Junseo Lee

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Research Interests

Theoretical Aspects of Quantum Computation
Quantum Learning Theory, Quantum Complexity Theory, Quantum Shannon Theory, and Quantum Algorithms

Education

Yonsei University — *Seoul, Korea*
Bachelor of Science in Electrical and Electronic Engineering — *March 2019 – February 2023*
Fully funded by the *Hyundai Motor Chung Mong-Koo Scholarship* (2021–2022); *Honors* (2020–2021); *High Honors* (2022)

Chungnam Science High School — *Gongju, Korea*
Mathematics Major, *Early Graduation for Top 20% Students* — *March 2017 – December 2018*

Research Experience

Professional Research Personnel* (Alternative Military Service) — *Seoul, Korea*
Quantum Research Scientist (Theory), Norma Inc. ****3-year mandatory national service*** — *January 2023 – present*
- Conducting research on quantum algorithms for problems in computational geometry and matrix algebra
- Providing technical consulting on near-term quantum algorithms for industry- and government-funded projects

Research Institute of Mathematics, Seoul National University — *Seoul, Korea*
Research Associate Member (Quantum Information Theory Group) — *January 2023 – present*
Research Assistant (Advisor: Kabgyun Jeong) — *March 2020 – December 2022*
- Conducting research in quantum learning theory, quantum complexity theory, and quantum Shannon theory, with a focus on quantum property estimation, quantum proof systems, and quantum entropy functionals.

Publications

$^{(\alpha\text{-}\beta)}$*Alphabetical order (theoretical computer science).* **Equal contribution.* †*Corresponding author.*

Preprints (Submitted)

[15] Marco Fanizza, Vishnu Iyer, **Junseo Lee**$^{(\alpha\text{-}\beta)}$, Antonio A. Mele, Francesco A. Mele. "Learning bosonic Gaussian uniatries," (to appear).

[14] Kartik Anand, **Junseo Lee**$^{(\alpha\text{-}\beta)}$. "Classical oracle separation of QMA and its unique variant," (to appear).

[13] Nhat A. Nghiem, **Junseo Lee**, Tzu-Chieh Wei. "Hybrid quantum-classical framework for Betti number estimation with applications to topological data analysis," *arXiv:2508.01516* (2025).

[12] Donghwa Ji, **Junseo Lee**, Myeongjin Shin, IlKwon Sohn, Kabgyun Jeong. "Bounding quantum uncommon information with quantum neural estimators," *arXiv:2507.06091* (2025).

[11] Kartik Anand, Kabgyun Jeong, **Junseo Lee**$^{(\alpha\text{-}\beta)}$. "Collapses in quantum-classical probabilistically checkable proofs and the quantum polynomial hierarchy," *arXiv:2506.19792* (2025).

[10] **Junseo Lee**$^{(\alpha\text{-}\beta)}$, Nhat 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

[9] Mingyu Lee, Myeongjin Shin, **Junseo Lee**†, Kabgyun Jeong†. "Mutual information maximizing quantum generative adversarial networks," Accepted in *Scientific Reports* (to appear).

[8] Myeongjin Shin*, **Junseo Lee***, Seungwoo Lee, Kabgyun Jeong. "Resource-efficient algorithm for estimating the trace of quantum state powers," *Quantum* **9**, 1832 (2025).

[7] Myeongjin Shin*, Seungwoo Lee*, **Junseo 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] Myeongjin Shin, **Junseo Lee**, Kabgyun Jeong. "Estimating quantum mutual information through a quantum neural network," *Quantum Information Processing* **23**, 57 (2024).

[5] **Junseo Lee**, Kabgyun Jeong. "Quantum Rényi entropy functionals for bosonic gaussian systems," *Physics Letters A* **490**, 129183 (2023).

[4] **Junseo Lee**, Hyeonjun Yeo, Kabgyun Jeong. "Weighted p-Rényi entropy power inequality: Information theory to quantum Shannon theory," *International Journal of Theoretical Physics* **62**, 253 (2023).

[3] **Junseo Lee**, Kabgyun 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] Kabgyun Jeong, **Junseo Lee**, Jintae Choi, Seokmin Hong, Myunggu Jung, Gyeongbeom Kim, Jaekwon Kim, Suntaek Kim. "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] **Junseo 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. Mohammad Hammoudeh, Abdullah T. Alessa, Amro M. Sherbeeni, Clinton M. Firth, Abdullah S. Alessa), *CRC Press* (2024).

Conference Abstracts

Ju-Young Ryu*, **Junseo Lee***, Tak Hur, Daniel K. Park. "Quantum multiple kernel learning with entropy power inequalities," *Quantum Techniques in Machine Learning (QTML)* (2025).

Patents

Kabgyun Jeong, Myeongjin Shin, **Junseo Lee**. "Method for estimating quantum mutual information through a quantum neural network," *Korea Patent: App. No. 10-2024-0104765* (2024).

Professional Activities

Reviewing

Conference: QTML 2025

Journals: Physical Review Letters, Physical Review A, Physical Review Applied, IEEE Transactions on Information Theory, Annalen der Physik

Community Service

Selection Committee, Quantum Internship Program, *National Information Society Agency*	*2024–2025*
Co-organizer, Quantum Information Theory Seminar (QST Seminar), *Seoul National University*	*2024–2025*
Co-organizer, Problem Writer, and Judge, Quantum AI Hackathon, *Jeonju University*	*2025*
Organizer, Quantum Complexity Reading Group	*2025*

Selected Honors and Awards

Funding and Fellowships

PhD Study Abroad Fellowship, *Hyundai Motor Chung Mong-Koo Scholarship*	*2026–TBD*
Full-Tuition Scholarship and Stipend, *Hyundai Motor Chung Mong-Koo Scholarship*	*2021–2022*
Academic Travel Grant (for QIP 2022, Caltech), *Hyundai Motor Chung Mong-Koo Scholarship*	*2022*
Teaching Fellowship for Software Courses, *Yonsei University*	*2021–2022*

Additional Honors and Awards

Best Tutor Award, Innovation Center for Teaching and Learning, *Yonsei University*	*2021–2022*
Selected Paper Award, Finance and Economics Contest, *DB Group*	*2022*
Excellent Translator Award, *NAVER Connect Foundation and Khan Academy*	*2018*
Gold Award (Regional), Honorable Mention (National), Korean Olympiad in Informatics	*2016*

Certifications and Achievements

Advanced Achievement, Quantum Spring Challenge, *IBM*	*2023*
Advanced Achievement, QHack Coding Challenges, *Xanadu Quantum Technologies*	*2023*
Advanced Data Analytics Semi-Professional, *Korea Data Agency*	*2023*
Certified Associate Developer (Quantum Computation), *IBM*	*2023*

Selected Talks*

**A complete list of talks is available at harris-junseo-lee.github.io/talks. †Online talk*

Research Talks

New aspects of quantum topological data analysis

Invited talk, *KISTI-SNU Joint Workshop, Daejeon, Korea*	*June 2025*

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

Invited talk, *Electronics and Telecommunications Research Institute, Daejeon, Korea*	*December 2024*
Invited talk, *Seoul National University, Seoul, Korea*	*December 2024*
Invited talk, *IBM-Yonsei Qiskit Fall Fest*, *Seoul, Korea*	*November 2024*
Invited talk, *KISTI-KU-SNU Joint Workshop, Seoul, Korea*	*October 2024*

Contributed talk, *Korean Mathematical Society, Suwon, Korea* — *October 2024*
Poster presentation, *QIP 2025, Raleigh, NC, USA* — *February 2025*

Mutual information maximizing quantum generative adversarial network
Invited talk†, *Triangle Quantum Computing Seminar*, *North Carolina State, Raleigh, NC, USA* — *November 2023*

Estimating quantum mutual information through a quantum neural network
Invited talk†, *National Institute of Science Education and Research, Bhubaneswar, India* — *August 2023*

Quantum Rényi entropy functionals for bosonic Gaussian systems
Poster presentation, *QIP 2022, Pasadena, CA, USA* — *March 2022*

Invited Academic Talks

Introduction to quantum machine learning
Invited lecture, *AWS Healthcare & Research Team, Seoul, Korea* — *March 2025*

Topics in theoretical quantum computer science
Invited lecture, *Shinil High School, Seoul, Korea* — *August 2024*

Quantum machine learning models for drug library generation
Invited talk, *Yonsei Quantum Computing and Monte Carlo Workshop, Chuncheon, Korea* — *August 2024*

The NLTS theorem and the quantum PCP conjecture
Invited talk, *Center for Quantum Network's Channel Capacity Summer Workshop, Seoul, Korea* — *July 2024*

Teaching Experience

**Best tutor award*

Instructor

College of Informatics Internship 2 (AAA559, external), *Korea University (Graduate)* — *Fall 2025*
College of Informatics Internship 1 (AAA558, external), *Korea University (Graduate)* — *Fall 2025*
Quantum Learning and Complexity Theory, *QISCA Summer School (Graduate and Undergraduate)* — *Summer 2025*
Software Field Placement 1 (SW4343, external), *Korea Aerospace University (Undergraduate)* — *Fall 2024*

Teaching Assistant

Change the World through Programming (YCS1009), *Yonsei University (Undergraduate)* — *Fall 2022*
Software Programming (YCS1002), *Yonsei University (Undergraduate)* — *Fall 2022*
Engineering Information Processing (EEE1108), *Yonsei University (Undergraduate)* — *Fall 2021*

Course Tutor

EM 3: Differential Equations and Linear Algebra (MAT2016), *Yonsei University (Undergraduate)* — *Spring 2022**
EM 2: Multivariable and Vector Calculus (MAT1012), *Yonsei University (Undergraduate)* — *Fall 2021**