Kaizhao Sun

Email: ksun46@gatech.edu
GitHub: github.com/ksun46
Website: ksun46.github.io

Research Interests

My research focuses on the theory and application of optimization. I am currently working on:

- distributed and decomposition algorithms for large-scale continuous/discrete optimization,
- theory and algorithms based on nonconvex augmented Lagrangian duality,
- convexification and smoothing in optimization, and
- sampling algorithms.

I am also interested in efficient and practical solution methods for nonconvex nonsmooth problems arising from data science and engineering fields.

Education

- **Georgia Institute of Technology** — Atlanta, GA, USA
  Ph.D. in Operations Research with a minor in Mathematics — August 2017–May 2022 (Expected)
  - Advisor: Dr. Xu Andy Sun
  - Thesis Advisory Committee: Drs. Santanu S. Dey, Renato D.C. Monteiro, Wotao Yin, and Enlu Zhou
  - Relevant Courseworks: Linear/Convex/Nonlinear/Discrete Optimization, Machine Learning, Stochastic Process, Simulation, Numerical Analysis, Functional Analysis, Graph Theory

- **Georgia Institute of Technology** — Atlanta, GA, USA
  B.S. in Industrial and Systems Engineering (ISyE) — August 2013–May 2017
  - Capstone Project: Work Measurement Improvement for UPS Small Package Facility

  B.S. in Discrete Mathematics — August 2013–May 2017
  - Thesis: A MIP Formulation of the Unit Commitment Problem and Polytope Analysis

Publications

Alphabetical order is indicated by "$*$".

1. J. Liang*, **K. Sun***, E. Zhou, and X.A. Sun, "Log-difference-of-convex (Log-DC) sampling by the unadjusted Langevin Algorithm", *submitted to Neural Information Processing Systems 2021.*

2. A. Gholami*, **K. Sun***, S. Zhang*, and X.A. Sun, "Solving Large-Scale Security Constrained AC OPF Problems", *submitted to Operations Research, 2021.*

3. **K. Sun** and X.A. Sun, "Algorithms for difference-of-convex (DC) programs based on difference-of-Moreau-envelopes smoothing", *submitted to Mathematical Programming. arXiv preprint arXiv:2104.01470, 2021.*

4. **K. Sun**, M. Sun, and W. Yin, "Decomposition methods for global solutions of mixed-integer linear programs", *submitted to Mathematical Programming. arXiv preprint arXiv:2102.11980, 2021.*

5. **K. Sun** and X.A. Sun, "A two-level ADMM algorithm for AC OPF with global convergence guarantees", *Accepted at IEEE Transactions on Power Systems, 2021.*

6. **K. Sun** and X.A. Sun, "A two-level distributed algorithm for nonconvex constrianed optimization", *submitted to Computational Optimization and Applications. arXiv preprint arXiv:1902.07654, 2019.*

Experience

- **Alibaba US-Damo Academy** — Bellevue, WA, USA
  Research Intern at Decision Intelligence Lab — June 2020-August 2020
  - Studied generic two-block mixed-integer linear programs (MILP) with block angular structures.
  - Proposed an ALM-based decomposition framework and ADMM variant with convergence guarantees.
  - Demonstrated the exactness and efficiency of the proposed algorithms on various MILP problems.

- **Georgia Institute of Technology** — Atlanta, GA, USA
  Graduate Research Assistant — January 2019-Present
  - Mentors: Dr. Wotao Yin, Dr. Jian Tan, and Mou Sun.
  - Decomposition and distributed algorithms for large-scale nonconvex constrained programs.
  - First-order algorithm for difference-of-convex (DC) programs.
  - Research collaboration with ISO New England on decentralized OPF:
    * applied ADMM on SOCP-OPF to achieve decentralized computation and recovered feasible AC solution;
    * implemented the algorithm in Python and submitted a technical report.

  Graduate Teaching Assistant — August 2017-December 2018
  - ISyE 6669: Deterministic Optimization — Spring 2018 and Fall 2018
  - ISyE 6644: Simulation and Modeling for Engineering and Science — Spring 2018
  - ISyE 3103: Introduction to Supply Chain Modeling: Logistics — Fall 2017

Grid Optimization Competition

I have been participating in the the ARPA-E Grid Optimization Competition (GO Competition). Entrant teams from around the globe thrive to develop innovative algorithmic softwares for modern power grids in the form of coding competition. I am a member of the GMI-GO team led by faculty advisors Prof. X. Andy Sun (PI) and Prof. Santanu Dey.

- **ARPA-E Grid Optimization Competition Challenge 1**
  GMI-GO Team Member — November 2018-February 2020
  - Problem: Security-constrained AC Optimal Power Flow (SC-ACOPF) under time limit.
    (In optimization language, this is a large-scale + two-stage + mixed-integer nonlinear program.)
  - Our Approach: We deployed various optimization techniques in C++, including:
    * smoothing techniques for disjunctive constraints;
    * outer approximation of second-order cones;
    * a convergence-guaranteed distributed algorithm though MPI;
    * an effective contingency screening method;
    * extensive engineering tuning and experiments of Ipopt, Gurobi, and Mosek;
    * various safe-guarding mechanisms for robust solution output.
  - Result: Our team ranked the third place in the final event, winning $400,000 USD grant funding.

- **ARPA-E Grid Optimization Competition Challenge 2**
  GMI-GO Team Member — August 2020-August 2021
  - Extension of SC-ACOPF with additional complicated constraints:
    * topology optimization, unit commitment, discretized tap ratio/phase shift.

Scholarships and Awards

- SIAM Conference on Optimization (OP21) Student Travel Award — Summer 2021
- McLean Fellowship Stipend — Fall 2018 and Spring 2019
- ISyE Stipend — Fall 2017 and Spring 2018

Invited and Contributed Talks

- Algorithms for DC Programs Based on DME Smoothing
  - SIAM Conference on Optimization (OP21) 2021, Virtual
  - INFORMS Annual Meeting 2021, Anaheim, CA, USA
- Decomposition Methods for Global Solutions of Mixed-Integer Linear Programs
  - Integer Programming and Combinatorial Optimization (IPCO) Workshop 2021, Virtual (Poster)
  - Mixed Integer Programming (MIP) Workshop 2021, Virtual (Poster)
- A Two-level ADMM Algorithm for AC OPF with Global Convergence Guarantee
  - Power Systems Engineering Research Center (PSERC) Meeting
    - December 2017, Phoenix, AZ, USA (Poster)
    - May 2018, Wichita, KS, USA (Poster)
  - Georgia Tech Workshop on Electric Energy Systems and Optimization
    - November 2018, Atlanta, GA, USA (Poster)
    - November 2019, Atlanta, GA, USA (Poster)
  - INFORMS Annual Meeting 2020, Virtual
- Distributed Algorithms for Sparse Regression
  - INFORMS Annual Meeting 2019, Seattle, WA, USA
- A Two-level Distributed Algorithm for Nonconvex Constrained Optimization
  - INFORMS Annual Meeting 2018, Phoenix, AZ, USA
  - International Conference on Continuous Optimization (ICCOPT) 2019, Berlin, Germany

Service

- Co-chair of the session *Distributed and Decentralized Optimization* in ICCOPT 2019, Berlin, Germany
- Reviewer for MPC, JOTA, IEEE (TAC, TCNS, TII, TPWRS, TSG), ACC, CDC, IET, Quantum

Technical Skills

- Programming Languages: working knowledge of C++, Julia, Python, and Matlab.
- Optimization Solvers: experience with IPOPT, Gurobi, Mosek, Baron, Bonmin, Couenne, and Xpress.
- Typesetting: LaTeXand Markdown.