Sungho Shin

Mathematics and Computer Science Division, Argonne National Laboratory, Lemont, IL 60439
Email: sushin@mit.edu | Cell: +1 608 448 5155 | Web: shin.mit.edu | Twitter: @SunghoShinSS | Github: @sshin23

Education

University of Wisconsin-Madison, Madison, WI 2021
Ph.D. in Chemical Engineering
Minor in Industrial Engineering
Thesis: *Graph-Structured Nonlinear Programming: Properties and Algorithms*
Thesis Advisor: Victor M. Zavala

Seoul National University, Seoul, South Korea 2016
B.S. in Chemical Engineering
B.S. in Mathematics
Thesis Advisors: Jong Min Lee (Chemical Engineering) and Seng Yeal Ha (Mathematics)
Summa Cum Laude

Research Interests

control theory; model predictive control; nonlinear optimization; stochastic optimization; energy systems

Research Experience

Postdoctoral Appointee 2021–Present
Argonne National Laboratory, Lemont, IL
Mathematics and Computer Science Division
Supervisor: Mihai Anitescu

Research Assistant 2016–2021
University of Wisconsin-Madison, Madison, WI
Department of Chemical and Biological Engineering
Supervisor: Victor M. Zavala

Research Intern 2020
Los Alamos National Laboratory, Los Alamos, NM
Advanced Network Science Initiative
Supervisor: Carleton Coffrin and Kaarthik Sundar

Research Intern 2018
Argonne National Laboratory, Lemont, IL
Mathematics and Computer Science Division
Supervisor: Mihai Anitescu

Research Intern 2016
Seoul National University, Seoul, South Korea
Department of Chemical and Biological Engineering
Supervisor: Jong Min Lee.

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
Grainger Wisconsin Distinguished Graduate Fellowship, University of Wisconsin-Madison 2020–2021
Kwanjeong Scholarship, Kwanjeong Educational Foundation 2016–2020
Korea Presidential Science Scholarship, Korea Student Aid Foundation 2010–2016

Mentoring Experience

Argonne National Laboratory, Lemont, IL

Alexis Montoison (Polytechnique Montréal) Fall 2023
Runxin Ni (University of Chicago) Summer 2023
Miao Li (Predoctoral Appointee) Fall 2022–Summer 2023
Anthony Spyros Degleris (Stanford University) Summer 2022
David Cole (University of Wisconsin-Madison) Summer 2022
Rishabh Gupta (University of Minnesota) Spring 2022

University of Wisconsin-Madison, Madison, WI

Sang-il Kwon (University of Wisconsin-Madison) Fall 2017

Teaching Experience

University of Wisconsin-Madison, Madison, WI

Statistics for Chemical Engineers, Teaching Assistant Spring 2019
Process Dynamics and Control, Teaching Assistant Fall 2018, Fall 2017

Seoul National University, Seoul, South Korea

Process Control and Design, Undergraduate Tutor Fall 2015
Process Fluid Mechanics, Undergraduate Tutor Spring 2015
Basic Chemistry, Undergraduate Tutor Spring 2015

Professional Services

Academic Services

Session Chair INFORMS Annual Meeting 2022
Session Co-Chair AIChE Annual Meeting 2022
Reviewer AIChE Annual Meeting CAST Division (10B, 10E) 2022
Co-Chair, Summer Argonne Students Symposium, 2022
Judge, Research Presentation Sessions, Argonne Postdoctoral Research and Career Symposium 2021

Peer Review

Proposals: NSF

Journals: AIChE Journal; IEEE Transactions on Automatic Control; Automatica; Computers & Chemical Engineering; IEEE Open Journal of Control Systems; IEEE Control Systems Letters; IEEE Transactions on Control Systems Technology; Industrial & Engineering Chemistry Research; INFORMS Journal on Computing; Journal of Physical Chemistry; Journal of Optimization Theory and Applications; Optimization Methods and Software; SIAM Journal on Optimization

Conferences: American Control Conference; IFAC Conference on Nonlinear Model Predictive Control; IFAC International Symposium on Advanced Control of Chemical Processes

Professional Affiliations

- **American Institute of Chemical Engineers** (AIChE)
- **Institute of Electrical and Electronics Engineers** (IEEE) – Control Systems Society
- **Institute for Operations Research and the Management Sciences** (INFORMS)
- **Society for Industrial and Applied Mathematics** (SIAM)

Publications

Preprints

[P6] **S. Shin**, V. Rao, M. Schanen, D. A. Maldonado, and M. Anitescu. Scalable multi-period AC optimal power flow utilizing GPUs with high memory capacities, 2024, 2405.14032.

[P5] F. Pacaud, **S. Shin**, A. Montoison, M. Schanen, and M. Anitescu. Condensed-space methods for nonlinear programming on GPUs, 2024, 2405.14236.

[P4] **S. Shin** and M. Anitescu. Improved perturbation bounds for graph-induced banded systems and application to optimal control. In Preparation.

[P3] **S. Shin**, S. Na, and M. Anitescu. Near-optimal performance of stochastic predictive control, arXiv:2210.08599. Under Review.

[P2] F. Pacaud and **S. Shin**. GPU-accelerated nonlinear model predictive control with ExaModels and MadNLP, 2024, 2403.15913. Under Review.

[P1] A. Engelmann, **S. Shin**, F. Pacaud, and V. M. Zavala. Scalable primal decomposition schemes for large-scale infrastructure networks, 2022, arxiv:2212.11571. Under Review.

Journal Publications

[J13] 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*, 2023, arXiv:2301.04869. Accepted.

[J12] 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.

[J11] **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.

[J10] **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.

[J9] 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.

[J8] D. L. Cole, **S. Shin**, and V. Zavala. A julia framework for graph-structured nonlinear optimization. *Industrial & Engineering Chemistry Research*, 2022, arXiv:2204.05264. doi:https://doi.org/10.1021/acs.iecr.2c01253.

[J7] S. Na*, **S. Shin***, M. Anitescu, and V. M. Zavala. On the convergence of overlapping schwarz decomposition for nonlinear optimal control. *IEEE Transactions on Automatic Control*, 2022, arXiv:2005.06674. doi:10.1109/TAC.2022.3194087. *Equal contribution.

[J6] 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.

[J5] **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.

[J4] **S. Shin**, V. M. Zavala, and M. Anitescu. Decentralized schemes with overlap for solving graph-structured optimization problems. *IEEE Transactions on Control of Network Systems*, 7(3):1225–1236, 2020, arXiv:1810.00491. doi:10.1109/TCNS.2020.2967805.

[J3] **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.

[J2] **S. Shin**, O. S. Venturelli, and V. M. Zavala. Scalable nonlinear programming framework for parameter estimation in dynamic biological system models. *PLoS Computational Biology*, 15(3):e1006828, 2019. doi:10.1371/journal.pcbi.1006828.

[J1] D. S. Kim, **S. Shin**, G. B. Choi, K. H. Jang, J. C. Suh, and J. M. Lee. Diagnosis of partial blockage in water pipeline using support vector machine with fault-characteristic peaks in frequency domain. *Canadian Journal of Civil Engineering*, 44(9):707–714, 2017. doi:10.1139/cjce-2016-0615.

Conference Publications

[C9] **S. Shin**, F. Pacaud, and M. Anitescu. Accelerating optimal power flow with GPUs: SIMD abstraction of nonlinear programs and condensed-space interior-point methods. In *XXIII Power Systems Computation Conference*, arXiv:2307.16830. Accepted.

[C8] **S. Shin**, F. Pacaud, E. Contantinescu, and M. Anitescu. Constrained policy optimization for stochastic optimal control under nonstationary uncertainties. In *2023 American Control Conference (ACC)*, 2023, arXiv:2209.13050.

[C7] D. Cole, **S. Shin**, F. Pacaud, V. M. Zavala, and M. Anitescu. Exploiting GPU/SIMD architectures for solving linear-quadratic MPC problems. In *2023 American Control Conference (ACC)*, 2023, arXiv:2209.13049.

[C6] **S. Shin** and V. M. Zavala. Controllability and observability imply exponential decay of sensitivity in dynamic optimization. In *7th IFAC Conference on Nonlinear Model Predictive Control*, volume 54, pages 179–184, 2021, arXiv:2101.06350. doi:10.1016/j.ifacol.2021.08.542. Young Author Award.

[C5] **S. Shin**, C. Coffrin, K. Sundar, and V. M. Zavala. Graph-based modeling and decomposition of energy infrastructures. In *11th IFAC International Symposium on Advanced Control of Chemical Processes*, volume 54, pages 693–698, 2021, arXiv:2010.02404. doi:10.1016/j.ifacol.2021.08.322. Keynote Paper, Young Author Award.

[C4] **S. Shin**, M. Anitescu, and V. M. Zavala. Overlapping Schwarz decomposition for constrained quadratic programs. In *2020 59th IEEE Conference on Decision and Control (CDC)*, pages 3004–3009, 2020, arXiv:2003.07502. doi:10.1109/CDC42340.2020.9304139.

[C3] Q. Lu, **S. Shin**, and V. M. Zavala. Characterizing the predictive accuracy of dynamic mode decomposition for data-driven control. In *21th IFAC World Congress*, volume 53, pages 11289–11294, 2020, arXiv:2003.01028. doi:https://doi.org/10.1016/j.ifacol.2020.12.373.

[C2] **S. Shin**, T. Faulwasser, M. Zanon, and V. M. Zavala. A parallel decomposition scheme for solving long-horizon optimal control problems. In *2019 IEEE 58th Conference on Decision and Control (CDC)*, pages 5264–5271, 2019, arXiv:1903.01055. doi:10.1109/CDC40024.2019.9030139.

[C1] **S. Shin**, A. D. Smith, S. J. Qin, and V. M. Zavala. On the convergence of the dynamic inner PCA algorithm. In *Foundations of Process Analytics and Machine Learning*, 2019, arXiv:2003.05928.

Book Chapters, Technical Reports, and Others

[B5] M. Anitescu, K. Kim, Y. Kim, A. Maldonado, F. Pacaud, V. Rao, M. Schanen, **S. Shin**, and A. Subramanian. Targeting Exascale with Julia on GPUs for multiperiod optimization with scenario constraints. *SIAG/OPT Views and News*, 2021. URL http://wiki.siam.org/siag-op/images/siag-op/e/e8/ViewsAndNews-29-1.pdf.

[B4] P. F. Lang, **S. Shin**, and V. M. Zavala. SBML2Julia: interfacing SBML with efficient nonlinear Julia modeling and solution tools for parameter optimization. 2020, arXiv:2011.02597.

[B3] **S. Shin**, Q. Lu, and V. M. Zavala. Unifying theorems for subspace identification and dynamic mode decomposition. 2020, arXiv:2003.07410.

[B2] **S. Shin** and V. M. Zavala. Computing economic-optimal and stable equilibria for droop-controlled microgrids. 2018, arXiv:2002.09802.

[B1] **S. Shin** and V. M. Zavala. Multi-grid schemes for multi-scale coordination of energy systems. In *Energy Markets and Responsive Grids*, pages 195–222. Springer, 2018, arXiv:2002.10680. doi:10.1007/978-1-4939-7822-9_9.

Thesis

[T1] **S. Shin**. *Graph-Structured Nonlinear Programming: Properties and Algorithms*. The University of Wisconsin-Madison, 2021.

Presentations

Invited Talks

[I6] **S. Shin**. Scalable decision-making for energy systems: A graph-structured optimization approach. Grid Science Winter School and Conference, Santa Fe, NM, 2023.

[I5] **S. Shin**. Scalable decision-making for energy infrastructures: Theory, algorithms, and software. Young Researcher Symposium, Seoul National University (Virtual), 2022.

[I4] **S. Shin**, M. Anitescu, and V. M. Zavala. Graph-structured nonlinear programming: Properties and algorithms. ALOP colloquium, Trier University (Virtual), 2021.

[I3] **S. Shin**, M. Anitescu, and V. M. Zavala. Graph-structured nonlinear programming: Properties and algorithms. Rigorous Systems Research Group, Caltech (Virtual), 2021.

[I2] **S. Shin** and V. M. Zavala. Graph-structured optimization for energy infrastructures. Department of Chemical and Biological Engineering Seminar, University of Wisconsin-Madison (Virtual), 2021.

[I1] **S. Shin**, M. Anitescu, and V. M. Zavala. Exponential decay of sensitivity in graph-structured nonlinear programs. University of Bayreuth (Virtual), 2020.

Conference Talks

[M18] **S. Shin**, S. Na, and M. Anitescu. On the performance of stochastic predictive control. AIChE Annual Meeting, Pheonix, AZ, 2022.

[M17] **S. Shin**, Y. Lin, G. Qu, A. Wierman, and M. Anitescu. Near-optimal distributed linear-quadratic regulator for networked systems. AIChE Annual Meeting, Pheonix, AZ, 2022.

[M16] **S. Shin**, S. Na, and M. Anitescu. On the performance of stochastic predictive control. INFORMS Annual Meeting, Indianapolis, IN, 2022.

[M15] **S. Shin**, S. Na, and M. Anitescu. Graph-structured nonlinear programming: Properties and algorithms. International Conference on Continuous Optimization, Lehigh, PA, 2022.

[M14] **S. Shin**. MadNLP.jl: A mad nonlinear programming solver. JuliaCon2021.

[M13] **S. Shin** and V. M. Zavala. Controllability and observability imply exponential decay of sensitivity in dynamic optimization. 7th IFAC Conference on Nonlinear Model Predictive Control (Virtual), 2021.

[M12] **S. Shin**, C. Coffrin, K. Sundar, and V. M. Zavala. Graph-based modeling and decomposition of energy infrastructures. 11th IFAC International Symposium on Advanced Control of Chemical Processes (Virtual), 2021.

[M11] **S. Shin**, M. Anitescu, and V. M. Zavala. Overlapping schwarz decomposition for constrained quadratic programs. 58th IEEE Conference on Decision and control (Virtual), 2020.

[M10] **S. Shin**, V. M. Zavala, and M. Anitescu. Unifying theorems for unifying theorems for subspace identification and dynamic mode decomposition. AIChE Annual Meeting (Virtual), 2020.
[M9] **S. Shin** and V. M. Zavala. Diffusing-horizon model predictive control. AIChE Annual Meeting (Virtual), 2020.
[M8] **S. Shin**, M. Anitescu, and V. M. Zavala. Overlapping domain decomposition schemes for solving graph-structured optimization problems. AIChE Annual Meeting (Virtual), 2020.
[M7] **S. Shin**, T. Faulwasser, M. Zanon, and V. M. Zavala. A parallel decomposition scheme for solving long-horizon optimal control problems. 58th IEEE Conference on Decision and control, Nice, France, 2019.
[M6] **S. Shin**, V. M. Zavala, and M. Anitescu. Overlapping domain decomposition schemes for solving graph-structured optimization problems. AIChE Annual Meeting, Orlando, FL, 2019.
[M5] **S. Shin** and V. M. Zavala. Low-rank system identification from high-dimensional data. Computing in Engineering Forum, Madison, WI, 2019.
[M4] **S. Shin**, A. D. Smith, S. J. Qin, and V. M. Zavala. Optimization algorithms for dynamic latent variable problems. MLSE, Atlanta, GA, 2019.
[M3] **S. Shin** and V. M. Zavala. Stability-preserving economic optimization of microgrids. AIChE Annual Meeting, Pittsburgh, PA, 2018.
[M2] **S. Shin** and V. M. Zavala. Multi-grid (hierarchical) control of power networks. AIChE Annual Meeting, Minneapolis, MN, 2017.
[M1] **S. Shin**, O. S. Venturelli, and V. M. Zavala. Large-scale estimation techniques for dynamic microbial community networks. TWCCC Fall Meeting, Madison, WI, 2017.

Software Products

[S1] **MadNLP.jl** (Main developer)
- a nonlinear programming solver
- allows for exploiting problem structures via abstract KKT system feature
- allows for solving dense nonlinear optimization problems on GPU efficiently
- https://github.com/MadNLP/MadNLP.jl

[S2] **ExaModels.jl** (Main developer)
- a sparse automatic differentiation and algebraic modeling tool
- https://github.com/sshin23/ExaModels.jl

[S3] **Plasmo.jl** (Contributor)
- a graph-based algebraic modeling framework
- https://github.com/plasmo-dev/Plasmo.jl

[S4] **DynamicNLPModels.jl** (Contributor)
- a GPU-friendly modeling tool for dynamic optimization problems
- https://github.com/MadNLP/DynamicNLPModels.jl

[S5] **BlockNLPModels.jl** (Contributor)
- a data structure for block nonlinear programming models
- https://github.com/exanauts/BlockNLPModels.jl

[S6] **BlockNLPAlgorithms.jl** (Contributor)
- a decomposition solver for BlockNLPModels
- https://github.com/exanauts/BlockNLPAlgorithms.jl

[S7] **SBML2Julia** (Contributor)
- a tool for estimating parameters of biological system models in SBML format
- https://github.com/paulflang/SBML2Julia

References

Provided upon request.

Last updated: July 2, 2024