Sungho Shin

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Education

University of Wisconsin-Madison.
Ph.D. in Chemical Engineering with Minor in Industrial Engineering (2021)
Thesis Advisor: Victor M. Zavala
Thesis Title: Graph-Structured Nonlinear Programming: Properties and Algorithms

Seoul National University.
B.S. in Chemical Engineering and Mathematics (2016)
Thesis Advisors: Jong Min Lee (Chemical Engineering) and Seng Yeal Ha (Mathematics)

Research Interests

control theory; sequential decision making; model predictive control; nonlinear optimization; numerical optimization; distributed optimization; decomposition algorithms; energy systems

Professional Appointments

Postdoctoral Appointee (2021 – Present)
Mathematics and Computer Science Division, Argonne National Laboratory.
Supervisor: Mihai Anitescu.

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

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

Research Intern (2018)
Mathematics and Computer Science Division, Argonne National Laboratory.
Supervisor: Mihai Anitescu.

Research Intern (2016)
Energy Process Engineering Laboratory, Seoul National University.
Supervisor: Jong Min Lee.

Publications

Thesis

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

Journal Publications

[J12] **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.

[J11] 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.

[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

[C8] **S. Shin**, F. Pacaud, E. Contantinescu, and M. Anitescu. Constrained policy optimization for stochastic optimal control under nonstationary uncertainties. arXiv:2209.13050. Under Review.

[C7] 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.

[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.

Honors and Awards

IFAC NMPC Young Author Award (2021).

IFAC ADCHEM Young Author Award (2021).

AIChE CAST Directors' Student Presentation Award (2020).

Grainger Wisconsin Distinguished Graduate Fellowship (2020 – 2021).

Travel Awards (CDC 2020; Wisconsin Student Research Grants Competition 2019; MLSE 2019)

Kwanjeong Scholarship (2016 – 2020).

Korea Presidential Science Scholarship (2010 – 2016).

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

[P14] **S. Shin**. MadNLP.jl: A mad nonlinear programming solver. JuliaCon2021.

[P13] **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.

[P12] **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.

[P11] **S. Shin**, M. Anitescu, and V. M. Zavala. Overlapping schwarz decomposition for constrained quadratic programs. 58th IEEE Conference on Decision and control (Virtual), 2020.

[P10] **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.

[P9] **S. Shin** and V. M. Zavala. Diffusing-horizon model predictive control. AIChE Annual Meeting (Virtual), 2020.

[P8] **S. Shin**, M. Anitescu, and V. M. Zavala. Overlapping domain decomposition schemes for solving graph-structured optimization problems. AIChE Annual Meeting (Virtual), 2020.

[P7] **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.

[P6] **S. Shin**, V. M. Zavala, and M. Anitescu. Overlapping domain decomposition schemes for solving graph-structured optimization problems. AIChE Annual Meeting, Orlando, FL, 2019.

[P5] **S. Shin** and V. M. Zavala. Low-rank system identification from high-dimensional data. Computing in Engineering Forum, Madison, WI, 2019.

[P4] **S. Shin**, A. D. Smith, S. J. Qin, and V. M. Zavala. Optimization algorithms for dynamic latent variable problems. MLSE, Atlanta, GA, 2019.

[P3] **S. Shin** and V. M. Zavala. Stability-preserving economic optimization of microgrids. AIChE Annual Meeting, Pittsburgh, PA, 2018.

[P2] **S. Shin** and V. M. Zavala. Multi-grid (hierarchical) control of power networks. AIChE Annual Meeting, Minneapolis, MN, 2017.

[P1] **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 solver for nonlinear programming.
https://github.com/MadNLP/MadNLP.jl

[S2] **MadDiff.jl** (Main developer): an automatic differentiation and algebraic modeling tool.
https://github.com/sshin23/MadDiff.jl

[S3] **BlockNLPModels.jl** (Contributor): a data structure for block nonlinear programming models.
https://github.com/exanauts/BlockNLPModels.jl

[S4] **BlockNLPAlgorithms.jl** (Contributor): a decomposition solver for block BlockNLPModels.
https://github.com/exanauts/BlockNLPAlgorithms.jl

[S5] **Plasmo.jl** (Contributor): a graph-based algebraic modeling framework.
https://github.com/plasmo-dev/Plasmo.jl

[S6] **SBML2Julia** (Contributor): a tool to for estimating parameters of models in SBML format.
https://github.com/paulflang/SBML2Julia

Teaching Experience

Teaching Assistant, Statistics for Chemical Engineers, UW-Madison (Spring 2019)

Teaching Assistant, Process Dynamics and Control, UW-Madison (Fall 2018, Fall 2017)

Tutor, Process Control and Design, Seoul National University (Fall 2015)

Tutor, Process Fluid Mechanics, Seoul National University (Spring 2015)

Tutor, Basic Chemistry, Seoul National University (Spring 2015)

Mentoring Experience

Undergraduate: Sang-il Kwon (UW-Madison, Fall 2017)

Graduate Interns: Rishabh Gupta (University of Minnesota, Spring 2022); David Cole (UW-Madison, Summer 2022).

Professional Services

Academic Services

Co-Chair and Reviewer, AIChE Annual Meeting CAST Division (10B co-chair/reviewer; 10E reviewer; 2022); Judge for Reserach Presentation Sessions, Argonne Postdoctoral Research and Career Symposium (2022).

Peer Review

AIChE Journal; Automatica; Computers & Chemical Engineering; IEEE Control Systems Letters; IEEE Transactions on Control Systems Technology; IEEE Transactions on Automatic Control; IFAC Conference on Nonlinear Model Predictive Control; IFAC International Symposium on Advanced Control of Chemical Processes; Industrial & Engineering Chemistry Research; Journal of Optimization Theory and Applications; SIAM Journal on Optimization

Outreach

SCIENCountErs (volunteered to help build a pipeline of STEM students from underrepresented groups; Fall 2018).

Skills

Language: English and Korean

Programming: Julia; MATLAB; Python; C/C++; LaTeX; git; MPI; linux; shell scripting

References

Provided upon request.

Last updated: September 27, 2022