Monu Kumar Pathak

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Qualifications	University	Programme	Year
M.Tech	IIT Bombay	IEOR	2023–25
Area of Research:	Computation and Data Science		

Work Experience

Kinaxis India | Software Developer - I (Algorithms) July'25 - Present

Agentic Supply Chain Decision Intelligence Platform

- Developed an agentic LLM decision layer on LangGraph (stateful, checkpointed, human-in-the-loop on every data write) that turns supply-chain data + live global events into quantified, auditable **business** decisions
- Engineered a **hybrid** Intent-Driven Selective Retrieval to query only needed data sources per **classified** intent
- Achieved **93%** eval pass, **96%** grounded, **structured**, and **2.4s** median latency under tight token budgets
- Reduced **numeric** hallucination from **18%** → **2%** **(9× fewer)** & increased citation coverage from **0** → **100%** & numeric attribution from **0.82** → **0.98** via the **controlled same-model** OKF **faithfulness** ablation
- Designed a human-in-the-loop execution layer for **safe**, controlled scenario and parameter changes, plus a 3-layer Data Assurance engine for **automated** anomaly detection and LLM-assisted root-cause analysis

Sample-Efficient Policy Learning through Differentiable Simulation

- Built an inventory model with **PyTorch** using **HDPO** to learn ordering policy using a differentiable simulator
- Implemented Vanilla & Graph Neural Networks to coordinate store & warehouse for replenishment decisions
- Compared HDPO & **GNN** inventory policies against heuristics such as echelon-stock and newsvendor across network settings, achieving **optimality gaps** as low as **0.03%** & reducing data requirements by up to **64×**

Probabilistic Modeling of Multi-Echelon Decision Systems

- Developed a **stochastic modeling framework** for demand and lead-time propagation across the networks
- Derived the mean and variance of lead-time demand under **stochastic demand** and lead-time uncertainty
- Modeled **lead-time demand** by selecting appropriate probability distributions for different demand patterns
- Computed service-level-constrained reorder points (ROPs) & expected backorders (EBOs) using inverse CDFs
- Modeled **Bill of Material (BOM)** dependencies as a directed network and implemented graph-ranking and cycle-detection algorithms for scalable demand propagation across the complete Inventory Network

Derivative-Free Learning and Optimization for Stochastic Systems

- Built a **Nonlinear** Optimization engine to minimize inventory cost by optimizing intermediate service-levels
- Formulated a stochastic nonlinear inventory optimization model under demand and lead-time uncertainty, and solved it using **SciPy**'s **Dual Annealing** and **Differential Evolution**, derivative-free global metaheuristics
- Implemented batched warm-start optimization using the prior batch's optimum as initialization to exploit the near-separable cost structure across the supply chain network, cutting convergence time significantly
- Reduced optimization complexity through cost-based variable elimination while improving numerical stability

Probabilistic Approximation and Distribution Validation

- Developed a parametric approximation for the convolution of two **independent probability distributions**
- Ranked candidate probability distributions using **AIC/BIC** and evaluated goodness of fit using **KS statistic**
- Applied **PP** & **QQ** plots for visual validation and diagnostic assessment of the predicted probability distribution

Research Work

Commonsense Reasoning in LLMs | Seminar | Prof. N. Hemachandra Jan'24 - Apr'24

- Fine-tuned **GPT-1** model to accurately generate, & enhance contextual commonsense **reasoning** & inferences
- Leveraged the **ConceptNet** and **ATOMIC** knowledge graphs with over **40M** and **877K** tokens for training
- Achieved **perplexity** of **11.14** & **BLEU-2** score of **15.10**, reflecting quality & novelty in sentence generation

XAI for Large-Scale Simulation Analysis | MTP | Prof. Jayendran June'24 - Jan'25

- Implemented **Data Farming techniques**, integrating the **explainable AI** to analyze large simulation data
- Performed **1M+ simulations** & clustered simulation output data using **K- Means** & **DBSCAN** algorithms
- Extracted insights & improved transparency with explainability in **Neural Networks** and **Random Forest**
- Utilized **SHAP** to calculate **marginal contribution** of each input feature on model output for explainability

DRL Agents for Adaptive Scheduling | **MTP** | **Prof. Jayendran** Jan'25 - June'25

- Developed an **RL**-based agent to optimize job scheduling across multiple machines based on its system state
- Implemented a **DQN agent** from scratch & modeled production scheduling system as a **DES** using **SimPy**
- Trained DQN using a custom reward function to maximize cumulative return for a given state & action pair
- Achieved a **42% reduction in makespan** compared with conventional dispatching rules using learned policy

Counterfactual Simulation Framework for Adaptive Scheduling | Open-Source Library

- Developed an open-source **DES** library in **Python** using **SimPy** for flexible job-shop production scheduling
- Configurable to any floor plan with multiple **WorkCenters & Machines**, supporting pluggable sequencing rules (**FIFO, SPT, EDD, LPT, FIS**) and exposing the complete live system state at every time interval
- Enabled **pause & resume** of runs, testing strategies via sub-simulations & resuming with the optimal Strategy

Internship

Sequential EHR Modeling using Transformers | **Cognitio Analytics** May'24 - Jul'24

- Reviewed over **10 research papers** on Generative AI and documented their use case into the medical domain
- Preprocessed EHR data containing **58,000** hospital admissions, **38,000+** adult patients and their diagnosis
- Developed **LSTM** & **Transformers** based models to predict patient next visit embedding from medical history
- Classified diseases into **5 classes**, achieved **19%** higher **AUROC** with **LightGBM** over end to end NN models

Projects

Privacy-Preserving Representation Learning in Recommender Systems Project Link

- Goal: Development of an **Open-Source** Privacy-Robust Recommendation System using Differential Privacy
- Applied **3 privacy-enhancing** algorithms by injecting **Laplace noise** at input, processing & output stages
- Implemented **Matrix Factorization** from scratch, including **Alternating Least Squares(ALS)** & **SGD**
- Achieved **RMSE** of **0.92** on perturbed data with 3 as privacy parameter, compared to **0.85** on clean data

Statistical Modeling & Risk Quantification using Parametric Methods Project Link

- Analyzed the claim amount data for different types of insurance using box plots, scatter plots, and histograms
- Identified the underlying distribution of claim amounts using the Kolmogorov-Smirnov and Chi-squared tests
- Analyzed the VaR and TVaR for both datasets and found that personal claims are more risky than other claims
- Proposed products like No-Claim Bonus Incentives and Tiered Premium Pricing for different user segments

Skills

- **Agentic AI & LLMs**: LangGraph, RAG, Tool Calling, Prompt & Context Engineering, LoRA/QLoRA
- **Machine Learning**: PyTorch, TensorFlow, Scikit-learn, LightGBM, GNNs, Transformers, LSTMs
- **Reinforcement Learning**: Gymnasium, DQN, DDQN, GDPO, GRPO
- **Optimization & Simulation**: Gurobi, CPLEX, SciPy, Optuna, SimPy, Arena, AnyLogic
- **Languages & Libraries**: Python, SQL, Bash, Pandas, NumPy, SHAP, Neo4j

Achievements

- Recognized by the **CEO of Kinaxis** for proposing and developing AI-driven Decision Intelligence platform, receiving organization-wide recognition for innovation and technical leadership
- Represented **IIT Bombay** at a global Level in **Rockwell Student Simulation Competition**

Teaching Experience

- Teaching Assistant for **Modelling & Simulation Lab** (Autumn 2024) and **Simulation, Modelling & Analysis** (Spring 2025)
- Mentored 200+ students through tutorials, laboratory sessions, Assignments & doubt resolution