Changyu Gao

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Education

University of Wisconsin–Madison Madison, WI
Ph.D. Candidate, Industrial Engineering, Optimization Track *Sep 2019 – June 2025 (Expected)*
M.S., Computer Science *Feb 2021 – June 2024*

University of Science and Technology of China Hefei, China
B.S., Mathematics and Applied Mathematics (Outstanding Graduate) *Aug 2015 – June 2019*

Research Experience

Advisor: **Prof. Stephen Wright** (All projects below are in collaboration with Prof. Wright)
Summary: design and analysis of optimization algorithms for machine learning applications.

Optimal Rates for Robust Stochastic Convex Optimization
Collaborator: **Andrew Lowy, Xingyu Zhou**

- Developed novel stochastic convex optimization algorithms with robustness guarantees.
- Achieved first *optimal-rate* results for robust stochastic convex optimization.
- Significantly improved sample complexity and relaxed strict requirements over existing algorithms, broadening their applicability.

Private Federated Learning
Collaborator: **Andrew Lowy, Xingyu Zhou**

- Designed *novel federated learning algorithm* with privacy guarantees for heterogeneous data.
- Achieved *optimal* population excess risk bounds, surpassing previous state-of-the-art methods.
- Significantly improved the communication and gradient complexity over SOTA algorithms.

Differentially Private Optimization

- Innovated differentially private algorithms for finding approximate second-order stationary points.
- Implemented adaptive line search and mini-batching strategies to enhance practical performance.
- Developed PyTorch implementation demonstrating empirical effectiveness through experiments.

Optimization Methods for Probabilistic Soft Logic
Collaborator: **Charles Dickens, Connor Pryor, Lise Getoor**

- Implemented and tested HOGWILD! and Frank-Wolfe methods for PSL framework using Java.
- Executed inference experiments on real-world datasets, validating the practicality of these methods.
- Proved theoretical guarantees for the proposed bilevel formulation of PSL.

Work Experience

Research Scientist Intern, Meta — Menlo Park, CA
Team: **Meta AI Research (FAIR) – Reality Labs** — *Sep 2022 – Jan 2023*

- **Adaptive Training for Transformer-based Models**:
  - Developed *adaptive training* algorithms and engineered gradient statistics analysis framework.
  - Achieved baseline performance with reduced computation, improving training efficiency for transformer-based models.
  - Contributed to Meta's FairScale library, resolving critical gradient accumulation issues.

Applied Scientist Intern, Amazon — Seattle, WA
Team: **Delivery Experience (DEX) – AI** — *May 2021 – Aug 2021*

- **Mining Inconsistency Issues using Semantic Search Model**:
  - Developed semantic search system for detecting customer experience inconsistencies using *natural language processing* techniques.
  - Enhanced search accuracy through *fine-tuning* using TensorFlow.
  - Identified and escalated critical inconsistency issues to the corresponding teams.

Programming Skills

Languages: Proficient: Python. Familiar: SQL, R, C, C++, Java

Frameworks: Pytorch, Tensorflow, JAX, Pandas, Numpy, Scipy

Hobbies and interests: music, guitar, hiking, learning foreign languages, reading (especially nonfiction), listening to podcasts, interests in new technology/gadgets and social issues.
Human Languages: English (fluent), Chinese (native), French (intermediate B2), Spanish (basic).

Publications

Changyu Gao, Andrew Lowy, Xingyu Zhou, Stephen J. Wright. Optimal Rates for Robust Stochastic Convex Optimization, to appear in the 6th annual Symposium on Foundations of Responsible Computing (**FORC 2025**).

Changyu Gao, Andrew Lowy, Xingyu Zhou, Stephen J. Wright. Private Heterogeneous Federated Learning Without a Trusted Server Revisited: Error-Optimal and Communication-Efficient Algorithms for Convex Losses, Proceedings of the 41st International Conference on Machine Learning (**ICML 2024**), Vienna, Austria. PMLR 235, 2024. [**Poster Award**, Midwest Machine Learning Symposium 2024]

Charles Andrew Dickens, **Changyu Gao**, Connor Pryor, Stephen J. Wright, Lise Getoor. Convex and Bilevel Optimization for Neuro-Symbolic Inference and Learning, Proceedings of the 41st International Conference on Machine Learning (**ICML 2024**), Vienna, Austria. PMLR 235, 2024.

Changyu Gao and Stephen J. Wright. Differentially Private Optimization for Smooth Nonconvex ERM, arXiv preprint arXiv:2302.04972 (2023). [Theory and Practice of Differential Privacy 2023 Poster]