Yikai Wu

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Education

Yale University **New Haven, CT, USA**
Ph.D. student in Computer Science *2021–present*

Duke University **Durham, NC, USA**
Bachelor of Science (Summa Cum Laude) *2017–2021*
Double major in Computer Science and Mathematics, Minor in Physics
Overall GPA: 3.97/4.00
Member of honor society Phi Beta Kappa

Research Experience

Hessian in Neural Networks **Duke University**
Mentor: Prof. Rong Ge *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 Conference on Neural Information Processing Systems (NeurIPS) 2021.

Differential Privacy for Multiple Analysts **Duke University**
Mentor: Prof. Ashwin Machanavajjhala *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.
- Paper [2] is accepted to the International Conference on Very Large Data Bases (VLDB) 2021. The preliminary version was presented at the Theory and Practice of Differential Privacy Workshop (TPDP) 2020.

Differential Privacy for Summation Queries

Duke University

Mentor: Prof. Ashwin Machanavajjhala — *May 2018–Nov 2019*

- 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.
- Paper [3] was presented at the Theory and Practice of Differential Privacy Workshop (TPDP) 2019.

Quantum Information and Algorithms

Duke University

Mentor: Prof. Iman Marvian — *May 2019–May 2020*

- 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.
- 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): 1805–1817, 2021. doi: 10.14778/3467861.3467870. Accepted to the International Conference on Very Large Data Bases (VLDB) 2021.

[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)

Duke University

Instructor: Prof. Vincent Conitzer — *Fall 2020*

COMPSCI 230: Discrete Mathematics for Computer Science

Duke University

Instructor: Prof. Kamesh Munagala — *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 Univeristy) *2017*

Computer skills

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