GUNTAS SINGH SARAN

Machine Learning • Computer Vision
Junior Undergraduate | Computer Science and Engineering

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EDUCATION

Indian Institute of Technology Gandhinagar (IITGN) — CGPA: **9.71**/10
B.Tech in Computer Science and Engineering [Transcript] — 2022 - 2026

Dr. Kitchlu Public School, Moga — Percentage: **99.4**
Class XII, Central Board for Secondary Education — 2020 - 2022

Sacred Heart School, Moga — Percentage: **98.6**
Class X, Indian Certificate of Secondary Education — 2006 - 2020

WORK EXPERIENCE

Summer Research Intern, CVIG Lab, IIT Gandhinagar

Prof. Shanmuganathan Raman | IIT Gandhinagar | Project Link | Report — *May 2024 - July 2024*

- Researched Variational Autoencoders, Vector-Quantized VAEs, GANs, and Diffusion Probabilistic Methods.
- Implemented unconditional Latent Diffusion Model on CelebAHQ-Mask dataset and performed Image Inpainting tasks using the trained LDM and implemented Deep Convolutional GAN on MNIST and CelebA datasets.
- Investigated GAN inversion for image compression and editing using StyleGAN architechture.

SELECTED PROJECTS

DNS Stub Resolver using `AF_XDP`

Project | Prof. Sameer G Kulkarni | IITGN | Project Link | Video Link — *Jan 2025 - Apr 2025*

- Developed a user-space DNS stub resolver leveraging **`AF_XDP`** sockets and **`eBPF`** to bypass the Linux kernel network stack.
- Implemented an **XDP packet filter** to intercept UDP port 53 traffic and redirect it to a custom **`AF_XDP`** socket in user space.
- Integrated a filesystem-based caching mechanism and evaluated performance using **`dnsperf`**, validated query handling with **`dig`** and Wireshark, and ensured compliance with **RFC 1035**.

Bytecode-generated compiler for an unambiguous language - `osl` .

Project | Prof. Balagopal Komarath | IITGN | Project Link | Documentation — *Jan 2025 - Apr 2025*

- Implemented functions as first-class objects and the support of lexical scoping, closures using custom environment object in the resolver to generate the Abstract Binding Tree (ABT).
- Designed an unambiguous grammar for our custom language and implemented it using a recursive descent parser.
- Generated bytecode from the ABT in our assembly and designed virtual machine to execute the same.

Rust-Based OS for Raspberry Pi

Project | Prof. Abhishek Bichhawat | IITGN | Project Link — *Jan 2025 - Apr 2025*

- Built a minimal operating system from scratch in **Rust** for ARMv8-A (Raspberry Pi 3), implementing custom boot code, memory sections, and device-mapped I/O.
- Developed low-level UART drivers to enable serial console I/O, interfaced with hardware registers via bit manipulation.
- Developed and debugged **bare-metal Rust code**, configuring cross-compilation and QEMU-based emulation for testing.

Leveraging LLMs for Medical Specialty Classification

Research Project | Prof. Nipun Batra | IITGN | Project Link | Deployed Site — *Mar 2025 - Apr 2025*

- Classified clinical case descriptions into medical specialties using LLMs on the **`hpe-ai/medical-cases-classification-tutorial`** dataset.
- Applied **Google's Gemma-3-1b-it** for zero-shot and few-shot learning, and evaluated performance using F1-score, precision, recall, and confusion matrix.
- Fine-tuned **Gemma-3-1b-it**, **Llama-3.2-3B-Instruct**, and **DeepSeek-R1-Distill-Qwen-1.5B** to enhance accuracy.
- Benchmarked all models across learning modes; reported consistent improvements post fine-tuning.

Axis-Aligned Object Detection for Solar Panels from Satellite Imagery

Research Project | Prof. Nipun Batra | IITGN | Project Link | Deployed Site — *Jan 2025 - Feb 2025*

- Developed an axis-aligned object detection pipeline to detect solar panels in satellite imagery using Ultralytics YOLO, achieving mAP50 of 94.85% and leveraging supervision for evaluation.

- Engineered custom evaluation metrics including IoU computation with shapely and Average Precision (AP) using Pascal VOC, COCO, and PR-curve methods, validating performance against `supervision.metrics`.
- Implemented geospatial analysis and visualization by extracting bounding box coordinates, verifying with Google Maps, and plotting locations using `leafmap` to identify clustering patterns.

Adapt-HIPIE: Open-Vocabulary Image Segmentation with Adapters

Research Project | Prof. Shanmuganathan Raman | IITGN | Project Link | Poster *Aug 2024 - Nov 2024*

- Investigated hierarchical and decoupled approaches for segmenting *"things"* and *"stuff"*, optimizing representation learning for distinct visual-textual features using the **HIPIE**: **HI**erarchical, o**P**en-vocabulary, and un**I**v**E**rsal segmentation model.
- Introduced a **parallel adapter** after the Text-Image fusion module, achieving a state-of-the-art performance on **RefCOCO** *(oIoU: 86.62, P@0.5: 93.88)* and **RefCOCO+** *(oIoU: 78.02, P@0.5: 86.2)* with a ResNet-50 backbone.
- Explored several unified object detection and segmentation frameworks like the DETR (**DE**tection **TR**ansformer) and DINO (**D**ETR with **I**mproved de**N**oising anch**O**r boxes), evaluating their performance for segmentation tasks.

Full FPGA Implementation of 32-bit FSM-based Multi-State MIPS Processor

Project | Prof. Sameer G Kulkarni | IITGN | Project Link *Aug 2024 - Nov 2024*

- Designed an expanded ISA by formulating a new data-path capable of supporting recursive functions and high-level MIPS assembly code, implemented on FPGA Block RAM (BRAM) with memory-mapped I/O integration.
- Progressed through multiple development versions, culminating in a stable multi-state processor (v3.2) achieving Fibonacci, Factorial, GCD computations demonstrated on a Basys3 FPGA board.
- Developed and implemented a Finite State Machine (FSM) architecture to handle each stage of the 32-bit MIPS processor pipeline by breaking them down into states.

MDP Visualizer Tool

Project | Prof. Neeldhara Misra & Prof. Manisha Padala | IITGN | Project Link | Interface Link *Nov 2024*

- Developed a web-based platform for modeling and analyzing Markov Decision Processes (MDPs), featuring an intuitive canvas, transition tables, and real-time Q-value computation using iterative Bellman updates.
- Designed an interactive UI with state-action visualization, MathJAX-powered side computations, and dynamic decision policy analysis to improve understanding of MDP mechanics.

LLM for Telugu Language

Project | Prof. Mayank Singh | IITGN | Project Link | Model Training *Aug 2024 - Nov 2024*

- Curated datasets for Telugu Language of 110+ GBs from existing corpora like AI4Bharat, WikiMedia, ROOTS, ALLENAI, OSCAR and further crawling and scraping data from the web.
- Compiled a pipeline for pre-processing the data by cleaning and de-duplication using MinHashLSH.
- Trained a 46M parameter Llama model over a small subset of the dataset achieving a perplexity of 153 for the epochs trained and tokenized the data using SentencePieceBPETokenizer.

Sparsifying Networks while Preserving Communities

Research Project | Prof. Anirban Dasgupta | IITGN | Project Link *Mar 2024 - Apr 2024*

- Leveraged NetworkX and CDLib to extract community structures from sparsified graphs and compared them with baseline sampling techniques like random edge sampling and edge betweenness based sampling.
- Implemented graph sparsifying techniques by edge sampling (clustering coefficients, effective resistance) especially Local Jaccard Similarity based (L-Spar) to achieve an average Normalised Mutual Information (NMI) score of 80%.

Text Generator based upon next character prediction from an MLP

Project | Prof. Nipun Batra | IITGN | Project Link *Feb 2024 - March 2024*

- Engineered a pipeline model for next character prediction based on previous k characters.
- Fine-tuned models on various corpora, including Gulliver's Travels, English Wikipedia 8, Atomic Habits, Tolstoy's Essays, and Alice in Wonderland, with different embedding sizes.
- Deployed a Streamlit application to enable users to graphically select various hyperparameters for the trained models like varying the token embedding dimensions from 15, 25, till 50.

Human Activity Recognition (HAR) Analysis

Project | Prof. Nipun Batra | IITGN | Project Link *Jan 2024 - Feb 2024*

- Analyzed the UCI-HAR dataset with time-series data of thirty subjects performing six activities.
- Harnessed the TSFEL library for feature extraction and Principal Component Analysis for dimensionality reduction.
- Trained a Decision Tree model on the featurized data and tested it using the activity data collected with the Physics Toolbox Suite app to achieve 70% precision and 67% accuracy.

Child Safety Monitoring App using MATLAB's Simulink Support Package for Android

Project | Prof. Nithin V. George | IITGN | Project Link *Aug 2023 - Nov 2023*

- Designed an Android application for a smart bicycle with embedded sensors from a device to ensure child safety.
- Integrated MATLAB's Simulink Support Package for Android Devices and configured TCP/IP models for efficient data transmission between the child's and parent's devices.

Logical Puzzle and Graph based Games developed using C and C++

Project | Prof. Balagopal Komarath | IITGN | Project Link *Aug 2023 - Nov 2023*

- Developed games like Connect4, Up-it-Up, Sudoku Solver, and 2x2x2 Rubik's Cube Solver using optimal move strategy between two player moves and graph traversal algorithms.
- Leveraged the SFML graphics library of C++ along with Entities, Components, Systems paradigm for designing simple interactive games.

AWARDS AND ACHIEVEMENTS

- Awarded for **Academic Excellence** for highest CPI in AY 2022-23.
- Felicitated with **Dean's List Award** IITGN for **Semester I, II, IV, V** for excellent academic performance.
- Secured **2nd Position** in the Machine Learning challenge at IITGN's Annual Hackathon - **HackRush 2023**.
- Secured an All India Rank of **1297** in the **JEE (Advanced)** and All India Rank of **598** in the **JEE (Main)**.
- Recognised as a **KVPY** (Kishore Vaigyanik Protsahan Yojana) Scholar with All India Rank **1402**.

SKILLS

Languages: Python | C | C++ | Rust | HTML | CSS | JavaScript | Verilog

Tools: Wireshark | Socket Programming | Mininet | Xilinx | Vivado | LaTeX | Quarto | Git | Git Workflows | Adobe Illustrator .

Libraries: Coverage | Pytest | Pynguin | Scapy | Socket | tcpreplay | PyTorch | Tensorboard | NumPy | Pandas | Plotly | Seaborn | Scikit-Learn | Streamlit | NetworkX | TSFEL | SFML .

RELEVANT COURSES

Computer Science Systems Courses

- **CS 330**: Operating Systems [**A+**]
- **CS 331**: Computer Networks [**A-**]
- **CS 202**: Software Tools & Techniques [**A+**]
- **CS 327**: Compilers [**A-**]
- **ES 215**: Computer Organization and Architecture [**A**]
- **ES 301**: Data Structures and Algorithms II (*Algorithms Design*) [**A-**]

AI/ML/Data Science Courses

- **ES 335**: Machine Learning [**A**]
- **CS 328**: Introduction to Data Science [**A**]
- **CS 613**: Natural Language Processing [**A**]
- **ES 666**: Computer Vision [**A**]
- **CS 329**: Foundations of AI: Multiagent Systems [**A**]
- **CS 618**: Theoretical Foundations of Machine Learning [**A-**]

Mathematics, Statistics, Electrical Courses

- **ES 244**: Signals, Systems, and Random Processes [**A**]
- **ES 114**: Probability, Statistics, and Data Visualization [**A**]
- **MA 205**: Calculus of Several Variables [**A**]
- **MA 103**: Calculus of Single Variable and Linear Algebra [**A+**]
- **ES 116**: Principles and Applications of Electrical Engineering [**A+**][1].

[1] A- is 9/10, A is 10/10, and A+ is 11/10, awarded in exceptional cases.

TEACHING EXPERIENCE

Served as the Undergraduate Teaching Assistant (UGTA) for the following courses:

1. **ES 335: MACHINE LEARNING | Prof. Nipun Batra** *Fall 2024*
2. **ES 114: PROBABILITY, STATISTICS, AND DATA VISUALIZATIONS | Prof. Nipun Batra** *Spring 2025*

As a UGTA, I delivered Guest Lectures, conducted tutorials, undertook invigilation, graded quizzes and assignments for a class of 350+ students, and managed the course website.

POSITIONS OF RESPONSIBILITY & EXTRA CURRICULAR

- **Deputy Contingent Leader, Inter IIT Tech Meet 13.0, IIT Gandhinagar** *(held at IIT Bombay)* *Oct 2024 - Dec 2024*
  - Led the IIT Gandhinagar Contingent of 50+ participants for the Inter IIT Tech Meet 13.0 held at IIT Bombay, to its remarkable performance with 1 Silver and 1 Bronze medals.
- **Core Committee Member, Amalthea '23** *(Annual Technical Summit of IIT Gandhinagar)* *April 2023 - Feb 2024*
  - Directed the **Finance Department**, meticulously preparing the budget, monitoring expenditures, and ensuring the financial health of the summit, thereby achieving a balanced and transparent financial record.
  - Led the **Design Team**, of 25 members, coordinating with multiple vendors, to create innovative branding materials and visual assets, enhancing the summit's aesthetic appeal and attendee engagement.
  - Fostered seamless collaboration between diverse teams comprising of over **150+ undergraduate students**, ensuring the seamless planning, execution, and delivery of all event activities.
- **General Member, Technical Council, IIT Gandhinagar** *May 2023 - April 2024*
  Contributed to IIT Gandhinagar's own centralized hub and interactive platform for students - **metaiitgn**.
- **Graphic Designer, Student Academic Council, IIT Gandhinagar** *May 2024 - Apr 2025*
  Developing design assets including visual presentations for council's social media handles.