# David Xing Wu

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## Education

**Massachusetts Institute of Technology** **May 2022**

*B.S. in Mathematics and Computer Science* GPA: 5.00/5.00

- *Computer Science Courses*: 6.437 (Inference and Information), 6.856 (Randomized Algorithms), 18.404 (Theory of Computation), 18.408 (Theory of Deep Learning), 18.434 (Spectral Graph Theory and Error Correcting Codes), 6.031 (Software Construction), 6.033 (Systems Engineering), 6.036 (Intro to Machine Learning), 6.S077 (Intro to Data Science), 6.806 (Advanced Natural Language Processing), 6.046 (Analysis of Algorithms)
- *Mathematics Courses*: 18.675 (Probability Theory), 18.102 (Functional Analysis), 18.112 (Complex Analysis), 18.725 (Algebraic Geometry I), 18.705 (Commutative Algebra), 18.783 (Elliptic Curves), 18.784 (Seminar in Number Theory)

## Research and Projects

**Batch Norm and SGD Shuffling in Neural Networks**, *OptML Group* **Sep 2021 – Present**

- Identifying unexpected train and test time phenomenon for deep linear neural networks using PyTorch.
- Proved global convergence for linear neural networks equipped with batch norm via gradient flow analysis.
- Constructed adversarial datasets where batch norm provably degrades optimal loss with high probability.
- Extending incremental gradient method techniques to prove convergence to suboptimal loss.

**High Probability Generalization for Weakly Stable Algorithms** **Apr 2021 – May 2021**

- Coauthored original research paper with Eshaan Nichani for a final project in 18.408.
- Proved new moment and generalization results that tighten the best known high probability generalization bounds for almost everywhere stable learning algorithms.
- Proposed and analyzed practical use cases for the generalization bound.

**Contrastive and Generative Representation Learning**, *Vision Group* **Jan 2021 – Apr 2021**

- Implemented and trained unsupervised contrastive encoders and bidirectional GANs in PyTorch. Compared representation quality via metrics such as alignment, unformity, and linear classification accuracy.
- Managed experiments on GPU clusters through logging and TensorBoard.

**Random Dot Product Graph Inference**, *Geometric Data Processing Group* **Feb 2020 – Jan 2021**

- Implemented maximum a posteriori (MAP) inference of random dot product graph embeddings via convex programming in CVXPY and manifold learning in Pymanopt.
- Proved explicit constraints on optimal solutions with duality theory and empirically demonstrated ability to cluster data and recover low rank solutions.
- Demonstrated scalability of inference procedure for real life networks with hundreds of nodes.
- Accepted for publication in SIOPT, available at https://arxiv.org/abs/2101.02180

**Trippy Video Generation**, *AIM Labs* **Sep 2020 – Dec 2020**

- Prototyped a web app using Flask and Tensorflow with a group of four other MIT undergraduate students that enables arbitrary neural style transfer for user uploaded images and videos.
- Experimented with different network architectures and pruning levels to balance quality of style transfer with inference speed. Currently investigating interpolation techniques to decrease inference workload.
- Planning on integrating our app into Azure to leverage GPU accelerated inference.

**Distributions of Prime Sequence Residues**, *with Robert Burklund* **Jun 2017 – Aug 2018**

- Investigated asymptotic frequencies of prime residue patterns using analytic number theory.
- Placed fifth at Regeneron STS and received a Davidson Fellowship, available on arXiv:1908.07095.

**Distributions of Zeros in Powers of Two**, *with Prof. Lawrence Washington* **Feb 2016 – Aug 2018**

- Proved elementary results about behaviors of digits in the base ten expansion of special sequences of powers of two and provided a heuristic that agrees with empirical trends, available on arXiv:1902.11198.

## Invited Talks

**Random Dot Product Graph Inference**, *at Washington State University* **Dec 2020**

## Awards

**Robert M. Fano UROP Award** **Jul 2021**

**Regeneron Science Talent Search** $5^{th}$ *place finalist* ($90,000 scholarship) **Mar 2018**

**Research Science Institute**, *Top 5 paper, Top 10 oral presentation* **Aug 2017**

## Employment

**Algorithm Developer Intern**, *Hudson River Trading* **Jun 2021 – Aug 2021**

- Developed low level high frequency signals in C++ and Python for trading cryptocurrency perpetuals.
- Implemented completely automated trading bot with two teammates in C++ for live trading.
- Modeled market impact of cryptocurrency liquidations with rigorous statistical techniques.
- Developed data structure to predict liquidation events based on open interest and price data.

**Quantitative Trading Intern**, *Akuna Capital* **Jun 2020 – Aug 2020**

- Identified and developed machine learning features in C++ for a futures trading algorithm.
- Improved insight generation for feature engineering by creating an interactive market book visualization and an order history dashboard in Python.
- Designed and implemented a Python package for order-specific feature generation from market book data, taking into account tradeoffs related to data storage formats and scalability.

**Quantitative Developer Intern**, *Akuna Capital* **Jun 2019 – Aug 2019**

- Created a user-friendly API in Python for researchers to calculate option theoretical values and greeks.
- Calculated trade quality metrics for PNL feedback and risk characteristics on Akuna trades.
- Profiled and optimized to remove bottlenecks by batching expensive API calls and using vectorization.

**Quantitative Research Intern**, *Virgil Capital* **Nov 2018 – Feb 2019**

- Modeled cryptocurrency mining breakevens for several crpytocurrencies including Bitcoin and Ethereum in Python based on fundamental parameters of mining ecosystem.
- Simulated different market scenarios to analyze their impact on large scale mining behavior.

## Activities

**MIT Poker Club Officer** **Sep 2018 – Present**

- Applied quantitative thinking to make game-theory optimal decisions in poker.
- Organized casino nights, workshops, study breaks, and tournaments for general members.

## Skills

Fluent in Python, Java, SageMath, numpy, pandas, git.

Capable in C++, PyTorch, Tensorflow, CVXPY, scikit-learn.

Some experience in C, MATLAB, Flask, HTML.