Junseo Lee harris.junseo@gmail.com https://harris-junseo-lee.github.io/

Research Interests

Quantum learning theory, Quantum complexity theory, Quantum algorithms, Theoretical computer science

Education

Yonsei University Seoul, Korea
Bachelor of Science in Electrical and Electronic Engineering Mar. 2019 – Feb. 2023
Fully funded by the *Hyundai Motor Foundation* (2021–2022); *Honors* (2020–2021); *High Honors* (2022)
Thesis: Combinatorial designs for information theory

Chungnam Science High School Gongju, Korea
Mathematics major, *Early graduation for top 20% students* Mar. 2017 – Dec. 2018

Research Experience

Professional Research Personnel* **(Alternative Military Service)** Seoul, Korea
Quantum Research Scientist (Theory), Norma Inc. **3-year mandatory national service* Jan. 2023 – Present
- Conducting research on quantum algorithms for topological data analysis and matrix problems
- Providing technical consulting on near-term quantum algorithms for industry and government-funded projects

Research Institute of Mathematics, Seoul National University Seoul, Korea
Research Fellow (Quantum Information Theory Group, Advisor: Kabgyun Jeong) Mar. 2020 – Present
- 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

Google Scholar Profile ORCiD (0000-0003-4858-2663)

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

Preprints (Submitted)

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

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

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

[10] New aspects of quantum topological data analysis: Betti number estimation, and testing and tracking of homology and cohomology classes
Junseo Lee$^{(\alpha\text{-}\beta)}$, Nhat A. Nghiem arXiv:2506.01432 (2025).

[9] Resource-efficient algorithm for estimating the trace of quantum state powers
Myeongjin Shin*, **Junseo Lee***, Seungwoo Lee, Kabgyun Jeong arXiv:2408.00314 (2024).

[8] Mutual information maximizing quantum generative adversarial networks
Mingyu Lee, Myeongjin Shin, **Junseo Lee**, Kabgyun Jeong arXiv:2309.01363 (2023).

Journal Articles

[7] Disentanglement provides a unified estimation for quantum entropies and distance measures
Myeongjin Shin*, Seungwoo Lee*, **Junseo Lee***, Donghwa Ji, Hyeonjun Yeo, Kabgyun Jeong
Physical Review A **110**, 062418 (2024).

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

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

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

[3] High-dimensional private quantum channels and regular polytopes
Junseo Lee, Kabgyun Jeong *Communications in Physics* **31**, 189 (2021).
Third Prize, Undergraduate Research Exhibition, Korean Physical Society (2021).

[2] Single qubit private quantum channels and 3-dimensional regular polyhedra
Kabgyun Jeong, **Junseo Lee**, Jintae Choi, Seokmin Hong, Myunggu Jung, Gyeongbeom Kim, Jaekwon Kim, Suntaek Kim *Bronze Award, The Humantech Paper Award, Samsung Electronics* (2018).
New Physics: Sae Mulli **68**, 232 (2018).

Book Chapters

[1] Quantum computing: A journey into the next frontier of information and communication security (1st ed.)
Mohammad Hammoudeh, Abdullah T. Alessa, Amro M. Sherbeeni, Clinton M. Firth, Abdullah S. Alessa
Junseo Lee, §11 Assessing Quantum Integer Factorization Performance with Shor's Algorithm *CRC Press* (2024).

Conference Abstracts

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

Patents

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

Working Papers

Learning t-doped bosonic Gaussian unitaries
(with Marco Fanizza, Vishnu Iyer, Antonio Anna Mele, Francesco Anna Mele)

Tight bounds on estimating trace of quantum state powers from incoherent measurements
(with Angus Lowe, Chirag Wadhwa, Qisheng Wang)

Professional Activities

Peer Reviewing

Journals: Physical Review Letters, Physical Review A, Physical Review Applied, IEEE Transactions on Information Theory, Annalen der Physik
Conference: QTML 2025

Community Service

Selection Committee, Quantum Internship Program, National Information Society Agency, 2024–2025
Co-organizer, Quantum AI Hackathon, 2025
Co-organizer, SNU QST Seminar, 2024–2025

Selected Honors and Awards

Funding and Fellowships

PhD Study Abroad Fellowship, Hyundai Motor Foundation, 2026–TBD
Full-Tuition Scholarship and Stipend, Hyundai Motor Foundation, 2021–2022
Academic Travel Grant (for QIP 2022, Caltech), Hyundai Motor Foundation, 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
Selected Paper Award, Finance and Economics Contest, DB Group, 2022
Excellent Translator Award, NAVER Connect Foundation, 2018
Gold Award, Korean Olympiad in Informatics, Regional Qualifiers, 2016

Certifications and Achievements

Advanced Achievement, IBM Quantum Spring Challenge, 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.

Research Talks

New aspects of quantum topological data analysis
Invited talk at the 5th KISTI-SNU Joint Workshop, Jun. 2025

Resource-efficient algorithm for estimating the trace of quantum state powers
Invited talk at Electronics and Telecommunications Research Institute, Dec. 2024
Invited talk at Seoul National University, Dec. 2024
Invited talk at IBM-Yonsei Qiskit Fall Fest, Nov. 2024
Invited talk at KISTI-KU-SNU Joint Workshop (Oct. 2024)
Contributed talk at the Korean Mathematical Society, Oct. 2024
Poster presentation at QIP 2025, Feb. 2025

Disentanglement provides a unified estimation for quantum entropies and distance measures
Contributed talk at the Korean Physical Society, Apr. 2024
Contributed talk at the Quantum Information Society of Korea, Apr. 2024
Poster presentation at QIP 2024, Jan. 2024

Mutual information maximizing quantum generative adversarial network
Invited talk at North Carolina State University Triangle Quantum Computing Seminar, Nov. 2023
Poster presentation at QIP 2024, Jan. 2024

Estimating quantum mutual information through a quantum neural network
Invited talk at National Institute of Science Education and Research Bhubaneswar India, Aug. 2023
Poster presentation at TQC 2023, Jul. 2023

Quantum Rényi entropy functionals for bosonic gaussian systems
Contributed talk at the Korean Society for Industrial and Applied Mathematics, Dec. 2021
Poster presentation at QIP 2022, Mar. 2022

Invited Lectures

Introduction to quantum machine learning
Invited lecture at AWS Healthcare & Research Team, Mar. 2025

Topics in theoretical quantum computer science
Invited lecture at Shinil High School, Aug. 2024

Teaching Experience

Instructor

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

Teaching Assistant

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

Course Tutor

Engineering Mathematics 3* (MAT2016), Yonsei University, Spring 2022 — **Best Tutor Award*
Engineering Mathematics 2* (MAT1012), Yonsei University, Fall 2021 — **Best Tutor Award*