Aditya Deshmukh

Contact Information

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Research Interests

Large Language Models (LLMs), Multi-objective Alignment, Prompt Engineering, Deep Learning, Robust Machine Learning, Reinforcement Learning, Statistical Inference, Data Compression, High-dimensional Statistics & Information Theory

Education

University of Illinois at Urbana-Champaign (UIUC) 2017 – 2023
Ph.D. in Electrical and Computer Engineering 3.97/4.0
- Advisor: Venugopal Veeravalli
- Thesis Committee: Venugopal Veeravalli, Maxim Raginsky, Pierre Moulin, Georgios Fellouris

Indian Institute of Technology Madras (IIT Madras) 2012 – 2017
B.Tech. & M.Tech. in Electrical Engineering 8.81/10.0
- Advisor: Srikrishna Bhashyam
- Presentation Committee: Srikrishna Bhashyam, Andrew Thangaraj, Pradeep Sarvepalli

Professional Experience

Coordinated Science Laboratory, UIUC
Postdoctoral Research Associate – Urbana, US June 2024 – Present
- Working with Lav Varshney on multi-objective alignment and prompt engineering in LLMs.

Amazon
Research Scientist Intern – Remote, US May - Aug 2021
- Identified relevant features using windowed statistics for the problem of online defect identification to improve erroneous responses of Alexa's NLP model.
- Built a pandas framework for creating training data by extracting aforementioned statistics from the vast Alexa utterances data, and analyzed machine learning models trained on collected features.

Tata Institute of Fundamental Research (TIFR)
Junior Research Fellow – Mumbai, India May – July 2015
- Conducted research under the mentorship of Rahul Vaze and developed an online algorithm to improve energy-efficient packet scheduling with provable guarantees.

Phasorz Technologies (MediBuddy)
Android Development Intern – Chennai, India March – July 2014
- Developed the XMPP and SQLite framework of DocsApp (now MediBuddy) - an android based messaging and consulting platform for patients and doctors.

Fellowships & Achievements

- Mavis Future Faculty Fellowship (conferred by UIUC) 2021
- Joan and Lalit Bahl Fellowship (conferred by UIUC) 2021,2022
- Dr. Ok Kyun Kim Fellowship (conferred by UIUC) 2019
- All India Rank 599 in IIT-JEE among half million applicants 2012
- Selected for KVPY Scholarship (SX Stream) by IISc 2011

Selected Research Projects

Multi-objective Alignment and Prompt Engineering in LLMs

- Designed efficient LLM alignment algorithms to optimize multiple objectives.
- Developed prompt optimization techniques for multi-objective optimization such that the user controls the trade-off between the competing objectives.
- Applications: *Learning from Human Feedback (LHF)*

Distributed and Adaptive Feature Compression

- Proposed an efficient adaptive scheme using deep neural networks for optimizing data compression in distributed sensor network without compromising performance of downstream task.
- Applications: Internet of Things (IoT) devices, edge computing.

Robust Estimation

- Designed a computationally efficient, outlier-fraction agnostic, optimal estimator for the problem of robust mean estimation.
- Applications: Robust federated learning, robust LDA, robust linear regression.

Hypothesis Testing in Multi-Armed Bandits

- Formulated a general framework of hypothesis testing which encompasses identification problems (e.g. top-k arms identification) in multi-armed bandits, and proposed an asymptotically optimal policy for quickest detection.
- Applications: Medical diagnostic systems, recommendation systems, clinical trials, sequential A/B testing.

Journal Publications & Preprints

- Multi-objective Prompt Optimization at the Information-Theoretic Limit
  A. Deshmukh and L. Varshney [under preparation]
  Accepted in AAAI 2024 Fall Symposium on Integrated Approaches to Computational Scientific Discovery (AAAI Fall Symposium 2024)

- Robust Mean Estimation in High Dimensions: An Outlier Fraction Agnostic and Efficient Algorithm
  A. Deshmukh, J. Liu, and V. Veeravalli [arXiv]
  IEEE Transactions on Information Theory (2023)

- Information Flow Optimization for Estimation in Linear Models Using a Sensor Network
  A. Deshmukh, J. Liu, V. Veeravalli, and G. Verma [IEEE Xplore]
  IEEE Signal Processing Letters (2023)

- Sequential controlled sensing for composite multihypothesis testing
  A. Deshmukh, S. Bhashyam, and V. Veeravalli [arXiv]
  Sequential Analysis (2021)

- Online Energy-Efficient Packet Scheduling for a Common Deadline With and Without Energy Harvesting
  A. Deshmukh and R. Vaze [arXiv]
  IEEE Journal on Selected Areas in Communications (2016)

Conference Proceedings

- Distributed and Rate-Adaptive Feature Compression using VQ-VAEs
  A. Deshmukh, V. Veeravalli, and G. Verma [arXiv]
  Accepted in 58th Asilomar Conference on Signals, Systems, and Computers (Asilomar 2024)

- Robust High-Dimensional Linear Discriminant Analysis under Training Data Contamination

Y. Shi, **A. Deshmukh**, Y. Mei, and V. Veeravalli [IEEE Xplore]
IEEE International Symposium on Information Theory (ISIT 2023)

- Robust Mean Estimation in High Dimensions: An Outlier Fraction Agnostic and Efficient Algorithm
  A. Deshmukh, J. Liu and V. Veeravalli [IEEE Xplore]
  IEEE Int. Symposium on Information Theory (ISIT 2022)
- High-dimensional robust mean estimation via outlier-sparsity minimization
  A. Deshmukh, J. Liu, and V. Veeravalli [IEEE Xplore]
  55th Asilomar Conference on Signals, Systems, and Computers (Asilomar 2021)
- Information Flow Maximization in Inference Networks
  A. Deshmukh, J. Liu, and V. Veeravalli [arXiv]
  IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP 2020)
- Controlled Sensing for Composite Multihypothesis Testing with Application to Anomaly Detection
  A. Deshmukh, S. Bhashyam, and V. Veeravalli [IEEE Xplore]
  52th Asilomar Conference on Signals, Systems, and Computers (Asilomar 2018)
- Online energy efficient packet scheduling with a common deadline
  A. Deshmukh and R. Vaze [IEEE Xplore]
  International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt 2016)

Teaching & Mentoring Experience

Teaching Assistant

6 semesters at UIUC and 2 semesters at IIT Madras.

- UIUC: Data Science and Engineering (ECE365), Introduction to Optimization (ECE490), Statistical Inference for Engineers and Data Scientists (ECE561), Computational Inference (ECE566)
- IIT Madras: Communication Systems (EE3005), Communication Networks (EE5150)

Undergraduate Mentor

- Naman Raina: 'Robust Estimation'
- Kevin Zhang: 'Distributed Feature Compression'

Professional Service

Reviewer

- Conferences: ISIT (2019, 2022, 2024)
- Journals: IEEE Transactions on Signal Processing (2020, 2021, 2 papers in 2024), IEEE Transactions on Information Theory (2020, 2022)

Programming Skills

Python (including PyTorch, scikit-learn, pandas, cvxpy), Java
Matlab (including SDPT3)