

Gaurav Budhwani

Senior Undergraduate · Modelling & Optimization · Machine Learning

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EDUCATION

Indian Institute of Technology, Gandhinagar [Transcript]
B.Tech. (Dual Majors) - Chemical and Computer Science Engineering

CPI: 8.59/10
2022 – Present

INTERNSHIPS

Research Scholar - PMTL Lab, University of Miami
Advisor — Prof. Yang Wang, University of Miami

Jun '25 – Jul '25

- Built Random Forest and advanced ensemble models (XGBoost, LightGBM, SVM, MLP) to predict New Particle Formation (NPF) events, achieving ROC–AUC > 0.92 via SMOTE-based balancing.
- Extracted and ranked atmospheric predictors (SO_2 , solar irradiance, relative humidity) using feature importance and partial dependence plots, cross-validating them with established NPF mechanisms.
- Performed comprehensive algorithm benchmarking on SGP atmospheric datasets, comparing training time, accuracy, and scalability to support future research publications.

PUBLICATIONS

- Hao, W., Mehra, M., **Budhwani, G.**, T. C. Chakraborty, Fan Mei, and Yang Wang. "Employing Machine Learning for New Particle Formation Identification and Mechanistic Analysis: Insights from a Six-Year Observational Study in the Southern Great Plains." **Under Review, AGU Journals**.

PROJECTS

TCP Congestion Control Simulator
Advisor — Prof. Sameer G. Kulkarni, IIT Gandhinagar | [Project Link]

Aug '25 – Nov '25

- Developed an interactive TCP congestion-control visualizer with a Python–Flask backend and React frontend, enabling real-time plots of cwnd, throughput, and packet loss for TCP Reno, CUBIC, and BBR.
- Implemented a custom discrete-packet simulation engine and an ns-3 packet-level backend, providing support for single-flow and multi-flow scenarios with programmable bandwidth and routing.
- Engineered Custom-topology support (parallel, series, triangle, mesh) with dynamic route selection to visualize congestion.

API Gateway Core
Independent Project | [Project Link]

Nov '25 – Dec '25

- Designed and implemented a production-style API Gateway core in C++17 using a middleware-based request processing pipeline (Chain of Responsibility) supporting authentication, rate limiting, and logging.
- Developed a concurrent request execution model using a custom thread pool and request-scoped context objects, ensuring thread safety, isolation of per-request state, and correct behavior under parallel workloads.
- Implemented prefix-based routing and clean backend service abstractions, enabling modular service integration and graceful handling of failure scenarios including 401 (Unauthorized), 404 (Not Found), and 429 (Too Many Requests).

VisuAlgo CSP Solver for N-Queens and KenKen
Advisor - Prof. Neeldhara Misra, IIT Gandhinagar | [Project Link]

Oct '25 – Nov '25

- Developed an interactive web app to visualize Constraint Satisfaction Problem (CSP) algorithms using React and TypeScript.
- Implemented complex solving strategies including Backtracking, Forward Checking, and Arc Consistency (AC-3) to demonstrate constraint propagation in real-time.
- Designed a dynamic user interface with React Router that features interactive puzzle generation, step-by-step solution playback, and visual feedback for constraint violations.

Human Activity Recognition (HAR) Analysis
Advisor - Prof. Nipun Batra, IIT Gandhinagar | [Project Link]

Aug '25 – Sep '25

- Analyzed the UCI-HAR dataset consisting of time-series sensor data from 30 subjects performing 6 daily activities, and applied Principal Component Analysis (PCA) to reduce dimensionality and visualize activity clusters.
- Utilized the TSFEL library to extract diverse statistical, temporal, and spectral features, and trained a Decision Tree model on the featurized dataset to classify human activities.
- Collected real-world activity data using the Physics Toolbox Suite app for model validation, achieving 70% precision and 70% accuracy, demonstrating the feasibility of deploying the pipeline beyond benchmark datasets.

- Developed a **multiphysics simulation** in **COMSOL** for wood pyrolysis under inert conditions, coupling **heat transfer**, **mass transport**, and **chemical kinetics** using anisotropic material properties.
- Conducted **parameter estimation using nonlinear least squares** to optimize kinetic and thermal parameters, improving alignment with experimental temperature and mass loss data.
- Performed **parametric studies** varying porosity, particle size, reaction kinetics, and ambient temperature to analyze their impact on thermal degradation, volatile release, and internal transport mechanisms.

- Designed a complete **cumene production process** in **Aspen Plus** and **MATLAB**, integrating reaction, separation, and heat recovery units for sustainable and optimized performance.
- Modeled a **plug flow reactor** with primary and secondary reactions using **mass and energy balances**, and validated the results against Aspen simulations with **<2% error** for key components.
- Performed **multi-variable optimization** using **MATLAB's fmincon**, achieving an optimal benzene-to-propylene ratio and inlet temperature that **maximized cumene yield** while minimizing side-product formation.

- Modeled and optimized **thermal boundary layer thickness** and **heat loss** using **Pyomo** and **MATLAB**, enhancing **convective heat transfer efficiency** for laminar airflow over a heated plate.
- Analyzed **trade-offs** between **heat dissipation** and **boundary layer control** under constrained flow conditions, demonstrating **optimal configurations** for improving thermal performance in engineering applications.

- Simulated **viscous fingering patterns** through **numerical modeling** (Darcy's Law, Diffusion-Limited Aggregation) to analyze the Saffman-Taylor instability, emphasizing computational approaches at the chemical-engineering interface.
- Designed and conducted controlled **experiments with Hele-Shaw cells** to validate simulations, investigating the interplay of viscosity, surface tension, and flow dynamics for interfacial instability.

- Designed and deployed a **web-based quiz** and attendance system using **Flask**, **JavaScript**, **Jinja2**, and **SQLite** to support **real-time quizzes** and **automated attendance tracking**.
- Implemented **geolocation validation**, **randomized number generation**, and **admin-approval workflows** to prevent cheating and enable secure session management with **automated reporting**.

- Conducted comprehensive calculations to determine the **heat transfer coefficient of circular finned pipes**, taking into account various parameters such as fluid properties, flow rates, and temperature gradients.
- Evaluated the **thermal efficiency** and **effectiveness** of the fin by analyzing its ability to enhance heat transfer and improve overall system performance.
- Developed a detailed **comparative analysis** between the circular finned pipe and a standard double heat exchanger.

- Executed detailed **numerical simulations** to assess the transient thermal behavior of a car brake system during braking, **analyzing heat distribution** and **temperature changes** over time to evaluate system performance.
- Utilized advanced **computational tools** and **finite element analysis (FEA)** to model the heat distribution and dissipation patterns across brake components, including the rotor, pads, and calipers.

- Implemented **thermodynamic analysis** and **simulation techniques** to identify and **adjust key cycle parameters**, such as turbine inlet temperature and condenser pressure, to maximize thermal efficiency and overall power output.
- Developed **graphical representations** to illustrate the relationship between cycle adjustments and performance metrics, providing clear visual insights into how different parameters influence efficiency and steam quality.

- Conducted analysis of Airbnb hosts' data, implementing comprehensive **data cleaning** to ensure dataset accuracy. Extracted valuable insights into host performance and guest interactions.
- Applied **advanced statistical techniques**, including **correlation analysis**, **regression models**, and **clustering**, to uncover significant trends related to pricing, location, and guest reviews.

Personal Portfolio Website

Self Initiated | [\[Website Link\]](#)

May '24 – Jun '24

- Designed and developed a personal **portfolio website** using **HTML**, **CSS**, and **JavaScript** to showcase projects, skills, and achievements, featuring a **responsive design** for optimal viewing on various devices.
- Conceptualised **dynamic elements** and **user-friendly navigation**, including interactive project galleries, animated elements, and contact forms to enhance user engagement and experience.

Developing Games and Puzzles with C and C++ Using DSA

Self Initiated | [\[Website Link\]](#)

Jan '24 – Apr '24

- Designed and implemented **Connect4** and **Up-it-Up** games utilizing optimal move strategies and **graph traversal algorithms** for strategic gameplay and decision-making.
- Developed **Sudoku Solver** and **2x2x2 Rubik's Cube Solver**, employing **advanced algorithms** to enhance solving efficiency and optimal move calculations.

TECHNICAL SKILLS

- Languages:** Python, C, C++, MATLAB, HTML, CSS, Javascript, SQL, Rust.
- Tools:** Git, LaTeX, Quarto, GitHub, Adobe Illustrator, Arduino IDE, Autodesk Inventor, Tableau, Data Modelling.
- Libraries:** PyTorch, NumPy, Pandas, Scikit-learn, SciPy, Plotly, Seaborn, Flask, SQLite, SMOTE, XGBoost, LightGBM.

ACHIEVEMENTS

- Received the **Academic Excellence Award** for achieving the highest CPI in AY 2023-24.
- Felicitated with **Dean's List Award** IITGN for **Semester II** for excellent academic performance.
- Awarded **Academic Research Ranking 2** (out of 50 students) for the Academic Year 2024-2025, recommended for institute-led academic internship and exchange programmes.
- Secured a grade of **A+** (11/10) for outstanding performance in the course of Numerical Methods by successfully doing the project and simulation on "**Transient Thermal Analysis of a Car Brake System.**"
- Completed **Deloitte Australia Data Analytics** Virtual Internship (Forage, Jun 2025), involving **Tableau dashboards**, **Excel-based classification**, and **business insight generation**. [\[Certificate\]](#)
- Earned the Specialist rank on Codeforces, highlighting strong competitive programming skills.

RELEVANT COURSES

Computer Science Courses

- CS 330: Operating Systems
- CS 331: Computer Networks
- CS 431: Computer and Network Security
- CS 202: Software Tools & Techniques
- ES 242: Data Structures and Algorithms I
- ES 204: Digital Systems
- ES 214: Discrete Mathematics
- CS 201: Theory of Computing

AI / ML Courses

- ES 335: Machine Learning
- CS 329: Foundations of AI: Multiagent Systems

Chemical Engineering Courses

- ES 211: Thermodynamics
- CL 201: Chemical Process Calculations
- CL 202: Chemical Engineering Thermodynamics
- CL 203: Process Fluid Mechanics
- CL 204: Heat Transfer
- CL 205: Chemical Reaction Engineering I
- CL 313: Chemical Reaction Engineering II
- CL 314: Separation Processes I
- CL 315: Process Dynamics and Control
- CL 326: Integrated Chemical Engineering Lab I
- CL 316: Separation Processes II
- CL 317: Process Synthesis, Design & Simulation
- CL 325: Transport Phenomena
- CL 327: Integrated Chemical Engineering Lab II
- ES 604: Engineering Optimization

- ES 617: Design of Experiments
- CL 427: Formulation Science and Engineering

Mathematics, Statistics & Electrical Courses

- ES 114: Probability, Statistics, and Data Visualization
- MA 103: Calculus of Single Variable and Linear Algebra
- MA 203: Numerical Methods
- MA 204: Introduction to Partial Differential Equations
- MA 104: Ordinary Differential Equations
- ES 116: Principles and Applications of Electrical Engineering

TEACHING EXPERIENCE

Undergraduate Teaching Assistant (UGTA)

Course: ES 604 Engineering Optimization | Prof. Hari S. Ganesh

Aug '24 – Nov '24

- Facilitated weekly doubt-clearing sessions and assignment discussions, assisting students with various optimization concepts.
- Evaluated and provided constructive feedback on course projects, ensuring alignment with course objectives.

POSITIONS OF RESPONSIBILITY

Design Team Member, Amalthea '23

(Annual Technical Summit of IIT Gandhinagar)

Dec '22 – Feb '24

- Created engaging social media designs for diverse platforms, utilizing Adobe Illustrator, Canva, and other graphic design software.
- Developed and executed visually compelling social media content for various platforms using Adobe Illustrator, Canva, and other graphic design tools.

Team Member, Vinteo

(Film Making Club of IIT Gandhinagar)

Jul '24 – May '25

- Contributed to a short film's production, handling concept development, and filming. Ensured smooth execution.

Team Member, MAPRC

(Media and Public Relations Committee of IIT Gandhinagar)

Jul '24 – May '25

- Designer for "ETHEREAL," IIT Gandhinagar's official monthly magazine, crafting visuals to showcase campus life, student achievements, events, and engaging stories.