Kabir Murjani

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Education

Nirma University — Ahmedabad, India
Bachelor of Technology, Electrical Engineering (Minor in Management) — *July 2023 – May 2027*

- **Relevant Coursework:** Control System Theory, Probability & Statistics, Electrical Design, Network Analysis, Power Systems

Research Experience

Indian Institute of Management Bangalore — Bangalore, India
Research Intern — Prof. Abhay Sobhanan — *May 2026 – July 2026*

- Developed neural and exact solvers for NP-hard knapsack, routing, and synchronization problems over massive combinatorial search spaces. Introduced the Traveling Thief Problem with Drone (TTP-D), a novel extension of the Traveling Thief Problem.
- Designed a neural hybrid solver combining a deep RL policy for solution construction with metaheuristic refinement, narrowing the solution-quality gap to a strong metaheuristic baseline at a fraction of its computational cost.

Singapore Institute of Technology NVIDIA AI Centre — Remote
Research Collaborator — Dr. Timothy Liu — *Jan 2026 – April 2026*

- Designed a sequential RL framework for multi-objective decision-making over hierarchical knowledge graphs. Developed anomaly detection methods for continuous tensor streams. Deployed models through NVIDIA Inference Microservices (NIM).
- Benchmarked transformer representations across 12 layers and 1,696 segments, identifying the optimal layer with 0.736 ROC-AUC and a ∼10% relative AUC gain over the final layer under identical evaluation conditions.

Xtin Capital, Inc. — Ahmedabad, India
Machine Learning Researcher — *May 2025 – Aug 2025*

- Built a high-frequency ingestion engine ingesting 800+ articles/min using sentiment models and hierarchical knowledge graphs to capture semantic relationships, converting unstructured real-time news into structured data for downstream decision making.
- Developed a backtesting environment with adversarial data generation to quantify qualitative data and evaluate portfolio rebalancing strategies across volatility regimes, enabling systematic stress testing across multiple volatility regimes.

Publications & Proceedings

Peer-Reviewed

- **Murjani, K.**, Bhavsar, M., Patel, M., & Talukdar, J. (2026). AlphaRoute: LLMs as Semantic Optimizers for Multi-Objective Routing. *In IEEE International Conference on LLM-Aided Design (LAD), Stanford University, CA* [arXiv] [Code]
- **Murjani, K.** (2026). Zero-Copy Semantic Contagion: An In-Memory Streaming Architecture for Evolving Attention Graphs. *In ACM SIGMOD Workshop on Data Management for the Modern Financial Systems, Bengaluru, India* [arXiv] [Code]
- **Murjani, K.**, & Vyas, P. (2026). LURE: Bayesian Signaling Game in Multi-Step Agent Interactions. *In Conference on the Mathematics of Artificial Intelligence, Sochi, Russia* [PDF] [Code]

Under Review

- **Murjani, K.**, & Sobhanan, A. (2026). Drive, Pack, Fly: The Travelling Thief Problem with Drone. *Under review, European Journal of Operational Research (EJOR)* [arXiv] [Code]
- **Murjani, K.**, Vyas, P., Abrol, A., Gupta, R., & Wang, Z. (2026). The Variance of a Judge: Zero-Variance Rewards by Deterministic Regression. *Under review, ACL Rolling Review (ARR)*
- **Murjani, K.**, & Sobhanan, A. (2026). Frozen-Policy Test-Time Search for Collection Routing with a Drone. *Under review, Workshop on ML×OR, NeurIPS 2026*

Projects

Approximate Numerics in Applied Transition Environments (Open-Source Library) [Code] [Website] [PyPI]

- Developed aniate, an open-source Python library for finite Markov and non-Markovian decision processes, representing history-dependent objectives as Mealy automata and solving the resulting product models exactly by dynamic programming.
- Designed statistical validation of simulators against their models using chi-square tests and value martingales, evaluated against exact and closed-form solutions for stochastic routing, Gaussian walks and heavy-tailed durations.
- Released the library on PyPI with a Gymnasium interface, notebook displays for reproducible experimentation, supported by 130 unit and property-based tests under continuous integration.

The Combinatorics of Trust over Knowledge Graphs [Code]

- Designed a closed-form structural consistency metric using Łukasiewicz continuous logic that eliminates iterative solvers, achieving a 3.7 times computational efficiency increase across test instances evaluated on three distinct models.
- Formulated an $\mathcal{NP}$-hard subset selection task as a submodular integer program, establishing a $1 - 1/e$ approximation while reducing the required evaluation data volume by roughly 96 percent.

Spectral Dominance in Sequential Control [Code]

- Modeled drug scheduling under resistance evolution as a zero-sum game on a within-host compartmental graph, deriving a spectral-radius condition for when sequential treatment dominates myopic dosing (at Jerzak Lab, UT Austin).
- Proved single-stage NP-completeness by reduction from 0-1 Knapsack and bounded the myopic–optimal gap across 3 regimes. Validated on 4 calibrated modules (N up to 30 nodes) via a bilevel MILP and a spectral-greedy heuristic.

Hierarchical Reinforcement Learning for Cost–Emission Optimal Dispatch [Code]

- Decomposed 24-hour cost–emission dispatch on IEEE 118-bus (54 generators, 4,242 MW) into a metaheuristic macro layer for a 15-point trade-off front and a decentralized RL micro layer (Undergraduate project, advised by Prof. Kuntal Bhattacharjee).
- Reduced per-zone action space from 5^{21} to 7 discrete dispatch levels, making tabular Q-learning tractable while maintaining $< 0.05\%$ daily fuel-cost variation. Benchmarked against value-based, policy-gradient, and neural architectures.

ChessNano: Autoregressive Search over Legal-Move [Code]

- Trained a sub-50M-parameter autoregressive transformer to predict moves directly from Standard Algebraic Notation, with no explicit board representation, so a game is learned as a walk over the position graph induced by the rules.
- Used quantized training (PolarQuant) and tree-of-thought constrained decoding, expanding only edges present in the legal-move graph at each ply so sampling stays on legal continuations. Awarded OpenAI compute grant through OpenAI Parameter Golf.

Selected Presentations

Large Language Models as Semantic Optimizers for Multi-Objective Routing [Slides] 26.08.2026

- Invited by Dr. Madhura Purnaprajna (Principal, Xilinx) & Dr. Dinesh Gaitonde to present the AlphaRoute at **AMD India**.

Zero-Copy Semantic Contagion: An In-Memory Streaming Architecture [Slides] 31.05.2026

- Oral presentation at the ACM SIGMOD Workshop on Data Management for Modern Financial Systems (Bengaluru).

Skills

Languages: Python, MATLAB, C/C++, Rust

ML & Frameworks: PyTorch, PyTorch Geometric, TensorFlow, Hugging Face (SFT, PEFT), LangGraph, NetworkX, RustworkX

Optimization & Solvers: Gurobi, CPLEX, HiGHS, OR-Tools, Pyomo, CVXPY, Z3, Lean/Mathlib

Tools & Infrastructure: LaTeX, Git, Docker, Linux, CUDA, Weights & Biases, Ray, Redis, Weaviate

Research Interests: Deep Reinforcement Learning, Neural Combinatorial Optimization, Game Theory, Language Models

Honors & Awards

ACM SIGMOD/PODS 2026 India Fellowship | *Recipient* | 2026

- Selected from a competitive nationwide applicant pool for excellence in advanced development and open-source research.

Scholar of Academic Excellence, Nirma University | *Recipient* | 2026

- Awarded by the Department of Electrical Engineering for top scholastic performance in the cohort during Semester 6.

IIT Kanpur Chess Masters Premier League 2.0 | *3rd Place* | 2024

- Placed **3rd** among 60+ universities representing the Nirma University Chess Team. Head of Chess representative for EE.

Leadership & Service

IEEE Computer Society, Nirma University | *General Secretary* | Dec 2025 – Feb 2026

- Founded the chapter and served as its inaugural General Secretary, establishing the organizing team and institutionalizing its activities through an NLP workshop series and recurring research seminars, fostering a research culture on campus.

Team Dyaus, Nirma University | *Technical Mentor* | Jan – May 2024

- Mentored the avionics subsystem for a CanSat entry in the Türksat Satellite Competition 2024, providing technical guidance on the architecture and development of the flight electronics stack, including PCB design and iterative layout revisions.

Association for Computational Linguistics (ACL) 2026 | *Volunteer* | July 2026

- Volunteered as Second Chair for the Main and Findings tracks at the 64th Annual Meeting of the Association for Computational Linguistics (ACL), supporting an event with 10,000+ virtual and in-person attendees in San Diego, CA.