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Richard Y. Zhang

Research

Optimization and machine learning, and their applications in power and energy systems. In particular, designing numerical algorithms that are provably low-complexity, in time, memory, and data, by utilizing and exploiting domain expertise.

Affiliation

2019–Current **Assistant Professor**, *Univ. of Illinois at Urbana-Champaign*, Urbana, IL, USA.
Department of Electrical and Computer Engineering.
Coordinated Science Laboratory.

2017–2019 **Postdoctoral Scholar**, *University of California*, Berkeley, CA, USA.
Department of Industrial Engineering and Operations Research.
Mentor: Javad Lavaei.

2014 **Research Intern**, *ISO New England*, Holyoke, MA, USA.
Business Architecture & Technology.
Mentor: Eugene Litvinov.

Education

2012–2017 **Ph. D.**, *Massachusetts Institute of Technology*, Cambridge, MA, USA.
Department of Electrical Engineering and Computer Science.
Thesis: *Robust Stability Analysis for Large-Scale Power Systems*
Advisor: Jacob K. White. Committee: John G. Kassakian, Konstantin S. Turitsyn, Eugene Litvinov.

2010–2012 **S. M.**, *Massachusetts Institute of Technology*, Cambridge, MA, USA.
Department of Electrical Engineering and Computer Science.
Thesis: *A Generalized Approach to Planar Induction Heating Magnetics*
Advisor: John G. Kassakian. GPA: 5/5 (equiv. 4/4).

2006–2009 **B. E. (Hons)**, *University of Canterbury*, Christchurch, New Zealand.
Department of Electrical and Computer Engineering.
Thesis: *Design Trade-offs Between Two- and Three-Level Inverters for Low Voltage, Low Power Utility Applications*
Advisor: Richard M. Duke. GPA: 8.75/9 (equiv. 4.1875/4). *First class honours*.

Awards and Honors

2018 Co-PI, National Science Foundation Award ECCS-1808859: *Low-Complexity Algorithms for Sparse Conic Optimization with Applications to Energy Systems and Machine Learning*.

2017 Best Reviewer Award, *IEEE Transactions on Smart Grid* (Impact factor 7.364).

2015 IEEE APEC Outstanding Presentation Award (with Yiou He), poster track: *System Design Considerations for Power Electronics*.

2014 IEEE APEC Outstanding Presentation Award, oral track: *Magnetic Components, Design and Characterization*.

2012 MIT-Imperial College Global Fellow.

2010 William Georgetti Scholarship. One of New Zealand's most prestigious postgraduate scholarships; awarded by the Chief Justice of the Supreme Court of New Zealand, the Prime Minister of New Zealand, and the Governor General of New Zealand.

MIT EECS Great Educators Fellowship.

2009 John R. Templin Scholarship.

Univ. Canterbury Premium ECE Award.

Univ. Canterbury Electric Power Engineering Centre Undergraduate Scholarship.

Beca Engineering in Society Scholarships.

2008 Univ. Canterbury Senior Scholar, 25 awarded university-wide out of 13,718 undergraduates.

Univ. Canterbury Electric Power Engineering Centre Undergraduate Scholarship.

Beca Engineering in Society Scholarships.

IET Electrical Engineering Prize.

2007 Brian Morrison Memorial Scholarships in Engineering, awarded to one student "likely in their future lives to promote and foster racial tolerance, co-operation, and understanding".

2006 Bickerton–Widdowson Trust Memorial Scholarship.

Journal Articles

1 R. Y. ZHANG, S. SOJOUDI, AND J. LAVAEI, *Sharp Restricted Isometry Bounds for the Inexistence of Spurious Local Minima in Nonconvex Matrix Sensing*. **Journal of Machine Learning Research**, 20.114 (2019): pp. 1-34. [http://jmlr.org/papers/v20/19-020.html]

2 R. Y. Zhang, J. Lavaei, and R. Baldick, *Spurious Local Minima in Power System State Estimation*. **IEEE Transactions on Control of Network Systems**, 6.3 (2019): pp. 1086-1096. [10.1109/TCNS.2019.2920586]

3 Y. Ouyang, R. Y. Zhang, J. Lavaei, and P. Varaiya, *Large-Scale Traffic Signal Offset Optimization.* To appear, **IEEE Transactions on Control of Network Systems**, 2019. [arXiv:1911.08368]

4 R. Y. Zhang and J. K. White, *GMRES-Accelerated ADMM for Quadratic Objectives*. **SIAM Journal on Optimization**, 28.4 (2018): pp. 3025-3056. [10.1137/16M1059941]

5 R. Y. Zhang, C. Josz, and S. Sojoudi, *Conic optimization for control, energy systems, and machine learning: Applications and algorithms*. **Annual Reviews in Control**, 47 (2018): pp. 323-340. [10.1016/j.arcontrol.2018.11.002]

6 S. Fattahi, R. Y. Zhang, and S. Sojoudi, *Linear Time Algorithms for Sparse Inverse Covariance Estimation*. **IEEE Access**, 7 (2018): pp. 12658-12672. [10.1109/ACCESS.2018.2890583]

7 R. Y. Zhang and J. K. White, *Toeplitz-Plus-Hankel Matrix Recovery for Green's Function Computations on General Substrates*. **Proceedings of the IEEE**, 103.11 (2015): pp. 1970-1984. [10.1109/JPROC.2015.2461005]

8 R. Y. Zhang, J. K. White, and J. G. Kassakian, *Fast simulation of complicated 3D structures above lossy magnetic media*. **IEEE Transactions on Magnetics**, 50.10 (2014): 7027416. [10.1109/TMAG.2014.2323933]

Conference Articles (Computer Science)

1 R. Y. Zhang, C. Josz, S. Sojoudi, and J. Lavaei, *How Much Restricted Isometry is Needed In Nonconvex Matrix Recovery?* **NeurIPS 2018**, Dec 3-8, 2018. Montreal, QC. Selected for Spotlight (one of 168/4856 submissions). [arXiv:1805.10251]

2 C. Josz, Y. Ouyang, R. Y. Zhang, J. Lavaei, and S. Sojoudi, *A Theory on the Absence of Spurious Solutions for Nonconvex and Nonsmooth Optimization*. **NeurIPS 2018**, Dec 3-8, 2018. Montreal, QC. [arXiv:1805.08204]

3 R. Y. Zhang, S. Fattahi, and S. Sojoudi, *Large-Scale Sparse Inverse Covariance Estimation via Thresholding and Max-Det Matrix Completion.* **ICML 2018**, Jul 10-15, 2018. Stockholm, Sweden. [arXiv:1802.04911]

4 Y. Ouyang, R. Y. Zhang, J. Lavaei, and P. Varaiya, *Conic Approximation with Provable Guarantee for Traffic Signal Offset Optimization.* **CDC 2018**, Dec 17-19, 2018. Miami Beach, FL.

5 R. Y. Zhang and J. Lavaei, *Sparse Semidefinite Programs with Near-Linear Time Complexity.* **CDC 2018**, Dec 17-19, 2018. Miami Beach, FL.

6 R. Y. Zhang and J. Lavaei, *Efficient Algorithm for Large-and-Sparse LMI Feasibility Problems.* **CDC 2018**, Dec 17-19, 2018. Miami Beach, FL.

7 R. Y. Zhang and J. Lavaei, *Modified Interior-Point Method for Large-and-Sparse Low-Rank Semidefinite Programs*. **CDC 2017**, Dec 12-15, 2017. Melbourne, Australia.

NeurIPS = Advances in Neural Information Processing Systems. **ICML** = International Conference on Machine Learning. **CDC** = IEEE Conference on Decision and Control.

Articles In Review

1 R. Y. Zhang and J. Lavaei, *Sparse Semidefinite Programs with Guaranteed Near-Linear Time Complexity via Dualized Clique Tree Conversion*. Under revision at **Mathematical Programming Series A**, 2019. [arXiv:1710.03475]

2 S.-W. Park, R. Y. Zhang, J. Lavaei, and R. Baldick, *Uniqueness of Power Flow Solutions Using Monotonicity Between Phase Angles and Power Flow*, Under revision at **IEEE Transactions on Control of Network Systems**, 2019.

Conference Articles (Other)

1 S.-W. Park, R. Y. Zhang, J. Lavaei, and R. Baldick, *Monotonicity Between Phase Angles and Power Flow and Its Implications for the Uniqueness of Solutions*. **HICSS 52**, Jan 8-11, 2019. Grand Wailea, HI.

2 S. Fattahi, R. Y. Zhang, and S. Sojoudi, *Sparse Inverse Covariance Estimation for Chordal Structures.* **ECC 2018**, Jun 12-15, 2018. Limassol, Cyprus.

3 R. Y. Zhang, C. Josz, and S. Sojoudi, *Conic Optimization Theory: Convexification Techniques and Numerical Algorithms*. **ACC 2018**, Jun 27-29, 2018. Milwaukee, WI.

4 R. Y. Zhang, J. Lavaei, and R. Baldick, *Spurious Critical Points in Power System State Estimation*. **HICSS 51**, Jan 3-6, 2018. Waikoloa Village, HI.

5 R. Y. Zhang, J. Elizondo, J. L. Kirtley, and J. K. White, *Small-Signal Stability Verification Issues for Transmission Systems with Distributed Renewables*. **PESGM 2016**, July 17-21, 2016. Boston, MA, USA.

6 R. Y. Zhang, J. Elizondo, J. L. Kirtley, and J. K. White, *Certifying Microgrid Stability Under Large-Signal Intermittency*. **COMPEL 2016**, June 27-30, 2016. Trondheim, Norway.

7 J. Elizondo, R. Y. Zhang, P.-H. Huang, and J. K. White, J. L. Kirtley, *Inertial and Frequency Response from Microgrids with Induction Motors*. **COMPEL 2016**, June 27-30, 2016. Trondheim, Norway.

8 R. Y. Zhang, A.-T. Avestruz, J. K. White, and S.B. Leeb, *Design of Resonance Damping via Control Synthesis*. **PESGM 2015**, Jul 12-15, 2015. Vancouver, BC, Canada.

9 J. Elizondo, R. Y. Zhang, J. L. Kirtley, and J. K. White, *Robust Small Signal Stability for Microgrids under Uncertainty*. **PEDG 2015**, Jun 22-25, 2015. Aachen, Germany.

10 Y. He, R. Y. Zhang, and J. G. Kassakian, *An Energy-Based Method for the Assessment of Battery and Ultracapacitor in Pulse Load Applications*. **APEC 2015**, Mar 15-19, 2015. Charlotte, NC, USA. Outstanding presentation award (poster track).

11 C. R. Sullivan and R. Y. Zhang, *Analytical Model for Effects of Twisting on Litz-wire Losses*. **COMPEL 2014**, Jun 22-25, 2014. Santander, Spain.

12 R. Y. Zhang, J. K. White, J. G. Kassakian, and C. R. Sullivan, *Characterization of Realistic Litz Wires using Fast Simulations*. **APEC 2014**, Mar 16-20, 2014. Ft. Worth, TX, USA. Outstanding presentation award (oral track).

13 C. R. Sullivan and R. Y. Zhang, *Simplified Design Method for Litz Wire*. **APEC 2014**, Mar 16-20, 2014. Ft. Worth, TX, USA.

14 B. Heffernan, R. Duke, R. Zhang, P. Gaynor, and M. Cusdin, *A go-cart as an electric vehicle for undergraduate teaching and assessment*. **AUPEC 2010**, Dec 5-8, 2010. Christchurch, New Zealand.

HICSS = Hawaii International Conference on System Sciences. **ACC** = American Control Conference. **ECC** = European Control Conference. **PESGM** = IEEE Power & Energy Society General Meeting. **PEDG** = International Symposium on Power Electronics for Distributed Generation Systems. **COMPEL** = Workshop on Control and Modeling for Power Electronics. **APEC** = Applied Power Electronics Conference & Exposition. **AUPEC** = Australasian Universities Power Engineering Conference.

Book Chapters

2011 *Integration of Variable Energy Resources*, with T.D. Heidel, A.M. Farid. In J. G. Kassakian and R. Schmalensee (eds.), *The Future of the Electric Grid – An Interdisciplinary MIT Study*. Cambridge, MA: MIT Energy Initiative.

Invited Talks (Select)

2018 **Cornell University**, *Restricted Isometry, Low-Rank Matrix Recovery, and Power System State Estimation*, at the Information, Systems and Networks (ISN) Seminar.

University of Michigan, *Restricted Isometry, Low-Rank Matrix Recovery, and Power System State Estimation*, at the Michigan Power & Energy Laboratory (MPEL) Seminar.

McGill University, *Restricted Isometry, Low-Rank Matrix Recovery, and Power System State Estimation*, at the Centre for Intelligent Machines (CIM) Seminar.

INFORMS, *Sparse Semidefinite Programs With Near-linear Time Complexity*, at the INFORMS Annual Meeting 2018.

INFORMS, *Linear-time Algorithm for Learning Large-scale Sparse Graphical Models*, at the INFORMS Annual Meeting 2018.

ISMP, *Sparse Conic Optimization: Low-rank Solutions and Near-linear Time Algorithms*, at the International Symposium on Mathematical Programming, Bordeaux, France, Jul 1-6, 2018.

ISMP, *Spurious Critical Points In Power Systems State Estimation*, at the International Symposium on Mathematical Programming, Bordeaux, France, Jul 1-6, 2018.

2017 **Federal Energy Regulatory Commission (FERC)**, *The Dangers of Local Search Algorithms for Power System State Estimation*, at the FERC conference "Increasing Market and Planning Efficiency through Improved Software", June 2017.

INFORMS, *Spurious Critical Points In Power Systems State Estimation*, at the INFORMS Annual Meeting 2017.

UC Berkeley, *Modified Interior-Point Method for Large-and-Sparse Low-rank Semidefinite Programs*, at the IEOR Power Seminar.

2016 **UC Berkeley**, *Robust Stability Analysis for Large-Scale Power Systems*, at the IEOR Power Seminar.

2014 **ISO New England**, *A Perspective on Adapting VLSI Techniques for Power System Simulations*, September 2014.

MIT Sea Grant College Program, *Optimizing Wireless Power Transfer using Computational Techniques*, June 2014.

Witricity Corporation, *Optimizing Wireless Power Transfer using Computational Techniques*, April 2014.

2012 **Dartmouth College**, *A Fast Induction Heating Solver*, July 2012.

Teaching

Fall 2019 **Univ. of Illinois**, ECE 330: *Power Circuits and Electromechanics*. Instructor.

Spring 2017 **UC Berkeley**, IEOR 258: *Control and Optimization for Power Systems*. Guest lecturer.

Summer 2014 **SkolTech**. MIT-Skoltech Application Period: *Computational Control and Fast Partial Differential Equations*. Head teaching assistant.

Spring 2013 **MIT**, 18.336J/6.335J: *Fast Methods for Partial Differential and Integral Equations*. Head teaching assistant.

Fall 2012 **MIT/EdX**, 6.002x: *Circuits and Electronics*. Head teaching assistant. (This was the second course ever offered on the EdX platform.)

2010 **Univ. of Canterbury**, ENEL 436: *Power Electronics 2*. Instructor. (Lectures, lab sessions, course development.)

2008 **Univ. of Canterbury**, ENCI 303: *Elements of Simulation and Inference for Engineering Decision Making*. Recitation lead. (Twice-weekly recitations.)

Professional Service

2019 Associate Editor, IEEE Control Systems Society Conference Editorial Board.

2018 Session Chair, "Sparse Semidefinite Programs with Machine Learning Applications", INFORMS Annual Meeting 2018.

Session Chair, "Algorithms for Power Systems", INFORMS Annual Meeting 2018.

2017 Session Chair, "Control and Optimization Techniques for Power Systems I", INFORMS Annual Meeting 2017.

Reviewing

Journals SIAM Journal on Optimization, Mathematical Programming Series A, IEEE Transactions on Automatic Control, IEEE Transactions on Control of Network Systems, IEEE Transactions on Power Systems, IEEE Transactions on Smart Grid, IEEE Transactions on Power Electronics, IET Generation, Transmission & Distribution.

Conferences IEEE Conference on Decision and Control (CDC), American Control Conference (ACC), Hawaii International Conference on System Sciences (HICSS).

Departmental Service

2014–2016 Student subcommittee of MIT EE faculty search committee.

Community Service & Outreach

2019 **Faculty Mentor**, *Rising Stars in EECS 2019*. Held at the University of Illinois at Urbana–Champaign.

2012–2013 **Co-President**, *MIT Energy Club*. Commanded budget of $200k+, directed team of 20 club officers, including the executives for the flagship events MIT Energy Conference, MIT Energy Night, and MIT Clean Energy Prize. (Each officer is responsible for 2-20 student volunteers.)

2011–2012 **Content Co-Director**, *MIT Energy Conference 2012*. Commanded budget of $100k+, directed team of 100+ volunteers to put on a 2-day multi-track conference.

2011–2012 **Executive Committee**, *MIT Graduate Student Council*. Orientation co-chair. Commanded budget of $60k, directed team of 100+ volunteers to put on 70+ events.

2011–2012 **Legislative Actions Subcommittee**, *MIT Graduate Student Council*. Lobbied the US government on behalf of the MIT graduate student body.

2010–2011 **Workshop Lead**, *MIT Energy Conference*. Led team of 4 to organize panel "Grid 101", with invited demo from National Grid and invited speakers Clark Gellings (Vice President, Electric Power Research Institute) and Gordon van Wellie (CEO, ISO New England).

2006–2009 **Tutor**, *Univ. of Canterbury International Student Support*. Tutoring services for international students, primarily those from East Asia, but also South Asia and the Middle East.

2006–2009 **Tutor**, *Univ. of Canterbury Pacific Academic Student Support*. Intensive tutoring and academic support for Pasifika students, either of native New Zealand Maori descent, or from Tonga, Samoa, Fiji, the Cook Islands, or another Pacific island.

Personal

Citizenship New Zealand.

Languages English (native), Mandarin Chinese (native), French (limited).

References

Available upon request.