HAIZHAO YANG

Department of Mathematics
University of Maryland, College Park
USA

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CURRENT POSITION

Assistant Professor 2022 -
Department of Mathematics
Department of Computer Science (affiliated)
University of Maryland College Park, US

PREVIOUS POSITION

Assistant Professor (tenure approved in 2022) 2019 - 2022
Department of Mathematics
Purdue University, US

Assistant Professor 2017 - 2019
Department of Mathematics
Affiliate, Institute of Data Science 2019
National University of Singapore, Singapore

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

ONR Young Investigator Award. 2022
Teaching for Tomorrow Award, Purdue University. 2021
NSF CAREER Award. 2020
AMS-Simons Travel Award. 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

$^+$ equal contribution; * corresponding author; † student or postdoc mentored.

Preprints

S16 Shixin Zheng, **Haizhao Yang**, Xiangxiong Zhang*. On the convergence of orthogonalization-free conjugate gradient method for extreme eigenvalues of Hermitian matrices: a Riemannian optimization interpretation. Submitted to Journal of Computational and Applied Mathematics. https://haizhaoyang.github.io/publications/RiemannianManifoldEig.pdf

S15 Yuling Jiao$^+$, Yanming Lai$^+$, Yang Wang$^+$, **Haizhao Yang**$^{+*}$, Yunfei Yang$^+$. Convergence Analysis of the Deep Galerkin Method for Weak Solutions. Submitted to SINUM. https://arxiv.org/abs/2302.02405

S14 Ke Chen$^{+\dagger}$, Chunmei Wang$^+$, **Haizhao Yang**$^{+*}$. Deep Operator Learning Lessens the Curse of Dimensionality for PDEs. Submitted to ICML. https://arxiv.org/abs/2301.12227

S13 Qiyuan Pang†, **Haizhao Yang***, A Distributed Block Chebyshev-Davidson Algorithm for Parallel Spectral Clustering. Submitted to Journal of Scientific Computing. arXiv:2212.04443

S12 Zhongzhan Huang, Senwei Liang†, Hong Zhang, **Haizhao Yang**, Liang Lin*, Accelerating Numerical Solvers for Large-Scale Simulation of Dynamical System via NeurVec. Submitted to Nature Communication. https://arxiv.org/abs/2208.03680

S11 Senwei Liang†, **Haizhao Yang***. Finite Expression Method for Solving High-Dimensional Partial Differential Equations. Submitted to SIAM Review. https://arxiv.org/abs/2206.10121

S10 Hanyang Jiang^{+*}, Yuehaw Khoo$^+$, **Haizhao Yang**$^+$. Reinforced Inverse Scattering. Submitted to SIAM Journal on Scientific Computing. https://arxiv.org/abs/2206.04186

S9 Songyang Han, Sanbao Su, Sihong He, Shuo Han, **Haizhao Yang**, and Fei Miao*. Robust Multi-Agent Reinforcement Learning Under Adversarial State Perturbations. Submitted to AAAI 2022.

S8 Hao Liu, **Haizhao Yang***, Minshuo Chen, Tuo Zhao, Wenjing Liao*. Deep Nonparametric Estimation of Operators between Infinite Dimensional Spaces. Submitted to Journal of Machine Learning Research. https://arxiv.org/abs/2201.00217

S7 Senwei Liang$^{\dagger *}$, Shixiao W. Jiang, John Harlim, **Haizhao Yang**. Solving PDEs on Unknown Manifolds with Machine Learning. Submitted to Applied and Computational Harmonic Analysis. https://arxiv.org/abs/2106.06682

S6 Ricardo A. Delgadillo$^{+\dagger}$, Jingwei Hu$^+$, **Haizhao Yang**$^{+*}$, Multiscale and Nonlocal Learning for PDEs using Densely Connected RNNs. Submitted to Research in Mathematical Sciences. https://arxiv.org/abs/2109.01790

S5 Senwei Liang$^{+\dagger}$, Liyao Lyu$^+$, Chunmei Wang$^+$, **Haizhao Yang**$^{+*}$. Reproducing Activation Function for Deep Learning. Submitted to Communication in Mathematical Sciences. https://arxiv.org/abs/2101.04844

S4 Efficient Attention Network: Accelerate Attention by Searching Where to Plug. Zhongshan Huang, Senwei Liang†, Mingfu Liang, Wei He, **Haizhao Yang***. Submitted to IEEE Transactions on Neural Networks and Learning Systems. https://arxiv.org/abs/2011.14058

S3 Tao Luo$^+$, **Haizhao Yang**$^{+*}$. Two-Layer Neural Networks for Partial Differential Equations: Optimization and Generalization Theory. https://arxiv.org/abs/2006.15733

S2 Yong-Zheng Ong†, Charles K. Chui, **Haizhao Yang***, CASS: Cross Adversarial Source Separation via Autoencoder. https://arxiv.org/abs/1905.09877

S1 Jieren Xu, Yitong Li, **Haizhao Yang***, David Dunson, Ingrid Daubechies. PiPs: a Kernel-based Optimization Scheme for Analyzing Non-Stationary 1D Signals. Major revision in Applied and Computational Harmonic Analysis. https://arxiv.org/abs/1805.08102

Journal Publications

J57 Fan Chen[+], Jianguo Huang[+], Chunmei Wang[+], **Haizhao Yang**[+*]. Friedrichs Learning: Weak Solutions of Partial Differential Equations via Deep Learning. To appear, SIAM Journal on Scientific Computing. https://arxiv.org/abs/2012.08023

J56 Yiqi Gu[+†], John Harlim[+], Senwei Liang[+†*], **Haizhao Yang**[+]. Stationary Density Estimation of Itô Diffusions Using Deep Learning. SIAM Journal on Numerical Analysis, Volume 61, Number 1, Pages 45-82, 2023.

J55 Fusheng Liu, **Haizhao Yang**, Soufiane Hayou, Qianxiao Li*. From Optimization Dynamics to Generalization Bounds via Lojasiewicz Gradient Inequality. Transactions on Machine Learning Research, 2022. https://openreview.net/pdf?id=mW6nD3567x

J54 Yong Zheng Ong[+†], Zuowei Shen[+], **Haizhao Yang**[+*]. IAE-Net: Integral Autoencoders for Discretization-Invariant Learning. Journal of Machine Learning Research, 23(286):1-45, 2022.

J53 Zuowei Shen[+], **Haizhao Yang**[+], Shijun Zhang[+*†]. Deep Network Approximation: Achieving Arbitrary Accuracy with Fixed Number of Neurons. Journal of Machine Learning Research, 23(276):1-60, 2022.

J52 Sean Hon[+*], **Haizhao Yang**[+]. Simultaneous Neural Network Approximations for Smooth Functions. Neural Networks, Volume 154, October 2022, Pages 152-164

J51 Qiang Du[+], Yiqi Gu[+†], **Haizhao Yang**[+*], Chao Zhou[+]. The Discovery of Dynamics via Linear Multistep Methods and Deep Learning: Error Estimation. SIAM Journal on Numerical Analysis, Vol. 60, Iss. 4, 2022

J50 Jingwei Hu[+*], Xiaodong Huang[+], Jie Shen[+], **Haizhao Yang**[+]. A fast Petrov-Galerkin spectral method for the multi-dimensional Boltzmann equation using mapped Chebyshev functions. SIAM Journal on Scientific Computing, volume 44, number 3, pages A1497-A1524, 2022.

J49 Yihui Tu[†], Zhenli Xu, Qiyuan Pang[†], Kenneth L. Ho, **Haizhao Yang**. Linear-Scaling Selected Inversion based on Hierarchical Interpolative Factorization for Self Green's Function for Modified Poisson-Boltzmann Equation in Two Dimensions. Journal of Computational Physics, Volume 461, 15 July 2022, 110893

J48 Zuowei Shen[+*], **Haizhao Yang**[+], Shijun Zhang[+†]. Optimal Approximation Rate of ReLU Networks in terms of Width and Depth. Journal de Mathématiques Pures et Appliquées, Volume 157, January 2022, Pages 101-135

J47 Yong-Zheng Ong[†], **Haizhao Yang***, Generative Imaging and Image Processing via Generative Encoder. Inverse Problems & Imaging, 16(3): 525-545, 2022.

J46 Ling Li, Carl Goodrich, **Haizhao Yang**, Katherine R Phillips, Zian Jia, Hongshun Chen, Lifeng Wang, Jinjin Zhong, Anhua Liu, Jianfeng Lu, Jianwei Shuai, Michael P Brenner, Frans Spaepen, Joanna Aizenberg. Microscopic Origins of the Crystallographically Preferred Growth in Evaporation-Induced Colloidal Crystals. Proceedings of the National Academy of Sciences (PNAS), 118(32), 2021.

J45 Jianfeng Lu[+], Zuowei Shen[+], **Haizhao Yang**[+*], Shijun Zhang[+†]. Deep Network Approximation for Smooth Functions. SIAM Journal of Mathematical Analysis, 53(5), 5465-5506, 2021.

J44 Yiqi Gu[†], **Haizhao Yang***, Chao Zhou. SelectNet: Self-Paced Learning for High-Dimensional Partial Differential Equations. Journal of Computational Physics, Volume 441, 15 September 2021, 110444.

J43 James Bremer[+], Ze Chen[+†], **Haizhao Yang**[+*], Rapid Application of the Spherical Harmonic Transform via Interpolative Decomposition Butterfly Factorization. SIAM Journal on Scientific Computing, 43(6), A3789-A3808, 2021

J42 Hadrien Montanelli, **Haizhao Yang***, Qiang Du, Deep ReLU Networks Overcome the Curse of Dimensionality for Bandlimited Functions. Journal of Computational Mathematics, 39 (2021), pp. 801-815.

J41 Yingzhou Li[+], **Haizhao Yang**[+*], Interior Eigensolver for Sparse Hermitian Definite Matrices Based on Zolotarevs Functions. Communications of Mathematical Sciences, Volume 19, Number 4, Pages 1113-1135, 2021.

J40 Zuowei Shen[+], **Haizhao Yang**[+*], Shijun Zhang[+†]. Neural Network Approximation: Three Hidden Layers Are Enough. Neural Networks, Volume 141, September 2021, Pages 160-173.

J39 Yiqi Gu[+†], Chunmei Wang[+], **Haizhao Yang**[+*]. Structure Probing Neural Network Deflation. Journal of Computational Physics, Volume 434, 1 June 2021, 110231.

J38 Zuowei Shen[+], **Haizhao Yang**[+*], Shijun Zhang[+†]. Deep Network Approximation with Discrepancy Being Reciprocal of Breadth to Power of Depth. Neural Computation (2021) 33 (4): 1005-1036.

J37 John Harlim[+*], Shixiao Jiang[+], Senwei Liang[+†], **Haizhao Yang**[+]. Machine Learning for Prediction with Missing Dynamics. Journal of Computational Physics, Volume 428, 1 March 2021, 109922.

J36 James Bremer[+], Qiyuan Pang[+†], **Haizhao Yang**[+*]. Fast Algorithms for Multi-Dimensional Jacobi Polynomial Transformations. Applied and Computational Harmonic Analysis, Volume 52, May 2021, Pages 231-250, 2021.

J35 **Haizhao Yang**[*]. Multiresolution Mode Decomposition for Adaptive Time Series Analysis. Applied and Computational Harmonic Analysis, Volume 52, May 2021, Pages 25-62, 2021.

J34 Senwei Liang[†], Yuehaw Kwoo, **Haizhao Yang**[*]. Drop-Activation: Implicit Parameter Reduction and Harmonic Regularization. Communications on Applied Mathematics and Computation, 3, Pages 293-311 (2021).

J33 Zuowei Shen[+], **Haizhao Yang**[+*], Shijun Zhang[+†]. Deep Network Approximation Characterized by Number of Neurons. Communications in Computational Physics, 28 (2020), pp. 1768-1811.

J32 Hadrien Montanelli[+*], **Haizhao Yang**[+], Error Bounds for Deep ReLU Networks using the Kolmogorov–Arnold Superposition Theorem. Neural Networks, Volume 129, September 2020, Pages 1-6.

J31 Jianguo Huang[+], Haoqin Wang[+], **Haizhao Yang**[+*], Int-Deep: A Deep Learning Initialized Iterative Method For Nonlinear Problems. Journal of Computational Physics, Volume 419, 15 October 2020, 109675.

J30 Xiangxiang Zhu[†], **Haizhao Yang**, Zhuosheng Zhang[*], Jinghuai Gao, Naihao Liu. Frequency-Chirprate Reassignment. Digital Signal Processing, Volume 104, September 2020, 102783.

J29 Ze Chen[†], Juan Zhang, Kenneth L. Ho, **Haizhao Yang**[*], Multidimensional Phase Recovery and IDBF for Fast Oscillatory Integral Transforms. Journal of Computational Physics, Volume 412, 1 July 2020, 109427.

J28 Gao Tang[†], **Haizhao Yang**[*], A Fast Algorithm for Multiresolution Mode Decomposition. Multiscale Modeling and Simulation, 18(2), 707-736, 2020.

J27 Qiyuan Pang[†], Kenneth L. Ho, **Haizhao Yang**[*]. Interpolative Decomposition Butterfly Factorization. SIAM Journal on Scientific Computing, Vol. 42, No. 2, pp. A1097–A1115, 2020.

J26 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.

J25 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, Volume 30, Issue 26, June 25, 2020, 1908242. **Frontispiece article**.

J24 Tao Zhang[†], Ling Li, **Haizhao Yang**[*]. 3D Atomic Crystal Analysis via Fast Synchrosqueezed Transform. Communications of Mathematical Sciences, Vol. 17, No. 8 (2019), pp. 2113-2140.

J23 James Bremer[+*], **Haizhao Yang**[+], Fast algorithms for Jacobi expansions via nonoscillatory phase functions. IMA Journal of Numerical Analysis, 04, 2019. ISSN 0272-4979.

J22 **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.

J21 Zuowei Shen[+], **Haizhao Yang**[+*], Shijun Zhang[+†]. Nonlinear Approximation via Compositions. Neural Networks, Volume 119, November 2019, Pages 74-84.

J20 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.

J19 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. Computer Physics Communications, Volume 222, January 2018, Pages 267-285.

J18 Jieren Xu, **Haizhao Yang***, and Ingrid Daubechies, Recursive Diffeomorphism-Based Regression for Shape Functions. SIAM Journal of Mathematical Analysis, 50(1), 5-32, 2018.

J17 **Haizhao Yang***. Statistical Analysis of Synchrosqueezed Transforms. Applied and Computational Harmonic Analysis, Volume 45, Issue 3, November 2018, Pages 526-550.

J16 Yingzhou Li^{+}, **Haizhao Yang**$^{+*}$ and Lexing Ying. Multidimensional Butterfly Factorization. Applied and Computational Harmonic Analysis, Volume 44, Issue 3, May 2018, Pages 737-758.

J15 Yingzhou Li^{+}, and **Haizhao Yang**$^{+*}$. Interpolative Butterfly Factorization. SIAM Journal on Scientific Computing, 39(2), A503-A531, 2017.

J14 John Harlim^{+*}, **Haizhao Yang**$^{+}$. Diffusion Forecasting Model with Basis Functions from QR Decomposition. Journal of Nonlinear Science, 28, Pages 847-872 (2018).

J13 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.

J12 Jianfeng Lu^{+} and **Haizhao Yang**$^{+*}$. Preconditioning Orbital Minimization Method for Planewave Discretization. Multiscale Modeling and Simulation, 15(1), 254-273, 2017.

J11 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.

J10 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.

J9 **Haizhao Yang***, Jianfeng Lu and Lexing Ying. Crystal Image Analysis Using 2D Synchrosqueezed Transforms. Multiscale Modeling and Simulation, 13(4), 1542-1572, 2015.

J8 Yingzhou Li, **Haizhao Yang**, Eileen Martin, Kenneth L. Ho, and Lexing Ying*. Butterfly factorization. Multiscale Modeling and Simulation, 13(2), 714-732, 2015.

J7 Yingzhou Li^{+}, **Haizhao Yang**$^{+*}$ and Lexing Ying^{+}. A Multiscale Butterfly Algorithm for Multidimensional Fourier Integral Operators. Multiscale Modeling and Simulation, 13(2), 614-631, 2015.

J6 **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.

J5 **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.

J4 **Haizhao Yang**$^{+*}$ and Lexing Ying^{+}. Synchrosqueezed Curvelet Transform for Two-Dimensional Mode Decomposition, SIAM Journal of Mathematical Analysis, 46(3):2052-2083, 2014.

J3 **Haizhao Yang**$^{+*}$ and Lexing Ying^{+}. Synchrosqueezed Wave Packet Transform for 2D Mode Decomposition, SIAM Journal on Imaging Science, 6(4):1979-2009, 2013.

J2 **Haizhao Yang**$^{+}$ and Lexing Ying^{+*}. A Fast Algorithm for Multilinear Operators, Applied and Computational Harmonic Analysis, 33(1):148-158, 2012.

J1 Zhenli Xu*, Xiaolin Cheng and **Haizhao Yang**. Treecode-Based Generalized Born Method, Journal of Chemical Physics, 134(6):064-107, 2011.

Conference Proceedings

C7 Zuowei Shen[+], **Haizhao Yang**[+], Shijun Zhang[+*†]. Neural Network Architecture Beyond Width and Depth. 36th Conference on Neural Information Processing Systems (NeurIPS 2022). https://arxiv.org/abs/2205.09459

C6 Zuowei Shen[+], **Haizhao Yang**[+], Shijun Zhang[+†*]. Deep Network Approximation in Terms of Intrinsic Parameters. The 39th International Conference on Machine Learning (ICML 2022), Spotlight.

C5 Wei He[+], Zhongzhan Huang[+], Mingfu Liang, Senwei Liang[†], **Haizhao Yang**[*]. Blending Pruning Criteria for Efficient Convolutional Neural Networks. 30th International Conference on Artificial Neural Networks, ICANN, 2021.

C4 Yong Zheng Ong[†*], Nan You, Yunyue Elita Li, **Haizhao Yang**. Digital Rock Image Inpainting using GANs. In 90-th Annual International Meeting, SEG, 2020.

C3 Yunru Liu[†], Tingran Gao, **Haizhao Yang**[*], SelectNet: Learning to Sample from the Wild for Imbalanced Data Training. Proceedings of Mathematical and Scientific Machine Learning Conference 2020.

C2 Senwei Liang[+†], Zhongzhan Huang[+], Mingfu Liang, **Haizhao Yang**[*], Instance Enhancement Batch Normalization: an Adaptive Regulator of Batch Noise. Proceedings of the AAAI Conference on Artificial Intelligence, 2020.

C1 Zhongzhan Huang[+], Senwei Liang[+†], Mingfu Liang, **Haizhao Yang**[*], DIANet: Dense-and-Implicit Attention Network. Proceedings of the AAAI Conference on Artificial Intelligence, 2020.

TEACHING EXPERIENCE

- Purdue University Spring 2022
  Instructor in **MA 36600**: This is a method course for juniors in any branch of engineering and science. An introduction to ordinary differential equations with emphasis on problem solving and applications. The one-hour computer lab will give students an opportunity for hands-on experience with both the theory and applications of the subject.
- Purdue University Fall 2021
  Instructor in **Mathematical Theory and Applications of Deep Reinforcement Learning (graduate level)**: This course provides a basic introduction to deep reinforcement learning, applications of deep reinforcement learning in mathematical science and scientific computing, and theoretical analysis of deep reinforcement learning.
- Purdue University Spring 2021
  Instructor in **MA 265 Introduction to linear algebra (undergraduate level)**: Systems of linear equations, matrix algebra, vector spaces, determinants, eigenvalues and eigenvectors, diagonalization of matrices, applications.
- Purdue University Fall 2020
  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.
- Purdue University Spring 2020
  Instructor in **MA 30300**: This is a method 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 modeling problems in real life and other disciplines into mathematical problems and simulating their solutions by scientific computing methods. Major topics covered include modeling and numerical simulations in selected areas of physical and engineering sciences, biology, finance, imaging, and optimization.
- 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, eigenvalue 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, eigendecomposition, 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 environments.

- **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-difference/finite-element methods.
- Relies on low-rank or butterfly formats under Hierarchical matrix, HODLR, or other hierarchically 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 SUMMER SCHOOL

Mathematical Theory and Applications of Deep Learning, 15 Lectures, Tianyuan Mathematical Center in Central China, Wuhan University, August 15-30, 2022.

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

67 Finite Expression Method: A Symbolic Approach for Scientific Machine Learning. Data Science Seminar, Data Science Initiative, University of Minnesota Twin Cities, January 24, 2023

66 Finite Expression Method for Discovering Physical Laws from Data. SIAM + Applied & Numerical Analysis Seminar, Department of Mathematics, University of Florida, January 20, 2023

65 Reinforced Inverse Scattering. Applied Math Seminar, Department of Mathematics, Shanghai Jiao Tong University, November 16, 2022

64 Finite Expression Method for Solving High-Dimensional PDEs. The Numerical Analysis and PDE Seminar, Department of Mathematics, Hong Kong Baptist University, November 9, 2022

63 Reinforced Inverse Scattering. Applied Math Seminar, Department of Mathematics, Tianjin University, October 15, 2022

62 Finite Expression Method for Solving High-Dimensional PDEs. The Numerical Analysis and PDE Seminar, Department of Mathematics, University of Delaware, September 23, 2022

61 Finite Expression Method for Solving High-Dimensional PDEs. Applied Mathematics Colloquium, Department of Applied Physics and Applied Mathematics, Columbia University, September 20, 2022

60 Finite Expression Method for Solving High-Dimensional PDEs. Applied Mathematics Seminar, Department of Mathematics, University of Florida, September 9, 2022

59 Finite Expression Method for Solving High-Dimensional PDEs. Optimal transport and Mean field games Seminar at UCLA and University of South Carolina, July 27, 2022

58 Solving Forward and Inverse Problems using Reinforcement Learning, Department of Mathematics, Wuhan University, July 7, 2022

57 Discretization-Invariant Operator Learning: Algorithms and Theory, Machine Learning Seminar, Department of Mathematics, Wuhan University, June 23, 2022

56 Discretization-Invariant Learning via Data-Driven Integral Kernels. One World Mathematics of INformation, Data, and Signals (1W-MINDS) Seminar, April 28, 2022

55 Discretization-Invariant Operator Learning: Algorithms and Theory, Machine Learning Seminar, Department of Mathematics, University of Central Florida, April 8, 2022

54 Discretization-Invariant Operator Learning: Algorithms and Theory, CCMA Seminar on Mathematics of Data and Computation, Department of Mathematics, Pennsylvania State University, March 31, 2022

53 Discretization-Invariant Operator Learning: Algorithms and Theory, Data Science Seminar, Department of Mathematics, National University of Singapore, February 18, 2022

52 Discretization-Invariant Operator Learning: Algorithms and Theory, Applied Math Seminar, Department of Mathematics, University of Florida, January 24, 2022

51 Discretization-Invariant Operator Learning: Algorithms and Theory, Applied Math Seminar, Department of Mathematics, University of Maryland, January 20, 2022

50 Discretization-Invariant Operator Learning: Algorithms and Theory, Applied Math Seminar, Department of Mathematics, UCLA, January 4, 2022

49 Two-Layer Neural Networks for Partial Differential Equations: Optimization and Generalization Theory, Applied Math Seminar, University of Florida, November 18th, 2021

48 Deep Network Approximation: Achieving Arbitrary Accuracy with Fixed Number of Neurons. Applied Math & Analysis Seminar, Department of Mathematics, Duke University, November 2, 2021.

47 Deep Network Approximation: Achieving Arbitrary Accuracy with Fixed Number of Neurons, Applied Math Seminar, University of Massachusetts Amherst, October 12th, 2021

46 Two-Layer Neural Networks for Partial Differential Equations: Optimization and Generalization Theory. Seminar of Mathematics in Imaging, Data and Optimization, Rensselaer Polytechnic Institute, September 8th, 2021

45 A Few Thoughts on Deep Learning-Based Scientific Computing. Seminar of Numerical PDE and Deep Learning in Industrial Applications, School of Mathematics and Statistics, Xi'an Jiao Tong University, May 26, 2021

44 A Few Thoughts on Deep Learning-Based Scientific Computing. Mathematical Machine Learning Seminar at Max Planck Institute and UCLA, May 6, 2021

43 A Few Thoughts on Deep Learning-Based Scientific Computing. Center of Computational Mathematics Seminar, Flatiron Institute, May 5, 2021

42 Reproducing Activation Functions for Deep Learning. Deep Learning for Dynamical System (ODE & PDE) Seminar, Duke Kunshan University, May 3, 2021

41 Reproducing Activation Functions for Deep Learning. Seminar of Big Data, Department of Mathematics, Tianjin University, April 17, 2021

40 Reproducing Activation Functions for Deep Learning. Applied Math Seminar, Department of Mathematics, Auburn University, March 5, 2021

39 Reproducing Activation Functions for Deep Learning. Scientific Computing and Numerics (SCAN) seminar, Department of Computer Science and Department of Mathematics, Cornell University, March 1, 2021

38 A Few Thoughts on Deep Learning-Based Scientific Computing. Inverse Problems Seminar, Department of Mathematics and Computer Science, University College London, February 5, 2021

37 A Few Thoughts on Deep Learning-Based Scientific Computing. CAM Colloquium, Committee on Computational and Applied Mathematics, Department of Statistics, The University of Chicago, November 19, 2020

36 A Few Thoughts on Deep Learning-Based Scientific Computing. Applied Math Seminar, Department of Mathematics, Georgia Institute of Technology, October 26, 2020

35 A Few Thoughts on Deep Networks. Seminar of Big Data, Department of Mathematics, Tianjin University, September 26, 2021

34 A Few Thoughts on Deep Learning-Based Scientific Computing. Applied Math Seminar, Department of Mathematics, Tsinghua University, August 28, 2020

33 A Few Thoughts on Deep Network Approximation. One World Seminar Series on the Mathematics of Machine Learning, August 12, 2020

32 A Few Thoughts on Deep Learning-Based Scientific Computing. Applied Mathematics Seminar, Fudan University, June 28, 2020

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

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

29 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)

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

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

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

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

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

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

22 $O(N \log^{\alpha} N)$ matvec and preconditioners for highly oscillatory kernels. Applied and Computational Mathematics Seminar, Department of Mathematics, National University of Singapore, February 2019

21 $O(N \log^{\alpha} N)$ matvec and preconditioners for highly oscillatory kernels. Applied Math Colloquium, Department of Mathematics, Purdue University, January 2019

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

19 $O(N \log N)$ algorithms for matrix multiplications from highly oscillatory phenomena, Applied Mathematics Colloquium, Department of Applied Physics and Applied Mathematics, Columbia University, October 2018

18 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

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

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

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

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

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

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

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

10 Data-Driven Mathematical Analysis and Scientific Computing for Oscillatory Data, Colloquium, Department of Mathematics, University of California, Davis, January 2017

9 Data-Driven Mathematical Analysis and Scientific Computing for Oscillatory Data, Colloquium, Department of Mathematics, University of California, Irvine, January 2017

8 Data-Driven Mathematical Analysis and Scientific Computing for Oscillatory Data, Department of Mathematics, Hong Kong University of Science and Technology, January 2017

7 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

6 A Cubic Scaling Algorithm to Calculate Excited States Based on PP-RPA, Research Colloquium, Department of Mathematics, Southern Methodist University, November 2016

5 Data-Driven fast algorithms in Applied Harmonic Analysis and Numerical Linear Algebra, Applied Math and Analysis Seminar, Duke University, October 2016

4 Variational Models for Crystal Image Analysis, Hong Kong University of Science and Technology, June 2016

3 Preconditioning Orbital Minimization Method for Planewave Discretization, Shanghai Jiao Tong University, Shanghai, China, June 2016.

2 Butterfly Algorithm and Butterfly Factorization. Shanghai Jiao Tong University, Shanghai, China, June 2016

1 Butterfly Algorithm and Butterfly Factorization. Applied Mathematics Colloquium. University of North Carolina at Chapel Hill. March 4, 2016

INVITED CONFERENCE

61 Finite Expression Method for Solving High-Dimensional PDEs. Minisymposium on "Data-Driven Methods in Scientific Machine Learning", The International Council for Industrial and Applied Mathematics (ICIAM), Japan, August 2023

60 Discretization-Invariant Operator Learning: Theory and Algorithms. Minisymposium on "Machine Learning Approaches for Inverse Problems and PDEs" at the 18th "Frontiers in Applied and Computational Mathematics" (FACM) Conference held annually at NJIT, May 26-27, 2023, Newark, NJ.

59 The Discovery of Dynamics via Linear Multistep Methods and Deep Learning. Minisymposium on "Reduced Order Modeling and Forecasting in Geophysical Flows and Complex Dynamical Systems", SIAM Conference on Applications of Dynamical Systems, Portland, Oregon, U.S, May 14 - 18, 2023

58 Finite Expression Method for Discovering Physical Laws from Data. Workshop on "Human Behavior and Disease Dynamics", the Brin Mathematics Research Center in the Department of Mathematics at the University of Maryland, College Park, April 24-28, 2023

57 Finite Expression Method for Solving High-Dimensional PDEs. Minisymposium on "Recent Development of Theory and Algorithms of Scientific Machine Learning", SIAM Southeastern Atlantic Section Annual Meeting (SIAM-SEAS23), Blacksburg, Virginia, March 25-26, 2023

56 Finite Expression Method for Solving High-Dimensional PDEs. Minisymposium on "Scientific Deep Learning", 5th Annual Meeting of the SIAM Texas-Louisiana Section, November 4th - 6th, 2022, Houston, TX

55 Finite Expression Method for Solving High-Dimensional PDEs. Workshop on Machine Learning and Scientific Computing, Wuhan University, October 22 - 25, 2022, Wuhan, China

54 Finite Expression Method for Solving High-Dimensional PDEs. Workshop of Machine Learning and Its Applications. National University of Singapore, October 17 -31, 2022, Singapore

53 Reinforced Inverse Scattering. Minisymposium on "Algorithms and Mathematical Theories of Deep Learning for PDEs in Scientific Computing", SIAM Conference on Mathematics of Data Science, San Diego, Sep. 26-30, 2022

52 Stationary Density Estimation of Itô Diffusions Using Deep Learning. Mini-symposium on "Uncertainty Quantification for Data-Intensive Inverse Problems and Machine Learning", SIAM Conference on Uncertainty Quantification, Atlanta, Georgia, April 12-15, 2022.

51 Discretization-Invariant Operator Learning. Mini-symposium on "Modeling and Forecasting Complex Turbulent Systems", AMS Sectional Meeting at Purdue University, March 26-27, 2022.

50 Operator Learning: Theory and Algorithms. 2022 Workshop on "Scientific Computing meets Machine Learning and Life Sciences" at Texas Tech University, March 5, 2022.

49 Generalization Analysis of Deep-Learning-based PDE Solvers, NUSRI-DKU Joint Workshop on Pure and Applied Mathematics, January 6-9, 2022, Kunshan, China

48 Deep Learning Prediction with Missing Dynamics: Algorithm and Theory. Session on "Applied Mathematics Perspectives on Prediction, Uncertainty Quantification, and State Estimation". The AGU Fall Meeting 2021 December 13-17, New Orleans, US

47 Deep Learning Theory for PDEs: Approximation, Optimization, and Generalization. Mini-symposium on "Recent Progress of Classical and Deep Learning Methods in Inverse Problems and Imaging", SIAM Southeastern Atlantic Section Annual Meeting (SEAS 2021), September 18-19, 2021, Auburn University, Alabama, US

46 A Few Thoughts on Deep Learning-Based Scientific Computing, 2021 Wutong Forum, Chinese University of Hong Kong-Shenzhen, August 14-16, 2021

45 Deep Network Approximation With Accuracy Independent of Number of Neurons, 2021 Workshop on Machine Learning and Scientific Computing, Wuhan University, August 7-9, 2021

44 A Few Thoughts on Deep Network Approximation. Mini-Symposium on "Approximation Theory of Neural Networks", SIAM Annual Meeting, Spokane, WA, US, July 19-23, 2021

43 Multi-Resolution Mode Decomposition: from Time-Frequency Analysis to Deep Learning, NoSAG21 Summer School and Conference, Dipartimento di Scienze Umane, Università degli Studi dell'Aquila, L'Aquila, Italy, July 19-24, 2021

42 $O(N \log^{\alpha} N)$ 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 12-16, 2021

41 A Few Thoughts on Deep Learning-based PDE Solvers. HKBU Virtual Conference on Mathematics, Statistics and Data Science, April 19-23, 2021

40 Intelligent Computing: From Learning to Solving PDEs. Mini-Symposium on "Hybrid Analysis and Modeling Toward Predictive Digital Twins", 2021 SIAM Conference on Computational Science and Engineering, Fort Worth, TX, US, March 1 - 5, 2021

39 A Few Thoughts on Deep Learning-Based Scientific Computing. Mini-Symposium on "Machine Learning for Solving PDEs and Inverse Problems", 3rd Annual Meeting of the SIAM Texas-Louisiana Section, October 16-18, 2020

38 A Few Thoughts on Deep Learning-Based Scientific Computing. Workshop on High-Performance Computing. Nanjing University of Information Science & Technology, May 23-24, 2020

37 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 (Canceled due to COVID-19)

36 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 (Canceled due to COVID-19)

35 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 (Canceled due to COVID-19)

34 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 (Canceled due to COVID-19)

33 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

32 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

31 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

30 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

29 On the Curse of Dimensionality of Deep Network Approximation, Second Conference on Scientific and Engineering Computing for Young Chinese Scientists, Beijing, China, August 2019

28 $O(N \log^{\alpha} N)$ matvec and preconditioners for highly oscillatory kernels, International Council for Industrial and Applied Mathematics (ICIAM), Spain, July 2019

27 Fast Algorithms for Calculating Excited States in PP-RPA, International Council for Industrial and Applied Mathematics (ICIAM), Spain, July 2019

26 Approximation Theory of Deep Learning in Scientific Computing, Workshop on Machine Learning Techniques in Scientific Computing. Wuhan University, China. June 2019

25 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

24 Drop-Activation: Implicit Parameter Reduction and Harmonic Regularization, 3rd NUPRI Workshop, Faculty of Engineering, National University of Singapore, 17 May 2019

23 $O(N \log^{\alpha} N)$ 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

22 $O(N \log N)$ algorithms for matrix multiplications from highly oscillatory phenomena, SIAM Conference on Computational Science and Engineering (CSE), Washington, US, February 2019

21 Optimal Approximation Theory of Parallel Deep Learning, International Congress of Chinese Mathematicians - Consortium on Computational and Applied Mathematics (ICCM-CAM), Nanjing, China, December 2018

20 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

19 The separation of signal components: geometric interpretation and random dynamics, SIAM Annual Meeting, Portland, 2018

18 Fast eigenvalue solvers for pp-RPA, SIAM Conference on Applied Linear Algebra, Hong Kong, 2018

17 Automatic information learning for atomistic structure, SIAM Conference on Mathematical Aspects of Materials Science, Portland, US, 2018

16 On the Convergence of Recursive Schemes for Wave Shape Functions. SIAM Annual Meeting, 2017

15 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

14 Preconditioning Orbital Minimization Method for Planewave Discretization, 2016 Workshop on Optimization and Eigenvalue Computation, Peking University, Beijing, China.

13 Butterfly Factorization for a Class of Transforms in Harmonic Analysis, SIAM Annual Meeting, 2016

12 Variational Models for Crystal Image Analysis, SIAM Conference on Analysis of Partial Differential Equations, 2015

11 Butterfly Factorization, SIAM Conference on Applied Linear Algebra, 2015

10 Synchrosqueezed Transform and Variational Method for Crystal Image Analysis, ICIAM, 2015

9 Synchrosqueezed Transforms in Seismic Data/Image Analysis, 1^{st} International Workshop on Mathematical Geophysics at Harbin Institute of Technology, China, Jan. 2015

8 Robustness Analysis of Synchrosqueezed Transforms, SEG 2014 Post Convention Workshop

7 Synchrosqueezed Wave Packet Transforms and Diffeomorphism Based Spectral Analysis for 1D General Mode Decompositions, SIAM Annual Meeting 2014

6 Synchrosqueezed Curvelet Transform for 2D mode decomposition, SIAM Conference on Imaging Science 2014

5 Synchrosqueezed Curvelet Transform for 2D mode decomposition, TCCS, March 2014

4 Synchrosqueezed Wave Packet Transform for 2D mode decomposition, SIAM Annual Meeting 2013

3 Adaptive Data Analysis and Sparsity, IPAM workshop, UCLA, 2013

2 Synchrosqueezed Wave Packet Transform for 2D mode decomposition, TCCS, October 2012

1 Fast computation for Multilinear Operators, TCCS, September 2011

RECOGNITION FOR MENTORING

The EASIAM (East Asia section of SIAM) Student Paper Prize for Shijun Zhang, first prize. 2020

STUDENTS AND POSTDOCS

Postdocs

Current:

1. Ling Liang, 2023-now
2. Ke Chen, 2022-now
3. Michelle Michelle, 2022-now

Previous:

1. Yiqi Gu, August 2019 to May 2021. First position afterward: Postdoc fellow in the Department of Mathematics at Hong Kong University
2. Ricardo A. Delgadillo, August 2019 to April 2020. First position afterward: Research fellow in the Department of Environmental and Civil Engineering, National University of Singapore
3. Simon Etter, August 2019 to July 2021. First position afterward: Research scientist at synchronous.ai

4. Sean Hon, March 2019 to May 2020. First position afterward: Assistant professor in the Department of Mathematics at Hong Kong Baptist University

PhD students

Current:

1. Junaid Aftab, 2023-now.
2. Chugang Yi, 2022-now.
3. Gareth C Hardwick, 2022-now.
4. Ong Yong Zheng, 2019-now.
5. Qiyuan Pang, 2018-now.

Previous:

1. Senwei Liang (2022)
   Ph.D. in the Department of Mathematics, Purdue University.
   Thesis title: Learning and Solving Partial Differential Equations with Deep Learning
   Position afterwards: Postdoc at Lawrence Berkeley National Laboratory
2. Ze Chen (2020)
   Ph.D. in the Department of Mathematics, National University of Singapore.
   Thesis title: Fast Matrix Vector Multiplication via Interpolative Decomposition Butterfly Factorization.
   Position after graduation: Research Scientist, Shopee, Singapore.
3. Shijun Zhang (2020)
   Ph.D. in the Department of Mathematics, National University of Singapore.
   Co-supervised with Zuowei Shen
   Thesis title: Deep Neural Network Approximation via Function Compositions.
   Position afterwards: Postdoc at National University of Singapore and Phillip Griffiths Assistant Research Professor at Duke University

Thesis defense committee member:

1. Lucas Bouck (2023)
   Ph.D. in applied mathematics in the AMSC program, University of Maryland College Park.
2. Xiaodong Huang (2022)
   Ph.D. in the Department of Mathematics, Purdue University.
   Thesis title: Structure Preserving and Fast Spectral Methods for Kinetic Equations
3. Yubo Wang (2022)
   Ph.D. in the Department of Mathematics, Purdue University.
   Thesis title: Efficient Numerical Methods for Kinetic Equations with High Dimensions and Uncertainties
4. Shixin Zheng (2021)
   Ph.D. in the Department of Mathematics, Purdue University.
5. Chenyang Cao (2020)
   Ph.D. in the Department of Mathematics, Purdue University.
6. Dr. Tongyao Pang (2019)
   Ph.D. in the Department of Mathematics, National University of Singapore.
   Thesis title: Image and Signal Restoration by Prior Knowledge.

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

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

Master students

Previous:

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.
   Position after graduation: Machine learning scientist in Facebook, UK
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.
   Position after graduation: Data scientists in Shopee, Singapore
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.
   Position after graduation: Data Scientist in Vivo then Ph.D. in mathematics at the University of Florida.
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

Current:

1. John Timothy Quinn (2022)
   B.S. at University of Colorado Boulder
2. Gengzhi Yang (2022)
   B.S. at Fudan University
3. Zhongyi Jiang (2022)
   B.S. at University of Delaware

Previous:

1. Jiaheng Chen (2021)
   B.S. in the Zhiyuan College of Mathematics, Shanghai Jiao Tong University
   Position after graduation: Ph.D. in the Department of Statistics at University of Chicago
2. Wenhan Gao (2021)
   B.S. in the Department of Applied Mathematics and Statistics at The State University of New York at Stony Brook
   Position after graduation: Ph.D. in the Department of Mathematics, The State University of New York at Stony Brook, US.
3. Jasen Lai (2021)
   B.S. in Mathematics and Computer & Information Sciences at the Ohio State University
   Position after graduation: Ph.D. in the Department of Statistics at Purdue University
4. Shiqin Dai (2020)
   B.S. in the Department of Mathematics and Computer Science, Purdue University
   Position after graduation: M.Sc. in ECE, Duke University.
5. Liyao Lyu (2020 spirng and summer)
   B.S. in the Department of Mathematics, Soochow University.
   Position after graduation: Ph.D. in the Department of Computational Mathematics, Science and Engineering, Michigan State University.
6. 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.
7. 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.
8. 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.
9. 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.
10. Seow Yaxin Claudia (2019)
    B.S. in the Department of Mathematics, National University of Singapore.

Thesis title: Decentralised Deep Learning Optimisation.
Position after graduation: co-founder of NodeFlair.

11. Xueying Guo (2019)
    B.S. in the Department of Mathematics, National University of Singapore.
    Thesis title: Deep Reinforcement Learning for Solving Linear Equations.
12. Mo Zhou (2018)
    B.S. in the Department of Mathematics, Tsinghua University.
    Thesis title: Advanced Mode Decomposition Algorithms in Signal Processing.
    Position after graduation: Ph.D. in mathematics at Duke University, US.
13. 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.
14. 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.
15. 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, Graduate Admission Committee, the Applied Mathematics & Statistics, and Scientific Computation (AMSC) graduate program, University of Maryland College Park, 2022-2023
- Co-organizer, PSU-Purdue-UMD Joint Seminar on Mathematical Data Science, Department of Mathematics, University of Maryland College Park, 2022-2023
- Member, PDE/Appl Math Field Committee, Department of Mathematics, University of Maryland College Park, 2022-2023
- Member, Numerical Analysis Field Committee, Department of Mathematics, University of Maryland College Park, 2022-2023
- Member, Analysis Field Committee, Department of Mathematics, University of Maryland College Park, 2022-2023
- Member, Computer Committee, Department of Mathematics, Purdue University, 2019-2022
- Member, Search Committee for Data Science, Department of Mathematics, Purdue University, 2019-2021
- Organizer, Mathematical Data Science Seminar, Department of Mathematics, Purdue University, 2019-2022

Editorial Duties

- Guest Editor, Frontiers in Applied Mathematics and Statistics, a special issue on Machine Learning for Mathematical Modeling and Computation, 2021
- Guest Editor, Computational and Mathematical Biophysics, a special issue on Optimization and Machine Learning Algorithms for Biological Data Analysis, 2020

Research Grant Refereeing

5 US National Science Foundation (NSF), DMS Computational Mathematics, 2023

4 US National Science Foundation (NSF), DMS Computational Mathematics, 2022

3 Engineering and Physical Sciences Research Council (EPSRC), 2021

2 Centre Européen de Calcul Atomique et Moléculaire (CECAM), 2021

1 French National Research Agency (ANR), 2019

Journal, Conference, and Book Refereeing

Advances in Continuous and Discrete Models: Theory and Applications;
AIMS Mathematics;
Annals of Statistics;
Applied and Computational Harmonic Analysis;
Applied Mathematics and Computation;
Applied Numerical Mathematics;
Applied Sciences;
Communications in Computational Physics;
Communications in Mathematical Sciences;
Communications in Mathematics and Statistics;
Communications on Applied Mathematics and Computation;
Computers and Mathematics with Applications;
Constructive Approximation;
CSIAM Transaction on Applied Mathematics;
East Asian Journal on Applied Mathematics;
Engineering Applications of Artificial Intelligence;
Geophysics;
IEEE Signal Processing Magazine;
IEEE Transactions on Antennas and Propagation;
IEEE Transactions on Computational Imaging;
IEEE Transactions on Signal Processing Letters;
IEEE Transactions on Signal Processing;
IEEE Transactions on Image Processing;
IEEE Transactions on Geoscience and Remote Sensing;
Inverse Problems and Imaging;
Journal of Computational Physics;
Journal of Computational Mathematics;
Journal of Computational and Applied Mathematics;
Journal of Fourier Analysis and Applications;
Journal of Machine Learning Research;
Journal of Neuroscience Methods;
Journal of Scientific Computing; Mathematics of Computation;

Nature Computational Science;
Neural Networks;
PLOS ONE;
Philosophical Transactions of the Royal Society A;
Research in Mathematical Sciences;
(SIAM) Multiscale Modeling and Simulation;
SIAM Journal on Imaging Science;
SIAM Journal on Mathematical Analysis;
SIAM Journal on Numerical Analysis;
SIAM Journal on Scientific Computing;
Terrestrial, Atmospheric and Oceanic Sciences

AAAI; ICANN; International Conference on Domain Decomposition Methods; Mathematical and Scientific Machine Learning Conference (MSML)

Conference/Workshop Organized

4 Co-organizer, Brin Mathematics Research Center, "Scientific Machine Learning: Theory and Algorithms", University of Maryland College Park, 2/21/24-2/23/24

3 Co-organizer, NSF-CBMS Conference: Deep Learning and Numerical PDEs, Morgan State University, June 19-23, 2023

2 Co-organizer, IMA PI conference, "Workshop on Deep Learning Theory and Applications", Purdue University, August 2021

1 Organizer, Workshop on "High-Dimensional Learning and Computation in Physics", National University of Singapore, Singapore, June 2019

Minisymposium/Symposium Organized

18 Co-chair. Minisymposium on "Recent Development of Theory and Algorithms of Scientific Machine Learning", The International Council for Industrial and Applied Mathematics (ICIAM), Japan, August 2023

17 Co-chair. Minisymposium on "Recent Development of Theory and Algorithms of Scientific Machine Learning", SIAM Southeastern Atlantic Section Annual Meeting (SIAM-SEAS23), Blacksburg, Virginia, March 25-26, 2023

16 Co-chair. Minisymposium on "Recent Advances in Scientific Deep Learning", SIAM Conference on Mathematics of Data Science, September 26-30, 2022, San Diego, USA

15 Co-chair. Minisymposium on "Data-Driven Models and Machine Learning Strategies for Complex Dynamical Systems", SIAM Annual Meeting, July 11-15, 2022, Pittsburgh, Pennsylvania, USA

14 Co-chair. Minisymposium on "Mathematical Foundation of Data Science in Scientific Computing", AMS Sectional Meeting at Purdue University, West Lafayette, IN on March 26-27, 2022

13 Co-chair. Minisymposium on "Mathematics of Machine Learning Methods for PDEs", SIAM Conference on Analysis of Partial Differential Equations, March 14 - 18, 2022. Technische Universität Berlin, Germany

12 Co-chair. Minisymposium on "Mathematical foundation of deep learning with the applications to PDE", 4th Annual Meeting of the SIAM Texas-Louisiana Section, November 5-7, 2021

11 Co-chair. Minisymposium on "Machine learning for interatomic potentials", SIAM Conference on Mathematical Aspects of Materials Science, May 18-22, 2020, Bilbao, Spain

10 Co-chair. Minisymposium on "Mathematical Understanding and Applications of Learning with Networks", SIAM Conference on Mathematics of Data Science, Cincinnati, Ohio, May 7-9, 2020 (canceled due to COVID-19)

9 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 (canceled due to COVID-19)

8 Co-chair. Minisymposium on "Machine Learning for Solving PDEs and Inverse Problems", 2nd Annual Meeting of the SIAM Texas-Louisiana Section, November 2019

7 Co-chair. Minisymposium on "Mathematical Theory and Applications of Deep Learning", The International Council for Industrial and Applied Mathematics (ICIAM), Spain, July 2019

6 Co-chair. Minisymposium on "Fast and Accurate Integral Methods for Highly Oscillatory Phenomena", SIAM Conference on Computational Science and Engineering, 2019

5 Co-chair. Minisymposium on "Low-Dimensional Structures in Imaging Science", SIAM Conference on Imaging Science, 2018

4 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

3 Co-chair. Minisymposium on "Hierarchical Structure and Randomness in Linear Algebra", SIAM Annual Meeting, 2016

2 Chair. Minisymposium on "Multidimensional Mode Decomposition and Applications", SIAM Conference on Imaging Science, 2016.

1 Co-chair. Minisymposium on "Structured Matrices and Applications", SIAM Conference on Applied Linear Algebra, 2015.