

Yikai Wu

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Education

Yale University

Ph.D. student in Computer Science

New Haven, CT, USA

2021–present

Duke University

Bachelor of Science (Summa Cum Laude)

Double major in Computer Science and Mathematics, Minor in Physics

Overall GPA: 3.97/4.00

Member of honor society Phi Beta Kappa

Durham, NC, USA

2017–2021

Research Experience

Hessian in Neural Networks

Mentor: Prof. Rong Ge

Duke University

May 2020–present

- The Hessian of the loss function captures important properties of neural networks. We observed that the Hessian has several interesting structures which appear commonly in different neural networks. We explained these structures using Kronecker factorization. Our new understanding of the Hessian can be used with PAC-Bayes techniques to get better generalization bounds.
- Paper [1] is under review at the International Conference on Machine Learning (ICML) 2021.
- We are currently working on extending our findings to optimization and other related topics.

Differential Privacy for Multiple Analysts

Mentor: Prof. Ashwin Machanavajjhala

Duke University

Jan 2020–May 2021

- Differential privacy is the gold standard of privacy protection. Existing differentially private algorithms are designed for a single analyst and are problematic for multiple analysts. We formulated three criteria to decide whether an algorithm is good for multiple analysts. We demonstrated how existing algorithms fail to satisfy them. We also designed new differentially private algorithms which satisfy these criteria provably.
- Preliminary paper [2] was presented at the Theory and Practice of Differential Privacy Workshop (TPDP) 2020. Full paper is under minor revision for the International Conference on Very Large Data Bases (VLDB) 2021.

Differential Privacy for Summation Queries

Mentor: Prof. Ashwin Machanavajjhala

Duke University

May 2018–Nov 2019

- o Answering summation queries under differential privacy is a little understood, non-trivial problem. Traditional differentially private algorithms for these queries are data-independent and often result in large errors for some types of data. We proposed a data-dependent algorithm using truncation to effectively reduce the errors in the results, while providing the same level of privacy protection.
- o Paper [3] was presented at the Theory and Practice of Differential Privacy Workshop (TPDP) 2019.

Quantum Information and Algorithms

Mentor: Prof. Iman Marvian

Duke University

May 2019–May 2020

- o Quantum information applies modern physics knowledge to develop a new type of computers and communication devices. We investigated a type of quantum operators useful for ion-trap quantum computers. We also designed and analyzed algorithms to purify quantum states, which is useful for quantum communication and quantum error correction.
- o In addition, I studied several research papers on quantum algorithms, quantum learning theory, and quantum complexity theory.

Publications

- [1] Yikai Wu, Xingyu Zhu, Chenwei Wu, Annie Wang, and Rong Ge. Dissecting Hessian: Understanding common structure of Hessian in neural networks. *arXiv:2010.04261 [cs.LG]*, 2020. Under review at the Conference on Neural Information Processing Systems (NeurIPS) 2021.
- [2] David Pujol, Yikai Wu, Brandon Fain, and Ashwin Machanavajjhala. Budget sharing for multi-analyst differential privacy. *Proceedings of the VLDB Endowment (PVLDB)*, 14(10), 2021.
Accepted to the International Conference on Very Large Data Bases (VLDB) 2021; Presented at the Theory and Practice of Differential Privacy Workshop (TPDP) 2020.
- [3] Yikai Wu, David Pujol, Ios Kotsogiannis, and Ashwin Machanavajjhala. Answering summation queries for numerical attributes under differential privacy. *arXiv:1908.10268 [cs.DB]*, 2019. Presented at the Theory and Practice of Differential Privacy Workshop (TPDP) 2019.

Teaching Assistant

COMPSCI 590.07: Computational Microeconomics (Graduate)

Instructor: Prof. Vincent Conitzer

Duke University

Fall 2020

COMPSCI 230: Discrete Mathematics for Computer Science

Instructor: Prof. Kamesh Munagala

Duke University

Spring 2018

Honors and Awards

Computing Research Association (CRA)

Outstanding Undergraduate Researcher Honorable Mention

2020

Duke University Faculty Scholar

Nomination (Top 2 in Computer Science department)

*2020***Mathematical Contest in Modeling (MCM)**

Meritorious Winner

*2019***Duke University Mathematics Student Award**

The Karl Menger Award

*2018***The International Collegiate Programming Contest (ICPC)**

Mid-Atlantic Regional Ranked 4th

*2017, 2018***William Lowell Putnam Mathematical Competition**

Ranked 142.5 (Top 4 at Duke University)

2017

Computer skills

Python, PyTorch, C, C++, R, Mathematica