

# Annan Yu

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## EDUCATION

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### CORNELL UNIVERSITY

Ithaca, NY

*Ph.D. Applied Mathematics (Expected Graduation May 2026)*

- **Advisor:** Prof. Alex Townsend
- **GPA:** 4.18/4.00

### VANDERBILT UNIVERSITY

Nashville, TN

*B.S. Computer Science and Mathematics, 2021*

*Summa Cum Laude*

*Highest Honors in Mathematics, Honors in Computer Science*

- **GPA:** 4.00/4.00
- **Senior Thesis Title:** *Geometric Analysis of Quasilinear Wave Equations*

## RESEARCH INTERESTS

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Deep Learning, Sequence Modeling, Numerical Analysis, Reduced-order Modeling

## PROGRAMMING LANGUAGES

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Python (including PyTorch), MATLAB, C++, JavaScript, Java

## PUBLICATIONS AND PREPRINTS

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[1] Annan Yu, Dongwei Lyu, Soon Hoe Lim, Michael W. Mahoney, N. Benjamin Erichson, *Tuning frequency bias of state space models*, arXiv:2410.02035.

[2] Soon Hoe Lim, Yijin Wang, Annan Yu, Emma Hart, Michael W. Mahoney, Xiaoye S. Li, N. Benjamin Erichson, *Elucidating the design choice of probability paths in flow matching for forecasting*, arXiv:2410.03229.

[3] Annan Yu, Michael W. Mahoney, N. Benjamin Erichson, *HOPE for a robust parameterization of long-memory state space models*, arXiv:2405.13975.

[4] Anil Damle, Silke Glas, Alex Townsend, Annan Yu, *How to reveal the rank of a matrix?*, arXiv:2405.04330.

- [5] Annan Yu, Arnur Nigmatov, Dmitriy Morozov, Michael W. Mahoney, N. Benjamin Erichson, *Robustifying state-space models for long sequences via approximate diagonalization*, International Conference on Learning Representations (spotlight), 2024.
- [6] Annan Yu, Alex Townsend, *Leveraging the Hankel norm approximation and block-AAA algorithms in reduced order modeling*, Numerical Linear Algebra with Applications; e2555, 2024.
- [7] Annan Yu, Alex Townsend, *On the stability of unevenly spaced samples for interpolation and quadrature*, BIT Numerical Mathematics, vol 63(23), 2023.
- [8] Annan Yu, Yunan Yang, Alex Townsend, *Tuning frequency bias in neural network training with nonuniform data*, International Conference on Learning Representations (poster), 2023.
- [9] Annan Yu, Chloe Becquey, Diana Halikias, Matthew E. Mallory, Alex Townsend, *Arbitrary-depth universal approximation theorems for operator neural networks*, arXiv:2109.11354.
- [10] Nancy Mae Eagles, Angèle M. Foley, Alice Huang, Elene Karangozishvili, Annan Yu, *On  $H$ -chromatic symmetric functions*, The Electronic Journal of Combinatorics, vol 29(1), 2022.
- [11] Larry Schumaker, Annan Yu, *Approximation by polynomial splines on curved triangulations*, Computer Aided Geometric Design, vol 92, 2022.

## INVITED TALKS

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- Representations and evolution of linear time-invariant systems in state-space models*, 26th International Symposium on Mathematical Theory of Networks and Systems, University of Cambridge, UK, 2024.
- Rectifying unstable rational representations in sequence models*, SIAM Conference on Applied Linear Algebra, Sorbonne Université, Paris, France, 2024.
- Robustifying state-space models for long sequences via approximate diagonalization*, International Conference on Learning Representations, Vienna, Austria, 2024.
- How to avoid HiPPOs?*, SCAN Seminar, Cornell University, USA, 2024
- Robustifying state-space models via approximate diagonalization*, SciDAC AI monthly synchronization, Lawrence Berkeley National Laboratory, USA, 2024. (online)
- Linear time-invariant systems in machine learning (50-minute tutorial)*, SIAM New York-New Jersey-Pennsylvania (NNP) Section Annual Meeting, New Jersey Institute of Technology, USA, 2023.

*Leveraging the Hankel norm approximation and data-driven algorithms in reduced order modeling*, Numerical Analysis in the 21st Century, University of Oxford, UK, 2023.

*Leveraging the Hankel norm approximation and block-AAA algorithms in reduced order modeling*, SIAM Southeastern Atlantic (SEAS) Section Annual Meeting, Virginia Tech, USA, 2023.

*Tuning frequency bias in neural network training*, International Conference on Learning Representations, 2023. (online)

*Tuning frequency bias in neural network training*, Workshop on Numerics and Acoustics, Imperial College London, UK, 2022.

*H-chromatic symmetric functions*, 2020 FUSRPs Mini-Conference, Fields Institute for Research in Mathematical Sciences, Canada, 2020. (online)

## RESEARCH EXPERIENCE

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### LAWRENCE BERKELEY NATIONAL LABORATORY, Berkeley, CA, USA

*Summer Research Internship, May 2023 - August 2023, May 2024 - August 2024*

- Supervised by Professor Michael Mahoney, Dr. Dmitriy Morozov, and Dr. Benjamin Erichson.
- Analyzed different initialization schemes of state-space models and improved them.
- Published the paper *Robustifying state-space models for long sequences via approximate diagonalization*.

### THE FIELDS INSTITUTE FOR RESEARCH IN MATHEMATICAL SCIENCES, Toronto, ON, Canada

*Summer Research Internship, July 2020 - August 2020*

- Supervised by Professor Angèle Foley.
- Defined the new concept of H-chromatic symmetric function, conducted numerical experiments, and formulated and proved its properties.
- Published the paper *On H-chromatic symmetric functions*.

### MATH DEPARTMENT AT VANDERBILT UNIVERSITY, Nashville, TN, USA

*Summer Research Internship, May 2019 - Jul 2019, May 2020 - Present*

- Assistant to Professor Larry Schumaker.
- Implemented over 10000 lines of MATLAB code.
- Designed and analyzed algorithms in a forthcoming book on spline functions.
- Published the paper *Polynomial Splines on Curved Triangulations*.

## TEACHING EXPERIENCE

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### **MATH DEPARTMENT AT CORNELL UNIVERSITY, Ithaca, NY**

*Recitation Teaching Assistant, August 2022 - Present*

- Fall 2023: MATH 6110, Real Analysis (1 recitation section)
- Fall 2022: MATH 2310, Linear Algebra with Applications (2 recitation sections)

### **MATH DEPARTMENT AT VANDERBILT UNIVERSITY, Nashville, TN**

*Grader/Teaching Assistant, Jan 2018 - Dec 2020*

- Fall 2020: MATH 3620, Introduction to Numerical Mathematics
- Spring 2020: MATH 3100, Introduction to Analysis
- Spring 2020: MATH 3620, Introduction to Numerical Mathematics
- Fall 2019: MATH 3200, Introduction to Topology
- Spring 2018: MATH 2300, Multivariable Calculus

### **EECS DEPARTMENT AT VANDERBILT UNIVERSITY, Nashville, TN**

*Grader/Teaching Assistant, Aug 2018 - Dec 2019*

- Fall 2019: CS 3251, Intermediate Software Design
- Fall 2018: CS 1101, Programming and Problem Solving

## HONORS & AWARDS

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### **RICHARD J. LARSEN AWARD FOR ACHIEVEMENT IN UNDERGRADUATE MATHEMATICS**

- Conferred by the Department of Mathematics at Vanderbilt University in April 2021.
- The award, along with a check for \$500, is presented each spring to the senior math major judged by the faculty to have excelled in all aspects of undergraduate mathematics.

### **WILSON L. AND NELLIE PYLE MISER AWARD**

- Conferred by the School of Engineering at Vanderbilt University in April 2021.
- This award is given to the senior who has excelled in all aspects of mathematics during the student's undergraduate career.

## RELEVANT COURSEWORK

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### **MATHEMATICS**

*Spring 2023*

MATH 6230, Differential Games and Optimal Control

*Spring 2022*

MATH 6150, Partial Differential Equations

*Fall 2021*

MATH 5250, Numerical Analysis and Differential Equations

MATH 6710, Probability Theory I

*Spring 2021*

MATH 4201, Topology II

MATH 7130, Harmonic Analysis

*Fall 2020*

MATH 4200, Topology I

MATH 7100, Complex Analysis

*Spring 2020*

MATH 3110, Complex Variables

MATH 3230, Introduction to Differential Geometry

MATH 6101, Real Analysis II

*Fall 2019*

MATH 3300, Abstract Algebra

MATH 3890, Selected Topics: Computing with Splines

MATH 6100, Real Analysis I

*Spring 2019*

MATH 3100, Introduction to Analysis

MATH 3200, Introduction to Topology

MATH 4630, Nonlinear Optimization

MATH 4700, Combinatorics

*Fall 2018*

MATH 3620, Introduction to Numerical Math

MATH 3640, Probability

MATH 3700, Discrete Mathematics

MATH 4710, Graph Theory

*Spring 2018*

MATH 2600, Linear Algebra

*Fall 2017*

MATH 2300, Multivariable Calculus

MATH 2400, ODE with Linear Algebra

**COMPUTER SCIENCE**

*Fall 2023*

CS 6241, Numerical Methods for Data Science

*Fall 2022*

CS 6783, Machine Learning Theory

*Spring 2022*

CS 6210, Matrix Computations

*Fall 2021*

CS 6820, Analysis of Algorithms

*Spring 2021*

CS 1151, Computers and Ethics

CS 4269, Project in Artificial Intelligence

*Fall 2020*

CS 3281, Operating Systems I

CS 4260, Artificial Intelligence

*Spring 2020*

CS 3270, Programming Languages

CS 6310, Graduate-level Algorithms

*Fall 2019*

CS 3250, Algorithms

CS 4262, Foundations of Machine Learning

*Spring 2019*

CS 2231, Computer Organization

CS 3251, Intermediate Software Design

*Fall 2018*

EECE 2116, Digital Logic

*Summer 2018 (at Stanford University)*

CS 106B, Data Structures

CS 193C, Client-side Web Technologies

STAT 202, Data Mining

*Spring 2018*

CS 1101, Programming and Problem Solving

CS 2212, Discrete Structure