Sungho Shin

Assistant Professor, Department of Chemical Engineering, Massachusetts Institute of Technology
Email: sushin@mit.edu | Cell: +1 617 715 5740 | Web: shin.mit.edu | LinkedIn: @sshin23 | Github: @sshin23

Education and Training

Argonne National Laboratory, Lemont, IL — 2021–2024
Postdoc in Mathematics and Computer Science Division

University of Wisconsin-Madison, Madison, WI — 2021
Ph.D. in Chemical Engineering

Seoul National University, Seoul, South Korea — 2016
B.S. in Chemical Engineering and B.S. in Mathematics

Research Interests

control theory; nonlinear optimization; energy systems

Professional Appointments

Assistant Professor — 2024-Present
Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA

Postdoctoral Appointee (Supervisor: Mihai Anitescu) — 2021-2024
Mathematics and Computer Science Division, Argonne National Laboratory, Lemont, IL

Honors and Awards

COIN-OR Cup, Computational Infrastructure for Operations Research — 2023

W. David Smith, Jr. Graduate Publication Award, AIChE — 2023

Young Author Award, IFAC Conference on Nonlinear Model Predictive Control — 2021

Young Author Award, IFAC International Symposium on Advanced Control of Chemical Processes — 2021

CAST Directors' Student Presentation Award, AIChE — 2020

Selected Publications

[P12] S. Shin, Y. Lin, G. Qu, A. Wierman, and M. Anitescu. Near-optimal distributed linear-quadratic regulator for networked systems. *SIAM Journal on Control and Optimization*, 61(3):1113–1135, 2023, arXiv:2204.05551. doi:10.1137/22M1489836.

[P11] S. Shin and V. M. Zavala. Diffusing-horizon model predictive control. *IEEE Transactions on Automatic Control*, 2023, arXiv:2002.08556. doi:10.1109/TAC.2021.3137100.

[P10] A. Engelmann, S. Shin, F. Pacaud, and V. M. Zavala. Scalable primal decomposition schemes for large-scale infrastructure networks. *IEEE Transactions on Control of Network Systems*, 2024, arxiv:2212.11571. Accepted.

[P9] S. Shin, M. Anitescu, and F. Pacaud. Accelerating optimal power flow with GPUs: SIMD abstraction of nonlinear programs and condensed-space interior-point methods. *Electric Power Systems Research*, 236:110651, 2024, arXiv:2307.16830. doi:10.1016/j.epsr.2024.110651.

[P8] F. Pacaud, D. A. Maldonado, S. Shin, M. Schanen, and M. Anitescu. A feasible reduced space method for real-time optimal power flow. *Electric Power Systems Research*, 212:108268, 2022, arXiv:2110.02590. doi:https://doi.org/10.1016/j.epsr.2022.108268.

[P7] S. Shin, P. Hart, T. Jahns, and V. M. Zavala. A hierarchical optimization architecture for large-scale power networks. *IEEE Transactions on Control of Network Systems*, 6(3):1004–1014, 2019, arXiv:2002.09796. doi:10.1109/TCNS.2019.2906917.

[P6] F. Pacaud, S. Shin, A. Montoison, M. Schanen, and M. Anitescu. Condensed-space methods for nonlinear programming on GPUs, 2405.14236. doi:10.48550/arXiv.2405.14236.

[P5] S. Shin, M. Anitescu, and F. Pacaud. Accelerating optimal power flow with GPUs: SIMD abstraction of nonlinear programs and condensed-space interior-point methods. *Electric Power Systems Research*, 236:110651. doi:10.1016/j.epsr.2024.110651.

[P4] F. Pacaud, M. Schanen, S. Shin, D. A. Maldonado, and M. Anitescu. Parallel interior-point solver for block-structured nonlinear programs on SIMD/GPU architectures. *Optimization Methods and Software*, arXiv:2301.04869. Accepted.

[P3] F. Pacaud, S. Shin, M. Schanen, D. A. Maldonado, and M. Anitescu. Accelerating condensed interior-point methods on SIMD/GPU architectures. *Journal of Optimization Theory and Applications*, pages 1–20, 2023, arXiv:2203.11875. doi:10.1007/s10957-022-02129-5.

[P2] J. Jalving, S. Shin, and V. M. Zavala. A graph-based modeling abstraction for optimization: Concepts and implementation in Plasmo.jl. *Mathematical Programming Computation*, 2022, arXiv:2006.05378. doi:10.1007/s12532-022-00223-3.

[P1] S. Shin, M. Anitescu, and V. M. Zavala. Exponential decay of sensitivity in graph-structured nonlinear programs. *SIAM Journal on Optimization*, 32(2):1156–1183, 2022, arXiv:2101.03067. doi:10.1137/21M1391079.

Grants

PI. Multi-Scale Production Cost Modeling for Optimal Storage Investment. MIT Energy Initiative. Total $100,000. 2024-2025.

PI. Analyzing the Ripple Effect of Consumer Flexibility on Utility Scale Energy System Investments. EQUINOR. Total $304,524. 2024-2025.

PI. Optimal Utilization Strategies of Utility-Scale Battery Storage: Slowing Down Degradation in the Face of Complex Physics and Uncertainties. MIT Energy Initiative. Total $150,000. 2024-2026.

PI. Characterizing the Trade-Off between CO2 Capture Rate and Energy Efficiency in Amine-Based Carbon Capture under Variable Feed Conditions. Total $250,000. 2025-2027.

Software Products

[S1] **MadNLP.jl** (Main developer): a nonlinear programming solver for GPUs

[S2] **ExaModels.jl** (Main developer): an algebraic modeling system for GPUs.

[S3] **Plasmo.jl** (Main developer): a graph-based modeling platform.

Synergetic Activities

Conference session organization: Organized "accelerated computing for mathematical programming" session at INFORMS Annual Meeting (2024), International Program Committee of IFAC NMPC Conference (2024), and session reviewer and chair of AIChE CAST Division (2022, 2024).

- Served as journal reviewer, including IEEE Transactions on Automatic Control, Automatica, and SIAM Journal on Optimization, and many others.

Invited Seminars: Given several invited seminars about "Nonlinear optimization on GPUs", including Los Alamos National Laboratory (2024), Oklahoma State University (2024), Purdue University (2024), AIChE CAST Webinar series (2024), General Electric (2024), Hitach Energy (2024)

- Contributed department activities at MIT to promote diversity in the field, including Rising Stars in Chemical Engineering (2024).