Anandsingh Chauhan

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Experienced Researcher at TCS Research specializing in Reinforcement Learning (RL) for networked systems under uncertainty, including power grids, supply chains, and multi-robot systems. Demonstrates a proven track record in developing robust RL solutions for complex, adversarial environments, leading to significant performance improvements. Adept at leveraging advanced AI techniques to ensure safe and reliable operations.

Education

Indian Institute of Technology Gandhinagar — Gujarat, India
M.Tech. in Electrical Engineering — *July 2018 – Aug 2020*

- **CPI**: 9.43/10.0
- Thesis: Peer-to-Peer Energy Trading Platform: Hardware and Software Integration
- Advisor: Dr. Naran Pindoriya

L. D. College of Engineering — Ahmedabad, Gujarat, India
B.E. in Electrical Engineering — *Aug 2014 – June 2018*

- **CPI**: 9.05/10.0

Professional Experience

Researcher — Sept 2020 – Present
Data and Decision Sciences, Tata Consultancy Services (TCS) Research — *Mumbai, India*

- Led data-driven control and management of power networks with increasing renewable integration and resilience against adversarial attacks, under the mentorship of **Dr. Mayank Baranwal and Dr. Harshad Khadilkar.**
- Developed a heuristic-guided RL framework, *PowRL*, which topped the leaderboard in the NeurIPS 2020 challenge and secured 3rd place (Out of 90 global teams) in the Learning to Run a Power Network Challenge, 2023.
- Applied RL, Graph Neural Networks (GNNs), Attention Models, and Large Language Models (LLMs) to optimize operations in power grids, transportation networks, and supply chain management.
- Worked on various supply chain and logistics problems, including multi-lead time inventory replenishment, multi-robot task allocation, mixed-fleet vehicle routing with time windows, and railway scheduling.

Adjunct Faculty — Dec 2023 – Present
S.P. Jain Institute of Global Management — *Mumbai, India*

- Adjunct faculty for the Bachelor of Data Science program, teaching **Introduction to Data Science** and **Introduction to Programming**, and mentoring students on projects to build foundational skills in data science.

Teaching Assistant — Aug 2018 – Apr 2020
Electrical Systems Lab and Electrical and Electronics Lab, IIT Gandhinagar — *Gandhinagar, India*

- Guided first-year and final-year undergraduates through hands-on experiments and assessments in the Electrical and Electronics Lab and Electrical Systems Lab, respectively.

Awards and Honors

- **NASSCOM AI Gamechangers Award, 2024**: Top 10 AI research projects in India for AI-driven solutions.
- **Certificate of Merit, ISGF, 2024**: Recognized for AI-based control and smart grid management.
- **Third Prize, L2RPN Challenge, 2023**: 3rd place out of 90 global teams, in L2RPN 2023 Challenge hosted by TU Delft & RTE France, to manage power grid under adversarial threats.
- **Platinum Award, ISGF, 2023**: Developed smart agent for peer-to-peer energy trading and demand response.
- **Gold Award, ISGF, 2023**: Innovations in grid reconfiguration for congestion management.
- **POSOCO Power Systems Award**: Selected as one of 15 recipients in India for exceptional M.Tech thesis in power systems (Grid-India & FITT, IIT Delhi).

Scholastic Achievements

- **Director's Fellowship**, IIT Gandhinagar (2018-2020)
- **Certificate of Academic Excellence**, L.D. College of Engineering (2017)
- **Prime Minister's Scholarship Scheme**, L.D. College of Engineering (2014-2018)
- **99.13 percentile (AIR 976)**, GATE Electrical Engineering (2019)

Research Projects

RL for Robust Power Grid Management under Adversarial Attacks *TCS Research*

- **Developed** *PowRL*, an advanced reinforcement learning framework ensuring uninterrupted and reliable power grid operations under adversarial attacks and uncertainties, crucial for modern grids with high renewable integration and dynamic loads.
- **Introduced** a novel heuristic for overload management and RL-guided optimal topology selection, reducing the action space to 240 key actions and significantly enhancing learning efficiency and decision-making speed.
- **Achieved** top rankings in international competitions: topped the leaderboard in the **L2RPN NeurIPS 2020** challenge (Robustness track), was the top-performing agent in the **L2RPN WCCI 2020** challenge, and secured 3rd place in the **L2RPN 2023** competition organized by TU Delft and RTE-France.
- **Collaborator**: Dr. Mayank Baranwal

Multi-Robot Task Allocation in Dynamic Warehouses using RL *TCS Research*

- **Developed** *MRTAgent*, a dual-agent reinforcement learning framework inspired by self-play, optimizing real-time multi-robot task allocation in dynamic warehouse environments.
- **Optimized** task assignments and robot selection to minimize total travel distance and task delays, considering practical constraints like battery management and collision avoidance.
- **Employed** a modified Linear Quadratic Regulator (LQR) for safe, collision-free navigation, supporting continuous robot movements under real-world conditions.
- **Demonstrated** significant improvements over baseline methods across various test datasets, showcasing the framework's generalizability and effectiveness.
- **Collaborators**: Dr. Mayank Baranwal, Aritra Pal

Optimizing Cost-to-Serve in E-Commerce using GNN and RL *TCS Research*

- **Developed** an integrated framework combining Graph Neural Networks (GNNs) and Reinforcement Learning (RL) to minimize product delivery costs by optimizing fulfillment node selection and vehicle routing.
- **Developed** a solution to the dual-level decision-making challenge of optimal fulfillment node selection for dynamic customer orders and multi-order vehicle routing. The approach incorporated constraints such as warehouse inventory limits, vehicle capacities, travel times, and delivery time windows. The problem was formulated as a Markov Decision Process and addressed using a Graph Autoencoder combined with Deep Q-Learning, achieving superior performance over heuristic-based methods across diverse demand scenarios
- **Demonstrated** robustness and generalizability across different customer data distributions, highlighting applicability in large-scale e-commerce operations with dynamic demand.
- **Collaborators**: Dr. Harshad Khadilkar, Omkar Shelke, Pranavi Pathakota

Optimizing Mixed-Fleet Vehicle Routing with Time Windows using RL *TCS Research*

- **Developing** an attention-based RL solution for large-scale Vehicle Routing Problems with Time Windows (VRPTW), involving mixed fleets of Electric Vehicles (EVs) and Internal Combustion Engine Vehicles (ICEVs).
- **Aiming** to optimize last-mile delivery routes while managing energy constraints, leveraging Vehicle-to-Grid (V2G) capabilities of EVs to minimize trip costs and reduce idle times.
- **Incorporating** complex logistics constraints such as varying vehicle capacities, energy consumption rates, charging needs, and customer delivery time windows.
- **Expected** to significantly enhance logistics operations for providers adopting EVs at scale, contributing to sustainable transportation solutions.
- **Collaborators**: Dr. Mayank Baranwal, Dr. Prasant Misra

Development of a Prosumer-Driven Integrated SMART Grid *IIT Gandhinagar*

- **Developed** a linear programming-based optimization model for peer-to-peer (P2P) energy trading between prosumers and consumers, maximizing economic benefits by minimizing total electricity purchasing costs, and **designed and built** a real-world testbed at IIT Gandhinagar integrating solar PV, Battery Energy Storage Systems (BESS), Vehicle-to-Grid (V2G) capabilities, and the *SMART AGENT*, a universal IoT-based smart energy management device enabling consumers to participate into P2P energy trading and demand response.
- **Utilized** a web-based user interface and blockchain platform to simplify and secure energy trading processes, enhancing reliability and transparency, and **demonstrated** significant economic gains over traditional feed-in tariff models, showcasing the scalability of the proposed model for future smart grid implementations.
- **Collaborator**: Dr. Naran Pindoriya

Publications

- Pal, A., **Chauhan, A.**, Baranwal, M., and Ojha, A. (2024). Optimizing Multi-Robot Task Allocation in Dynamic Environments via Heuristic-Guided Reinforcement Learning. *27th European Conference on Artificial Intelligence (ECAI).* [Acceptance Rate: 23%] `Paper Link`
- **Chauhan, A.**, Suthar, S., Kuhada, R., Cherukuri, S., and Pindoriya, N. (2024). Peer-to-Peer Energy Trading Framework: An Experimental Evaluation. *13th IEEE PES ISGT Asia*
- **Chauhan, A.**, Baranwal, M., and Basumatary, A. (2023). *PowRL: A Reinforcement Learning Framework for Robust Management of Power Networks.* 37$^{\text{th}}$ AAAI Conference on Artificial Intelligence [Acceptance Rate: 19.2%] `Paper Link`
- **Shelke, O.***, **Pathakota, P.***, **Chauhan, A.***, Meisheri, H., Khadilkar, H., and Ravindran, B. (2024). A Learning Approach for Cost-Efficient Sourcing and Routing Strategies in E-Commerce. *Proceedings of the 7th Joint International Conference on Data Science & Management of Data (11th ACM IKDD CODS and 29th COMAD).*[***Co-first authors**] `Paper Link`
- Shelke, O., Pathakota, P., **Chauhan, A.**, Meisheri, H., Khadilkar, H., and Ravindran, B. (2023). Multi-Agent Learning of Efficient Fulfillment and Routing Strategies in E-Commerce. *NeurIPS Generalization in Planning Workshop 2023.* `Paper Link`
- Kuhada, R. B., **Chauhan, A.**, and Pindoriya, N. M. (2020). Real-time Simulation of V2G Operation for EV Battery. *21st National Power Systems Conference (NPSC).* `Paper Link`

Patents

- Pal, A., **Chauhan, A.**, and Baranwal, M. (2024). Methods and Systems for Optimizing Multi-Robot Task Allocation Through Heuristic-guided RL in Dynamic Environments. India Patent 202421064122, Filed on Aug 25, 2024.
- **Chauhan, A.**, and Baranwal, M. (2023). Reinforcement Learning and Heuristic-based Real-time Power Grid Management. U.S. Patent US 2024/0186789 A1. `Patent Link`
- **Chauhan, A.**, and Baranwal, M. (2022). Reinforcement Learning and Heuristic-based Real-time Power Grid Management. India Patent 202221069773, Published on Jun 7, 2024.
- Pindoriya, N., **Chauhan, A.**, Kuhada, R., and Jha, M. (2022). Universal IoT-based Smart Energy Management Device. India Patent 202221028935, Published on Nov 24, 2023.

Under Review Papers

- Pal, A., **Chauhan, A.**, and Baranwal, M. Together We Rise: Coordinated Heterogeneous Plays for Optimizing Real-Time Multi-Robot Task Allocation. **Under review at the AAAI 2025.**

Services

- **Invited Talk**: Learning and Control Colloquium 2024, System & Control Department, IIT Bombay
- **Invited Talk**: Applying RL in the Real World 2024, TCS iON
- **Reviewer**: AAAI GenPlan, Indian Control Conference (ICC) 2023, 2024

Technical Skills

- **Programming Languages**: Python, MATLAB, HTML, SQL
- **Frameworks and Tools**: PyTorch (Primary), TensorFlow, Hugging Face Transformers, OpenAI Gym, Spinning Up AI, AWS, GitHub, GitLab, Simulink, PSSE, LaTeX
- **Hardware**: Lab-Volt, OPAL-RT, Raspberry Pi