Junseo Lee

CONTACT INFORMATION

Team QST, Seoul National University
Research Institute of Mathematics
1 Gwanak-ro, Gwanak-gu, Seoul 08826, Republic of Korea

E-mail: harris.junseo@gmail.com
Website: harris-junseo-lee.github.io
TEL: +82 10-6768-3451

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
Thesis: Combinatorial designs for information theory (Advisor: Prof. Hong-Yeop Song)

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
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
Research Assistant (Advisor: Prof. Chulhee Lee)   Jul. 2022 – Dec. 2022

Mathematical Biology Lab, Yonsei University   Seoul, Korea
Lead 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, Physical Review Research, Physical Review Applied, Physical Review A, Physics Letters A, Annalen der Physik

Conference Reviewer: Quantum Techniques in Machine Learning (QTML 2025)

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
"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

"QMA $\overset{?}{=}$ 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