Junseo Lee

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Contact Information

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Education

Yonsei University — Seoul, Korea
B.S. in Electrical and Electronic Engineering — Mar. 2019 – Feb. 2023
Fully funded by the Hyundai Motor Chung Mong-Koo (CMK) Scholarship in Intelligent Information Technology

Chungnam Science High School — Gongju, Korea
Concentration in Mathematics, Early Graduation (Top 20%) — Mar. 2017 – Dec. 2018

Research Interests

Theory of Quantum Information Processing, Quantum Learning Theory, Quantum Complexity Theory, Quantum Many-Body Physics, Computational Topology, Categorical Quantum Mechanics, Theoretical Computer Science

Research Experience

Research Institute of Mathematics (RIM), Seoul National University (SNU) — Seoul, Korea
Research Affiliate (Quantum Information Theory Group) — Jan. 2023 – Present
Undergraduate Research Assistant (Advisor: Dr. Kabgyun Jeong) — Mar. 2021 – Dec. 2022

Technical Research Personnel, Republic of Korea Army — Seoul, Korea
Research Scientist (Mandatory 3-Year National Military Service) — Mar. 2023 – Mar. 2026
A designation under South Korea's Military Service Act for qualified scientists

High Dimensional Signal Processing Lab, Yonsei University — Seoul, Korea
Undergraduate Research Assistant (Advisor: Prof. Chulhee Lee) — Jul. 2022 – Dec. 2022

Mathematical Biology Lab, Yonsei University — Seoul, Korea
Undergraduate Research Assistant (Advisor: Prof. Jeehyun Lee) — Dec. 2021 – Jun. 2022

Publications (Google Scholar Profile)

*Equal contribution. †Authors listed alphabetically.

Preprints

[1] **J. Lee**†, M. Shin, "Optimal certification of constant-local Hamiltonians," arXiv:2512.09778 (2025).

[2] M. Fanizza, V. Iyer, **J. Lee**†, A. A. Mele, F. A. Mele, "Efficient learning of bosonic Gaussian unitaries," arXiv:2510.05531 (2025).
► Contributed talk, **QIP 2026**.

[3] N. A. Nghiem, **J. Lee**, T.-C. Wei, "Hybrid quantum-classical framework for Betti number estimation with applications to topological data analysis," arXiv:2508.01516 (2025).

[4] K. Anand, K. Jeong, **J. Lee**†, "Collapses in quantum-classical probabilistically checkable proofs and the quantum polynomial hierarchy," arXiv:2506.19792 (2025).

[5] **J. Lee**†, N. A. Nghiem, "New aspects of quantum topological data analysis: Betti number estimation, and testing and tracking of homology and cohomology classes," arXiv:2506.01432 (2025).

Journal Articles

[6] D. Ji, **J. Lee**, M. Shin, I. Sohn, K. Jeong, "Bounding quantum uncommon information with quantum neural estimators," Quantum Science and Technology **11**, 015001 (2026). doi:10.1088/2058-9565/ae18f4.

[7] M. Shin*, **J. Lee***, S. Lee, K. Jeong, "Resource-efficient algorithm for estimating the trace of quantum state powers," Quantum **9**, 1832 (2025). doi:10.22331/q-2025-08-27-1832.

[8] M. Lee, M. Shin, **J. Lee**, K. Jeong, "Mutual information maximizing quantum generative adversarial networks," Scientific Reports **15**, 32835 (2025). doi:10.1038/s41598-025-18476-y.

[9] M. Shin*, S. Lee*, **J. Lee***, D. Ji, H. Yeo, K. Jeong, "Disentanglement provides a unified estimation for quantum entropies and distance measures," Physical Review A **110**, 062418 (2024). doi:10.1103/PhysRevA.110.062418.

[10] M. Shin, **J. Lee**, K. Jeong, "Estimating quantum mutual information through a quantum neural network," Quantum Information Processing **23**, 57 (2024). doi:10.1007/s11128-023-04253-1.

[11] **J. Lee**, K. Jeong, "Quantum Rényi entropy functionals for bosonic gaussian systems," Physics Letters A **490**, 129183 (2023). doi:10.1016/j.physleta.2023.129183
► Special Issue, Foundations and applications of Quantum Optics (2024).

[12] **J. Lee**, H. Yeo, K. Jeong, "Weighted p-Rényi entropy power inequality: Information theory to quantum Shannon theory," International Journal of Theoretical Physics **62**, 253 (2023). doi:10.1007/s10773-023-05512-8

[13] **J. Lee**, K. Jeong, "High-dimensional private quantum channels and regular polytopes," Communications in Physics **31**, 189 (2021). doi:10.15625/0868-3166/15762
► Third Prize, Undergraduate Research Exhibition, Korean Physical Society (2021).

[14] K. Jeong, **J. Lee**, J. Choi, S. Hong, M. Jung, G. Kim, J. Kim, S. Kim, "Single qubit private quantum channels and 3-dimensional regular polyhedra," New Physics: Sae Mulli **68**, 232 (2018). doi:10.3938/NPSM.68.232
► Bronze Award, The Humantech Paper Award, Samsung Electronics (2018).

Book Chapters

[15] **J. Lee**, "Assessing Quantum Integer Factorization Performance with Shor's Algorithm," In: *Quantum Computing: A Journey into the Next Frontier of Information and Communication Security*, CRC Press (2024). doi:10.1201/9781003475286

Patents

[16] K. Jeong, M. Shin, **J. Lee**, "Method for estimating quantum mutual information through a quantum neural network," Korea Patent Application No. 10-2024-0104765 (2024, pending).

Professional Activities

Journal Reviewer: Physical Review Letters, IEEE Transactions on Information Theory, npj Quantum Information, Quantum, Physical Review Research, Physical Review Applied, Physical Review A, Physics Letters A, Annalen der Physik

Conference Reviewer: QTML 2025, QCTiP 2026

Community Service:

- *Creator and Maintainer*, Quantum Learning Theory Zoo, curated repository of quantum learning theory papers, 2025 – Present
- *Selection Committee*, Quantum Internship Program, National Information Society Agency and Korea Quantum Industry Center, 2024 – 2025
- *Co-organizer*, SNU Quantum Information Theory Seminar, 2024 – 2025
- *Co-organizer*, Quantum AI Hackathon, jointly organized by Kakao Enterprise Corp. and Jeonju University, 2025
- *Facilitator (Mentor)*, Mathematics Section, Korea Scholar's Conference for Youth (KSCY), Yonsei University, 2019

Selected Honors and Awards

Funding and Fellowships

- *PhD Study Abroad Fellowship*, Hyundai Motor CMK Foundation, 2026 (Expected)
- *Academic Travel Grant*, Hyundai Motor CMK Foundation, 2022
- *Hyundai Motor CMK Scholarship in Intelligent Information Technology*, full tuition and living stipend, 2021–2022

- *Teaching Fellowship for Software Courses*, Yonsei University, 2021–2022

Additional Honors and Awards

- *High Honor Student*, Yonsei University, 2022
- *Selected Paper Award*, Finance and Economics Contest, DB Group, 2022
- *Best Tutor Award*, Yonsei University, 2021–2022
- *Third Prize*, Undergraduate Research Exhibition, Korean Physical Society, 2021
- *Honor Student*, Yonsei University, 2020–2021
- *Bronze Award*, The Humantech Paper Award, Samsung Electronics, 2018
- *Best Translator Award*, NAVER Connect Foundation and Khan Academy, 2018
- *National Honorable Mention and Regional Gold Award*, Korean Olympiad in Informatics, 2016

Teaching Experience

Quantum Information Science Club Association (2025–2026)
(Teaching materials are available at: `harris-junseo-lee.github.io/teaching/`)

- *Invited Lecturer*, Quantum Learning Theory for Bosonic Systems, Winter 2025
- *Invited Lecturer*, Quantum Complexity Reading Group, Fall 2025
- *Invited Lecturer*, Quantum Learning and Complexity Theory, Summer 2025

University–Industry Research Internship (2024–2025)

- *Instructor*, AAA558/AAA559: College of Informatics Internship, Korea University (Graduate Course), Fall 2025
- *Instructor*, SW4343: Software Field Placement 1, Korea Aerospace University, Fall 2024

Yonsei University (2021–2022)

- *Teaching Assistant*, YCS1009: Change the World through Programming, Fall 2022
- *Teaching Assistant*, YCS1002: Software Programming, Fall 2022
- *Teaching Assistant*, EEE1108: Engineering Information Processing, Fall 2021
- *Course Tutor*, MAT2016: Engineering Mathematics 3, Spring 2022 [Best Tutor Award]
- *Course Tutor*, MAT1012: Engineering Mathematics 2, Fall 2021 [Best Tutor Award]

Selected Talks

*Online talk.

Research Talks

"Optimal certification of constant-local Hamiltonians"

- *Invited talk*, Quantum Software Lab Seminar, University of Edinburgh, Mar. 2026

"Efficient learning of bosonic Gaussian unitaries"

- *Invited talk*, Annual Meeting of the Quantum Information Society of Korea, Feb. 2026
- *Invited talk*, N^3etFraST Workshop, Nov. 2025
- *Invited talk*, Yonsei Quantum Data Science & AI Lab Seminar, Nov. 2025
- *Contributed talk*, **QIP 2026**, Jan. 2026 (Presented under the title "Efficient Learning Algorithms for Structured Bosonic and Fermionic Unitary Operators", as a merged submission with `arXiv:2504.11318`.)

"New aspects of quantum topological data analysis"

- *Invited talk*, KISTI-SNU Joint Workshop, Jun. 2025

"Resource-efficient algorithm for estimating the trace of quantum state powers"

- *Invited talk*, Electronics & Telecommunications Research Institute, Dec. 2024
- *Invited talk*, SNU Quantum Information Theory Seminar, Dec. 2024*
- *Invited talk*, IBM-Yonsei Qiskit Fall Fest, Nov. 2024*
- *Contributed talk*, Annual Meeting of Korean Mathematical Society, Oct. 2024
- *Poster*, QIP 2025, Feb. 2025

"Mutual information maximizing quantum generative adversarial network"
- *Invited talk*, Triangle Quantum Computing Seminar, NC State University Quantum Initiative, Nov. 2023*

"Estimating quantum mutual information through a quantum neural network"
- *Invited talk*, CS Katha Barta, National Institute of Science Education and Research Bhubaneswar, Aug. 2023*

"Quantum Rényi entropy functionals for bosonic Gaussian systems"
- *Poster*, QIP 2022, Mar. 2022

"High-dimensional private quantum channels and regular polytopes"
- *Invited talk*, KISTI-KU-SNU Joint Workshop, Sep. 2023*
- *Invited talk*, SNU Quantum Information Theory Seminar, Aug. 2021*
- *Contributed talk*, Winter Meeting of the Optical Society of Korea, Feb. 2022
- *Contributed talk*, Fall Meeting of the Korean Physical Society, Oct. 2021*
- *Poster*, QIP 2022, Mar. 2022

Tutorials and Public Lectures

"Learning theory in ∞-dimensional quantum systems"
- *Invited talk*, Team QST Summer Workshop, Seoul National University, Aug. 2025

"Introduction to quantum machine learning"
- *Invited talk*, AWS Korea Healthcare & Research Team Seminar, Mar. 2025

"Topics in theoretical quantum computer science"
- *Invited talk*, Shinil High School, Aug. 2024

"Quantum machine learning models for drug library generation"
- *Invited talk*, Yonsei Quantum Computing and Monte Carlo Workshop, Aug. 2024

"$\mathsf{QMA} \overset{?}{=} \mathsf{NP}$: The NLTS theorem and the quantum PCP conjecture"
- *Invited talk*, SNU Center for Quantum Network's Channel Capacity Summer Workshop, Jul. 2024

"Minimal data may be sufficient for quantum artificial intelligence"
- *Invited talk*, SNU Department of Mathematical Sciences Seminar, Jun. 2023*

Skills and Technical Experience

Programming Languages: Proficient in C, C++ (Informatics Olympiad), and Python; experienced with Java.

Quantum Software: Proficient in PennyLane and IBM Qiskit (certified); experienced with $Q^{\#}$ and PyZX.
- *IBM Certified Associate Developer*, Quantum Computation using Qiskit, 2023
- *Advanced Achievement*, IBM Quantum Spring Challenge, 2023
- *Advanced Achievement*, Xanadu QHack Coding Challenges, 2023