

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, Continuous-Variable 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 continuous-variable 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. Słowiak. “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](#).
- [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](#).
- [12] (α - β) K. Anand, K. Jeong, [J. Lee](#). “Collapses in quantum-classical probabilistically checkable proofs and the quantum polynomial hierarchy”. [arXiv: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](#).

Journal Articles

- [10] D. Ji, [J. Lee](#), M. Shin, I. Sohn, K. Jeong. “Bounding quantum uncommon information with quantum neural estimators”. Accepted in *Quantum Science and Technology* (2025).
- [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](#)*, Donghwa Ji, Hyeonjun Yeo, Kabgyun 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).
- [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).

^(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.

- [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)

Community Service

Creator and Maintainer, <i>Quantum Learning Theory Zoo</i> (curated database of quantum learning papers)	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

Undergraduate Research Assistant Mentoring at RIM, SNU

Current: Myeongjin Shin (2023–, KAIST CS), Mingyu Lee (2023–, SNU CSE), Donghwa Ji (2024–, SNU Math)
Former: Kartik Anand (2025, IIT Goa CSE)

^(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 \(QISK\)](#), Seoul, Korea Feb. 2026 (Upcoming)
[Invited] [N³etFraST Workshop](#), organized by *Korea Institute of Science & Technology Information*, Seoul, Korea Nov. 2025
[Invited] [Quantum Data Science & AI \(Q-DNA\) Lab Seminar](#), Yonsei University, Seoul, Korea Nov. 2025
- “New aspects of quantum topological data analysis”
[Invited] KISTI-SNU Joint Workshop, Daejeon, Korea Jun. 2025
- “Resource-efficient algorithm for estimating the trace of quantum state powers”
[Invited] Quantum Computing Lab Seminar, *Electronics & Telecommunications Research Institute*, Daejeon, Korea Dec. 2024
[Invited] [Quantum Information Theory Seminar \(QST Seminar\)](#), Seoul National University, Seoul, Korea *Dec. 2024
[Invited] [IBM-Yonsei Qiskit Fall Fest](#), Seoul, Korea *Nov. 2024
[Invited] KISTI-KU-SNU Joint Workshop, Seoul, Korea Oct. 2024
[Contributed] Annual Meeting of Korean Mathematical Society (KMS), Suwon, Korea Oct. 2024
[Poster] Annual Quantum Information Processing Conference (QIP 2025) Raleigh, NC, USA Feb. 2025
- “Mutual information maximizing quantum generative adversarial network”
[Invited] [Triangle Quantum Computing Seminar](#), UNC Kenan-Flagler’s Rethinc. Labs, Raleigh, NC, USA *Nov. 2023
- “Estimating quantum mutual information through a quantum neural network”
[Invited] [CS Katha Barta](#), National Institute of Science Education and Research, Bhubaneswar, India *Aug. 2023
- “Quantum Rényi entropy functionals for bosonic Gaussian systems”
[Poster] Annual Quantum Information Processing Conference (QIP 2022), Pasadena, CA, USA Mar. 2022
- “High-dimensional private quantum channels, ε -randomizing maps and regular polytopes”
[Invited] KISTI-KU-SNU Joint Workshop, Seoul, Korea *Sep. 2023
[Invited] [Quantum Information Theory Seminar \(QST Seminar\)](#), Seoul National University, Seoul, Korea *Aug. 2021
[Contributed] Winter Meeting of the Optical Society of Korea (OSK), Daejeon, Korea Feb. 2022
[Contributed] Fall Meeting of the Korean Physical Society (KPS), Virtual Conference *Feb. 2022
[Poster] Annual Quantum Information Processing Conference (QIP 2022), Pasadena, CA, USA Mar. 2022

Tutorials and Lectures

- “Introduction to quantum machine learning”
[Invited] Healthcare & Research Team Seminar, *Amazon Web Services (AWS)*, Seoul, Korea Mar. 2025
- “Topics in theoretical quantum computer science”
[Invited] Shinil High School Seminar, Seoul, Korea Aug. 2024
- “Quantum machine learning models for drug library generation”
[Invited] Yonsei Quantum Computing and Monte Carlo Workshop, Chuncheon, Korea 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, Korea Jul. 2024
- “Minimal data may be sufficient for quantum artificial intelligence”
[Invited] [Department of Mathematical Sciences Seminar](#), Seoul National University, Seoul, Korea 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