Clayton H. Sanford

claytonsanford.com ⋄ clayton@cs.columbia.edu ⋄ (831) 332-0431
LinkedIn: in/claytonsanford ⋄ Github: chsanford

EXECUTIVE SUMMARY

Machine learning researcher and theoretical computer scientist with NSF GRFP support and a publication record at top-tier ML venues (NeurIPS, COLT) on the fundamental representational and generalization properties of feed-forward neural networks, recurrent neural networks, and transformers.

Creative and adaptable interdisciplinary researcher with published empirical work on the intersections of machine learning/data science and climate modeling, dynamical systems, and molecular biology.

Skilled data scientist and engineer with successful internships at Microsoft Research and Allen Institute for AI (Outstanding Intern award) and full-time employment at LinkedIn.

Effective communicator and leader in technical research, teaching, academic service, and local government.

CORE COMPETENCIES

Machine Learning & Artificial Intelligence ⋄ Python and Java ⋄ Deep Learning in Pytorch
Mathematical Modeling ⋄ Data Analytics (Hadoop, Spark, SQL) ⋄ Dynamical Systems and Climate Modeling
Communication and Leadership ⋄ Technical and Academic Writing ⋄ Public Speaking

EDUCATION

Columbia University — September 2019 — May 2024 (expected)
Ph.D. in Computer Science — *New York, NY*

- Advisors: Daniel Hsu and Rocco Servedio.

Brown University — September 2014 — May 2018
Sc.B. with Honors in Applied Math - Computer Science, Magna Cum Laude — *Providence, RI*

WORK EXPERIENCE

Student Researcher — January 2024 - March 2024
Google Research — *New York, NY*

- Runs experiments and proves theorems about transformers' fundamental limitations and graph algorithm capabilities.

Applied Sciences Intern — May 2023 — August 2023
Microsoft Research — *New York, NY*

- Trained transformer models with up to 500 million parameters to learn combinatorial search tasks with behavioral cloning and chain-of-thought reasoning.
- Proved theoretical results about the advantages of transformers over graph neural networks (GNNs) for identifying isomorphisms between different combinatorial problems, to support empirical results. (Manuscript in progress.)

Research Intern (PhD) — May 2022 — August 2022
Allen Institute for AI — *Seattle, WA*

- Improved reliability and quality of annual temperature and humidity estimates of ML-corrected coarse-grid climate model with novelty detection.
- Presentations at NeurIPS 2022 climate ML workshop and American Meteorological Society.
- Contributions recognized with Outstanding Intern award.

Software Engineering Intern — April 2019 — August 2019
Lumi Labs — *Palo Alto, CA*

- Designed and built front-end (Objective C) and back-end (Java and Scala) features as at 15-person startup.
- Implemented clustering algorithms on geographic data in Java.

Associate Data Scientist — August 2018 — April 2019
LinkedIn — *San Francisco, CA*

- Analyzed usage patterns of LinkedIn Learning, conducted A/B tests, and tracked metrics with Hive and Spark.

PUBLICATIONS

Neural networks

- C. Sanford, D. Hsu, M. Telgarsky. "Transformers perform parallel computation in log-depth." *Preprint.*
- C. Sanford, D. Hsu, M. Telgarsky. "Representational strengths and limitations of transformers." *Neural Informational Processing Systems (NeurIPS) 2023.*
- N. Ardeshir*, D Hsu*, C. Sanford*. "Intrinsic dimensionality and generalization properties of the R-norm inductive bias." *Conference on Learning Theory (COLT) 2023.*
- A. Bietta*, J. Bruna*, C. Sanford*, M. Song*. "Learning single-index models with shallow neural networks." *NeurIPS 2022.*
- V. Chatziafratis*, I. Panageas*, C. Sanford*, S. Stavroulakis*. "On scrambling phenomena for randomly initialized recurrent networks." *NeurIPS 2022.*
- D. Hsu*, C. Sanford*, R. Servedio*, E.-V. Vlatakis-Gkaragkounis*. "Near-Optimal Statistical Query Lower Bounds for Agnostically Learning Intersections of Halfspaces with Gaussian Marginals." *COLT 2022.*
- C. Sanford, V. Chatziafratis. "Expressivity of Neural Networks via Chaotic Itineraries beyond Sharkovsky's Theorem." *AISTATS 2022.*
- N. Ardeshir*, C. Sanford*, D. Hsu. "Support vector machines and linear regression coincide with very high-dimensional features." *NeurIPS 2021.*
- D. Hsu*, C. Sanford*, R. Servedio*, E.-V. Vlatakis-Gkaragkounis*. "On the Approximation Power of Two-Layer Networks of Random ReLUs." *COLT 2021.*

Interdisciplinary ML and data science

- C. Sanford, A. Kwa, O. Watt-Meyer, S. Clark, N. Brenowitz, J. McGibbon, C. Bretherton. "Improving the predictions of ML-corrected climate models with novelty detection." *Appearing in Journal of Advances in Modeling Earth Systems.*
- T. Chin*, J. Ruth*, C. Sanford*, R. Santorella*, P. Carter, B. Sandstede. "Enabling equation-free modeling via diffusion maps." *Journal of Dynamics and Differential Equations,* 2022.
- K. Cygan*, C. Sanford*, W. Fairbrother. "Spliceman2 - A Computational Web Server That Predicts Sequence Variations in Pre-mRNA Splicing." *Bioinformatics* 33 (18), 2017.

AWARDS

NSF GRFP Fellow March 2021

Outstanding Intern Award, Allen Institute for AI December 2022
Awarded to four summer interns who went above and beyond as researchers and as colleagues (cash prize).

Paul Charles Michelman Memorial Award May 2023
Given to a PhD student in Computer Science who has performed exemplary service to the department, devoting time and effort beyond the call to further the department's goals (cash prize).

Department Service Award, Columbia Computer Science May 2020, 2022, 2023

Senior Prize, Brown Computer Science May 2018
Awarded to the top students in the Computer Science department by faculty selection (cash prize).

Outstanding Winner, Interdisciplinary Contest in Modeling April 2016
Top 5 teams out of over 3000 in 96-hour math modeling competition on water scarcity.

TEACHING AND SERVICE

Reviewer: ICLR (2024), ALT (2024), NeurIPS (2023), JMLR (2023), SODA (2022), STOC (2022).

Teaching Assistant, Brown and Columbia Universities September 2015 — present
Designed assignments, taught lab sections, held office hours, and hired undergraduates TAs, and managed course logistics as a TA for 8 different computer science and applied math classes.

PhD Representative, Columbia Computer Science September 2022 — present
Serves as liaison between computer science students, faculty, and administrators and attends faculty meetings.

Community Board Member, Manhattan Community Board 9 May 2023 — present
Appointed by the borough president to represent community needs of a district on the west side of Manhattan between 110th and 155th St. Serves on Economic Development and LGBTQ Committees.

President, qSTEM September 2022 — September 2023
Led a team of student organizers in planning events for LGBTQ+ students at the Columbia School of Engineering.