

# (Harris) Junseo Lee – Curriculum Vitae

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## RESEARCH INTERESTS

I work broadly on the **theoretical aspects of quantum information and computation**. My research focuses particularly on the following topics:

- Quantum learning theory using information-theoretic tools (including concentration inequalities)
- Computational complexity, quantum algorithms, and provable quantum computational advantages
- Quantum Shannon theory, including determining bounds on quantum channel capacity and quantum entropy inequalities
- Quantum error-correcting codes, primarily quantum LDPC codes, and their applications in theoretical computer science

## EDUCATION

### Yonsei University

B.S. in Electrical and Electronic Engineering  
Thesis: *Combinatorial Designs for Information Theory*

Seoul, South Korea  
Mar. 2019 – Feb. 2023

### Chungnam Science High School

High School Diploma (Mathematics Major, Early Graduation for Top 20% Students)

Gongju, South Korea  
Mar. 2017 – Dec. 2018

## NATIONAL SERVICE

### Research Scientist (National Service) – Alternative to Military Conscription

Quantum Computing Research Scientist at Norma Inc.  
Completed Basic Military Training, Korea Army Training Center

Seoul, South Korea  
Jan. 2023 – present  
Dec. 2023 – Jan. 2024

## RESEARCH EXPERIENCE

### Research Institute of Mathematics, Seoul National University

Research Collaboration (with Dr. Kabgyun Jeong)  
Research Assistant (Supervisor: Dr. Kabgyun Jeong)

Seoul, South Korea  
Jan. 2023 – present  
Mar. 2020 – Jan. 2023

### High Dimensional Signal Processing Lab, Yonsei University

Research Intern (Supervisor: Prof. Chulhee Lee)

Seoul, South Korea  
Jul. 2022 – Dec. 2022

### Mathematical Biology Lab, Yonsei University

Lead Research Intern (Supervisor: Prof. Jeehyun Lee)

Seoul, South Korea  
Dec. 2021 – Jun. 2022

## PUBLICATIONS

### Journal Articles

- [6] M. Shin<sup>†</sup>, S. Lee<sup>†</sup>, **J. Lee<sup>†</sup> (co-first author)**, M. Lee, D. Ji, H. Yeo, K. Jeong. “Disentanglement provides a unified estimation for quantum entropies and distance measures”. *Physical Review A* **110**, 062418 (2024).

- [5] M. Shin, **J. Lee**, K. Jeong. “Estimating quantum mutual information through a quantum neural network”. *Quantum Information Processing* **23**, 57 (2024).
- [4] **J. Lee**, K. Jeong. “Quantum Rényi entropy functionals for bosonic gaussian systems”. *Physics Letters A* **490**, 129183 (2023).
- [3] **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).
- [2] **J. Lee**, K. Jeong. “High-dimensional private quantum channels and regular polytopes”. *Communications in Physics* **31**, 189 (2021).
- [1] K. Jeong, **J. Lee**, J. Choi, S. Hong, M. Jung, G. Kim, J. Kim, S. Kim. “Single qubit private quantum channels and 3-dimensional regular polyhedra”. *New Physics: Sae Mulli* **68**, 232 (2018).

### Preprints

- [2] M. Shin<sup>†</sup>, **J. Lee<sup>†</sup> (co-first author)**, S. Lee, K. Jeong. “Resource-efficient algorithm for estimating the trace of quantum state powers”. arXiv:2408.00314 (2024).
- [1] M. Lee, M. Shin, **J. Lee**, K. Jeong. “Mutual information maximizing quantum generative adversarial network and its applications in finance”. arXiv:2309.01363 (2023).

### 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 (1st ed.)*, edited by M. Hammoudeh, A. T. Essa, A. M. Sherbeeni, C. M. Firth, A. S. Essa. *CRC Press* (2024).

### Patents

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

## PROFESSIONAL ACTIVITIES

**Journal Reviewer:** IEEE Transactions on Information Theory

**Internship Reviewer:** 3rd Quantum Internship Program – Korea Quantum Industry Center and National Information Society Agency

## MAJOR HONORS & SCHOLARSHIPS

High Honor Student, Yonsei University	2022
Research Travel Grant for Academic Conference Participation, Hyundai Motor Foundation	2022
Selected Paper Award, DB Group Finance and Economics Contest	2022
Teaching Scholarship for Software Courses, Yonsei University	2021, 2022
Best Tutor Award, Innovation Center for Teaching and Learning, Yonsei University	2021, 2022
Tutoring Scholarship, Innovation Center for Teaching and Learning, Yonsei University	2021, 2022
Student Research Grant, Hyundai Motor Foundation	2021, 2022
Full-Tuition Scholarship, Hyundai Motor Foundation	2021, 2022
Third Prize, Korean Physical Society Undergraduate Research Project Exhibition	2021
Honor Student, Yonsei University	2020, 2021
Bronze Award, The Humantech Paper Award, Samsung Electronics	2018
Excellent Translator Award, NAVER Connect Foundation	2018
Gold Award, Korean Olympiad in Informatics – Regional Qualifiers	2016

## CERTIFICATIONS & 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
IBM Certified Associate Developer – Quantum Computation, IBM Professional Certification	2023

## TEACHING EXPERIENCE

### Research Internship Supervisor

SW4343: Software Field Placement 1 (Korea Aerospace University & Korea Quantum Industry Center) Fall 2024

### Teaching Assistant at Yonsei University

YCS1009: Change the World through Programming	Fall 2022
YCS1002: Software Programming	Fall 2022
EEE1108: Engineering Information Processing	Fall 2021

### Course Tutor at Yonsei University

MAT2016: Engineering Mathematics 3 – Linear Algebra and Differential Equations	Spring 2022
MAT1012: Engineering Mathematics 2 – Multivariable and Vector Calculus	Fall 2021

## RESEARCH PROJECT

- [9] **“Development of a personal credit information analysis algorithm and a quantum credit rating service using quantum machine learning”** (sponsored by) Seoul Business Agency, Jun. 2024 – present.
- [8] **“Realizing quantum advantage in the generation of drug library by quantum machine learning”** (sponsored by) National Research Foundation of Korea, Apr. 2024 – present.
- [7] **“Development of anomaly detection and blocking technology through threat hunting-based IoT/network vulnerability analysis”** (sponsored by) National Research Foundation of Korea, Feb. 2023 – Apr. 2024.
- [6] **“International cooperation toward channel capacity of quantum network”** (sponsored by) National Research Foundation of Korea, Dec. 2022 – Jan. 2023.
- [5] **“Quantum-computing based analysis on vertical dynamics of the quarter car model”** (sponsored by) Hyundai NGV, Sep. 2022 – Jan. 2023.
- [4] **“Coverage optimization of training data using search engines for training data enhancement of ill-performing classes”** (sponsored by) National Research Foundation of Korea, Jul. 2022 – Dec. 2022.
- [3] **“Development of an algorithm to measure the degree of oldness and contamination of banknotes”** (sponsored by) Hyosung TNS, Jul. 2022 – Aug. 2022.
- [2] **“Mathematical modeling for superbacteria infection control”** (sponsored by) National Research Foundation of Korea, Jan. 2022 – Jun. 2022.
- [1] **“Determination of qualitative bounds for quantum channel capacities and quantum algorithms”** (sponsored by) National Research Foundation of Korea, Mar. 2021 – Jan. 2023.

## TALKS AND POSTERS

### Invited and Contributed Talks

- [20] “TBD” Invited talk at AWS Quantum, Mar. 27th, 2025.
- [19] “Rank-dependent estimator for  $q$ -Tsallis entropy” Invited talk at Electronics and Telecommunications Research Institute, Dec. 18th, 2024.
- [18] “Rank-dependent complexity in estimating traces of quantum state powers” Invited talk at Seoul National University QST Seminar, Dec. 13th, 2024.
- [17] “Rank is all you need to estimate the trace of the powers of density matrices” Invited talk at IBM-Yonsei Qiskit Fall Fest 2024, Nov. 7th, 2024.
- [16] “Efficient estimation of trace of powers of density matrices via rank-based methods” Contributed talk at the Annual Meeting of Korean Mathematical Society, Oct. 25th, 2024.
- [15] “Rank is all you need to estimate the trace of the powers of density matrices” Invited talk at the 4th Korea Institute of Science and Technology Information-Korea University-Seoul National University Joint Workshop, Oct. 15th, 2024.
- [14] “Quantum machine learning models for drug library generation” Invited talk at Yonsei University Quantum Computing and Monte Carlo Workshop, Aug. 30th, 2024.
- [13] “Topics in theoretical quantum computer sciences” Invited lecture at Shinil High School, Aug. 28th, 2024.
- [12] “QMA  $\neq$  NP? The remaining journey in quantum complexity theory: The NLTS theorem and the quantum PCP conjecture” Invited talk at Center for Quantum Network’s Channel Capacity Summer Workshop, Jul. 25th, 2024.
- [11] “Disentanglement provides a unified estimation for quantum entropies and distances” Contributed talk at the Spring Meeting of the Korean Physical Society, Apr. 25th, 2024.
- [10] “Disentanglement provides a unified estimation for quantum entropies and distance measures” Contributed talk at the Annual Meeting of the Quantum Information Society of Korea, Apr. 23rd, 2024.
- [9] “Mutual information maximizing quantum generative adversarial network and its applications in finance” Invited talk at North Carolina State University Triangle Quantum Computing Seminar, Nov. 3rd, 2023.
- [8] “Estimating quantum mutual information through a quantum neural network” Invited talk at National Institute of Science Education and Research Bhubaneswar, Aug. 18th, 2023.
- [7] “Generalized private quantum channel and randomizing quantum states” Invited talk at the 2nd Korea Institute of Science and Technology Information-Korea University-Seoul National University Joint Workshop, Sep. 22nd, 2023.
- [6] “Minimal data may be sufficient for quantum artificial intelligence” Invited talk at Seoul National University QST Seminar, Jun. 30th, 2023.
- [5] “Isotropic measure and  $\varepsilon$ -randomizing maps on the high-dimensional quantum system” Contributed talk at Center for Quantum Network’s Channel Capacity Winter Kick-off Workshop, Jan. 15th, 2023.
- [4] “Geometric representation of quantum randomizing maps on high-dimensional quantum systems” Contributed talk at the Winter Meeting of the Optical Society of Korea, Feb. 17th, 2022.
- [3] “Structure of private quantum channels: to higher dimensional regular polytopes” Invited talk at Seoul National University QST Seminar, Aug. 27th, 2021.
- [2] “Quantum Rényi entropy power inequality for bosonic gaussian systems” Contributed talk at the Annual Meeting of the Korean Society for Industrial and Applied Mathematics, Dec. 3rd, 2021.
- [1] “Geometric approach to private quantum channels: High-dimensional cases and regular polytopes” Contributed talk at the Fall Meeting of the Korean Physical Society, Oct. 21st, 2021.

## Posters

- [13] “Rank is all you need: Estimating the trace of powers of density matrices” 28th Annual Conference on Quantum Information Processing (QIP 2025), Feb. 2025.
- [12] “Disentanglement provide a unified estimation for quantum entropies and distance measures” 24th Asian Quantum Information Science Conference (AQIS 2024), Aug. 2024.
- [11] “Disentangling to a reduction for estimating quantum information fundamental properties” 2nd Annual Conference on Quantum Simulation (QSim 2024), Aug. 2024.
- [10] “Disentanglement provide a unified estimation for quantum entropies and distance measures” 28th International Conference on Atomic Physics (ICAP 2024), Jul. 2024.
- [9] “Mutual information maximizing quantum generative adversarial network and its applications” 27th Annual Conference on Quantum Information Processing (QIP 2024), Jan. 2024.
- [8] “Estimation of quantum entropies using quantum convolutional neural networks” 27th Annual Conference on Quantum Information Processing (QIP 2024), Jan. 2024.
- [7] “Quantum neural networks for quantum mutual information estimation” 23rd Asian Quantum Information Science Conference (AQIS 2023), Aug. 2023.
- [6] “Optimizing quantum integer factorization performance: A scalable evaluation approach with parameter pre-selection Method” 23rd Asian Quantum Information Science Conference (AQIS 2023), Aug. 2023.
- [5] “Quantum Rényi entropy functionals for bosonic gaussian systems” 27th edition of the Central European Workshop on Quantum Optics (CEWQO 2023), Jul. 2023.
- [4] “Quantum neural network approach to measuring von Neumann entropy” 18th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC 2023), Jul. 2023.
- [3] “Quantum Rényi entropy functionals for bosonic gaussian systems” 17th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC 2022), Jul. 2022.
- [2] “Quantum Rényi entropy functionals for bosonic gaussian systems” 25th Annual Conference on Quantum Information Processing (QIP 2022), Jan. 2022.
- [1] “Geometry of random unitary channels in high-dimensional quantum states” 25th Annual Conference on Quantum Information Processing (QIP 2022), Jan. 2022.

Updated February 2025