

# Junseo Lee

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Research Associate, Seoul National University & 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<sup>(a)</sup>, 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

( $\alpha$ - $\beta$ ) Authors listed alphabetically (theoretical computer science convention). \*Equal contribution.

### Preprints

- [15] ( $\alpha$ - $\beta$ ) D. Ji, [J. Lee](#), A. Sawicki, O. Slowik. “Explicit bounds on polylogarithmic spectral gap decay in unitary channels”. (to appear).
- [14] ( $\alpha$ - $\beta$ ) 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] ( $\alpha$ - $\beta$ ) K. Anand, K. Jeong, [J. Lee](#). “Collapses in quantum-classical probabilistically checkable proofs and the quantum polynomial hierarchy”. [arXiv:2506.19792](#).
- [11] ( $\alpha$ - $\beta$ ) [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).

<sup>(a)</sup>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 <sup>(b)</sup> , <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> ( <i>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, <i>Korea Scholar's Conference for Youth (KSCY)</i> , <i>Yonsei University</i>	2019

## Research Projects

"Realizing Quantum Advantage in the Generation of Drug Library by Quantum Machine Learning" PI: Prof. Art Cho   Sponsored by the National Research Foundation of Korea (NRF)	Apr. 2024 – Present Role: Technical advising
"Quantum-Computing-Based Analysis on Vertical Dynamics of the Quarter Car Model" PI: Prof. Soojoon Lee   Sponsored by <i>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   Sponsored by the National Research Foundation of Korea (NRF)	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</i> (external)	† 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</i> (external)	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)

<sup>(b)</sup>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] <a href="#">Annual Meeting of the Quantum Information Society of Korea (QISK)</a> , Seoul, Korea	Feb. 2026 (Upcoming)
[Invited] <a href="#">N<sup>3</sup>etFraST Workshop</a> , organized by <i>Korea Institute of Science &amp; Technology Information</i> , Seoul, Korea	Nov. 2025	Nov. 2025
[Invited] <a href="#">Quantum Data Science &amp; AI (Q-DNA) Lab Seminar</a> , Yonsei University, Seoul, Korea		
"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, <i>Electronics &amp; Telecommunications Research Institute</i> , Daejeon, Korea	Dec. 2024
[Invited] <a href="#">Quantum Information Theory Seminar (QST Seminar)</a> , Seoul National University, Seoul, Korea	*Dec. 2024	
[Invited] <a href="#">IBM-Yonsei Qiskit Fall Fest</a> , 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] <a href="#">Triangle Quantum Computing Seminar</a> , UNC Kenan-Flagler's Rethinc. Labs, Raleigh, NC, USA	*Nov. 2023
"Estimating quantum mutual information through a quantum neural network"	[Invited] <a href="#">CS Katha Barta</a> , 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, $\varepsilon$ -randomizing maps and regular polytopes"	[Invited] KISTI-KU-SNU Joint Workshop, Seoul, Korea	*Sep. 2023
[Invited] <a href="#">Quantum Information Theory Seminar (QST Seminar)</a> , 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, <i>Amazon Web Services (AWS)</i> , 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 $\stackrel{?}{=}$ 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] <a href="#">Department of Mathematical Sciences Seminar</a> , 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), <i>IBM</i>	2023
Advanced Achievement, Quantum Spring Challenge, <i>IBM</i>	2023
Advanced Achievement, QHack Coding Challenges, <i>Xanadu Quantum Technologies</i>	2023

## References

<b>Prof. Soojoon Lee</b> (Department of Mathematics, Kyung Hee University)
<b>Prof. Daniel K. Park</b> (Department of Applied Statistics, Yonsei University)
<b>Dr. Kabgyun Jeong</b> (Research Institute of Mathematics, Seoul National University)
<b>Dr. Marco Fanizza</b> (Inria, Télécom Paris - LTCI, Institut Polytechnique de Paris)

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