Zhihui Zhu

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Research Interests

- Machine learning, data science, signal processing, and computational engineering
- Design, training, and analysis of deep neural networks
- Statistical and algorithmic aspects of quantum information science
- Design, analysis, and implementation of optimization algorithms for high-dimensional and large-scale problems
- Signal and data processing using sparse, low-rank, and manifold-based models

Education

2017	Ph.D. in Electrical Engineering (Dr. Michael Wakin, advisor)	Colorado School of Mines
2012	B.E. in Telecommunications Engineering (Dr. Gang Li, advisor), winner of Best Bachelor's Thesis Award (1/125)	Zhejiang University of Technology Jianxing Honors College

Positions

2022-	Assistant Professor	Ohio State University Department of Computer Science & Engineering
2020-2022	Assistant Professor	University of Denver Department of Electrical & Computer Engineering
2018-2019	Postdoctoral Fellow (Dr. René Vidal, advisor)	Johns Hopkins University Center for Imaging Science Mathematical Institute for Data Science
2014-2017	Research Assistant (Dr. Michael Wakin, advisor)	Colorado School of Mines Dept. of Electrical Engineering
2013-2014	Teaching Assistant	Colorado School of Mines Dept. of Electrical Engineering
2010-2013	Research Assistant (Dr. Gang Li, advisor)	Zhejiang University of Technology Zhejiang Key Lab. for Signal Processing

Honors

2021	Research, Scholarship, and Creative Work Faculty Recognition	Univ. Denver
2019	Finalist for the Best Student Paper Award	IEEE CAMSAP
2018	Electrical Engineering Graduate Research Award	Colorado School of Mines

2013	National Scholarship	Ministry of Education of PRC
2012	Best Bachelor's Thesis Award (1/125) for the Thesis "On The Sparse Representation of Signals in Compressive Sensing"	ZJUT
2011	Meritorious Winner in the Mathematical Contest in Modeling (MCM, sponsored by SIAM, NSA, and INFORMS)	

Research Support

2021-2025 "Collaborative Research: CIF: Medium: Structured Inference and Adaptive Measurement Design in Indirect Sensing Systems,"
DU PI, $344K, NSF Division of Computing and Communication Foundations
(Collaborative with M. Wakin and G. Tang at Colorado School of Mines)

2020-2023 "Collaborative Research: CIF: Small: Deep Sparse Models: Analysis and Algorithms,"
DU PI, $205K, NSF Division of Computing and Communication Foundations
(Collaborative with J. Sulam at Johns Hopkins University)

Preprints[1]

1. Q. Qu*, Z. Zhu*, X. Li, M. C. Tsakiris, J. Wright, R. Vidal, "Finding the Sparsest Vectors in a Subspace: Theory, Algorithms, and Applications," arXiv preprint arXiv: 2001.06970, 2020.
2. X. Li, Z. Zhu, A. M. So, and J. Lee, "Incremental Methods for Weakly Convex Optimization," arXiv preprint arXiv:1907.11687, 2019.
3. Q. Li*, Z. Zhu*, G. Tang, and M. B. Wakin, "Provable Bregman-divergence based Methods for Nonconvex and Non-Lipschitz Problems," arXiv preprint arXiv:1904.09712, 2019.
4. Z. Zhu and X. Li, "Convergence Analysis of Alternating Nonconvex Projections," arXiv preprint arXiv:1802.03889, 2018.
5. Z. Zhu and M. B. Wakin, "Time-Limited Toeplitz Operators on Abelian Groups: Applications in Information Theory and Subspace Approximation," arXiv preprint arXiv:1711.07956, 2017.

Book Chapters

1. R. Vidal, Z. Zhu, and B. Haeffele, "Optimization Landscape of Neural Networks," in P. Grohs and G. Kutyniok (Eds.), *Mathematics Aspects of Deep Learning*, Cambridge University Press, 2022.

Journal Publication

1. J. Sulam, C. You, and Z. Zhu, "Recovery and Generalization in Over-Realized Dictionary Learning," *Journal of Machine Learning Research*, vol. 23, no. 135, pp. 1-23, 2022.
2. Z. Zhu and M. B. Wakin, "Time-Limited Toeplitz Operators on Abelian Groups: Applications in Information Theory and Subspace Approximation," to appear in *Pure and Applied Functional Analysis*, 2022.
3. Z. Zhu*, Q. Li*, G. Tang, and M. B. Wakin, "The Global Optimization Geometry of Low-Rank Matrix Optimization," *IEEE Transactions on Information Theory*, vol. 67, no. 2, pp. 1308-1331, 2021.

[1] *indicates equal contribution.

4. X. Li*, S. Chen*, Z. Deng, Q. Qu, Z. Zhu, and A.M.-C. So, "Weakly Convex Optimization over Stiefel Manifold Using Riemannian Subgradient-Type Methods," *SIAM Journal on Optimization*, vol. 31, no. 3, pp. 1605–1634, 2021.

5. X. Li, Z. Zhu, Q. Li, and K. Liu, "A Provable Splitting Approach for Symmetric Nonnegative Matrix Factorization," *IEEE Transactions on Knowledge and Data Engineering*, 2021.

6. K. Liu, X. Li, Z. Zhu, L. Brand, and H. Wang, "Factor-Bounded Nonnegative Matrix Factorization," *ACM Transactions on Knowledge Discovery from Data*, vol. 15, pp. 1-18, 2021.

7. Y. Li, Z. Zhu, J. Yu, and Y. Zhang, "Learning Deep Cross-Modal Embedding Networks for Zero-Shot Remote Sensing Image Scene Classification," to appear in *IEEE Transactions on Geoscience and Remote Sensing*, 2021.

8. Q. Qu, X. Li, and Z. Zhu, "Exact Recovery of Multichannel Sparse Blind Deconvolution via Gradient Descent," *SIAM Journal on Imaging Sciences*, vol. 13, no. 3, pp. 1630-1652, 2020.

9. Y. Li, Y. Zhang, and Z. Zhu, "Error-Tolerant Deep Learning for Remote Sensing Image Scene Clas-sification," *IEEE Transactions on Cybernetics*, vol. 51, pp. 1756-1768., 2020.

10. S. Li, Q. Li, Z. Zhu, G. Tang, and M. B. Wakin, "The Global Geometry of Centralized and Distributed Low-rank Matrix Recovery without Regularization," *IEEE Signal Processing Letters*, vol. 27, pp. 1400-1404, 2020.

11. X. Li*, Z. Zhu*, A.M.-C. So, and R. Vidal, "Nonconvex Robust Low-rank Matrix Recovery," *SIAM Journal on Optimization*, vol. 30, no. 1, pp. 660-686, 2020.

12. Z. Zhu, D. Soudry, Y. C. Eldar, and M. B. Wakin, "The Global Optimization Geometry of Shallow Linear Neural Networks," *Mathematical Foundations of Deep Learning in Imaging Science*, special issue of *Journal of Mathematical Imaging and Vision*, vol. 62, pp. 279-292, 2020.

13. C. Wang, Z. Zhu Z, and H. Gu, "Low-rank Seismic Denoising with Optimal Rank Selection for Hankel Matrices," *Geophysical Prospecting*, 2020, vol. 68, no. 3, pp. 892-909, 2020.

14. Q. Jiang, S. Li, Z. Zhu, H. Bai, X. He, and R. C. de Lamare, "Design of compressed sensing system with probability-based prior information." *IEEE Transactions on Multimedia*, vo. 22, no. 3, pp. 594-609, 2019.

15. Q. Li, Z. Zhu, and G. Tang, "The Non-convex Geometry of Low-rank Matrix Optimization," *Information and Inference: A Journal of the IMA*, vol 8, no. 1, pp. 51-96, March 2019.

16. S. Karnik, Z. Zhu, M. B. Wakin, J. Romberg, and M. A. Davenport, "The Fast Slepian Transform," *Applied and Computational Harmonic Analysis*, vol 46, no. 3, pp. 624-652, May 2019.

17. T. Hong, X. Li, Z. Zhu, and Q. Li, "Optimized Structured Sparse Sensing Matrices for Compressive Sensing," *Signal Processing*, vol. 159, pp. 119-129, June 2019.

18. C. Wang, Z. Zhu, H. Gu, X. Wu, and S. Liu, "Hankel Low-Rank Approximation for Seismic Noise Attenuation," *IEEE Transactions on Geoscience and Remote Sensing*, vol 57, no. 1, pp. 561-573, January 2019.

19. Z. Zhu, S. Karnik, M. Wakin, M. Davenport, and J. Romberg, "ROAST: Rapid Orthogonal Approximate Slepian Transform,", *IEEE Transactions on Signal Processing*, vol 66, no. 22, pp. 5887-5901, November 2018.

20. Z. Zhu, G. Li, J. Ding. Q. Li, and X. He, "On Collaborative Compressive Sensing Systems: The Framework, Design and Algorithm," *SIAM Journal on Imaging Sciences*, vol 11, no. 2, pp. 1717-1758, 2018.

21. Z. Zhu, Q. Li, G. Tang, and M. B. Wakin, "Global Optimality in Low-rank Matrix Optimization," *IEEE Transactions on Signal Processing*, vol 66, no. 13, pp. 3614-3628, July 2018.

22. T. Hong and Z. Zhu, "An Efficient Method for Robust Projection Matrix Design," *Signal Processing*, vol. 143, pp. 200-210, February 2018.

23. Z. Zhu, S. Karnik, M. A. Davenport, J. K. Romberg, and M. B. Wakin, "The Eigenvalue Distribution of Discrete Periodic Time-Frequency Limiting Operators," *IEEE Signal Processing Letters*, vol. 25, no. 1, pp. 95–99, January 2018.

24. Z. Zhu and M. B. Wakin, "Approximating Sampled Sinusoids and Multiband Signals Using Multiband Modulated DPSS Dictionaries," *Journal of Fourier Analysis and Applications*, vol. 23, no. 6, pp. 1263–1310, December 2017.

25. Z. Zhu and M. B. Wakin, "On the Asymptotic Equivalence of Circulant and Toeplitz Matrices," *IEEE Transactions on Information Theory*, vol. 63, no. 5, pp. 2975-2992, May 2017.

26. S. Liu, M. Liu, P. Li, J. Zhao, Z. Zhu, and X. Wang, "SAR Image Denoising via Sparse Representation in Shearlet Domain Based on Continuous Cycle Spinning," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 55, no. 5, pp. 2985-2992, 2017.

27. H. Tao, H. Bai, S. Li, and Z. Zhu, "An Efficient Algorithm for Designing Projection Matrix in Compressive Sensing Based On Alternating Optimization," *Signal Processing*, vol. 125, pp. 9-20, 2016.

28. G. Li, Z. Zhu, D. Yang, L. Chang, and H. Bai, "On Projection Matrix Optimization for Compressive Sensing Systems," *IEEE Transactions on Signal Processing*, vol. 61, no. 11, pp. 2887-2898, June 2013.

Conference Publications—Machine Learning

1. T. Chen, L. Liang, T. Ding, Z. Zhu, and I. Zharkov, "OTOv2: Automatic, Generic, User-Friendly", *International Conference on Learning Representations (ICLR)*, May 2023.

2. J. Zhou, C. You, X. Li, K. Liu, S. Liu, Q. Qu, and Z. Zhu, "Are All Losses Created Equal: A Neural Collapse Perspective," *Neural Information Processing Systems (NeurIPS)*, December 2022.

3. Z. Qin, A. Lidiak, Z. Gong, G. Tang, M. B. Wakin, and Z. Zhu, "Error Analysis of Tensor-Train Cross Approximation," *Neural Information Processing Systems (NeurIPS)*, December 2022.

4. C. Yaras, P. Wang, Z. Zhu, L. Balzano, and Qing Qu, "Neural Collapse with Normalized Features: A Geometric Analysis over the Riemannian Manifold," *Neural Information Processing Systems (NeurIPS)*, December 2022.

5. X. Dai, M. Li, P. Zhai, S. Tong, X. Gao, S. Huang, Z. Zhu, C. You, and Yi Ma, "Revisiting Sparse Convolutional Model for Visual Recognition," *Neural Information Processing Systems (NeurIPS)*, December 2022.

6. Jinxin Zhou*, Xiao Li*, Tianyu Ding, Chong You, Qing Qu, and Zhihui Zhu, "On the Optimization Landscape of Neural Collapse under MSE Loss: Global Optimality with Unconstrained Features," *International Conference in Machine Learning (ICML)*, 2022. (acceptance rate = 20%)

7. S. Liu, Z. Zhu, Q. Qu, and C. You, "Robust Training under Label Noise by Over-parameterization," *International Conference in Machine Learning (ICML)*, 2022. (acceptance rate = 20%)

8. Z. Zhu*, T. Ding*, J. Zhou, X. Li, C. You, J. Sulam, and Q. Qu, "A Geometric Analysis of Neural Collapse with Unconstrained Features," *Neural Information Processing Systems (NeurIPS)*, 2021. (spotlights, top 3%; acceptance rate = 26%)

9. S. Liu*, X. Li*, Y. Zhai, C. You, Z. Zhu, C. Fernandez-Granda, and Q. Qu, "Convolutional Normalization: Improving Deep Convolutional Network Robustness and Training," *Neural Information Processing Systems (NeurIPS)*, 2021. (acceptance rate = 26%)

10. L. Ding, L. Jiang, Y. Chen, Q. Qu, and Z. Zhu, "Rank Overspecified Robust Matrix Recovery: Subgradient Method and Exact Recovery", *Neural Information Processing Systems (NeurIPS)*, 2021. (acceptance rate = 26%)

11. T. Chen, B. Ji, T. Ding, B. Fang, G. Wang, Z. Zhu, L. Liang, Y. Shi, S. Yi, and X. Tu, "Only Train Once: A One-Shot Neural Network Training And Pruning Framework", *Neural Information Processing Systems (NeurIPS)*, 2021. (acceptance rate = 26%)

12. T. Ding, Z. Zhu, R. Vidal, and D. P. Robinson, "Dual Principal Component Pursuit for Robust Subspace Learning: Theory and Algorithms for a Holistic Approach," *International Conference on Machine Learning (ICML)*, 2021. (acceptance rate = 21%)

13. T. Ding, L. Liang, Z. Zhu, and I. Zharkov, "CDFI: Compression-driven Network Design for Frame Interpolation," *Computer Vision and Pattern Recognition (CVPR)*, 2021. (acceptance rate = 23%)

14. T. Ding, Z. Zhu, M. C. Tsakiris, R. Vidal, and D. P. Robinson, "Dual Principal Component Pursuit for Learning a Union of Hyperplanes: Theory and Algorithms," Artificial Intelligence and Statistics (AISTATS), 2021. (acceptance rate = 29%)

15. C. You*, Z. Zhu*, Q. Qu, and Y. Ma, "Robust Recovery via Implicit Bias of DiscrepantLearning Rates for Double Over-parameterization," *Neural Information Processing Systems (NeurIPS)*, 2020. (spotlights, top 4%; acceptance rate = 20%)

16. T. Chen, T. Ding, B. Ji, G. Wang, Y. Shi, S. Yi, X. Tu, and Z. Zhu, "Orthant Based Proximal Stochastic Gradient Method for L-1 Regularized Optimization", *European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases (ECML-PKDD)*, Ghent, Belgium, September 2020. (acceptance rate = 19%)

17. T. Ding, Y. Yang, Z. Zhu, D. Robinson, R. Vidal, L. Kneip, M. C. Tsakiris, "Robust Homography Estimation via Dual Principal Component Pursuit," *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, Seattle, Washington, June 2020. (acceptance rate = 22%)

18. Q. Qu, Y. Zhai, X. Li, Y. Zhang, and Z. Zhu, "Analysis of the Optimization Landscapes for Overcomplete Representation Learning," *International Conference on Learning Representations (ICLR)*, Addis Ababa, Ethiopia, April 2020. (oral, top 1.85%; acceptance rate = 26.5%)

19. Z. Zhu, T. Ding, M.C. Tsakiris, D. Robinson, and R. Vidal, "A Linearly Convergent Method for Non-smooth Non-convex Optimization on Grassmannian with Applications to Robust Subspace and Dictionary Learning," *Neural Information Processing Systems (NeurIPS)*, Vancouver, Canada, December 2019. (acceptance rate = 21%)

20. Z. Zhu, Q. Li, X. Yang, G. Tang, and M. B. Wakin, " Global Optimality in Distributed Low-rank Matrix Factorization," *Neural Information Processing Systems (NeurIPS)*, Vancouver, Canada, December 2019. (acceptance rate = 21%)

21. Q. Qu, X. Li, and Z. Zhu, " A Nonconvex Approach for Exact and Efficient Multichannel Sparse Blind Deconvolution," *Neural Information Processing Systems (NeurIPS)*, Vancouver, Canada, December 2019. (spotlights, top 4.2%; acceptance rate = 21%)

22. Q. Li*, Z. Zhu*, and G. Tang, "Alternating Minimizations Converge to Second-Order Optimality Solutions", *International Conference on Machine Learning (ICML)*, Long Beach, CA, USA, June 2019. (acceptance rate = 22%)

23. T. Ding*, Z. Zhu*, T. Ding, M. C. Tsakiris, D. P. Robinson, and R. Vidal, "Noisy Dual Principal Component Pursuit", *International Conference on Machine Learning (ICML)*, Long Beach, CA, USA, June 2019. (acceptance rate = 22%)

24. Z. Zhu, Y. Wang, D. P. Robinson, D. Naiman, R. Vidal, and M. C. Tsakiris, "Dual Principal Component Pursuit: Improved Analysis and Efficient Algorithms," *Neural Information Processing Systems (NeurIPS)*, December 2018. (acceptance rate = 21%)

25. Z. Zhu*, X. Li*, K. Liu, and Q. Li, "Dropping Symmetry for Fast Symmetric Nonnegative Matrix Factorization," *Neural Information Processing Systems (NeurIPS)*, December 2018. (acceptance rate = 21%)

Workshop Publications—Machine Learning

1. Z. Zhu*, T. Ding*, J. Zhou, X. Li, C. You, J. Sulam, and Q. Qu, "A Geometric Analysis of Neural Collapse with Unconstrained Features," *Conference on the Mathematical Theory of Deep Learning*, 2021.

2. X. Li, Z. Zhu, A. Man-Cho So, J. D Lee, "Incremental Methods for Weakly Convex Optimization," *Neural Information Processing Systems (NeurIPS) Workshop on Optimization for Machine Learning (OPT)*, 2020.

Conference Publications—Signal Processing

1. H. Yu, Z. Qin, and Z. Zhu, "Learning Approach for Fast Approximate Matrix Factorizations," *International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, 2022.

2. Q. Qu, Y. Zhai, X. Li, Y. Zhang, and Z. Zhu, "Analysis of the Optimization Landscapes for Overcomplete Representation Learning," *IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP)*, 2020.

3. Q. Li, X. Yang, Z. Zhu, G. Tang, and M. B. Wakin, "The Geometric Effects of Distributing Constrained Nonconvex Optimization Problems," *IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP)*, 2019. (candidates for the Best Student Paper Award)

4. Q. Qu, X. Li, and Z. Zhu, "Exact and Efficient Multi-Channel Sparse Blind Deconvolution—a Nonconvex Approach," *Asilomar Conference on Signals, Systems, and Computers (Asilomar)*, Pacific Grove, CA, USA, November 2019.

5. Q. Li, Z. Zhu, M. B. Wakin, and G. Tang, "The Local Geometry of Orthogonal Dictionary Learning using L1 Minimization," *Asilomar Conference on Signals, Systems, and Computers (Asilomar)*, Pacific Grove, CA, USA, November 2019.

6. Y. Li, Y. Zhang, and Zhihui Zhu, "Learning Deep Networks under Noisy Labels for Remote Sensing Image Scene Classification," *IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, Yokohama, Japan, July 2019.

7. Q. Li, Z. Zhu, G. Tang, and M. B. Wakin, "The Geometry Of Equality-Constrained Global Consensus Problems," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Brighton, UK, May 2019.

8. Z. Zhu, M. Lopez-Santillana, and M. B. Wakin,"Super-Resolution of Complex Exponentials from Modulations with Known Waveforms," *IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP)*, Curacao, Dutch Antilles, December 2017.

9. Z. Zhu, Q. Li, G. Tang, and M. B. Wakin, "Global Optimality in Low-rank Matrix Optimization," *IEEE Global Conference on Signal and Information Processing (GlobalSIP)*, Montreal, Quebec, Canada, November 2017.

10. Z. Zhu, D. Yang, M. B. Wakin, and G. Tang, "A Super-Resolution Algorithm for Multiband Signal Identification," *51st Asilomar Conference on Signals, Systems and Computers*, Pacific Grove, California, October 2017.

11. Z. Zhu, S. Karnik, M. B. Wakin, M. A. Davenport, and J. K. Romberg, "Fast Orthogonal Approximations of Sampled Sinusoids and Bandlimited Signals," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, New Orleans, March 2017.

12. G. Li, Z. Zhu, H. Bai, and A. Yu, "A New Framework for Designing Incoherent Sparsifying Dictionaries," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, New Orleans, March 2017.

13. Q. Li, S. Li, H. Mansour, M. Wakin, D. Yang, and Z. Zhu, "JAZZ: A Companion to MUSIC for Frequency Estimation with Missing Data," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, New Orleans, March 2017.

14. S. Karnik, Z. Zhu, M. B. Wakin, J. K. Romberg, and M. A. Davenport, "Fast Computations for Approximation and Compression in Slepian Spaces," *IEEE Global Conference on Signal and Information Processing (GlobalSIP)*, Greater Washington, D.C., December 2016.

15. Z. Zhu and M. B. Wakin, "On the Dimensionality of Wall and Target Return Subspaces in Through-the-Wall Radar Imaging," *4th International Workshop on Compressed Sensing Theory and its Applications to Radar, Sonar and Remote Sensing (CoSeRa)*, Aachen, Germany, September 2016.

16. Z. Zhu, G. Tang, P. Setlur, S. Gogineni, M. Wakin, and M. Rangaswamy, "Super-Resolution in SAR Imaging: Analysis With the Atomic Norm," *IEEE Sensor Array and Multichannel Signal Processing (SAM) Workshop*, Rio de Janeiro, Brazil, July 2016.

17. Z. Zhu and M. B. Wakin, "New Analysis of Multiband Modulated DPSS Dictionaries," *Workshop on Signal Processing with Adaptive Sparse Structured Representations (SPARS)*, Cambridge, England, July 2015.

18. Z. Zhu and M. B. Wakin, "Wall Clutter Mitigation and Target Detection Using Discrete Prolate Spheroidal Sequences," *3rd International Workshop on Compressed Sensing Theory and its Applications to Radar, Sonar and Remote Sensing (CoSeRa)*, Pisa, Italy, June 2015.

19. Z. Zhu and M. B. Wakin, "Detection of Stationary Targets Using Discrete Prolate Spheroidal Sequences," *International Review of Progress in Applied Computational Electromagnetics (ACES)*, Williamsburg, Virginia, March 2015.

20. H. Bai, Z. Zhu, G. Li, and S. Li, "Design of Optimal Measurement Matrix for Compressive Detection," *International Symposium on Wireless Communication Systems (ISWCS)*, Ilmenau, Germany, August 2013.

21. S. Li, Z. Zhu, G. Li, L. Chang, and Q. Li, "Projection Matrix Optimization for Block-sparse Compressive Sensing," *IEEE International Conference on Signal Processing, Communication and Computing (ICSPCC)*, KunMing, August 2013.

22. Q. Li, Z. Zhu, S. Tang, L. Chang, and G. Li, "Projection Matrix Optimization Based on SVD for Compressive Sensing Systems," *Chinese Control Conference (CCC)*, July 2013.

23. Z. Zhu, D. Yang, G. Li, and C. Huang, "Stable 2nd Order Adaptive IIR filter Structure for Blind Deconvolution," *International Congress on Image and Signal Processing (CISP)*, Shanghai, October 2011.

Tutorials and Short Courses

1. "Learned Representations and Low-Dimensional Structures", *The Third Workshop on Seeking Low-Dimensionality in Deep Neural Networks*, Jan 2023.

2. "Low-Dimensional Models for High-Dimensional Data: From Linear to Nonlinear, Convex to Nonconvex, and Shallow to Deep", *2022 IEEE International Conference on Acoustics, Speech and Signal Processing*, May 2022. (10-hours short course with Sam Buchanan, Yi Ma, Qing Qu, John Wright, and Yuqian Zhang)

3. "Nonconvex Approaches for Data Science," *School of Information Science and Technology, ShanghaiTech University*, June 2019.

Guest Lectures

1. "Geometric Analysis of Neural Collapse with unconstrained features," invited by Dr. Qu for *EECS 559: Optimization Methods for Signal and Image Processing and Machine Learning, University of Michigan-Ann Arbor*, April 2021.

2. "Robust Recovery with Over-parameterized Model," invited by Dr. Qu for *EECS 559: Optimization Methods for Signal and Image Processing and Machine Learning, University of Michigan-Ann Arbor*, April 2021.

Invited Presentations

1. "Neural Collapsed Representation in Deep Learning Classifiers", *Department of Computer Science, Missouri S&T*, Oct 2022.

2. "Rank-Overspecified Robust Matrix Recovery: Subgradient Method And Exact Recovery", *International Conference on Continuous Optimization (ICCOPT),* July 2022.

3. "Low-dimensional Modeling for Deep Learning", *IEEE Denver Computer, Information Theory, and Robotics Society*, June 2022.

4. "A Geometric Analysis Of Neural Collapse With Unconstrained Features,", *VITA at University of Texas at Austin*, March 2022.

5. "Low-dimensional Modeling for Deep Learning", *Applied and Computational Mathematics Seminar, Georgia Institute of Technology*, March 2022.

6. "Low-dimensional Modeling for Deep Learning", *Department of Computer Science & Engineering, The Ohio State University*, March 2022.

7. "Low-dimensional Modeling for Deep Learning", *Department of Electrical & Systems Engineering, Washington University in St. Louis*, February 2022.

8. "Landscape Analysis of Neural Collapse with Unconstrained Features," *The 2nd Workshop on Seeking Low-dimensionality in Deep Neural Networks (SLowDNN)*, November 2021.

9. "A Geometric Analysis Of Neural Collapse With Unconstrained Features," *Institute for Operations Research and the Management Sciences (INFORMS) Annual Meeting, Special Session on The Interplay between Optimization and Statistics, Anaheim, California*, October 2021.

10. "Landscape Analysis of Neural Collapse with Unconstrained Features", *Center for Biological & Computational Learning (CBCL), Massachusetts Institute of Technology*, October, 2021.

11. "Landscape Analysis of Neural Collapse", *Berkeley Learning Theory Group, University of California, Berkeley*, June, 2021.

12. "Robust Recovery with Over-parameterized Model", Microsoft Research Day, Microsoft, March, 2021.

13. "Robust Recovery with Over-parameterized Model", Computational Interpretation Group, University of Science and Technology of China, March, 2021.

14. "Provable Nonsmooth Nonconvex Approaches for Low-Dimensional Models", *Statistics, Optimization and Machine Learning (StaOptML) Seminar*, University of Colorado Boulder, Jan 2020.

15. "Provable Nonsmooth Nonconvex Approaches for Low-Dimensional Models", Colorado School of Mines, Jan 2020.

16. "Provable Nonsmooth Nonconvex Approaches for Low-Dimensional Models", *Signal and Information Processing Seminar (SIP) Seminar*, Rutgers University, Dec 2019.

17. "Provable Nonconvex Approaches for Low-rank Models", *Workshop on Low-Rank Models and Applications (LRMA)*, University of Mons, Belgium, Sep 2019.

18. "A Linearly Convergent Method for Non-Smooth Non-Convex Optimization on the Sphere with Applications to Robust Subspace and Dictionary Learning", *the Sixth International Conference on Continuous Optimization (ICCOPT)*, Technical University (TU) of Berlin, Aug 2019.

19. "Nonconvex Approaches for Data Science," *Wuhan University*, June 2019.

20. "Nonconvex Approaches for Data Science," *Zhejiang University of Technology*, June 2019.

21. "Nonconvex Nonsmooth Approaches for Data Science," *Center for Data Science*, New York University, April 2019.

22. "Nonconvex Approaches for Data Science," *University of Denver*, Feb 2019.

23. "Nonconvex Approaches for Data Science," *George Washington University*, Feb 2019.

24. "Nonconvex Approaches for Data Science," *University of Utah*, March 2019.

25. "Nonconvex Approaches for Data Science," *University of Vermont*, March 2019.

26. "Nonconvex Approaches for Data Science," *University of Hawaii at Manoa*, March 2019.

27. "Nonconvex Geometry of Low-rank Matrix Optimizations," *JHU Vision Lab*, 2017.

28. "A Super-resolution Algorithm for Multiband Signal Identification," *51st Asilomar Conference on Signals, Systems and Computers*, Pacific Grove, October 2017.

Poster and Contributed Presentations

1. "Object Identification with Less Supervision," *Northrop Grumman University Research Symposium*, October, 2019.

2. "A Linearly Convergent Method for Non-smooth Non-convex Optimization on Grassmannian with Applications to Robust Subspace and Dictionary Learning," *Computational Imaging Workshop, Institute for Mathematics and its Applications, University of Minnesota Twin Cities,* October 2019.

3. "Fast Orthogonal Approximations of Sampled Sinusoids and Bandlimited Signals," *Graduate Research And Discovery Symposium (GRADS), Colorado School of Mines*, April 2017.

4. "Fast Orthogonal Approximations of Sampled Sinusoids and Bandlimited Signals," *Computing-Mines Affiliates Partnership Program (C-MAPP) Award Event*, January 2017.

5. "Wall Clutter Mitigation and Target Detection in Through-the-Wall Radar Imaging," *Graduate Research And Discovery Symposium (GRADS), Colorado School of Mines*, March 2016.

6. "On the Asymptotic Equivalence of Circulant and Toeplitz Matrices", *2016 February Fourier Talks – FFT 2016, Norbert Wiener Center for Harmonic Analysis and Applications, Department of Mathematics, University of Maryland*, College Park, Maryland, February 2016.

7. "SAR Radar Imaging of Targets Through the Wall," *Graduate Research And Discovery Symposium (GRADS), Colorado School of Mines*, January 2016.

8. "New Analysis of Multiband Modulated DPSS Dictionaries," *Zhejiang Key Laboratory for Signal Processing*, May 2015.

9. "SAR Radar Imaging of Targets Through the Wall", *Graduate Research And Discovery Symposium (GRADS), Colorado School of Mines*, April 2015.

Teaching Experience

Professor (OSU):	CSE5539	Deep Learning: Models, Theory & Application	(S'23)
	CSE5523	Machine Learning	(F'22)
Professor (DU):	ENGR4622	Advanced Optimization	(F'21)
	ENGR4620	Large-scale Optimization	(F'20)
	ENCE4631	Machine Learning	(S'20,S'21,S'22)
	ENGR3650	Probability and Statistics for Engineers	(W'20,W'21)
Participant (JHU):	Johns Hopkins Teaching Institute		(May 18)
Lab Instructor (Mines):	EENG 284	Advanced Optimization	(S'14, F'13)
Teaching Assistant (ZJUT):	Signals and Systems		(F'12,S'13)

Student Supervision and Advising

PhD Students

Jinxin Zhou, Sep. 2021-present
Topic: Seeking Low Dimensionality in Deep Neural Network

Qin Zhen, Sep. 2021-present
Topic: Structured Inference and Adaptive Measurement Design in Indirect Sensing Systems

Funded Thesis-based MS Students

Haiyan Yu, Jan. 2021-June 2022
Topic: Deep Sparse Models: Analysis and Algorithms

Doctoral Committees

Dongcheng He, Electrical & Computer Engineering, University of Denver, 2022
Advisor: Haluk Ogmen
Thesis: Reference Frames in Human Sensory, Motor, and Cognitive Processing

Rohola Zandie, Electrical & Computer Engineering, University of Denver, 2022
Advisor: Mohammad H. Mahoor
Thesis: Controllable Language Generation using Deep Learning

Fahad Alhomayani, Electrical & Computer Engineering, University of Denver, 2021
Advisor: Mohammad H. Mahoor
Thesis: Deep Learning Methods for Fingerprint-based Positioning

Tianyu Ding, Applied Mathematics & Statistics, Johns Hopkins University, 2021
Advisor: Daniel Robinson
Thesis: Subspace Learning for Data Arising from the Union of Subspaces of High Relative Dimension

Professional Activities

Professional Societies

IEEE, SIAM

Editorial Activity

Action Editor for Transactions on Machine Learning Research (2022-present)

Technical Program Committees (Area Chair)

Neural Information Processing Systems (NeurIPS)

Grant Review Panels

National Science Foundation

Reviewer for the Following Journals

Applied Computational and Harmonic Analysis
Bikhause Springer Series on Harmnois Analysis
BIT Numerical Mathematics
Digital Signal Processing
Frontiers in Applied Mathematics and Statistics
IEEE Geoscience and Remote Sensing Letters
IEEE Journal of Selected Topics in Signal Processing
IEEE Signal Processing Letters
IEEE Transactions on Image Processing
IEEE Transactions on Information Theory
IEEE Transactions on Multimedia
IEEE Transactions on Pattern Analysis and Machine Intelligence
IEEE Transactions on Signal Processing
Information and Inference: A Journal of the IMA
International Journal of Computer Vision
International Journal of Imaging Systems and Technology
Journal of Machine Learning Research
Operations Research
Patter Recognition Letters
Signal Processing

Reviewer for the Following Conferences

AAAI Conference on Artificial Intelligence (AAAI)
Asilomar Conference on Signals, Systems, and Computers (Asilomar)
Conference on the Mathematical Theory of Deep Neural Networks (DeepMath)
European Conference on Computer Vision (ECCV)
International Conference on Computer Vision (ICCV)
IEEE Conference on Computer Vision and Pattern Recognition (CVPR)
IEEE International Conference on Communication Technology (ICCT)
IEEE International Conference on Digital Signal Processing (DSP)
IEEE Radar Conference (RadarConf)
IEEE Int. Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP)
International Conference on Learning Representations (ICLR)
International Conference on Machine Learning (ICML)
Neural Information Processing Systems (NeurIPS)
Signal Processing with Adaptive Sparse Structured Representations (SPARS)

Workshop and Conference Session Organizer

1. SIAM Conference on Mathematics of Data Science (MDS22) — Mini-symposium on *Deep Learning with Low-Dimensional Models*, San Diego, CA, U.S., September 2022 (with Qing Qu and Chong You).
2. The 2nd Workshop on *Seeking Low-dimensionality in Deep Neural Networks (SlowDNN)*, November 2021 (with Yuejie Chi, Yi Ma, Qing Qu, Saiprasad Ravishankar, Jeremias Sulam, Atlas Wang, and Chong You)
3. IEEE Workshop on *Seeking Low-dimensionality in Deep Neural Networks (SlowDNN)*, November 2020 (with Yi Ma, Qing Qu, Jeremias Sulam, Atlas Wang, and Chong You)
4. SIAM Conference on Imaging Science — Minisymposium on *Machine Learning Meets Imaging Science*, Toronto, Ontario, Canada, July 2020 (with Tingran Gao and Qing Qu).
5. SIAM Conference on Mathematics of Data Science (MDS20) — Mini-symposium on *Recent Advances in Optimization Methods for Signal Processing and Machine Learning*, Cincinnati, Ohio, U.S., May 2020 (with Shuyang Ling and Qing Qu).

College Service

2021-present	RSECS JEDI committee member, DU
2020-present	IEEE Student Branch Faculty Supervisor, DU

Department Service

2021	Faculty Search Committee for CS Tenure-Track Faculty (Assistant Professor), DU
2021	Faculty Search Committee for ECE Tenure-Track Faculty (all ranks), DU
2020-present	ECE Graduate Admissions Committee, DU

Educational Experience

We developed "STEM in a Box" projects (2021) related to sensors, circuits, physics, and environment for Scouts-Denver who will send kits to schools around the Denver Metro area with a focus on campuses that serve mostly lower-income families, and presented lessons and activities related to signal filtering, movie recommendation systems, Google PageRank, and signal and video enhancement at the Mines Tech Camp/Discover STEM summer outreach program for middle school students

(2014-2016), the Creating Technology program for high school girls (2015), and the Rocky Mountain Camp summer camp for dyslexic kids (2015-2016).