal on Mathematical Analysis, 46(3):2052-2083, 2014.
44. **Haizhao Yang**[+*] and Lexing Ying[+]. Synchrosqueezed Wave Packet Transform for 2D Mode Decomposition, SIAM Journal on Imaging Science, 6(4):1979-2009, 2013.
45. **Haizhao Yang**[+] and Lexing Ying[+*]. A Fast Algorithm for Multilinear Operators, Applied and Computational Harmonic Analysis, 33(1):148-158, 2012.
46. Zhenli Xu[*], Xiaolin Cheng and **Haizhao Yang**. Treecode-Based Generalized Born Method, J. Chem. Phys., 134(6):064-107, 2011.

Conference Proceedings

1. Senwei Liang[+†], Zhongzhan Huang[+], Mingfu Liang, **Haizhao Yang**[*], Instance Enhancement Batch Normalization: an Adaptive Regulator of Batch Noise. arXiv:1908.04008 [cs.LG]. Proceedings of the AAAI Conference on Artificial Intelligence, 2020.
2. Zhongzhan Huang[+], Senwei Liang[+†], Mingfu Liang, **Haizhao Yang**[*], DIANet: Dense-and-Implicit Attention Network. arXiv:1905.10671 [cs.CV]. Proceedings of the AAAI Conference on Artificial Intelligence, 2020.

[+] equal contribution; [*] corresponding author; [†] student or postdoc mentored.

TEACHING EXPERIENCE

- Purdue University Spring 2020
  Instructor in **MA 30300**: This is a methods course for juniors in any branch of engineering and science. Basic techniques for solving systems of linear ordinary differential equations. Series solutions for second order equations, including Bessel functions, Laplace transform, Fourier series, numerical methods, separation of variables for partial differential equations and Sturm-Liouville theory.
- National University of Singapore Term II 2017-2019
  Instructor in **Mathematical Theory and Applications of Deep Learning (graduate level)**: Part I: machine learning basics; deep feedforward networks; convolutional networks; advanced network design; Part II: approximation theory of deep neural networks; stochastic optimization methods; regularization for deep learning; generalization error of deep neural networks; Part III: sparse and structured computation; sequence modeling: recurrent and recursive nets; deep reinforcement learning; deep generative models; distributed and decentralized learning.
- National University of Singapore Term II 2018-2019
  Instructor in **Modeling and Numerical Simulation (graduate level)**: This module is designed for graduate students in mathematics. It focuses on modelling problems in real life and other disciplines into mathematical problems and simulating their solutions by scientific computing methods. Major topics covered include modelling and numerical simulations in selected areas of physical and engineering sciences, biology, finance, imaging and optimisation.

- National University of Singapore Term I 2018-2019
  Instructor in **Convex Optimization (undergraduate level)**: modeling examples and basic concepts of optimization; convex functions and properties; gradients and subgradients; gradient methods; sub-gradient methods; Newton-type algorithms and the Barzilai-Borwein method; constrained optimization; accelerated proximal gradient methods; stochastic block coordinate descent methods; convex conjugacy and duality; splitting algorithms and implementations; CVX Matlab software for convex programming.
- National University of Singapore Term I 2017-2018
  Instructor in **Matrix Computation (undergraduate level)**: QR factorization, singular value decomposition, condition numbers, stability, perturbation analysis, least squares problems, eigen value problems.
- Duke University Spring 2017
  Instructor in **Math 532**: **Basic analysis II (undergraduate level)**: Fourier and wavelet analysis, differential and integral calculus in R^n, low-dimensional manifolds, inverse and implicit function theorems.
- Duke University Fall 2016
  Instructor in **Math 561**: **Scientific computing I (graduate level)**: direct and iterative solvers for dense and sparse linear systems, QR factorization, eigen decomposition, sparse matrix factorizations, basic parallel computation.
- Duke University Autumn 2015 and Spring 2016
  Instructor in **Math 353 Ordinary differential equations and partial differential equations.**

CONTRIBUTED PACKAGES

Familiar with high performance computing with C/C++, Fortran, Matlab and Python in distributed and parallel computing environment.

- **ButterflyLab** 2014-now
  - Optimal complexity for evaluating multidimensional Fourier integral operators, special function transforms, and Green's functions in 1D to 3D integral equations for high-frequency wave propagation.
  - Optimal complexity preconditioners for high-frequency wave equations.
  - The latest version of ButterflyLab for solving large-scale dense linear systems is organized and coded by Haizhao Yang and is available at https://github.com/ButterflyLab/ButterflyLab.
- **ButterflyPACK** 2018-now
  - A mathematical software for rapidly solving large-scale dense linear systems that exhibit off-diagonal rank-deficiency. These systems arise frequently from boundary element methods, or factorization phases in finite-differenece/finite-element methods.
  - Relies on low-rank or butterfly formats under Hierarchical matrix, HODLR or other hierarhically nested frameworks to compress, factor and solve the linear system in quasi-linear time.
  - The butterfly format, originally inspired by the butterfly data flow in fast Fourier Transform, is a linear algebra tool well-suited for compressing matrices arising from high-frequency wave equations or highly oscillatory integral operators.
  - The distributed and parallel version is available at https://github.com/liuyangzhuan/ButterflyPACK by Yang Liu. The sequential MATLAB version is referred to ButterflyLab right above by Haizhao Yang.
- **ELSI** 2015-now

- ELSI provides and enhances scalable, open-source software library solutions for electronic structure calculations in materials science, condensed matter physics, chemistry, molecular biochemistry, and many other fields. ELSI focuses on methods that solve or circumvent the Kohn-Sham eigenvalue problem in density-functional theory. The ELSI infrastructure should also be useful for other challenging eigenvalue problems.
- One of the key design pillars of ELSI is portability and support for various computing environments, from laptop-type computers all the way to the most efficient massively parallel supercomputers and new architectures (GPU and manycore processors).
- Available at https://wordpress.elsi-interchange.org/.

- **ZoloEig** 2016-now
  - Interior eigenvalue solver based on fast direct solver and the best high order rational function approximation to step functions.
  - Can be implemented in spectrum slicing libraries for full diagonalization.
  - Can also be used to compute leading eigenpairs.
  - Available at http://www.math.nus.edu.sg/~matyh/codes/ZoloEig.tar.gz.
- **PSP** 2015-now
  - The PSP is an extensible distributed-memory parallel library offering a basic set of linear algebra primitives.
  - It achieves scalability and load balance via its 2D block cyclic distribution.
  - Rountines for sparse data types includes (sparse) matrix (sparse) vector multiplication, (sparse) matrix (sparse) matrix multiplication, etc.
  - Supports several sparse format, e.g. COO, CSC, and CSR.
  - Similar user habits with Scalapack.
  - Available at https://github.com/HaizhaoYang/PSP.
- **DeCom** 2014-2016
  - 1D to 3D Synchrosqueezed wave packet transforms for analyzing instantaneous/local properties of non-linear oscillatory signals in a superposition.
  - 2D synchrosqueezed curvelet transforms for analyzing local properties of banded textures in a superposition.
  - Application examples in atomic materials science, wave propagation in geophysics, biological and medical signals, and canvas painting art investigation.
  - Available at https://github.com/HaizhaoYang/DeCom.
- **SynCrystal** 2015-now
  - A MATLAB toolbox for atomic crystal analysis based on synchrosqueezed transforms and variational optimization.
  - Automatic tool for classifying crystal lattices, identifying grain boundaries, isolated defects, estimating grain orientation and elastic deformation.
  - Fast analysis for 2D and 3D atomic scale crystal data.
  - Available https://github.com/SynCrystal/SynCrystal.

INVITED COLLOQUIUM TALKS

$O(N \log^{\alpha} N)$ matvec and preconditioners for highly oscillatory kernels, Colloquium, Department of Mathematics and Statistics, University of North Carolina at Charlotte, October 4, 2019

INVITED SEMINAR TALKS

Deep Network Approximation. CAM Colloquium, Committee on Computational and Applied Mathematics, Department of Statistics, The University of Chicago, April 23, 2020

Fast Algorithms for Deep Learning-Based PDE Solvers. Applied Math Seminar, Department of Mathematics, University of California, Irvine, January 13, 2019

Deep Network Approximation. Applied Math Seminar, Department of Mathematics, The Pennsylvania State University, December 2, 2019

Fast Algorithms for Deep Learning Based PDE Solvers, Applied Math Seminar, Department of Mathematics, Hong Kong University, November 18, 2019 (canceled due to campus violence)

Deep Network Approximation. Applied Math Seminar, Department of Mathematics, Texas Tech University, November 6, 2019

Deep Network Approximation. Applied Math Colloquium, Department of Mathematics, University of North Carolina at Chapel Hill, September 27, 2019

Regularization Methods for Deep Learning. Computer Science Seminar, School of Electronics, Information and Electrical Engineering, Shanghai Jiao Tong University, June, 2019

Regularization Methods for Deep Learning. Applied Math Seminar, School of Mathematics, Shanghai Jiao Tong University, June, 2019

Approximation Theory and Regularization in Deep Learning. Applied Math Seminar, Nanyang Technological University, May, 2019

Approximation Theory and Regularization in Deep Learning. Applied Math and Analysis Seminar, Duke University, February, 2019

$O(N \log^{\alpha} N)$ matvec and preconditioners for highly oscillatory kernels. Applied and Computational Mathematics Seminar, Department of Mathematics, National University of Singapore, February, 2019

$O(N \log^{\alpha} N)$ matvec and preconditioners for highly oscillatory kernels. Applied Math Colloquium, Department of Mathematics, Purdue University, January, 2019

$O(N \log N)$ algorithms for matrix multiplications from highly oscillatory phenomena, Applied Mathematics Seminar, School of Mathematics, Shanghai Jiao Tong University, December, 2018

$O(N \log N)$ algorithms for matrix multiplications from highly oscillatory phenomena, Applied Mathematics Colloquium, Department of Applied Physics and Applied Mathematics, Columbia University, October, 2018

A Unified Framework for Oscillatory Integral Transform: When to Use NUFFT or Butterfly factorization? Applied & Computational Math Seminar, Department of Mathematics, University of Wisconsin-Madison, February, 2018

A Unified Framework for Oscillatory Integral Transform: When to Use NUFFT or Butterfly factorization? Applied Math Colloquium, Department of Mathematics, Purdue University, February, 2018

Spectrum Slicing for Sparse Hermitian Definite Matrices Based on Zolotarevs Functions, Department of Mathematics, Hong Kong Baptist University, March, 2017

Scientific Computing in Imaging and Image Analysis at the Atomic Scale. Lawrence Berkeley National Laboratory, March, 2017

Data-Driven Mathematical Analysis and Scientific Computing for Oscillatory Data, Department of Mathematics, Johns Hopkins University, February, 2017

Data-Driven Mathematical Analysis and Scientific Computing for Oscillatory Data, Department of Mathematics, National University of Singapore, February, 2017

Data-Driven Mathematical Analysis and Scientific Computing for Oscillatory Data, Computational and Applied Mathematics Colloquium, Department of Mathematics, The Pennsylvania State University, February, 2017

Data-Sparse Structures and their Applications in the Electronic Structure Calculation, CCMA Luncheon Seminar, Department of Mathematics, The Pennsylvania State University, February, 2017

Data-Driven Mathematical Analysis and Scientific Computing for Oscillatory Data, Colloquium, Department of Mathematics, University of California, Davis, January, 2017
Data-Driven Mathematical Analysis and Scientific Computing for Oscillatory Data, Colloquium, Department of Mathematics, University of California, Irvine, January, 2017
Data-Driven Mathematical Analysis and Scientific Computing for Oscillatory Data, Department of Mathematics, Hong Kong University of Science and Technology, January, 2017
Data-Driven Mathematical Analysis and Scientific Computing for Oscillatory Data, Computational and Applied Math Seminar, Department of Mathematics, University of California, San Diego, December, 2016
A Cubic Scaling Algorithm to Calculate Excited States Based on PP-RPA, Research Colloquium, Department of Mathematics, Southern Methodist University, November, 2016
Data-Driven fast algorithms in Applied Harmonic Analysis and Numerical Linear Algebra, Applied Math and Analysis Seminar, Duke University, October, 2016
Variational Models for Crystal Image Analysis, Hong Kong University of Science and Technology, June, 2016
Preconditioning Orbital Minimization Method for Planewave Discretization, Shanghai Jiao Tong University, Shanghai, China, June, 2016.
Butterfly Algorithm and Butterfly Factorization. Shanghai Jiao Tong University, Shanghai, China, June, 2016
Butterfly Algorithm and Butterfly Factorization. Applied Mathematics Colloquium. University of North Carolina at Chapel Hill. March 4, 2016

INVITED CONFERENCE

Multiresolution Mode Decomposition: Theory and Fast Algorithm, NoSAG20 Summer School and Conference, Gran Sasso Science Institute, L'Aquila, Italy, July 13-18, 2020
$O(N \log^{\alpha} N)$ matvec and preconditioners for highly oscillatory kernels, Mini-Symposium on "Non-local Operators for Scattering Problems: Analysis and low-rank approximation", International Conference on Spectral and High-Order Methods, Vienna, July 6-10, 2020
Deep Network Approximation, Mini-Symposium on "Deep Numerical Analysis and Optimization for PDEs", International Conference on Spectral and High-Order Methods, Vienna, July 6-10, 2020
Outstanding Challenges in Computational Methods for Integral Equations, Casa Matemática Oaxaca (CMO) Workshop, Banff International Research Station for Mathematical Innovation and Discovery (BIRS), Sunday, May 31 to Friday, June 5, 2020
Deep Network Approximation, Mini-Symposium on "Machine learning for interatomic potentials", SIAM Conference on Mathematical Aspects of Materials Science, BCAM, Bilbao, Spain, May 18-22, 2020
On the Curse of Dimensionality of Deep Network Approximation, Mini-Symposium on "Machine Learning on data with low dimensional structures", SIAM Conference on Mathematics of Data Science, Cincinnati, Ohio, May 7-9, 2020
Fundamental Limits of Deep Learning Approaches for Scientific Computing, Special Session on "Contemporary Applications of Gradient Flows and Variational Methods", 2020 AMS Spring Sectional Meeting at Purdue University, West Lafayette, US, April 4-5, 2020
Machine Learning for Missing Dynamics, Mini-symposium on "Classic and Deep Learning Methods for Data Driven Models", the 44th SIAM Southeastern Atlantic Section meeting, March 14-15, 2020 at Auburn University
Fast Algorithms for Deep Learning Based PDE Solvers, Mini-Symposium on "Recent Developments in Numerical Analysis of PDEs and Their Applications", SIAM Conference on Analysis of Partial Differential Equations, December 11-14, 2019
Fast Algorithms for Deep Learning Based PDE Solvers, NUS-IMS Workshop: Modeling and Simulation for Quantum Condensation, Fluids and Information: November 18-22, 2019, Singapore
Fundamental Limits of Deep Learning Approaches for Scientific Computing, Mini-Symposium on "Machine Learning for Solving PDEs and Inverse Problems", 2nd Annual Meeting of the SIAM Texas-Louisiana Section, November, 2019
Fundamental Limits of Deep Learning Approaches for Scientific Computing, Mini-Symposium on "Numerical Methods and Deep Learning for PDEs", Conference on Computational Mathematics and Applications

(CCMA) University of Nevada, Las Vegas October 25 - 27, 2019
On the Curse of Dimensionality of Deep Network Approximation, Second Conference on Scientific and Engineering Computing for Young Chinese Scientists, Beijing, China, August, 2019
$O(N \log^{\alpha} N)$ matvec and preconditioners for highly oscillatory kernels, International Council for Industrial and Applied Mathematics (ICIAM), Spain, July, 2019
Fast Algorithms for Calculating Excited States in PP-RPA, International Council for Industrial and Applied Mathematics (ICIAM), Spain, July, 2019
Approximation Theory of Deep Learning in Scientific Computing, Workshop on Machine Learning Techniques in Scientific Computing. Wuhan University, China. June, 2019
Approximation Theory of Deep Learning in Scientific Computing, Young Researcher Workshop on Uncertainty Quantification and Machine Learning, Institute of Natural Sciences, Shanghai Jiao Tong University, June, 2019
Drop-Activation: Implicit Parameter Reduction and Harmonic Regularization, 3rd NUPRI Workshop, Faculty of Engineering, National University of Singapore, 17 May 2019
$O(N \log^{\alpha} N)$ matvec and preconditioners for highly oscillatory kernels, the BIRS-CMO Workshop on "Outstanding Challenges in Computational Methods for Integral Equations" on May 31 - June 5, 2020, at Casa Matemática Oaxaca, Mexico
$O(N \log N)$ algorithms for matrix multiplications from highly oscillatory phenomena, SIAM Conference on Computational Science and Engineering (CSE), Washington, US, February, 2019
Optimal Approximation Theory of Parallel Deep Learning, International Congress of Chinese Mathematicians - Consortium on Computational and Applied Mathematics (ICCM-CAM), Nanjing, China, December, 2018
Fast eigenvalue solvers for pp-RPA, ELSI Conference: Solving or Circumventing Eigenvalue Problems in Electronic Structure Theory, The Molecular Sciences Software Institute-Blacksburg, Virginia, August 15-17, 2018
The separation of signal components: geometric interpretation and random dynamics, SIAM Annual Meeting, Portland, 2018
Fast eigenvalue solvers for pp-RPA, SIAM Conference on Applied Linear Algebra, Hong Kong, 2018
Automatic information learning for atomistic structure, SIAM Conference on Mathematical Aspects of Materials Science, Portland, US, 2018
On the Convergence of Recursive Schemes for Wave Shape Functions. SIAM Annual Meeting, 2017
Recursive schemes for shape functions in the mode decomposition problem. The First International Conference on Mathematics of Data Science, Hong Kong Baptist University, March, 2017
Preconditioning Orbital Minimization Method for Planewave Discretization, 2016 Workshop on Optimization and Eigenvalue Computation, Peking University, Beijing, China.
Butterfly Factorization for a Class of Transforms in Harmonic Analysis, SIAM Annual Meeting, 2016
Variational Models for Crystal Image Analysis, SIAM Conference on Analysis of Partial Differential Equations, 2015
Butterfly Factorization, SIAM Conference on Applied Linear Algebra, 2015
Synchrosqueezed Transform and Variational Method for Crystal Image Analysis, ICIAM, 2015
Synchrosqueezed Transforms in Seismic Data/Image Analysis, 1^{st} International Workshop on Mathematical Geophysics at Harbin Institute of Technology, China, Jan. 2015
Robustness Analysis of Synchrosqueezed Transforms, SEG 2014 Post Convention Workshop
Synchrosqueezed Wave Packet Transforms and Diffeomorphism Based Spectral Analysis for 1D General Mode Decompositions, SIAM Annual Meeting 2014
Synchrosqueezed Curvelet Transform for 2D mode decomposition, SIAM Conference on Imaging Science 2014
Synchrosqueezed Curvelet Transform for 2D mode decomposition, TCCS, March, 2014
Synchrosqueezed Wave Packet Transform for 2D mode decomposition, SIAM Annual Meeting 2013
Adaptive Data Analysis and Sparsity, IPAM workshop, UCLA, 2013
Synchrosqueezed Wave Packet Transform for 2D mode decomposition, TCCS, October, 2012
Fast computation for Multilinear Operators, TCCS, September, 2011

STUDENTS AND POSTDOCS

Postdocs

1. Ricardo A. Delgadillo, August 2019 to July 2021.
2. Yiqi Gu, August 2019 to July 2021.
3. Simon Etter, August 2019 to July 2021.
4. Sean Hon, March 2019 to June 2020.

PhD students

Current:

1. Ong Yong Zheng, 2019-now.
2. Sikai Huang, 2019-now.
3. Haoxuan Wang, 2018-now.
4. Senwei Liang, 2018-now.
5. Yihui Tu, 2017-now.
6. Qiyuan Pang, 2018-now.
7. Ze Chen, 2018-now.
8. Shijun Zhang, 2018-now.

Thesis defense committee member:

1. Dr. Tongyao Pang (2019)
   PhD in the Department of Mathematics, National University of Singapore.

2. Dr. Guodong Xu (2018)
   PhD in the Department of Mathematics, National University of Singapore.
   Thesis title: Sparsity based regularization for signal recovery and clustering.

3. Dr. Guan Yu (2018)
   PhD in the Department of Mathematics, National University of Singapore.
   Thesis title: Convergence Analysis on SVD-Based Algorithms for Tensor Low-Rank Approximations.

Master students

Past:

1. Lin Chen (2019)
   M.Sc. in the Department of Mathematics, National University of Singapore.
   Thesis title: Adversarial Encoder-Decoder for Compressed Sensing.
   Position after graduation: Ph.D. in Management at INSEAD.
2. Yunrui Liu (2019)
   M.Sc. in the Department of Mathematics, National University of Singapore.
   Thesis title: Semi-supervised Learning in Imbalanced Dataset.
3. Linpo Guo (2019)
   M.Sc. in the Department of Mathematics, National University of Singapore.
   Thesis title: Width and Depth Based Graph Neural Network for Semi-Supervised Classification.

4. Fan Yang (2018)
   M.Sc. in the Department of Mathematics, National University of Singapore.
   Thesis title: Single Channel Audio Classification and Source Separation Using Convolutional Neural Networks.
5. Yurui Chen (2018)
   M.Sc. in the Department of Mathematics, National University of Singapore.
   Thesis title: Time-Frequency Analysis in Fetal ECG Extraction.
   Position after graduation: Ph.D. in mathematics at National University of Singapore.
6. Tao Zhang (2018)
   M.Sc. in the Department of Mathematics, National University of Singapore.
   Thesis title: 3D Atomic Crystal Analysis via Fast Synchrosqueezed Transform.
7. Han Wang (2018)
   M.Sc. in the Department of Mathematics, National University of Singapore.
   Thesis title: Interpolation and Approximation of Computationally Expensive Posterior Density.
   Position after graduation: M.Sc. in statistics at University of Pennsylvania.

Thesis defense committee member:

1. Renbo Zhao (2018)
   M.Sc. in the Department of Mathematics, National University of Singapore.
   Thesis title: Stochastic and Randomized Algorithms for Large-Scale Optimization in Machine Learning.

Undergraduate students

Past:

1. Nail Sachin Palkar (2019 summer)
   B.S. in the Department of Mathematics and Computer Science, University of North Carolina, Chapel Hill.
   UROPS project: Fourier Analysis in Deep Learning.
2. Ong Yong Zheng (2019)
   B.S. in the Department of Mathematics, National University of Singapore.
   Thesis title: Generative Adversarial Networks for Source Separation.
   Position after graduation: Ph.D. in mathematics with Shopee Fellowship at National University of Singapore.
3. Yong Teck Xuan Ivan (2019)
   B.S. in the Department of Mathematics, National University of Singapore.
   Thesis title: Semi-Supervised Learning for Imbalanced Classification Problems.
4. Lee Zhi Qiang Leonard (2019)
   B.S. in the Department of Mathematics, National University of Singapore.
   Thesis title: Approximation Theory for Deep Learning.
   Position after graduation: Ph.D. in School of Computing with Shopee Fellowship at National University of Singapore.
5. Seow Yaxin Claudia (2019)
   B.S. in the Department of Mathematics, National University of Singapore.
   Thesis title: Decentralised Deep Learning Optimisation.
6. Xueying Guo (2019)
   B.S. in the Department of Mathematics, National University of Singapore.
   Thesis title: Deep Reinforcement Learning for Solving Linear Equations.
7. Mo Zhou (2018)
   B.S. in the Department of Mathematics, Tsinghua University.

Thesis title: Advanced Mode Decomposition Algorithms in Siganl Processing.
Position after graduation: Ph.D. in mathematics at Duke University, US.

8. Shengtong Zhang (2018)
   B.S. in the Department of Mathematics, Tsinghua University.
   Thesis title: Approximation Theory of Deep Learning.
   Position after graduation: Ph.D. in industrial engineering & management sciences at Northwestern University, US.
9. Qiyuan Pang (2018)
   B.S. in the Department of Mathematics, Sun Yat-Sen University.
   Thesis title: Fast Algorithms for Non-Uniform Fourier Transformation.
   Position after graduation: Ph.D. in mathematics at Purdue University, US.
10. Haoxuan Wang (2018)
    B.S. in the Department of Mathematics, Zhejiang University
    Thesis title: Fast Algorithms for Deep Learning.
    Position after graduation: Ph.D. in mathematics at National University of Singapore.

ACADEMIC SERVICE

University and Departmental Services

Member, Search Committee for Data Science, Mathematics Department, Purdue University, 2019-2020

Editorial Duties

Associate Editor, the Editorial Board of Mathematics of Computation and Data Science, 2016-Now

Journal, Conference, and Book Refereeing

Neural Networks;
Constructive Approximation;
Applied and Computational Harmonic Analysis;
Journal of Fourier Analysis and Applications;
SIAM Journal on Mathematical Analysis;
SIAM Journal on Scientific Computing;
SIAM Journal on Imaging Science;
SIAM Multiscale Modeling and Simulation;
Mathematics of Computation;
Communications in Mathematical Sciences;
Journal of Scientific Computing;
Journal of Computational Physics;
Journal of Computational Mathematics;
Journal of Computational and Applied Mathematics;
Inverse Problems and Imaging;

Philosophical Transactions of the Royal Society A;
IEEE Signal Processing Magazine;
IEEE Transactions on Signal Processing Letters;
IEEE Transactions on Signal Processing;
IEEE Transactions on Imagel Processing;
IEEE Transactions on Geoscience and Remote Sensing;
Geophysics;
PLOS ONE;
Journal of Neuroscience Methods;
Terrestrial, Atmospheric and Oceanic Sciences
Mathematical and Scientific Machine Learning Conference

Conference/Workshop Organized

Co-organizer, Workshop in Machine Learning and Its Applications, and a summer school on machine learning, National University of Singapore, Singapore, 2021
Organizer, Workshop on "High-Dimensional Learning and Computation in Physics", National University of Singapore, Singapore, June, 2019

Minisymposium/Symposium Organized

Chair, Minisymposium on "Deep Numerical Analysis and Optimization for PDEs", 2020 International Conference of Spectral and High Order Methods, July 6-10, 2020, Vienna, Austria
Co-chair, Minisymposium on "Machine learning for interatomic potentials", SIAM Conference on Mathematical Aspects of Materials Science, May 18-22, 2020, Bilbao, Spain
Co-char, Minisymposium on "Mathematical Understanding and Applications of Learning with Networks", SIAM Conference on Mathematics of Data Science, Cincinnati, Ohio, May 7-9, 2020
Co-chair, Minisymposium on "Theory and Algorithms for Data Science", 2020 AMS Spring Sectional Meeting at Purdue University, West Lafayette, IN, April 4-5, 2020
Co-chair, Minisymposium on "Machine Learning for Solving PDEs and Inverse Problems", 2nd Annual Meeting of the SIAM Texas-Louisiana Section, November, 2019
Co-chair, Minisymposium on "Mathematical Theory and Applications of Deep Learning", The International Council for Industrial and Applied Mathematics (ICIAM), Spain, July, 2019
Co-chair, Minisymposium on "Fast and Accurate Integral Methods for Highly Oscillatory Phenomena", SIAM Conference on Computational Science and Engineering, 2019
Co-chair, Minisymposium on "Low-Dimensional Structures in Imaging Science", SIAM Conference on Imaging Science, 2018
Co-chair, Minisymposium on "Large-Scale Eigenvalue Problems and Applications", SIAM Conference on Applied Linear Algebra, 2018
Co-chair, Minisymposium on "Numerical Linear Algebra in Data Science", SIAM Annual Meeting, 2017
Co-chair, Minisymposium on "Hierarchical Structure and Randomness in Linear Algebra", SIAM Annual Meeting, 2016
Chair, Minisymposium on "Multidimensional Mode Decomposition and Applications", SIAM Conference on Imaging Science, 2016.
Co-chair, Minisymposium on "Structured Matrices and Applications", SIAM Conference on Applied Linear Algebra, 2015.