# Harshvardhan@ucsd.edu

Interests : Optimization, Statistical Learning, Distributed Learning

# EDUCATION

## UNIVERSITY OF CALIFORNIA, SAN DIEGO (UCSD)

PhD in Computer Science, Advisor : Dr. Arya Mazumdar Expected June 2026, Grade: 3.9/4.0

## SWISS FEDERAL INSTITUTE OF TECHNOLOGY, LAUSANNE (EPFL)

MS IN DATA SCIENCE Aug 2021, Grade: 5.5/6.0

## INDIAN INSTITUTE OF TECHNOLOGY, KANPUR

BTech in Electrical Engineering, Minor in Artificial Intelligence Jun 2019, Grade: 9.5/10.0

# PUBLICATIONS

- H. Vardhan, A. Ghosh, A. Mazumdar. "An Improved Federated Clustering Algorithm with Model-based Clustering." Transactions of Machine Learning Research (TMLR 2024).
- X. Yu, L. Cherkasova, H. Vardhan, Q. Zhao, E. Ekaireb, X. Zhang, A. Mazumdar, T. Rosing. "Async-HFL: Efficient and robust asynchronous federated learning in hierarchical IoT networks." Proceedings of the 8th ACM/IEEE Conference on Internet of Things Design and Implementation (IoTDI 2023).
- S.T. Thomdapu, H. Vardhan, K. Rajawat. "Stochastic Compositional Gradient Descent Under Compositional Constraints" IEEE Transactions on Signal Processing 2023.
- H.Vardhan, S. Stich. "Tackling benign nonconvexity with smoothing and stochastic gradients." NeuRIPS workshop on Optimization in Machine Learning (OPT 2021).
- V. Singh, H. Vardhan, N. K. Verma and Y. Cui, "Optimal Feature Selection using Fuzzy Combination of Feature Subset for Transcriptome Data," IEEE International Conference on Fuzzy Systems (FUZZ-IEEE 2018).

#### **UNDER SUBMISSION**

- H. Vardhan, A. Ghosh, A. Mazumdar. "Learning and Generalization with Mixture Data". ISIT 2024.
- H. Vardhan, X. Yu, T. Rosing, A. Mazumdar. "Client Selection in Federated Learning with Data Heterogeneity and Network Latencies." ICDCS 2024.

# WORK EXPERIENCE

# MACHINE LEARNING ENGINEER, NIMBLEEDGE INC.

July 2023 - Sep 2023 | PhD Internship

- Designed the in-house FL and personalization simulator, based on flower, to simulate on-device training.
- Tested existing personalization algorithms for deep NNs at the scale of million devices on limited compute.
- Proposed a new algorithm for federated training and personalization of Decision Trees and other nonparametric models.
- Supervised a team of 2 ML engineers to design and benchmark on-device training of ML models using onnxruntime.

# JUNIOR MACHINE LEARNING ENGINEER, VISIUM SA

Sep 2020 - Jan 2021 | Master's industrial Internship

- Extended dockerized training, evaluation and inference pipelines for BERTQA models to extract information from contracts.
- Implemented outlier detection, generalization to other inputs, and item specific scaling in CNN based forecasting pipeline.

# **CLUSTERED FEDERATING LEARNING**

Supervisor : Arya Mazumdar | Sep 2021 - June 2023

- Proposed an algorithm for federated clustering which can run without any initialization.
- Obtained theoretical guarantees in terms of sample size, data heterogeneity and number of machines.
- Using a novel distance metric to measure client heterogeneity, recovered correct clustering and obtained best test accuracies as compared to baselines on real and simulated datasets. Accepted in TMLR 2024.

# DELAY AND HETEROGENEITY IN FEDERATED LEARNING

Supervisor : Arya Mazumdar, Tajana Rosing | Jan 2022 - Jan 2024

- Proposed a theoretically optimal client selection scheme to balance both delay and data heterogeneity of clients.
- By analyzing quadratic models and to feature heterogeneity, extended our algorithm to accommodate deep NNs.
- Under a variety of real and simulated data heterogeneity and network delays, our proposed methods outperform existing baselines in terms of total time to target test performance. Atleast 2x speedup for real datasets. Submitted to ICDCS 2024.
- In previous work in IoTDI 2023, established theoretical convergence of two-tier asynchronous GD for FL.

## BENIGN NONCONVEXITY WITH STOCHASTIC GRADIENTS

Supervisor : Sebastian Stich | Feb 2021 - June 2021 | Master Thesis

- Utilized biased gradient analysis to show that smoothed GD converges linearly to the global minima for a class of benign non-convex problems with local minima.
- Using the equivalence between smoothing and SGD, showed that SGD also has same convergence in expectation.
- Performed numerical experiments to show that this phenomena holds for quadratic with sinusoidal non-convexity. Accepted to OPT 2021 workshop.

# CONSTRAINED STOCHASTIC COMPOSITIONAL DESCENT

Supervisor : Ketan Rajawat | August 2018 - Sep 2019 | Undergraduate Project

- Proposed an algorithm, based SCGD, for compositional objective functions (E[f(E[g(x)]])) with compositional constraints.
- Established bounds on the convergence rates as well as time-averaged constraint violation for the algorithm for constant and variable step sizes for convex objectives along with a special case of zero constraint violation under mild assumptions.
- Evaluated the algorithm's performance on synthetic and Adult datasets to solve fair classification problem using Risk Difference fairness constraint and a novel fair formulation of the SpAM problem. Accepted to IEEE Transactions on Signal Processing.

# MISC

# COURSEWORK

Learning Theory Adv Probability Detection and Estimation Theory Natural Language Processing Game Theory and Mechanism Design Applied Data Analysis Deep Learning Theory Optimization in ML Random Networks Algorithmic Robust Statistics Probabilistic Modeling and Inference Randomized Algorithms Deep Learning Sequential Methods in Info Theory Adv Algorithms Information Theory Convex Optimization Time Series Analysis Visual Recognition Trustworthy Machine Learning Stochastic Calculus

# SKILLS

Matlab • Python • C++ • Bash • Javascript • C • ROS • OpenCV • Arduino • Scikit • PyTorch • Git • Flask • Docker • Kubernetes

# ACHIEVEMENTS

- Received IIT Kanpur Academic Excellence Award, awarded to top 10% students in a batch, for 2015-16 and 2016-17.
- Among top 1% in the National Standard Examination in Chemistry.
- All India Rank 263 in JEE Advanced 2015 and All India Rank 1324 in JEE Mains 2015 among 1.5 mil students.

# REVIEWING

ISIT 2022,2024 • ICML 2024 • NeuRIPS 2022-2023 • ICLR 2023 • TMLR 2023