

Anmol Saraf

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RESEARCH INTERESTS

Edge Computing, Distributed Systems, Data Systems, Operating Systems, ML for Systems, Systems for ML, Compilers

EDUCATION

Indian Institute of Technology Bombay

(2020-2024)

B.Tech in **Electrical Engineering** (with Honors) and a minor degree in **Computer Science**

CGPA : 9.02/10

PUBLICATIONS

1. [A. Saraf](#), A. Kowli; **Extracting Daily Aggregate Load Profiles from Monthly Consumption**, Published at the Energy Informatics Academy Conference 2024 [[Paper](#)]
2. [A. Saraf](#), A. Kowli; **Appliance Ownership Prediction With Smart Meter Data**, Published at the 15th ACM International Conference on Future and Sustainable Energy Systems 2024 [[Paper](#)]
3. S. Nasser, A. Sharma, [A. Saraf](#), A. Parulekar **Transforming Breast Cancer Diagnosis: Towards Real-Time Ultrasound to Mammogram Conversion for Cost-Effective Diagnosis**, Accepted at the Journal of Ultrasonics 2023 [[Paper](#)]

WORK EXPERIENCE

Amazon Development Centre

Team: Amazon Aurora Storage | Amazon Web Services

Aurora is a relational database management system that delivers enterprise-level speed, availability, and reliability.

Software Development Engineer - I

(Aug'24 - Present)

- Contributing to the **Control Plane** team, responsible for managing and developing large-scale distributed systems for Aurora Storage, spanning tens of thousands of servers across multiple data centers worldwide.
- Developing tools to monitor and remediate resources in Aurora Storage that breach **Service Level Agreements** (SLAs), aiming to mitigate security risks, enhance reliability, and ensure compliance with performance standards.

Software Development Engineer Intern

(May'23 - Jul'23)

- Implemented a new isolated state in **Java**, for identifying and handling error-ridden Aurora Storage data instances
- Improved **bugfix turnaround time**, by customizing current automated workflows to include the new isolated state
- Created automated tests in **JUnit** and **TestNG** to validate data safety and read/write operations on these instances

RESEARCH EXPERIENCE

Harvard University

Guide: Prof Vijay Janapa Reddi | Edge Computing Lab

Generative AI for Hardware Design

(May'24 - Present)

- Developed **RTLGenBench**, a tool to systematically benchmark LLM's on their ability to generate RTL code.
- Utilized **LangChain** to prompt the LLM with five techniques—zero-shot, few-shot, chain of thought, raw context mode, and summarized context mode—while also managing persistent memory for chat history tracking.
- Integrated the tool with **Icarus Verilog** to validate code syntax and run simulation tests on generated RTL, incorporating automatic reprompting at each stage to iteratively refine and correct outputs, enhancing accuracy.
- Designed the tool to prompt the LLM for a module description with TODOs at three difficulty levels: **easy** — single line of code insertion, **medium** — code block insertion (4-6 lines), and **hard** - complete code generation.

ArchGym

(Jun'23 - Nov'23)

- **ArchGym** (ISCA'23), is an OpenAI Gymnasium for using machine learning methods for design space exploration for domain-specific architectures. It is a framework that connects diverse search algorithms to architecture simulators.
- Collaborated with a **13-member** team to generate domain-specific hardware, employing the computer architecture simulator **AstraSim** integrated with cutting-edge reinforcement learning and machine learning-based algorithms
- Wrapped AstraSim environment in **Google's DeepMind** envlogger interface to generate **15,000+** hardware designs
- Developed a machine learning proxy pipeline to train on generated data, optimizing simulation time with minimal impact on accuracy. Leveraged models like **NODE** and **XGBoost**, known for their effectiveness in tabular data tasks.

Predictive Analysis for Smart Connected Buildings

(Mar'23 - May'24)

Guide: Prof Anupama Kowli | Dept. of Electrical Engineering

- Examined and built solutions for the issues of data loss due to network issues and privacy concerns in **smart meters**

- Engineered models to derive **daily load profiles** from monthly consumption data, reducing privacy and security risks while supporting cost reduction, peak demand mitigation, and enhanced operational efficiency.
- Achieved **6% MAPE** for aggregate imputation of **50 households** using statistical and machine learning-based imputation techniques such as **historical averaging**, **autoencoders**, **GANs** to mitigate the missing data problem
- Accomplished an accuracy of **78%** on predicting appliances present in a household, through **deep neural networks** on sparse energy consumption data of **15 minute** intervals for a duration of **2.5 years** of less than **100** households

Transforming Breast Cancer Diagnosis

(Apr'23 - Aug'23)

Guide: Prof Amit Sethi | Medical Deep Learning and Artificial Intelligence Lab

- Designed a system to convert ultrasound images into mammogram-like images, enhancing real-time breast cancer diagnosis. Leveraged **CycleGAN** and **pix2pix** models, achieving an MSE of 0.008 for high-quality image synthesis.
- Preprocessed CTs to **SoS** images to simulate ultrasound through wave interference equations using **Stride** module
- Applied **Fourier Domain Adaptation** to enhance the quality of simulated images with authentic ultrasound images

Exploring In-Memory Object Stores and ANN Indexing

(May'24 - Jul'24)

Guide: Prof Dixin Tang | Dept. of Computer Science, University of Texas, Austin

- Studied the **Distributed Data Parallel** module and its application in **Ray** for training deep neural networks. Also explored relay buffer memories and object stores used in reinforcement learning algorithms such as DQN.
- Researched data communication between processes in distributed systems, including data transfer mechanisms in Ray's object store and potential applications of **Compute Express Link (CXL)** for high-level data sharing.
- Analyzed **ANN indexing** with Starling, and explored the storage of graph index data in a Parquet file for efficiency.

SCHOLASTIC ACHIEVEMENTS

- Awarded the **Undergraduate Research Award** for excellence in Research and Development (2024)
- Felicitated with the **Best Project Award** for our design of a reflow oven in Electronic Design Lab (2023)
- Awarded the **Chanakya Fellowship** of ₹120,000 by Department of Science and Technology, GoI (2023)
- Secured **All India Rank 92** in **JEE Advanced** among 0.15 million candidates (2020)
- Recipient of the **KVPY Fellowship** granted by the Department of Science and Technology, GoI (2018)

TECHNICAL PROJECTS

Team Rakshak

(Aug'21 - Jul'23)

Guide: Prof Krishnendu Halder | Dept. of Aerospace Engineering

The team aims to design UAVs for search and rescue missions and participate in Student Unmanned Aerial Systems

- Responsible for classifying image features captured by the UAV, including shape, color, letters, and orientation, by developing machine learning models based on the **ResNet-50** and **VGG-16** architectures to recognize these features.
- Incorporated **Principal Component Analysis** to extract the angle of tilt between the drone and the object's axis
- Synthesized training datasets for the models using image processing techniques on **OpenCV** applied to 5,00,000 images which gave testing accuracy of **94%** and testing them on real life images gave an accuracy of **78.6%**

Valet Parking Robot

(Jan'23 - May'23)

Guide: Prof Paritosh Pandya | Dept. of Computer Science & Engineering

- Developed an autonomous robot that is capable of traversing a complex, predefined arena by utilizing a combination of PID control and advanced reactive algorithms to achieve efficient line following and effective obstacle avoidance.
- Utilized **Heptagon** for designing the bot's reactive kernel, implementing Mealy machine automata to model states and transitions, and integrated the generated C code with Arduino IDE for functionality.
- Optimized algorithms for transitions between line-following modes and parking maneuvers, addressing sensor calibration and variability. Implemented an obstacle-avoidance algorithm with infrared sensors on an **ATmega328P**.

Morphing Attacks and Defence Systems

(Jan'23 - May'23)

Guide: Prof Sunita Sarawagi | Dept. of Computer Science & Engineering

- Examined face morphing attacks with diffusion autoencoders to identify vulnerabilities in facial recognition systems.
- Attained **80%** success rate, on attacking SOTA Face Recognition models, **OpenFace** & **FaceNet512**, by morphing two face images by interpolating their semantic and stochastic embeddings produced by **Diffusion Autoencoders**
- Implemented a defense technique using morphed images to train a discriminator model that effectively distinguishes between real and morphed face images, achieving a **200x** reduction in mean squared error loss on unknown faces.

Reflow Oven for Soldering SMD Components

(Jan'23 - May'23)

Guide: Prof Joseph John & Prof Gaurav Kasbekar | Dept. of Electrical Engineering

- Designed and built a cost-effective reflow oven for surface-mount device (SMD) soldering, enabling efficient and precise attachment of components to printed circuit boards (PCBs) while accommodating various custom reflow profiles.

- Achieved a **six-fold** cost reduction for our product over industrial grade by optimal use of in-house components
- Designed a **printed circuit board** to host the power supply, temperature sensor, cooling fans and microcontroller
- Implemented **PID** control algorithm to follow the reflow soldering thermal profile on an **AT89C5131** microcontroller

Multicycle Processor Design

(Jan'22 - Apr'22)

Guide: Prof Virendra Singh | Dept. of Electrical Engineering

- Developed a RISC microprocessor with an efficient data path and designed essential hardware components, including ALUs, Register Bank, MUXes, Instruction Decoder, and Sign Extenders to support varied instruction execution.
- Designed control logic and a custom controller to manage signal flow and operation sequencing, integrating a 256B RAM for code and data storage to ensure full microprocessor functionality within Quartus software limitations.
- Defined an optimized datapath and detailed hardware flowcharts for each instruction, developing a control status word and a comprehensive finite state machine to effectively implement the microprocessor's architecture and functionality.

Parallel SAT Solver

(Jan'23 - May'23)

Guide: Prof Prabhu Ramachandran | Dept. of Aerospace Engineering

- Developed a parallel SAT solver using DPLL and CPCL algorithms, achieving a 2x speedup on 64-variable SAT equations. Established dataflow management between parent and child threads for efficient parallel processing.
- Utilized mpi4py to implement a binary tree-based multithreading structure, optimizing task distribution and execution.

TECHNICAL SKILLS

Programming Languages	C++, C, Embedded C, Python, Ruby, Java, Verilog, VHDL, MATLAB, Assembly(x86), Heptagon, Go, L ^A T _E X
Python Packages	Langchain, SciPy, Numpy, Pandas, Keras, Tensorflow, OpenCV, Sklearn, OS, Pytorch, Matplotlib, OpenAI Gym, Numba, MPI4PY, Automan

POSITIONS OF RESPONSIBILITY

Software Vice Head | Team Rakshak, IIT Bombay

(Jul'22 - Jul'23)

- Participated in a team of **8** in the **SUAS competition** in the **USA**, resulting in 30th place ranked among **80 teams**
- Spearheaded a **2-tier, 8-member** software subsystem while facilitating streamlined information transfer between subdivisions. Interviewed, **recruited** and **mentored** 5 junior design engineers out of a pool of 50+ UG applicants

Department Academic Mentor (DAMP Mentor)

(Jun'23 - May'24)

DAMP Cabinet, Student Mentorship Programme, IIT Bombay

- Selected into a team of **54** members out of **140+** candidates on the basis of SOPs, **interviews** and **peer reviews** to mentor **10** sophomores and help them manage academic and co-curricular pursuits and also develop self-sufficiency
- Received **2 days** of training on essential **mentorship skills** from a certified CBT-REBT therapist and trainer

Teaching Assistant

CS101: Introduction to Programming | Prof Ajit Rajwade

(Nov'22 - Feb'23)

- Entrusted with the responsibility of being a teaching assistant for the freshmen course CS101 with over 700 students
- Closely mentored **14 students** through software labs to introduce them to **C++** as their first programming language.
- Assisted with invigilation and grading for laboratory sessions and examinations conducted throughout the semester.

MA108: Differential Equations | Prof Santanu Dey

(May'22 - Jul'22)

- Mentored **42 students** in weekly tutorial sessions, facilitating assignment discussions and clarifying complex concepts while providing personalized support to enhance their understanding and encourage active engagement.

KEY COURSES UNDERTAKEN

Systems	Parallel Scientific Computing and Visualization, Embedded Systems, Principles of Data and System Security, Communication Networks, Microprocessors
Machine Learning	Online Learning and Optimisation, Foundations of Intelligent and Learning Agents, Speech Processing, Advanced Machine Learning, Image Processing
Electrical Engineering	Analog Devices, Digital Circuits, Spin-Based Computing, Decentralized Control of Complex Systems, Signal Processing, Restructured Power Systems
Computer Science	Automata Theory, Design and Analysis of Algorithms, Data Structures and Algorithms

EXTRA CURRICULAR ACTIVITIES

- Awarded ₹4,000 for placing **2nd** in the **Trust Lab CTF** competition organized for 50+ participants (2023)
- Participated in various intra-department, inter-department and inter-college **chess** competitions (2023)
- Secured **1st** position in **National Cadet Corps** (NCC) debate competition (2020)