Sungho Shin

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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

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

Miao Li (Predoctoral Appointee) Fall 2022–Present

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 (expected) 2022

Session Co-Chair AIChE Annual Meeting (expected) 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 Control Systems Letters; IEEE Transactions on Control Systems Technology; Industrial & Engineering Chemistry Research; Journal of Optimization Theory and Applications; 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

In Preparation

[P2] **S. Shin** and M. Anitescu. Improved perturbation bounds for graph-induced banded systems and application to optimal control. In Preparation.

[P1] **S. Shin**, S. Na, and M. Anitescu. Near-optimal performance of stochastic predictive control. In Preparation.

Under Review

[U4] **S. Shin**, F. Pacaud, E. Contantinescu, and M. Anitescu. Constrained policy optimization for stochastic optimal control under nonstationary uncertainties. arXiv:2209.13050. Under Review.

[U3] D. Cole, **S. Shin**, F. Pacaud, V. M. Zavala, and M. Anitescu. Exploiting GPU/SIMD architectures for solving linear-quadratic MPC problems. 2022, arXiv:2209.13049. Under Review.

[U2] **S. Shin**, Y. Lin, G. Qu, A. Wierman, and M. Anitescu. Near-optimal distributed linear-quadratic regulator for networked systems. arXiv:2204.05551. Under Review.

[U1] F. Pacaud, **S. Shin**, M. Schanen, D. A. Maldonado, and M. Anitescu. Condensed interior-point methods: porting reduced-space approaches on GPU hardware. arXiv:2203.11875. Under Review.

Journal Publications

[J10] 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.

[J9] 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.

[J8] 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.

[J7] 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.

[J6] **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.

[J5] **S. Shin** and V. M. Zavala. Diffusing-horizon model predictive control. *IEEE Transactions on Automatic Control*, 2022, arXiv:2002.08556. doi:10.1109/TAC.2021.3137100.

[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

[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

[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

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

[S3] **MadDiff.jl** (Main developer)
  - a sparse automatic differentiation and algebraic modeling tool
  - https://github.com/sshin23/MadDiff.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: October 7, 2022