Zhijian Lai (赖志坚)

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Research Interests

My research focuses on **Riemannian manifold optimization** and **quantum computing**, as well as the intersection between optimization theory and quantum computing. Currently, my interests include parameter optimization in quantum circuits, quantum circuit design, and quantum search.

Academic Experience

Peking University   **May 2024 – Present**
Postdoc in Beijing International Center for Mathematical Research   Beijing, China
Advisor: Prof. Zaiwen Wen

University of Tsukuba   **Apr. 2019 – Mar. 2024**
M.S. & Ph.D. in Policy and Planning Sciences   Tsukuba, Japan
Advisor: Prof. Akiko Yoshise

Dongbei University of Finance and Economics   **Sep. 2013 – Jun. 2017**
B.Mgmt. in Logistics Management   Dalian, China

Research Grants

National Natural Science Foundation of China (NSFC)   **2026 – 2028**
Young Scientists Fund (Class C), Grant No. 12501419   Role: PI
Project Title: Manifold Optimization Theory and Algorithms in Quantum Information Science

Research Papers

Classifications: CAS: Chinese Academy of Science Journal Ranking; **JCR**: Journal Citation Reports (IF Quartile); **CMS**: Chinese Mathematical Society, High-Quality Scientific Journals in Mathematics; **CCF**: China Computer Federation.

Peer-reviewed Publications

1. **Zhijian Lai**, Jiang Hu, Taehee Ko, Jiayuan Wu and Dong An, "Interpolation-based coordinate descent method for parameterized quantum circuits", accepted by *Communications Physics*, 2025.
   [CAS T1 (Top), JCR Q1, Nature Portfolio]

2. **Zhijian Lai**, Jiang Hu, Dong An and Zaiwen Wen, "Extended parameter shift rules with minimal derivative variance for parameterized quantum circuits", accepted by *Physical Review Applied*, 2025.   **[CAS T2, JCR Q2]**

3. Xin Yang, Heng Chang, **Zhijian Lai**, Jinze Yang, Xingrun Li, Yu Lu, Shuaiqiang Wang, Dawei Yin and Erxue Min, "Hyperbolic contrastive learning for cross-domain recommendation", *Proceedings of the 33rd ACM International Conference on Information and Knowledge Management (CIKM)*, 2024.
   [CCF-B, Accept Rate ≈ 23.2%]

4. **Zhijian Lai** and Akiko Yoshise, "Riemannian interior point methods for constrained optimization on manifolds", *Journal of Optimization Theory and Applications*, 2024.   **[CAS T3, JCR Q2, CMS T2]**

5. **Zhijian Lai** and Akiko Yoshise, "Completely positive factorization by a Riemannian smoothing method", *Computational Optimization and Applications*, 2022.   **[CAS T3, JCR Q1, CMS T2]**

Preprints and Manuscripts

1. **Zhijian Lai**, Hantao Nie, Dong An, Jiang Hu and Zaiwen Wen, "Riemannian first and second order optimization algorithms for quantum circuit design", manuscript (2025).

2. **Zhijian Lai**, Dong An, Jiang Hu and Zaiwen Wen, "A Grover-compatible manifold optimization algorithm for quantum search", arXiv:2512.08432 (2025).

3. Chenyi Li, **Zhijian Lai**, Dong An, Jiang Hu and Zaiwen Wen, "Advancing mathematical research via human–AI interactive theorem proving", arXiv:2512.09443 (2025).

4. Yuan Zhang, Jiang Hu, **Zhijian Lai**, Lin Lin and Zaiwen Wen, "Retraction-free optimization over the Stiefel manifold for the LoRA fine-tuning" (2024).

PRESENTATIONS

- 29th Annual Quantum Information Processing Conference (QIP 2026)   Riga, 2026
  Poster: On the role of Fourier structure in the training of parameterized quantum circuits

- 2nd Conference on Mathematics and AI (Math & AI 2025)   Dongguan, 2025
  Talk: Optimal interpolation-based coordinate descent method for parameterized quantum circuits

- 4th CCF Quantum Computing Conference (CQCC 2025)   Chengdu, 2025
  Talk: Optimal interpolation-based coordinate descent method for parameterized quantum circuits

- 6th CSIAM Conference on Big Data and Artificial Intelligence   Guilin, 2025
  Talk: Optimal interpolation-based coordinate descent method for parameterized quantum circuits

- Workshop on Quantum Information and Optimization, Tianyuan Math. Center   Kunming, 2025
  Talk: Optimal interpolation-based coordinate descent method for variational quantum algorithms

- 25th International Symposium on Mathematical Programming (ISMP 2024)   Montréal, 2024
  Talk: Riemannian interior point methods for constrained optimization on manifolds

- 10th International Congress on Industrial and Applied Mathematics (ICIAM 2023)   Tokyo, 2023
  Talk: Riemannian interior point methods for constrained optimization on manifolds

- 2023 SIAM Conference on Optimization (SIAM OP23)   Seattle, 2023
  Talk: Interior point methods for nonlinear optimization on Riemannian manifolds

- 2021 SIAM Conference on Optimization (SIAM OP21)   Hong Kong, 2021
  Talk: Completely positive factorization via orthogonality constrained problem

HONORS AND AWARDS

- Boya Postdoctoral Fellowship, Peking University   2024 – Present

- SPRING Research Fellowship, Japan Science and Technology Agency (JST)   2021 – 2024
  Selected as Class 1 Student (Equivalent to JSPS DC1); Grant: ≈ $20,500/year.

- Summer Travel Grant, The Institute of Statistical Mathematics (ISM)   Aug. 2023

Teaching Experience

Lecturer (Independent Instructor) at Peking University

- **Advanced Mathematics B II (00130202)**   Spring 2025
  Undergraduate Core Course · 200 Students
  ↪ **Lecture Notes:** Authored a **500-page** self-contained manuscript.
  Repository: gitee.com/galvin-lai/Advanced-Mathematics-Class-B2-07

- **Advanced Mathematics B I (00130201)**   Fall 2024
  Undergraduate Core Course · 155 Students
  ↪ **Lecture Notes:** Authored a **480-page** self-contained manuscript.
  Repository: gitee.com/galvin-lai/Advanced-Mathematics-Class-B-07

Teaching Assistant at University of Tsukuba

- Society and Optimization (H61141)   Fall 2022, 2023
- Problem Identification and Resolution (FH35012)   Fall 2022
- Supply Chain Management (AL5100)   Fall 2021

Professional Services

Conference Organization

- Session Organizer: "Quantum Optimization Algorithms — Theory and Applications"
  The 2nd Conference on Mathematics and AI (Math & AI 2025)   Dongguan, 2025
  (Hosted by Great Bay University and ORSC)

Journal & Conference Reviewer

- Physical Review Applied (PRApplied)
- Electronic Research Archive (ERA)
- 25th Asian Quantum Information Science Conference (AQIS 2025)
- Journal of Scientific Computing (JSC)
- Journal of Global Optimization (JGO)

Memberships

- Operations Research Society of China (ORSC)
- Operations Research Society of Japan (ORSJ)
- China Society for Industrial and Applied Mathematics (CSIAM)

Technical Skills & Open Source

Programming & Tools: Python, Matlab, Mathematica, LaTeX, Git

Languages: Chinese, English, Japanese (JLPT N1)

Open Source Projects:

- ▶ **LatexFormatting** (★ 110+) — *A utility tool for formatting LaTeX code generated by LLMs.*
- ▶ **RIPM** — *A primal-dual interior point method solver for nonlinear optimization on Riemannian manifolds.* ↪ **Integration:** Algorithm adopted by the official **Manopt.jl** library.
- ▶ **RieSmooth** — *A general Riemannian smoothing solver for nonsmooth Riemannian optimization.*