Sanae Lotfi

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Research Interests

○ Large language, vision, and multimodal models.
○ Robustness, reliability, and out-of-distribution generalization.
○ Probabilistic and Bayesian deep learning, information theory and model compression.
○ Theoretical and empirical understanding of generalization in foundation models.

Education

2020–current **Ph.D. in Data Science, New York University**, USA
○ Research focus: Understanding, quantifying, and improving generalization in deep learning.
○ Advisor: Andrew Gordon Wilson
○ Affiliations: CDS, CILVR

2018–2020 **M.Sc. in Applied Mathematics, Polytechnique Montreal**, Canada
GPA: 4.0/4.0
○ Research focus: Stochastic first-, and second-order optimization methods for machine learning.
○ Advisors: Andrea Lodi, Dominique Orban
○ Affiliations: MILA, CERC, GERAD

2015–2018 **M.Eng. in Applied Mathematics, Centrale Paris**, France
GPA: 3.97/4.33

Publications

2023 Non-Vacuous Generalization Bounds for Large Language Models [arxiv]
Sanae Lotfi*, Marc Finzi*, Yilun Kuang*, Tim G. J. Rudner, Micah Goldblum, Andrew Gordon Wilson
Mathematics of Modern Machine Learning (M3L) Workshop, NeurIPS 2023
Under conference review.

2023 Mitigating Augmentation Bias with Input-Dependent Distributions over Augmentations
Sanae Lotfi, Tim G. J. Rudner, Brandon Amos, Andrew Gordon Wilson
Under review, soon on arxiv.

2023 Bayesian Model Selection, the Marginal Likelihood, and Generalization (Extended Paper) [arxiv]
Sanae Lotfi, Pavel Izmailov, Gregory Benton, Micah Goldblum, Andrew Gordon Wilson
Journal of Machine Learning Research (JMLR), **Best Papers Track**

2022 PAC-Bayes Compression Bounds So Tight That They Can Explain Generalization [arxiv]
Sanae Lotfi*, Marc Finzi*, Sanyam Kapoor*, Andres Potapczynski*, Micah Goldblum,
Andrew Gordon Wilson
Neural Information Processing Systems (NeurIPS)

2022 Bayesian Model Selection, the Marginal Likelihood, and Generalization [pmlr]
Sanae Lotfi, Pavel Izmailov, Gregory Benton, Micah Goldblum, Andrew Gordon Wilson
International Conference on Machine Learning (ICML), **long oral presentation, top 2% submissions**
Outstanding Paper Award

2022 Evaluating Approximate Inference in Bayesian Deep Learning [pmlr]
Andrew Gordon Wilson, **Sanae Lotfi**, Sharad Vikram, Matthew D. Hoffman, Yarin Gal, Yingzhen Li,
Melanie F. Pradier, Andrew Foong, Sebastian Farquhar, Pavel Izmailov
NeurIPS Competition and Demonstration Track, Proceedings of Machine Learning Research (PMLR)

2022 Adaptive First- and Second-Order Algorithms for Large-Scale Machine Learning [arxiv]
Sanae Lotfi, Tiphaine Bonniot de Ruisselet, Dominique Orban, Andrea Lodi
Annual Conference on Machine Learning, Optimization, and Data Science (LOD), **oral presentation**

2022   Ocular Cataract Identification Using Deep Convolutional Neural Networks   [IEEE]
<u>Feliciana Manuel</u>, Saide Saide, Felermino Ali, **Sanae Lotfi**
International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems

2021   Dangers of Bayesian Model Averaging under Covariate Shift   [arxiv]
Pavel Izmailov, Patrick Nicholson, **Sanae Lotfi**, Andrew Gordon Wilson
Neural Information Processing Systems (NeurIPS)

2021   Loss Surface Simplexes for Mode Connecting Volumes and Fast Ensembling   [arxiv]
Gregory W. Benton, Wesley J. Maddox, **Sanae Lotfi**, Andrew Gordon Wilson
International Conference on Machine Learning (ICML), **spotlight presentation**

2021   Stochastic Damped L-BFGS with Controlled Norm of the Hessian Approximation   [arxiv]
Sanae Lotfi, Tiphaine Bonniot de Ruisselet, Dominique Orban, Andrea Lodi
SIAM Conference on Optimization, **oral presentation**

Workshop Papers:

2019   Home Health Care Resource Allocation Problem: A Reinforcement Learning Approach
Sanae Lotfi, Abderrahim Khalifa, Amine Bellahsen, Ola Bdawy, Loubna Benabbou, Ismail El Hallaoui
NeurIPS ML for the Developing World Workshop

2019   Planning in Home Health Care Structures using Reinforcement Learning
Sanae Lotfi, Abderrahim Khalifa, Amine Bellahsen, and Loubna Benabbou
ICLR AI for Social Good Workshop, problem introduction track, **oral presentation**

Thesis:

2020   Stochastic First and Second Order Optimization Methods for Machine Learning
Sanae Lotfi
Master's thesis, Polytechnique Montreal
Best Master's Thesis Award, Department of Mathematics and Industrial Engineering

I served as a research mentor to Feliciana Manuel, whose name is <u>underlined</u>, through the Deep Learning Indaba program. * denotes equal contribution.

Work Experience

Oct. 2022 – Oct. 2023
Visiting Researcher, Meta AI, Fundamental AI Research (FAIR), New York, USA
- Mentor: Brandon Amos.
- Research on robustness to model misspecification, learning approximate invariances, improving generalization through input-dependent data augmentations, and non-vacuous generalization bounds for large language models.
- 3 publications in preparation/under review.

May – Oct. 2022
Applied Scientist Intern, Amazon AWS, Santa Clara, USA
- Mentors: Yuyang (Bernie) Wang and Richard Kurle.
- Research on time series modeling under distribution shift.

Feb. – Aug. 2018
Research Intern, Air Liquide, Paris, France
- Designing algorithms to predict the gas consumption and optimize the production planning.

July – Dec. 2017
Research Intern, BeeBryte, Singapore
- Developing and optimizing strategies for trading and hedging in the electricity markets.

June – July 2016
Research Assistant, USTEM (Electron Microscopy Laboratory), Vienna, Austria
- Conducting mathematical and numerical simulations of the atomic diffusion in dissimilar materials.

Awards and Honors

2023   **Rising Stars Award in Machine Learning**
Distinguished as a Rising Star in ML by the University of Maryland Center for Machine Learning.

2023-2025   **Microsoft Research PhD Fellowship**
One of 10 PhD students in Canada and the United States to be awarded this fellowship.

2022   **ICML Outstanding Paper Award**
Awarded for "Bayesian Model Selection, the Marginal Likelihood, and Generalization".

2022 – 2023   **Meta AI Research Grant**
Covers full tuition and stipend as a part of the Meta AI Mentorship Program.

2022 – 2023   **Travel Awards**
ICML 2023 (ICML Participation Grant), NeurIPS 2022 (NeurIPS Scholar Award), ICML 2022 (Women in Machine Learning Travel Award).

2021   **DeepMind Fellowship**
One of three DeepMind Fellows to join NYU in 2020–2021.

2020 – 2025   **Data Science Graduate Fellowship**
5-year graduate fellowship awarded by the NYU Center for Data Science. Also awarded the Data Science Supplementary Fellowship Grant for Fall 2020.

2020   **McKinsey First Generation Achievement Award**
Prize for outstanding individuals who are the first in their family to earn a higher-education degree.

2020   **Best Master's Thesis Award**
Awarded by the department of Mathematics and Industrial Engineering at Polytechnique Montréal.

2015 – 2018   **French Government Scholarship for Excellence**
3-year scholarship. Awarded for ranking 2nd in CentraleSupélec's entrance exam.

2013 – 2021   **Académie Hassan II Scholarship for Excellence**
8-year scholarship. Awarded for ranking 1st in nationwide open competition in mathematics.

2010 – 2013   **Various first prizes in regional mathematics and physics Olympiads in Morocco.**

Teaching

Fall 2023
Fall 2021   Section Leader, DS-GA 3001: Introduction to Data Science for PhD Students, New York University
- Prepared and delivered lab sessions, created assignments, graded assignments and class projects, and held office hours.

Spring 2022   Grader, DS-GA 1004: Big Data, New York University
- Graded quizzes, assignments and class projects.

Summer 2021   Teaching Assistant, Harnessing Quantum Matter Data Revolution Summer School.
- Prepared and delivered hands-on sessions on density estimation methods, probabilistic PCA, and probabilistic modeling tools.

Fall 2020   Teaching Assistant, IFT6135: Representation Learning, University of Montreal
- Created new quizzes and assignments, graded assignments and exams, and held office hours.

Fall 2020
Winter 2019
Fall 2019   Section Leader, MTH3302: Probability and Statistics for AI, Polytechnique Montréal
- Prepared and delivered lab sessions, created new lab assignments and class projects, graded assignments and exams, and held office hours.

Summer 2018   Mathematics Instructor, Renovo Association
- Developed practice exercises and conducted training sessions to prepare students for rigorous oral mathematics examinations at the Classes Préparatoires level, targeting the highly competitive undergraduate entrance exam in France.

2016 - 2018   Mathematics and Physics Instructor, Renovo Association
- Created and delivered mathematics and physics to students from disadvantaged backgrounds at the high school level.

Invited Talks

Are the Marginal Likelihood and PAC-Bayes Bounds the Right Proxies for Generalization?

Nov. 2023	Rising Stars in Machine Learning Workshop, UMD
Oct. 2023	Carnegie Mellon University (CMU), Artificial Intelligence Seminar Series
Mar. 2023	Massachusetts Institute of Technology (MIT), CSAIL Seminar
Mar. 2023	Harvard University, Data to Actionable Knowledge Lab
Feb. 2023	FAIR Labs, Meta AI NYC
Dec. 2022	North Africans in ML Workshop, Neural Information Processing Systems (NeurIPS), Invited Talk

Non-Vacuous Generalization Bounds for Large Language Models

Mar. 2024	Cohere For AI, Guest Talk (upcoming)

PAC-Bayes Compression Bounds So Tight That They Can Explain Generalization

June 2023	FAIR Labs, Meta AI NYC
Mar. 2023	New York University, CDS Graduate Student Seminar
Dec. 2022	Neural Information Processing Systems (NeurIPS)
Nov. 2022	Women in AI Ignite, Neural Information Processing Systems (NeurIPS), Invited Talk

Bayesian Model Selection, the Marginal Likelihood, and Generalization

May 2023	The Data Science and Machine Learning Research Group
Sep. 2022	ML Collective, Deep Learning: Classics and Trends
July 2022	Amazon, Forecast Science Talks
July 2022	International Conference on Machine Learning (ICML), **Long Oral**, [video]
June 2022	INRIA Social Data Group
Apr. 2022	Morocco AI, Webinar Series [video]
Apr. 2022	New York University, CDS Graduate Student Seminar

Mitigating Augmentation Bias with Input-Dependent Distributions over Augmentations

July 2023	Generative AI Lightning Talk, FAIR Labs, Meta AI

Robustness of Deep Learning Models to Distribution Shift

July 2022	Women in Machine Learning Workshop, International Conference on Machine Learning (ICML), **Session Leader**

Understanding and Quantifying Generalization in Deep Learning Models

Oct. 2021	New York University, Women in Data Science Panel
Sep. 2021	DeepMind Montreal

Dangers of Bayesian Model Averaging under Covariate Shift

Dec. 2021	Neural Information Processing Systems (NeurIPS), [video]
Nov. 2021	New York University, Women in Mathematics Research Talks

Adaptive First and Second Order Algorithms for Large-Scale Machine Learning

July 2021	SIAM Conference on Optimization
Dec. 2020	NeurIPS Optimization for ML Workshop, **Spotlight Presentation**, [video]
Nov. 2019	Montreal Machine Learning and Optimization Group

Planning in Home Health Care Structures using Reinforcement Learning

May 2019	ICLR AI for Social Good, **Spotlight Presentation**

Invited Panels

Mar. 2022	Affinity Group Supported Pathways to ML Research Panel and Social, International Conference on Artificial Intelligence and Statistics (AISTATS)
Oct. 2021	Data Science Career Panel, Women in Data Science (WiDS) at NYU

Professional and Community Activities

Reviewing

Conferences	Neural Information Processing Systems (NeurIPS), International Conference on Machine Learning (ICML), International Conference on Learning Representations (ICLR), Conference on Machine Learning, Optimization, and Data Science (LOD)
Journals	Journal of Machine Learning Research (JMLR)
Workshops	NeurIPS 2023 Attributing Model Behavior at Scale Workshop, NeurIPS 2022 Women in Machine Learning Workshop - Area Chair, NeurIPS 2021 Bayesian Deep Learning Workshop, NeurIPS 2019 Women in Machine Learning Workshop
Competitions	NeurIPS 2023 Competition Track

Organizing and Leadership

2023	Co-organizer of the NeurIPS Muslims in ML workshop
2022	Co-leader of the "Robustness of Deep Learning Models to Distribution Shift" session at the Women in Machine Learning Workshop, ICML
2021	Founding organizer of research talks, *Tea-Talks*, at the NYU Association of Women in Mathematics
2021	Co-organizer of the NeurIPS competition "Approximate Inference in Bayesian Deep Learning"
2016	Co-founder of the competitive programming association at Centrale Paris

Research Mentorship

2021 – 2022	Mentored Feliciana Manuel to conduct her undergraduate research on "Ocular Cataract Identification Using Deep Convolutional Neural Networks" at Lúrio University, Mozambique.

- Research paper accepted to the International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems. Published in IEEE Xplore.
- Current position: Information Technology Assistant at Save the Children International.

Outreach and Volunteering

2022	Mentor for the NeurIPS High School Outreach Program to broaden participation in machine learning by engaging with students early
2021-2022	Mentor for the Deep Learning Indaba Mentorship Programme to support and strengthen the African machine learning community
2020	Consultant for the university of Montreal to increase enrollment in mathematics by students from underrepresented groups
2016-2018	Mathematics and physics volunteer instructor for high school students from disadvantaged backgrounds

Mental Health Advocacy

2023	Co-organizer and coordinator of the workshop "Everything I wish I knew as I navigated my Ph.D." at NYU and CMU, where we discussed mental health challenges, academic culture in doctoral programs, and how to create mental health advocacy groups and activities in both universities.
2017	Mental health campaign leader: led a group of over 70 students to promote emotional well-being and prevent suicide among hundreds of students at Ecole Centrale Paris.

Summer Schools

2023   Oxford Machine Learning Summer School: Machine Learning Fundamentals, Cases, and Health Care Applications

2021   Deep Learning Theory Summer School at Princeton

2021   Harnessing Quantum Matter Data Revolution, Virtual Summer School

Technical Reports

2022   Understanding the Generalization of Deep Neural Networks through PAC-Bayes bounds   [report]
Joint with Andres Potapczynski, Anthony Chen, and Chris Ick

2021   Causal Representation Learning   [report]
Joint with Taro Makino and Lily Zhang

2019   Analysis of High Dimensional Distributions with Decoupled Norm and Direction   [report]
Joint with Jose Gallego, Ankit Vani, and Max Schwarzer

2019   Variance Reduction with Neighbours for Adaptive Optimization   [report]
Joint with Jose Gallego

Technical Skills

Proficient   Python (Scikit-learn, SciPy stack, PyTorch), Git, Latex

Experienced   TensorFlow, Julia, Matlab, R

Selected Media Coverage

2021   *Scholar Q&A: Sanae*, DeepMind

2020   *DeepMind Fellow Profile: Sanae Lotfi*, NYU Center for Data Science

2016   *Barcelonnette vise l'autonomie énergétique*, Magazine Barcelonnette

2013   تلاميذ ينجحون في المباراة العامة للعلوم والتقنيات, Maghress