JINHWAN SUL

Optimization | Machine Learning

jsul7@gatech.edu | Google Scholar | GitHub | LinkedIn

Research Summary

I develop **machine learning methods** for **large-scale optimization** through the lens of **optimal control theory**.

OPTIMIZATION	MACHINE LEARNING
Large-scale optimization	ML for Optimization
GPU-based optimization algorithms	Schrödinger bridge
Stochastic optimal control	Diffusion-based generative models
Linear programming; Mixed integer programming	Reinforcement learning

Education

Jan 2025–Spring 2029 **Ph.D. in Machine Learning**, Georgia Institute of Technology
Autonomous Control and Decision Systems (ACDS) Laboratory
Advisor: Prof. Evangelos A. Theodorou

Mar 2020–Feb 2023 **B.S. in Computer Science and Engineering**, Seoul National University

Mar 2016–Feb 2023 **B.S. in Mechanical Engineering**, Seoul National University

Mar 2013–Feb 2016 **Gyeonggi Science High School for the Gifted**

Publications

* Equal contribution.

P1 **Reinforcement Learning to Accelerate Primal-Dual Hybrid Gradient for Linear Programming.**
Jinhwan Sul, Alex Oshin, Evangelos A. Theodorou | **arXiv preprint, 2026**

P2 **Distributionally Robust Schrödinger Bridge.**
Jinhwan Sul, Panagiotis Theodoropoulos, Vincent Pacelli, Jaemoo Choi, Evangelos A. Theodorou | **arXiv preprint, 2026**

P3 **Efficient Generative Modeling beyond Memoryless Diffusion via Adjoint Schrödinger Bridge Matching.**
Jeongwoo Shin, **Jinhwan Sul**, Joonseok Lee, Jaewoong Choi, Jaemoo Choi | **ICML 2026**

P4 **SummDiff: Generative Modeling of Video Summarization with Diffusion.**
Kwanseok Kim*, Jaehoon Hahm*, Sumin Kim, **Jinhwan Sul**, Byunghak Kim, Joonseok Lee | **ICCV 2025, Highlight**

P5 **Mr. HiSum: A Large-scale Dataset for Video Highlight Detection and Summarization.**
Jinhwan Sul*, Jihoon Han*, Joonseok Lee [Code/data] | **NeurIPS 2023, Datasets and Benchmarks**

P6 **Towards Physically Reliable Molecular Representation Learning.**
Seunghoon Yi, Youngwoo Cho, **Jinhwan Sul**, Seung Woo Ko, Soo Kyung Kim, Jaegul Choo, Hongkee Yoon, Joonseok Lee | **UAI 2023**

P7 **Generic and Scalable Differential-Equation Solver for Quantum Scientific Computing.**
Jinhwan Sul, Yan Wang | **Physical Review A, 2025**

P8 **Quantum Functional Expansion to Solve Stochastic Differential Equations.**
Jinhwan Sul, Jungin E. Kim, Yan Wang | **IEEE QCE 2024, Best Paper (Quantum Applications, 3rd)**

P9 **Quantum Machine Learning for Additive Manufacturing Process Monitoring.**
Eunsik Choi*, **Jinhwan Sul***, Jungin E. Kim, Sungjin Hong, Beatriz Izquierdo Gonzalez, Pablo Cembellin, Yan Wang | **Manufacturing Letters / NAMRC 52, 2024**

Patent Applications

Quantum Functional Expansion System for Quantum Scientific Computing.
Jinhwan Sul (co-inventor) | U.S. Provisional Patent Application No. 63/692,936
Filed September 10, 2024.

Research Experience

Georgia Institute of Technology Jan 2025–Present

Doctoral Research | ACDS Laboratory | Advisor: Prof. Evangelos A. Theodorou

GALLOP: Reinforcement Learning to Accelerate Large-Scale Linear Programming [P1]

- **GPU-based large-scale optimization.** Developed a generalized acceleration scheme for primal–dual hybrid gradient (PDHG) while retaining GPU-friendly matrix–vector products and projections.
- **Reinforcement learning.** Formulated PDLP acceleration as an optimal control problem and trained a feedback policy to coordinate solver parameters and restarts.
- **Speed and size generalization.** Achieved up to 16× speedup in algorithm runtime over a baseline solver and generalized without retraining to 3–400× larger LPs within the same problem family.

Large-Scale Robust Inventory Management

- **Robust optimization modeling.** Formulated multi-item inventory control with purchase policies affine in past demand and derived a sparse LP counterpart under demand uncertainty.
- **Solver benchmarking & decomposition.** Benchmarked Gurobi, HiGHS, NVIDIA cuOpt, and ADMM. Solved a 50,000-item inventory instance using Dantzig–Wolfe column generation.

Distributionally Robust Fine-tuning of Schrödinger Bridge Generative Models [P2]

DARPA AIQ Program *(Artificial Intelligence Quantified)*

- **Robust generative modeling.** Developed distributionally robust fine-tuning methods to make diffusion-based Schrödinger bridge models more resilient to noisy and shifted inputs without test-time retraining.
- **Generative AI reliability.** Formulated and experimentally validated probabilistic bounds on how much input noise can change generated outputs using conformal prediction.

Seoul National University Feb 2022–Sep 2024

Research Internship and Collaboration | Advisor: Prof. Joonseok Lee

- **Generative video summarization.** Developed SummDiff, a diffusion model that captures subjectivity by learning a distribution of plausible summaries for each video [P4].
- **Video summarization dataset.** Created **Mr. HiSum** with 31,892 videos and importance labels from YouTube's "Most Replayed" statistics, aggregated from 50,000+ users per video [P5].
- **Molecular representation learning.** Designed transformer models regularized by physical principles, with constraints for stable molecular structures and an evaluation criterion for molecular relaxation [P6].

Georgia Institute of Technology Jun 2023–Dec 2024

Prior Research | Advisor: Prof. Yan Wang

- **Machine learning for process monitoring.** Adapted transformer attention inputs for semiconductor process monitoring and applied symbolic regression to process data in collaboration with Samsung.
- **Quantum computing.** Developed quantum functional expansion methods for solving differential equations [P7, P8] and evaluated quantum machine learning for additive manufacturing process monitoring [P9].

Internship

Samsung C-Lab, Intern | Seoul, Korea Jan–Feb 2020

Supported a long-range wireless charging project through rectifier-circuit and heat-transfer experiments and a review of wireless power transmission patents.

Honors and Scholarships

- **Best Paper Award, 3rd Place**, Quantum Applications Track, IEEE QCE (2024).
- **2nd Place, Graph Pattern Matching Challenge**, Seoul National University (2021), among more than 60 teams, including graduate students.
- **Special Prize, SNU X-Corps Research Competition** (2021), for the design and analysis of a hydrogen and floating-photovoltaic electricity supply system.
- **Kwanjeong Education Foundation Scholarship** (Spring 2020–Fall 2021), covering full tuition and a study subsidy.
- **Eminence Scholarship**, Seoul National University (Spring 2017), covering full tuition.
- **Merit-Based Scholarships**, Seoul National University: 30% tuition (Fall 2019 and Fall 2016) and 10% tuition (Spring 2016, admission with high distinction).

Invited Talks

- **Invited talk:** *Quantum Functional Expansion to Solve Stochastic Differential Equations*, IEEE Quantum Week (QCE) 2024 Review Workshop, The Institute of Semiconductor Engineers, Korea (online), Nov 8, 2024.
- **Conference presentation: Jinhwan Sul**, Jungin E. Kim, Yan Wang, *Quantum Solver of Stochastic Differential Equations*, WCCM (2024).

Professional Service

Reviewer: ICLR (2027); NeurIPS Datasets and Benchmarks (2023, 2024, 2026); WACV (2024).

Teaching

- **Engineering Mathematics 2**, Seoul National University — Sep 2020–Feb 2021
- **Foundation of Physics 2**, Seoul National University — Sep–Dec 2019

Technical Skills

Optimization: Gurobi, HiGHS, NVIDIA cuOpt, CVXPY, OSQP, MPAX; PDHG/PDLP, ADMM.
Machine learning: JAX, Flax, PyTorch; RL/PPO, optimal transport, diffusion models.
Computing: Python, C/C++, MATLAB, Java; NumPy, SciPy; GPU computing, sparse linear algebra.
Research software: Git, pytest, Hydra.
Languages: Korean (native), English (fluent).

Extracurricular

Mandatory military service, Republic of Korea (Auxiliary Police) — Mar 2017–Dec 2018