

# VAISHNAVH NAGARAJAN

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## Professional Career

- **Senior Research Scientist**, Google May 2025 - Present
- **Research Scientist**, Google Oct 2021 - Apr 2025
- **Ph.D. in Computer Science** Aug 2015 - July 2021  
Carnegie Mellon University (CMU)  
**Advisor:** J. Zico Kolter  
**Thesis:** Explaining generalization in deep learning: progress and fundamental limits [\[arxiv\]](#)
- **Bachelors in Technology** 2011 - 2015  
Indian Institute of Technology (IIT) Madras GPA: 9.88/10.0 (Rank 2)  
**Advisor:** Balaraman Ravindran  
**Thesis:** KWIK Inverse Reinforcement Learning

## Preprints

- [1] **Deep sequence models memorize geometrically; it's unclear why** [\[arxiv\]](#)  
Shahriar Noroozizadeh, Vaishnavh Nagarajan, Elan Rosenfeld, Sanjiv Kumar  
*In NeurIPS 2025 Workshop on Foundations of Reasoning in Language Models Workshop (2025)*

## Conference Publications

- [2] **Roll the dice and look before you leap: Going beyond the creative limits of next-token prediction** [\[arxiv\]](#)  
Vaishnavh Nagarajan\*, Chen Henry Wu\*, Charles Ding, Aditi Raghunathan  
*International Conference on Machine Learning (ICML 2025)*  
**Oral** paper (1% acceptance) and winner of **Outstanding Paper Award** (6 out of 12k submissions)
  - Also in ICLR 2025 Workshop on Workshop on Spurious Correlation and Shortcut Learning: Foundations and Solutions
- [3] **The pitfalls of next-token prediction** [\[arxiv\]](#)  
Gregor Bachmann\* and Vaishnavh Nagarajan\*  
*International Conference on Machine Learning (ICML 2024)*
  - Also **oral** presentation in ICLR 2024 Workshop “How Far Are We From AGI?”

- [4] **Sharpness-Aware Minimization enhances feature quality via balanced learning** [\[openreview\]](#)  
 Jacob Mitchell Springer, Vaishnavh Nagarajan, Aditi Raghunathan  
*International Conference on Learning Representations 2024 (ICLR 2024)*
- [5] **The cost of scaling down large language models: Fact recall deteriorates before in-context learning** [\[arxiv\]](#)  
 Tian Jin, Nolan Clement, Xin Dong, Vaishnavh Nagarajan, Michael Carbin, Jonathan Ragan-Kelley, Gintare Karolina Dziugaite  
*International Conference on Learning Representations 2024 (ICLR 2024)*
- [6] **Think before you speak: Training language models with pause tokens** [\[arxiv\]](#)  
 Sachin Goyal, Ziwei Ji, Ankit Singh Rawat, Aditya Krishna Menon, Sanjiv Kumar, Vaishnavh Nagarajan.  
*International Conference on Learning Representations 2024 (ICLR 2024)*
- Also in NeurIPS 2023 Workshop on Robustness of Few-shot and Zero-shot Learning in Foundation Models
- [7] **On student-teacher deviations in distillation: does it pay to disobey?** [\[arxiv\]](#)  
 Vaishnavh Nagarajan, Aditya Krishna Menon, Srinadh Bhojanapalli, Hossein Mobahi, Sanjiv Kumar.  
*In Advances in Neural Information Processing Systems 36 (NeurIPS 2023)*
- [8] **ResMem: Learn what you can and memorize the rest** [\[arxiv\]](#)  
 Zitong Yang, Michal Lukasik, Vaishnavh Nagarajan, Zonglin Li, Ankit Singh Rawat, Manzil Zaheer, Aditya Krishna Menon, Sanjiv Kumar  
*In Advances in Neural Information Processing Systems 36 (NeurIPS 2023)*
- [9] **Assessing generalization of SGD via disagreement.** [\[arxiv\]](#)  
 Yiding Jiang\*, Vaishnavh Nagarajan\*, Christina Baek and J. Zico Kolter  
*International Conference on Learning Representations 2022 (ICLR 2022)*  
**Spotlight** paper (5.2% acceptance)
- Also in ICML 2021 Workshop on Over-parameterization: Pitfalls and Opportunities
- [10] **Understanding the failure modes of out-of-distribution generalization.** [\[arxiv\]](#)  
 Vaishnavh Nagarajan, Anders Andreassen and Behnam Neyshabur  
*International Conference on Learning Representations 2021 (ICLR 2021)*
- [11] **A learning theoretic perspective on local explainability.** [\[arxiv\]](#)  
 Jeffrey Li\*, Vaishnavh Nagarajan\*, Gregory Plumb and Ameet Talwalkar  
*International Conference on Learning Representations 2021 (ICLR 2021)*
- [12] **Provably safe PAC-MDP exploration using analogies.** [\[arxiv\]](#)  
 Melrose Roderick, Vaishnavh Nagarajan and J. Zico Kolter  
*In Proceedings of the 24th International Conference on Artificial Intelligence and Statistics (AISTATS 2021)*
- [13] **Uniform convergence may be unable to explain generalization in deep learning.** [\[arxiv\]](#)  
 Vaishnavh Nagarajan and J. Zico Kolter.  
*In Advances in Neural Information Processing Systems 32 (NeurIPS 2019)*

**Oral** paper (0.55% acceptance) and winner of **The Outstanding New Directions Paper Award**

- In *Workshop on Understanding and Improving Generalization in Deep Learning*. (**ICML 2019**; **spotlight** talk in workshop)
- In *IAS/Princeton Workshop on Theory of Deep Learning 2019* (**spotlight** talk)

[14] **Deterministic PAC-Bayesian generalization bounds for deep networks via generalizing noise-resilience.** [[arxiv](#)]

Vaishnavh Nagarajan and J. Zico Kolter.

*International Conference on Learning Representations 2019* (**ICLR 2019**)

[15] **Revisiting adversarial risk.** [[arxiv](#)]

Arun Sai Suggala, Adarsh Prasad, Vaishnavh Nagarajan and Pradeep Ravikumar

*In Proceedings of the 22nd International Conference on Artificial Intelligence and Statistics (AISTATS 2019)*

[16] **Geriatricx: Aging what you see and what you don't see. A file system aging approach for modern storage systems**

Saurabh Kadekodi, Vaishnavh Nagarajan, Greg Ganger and Garth Gibson

*Proceedings of the 2018 USENIX Conference on Usenix Annual Technical Conference (ATC 2018)*

[17] **Gradient descent GAN optimization is locally stable** [[arxiv](#)]

Vaishnavh Nagarajan and J. Zico Kolter.

*In Advances in Neural Information Processing Systems 30 (NeurIPS 2017)*

**Oral** paper (1.2% acceptance)

[18] **Lifelong learning in costly feature spaces.** [[arxiv](#)]

with Avrim Blum and Maria-Florina Balcan.

*In Proceedings of the 28th International Conference in Algorithmic Learning Theory (ALT 2017)*

[19] **Learning-theoretic foundations of algorithm configuration for combinatorial partitioning problems.** [[arxiv](#)]

with Maria-Florina Balcan, Ellen Vitercik and Colin White.

*In Proceedings of the 30th Annual Conference on Learning Theory (COLT 2017)*

[20] **Every team deserves a second chance: Identifying when things go wrong.** [[PDF](#)]

Vaishnavh Nagarajan\*, Leandro S. Marcolino\* and Milind Tambe.

*In Proceedings of the 14th International Conference on Autonomous Agents and Multi-agent Systems (AAMAS 2015)*

## Journal Publications

[21] **What do larger image classifiers memorise?** [[arxiv](#)]

Michal Lukasik, Vaishnavh Nagarajan, Ankit Singh Rawat, Aditya Krishna Menon, Sanjiv Kumar  
*Transactions on Machine Learning Research (TMLR 2024)*

*The following are journal versions of conference papers listed earlier.*

- [22] **Lifelong learning in costly feature spaces.**  
 with Avrim Blum and Maria-Florina Balcan.  
*In Theoretical Computer Science (invited) (TCS 2019)*
- [23] **Every team deserves a second chance: An extended study on predicting team performance.**  
 Leandro S. Marcolino, Aravind Lakshminarayanan, Vaishnavh Nagarajan and Milind Tambe.  
*In Journal of Autonomous Agents and Multi-Agent Systems (JAAMAS 2016)*

## Workshop/Short papers

- [24] **Avoiding Spurious Correlations: Bridging Theory and Practice** [openreview]  
 Thao Nguyen, Vaishnavh Nagarajan, Hanie Sedghi, Behnam Neyshabur  
*NeurIPS 2021 Workshop on Distribution Shifts: Connecting Methods and Applications (2021)*
- [25] **Theoretical insights into memorization in GANs.** [PDF]  
 Vaishnavh Nagarajan, Colin Raffel and Ian Goodfellow.  
*In Workshop on Integration of Deep Learning Theories (NeurIPS 2018)*
- [26] **Generalization in deep learning: the role of distance from initialization.** [arxiv]  
 Vaishnavh Nagarajan and J. Zico Kolter.  
*In Workshop on Deep Learning: Bridging Theory and Practice (NeurIPS 2017)*  
**spotlight** talk in workshop)
- [27] **A reinforcement learning approach to online learning of decision trees.** [arxiv]  
 Abhinav Garlapati, Aditi Raghunathan, Vaishnavh Nagarajan and Balaraman Ravindran.  
*In Proceedings of the 12th European Workshop on Reinforcement Learning, International Conference on Machine Learning (EWRL-ICML 2015)*
- [28] **KWIK inverse reinforcement learning.** [PDF]  
 Vaishnavh Nagarajan and Balaraman Ravindran.  
*The Multi-disciplinary Conference on Reinforcement Learning and Decision Making. (RLDM 2015)*

## Talks

- Deep sequence models tend to memorize geometrically – it's unclear why.
  - Simons Institute, Modern Paradigms in Generalization Reunion (invited) Jan 2026
- What can('t) next-token prediction do?
  - What can('t) Transformers do, NeurIPS 2025 workshop (invited keynote) Dec 2025
- Going beyond the creative limits of next-token prediction
  - ITA Workshop 2026 (invited plenary talk) Feb 2026
  - Amazon AGI Autonomy Reading Group (invited) Sep 2025

- National University of Singapore AI Institute Talk (**invited**) *Oct 2025*
  - ICML 2025 Oral *July 2025*
  - Mila - Quebec AI Institute Seminar (**invited**) *July 2025*
  - Learning workshop (**invited**) *April 2025*
- The pitfalls of next-token prediction
  - ML at Flatiron Institute (**invited**) *Sep 2025*
  - CMU 15-789 Guest Lecture (**invited**) *Fall 2024*
  - CMU AI Lunch (**invited**) *Fall 2024*
  - Simons Institute Workshop on Emerging Generalization Settings (**invited**) *Fall 2024*
  - Amazon Search Research Talk Series (**invited**) *Fall 2024*
  - Microsoft Research (**invited**) *Fall 2024*
  - Princeton Guest Lecture (**invited**) *Fall 2024*
  - NYU CILVR Seminar (**invited**) *Fall 2024*
  - ICLR 2024 Workshop “How Far Are We From AGI?” *May 2024*
- Assessing generalization via disagreement
  - ICLR 2021 spotlight talk *May 2021*
- Understanding the failure modes of out-of-distribution generalization.
  - IISA 2022 (**invited**) *Fall 2022*
  - CMU AI lunch *Mar 2021*
- Uniform convergence may be unable to explain generalization in deep learning.
  - CMU Lecture (**invited**) *Fall 2022*
  - Google Research (New York) Learning Theory (**invited**) *Oct 2020*
  - Center for Human Compatible AI, UC Berkeley (**invited**) *Aug 2020*
  - Google Brain (Mountain View) Deep Learning Phenomena (**invited**) *Jul 2020*
  - NeurIPS 2019 Oral presentation *Dec 2019*
  - CMU AI Lunch *Nov 2019*
  - IAS/Princeton University Workshop on Theory of Deep Learning: Where next? *Oct 2019*
  - ICML Workshop: Understanding and Improving Generalization in Deep Learning *Jun 2019*
- Generalization in deep learning: The role of distance from initialization
  - NeurIPS Workshop on Deep Learning: Bridging Theory and Practice *Dec 2017*
- Gradient Descent GAN optimization is locally stable.
  - NeurIPS 2017 Oral presentation *Dec 2017*
  - CMU AI lunch *Oct 2017*

- Lifelong learning in costly feature spaces.
  - ALT 2017 Oct 2017
- Learning the best algorithm for max-cut, clustering, and other partitioning problems.
  - Learning, Algorithm Design & Beyond Worst-Case Analysis, Simons Institute, Berkeley. Nov 2016  
**(invited)**
  - CMU Theory Lunch Nov 2016

## Professional Service

- Member of Thesis Committee (as External Examiner)
  - Gabriele Prato, Mila, University of Montreal, *On the Consolidation of Knowledge in Large Language Models*, Principal Advisor: Sarath Chandar Anbil Parthipan. Mar 2026.
  - Sachin Goyal, Machine Learning Department, Carnegie Mellon University, *Token-Efficient Scaling of Foundation Models: From Pretraining to Inference*, Principal Advisor: Zico Kolter. Nov 2025.
- Session Chair: ICML 2025
- Area Chair:
  - ICML 2025
  - COLM 2025
  - NeurIPS 2025
  - NeurIPS 2023 R0-FoMo Workshop
- Reviewer:
  - ALT 2021
  - ICLR 2023, 2021 (**outstanding reviewer award**, top 10%);
  - NeurIPS 2024 (top 7% reviewer), 2023 (top 10% reviewer), 2021, 2020 (top 10% reviewer), 2019 (top 50% reviewer), 2018 (top 30% reviewer)
  - ICML 2024 (Expert Reviewer), 2023 (Expert Reviewer), 2022, 2021 (Expert reviewer), 2020, 2019 (**top 5%** reviewer)
  - COLT 2019
  - AISTATS 2023 (top 10% reviewer), 2019
  - UAI 2022
  - JMLR
  - Nature
  - Workshops: ICML PODS 2022, ICML OPPO 2021, ICLR 2023 ME-FoMo, NeurIPS 2023 DistShift
- Mentor at Learning Theory Alliance Workshop (**invited**) Fall 2022 & 2023

- Fatima Fellowship Mentor. 2022
- Member of CMU Computer Science MS admissions committee. *Spring 2018*
- Representative of the Computer Science Department in the SCS4ALL PhD Committee, a student advisory council for the CMU School of Computer Science. *Fall 2017 - Fall 2018*
- Organized the Learning Theory Reading group in CMU. *Fall 2016*

## Mentorship

- Shahriar Noorizadeh (PhD student at CMU as of 2025, hosted as intern at Google)
- Chen Henry Wu (PhD student at CMU as of 2025)
- Vansh Bansal (PhD student at UT Austin as of 2025)
- Aditya Gudibanda (Software Engineer at Google as of 2025, mentee through Google-internal scientific mentorship program)
- Peng-Yu Chen (Software Engineer at Google as of 2025, mentee through Google-internal scientific mentorship program)
- Gregor Bachmann (PhD student at ETH Zürich as of 2024)
- Sachin Goyal (PhD student at CMU as of 2024, hosted as intern at Google)
- Zitong Yang (PhD student at Stanford as of 2025)
- Jacob Springer (PhD student at CMU as of 2024)
- Yuri Galindo (mentee through Fatima Fellowship)
- Marcus Blake (Software Engineer at Google as of 2024, mentee through Learning Theory Alliance)
- Kimia Hamidieh (PhD student at MIT as of 2024)
- Nuredin Ali (PhD student at the University of Minnesota as of 2024)
- Thao Nguyen (PhD student at UW as of 2024)
- Yiding Jiang (PhD student at CMU as of 2024)
- Melrose Roderick (postdoc at Mila as of 2024)
- Jeffrey Li (PhD student at UW as of 2024)

## Teaching

- Teaching assistant, 10-715: Advanced Introduction to Machine Learning *Fall 2016*
- Teaching assistant, 15-780: Graduate Artificial Intelligence *Spring 2018*

## Internships

- **PhD Research Internship** Summer 2020  
 Google X  
**Host:** Behnam Neyshabur  
 Theoretically explained when and why machine learning models fail to generalize under test-time distribution shifts.
- **PhD Research Internship** Summer 2019  
 Bosch Center for AI  
**Host:** David Reeb  
 Developed generalization bounds for high-dimensional linear models that circumvent limitations of uniform convergence bounds.
- **PhD Research Internship** Summer 2018  
 Google Brain  
**Host:** Colin Raffel, Ian Goodfellow  
 Explained why Generative Adversarial Networks (GANs) counterintuitively do not memorize their training data. Explored metrics for measuring diversity of GAN samples and developed a theoretically-grounded technique for improving sample diversity.
- **Undergraduate Research Internship** Summer 2014  
 University of Southern California (USC)  
**Advisor:** Milind Tambe  
 Identified that a machine learning model can predict the success/failure of an artificial multi-agent team playing Computer Go.
- **Undergraduate Internship** Summer 2013  
Report Bee  
**Advisor:** Madhavan Mukund, Chennai Mathematical Institute  
 Designed an index that quantifies learning experiences of schoolchildren. Implemented the model within Report Bee's web application.

## Scholastic Achievements

- Among **national top 1%** candidates in national level olympiads (2011) in **five different fields**, namely, Informatics, Maths, Physics, Chemistry and Astronomy.
- Directly qualified for the Indian National Math Olympiad (INMO) 2011 based on outstanding performance in the Regional Math Olympiad 2010 and INMO 2010.
- One of the 35 students that qualified further for the national selection camp for International Chemistry Olympiad.
- Secured **All India Rank 70** (out of 0.5 million candidates) and State Rank 3 in IIT Joint Entrance Examination 2011, **All India Rank 56** (out of 1.1 million candidates) in All India Engineering Entrance Examination 2011 and **All India Rank 16** (out of 0.1 million candidates) in Indian Institute of Space Science and Technology Admission Test 2011

## Honors and Awards

- Winner of **Outstanding Paper Award** at ICML 2025 (given to only 6 out of 12k submitted papers.)
- **Reviewer Award** at ICLR 2021 for being an outstanding reviewer.
- Winner of the **Outstanding New Directions Paper Award** at NeurIPS 2019 (given to only one out of ~ 6500+ submitted papers).
- Awarded the ACM-India/IARCS student grant to attend AAMAS 2015 in Istanbul, Turkey.
- One of ~ 30 Viterbi-India scholars selected by Viterbi School of Engineering (USC) and Indo-US Science and Technology Forum for a fully funded research internship in Summer 2014.
- Awarded the prestigious **KVPY** Fellowship 2009 by the **Government of India** to attract highly motivated students for pursuing a research career in science.
- Invited participant in the Council of Scientific and Industrial Research Programme on Youth for Leadership in Science 2009.

## Other Activities

- Board member of CMU Indian Graduate Student Association (IGSA). Dec 2015 - Dec 2018
- National Service Scheme Volunteer involved in Scientific Toys & Assistive Technology. 2011-12
- Taught basic maths to underprivileged primary school children in villages in India, in association with the NGO, *AID India*. Dec 2011
- Scribe for the students of **Vidya Sagar** (formerly, the Spastics Society of India). 2008-09