Kaizhao Sun

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EDUCATION

- **Georgia Institute of Technology**   Atlanta, GA, USA
  Ph.D. in Operations Research with a minor in Mathematics   August 2017–May 2022
    - Thesis: Decomposition Algorithms based on the Nonconvex Augmented Lagrangian Framework
    - Committee: Drs. Xu Andy Sun (advisor), 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

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.

PUBLICATIONS

[1]   A. Gholami, **K. Sun**, S. Zhang, and X. A. Sun, "Solving large-scale security constrained ac optimal power flow problems", *arXiv preprint arXiv:2202.06787*, 2022.

[2]   **K. Sun**, M. Sun, and W. Yin, "Decomposition methods for global solutions of mixed-integer linear programs", *arXiv preprint arXiv:2102.11980*, 2021.

[3]   **K. Sun** and X. A. Sun, "A two-level ADMM algorithm for AC OPF with global convergence guarantees", *IEEE Transactions on Power Systems*, vol. 36, no. 6, pp. 5271–5281, 2021.

[4]   **K. Sun** and X. A. Sun, "Algorithms for difference-of-convex (DC) programs based on difference-of-Moreau-envelopes smoothing", *arXiv preprint arXiv:2104.01470*, 2021.

[5]   **K. Sun** and X. A. Sun, "Dual descent ALM and ADMM", *arXiv preprint arXiv:2109.13214*, 2021.

[6]   **K. Sun** and X. A. Sun, "A two-level distributed algorithm for general constrained non-convex optimization with global convergence", *arXiv preprint arXiv:1902.07654*, 2019.

Experience

- **Georgia Institute of Technology** — Atlanta, GA, USA
  Graduate Research Assistant — January 2017-Present
  - Decomposition algorithms for large-scale nonconvex constrained programs.
  - Research collaboration with ISO New England on decentralized OPF.

  Graduate Teaching Assistant
  - 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

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

Grid Optimization Competition

I have been participating in the ARPA-E Grid Optimization Competition (GO Competition). Entrant teams from around the globe strive to develop innovative algorithmic software 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 through 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 in third place in the Final Event, receiving $400,000 research grants award.

- **ARPA-E Grid Optimization Competition Challenge 2**
  GMI-GO Team Member — August 2020-October 2021
  - Extension of SC-ACOPF with additional complicated constraints:
    * unit commitment, line switching, discretized tap ratio and phase shift.
  - Result: Our team was among the competition prize winners, receiving a total of $120,000 research grants award:
    * third place in off-line divisions of Challenge 2 Trial Event 3 ($60,000);
    * fifth place in real-time divisions of Challenge 2 Final Event ($60,000).

Awards and Honors

- Prize-winning team in ARPA-E Grid Optimization Challenge 2 — October 2021
- SIAM Conference on Optimization (OP21) Student Travel Award — Summer 2021
- Third-place team in ARPA-E Grid Optimization Challenge 1 — February 2020
- McLean Fellowship Stipend — Fall 2018 and Spring 2019
- ISyE Stipend — Fall 2017 and Spring 2018

Invited and Contributed Talks

- Dual Descent ALM and ADMM
    - ISyE Ph.D. Student Seminar, GA, USA, November 2021
- Algorithms for DC Programs Based on DME Smoothing
    - SIAM Conference on Optimization (OP21), Virtual, July 2021
    - INFORMS Annual Meeting, Anaheim, CA, USA, October 2021
    - INFORMS Optimization Society Conference, SC, USA, March 2022
- Decomposition Methods for Global Solutions of Mixed-Integer Linear Programs
    - Integer Programming and Combinatorial Optimization (IPCO) Workshop (poster), Virtual, May 2021
    - Mixed Integer Programming (MIP) Workshop (poster), Virtual, May 2021
- A Two-level ADMM Algorithm for AC OPF with Global Convergence Guarantees
    - Power Systems Engineering Research Center (PSERC) Meeting (poster)
        * Phoenix, AZ, USA, December 2017
        * Wichita, KS, USA, May 2018
    - Georgia Tech Workshop on Electric Energy Systems and Optimization (poster)
        * Atlanta, GA, USA, November 2018
        * Atlanta, GA, USA, November 2019
    - INFORMS Annual Meeting, Virtual, October 2020
- Distributed Algorithms for Sparse Regression
    - INFORMS Annual Meeting, Seattle, WA, USA, October 2029
- A Two-level Distributed Algorithm for Nonconvex Constrained Optimization
    - INFORMS Annual Meeting, Phoenix, AZ, USA, October 2018
    - International Conference on Continuous Optimization (ICCOPT), Berlin, Germany, August 2019

Service

- Session chair for *Forecasting/Accounting and Nonlinear Programming*, INFORMS Annual Meeting 21, Anaheim, CA
- Co-chair of the session *Distributed and Decentralized Optimization*, ICCOPT 2019, Berlin, Germany
- Reviewer for
    - Optimization: MPC, JOTA, IJOO, Quantum,
    - Power Systems: IEEE (TAC, TCNS, TII, TPWRS, TSG, L-CSS), IET, ACC, CDC
    - Machine Learning: AISTATS 21

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: LaTeX and Markdown.