

# Clayton H. Sanford

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## EXECUTIVE SUMMARY

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**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 Google Research, 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

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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

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**Columbia University** September 2019 — May 2024  
*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

## EXPERIENCE

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**Research Scientist** August 2024 — present  
*Google Research* New York, NY

**Student Researcher** January 2024 — May 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.

**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

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### Neural networks

- C. Sanford, B. Fatemi, E. Hall, A. Tsitsulin, M. Kazemi, J. Halcrow, B. Perozzi, V. Mirrokni. “Understanding Transformer Reasoning Capabilities via Graph Algorithms.” *Preprint*.
- C. Sanford, D. Hsu, M. Telgarsky. “Transformers perform parallel computation in log-depth.” *ICML 2024*.
- C. Sanford, D. Hsu, M. Telgarsky. “Representational strengths and limitations of transformers.” *NeurIPS 2023*.
- N. Ardeshtir\*, D. Hsu\*, C. Sanford\*. “Intrinsic dimensionality and generalization properties of the R-norm inductive bias.” *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. Ardeshtir\*, 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

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<b>NSF GRFP Fellow</b>	March 2021
<b>Outstanding Intern Award, Allen Institute for AI</b> Awarded to four summer interns who went above and beyond as researchers and as colleagues (cash prize).	December 2022
<b>Paul Charles Michelman Memorial Award</b> 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).	May 2023
<b>Department Service Award, Columbia Computer Science</b>	May 2020, 2022, 2023
<b>Senior Prize, Brown Computer Science</b> Awarded to the top students in the Computer Science department by faculty selection (cash prize).	May 2018
<b>Outstanding Winner, Interdisciplinary Contest in Modeling</b> Top 5 teams out of over 3000 in 96-hour math modeling competition on water scarcity.	April 2016

## TEACHING AND SERVICE

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<b>Reviewer:</b> AAAI 2024, FOCS 2024, ICLR 2024, ALT 2024, NeurIPS 2023, JMLR 2023, SODA 2022, STOC 2022.	
<b>Teaching Assistant, Brown and Columbia Universities</b>	September 2015 — December 2023
<b>PhD Representative, Columbia Computer Science</b> Serves as liaison between computer science students, faculty, and administrators and attends faculty meetings.	September 2022 — May 2024
<b>Community Board Member, Manhattan Community Board 9</b> 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.	May 2023 — present
<b>President, qSTEM</b> Led a team of student organizers in planning events for LGBTQ+ students at the Columbia School of Engineering.	September 2022 — September 2023