

Ajinkya K. Mulay

MACHINE LEARNING ENGINEER · PRIVACY RESEARCHER

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Research Interests

Privacy, Federated Learning & AutoML: My primary focus is learning, designing, and building privacy-preserving federated and automated learning systems. In my Ph.D. thesis, I study ways to minimize the expected risk of differentially private and federated algorithms for finite samples, and high dimensional models. Some of my past interests include Wireless Communications (3G and 4G), IoT, and Computational Social Sciences.

Education

Purdue University

PHD IN ELECTRICAL AND COMPUTER ENGINEERING

W. Lafayette, IN

Aug. 2018 - Dec. 2023

- Advised by Prof. Xiaojun Lin
- GPA: 3.6/4.0
- **Thesis:** Designing Optimal Locally Differentially Private and Federated Algorithms

Indian Institute of Technology, Hyderabad

B.TECH (WITH HONORS) IN ELECTRICAL ENGINEERING

Hyderabad, India

Aug. 2014 - May 2018

- Advised by Prof. Bheemarjuna Reddy
- GPA: 8.88/10
- **Thesis:** Inference aware game-theoretic framework for unlicensed LTE and Wi-Fi Bands

Skills

- Research Topics:** Differential Privacy, Federated Learning, Synthetic datasets, Document AI, Computational Social Sciences
- Machine Learning Programming:** PyTorch, Tensorflow, Keras, Scikit-Learn, PySyft, Pandas, Numpy, Matplotlib
- Programming:** Python, C++, R, Go, AWS

Honors & Awards

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|------|--|-----------------------|
| 2020 | Graduate Research Assistantship , SuperPower Group, Psychological Sciences, Purdue | <i>Indiana, USA</i> |
| 2017 | Two-Year Graduate Teaching Assistantship , Electrical and Computer Engineering Department, Purdue | <i>Indiana, U.S.A</i> |
| 2018 | Winner and World Finalist for Emergensor Startup , Microsoft Imagine Cup, Japan National Final | <i>Tokyo, Japan</i> |
| 2018 | Winner , Third Business Plan Competition, University of Tokyo | <i>Tokyo, Japan</i> |
| 2017 | India-Japan Engineering Program Research Scholarship , University of Tokyo | <i>Tokyo, Japan</i> |
| 2016 | Undergraduate Teaching Assistantship , IIT Hyderabad | <i>India</i> |
| 2016 | Special Recognition & 8th Rank for Young Team , IEEE Signal Processing Cup | <i>India</i> |
| 2014 | Academic Excellence Award , IIT Hyderabad | <i>India</i> |
| 2010 | Recipient of the prestigious National Talent Search Examination (N.T.S.E) , Govt. of India | <i>India</i> |

Publications

- Ajinkya Mulay, Sean Lane, Erin Hennes “Private Hypothesis Testing for Social Sciences”** *SuperPower Lab, Purdue*
THEORY AND PRACTICE OF DIFFERENTIAL PRIVACY, ICML 2022
- Ajinkya Mulay, Sean Lane, Erin Hennes “PowerGraph: Using neural networks and principal components to multivariate statistical power trade-offs”** *SuperPower Lab, Purdue*
AI FOR SCIENCE, ICML 2022
- Rakshit Naidu, Harshita Diddee, Ajinkya Mulay, Aleti Vardhan, Krithika Ramesh, Ahmed Zamzam, “Towards Quantifying the Carbon Emissions of Differentially Private Machine Learning”** *OpenMined*
SOCIALLY RESPONSIBLE MACHINE LEARNING, ICML 2021
- Ajinkya Mulay, Tushar Semwal, Ayush Agrawal, “FedPerf: A Practitioners’ Guide to Performance of Federated Learning Algorithms”** *OpenMined*
NEURIPS 2020 PRE-REGISTRATION EXPERIMENT WORKSHOP
- Ajinkya Mulay, Anand Basawade, Bheemarjuna Tamma, Anthony Franklin, “DFC: Dynamic UL-DL Frame Configuration for Improving Channel Access in eLAA”** *NeWS Lab, IIT Hyderabad*
IEEE NETWORKING LETTERS

Ajinkya Mulay, Hideya Ochiai, Hiroshi Esaki, “IoT WebSocket Connection Management Algorithm for Early Warning Earthquake Alert Applications”

ACM/IEEE UCC, AUSTIN, TX, USA

Esaki Lab, University of Tokyo

Konkimalla Chandra Prakash, et. al., “A Novel Electric Network Frequency Classification Algorithm and an Electrical Power Signal Measurement Circuit”

IEEE SIGNAL PROCESSING CUP, 2016

LFOVIA Group, IIT Hyderabad

Pre-Prints

Ajinkya Mulay “LOCKS: User Differentially Private and Federated Optimal Client Sampling”

ARXIV, 2022

Purdue

Invited Talks

- 2022 **How to promote open science under privacy**, Psychological Sciences Department, Purdue University
- 2022 **PowerGraph: Using neural networks and principal components to multivariate statistical power trade-offs**, IMPS
- 2021 **Graphing multivariate statistical power manifolds with Machine Learning**, MCP Colloquium, Purdue University
- 2020 **FedPerf: A Practitioners' Guide to Performance of Federated Learning Algorithms**, NeurIPS Pre-Registration Workshop

Experience

Meta (Facebook)

PH.D. SOFTWARE ENGINEERING INTERN

Menlo Park, CA

May 2022 - Aug 2022

- Designed and deployed a modular and fully configurable **end-to-end production stack** for **Federated Semi-Supervised Learning (FSSL)** vision tasks to increase prototyping speed by 50%.
- Identified and benchmarked high computational overhead due to **certain PyTorch matrix** operators (75% of the total cost).
- Replicated performance benchmarks with popular SSL algorithms **FixMatch** and **SimCLR** on real devices.
- Enabled fast privacy research exploration to explore differential privacy, NoPeek, and NLP tasks with the deployed production environment.
- Technology Stack:** C++, Torchscript, Python, PyTorch.

Meta (Facebook)

PH.D. SOFTWARE ENGINEERING INTERN

Menlo Park, CA

May 2021 - Aug 2021

- Developed a fast, highly scalable private machine learning algorithm using **PCA with differential privacy** that outperforms the state-of-the-art models by **15%** (test accuracy).
- Improved performance to privacy trade-off by more than 35% by enabling varying tree restarts for the private algorithm **DP-FTRL**.
- Implemented novel visualizations to understand gradient flow and noise relationships while enabling better ML debugging.
- Technology Stack:** Python, PyTorch, Differential Privacy, Federated Learning.

SuperPower Group, Psychological Sciences, Purdue University

MACHINE LEARNING TEAM LEAD

West Lafayette, IN, USA

Aug. 2020 - Present

- Developed a novel AI engine that assists psychology researchers in **identifying the ideal sample size** for hypothesis testing (NIH-funded).
- The AI engine examines the effects of **parameter uncertainty on statistical power** and identifies regions of robustness/reactivity in specified parameter values over extremely high-dimensional parameter space.
- Computational cost slashed by 90% of the baseline while maintaining an error rate of less than 5%.
- Generating synthetic private tabular datasets with diffusion models** to promote empirical reproducibility in social sciences
- Developed theoretical results for increased sample size requirement due to the addition of differential privacy for hypothesis testing.
- Technology Stack:** PyTorch, R, Hypothesis Testing, Bayesian Learning, Git, Differential Privacy, Federated Learning, Computational Social Science.

OpenMined

RESEARCH SCIENTIST

Remote, USA

Mar. 2020 - Present

- Collaborating with researchers worldwide to quantify the impact of Differential Privacy and Federated Learning on real-world systems-[Link](#).
- Provided a detailed quantification of the impact of differential privacy on carbon emissions for benchmark NLP (Bert) and vision tasks.
- Suggested a new metric for benchmarking the performance of popular Federated Algorithms.
- Technology Stack:** PyTorch, PySyft, Git.

NeWS Lab at IIT Hyderabad

UNDERGRADUATE STUDENT RESEARCHER

Hyderabad, India

Aug. 2017 - Apr. 2018

- Designed and developed an algorithm to **reduce interference between eLAA-WiFi networks** by 40% using Game Theory techniques.
- Technology Stack:** MATLAB, Python.

Emergensor (Startup), University of Tokyo

CHIEF SERVER ENGINEER

Tokyo, Japan

Jul. 2017 - Dec. 2018

- Built and maintained the back-end for a mobile application used to notify people of local emergencies.
- Reduced the map's refresh time by **60%** to improve user experience.
- Technology Stack:** Azure, Java, Google Maps API, Android Studio, Go, Python.

Esaki Lab, University of Tokyo

Tokyo, Japan

RESEARCH INTERNSHIP

May 2017 - Jul. 2017

- Slashed the packet drop rate over a 3G IoT-Cloud network by **99%** by designing a dynamic ping-pong connection management algorithm.
- **Technology Stack:** Go, Arduino, C.

LFOVIA Lab, IIT Hyderabad

Hyderabad, India

UNDERGRADUATE STUDENT RESEARCHER

May 2015 - Jul. 2016

- Developed a novel Neural Network-based classification algorithm to predict the location of an audio recording using the Electrical Network Frequency (ENF) signature embedded in the audio file; achieved an accuracy of over **85%**.
- **Technology Stack:** MATLAB, Python.

Teaching and Mentoring

MENTORING STUDENTS FOR ANVIL

Jan 2022 - May 2022

Mentoring Undergraduate Students for the Anvil's Co-Founder AI Matching Platform Development

GRADUATE TEACHING ASSISTANT FOR ECE 27000

Aug 2019 - May 2020

Teaching assistant for *Introduction to Digital Design*

GRADUATE TEACHING ASSISTANT FOR ECE 20002

Aug 2018 - May 2019

Teaching assistant for *Electrical Engineering Fundamentals II*

Open Source

OPENMINED PADAWAN PROGRAM [LINK](#)

January 2023-Present

Preparing for contributing to the core team of OpenMined's privacy effort for the UN and Twitter.

DIFFUSERS BY HUGGINGFACE [GITHUB LINK](#)

Nov 2022 - Present

Contributions to the Hugging Face Diffusers library for audio and speech models

GRADIO BY HUGGINGFACE [GITHUB LINK](#)

Nov 2022 - Present

Designing the backend infrastructure for building quick ML/data prototypes.

PIPELINE DP BY GOOGLE AND OPENMINED | [GITHUB LINK](#) | [WEBSITE](#)

May 2022 - Present

Developing the next generation of open-source tools for enterprise use

Other Services

2022- **Meta-Reviewer**, Representation learning for Responsible Human-Centric AI workshop at AAAI-2023

2022- **Reviewer**, Conference on Health, Inference, and Learning (CHIL-2022, 2023), Privacy-Preserving AI (PPAI) workshop at AAAI-2023

2022 **Active Member**, Cohere for AI, OpenMined

2022- **Professional Grant Reviewer**, Grant Review Allocation Committee

2022 **Volunteer**, ICLR

Extra-Curricular

2020-21 **Active Blogger**, Topics- Machine Learning, Differential Privacy, MS/PhD Applications

2018-21 **Active Member**, HKN (Eta Kappa Nau), Purdue University

2020-21 **Active Member**, Startup Purdue, Co-Founded Happyyou, a mental health SaaS startup

2014-18 **Soccer Member, Varsity Team**, Inter & Intra-Collegiate Events, IIT Hyderabad

2015-17 **Head of Finance**, ELAN, IIT Hyderabad's Techno-Cultural Fest, managed budget in excess of \$40K

2015-17 **Events and Workshop Manager**, Entrepreneurship Cell, IIT Hyderabad