

Seongmuk Khang

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Seoul, S.Korea

RESEARCH INTEREST

My research focuses on quantum algorithms and quantum-classical hybrid methods, particularly on clarifying the conditions and limits of practical quantum advantage. I am interested in developing theoretically grounded, hardware-aware algorithms that account for problem-dependent structures, with applications to optimization, chemistry, finance, AI, and other computationally challenging domains.

EDUCATION

Chiba University

M.Eng. in Applied and Cognitive Informatics, Division of Mathematics and Informatics

Apr 2018 – Mar 2020

Chiba, Japan

- Thesis: *Quantum Algorithms for Finding All Eigenvalues of Sparse Hermitian Matrices*
- Advisor: Prof. Yuichiro Fujiwara
- GPA (WES evaluated): 3.94/4.00

Chiba University

B.Eng. in Informatics and Imaging Systems, Faculty of Engineering

Apr 2014 – Mar 2018

Chiba, Japan

- Thesis: *The Lower Bound on The Maximum Generalized Independent Number*
- Advisor: Prof. Yuichiro Fujiwara
- GPA (WES evaluated): 3.60/4.00

RESEARCH EXPERIENCE

Independent Research

May 2025 – Nov 2025

Seoul, South Korea

Project: *Local Scrambling and Structural Gradient Bias in Hardware-Efficient Quantum Circuits*
(Manuscript under peer review)

- Analyzed trainability of hardware-efficient quantum circuits by simulating gradient behavior across circuit depths, cost placements, and gate layouts
- Quantified structural gradient bias through segment-wise gradient energy measurements, identifying parameter regions with dominant or suppressed gradient contributions
- Tested local scrambling strategies to improve gradient propagation while examining trade-offs in convergence behavior and cost-function dependence

Project: *Extension of Quantum Algorithms for Finding All Eigenvalues of Sparse Hermitian Matrices*

- Investigated how reconstruction complexity depends on the minimum eigenvalue spacing, clarifying why closely spaced eigenvalues impose stronger precision requirements
- Refined the theoretical interpretation of the original algorithm by connecting its efficiency conditions to quantum phase estimation precision and Heisenberg-limit scaling

Chiba University

M.Eng. Researcher

May 2019 – Mar 2020

Chiba, Japan

Project: *Quantum Algorithms for Finding All Eigenvalues of Sparse Hermitian Matrices*

- Architected a quantum algorithm to find and reconstruct the full spectrum of sparse Hermitian matrices by integrating Quantum Phase Estimation with the Coupon Collector's theorem
- Optimized the expected computational complexity to $\tilde{O}(N(\log N)^2)$, achieving efficient global eigenvalue extraction for high-dimensional quantum systems

PATENTS AND PUBLICATIONS

C=CONFERENCE, J=JOURNAL, P=PATENT, S=IN SUBMISSION, T=THESIS

- [S.1] Seongmuk Khang. (2026). *Local scrambling and structural gradient bias in hardware-efficient quantum circuits*. Manuscript under review.
- [P.1] Seongmuk Khang, et al. (2022). **Method and Device for Predicting Patient Prognosis**. Korean Patent Application No. 10-2022-0069591. Filed Jun. 8, 2022; published as KR 10-2023-0069798 A, May 19, 2023. Korean Intellectual Property Office.

PROFESSIONAL EXPERIENCE

Qunova Computing [🌐]
Quantum Algorithm Researcher

May 2026 – Present
Daejeon and Seoul, South Korea

- Develop and improve quantum optimization algorithms, focusing on theoretical efficiency, hardware-constrained performance, and practical applicability

Acryl Inc. [🌐]
Senior Research Engineer

Sep 2020 – Mar 2025
Seoul, South Korea

- Built AI models for medical applications, including COVID-19 screening and pressure-ulcer detection, under a partnership with Samsung Medical Center
- Designed and engineered preprocessing pipelines to enhance dataset quality, consistency, and robustness for machine learning workflows
- Collaborated with cross-functional teams to translate domain-specific requirements into practical AI system components

Project: Open-Source LLM Performance Improvement

- Managed the data team by coordinating dataset construction, preprocessing, and delivery to the model training team
- Enhanced question-based training examples by implementing semantic-preserving paraphrase preprocessing, which increased expression diversity without changing the intended meaning
- Expanded the use of non-question datasets by designing a new training task for examples that lacked explicit question fields

Project: COVID-19 Prognosis AI

- Contributed to a patent application by outperforming two other participating companies by approximately 5% in predictive performance through comparative evaluation
- Constructed neural network-based models for COVID-19 patient prognosis prediction through collaboration with Samsung Medical Center
- Analyzed clinical data to inform feature design, model architecture adaptation, and loss-function modification for prognosis-specific prediction

SKILLS

- **Technical Skills:** Python, Qiskit, PennyLane, PyTorch, NumPy, SciPy, pandas, scikit-learn, Git, Docker
- **Languages:** Korean: Native; English: Professional (TOEFL iBT 102/120; R: 29, L: 23, S: 24, W: 26); Japanese: Fluent

HONORS AND AWARDS

Horangi LLM Leaderboard: Open-Source Category, 1st Place

Jul 2024 – Oct 2024

Weights & Biases (W&B)



- Ranked 1st for four consecutive months among open-source LLMs on the Horangi LLM Leaderboard

Japan-Korea Joint Scholarship Program for Science and Engineering Students

Mar 2013 – Mar 2018

Governments of Korea and Japan



- Selected as a government-sponsored scholar in a merit-based Korea-Japan program for science and engineering students
- Funded through a full tuition waiver, monthly stipends, and Japanese language and academic preparation training throughout undergraduate study in Japan

LEADERSHIP EXPERIENCE

Chiba University: Traditional Music Club

Jan 2016 – Mar 2017

President

- Led a student cultural organization promoting Korean traditional music through campus activities, community outreach, and public performances
- Facilitated Samulnori instruction for students at a UNESCO-associated school, introducing Korean percussion traditions to an international audience
- Performed at major multicultural and Korean community events, including the Yokohama Multicultural Parade and Korea Liberation Day event hosted by the Korean Residents Union in Japan (Mindan)

TEACHING AND MENTORING EXPERIENCE

Chiba University

Fall 2018, Fall 2019

Instructor, Basic Mathematics

- Taught foundational mathematics to international students in the Japan-Korea Joint Program for Science and Engineering
- Supported students' transition to university-level quantitative coursework through problem-solving instruction and academic guidance

Chiba University

Apr 2018 – Mar 2019

Academic Mentor, Japan-Korea Joint Program for Science and Engineering

- Mentored first-year international undergraduates during their academic, language, and campus-life transition
- Provided peer guidance on mathematics coursework, study strategies, and adaptation to the Japanese university environment

VOLUNTEER EXPERIENCE

Kkumnamu Community Child Center

Oct 2012 – Jan 2013

Volunteer Tutor

- Conducted academic tutoring and study guidance to middle school students through 63 hours of volunteer service across 22 sessions
- Offered emotional support to foster students' confidence and motivation