Tak Hur

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Profile

Completed Master's in Physics with Theoretical Physics at Imperial College London. I am interested in quantum machine learning, quantum simulation, topological quantum computation and error correction.

Education

Imperial College London United Kingdom
Graduated Msci Physics with Theoretical Physics *Sept.30, 2017 – August.1, 2022*

- Relavent Courses: *(Year 1)* Quantum Physics, Linear Algebra *(Year2)* Quantum Mechanics, Solid State Physics *(Year3)* Quantum Information, Foundation of Quantum Mechanics, Computational Physics *(Year4)* Quantum Theory of Matter, Quantum Optics, Quantum Field Theory, Information Theory

Publications

[1] **Hur, T.** Kim, L. Park, D. (2022). "Quantum convolutional neural network for classical data classification". *Quantum Machine Intelligence 4, 3.*

Invited Talks

[1] "Quantum Kernel Optimization via Deep Learning." *Electronics and Telecommunications Research Institute* (ETRI), 2023

Research Experiences

Quantum Kernel Optimiziation via Deep Learning
with Dr. Israel Araujo, Prof. Daniel Park Sept. 2022 – Present

- Studying generalization error bounds of quantum machine learning models
- Researching efficient methods to embed classical data into quantum machine learning models
- Applying Quantum Convolutional Neural Networks to classify various classical datasets

Topological Quantum Computation
Supervisor: Dr. Derek Lee Oct. 2021 – June 2022

- Investigated braiding statistics of Non-Abelian Anyons for topological quantum computation
- Demonstrated the braiding simulation in a tri-junction using a pulse level control of a quantum circuit (Qiskit Pulse)
- Investigated topologically protected error correction codes and their decoding methods with variational quantum autoencoder

Quantum Convolutional Neural Network
with Leeseok Kim, Supervisor: Prof. Daniel Park March 2021 – Aug. 2021

- Investigated the performance of various designs Quantum Convolutional Neural Network (QCNN) for classical pattern recognition
- Suggested different convolution ansatze and data embedding methods and benchmarked the accuracy of MNIST classification with 8 qubits QCNN circuit
- Compared QCNN with classical CNN under various classical datasets
- Paper accepted in *Quantum Machine Intelligence*

Quantum Optomechanics

Supervisor: Dr. Yue Ma, Prof. Myungshik Kim Sept. 2020 – Feb. 2021

- Studied transformation that reduces optomechanical entanglement of geometrical phase gates
- Analyzed purity and fidelity of imperfect Sørensen-Mølmer gate and Milburn gate and showed performance of the gates increase with the transformation
- Extended the calculation into a open quantum model with thermal dissipation by considering an interaction with an infinite Markovian bath of harmonic oscillators (Main Contribution)

Other Experiences

2022 QHACK/ 2021 QHACK Feb 2022 / Feb 2021

Pennylane.ai / Xanadu

- Learned the implementation of parameterized quantum circuit and optimization methods
- Solved interesting QML problems such as weighted Max-Cut problem with QAOA, and solving excited states of the Hamiltonian using Variational Multiclass Eigensolver
- QHACK 2022 - Top 4 / 300
- QHACK 2021 - Top 30 / 300

NYU Deep Learning July – Sept 2021

NYU Center for Data Science

- Learned inference framework of probabilistic learning models and energy based models
- Implemented variational autoencoders and Generative Adversarial Networks with PyTorch
- Studied and implemented graph convolution networks

2021 Qiskit Global Summer School July 2021

IBM

- Studied expressibility of parameterized quantum models and their trainability issues with Barren Plateaus
- Learned transmon qubit structure and implemented hardware efficient ansatze
- Implemented advanced quantum learning models including Quantum Boltzmann Machine and Quantum Generative Adversarial Networks

2020 Qiskit Summer School July 2020

IBM

- Implemented basic Quantum Algorithms (Deutsch-Jozsa, Grover, Shor) using Qiskit
- Simulated hydrogen molecule using Variational Quantum Eigensolvers(VQEs)
- Learned Qauntum Error Correction method and structure of Transmon Qubit used in IBMQ
- Earned Certificate of Excellence

Neural Networks and Deep Learning July – Sept 2020

Deeplearning.Ai

- Implemented neural networks (RNN, DNN, CNN etc.) for different classification problems
- Implemented various training methods such as mini-batch, RMS prop, ADAM optimization
- Learned TensorFlow and PyTorch for gradient based optimization

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References

[1] Prof. Kyungdeock Park, dkd.park@yonsei.ac.kr

- *Assistant Professor* at Department of Applied Statistics, Department of Statistics and Data Science, Yonsei University