

Guanyi Wang

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EDUCATION

Georgia Institute of Technology

Ph.D. in Algorithm, Combinatorics and Optimization (ACO), Advisor: Santanu S. Dey

Atlanta, GA

August 2016 - Present

Johns Hopkins University

Master in Applied Mathematics and Statistics (AMS), Advisor: Amitabh Basu

Baltimore, MD

Aug. 2014 - May 2016

University of Science and Technology Beijing

Bachelor in Mathematics and Applied Mathematics

Beijing

August 2010 - May 2014

RESEARCH INTERESTS

My research interest lies in **Operations Research (OR)**, mainly focusing on efficient **Mixed Integer Programming (MIP) approximation algorithms** for non-convex optimization in **data analysis** and **deep learning**.

PUBLICATIONS

- Solving Row-Sparse Principal Component Analysis via Convex Integer Programs, Santanu S. Dey, Marco Molinaro, Guanyi Wang, *Submitted to SIAM Journal on Optimization, Available online: <https://arxiv.org/pdf/2010.11152.pdf>.*
- Automatic Loop Nest Tiling, Ofer Dekel, Guanyi Wang, *Submitted to Machine Learning and Systems 2021.*
- A Half-Space Stochastic Projected Gradient Method for Group-Sparsity Regularization, Tianyi Chen, Guanyi Wang, Tianyu Ding, Bo Ji, Sheng Yi, Zhihui Zhu, *Submitted to ICLR 2021, Available online: <https://arxiv.org/pdf/2009.12078.pdf>.*
- Upper bounds for Model-Free Row-Sparse Principal Component Analysis, Santanu S. Dey, Guanyi Wang, *International Conference on Machine Learning (ICML) 2020, Available online: https://proceedings.icml.cc/static/paper_files/icml/2020/3046-Paper.pdf.*
- An Approximation Algorithm for Training One-Node ReLU Neural Network, Santanu S. Dey, Guanyi Wang, Yao Xie, *Submitted to IEEE Transactions on Signal Processing, Available online: <https://arxiv.org/abs/1810.03592>. First round: Minor Revision*
- A Convex Integer Programming Approach for Optimal Sparse PCA, Santanu S. Dey, Rahul Mazumder, Guanyi Wang, *Submitted to Operations Research, Available online: <https://arxiv.org/abs/1810.09062>. Third round: Major Revision*
- The Strength of Multi-row Aggregation Cuts for Sign-pattern Integer Programs, Santanu S. Dey, Andres Iroume, Guanyi Wang, *Operations Research Letters, 46 (6), 611-615, Available online: <https://arxiv.org/abs/1711.06963>.*
- Mixed-integer Linear Representability, Disjunctions, and Chvtal Functions — Modeling Implications, Amitabh Basu, Kipp Martin, Christopher Thomas Ryan, Guanyi Wang, *Mathematics of Operations Research, 44 (4), 1264-1285, Available online: <https://arxiv.org/abs/1711.07028>.*
- Mixed-integer Linear Representability, Disjunctions, and Variable Elimination, Amitabh Basu, Kipp Martin, Christopher Thomas Ryan, Guanyi Wang, *International Conference on Integer Programming and Combinatorial Optimization (IPCO), 75-85, 2017, Available online: <http://www.math.uwaterloo.ca/ipco2017/accepted.html>.*

RESEARCH EXPERIENCE

Convex Integer Programming for (row-)Sparse Principal Component Analysis (PCA) Aug 2016 - Present
Georgia Institute of Technology Atlanta, GA

- Derive convex integer programming relaxations of (row-)Sparse PCA with theoretical approximation guarantees.
- Provide a method to verify the quality of given primal solutions via solving the derived convex integer programming relaxations.
- Propose a novel local search algorithm for finding primal feasible solutions for (row-)Sparse PCA in the general setting.
- Demonstrate the efficiency and scalability of our methods empirically by comparing with cutting edge methods.

Optimizing with Group-Sparisty for Parameter Pruning Nov 2019 - Present
Georgia Institute of Technology Atlanta, GA

- Formulate the parameter pruning problem in model compression as an optimization problem with group-sparsity regularization.
- Propose a novel stochastic group-sparsity exploration algorithm for above optimization problem while maintain the convergence.
- Provide a theoretical convergence guarantee for proposed stochastic group-sparsity exploration algorithm.
- Illustrate the efficiency and high group-sparsity exploration of our method empirically without impeding the validation accuracy.

Automatic Loop Nest Tiling Summer Intern 2020
Microsoft Research Machine Learning and Optimization Group

- Propose a formal way of studying the iteration space tiling problem.
- Formulate the tile shape optimization problem as an integer log-log convex programming and design an efficient approximation algorithm for this problem, with a formal approximation-ratio analysis.
- Devise the thick boundary method for non-uniform tiling and theoretically analyze how far it is from the optimal non-uniform tiling.
- Demonstrate the merits of our approach empirically.

Approximation Algorithm for the Regression with ReLU Activation Function May 2018 - June 2019
Georgia Institute of Technology Atlanta, GA

- Provide an efficient approximation algorithm for ReLU regression with the perspective of active subset selection for arbitrary data scenarios.
- Derive a constant asymptotic approximation ratio for i.i.d. random data scenarios.
- Illustrate the merits of our method as a good initialization for general gradient-descent method.

PRESENTATION

- **INFORMS Annal meeting, 2020**
<https://www.abstractsonline.com/pp8/#!/9022/presentation/7302>
Upper bounds for Model-Free Row-Sparse Principal Component Analysis (Journal Version),
Nov 12, 2020, 12:30pm - 1:45pm, Presentation, 15 min.
- International Conference on Machine Learning (ICML) 2020,
<https://icml.cc/virtual/2020/poster/6283>
Upper bounds for Model-Free Row-Sparse Principal Component Analysis,
July 16, 2020, Presentation, 15 min.
- CRM/DIMACS Workshop on Mixed-Integer Nonlinear Programming,
<http://dimacs.rutgers.edu/events/details?eID=%20321>
Using ℓ_1 -relaxation and integer programming to solve sparse PCA,
Oct 7, 2019, Poster Session.
- The Mixed Integer Programming (MIP) workshop series,
<https://sites.google.com/view/mipworkshop2019>
An Approximation Algorithm for Training One-Node ReLU Neural Network,
July 15, 2019, Poster Session.
- INFORMS Annal meeting,
<http://e.ctt.bz/e.asp?e=D5C16A44-191A-4615-8FEC-AE25F6321537>
Computational Evaluation of New Dual Bounding Techniques for Sparse PCA,
November 6, 2018, 20min.

- The 23rd International Symposium on Mathematical Programming (ISMP 2018), <https://ismp2018.sciencesconf.org/>
Computational evaluation of new dual bounding techniques for sparse PCA, July 4th, 2018, 30min, invited, accepted by ISMP 2018.
- The Mixed Integer Programming (MIP) workshop series, <https://or.clemson.edu/mip-2018/>,
Computational evaluation of new dual bounding techniques for sparse PCA, June 18th, 2018, Poster Session, invited.
- Integer Programming and Combinatorial Optimization (IPCO 2017), <http://www.math.uwaterloo.ca/ipco2017/>,
Mixed-integer linear representability, disjunctions, and variable elimination, June 26th 2017, 30min, invited, accepted by IPCO 2017.

TEACHING EXPERIENCE

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| • ISyE 6661 Linear Optimization (Graduate level, GT) | 2020 Fall |
| • ISyE 3133 Engineering Optimization (Instructor, Undergraduate level, GT) | 2020 Spring |
| • ISyE 3133 Engineering Optimization (Undergraduate level, GT) | 2016 Fall |
| • 550.620 Probability Theory (Graduate level, JHU) | 2015 Fall |
| • 550.311 Probability and Statistics (Undergraduate level, JHU) | 2015 Spring |

PROFESSIONAL SKILLS

- Proficient in Python/Matlab.
- Proficient in commercial optimization solvers (Gurobi, Mosek, CVX).
- Proficient in Loo.py (a transformation-based generation of high-performance CPU/GPU code).

SERVICES

- External Reviewer for *Mathematical Programming (MAPR)*.
- External Reviewer for *INFORMS Journal on Computing*.
- External Reviewer for *Mathematical Programming Computation*.