

SAURABH SAGAR SHINDE

Computer Science Undergraduate — Researcher in Machine Learning & Intelligent Systems

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Research Interests

Predictive Maintenance / Prognostics and Health Management (PHM); Remaining Useful Life (RUL) Prediction; **Uncertainty Quantification**; Conformal Prediction; Decision-Theoretic Machine Learning; Risk-Aware Decision Making; Time-Series Deep Learning; Transformers; Temporal Convolutional Networks; Business Analytics; Intelligent Maintenance Systems; AI Agents and Multi-Agent Systems.

Research Profile

Computer Science undergraduate with research experience spanning **predictive maintenance, uncertainty quantification, decision-theoretic machine learning, enterprise AI agents, and AI-enabled public systems**. Currently developing a **decision-oriented Predictive Maintenance framework** that integrates RUL prediction, calibrated uncertainty, maintenance optimization, and operational value using NASA C-MAPSS data.

Research interests focus on moving machine learning beyond predictive accuracy toward **calibrated, risk-aware, and decision-useful AI systems**. Co-author of research work on enterprise AI agent ecosystems and digital justice, with additional experience building and deploying AI systems in collaboration with public-sector stakeholders.

Research Experience

Decision-Theoretic Predictive Maintenance with Calibrated Uncertainty 2026 – Present
Independent Research / Manuscript in Preparation

- Developing a unified framework for **Remaining Useful Life (RUL) prediction, predictive uncertainty, maintenance decision-making, and business-value evaluation** using the NASA C-MAPSS turbofan degradation benchmark.
- Designing a hybrid temporal prediction backbone combining **Temporal Convolutional Networks (TCN), Transformer encoders, temporal attention pooling, and multi-quantile regression**.
- Implementing **Conformalized Quantile Regression (CQR)** to produce statistically calibrated prediction intervals and evaluate uncertainty using coverage, interval width, calibration, and related uncertainty metrics.
- Comparing uncertainty methods including **Split Conformal Prediction, uncalibrated quantile regression, MC Dropout, Deep Ensembles, Bayesian Neural Networks, and Evidential Deep Learning**.
- Developing a **risk-aware maintenance decision layer** that converts predicted RUL and uncertainty into expected maintenance loss using asymmetric early-maintenance and failure costs.
- Evaluating the framework across statistical, classical ML, deep-learning, and Transformer-based baselines, including Linear/Ridge/Lasso/Elastic Net, Random Forest, SVR, Gradient Boosting, XGBoost, LightGBM, CNN, LSTM, GRU, BiLSTM-Attention, TCN, Transformer, CNN-LSTM, and CNN-BiLSTM-Attention.
- Building a rigorous experimental protocol involving **ablation studies, sensitivity analysis, statistical significance testing, calibration evaluation, decision analysis, and economic metrics**.
- Current implementation has passed **448 cumulative verification tests with 0 failures**; 32 dependency-specific tests are skipped when required ML libraries are unavailable.
- Verified end-to-end CQR calibration behavior, interval ordering, deterministic calibration artifact reload, and Deep Ensemble epistemic-uncertainty behavior.

Enterprise AI Agent Ecosystems: Architecture, Economics, and the Composition Gap 2026
Co-author — SSRN research paper

- Analyzed enterprise AI agent ecosystems across **architecture, protocols, economics, and adoption** to identify the gap between available agent capabilities and measurable enterprise value.
- Investigated agent discovery, selection, trust, reputation, task-context fitness, governance, latency, and economic constraints.
- Contributed to the analysis supporting a proposed **Trust-Aware Ranking System (TARS)** for federated, context-aware agent selection at the control plane.

Justice-as-a-Protocol: Stateless and Self-Enforcing Digital ODR 2025
Co-author — Research paper

- Contributed to research proposing a scalable, **AI-assisted Online Dispute Resolution (ODR) architecture** for the Indian legal ecosystem.
- Worked on system logic and application development for a framework integrating legal rules, AI assistance, multilingual access, digital workflows, and automated enforcement mechanisms.
- Research incorporated multiple Indian legal statutes and explored architectural, compliance, economic, and deployment considerations.

Selected Projects

Rakshak AI – AI-Based Civic Policing Platform

2025 – Present

AI / RAG / Civic Technology / Public-Sector Deployment

- Co-developed a bilingual **AI + Retrieval-Augmented Generation (RAG)** system in collaboration with **Nashik Rural Police** to improve citizen access to police services.
- Mapped police procedures, citizen-service intents, and legal information into a conversational system supporting Marathi and English.
- Built capabilities for complaint guidance, lost-item reporting, legal guidance, police-station discovery, and emergency assistance.
- Contributed to the system's frontend and application development, while working within a multidisciplinary team responsible for AI, backend, data, and system architecture.
- Deployed as a citizen-facing WhatsApp-based platform and subsequently evolved toward **voice/IVR-based access** to improve accessibility.
- Achieved substantial real-world usage, with **5,000+ users, 51,000+ citizen conversations, and 80+ complaints and reports processed/resolved.**

NyayMargadarshak – LegalTech Platform

2026

React.js / Node.js / Express.js / Python / AWS

- Developed a full-stack LegalTech platform designed to make Indian legal information and lawyer access more accessible to citizens.
- Implemented a legal explorer covering **BNS, BNSS, and BSA**, advocate discovery, client-lawyer communication, and role-specific dashboards.
- Built a Python-based legal-update scraping pipeline and integrated JWT-secured APIs with role-based access control.
- Deployed the frontend on Vercel and backend infrastructure on **AWS EC2** with PM2.

NyayBot – AI Legal Assistance System

2025

AI / LegalTech / Full-Stack Development

- Designed and developed the frontend for an AI-based legal assistant intended to simplify access to Indian legal information.
- Worked on user-centric interaction design and integration with backend and AI components for context-aware legal assistance.

Shakti Link – Transparent In-Kind Donation Platform

2025

National-Level Hackathon Project

- Developed the **frontend and UI/UX** for a platform connecting donors, NGOs/receivers, and verified suppliers without direct cash transactions.
- Designed workflows supporting donation transparency, vendor selection, feedback-based quality checks, and fraud reduction.
- Built the prototype under a **48-hour national-level hackathon constraint**, emphasizing rapid system design and deployment.

Nirvan Care – Healthcare Management Platform

2024

Web Development

- Developed a healthcare platform supporting **appointment booking and medical-history access.**
- Contributed to frontend development and user-oriented workflow design in a collaborative development team.

Research Publications & Manuscripts

- **Shinde, S. S.**, et al. "Enterprise AI Agent Ecosystems: Architecture, Economics, and the Composition Gap." *SSRN*, May 2026.
- **Shinde, S. S.**, et al. "Justice-as-a-Protocol: Designing a Stateless, Scalable, and Self-Enforcing Online Dispute Resolution (ODR) System for 21st Century India." *ResearchGate*, 2025.
- **Shinde, S. S.**, et al. "Decision-Theoretic Predictive Maintenance with Calibrated Predictive Uncertainty for Remaining Useful Life Prediction." *Manuscript in preparation*, 2026.
- **Shinde, S. S.**, and A. D. Thorat. "From Chariots to Cavalry: The Evolution of Indian Warfare and the Fall of the War Chariot." *Published research article*, 2025.

Technical Skills

Programming	Python, Java, C++, JavaScript
Machine Learning	scikit-learn, XGBoost, LightGBM, classical ML, regression, classification, ensemble learning
Deep Learning	PyTorch, neural networks, CNN, LSTM, GRU, TCN, Transformers, attention mechanisms, multi-quantile regression
Uncertainty & Decision Science	Conformal Prediction, CQR, uncertainty calibration, prediction intervals, Deep Ensembles, MC Dropout, expected-loss decision making, sensitivity analysis, statistical testing
Data & Statistics	Pandas, NumPy, SciPy, statistical modeling, regression, hypothesis testing, time-series analysis, econometrics, data preprocessing and visualization
AI / Research	RAG, LLM applications, AI agents, multi-agent systems, experimental design, ablation studies, benchmarking, research literature analysis
Web / Systems	React.js, Node.js, Express.js, REST APIs, JWT, Tailwind CSS, SQLite, AWS EC2, Vercel, PM2
Other	Git, GitHub, Linux, API integration, IoT concepts, system architecture, data pipelines

Education

K. K. Wagh Institute of Engineering Education & Research, Nashik

Expected July 2027

B.E. / B.Tech. in Computer Science / Computer Engineering

CGPA: 8.0/10

Relevant Coursework: Probability and Statistics; Engineering Mathematics; Statistical Methods; Data Structures and Algorithms; Database Management Systems; Machine Learning; Artificial Intelligence; Computer Networks; Operating Systems; Object-Oriented Programming; Software Engineering.

Professional Experience

DREAMCARE DEVELOPERS Pvt. Ltd.

2025

Full-Stack Developer Intern

- Contributed to the development and management of government-oriented web applications and citizen-facing digital systems.
- Worked on full-stack development, frontend implementation, and scalable web application workflows.

Cognifyz Technologies

2025

Web Development Intern

- Worked on web-development tasks involving frontend implementation, application workflows, and practical software development.

Achievements & Recognition

- **Design patent/application under review** for an innovation developed during academic/project work.
- Rakshak AI received institutional and public-sector recognition for its work with Nashik Rural Police, including presentation of the project to the **Governor of Maharashtra**.
- Participated in **Tech Horizon 2025 National-Level Hackathon**, developing Shakti Link under a 48-hour development constraint.
- Completed **Econometrics: Methods and Applications**, Erasmus University Rotterdam, covering regression, time-series and panel-data methods, causal inference, instrumental variables, and empirical modeling.

Leadership & Community

- **Co-Founder, Neuronex Developers** – involved in building technology-oriented products and collaborative software initiatives.
- **Secretary, Rotaract Club of Nashik Nine Hills** – organizational coordination, technical initiatives, and community engagement.