Avi Amalanshu

ML Researcher · Updated Dec 2024

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New Delhi, IN · Born 2001, Baltimore, MD, USA · US Citizen

About

I am a dual bachelors+masters student at ECE, IIT Kharagpur, one of the most competitive programs in the world. I want to build **AI systems** that are ***usable and democratic***.

Neurosymbolic AI: Neurosymbolic learning, neural program synthesis.

Distributed Learning: Fault tolerance, asynchronicity, privacy.

Skills

Programming: C/C++, Python (with PyTorch, including Geometric and Lightning), some Rust and OCaml

Systems: git, Slurm, angr, radare2, pwntools, CUDA, OpenMP

Misc: Technical writing and LaTeX, probability & statistics, linear algebra, academic writing, visual design. Broad research experience and coursework.

Experience

Research Assistant (May-Jul '24)

Carnegie Mellon University

– Funded by Boeing, hosted by AirLab

– Project: Amelia Intent Prediction

Research Fellow (May-Aug '23)

Purdue University

– Funded by the NSF (as a SURF REU), hosted by Prof. David Inouye

– Project: Internet Learning

Education

Bachelor and Master of Technology, **Indian Institute of Technology Kharagpur** (2020-2025)

– B.Tech *Electronics & Electrical Communication Engineering*. Minor in Computer Science

– M.Tech *Vision & Intelligent Systems*. Cumulative GPA (8 semesters): 8.85/10

Publications and Preprints

Two conference submissions on neurosymbolic learning are under preparation. When working papers are available, they will be linked on my website.

– **A. Amalanshu** et al "Decoupled Vertical Federated Learning for Practical Training on Vertically Partitioned Data" *Under review, **MLSys***. Also at **NeurIPS** SSL workshop. arxiv:2403.03871, **2024**.

– **A. Amalanshu** et al "Entity Augmentation for Efficient Classification of Vertically Partitioned Data" *Workshop on Generalizing from Limited Resources in the Open World* at ***IJCAI*** **2024**. (Archival. Derivative VLDB'25 under prep.)

– S. Ganguli, **A. Amalanshu** et al "Internet Learning: Preliminary Steps Towards Highly Fault-Tolerant Learning on Device Networks." *Workshop on Localized Learning* at ***ICML*** **2023**.

– A. Shukla, S. Roy, Y. Chawla, **A. Amalanshu**, et al "(RE) From Goals, Waypoints & Paths To Long Term Human Trajectory Forecasting" ***ReScience-C*** *Vol. 8 No. 2*, **2022**. (Invite to **NeurIPS** Reproducibility Track poster session)

Academic Activities

Teaching Assistant TA'ed Network Theory Lab for UG freshmen in Fall '24. Enrolled for TAship in Spring '25.

AGV.AI Selective undergraduate robotics group (yearly: $<$ 15 from 500+ hopefuls).

– Developed perception software for competition robots.

– Novel research in verifiable perception & planning, FL.

Awards and Honors

Fellowships Awarded the selective Guru Kripa Fellowship by IIT Kharagpur Foundation USA, NSF REU (Summer Undergraduate Research Fellowship) by Purdue Univ.

Research Programs Selected for the Globalink internship program by MITACS, Canada and the SRIP by IIT Gandhinagar. CMU RISS nominee by AirLab.

Recent Projects (more at https://avi-amalanshu.github.io)

Information-Theoretic Bridge between Neural and Symbolic AI (ongoing)

Master thesis. Guide: Prof. Saumik Bhattacharya, IIT Kharagpur

– Exploring **instability** and **computational hardness** for **semantic loss** (Xu et al. ICML 2018) and the associated weighted model counting.

– Developing a **conformal prediction**-based interpretable neural program search heuristic for **program synthesis**.

– Derived some **tractable upper bounds** for semantic loss via ELBO and a novel mixture architecture. Goal: **interpretable** & symbolically **verifiable** latent space model.

Amelia: Airport Movement Forecasting, Intent Prediction (May-Jul '24)

Guide: Prof. Sebastian Scherer, Carnegie Mellon University

– Rule-based anomaly detection for the broader Amelia project investigating DL-based airport surface operations. Developed a **LLM heuristic** to induce procedural bias in **inductive logic programming** to translate **English rules to first-order logic**. Few-shot on simple problems.

– Developed a **fast map-matching** algorithm; grounds transformer-predicted trajectory to a semantic graph. Uses **discrete time warping, Dijkstra**'s algorithm, **B-splines**.

Distributed Inference under Communication Constraints (Mar '24)

Guide: Prof. Jithin R, IIT Kharagpur

– Conducted a survey of some new information theoretic results for **binary detection**.
– Used those new results to derive elementary corollaries for sample complexity and higher order asymptotics for goodness of fit in rate-constrained **distributed inference**.

Entity Augmentation for Vertically Partitioned Datasets (Feb-Apr '24)
as Deep Learning Team Leader, Autonomous Ground Vehicle
– Proposed that allowing guests to pass arbitrary features and averaging one-hot labels can **eschew entity alignment** in **vertical federated learning**.
– Developed experiments showing it **outperforms** entity alignment on classification. Generalized experiments underway.

Decoupled Vertical Federated Learning (Sep-Nov '23, Feb-Mar '24)
Bachelor thesis. Guides: Prof. David Inouye, Purdue Univ.; Prof. Jithin R.
– Developed a **fault-tolerant** layer-wise greedy strategy for **split-NN** training on vertically partitioned data. Performance **gracefully degrades** with simulated **crash faults**.
– Comparable to standard VFL SplitNN under perfect conditions. Can learn **asynchronously** and from **unlabeled data**. Privacy **attacks** on gradients **impossible**.

Domain Adaptation in Breast Cancer Detection (Dec '24)
Guide: Prof. Chetan Arora, Indian Institute of Technology Delhi
– Wrote internal scripts and analyzed data to investigate poor domain adaptation performance of MRT (Zhao et al. ICCV '23) on Indian mammograms.
– Devised appropriate masking strategy and helped implement switch from attention to focal modulation for more visually robust short-range semantics.

Internet Learning (May-Aug '23)
NSF REU project. Guide: Prof. David Inouye, Purdue University
– Surveyed **fault tolerance** in **distributed optimization** and biologically plausible/**energy based** learning.
– Helped develop and implement a decentralized **collaborative backpropagation** baseline for Internet Learning, a paradigm intended for deep learning in dynamic and decentralized environments.

Coursework

Core curriculum available at IIT Kharagpur's website.
Elective Courses Advanced **Operating System** Design, **Algorithms**, Algorithms Lab, Communication **Networks**, Computational **Neuroscience**, Information and System **Security**, Introduction to **Language and Linguistics**, Neuronal Coding of Sensory Information, **Systems Biology**
Additional and Audited Credits Algorithmic **Game Theory**, Computational Foundations of **Cyber-Physical Systems**, **Information Retrieval**, **Machine Learning**, **Reinforcement Learning**, **Usable Privacy and Security**
Workshops and Online Certifications **Deep Learning** Specialization (DeepLearning.AI via Coursera), **Cloud Computing** Specialization (UIUC via Coursera), **Programming Languages** (University of Washington via Coursera), Winter Workshop in **Computer Vision** (IEEE IIT Kharagpur Section)

Course Projects Summary

Advanced OS Design: Low-level implementation of some **distributed algorithms** · **Deep Learning**: An analysis of **low-rank adaptation** and a proposal for **SVD** initialization · **Reinforcement Learning**: Implementation and comparison of **online on-policy learning** algorithms for a dynamic gridworld · **Computational Neuroscience**: **Neural signal processing** in MATLAB · **Machine Learning**: · Rice Variety Classificaiton using **Naive Bayes** · Heart Disease Detection using **SVMs** · **K-means** vs. Single-Linkage top-down **agglomerative clustering** · **Neuronal Coding of Sensory Information**: Processing **cat auditory system** signals in MATLAB · **Embedded Systems Lab**: Temperature-based fan **controller on an 8051** · **Computational Foundations of Cyber-Physical Systems**: Simulating a **smart grid** with **differential privacy** · **DIY Project:** Hand-gesture controlled medical robot over WiFi

Extracurricular Stuff

– Won gold at the Inter-IIT Tech Meet (2024). Developed a multithreaded VLM-based approach for runtime task goal detection.[a] Also helped another gold-winning team implement an explainable classifier for fake image detection.[b]
– Participated in the Inter-IIT Cultural Meet thrice. Contributed to both gold-winning contingents as a part of the Scrabble, Cryptic Crossword and Word Games teams. Currently on the Quiz team for 2024-25.
– Active member of the Quiz Club at IIT Kharagpur. Strong suits include general, history, sports, tech.
– Helped found WordWeave, the official word games society at IIT Kharagpur.
– Volunteered for the National Social Service for two years.
– Volunteered at an underfunded public school in rural India.
– Volunteered for the Rohini Ghadiok foundation, teaching at-risk and vulnerable students after school hours.
– Amateur weightlifter and intramural basketball player.
– Competitive programmer and CTF enthusiast.

[a] Click here for full problem statement.
[b] Click here for full problem statement.