

# Nachuan Xiao

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## Education

**Academy of Mathematics and Systems Science**  
**Chinese Academy of Sciences, Beijing, China**  
*Ph.D. in Computational Mathematics*  
Advisor: Prof. Ya-xiang Yuan

September 2016 – July 2021

**School of Mathematical Science**  
**Fudan University, Shanghai, China**  
*B.S. in Mathematics*

September 2012 – June 2016

## Academic Experience

**Institute of Operations Research and Analytics (IORA)**  
**National University of Singapore, Singapore**  
*Research Fellow*  
Advisor: Prof. Kim-Chuan Toh

August 2021 – present

## Research Interests

- Optimization over Riemannian manifolds
- Nonsmooth optimization
- Constrained optimization

My research interests include numerical methods for optimization problems on Riemannian manifolds arising from statistics and machine learning problems. I am also interested in designing algorithms for minimizing nonsmooth functions with constraints, especially for those problems related to deep learning.

## Publications

1. **Nachuan Xiao**, Xiaoyin Hu\*, Xin Liu, Kim-Chuan Toh, CDOpt: A Python package for a class of Riemannian optimization, Mathematical Programming Computation (to appear). (link)
2. **Nachuan Xiao**, Xiaoyin Hu\*, Xin Liu, Kim-Chuan Toh, Adam-family methods for nonsmooth optimization with convergence guarantees, Journal of Machine Learning Research 25(48):1-53, 2024. (link)
3. **Nachuan Xiao**, Xin Liu, Kim-Chuan Toh\*, Dissolving constraints for Riemannian optimization, Mathematics of Operations Research 49(1):366-397. (link)
4. Tianyun Tang, Kim-Chuan Toh, **Nachuan Xiao**\*, Yinyu Ye, A Riemannian dimension-reduced second order method with application to sensor network localization, SIAM Journal on Scientific Computing, 2024, 46(3), A2025-A2046. (link)
5. Xiaoyin Hu, **Nachuan Xiao**\*, Xin Liu, Kim-Chuan Toh, A constraint dissolving approach for nonsmooth optimization over the Stiefel manifold, IMA Journal of Numerical Analysis, 2023, drad098. (link)
6. Xiaoyin Hu, **Nachuan Xiao**\*, Xin Liu, Kim-Chuan Toh, An improved unconstrained approach for bilevel optimization, SIAM Journal on Optimization, 2023, 33(4): 2801-2829. (link)
7. **Nachuan Xiao**, Xin Liu\*, Ya-xiang Yuan, Exact penalty function for  $\ell_{2,1}$  norm minimization over the Stiefel manifold, SIAM Journal on Optimization, 2021, 31(4): 3097-3126. (link)
8. **Nachuan Xiao**, Xin Liu\*, Ya-xiang Yuan, A class of smooth exact penalty function methods for optimization problems with orthogonality constraints. Optimization Methods and Software, 2022, 37:4, 1205-1241. (link)
9. Xin Liu, **Nachuan Xiao**\*, Ya-xiang Yuan, A penalty-free infeasible approach for a class of nonsmooth optimization problems over the Stiefel manifold, Journal of Scientific Computing, 2024, 99(30). (link)
10. Xiaoyin Hu, Xin Liu, **Nachuan Xiao**\*, Convergence properties of stochastic proximal subgradient method in solving a class of composite optimization problems with cardinality regularizer, Journal of Industrial and Management Optimization, 2024, 20(5): 1934-1950. (link)

11. **Nachuan Xiao**, Xin Liu\*, Solving optimization problems over the Stiefel manifold by smooth exact penalty function, Journal of Computational Mathematics (to appear). (link)

## Preprints

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1. **Nachuan Xiao**, Xiaoyin Hu\*, Kim-Chuan Toh, SGD-type methods with guaranteed global stability in nonsmooth nonconvex optimization, major revision at Mathematical Programming. arXiv:2307.10053
2. **Nachuan Xiao**, Xin Liu\*, Kim-Chuan Toh, A partial exact penalty function approach for constrained optimization, submitted to Informs Journal on Optimization. arXiv:2304.01467
3. Kuangyu Ding, **Nachuan Xiao**\*, Kim-Chuan Toh, Adam-family methods with decoupled weight decay in deep learning, submitted to SIAM Journal on Optimization. arXiv:2310.08858
4. Siyuan Zhang, **Nachuan Xiao**, Xin Liu\*, Decentralized stochastic subgradient methods for nonsmooth nonconvex optimization, submitted to IEEE Transaction on Signal Processing. arXiv:2403.11565
5. **Nachuan Xiao**, Kuangyu Ding\*, Xiaoyin Hu, Kim-Chuan Toh, Developing Lagrangian-based methods for nonsmooth nonconvex optimization, submitted to Mathematics of Operations Research. arXiv:2404.09438
6. Xiaoyin Hu, **Nachuan Xiao**\*, Xin Liu, Kim-Chuan Toh, Learning-rate-free momentum SGD with reshuffling converges in nonsmooth nonconvex optimization, submitted to Journal of Scientific Computing. arXiv:2406.18287
7. Xiaoyin Hu, Kim-Chuan Toh, Shiwei Wang, **Nachuan Xiao**\*, A minimization approach for minimax optimization with coupled constraints, submitted to SIAM Journal on Optimization. arXiv:2408.17213

## Software

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- CDOpt: A Python Package for a Class of Riemannian Optimization. (website)
- STOP: A toolbox for STiefel manifold OPTimization. (website)

## Presentations

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- The 14th International Conference on Numerical Optimization and Numerical Linear Algebra August 15-18, 2023, Taiyuan, Shanxi, China.
- The 8th Youth Symposium on Scientific and Engineering Computing of Scientific Computing Forum, 2022.12, Beijing, China.
- The 17th Annual Meeting of China Society for Industrial and Applied Mathematics, 2019.09, Foshan, China.
- The 12th International Conference on Numerical Optimization and Numerical Linear Algebra, 2019.04, Shangrao, China.

## Honors & Awards

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- Second Prize in Tianchi Competition on Algorithm Design for Fabric Packing Problems (2/832).
- Excellence Award in Alibaba Global Mathematics Competition, 2018.

## Referred Journals

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- Mathematical Programming Computation.
- SIAM Journal on Optimization.
- IEEE Transaction on Signal Processing.
- Journal of Scientific Computing.
- Numerical Algorithms.
- Journal of Global Optimization.
- Journal of Industrial and Management Optimization.