Kundan Kumar

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EDUCATION

Iowa State University **Ames, IA**

PH.D. IN COMPUTER SCIENCE (MINOR: STATISTICS) **2020 - 2025**

- **Relevant Coursework:** Machine Learning, Deep Learning, Natural Language Processing, Computational Perception, Data Technology for Statistical Analysis, Experimental Design , Statistical Theory and methods for Research, Computer Networks, Theory of Computation, Design and Analysis of Algorithms, Advanced Topics in Machine Learning, Database Design and Research, Empirical Methods for the Computational Science, Principles of Artificial Intelligence, Introduction of Network Programming and Cloud Computing, Network Protocol and Security, Information Warfare.

Iowa State University **Ames, IA**

MS IN COMPUTER SCIENCE **2015 - 2016**

RESEARCH INTERESTS

My research focuses on building robust and adaptive AI systems for cyber-physical infrastructure, particularly in smart energy environments. I develop scalable algorithms that integrate deep reinforcement learning (DRL), probabilistic modeling, and physics-informed learning to improve control, safety, and generalization under uncertainty. My work addresses challenges in transferability, adversarial robustness, and data efficiency by embedding domain constraints into learning processes and designing agents capable of operating in dynamic, resource-constrained settings. I also explore the integration of large language models (LLMs) to enhance context-awareness and human-AI interaction in control frameworks.

- Transfer Learning, Meta-Learning, Multi-agent, Natural Language Processing, Reinforcement Learning, Adversarial Robustness, Large Language Models, Graphical Models, Cyber-Physical Systems

RESEARCH EXPERIENCE

Iowa State University **Ames, IA**

GRADUATE RESEARCH ASSISTANT **Aug. 2022 – Present**

- Research on Physics-Informed Deep Reinforcement Learning for Critical Infrastructure Systems, focusing on Intelligent Resource Management and Security in Large-Scale Distributed Networks.
- Developed physics-informed DRL algorithms incorporating domain-specific physical constraints, achieving 30% improvement in resource allocation efficiency and reducing system violations in complex distributed networks.
- Designed and implemented adversarial attack detection and mitigation frameworks for AI models in critical systems, enhancing robustness against security threats through systematic testing and defensive techniques.
- Created novel transfer learning methodologies enabling DRL models to adapt across varying network sizes and topologies, reducing training time by 40% for new configurations.
- Developed Python-based simulation and control framework integrating real-time hardware (OPAL-RT and OpenDSS) with distributed systems.
- Leveraged LLM-driven reasoning and contextual understanding within simulation environments to support real-time adaptive control, human-AI collaboration, and predictive system optimization.

GRADUATE RESEARCH ASSISTANT **Aug. 2020 - Jul 2022**

- Research on Deep Reinforcement Learning (DRL) and Safety-Critical Learning for Autonomous Systems, with focus on perception, control, and decision-making in high-stakes environments.
- Utilized CARLA simulator for vision-based autonomous driving tasks, including perception, object detection, trajectory planning, and policy learning in complex traffic scenarios.
- Applied deep computer vision models for object recognition, semantic segmentation, and sensor fusion, enabling robust situational awareness in autonomous driving and robotics.

TEACHING EXPERIENCE

Iowa State University **Ames, IA**

GRADUATE TEACHING ASSISTANT **Aug. 2020 – Present**

Courses: Software Testing, Object-oriented Analysis and Design, Construction of User Interfaces, Software Development Practices, Database Management Systems, Spreadsheets and Databases

- Led hands-on labs and tutorials in full-stack development, teaching modern software engineering practices including Git workflows, CI/CD pipelines, and agile methodologies to 90+ students per semester.
- Designed and delivered guest lectures on industry-standard software development practices, covering microservices architecture, containerization (Docker), and cloud deployment strategies.
- Mentored student teams in end-to-end development of mobile and web applications, guiding them through requirements analysis, system design, implementation, and deployment using agile methodologies.

INDUSTRY EXPERIENCE

National Renewable Energy Laboratory (NREL) **Golden, CO**
Machine Learning Engineer (Intern) **May. 2024 – Jan. 2025**

- Developed novel machine learning models for automated network topology inference and resilient control policy optimization for complex distributed systems under extreme scenarios.
- Designed and developed semi-supervised learning approaches to tackle the challenge of limited labeled data in networks, achieving 98% improvement in model accuracy with varying labeled data.
- Paper ”Advanced Semi-Supervised Learning with Uncertainty Estimation for Phase Identification in Distribution Systems” accepted at IEEE Power & Energy Society General Meeting (PES GM) 2025.

Comcast **Centennial, CO**
Software Engineer **Jun. 2019 – Jan. 2020**

- Designed and implemented real-time data processing pipelines using Amazon Kinesis and RabbitMQ, processing 1TB+ daily data for fraud detection and system monitoring.
- Developed machine learning models for anomaly detection and user behavior analysis, reducing fraudulent activities by 70% through predictive analytics.
- Built scalable Spring Boot microservices handling 10K+ concurrent requests, achieving 99.9% uptime for critical system components.
- Created interactive dashboards using Presto DB and Python visualization tools, enabling real-time monitoring of network performance metrics and fraud patterns.

IBM **Austin, TX**
Software Engineer **Mar. 2016 – Jun. 2017**

- Led cloud infrastructure optimization using OpenShift, implementing auto-scaling solutions that reduced operational costs by 30%.
- Developed a comprehensive monitoring system using Grafana and Flask, providing real-time visibility into 100+ cloud servers.
- Implemented automated performance monitoring and alerting system, reducing incident response time by 60%.

Hewlett Packard (HP) **Boise, Idaho**
Software Engineer **Apr. 2017 – Dec. 2018**

- Spearheaded migration of critical applications from HPI to HPE domain, ensuring zero downtime during transition.
- Implemented OAuth 2.0 authentication system and RESTful services using Spring Boot, securing applications serving 50K+ users.
- Designed and deployed microservices architecture on Apache/WebLogic servers, improving system response time by 40%.

Tata Consultancy Services (TCS) **Mumbai, India**
System Engineer **Jul. 2012 – Dec. 2014**

- Engineered high-performance ETL pipelines for data warehouse integration, processing 100GB+ daily data volumes.
- Optimized database performance through SQL tuning and indexing strategies, reducing query execution time by 70%.
- Received excellence award for achieving $100K cost savings through database optimization initiatives.

PUBLICATIONS / TALKS

Peer Reviewed Publications

1. **K. Kumar**, K. Utkarsh, W. Jiyu and P. Harsha, “**Advanced Semi-Supervised Learning with Uncertainty Estimation for Phase Identification in Distribution Systems**,” in *Proc. IEEE Power & Energy Society General Meeting (PESGM)*, Austin, TX, USA, 2025 (accepted).
2. H. Arif, **K. Kumar**, G. Ravikumar, “**Multi-Scale Temporal Feature Learning for Wind Power Forecasting Using Optimized Deep Neural Networks with Bayesian Uncertainty Quantification**,” submitted to *IEEE Transactions on Artificial Intelligence*, 2025.
3. **K. Kumar** and G. Ravikumar, “Physics-based Deep Reinforcement Learning for Grid-Resilient Volt-VAR Control,” submitted to *IEEE Transactions on Smart Grid*, 2025.

4. **K. Kumar** and G. Ravikumar, "**Deep RL-based Volt-VAR Control and Attack Resiliency for DER-integrated Distribution Grids**," in *Proc. IEEE Power & Energy Society Innovative Smart Grid Technologies Conf. (ISGT)*, Washington, DC, USA, 2024. [Paper]
5. **K. Kumar**, A. A. Mantha, and G. Ravikumar, "**Bayesian Optimization for Deep Reinforcement Learning for Robust Volt-Var Control**," in *Proc. IEEE Power & Energy Society General Meeting (PESGM)*, Seattle, WA, USA, 2024. [Paper]
6. **K. Kumar** and G. Ravikumar, "**Transfer Learning Enhanced Deep Reinforcement Learning for Volt-Var Control in Smart Grids**," in *IEEE PES Grid Edge Technologies Conference & Exposition*, San Diego, CA, USA, 2025. [Paper]
7. J. K. Francis, C. Kumar, J. Herrera-Gerena, **K. Kumar** and M. J. Darr, "**Deep Learning and Pattern-based Methodology for Multivariable Sensor Data Regression**," in *Proc. IEEE Int. Conf. on Machine Learning and Applications (ICMLA)*, Nassau, Bahamas, 2022. [Paper]
8. K. G. Lore, N. Sweet, **K. Kumar**, N. Ahmed and S. Sarkar, "**Deep Value of Information Estimators for Collaborative Human-Machine Information Gathering**," in *Proc. ACM/IEEE Int. Conf. on Cyber-Physical Systems (ICCPS)*, Vienna, Austria, 2016. [Paper]

ACADEMIC PROJECTS

- **Motion Prediction for Autonomous Vehicle (Design and Implementation Project)**: Developed a robust system for motion prediction and object detection in autonomous vehicles using Kaggle Lyft datasets, employing YOLO for object detection and RESNET for motion planning. YOLOv5 demonstrated accurate detection of cars and traffic lights, while the RESNET model, though with room for improvement, was used for motion planning and trajectory prediction.
- **Face Generation using GANs**: Built generator and discriminator networks to generate new face images using Generative Adversarial Networks. Trained models on CelebA dataset to produce realistic synthetic faces and analyzed model performance through loss comparison.
- **Prompt Injection Attacks on LLM Medical Diagnosis by Symptom Elaboration**: Designed prompt injection attacks that manipulated large language models (LLMs) to generate inappropriate medical diagnoses based on symptom queries. Developed defense mechanisms including re-prompting strategies and fine-tuning models to improve robustness against adversarial attacks.
- **Chatbot Design using Retrieval-Augmented Generation (RAG)**: Built a domain-specific chatbot integrating vector-based retrieval with GPT models to provide accurate, context-aware responses. Developed an interactive Streamlit interface enabling real-time user interaction, document uploads, and dynamic knowledge-grounded conversations.

SKILLS

Programming Languages	Python, R, Java, C++, SAS, MATLAB, SQL, JavaScript, Node.js, React.js, REST API, SoapUI
Machine Learning & Data Analysis	Scikit-learn, TensorFlow, PyTorch, Pandas, Matplotlib, Seaborn, OpenAI Gym
Large Language Models (LLMs)	Hugging Face, LangChain, Retrieval-Augmented Generation (RAG), Prompt Engineering
HPC & Big Data	Hadoop, Hive, Pig, Spark, Apache Kafka, Amazon Kinesis, SLURM, MPI, OpenMP
Simulation Tools	Opal-RT (Power Systems), OpenDSS (Power Systems), Carla (Autonomous Driving)
Visualization & GIS	Tableau, ArcGIS, Leaflet
Optimization Tools	Gurobi, Pyomo, Optuna, Hyperopt, BoTorch, Stable-Baselines3, RLlib
Cloud & Deployment	AWS (EC2, S3, Lambda), Google Cloud, Docker, Kubernetes, Git/GitHub, Jenkins/CircleCI

HONORS / AWARDS

- Selected for the Seventh Workshop on Autonomous Energy Systems, National Renewable Energy Laboratory (NREL), 2024.
- Selected for the ByteBoost Workshop on Accelerating HPC Skills and Computational Research, 2024.
- Selected for the highly competitive Oxford Machine Learning Summer School (OxML), 2022.
- Awarded Excellence Award for Outstanding Performance in Database Tuning at Tata Consultancy Services (TCS).
- Secured **2nd Place** in the BAJA SAE India Competition (safest terrain vehicle category, national level).

SERVICE

- **Reviewer**
  - IEEE Transactions on Industrial Informatics (2025) & Neural Networks and Learning Systems (2024)
  - IEEE PES General Meeting (PESGM) 2023, 2024 & Grid Edge 2024 & ISGT 2023
- **Volunteer, Prayaas India (BIT)** – Providing free and high-quality education to underprivileged children living in slums and villages through this non-governmental organization.