

Junseo Lee

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Research Associate, *Seoul National Univeristy* & Quantum Research Scientist, *Norma Inc.* | Seoul, Republic of Korea

Research Interests

Quantum Information and Theoretical Computer Science: Quantum Learning Theory, Quantum Complexity Theory, Quantum Property Testing, Quantum Algorithms, Bosonic Systems, and Quantum Shannon Theory

Education

Yonsei University

Seoul, Korea

Bachelor of Science in Electrical and Electronic Engineering

Mar. 2019 – Feb. 2023

Fully funded by the *Hyundai Motor Chung Mong-Koo Foundation* (2021–2022); *High Honors* (2022); *Honors* (2020–2021)

Chungnam Science High School

Gongju, Korea

Concentration in Mathematics, *Early Graduation (Top 20%)*

Mar. 2017 – Dec. 2018

Research Experience

Norma Inc. (Alternative Military Service)

Seoul, Korea

Professional Research Personnel^(a), Quantum Research Scientist (Theory)

Jan. 2023 – Present

- Provided technical consulting on quantum software and near-term algorithm design for government-funded projects.
- Conducted theoretical and numerical research on quantum algorithms for topological data analysis [11, 13] and on hybrid quantum-classical machine learning [8].

Research Institute of Mathematics (RIM), Seoul National University (SNU)

Seoul, Korea

Research Associate, Quantum Information Theory Group

Jan. 2023 – Present

Research Assistant (Advisor: *Dr. Kabgyun Jeong*)

Mar. 2020 – Dec. 2022

- Collaborated with international research groups at Inria Paris, UT Austin, FU Berlin, SNS Pisa, Stony Brook University, and the Center for Theoretical Physics of the Polish Academy of Sciences.
- Conducted theoretical research on quantum entropy functionals [3–5], quantum property estimation [6, 7, 9, 10], quantum polynomial hierarchies and proof systems [12], and quantum unitary tomography for bosonic systems [14].

Publications

(α - β) Authors listed alphabetically (theoretical computer science convention). *Equal contribution.

Preprints

- [15] (α - β) D. Ji, **J. Lee**, A. Sawicki, O. Slowik. “Explicit bounds on polylogarithmic spectral gap decay in unitary channels”. (to appear).
- [14] (α - β) M. Fanizza, V. Iyer, **J. Lee**, A. A. Mele, F. A. Mele. “Efficient learning of bosonic Gaussian unitaries”. [arXiv:2510.05531](https://arxiv.org/abs/2510.05531).
- [13] 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](https://arxiv.org/abs/2508.01516).
- [12] (α - β) K. Anand, K. Jeong, **J. Lee**. “Collapses in quantum-classical probabilistically checkable proofs and the quantum polynomial hierarchy”. [arXiv:2506.19792](https://arxiv.org/abs/2506.19792).
- [11] (α - β) **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](https://arxiv.org/abs/2506.01432).

Journal Articles

- [10] 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).
- [9] M. Shin*, **J. Lee***, S. Lee, K. Jeong. “Resource-efficient algorithm for estimating the trace of quantum state powers”. *Quantum* **9**, 1832 (2025).
- [8] M. Lee, M. Shin, **J. Lee**, K. Jeong. “Mutual information maximizing quantum generative adversarial networks”. *Scientific Reports* **15**, 32835 (2025).
- [7] 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).
- [6] M. Shin, **J. Lee**, K. Jeong. “Estimating quantum mutual information through a quantum neural network”. *Quantum Information Processing* **23**, 57 (2024).
- [5] **J. Lee**, K. Jeong. “Quantum Rényi entropy functionals for bosonic gaussian systems”. *Physics Letters A* **490**, 129183 (2023).
- [4] **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).

^(a)A selective national service program in South Korea enabling qualified scientists to complete military service through three years of full-time research in industry.

- [3] **J. Lee**, K. Jeong. “High-dimensional private quantum channels and regular polytopes”. *Communications in Physics* **31**, 189 (2021). *Third Prize, Undergraduate Research Exhibition, Korean Physical Society* (2021).
- [2] K. Jeong, **J. Lee**, *et al.* “Single qubit private quantum channels and 3-dimensional regular polyhedra”. *New Physics: Sae Mulli* **68**, 232 (2018). *Bronze Award, The Humantech Paper Award, Samsung Electronics* (2018).

Book Chapters

- [1] **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*” (eds. M. Hammoudeh, A. T. Alessa, A. M. Sherbeeni, C. M. Firth, A. S. Alessa). *CRC Press* (2024).

Patents

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

Selected Honors and Awards

Funding and Fellowships

PhD Study Abroad Fellowship ^(b) , <i>Hyundai Motor Chung Mong-Koo Foundation</i>	2026 (Expected)
Academic Travel Grant (for QIP 2022, Caltech), <i>Hyundai Motor Chung Mong-Koo Foundation</i>	2022
Full Scholarship in Intelligence Information Technology, <i>Hyundai Motor Chung Mong-Koo Foundation</i>	2021–2022
Teaching Fellowship (Software Courses), <i>Yonsei University</i>	2021–2022

Additional Honors and Awards

Best Tutor Award, <i>Innovation Center for Teaching and Learning, Yonsei University</i>	2021–2022
Outstanding Translator Award (with Travel Prize), <i>NAVER Connect Foundation and Khan Academy</i>	2018
Gold Award (Regional), Honorable Mention (National), <i>Korean Olympiad in Informatics (Middle School Division)</i>	2016

Professional Activities

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

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

Community Service

Creator and Maintainer, <i>Quantum Learning Theory Zoo (curated database of quantum learning papers)</i>	2025–Present
Selection Committee, <i>Quantum Internship Program</i> , organized by <i>National Information Society Agency</i>	2024–2025
Co-organizer, <i>Quantum Information Theory Seminar (QST Seminar)</i> , <i>Seoul National University</i>	2024–2025
Co-organizer, <i>Quantum AI Hackathon</i> , jointly organized by <i>Kakao Enterprise Corp.</i> , and <i>Jeonju University</i>	2025
Facilitator (Mentor), Mathematics Section, Korea Scholar’s Conference for Youth (KSCY), <i>Yonsei University</i>	2019

Research Projects

“Realizing Quantum Advantage in the Generation of Drug Library by Quantum Machine Learning” PI: Prof. Art Cho <i>Sponsored by the National Research Foundation of Korea (NRF)</i>	Apr. 2024 – Present Role: Technical advising
“Quantum-Computing-Based Analysis on Vertical Dynamics of the Quarter Car Model” PI: Prof. Soojoon Lee <i>Sponsored by Hyundai NGV Tech Co., Ltd.</i>	Sep. 2022 – Feb. 2023 Role: Numerical simulation
“Determination of Qualitative Bounds for Quantum Channel Capacities and Quantum Algorithms” PI: Dr. Kabgyun Jeong <i>Sponsored by the National Research Foundation of Korea (NRF)</i>	Mar. 2020 – Dec. 2022 Role: Theoretical research

Teaching

*Best tutor award. †Graduate course.

Instructor

<i>Quantum Complexity Reading Group</i> , <i>Quantum Information Science Club Association</i>	†Fall 2025
[AAA558, AAA559] College of Informatics Internship, <i>Korea University (external)</i>	†Fall 2025
<i>Quantum Learning and Complexity Theory</i> , <i>Quantum Information Science Club Association</i>	†Summer 2025
[SW4343] Software Field Placement 1, <i>Korea Aerospace University (external)</i>	Fall 2024

Teaching Assistant

[YCS1009] Change the World through Programming, <i>Yonsei University</i>	Fall 2022
[YCS1002] Software Programming, <i>Yonsei University</i>	Fall 2022
[EEE1108] Engineering Information Processing, <i>Yonsei University</i>	Fall 2021

Course Tutor

[MAT2016] Engineering Mathematics 3: Differential Equations and Linear Algebra, <i>Yonsei University</i>	*Spring 2022
[MAT1012] Engineering Mathematics 2: Multivariable and Vector Calculus, <i>Yonsei University</i>	*Fall 2021

^(b)Continuation of the undergraduate fellowship; recipients may extend the support for graduate study upon successful admission approval.

Selected Talks

*Online talk.

Research Talks

- “Efficient learning of bosonic Gaussian unitaries”
[Invited] [Annual Meeting of the Quantum Information Society of Korea \(QISK\)](#) Feb. 2026 (Upcoming)
[Invited] [N³etFraST Workshop, Korea Institute of Science & Technology Information \(KISTI\)](#) Nov. 2025
[Invited] [Quantum Data Science & AI \(Q-DNA\) Lab Seminar, Yonsei University](#) Nov. 2025
- “New aspects of quantum topological data analysis”
[Invited] KISTI-SNU Joint Workshop, *Daejeon KW Convention Center* Jun. 2025
- “Resource-efficient algorithm for estimating the trace of quantum state powers”
[Invited] Quantum Computing Lab Seminar, *Electronics & Telecommunications Research Institute (ETRI)* Dec. 2024
[Invited] [Quantum Information Theory Seminar \(QST Seminar\), Seoul National University](#) *Dec. 2024
[Invited] [IBM-Yonsei Qiskit Fall Fest, Yonsei University](#) *Nov. 2024
[Invited] KISTI-KU-SNU Joint Workshop, *Seoul Biohub* Oct. 2024
[Contributed] Annual Meeting of Korean Mathematical Society (KMS), *Sungkyunkwan University* Oct. 2024
[Poster] Annual Quantum Information Processing Conference (QIP 2025) *Raleigh Convention Center* Feb. 2025
- “Mutual information maximizing quantum generative adversarial network”
[Invited] [Triangle Quantum Computing Seminar, NC State University Quantum Initiative](#) *Nov. 2023
- “Estimating quantum mutual information through a quantum neural network”
[Invited] [CS Katha Barta, National Institute of Science Education and Research \(NISER\) Bhubaneswar](#) *Aug. 2023
- “Quantum Rényi entropy functionals for bosonic Gaussian systems”
[Poster] Annual Quantum Information Processing Conference (QIP 2022), *California Institute of Technology* Mar. 2022
- “High-dimensional private quantum channels, ε -randomizing maps and regular polytopes”
[Invited] KISTI-KU-SNU Joint Workshop, *Virtual Conference* *Sep. 2023
[Invited] [Quantum Information Theory Seminar \(QST Seminar\), Seoul National University](#) *Aug. 2021
[Contributed] Winter Meeting of the Optical Society of Korea (OSK), *Daejeon Convention Center* Feb. 2022
[Contributed] Fall Meeting of the Korean Physical Society (KPS), *Virtual Conference* *Feb. 2022
[Poster] Annual Quantum Information Processing Conference (QIP 2022), *California Institute of Technology* Mar. 2022
- ### Tutorials and Lectures
- “Learning theory in ∞ -dimensional quantum systems”
[Invited] Team QST Summer Workshop, *Seoul National University* Aug. 2025
- “Introduction to quantum machine learning”
[Invited] Healthcare & Research Team Seminar, *Amazon Web Services (AWS), Korea* Mar. 2025
- “Topics in theoretical quantum computer science”
[Invited] Quantum Club Seminar, *Shinil High School* Aug. 2024
- “Quantum machine learning models for drug library generation”
[Invited] Quantum Computing and Monte Carlo Workshop, *Yonsei University* Aug. 2024
- “QMA $\stackrel{?}{=} \text{NP}$: The NLTs theorem and the quantum PCP conjecture”
[Invited] Center for Quantum Network’s Channel Capacity Summer Workshop, *Seoul National University* Jul. 2024
- “Minimal data may be sufficient for quantum artificial intelligence”
[Invited] [Department of Mathematical Sciences Seminar, Seoul National University](#) Jun. 2023

Skills and Technical Experience

Programming Languages: Proficient in C, C++, and Python; experienced with Java.

Quantum Software: Proficient in PennyLane and IBM Qiskit (certified); experienced with Q# and PyZX (ZX-calculus).

- Certified Associate Developer (Quantum Computation using Qiskit), *IBM* 2023
Advanced Achievement, Quantum Spring Challenge, *IBM* 2023
Advanced Achievement, QHack Coding Challenges, *Xanadu Quantum Technologies* 2023

References

- Prof. Soojoon Lee** (Department of Mathematics, Kyung Hee University) level@khu.ac.kr
Prof. Daniel K. Park (Department of Applied Statistics, Yonsei University) dkd.park@yonsei.ac.kr
Dr. Kabgyun Jeong (Research Institute of Mathematics, Seoul National University) kgjeong6@snu.ac.kr
Dr. Marco Fanizza (Inria, Télécom Paris - LTCI, Institut Polytechnique de Paris) marco.fanizza@inria.fr