Nilaksh

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Final Year Masters Student

Education

9.42/10   **B.Tech + M.Tech Dual Degree in Electronics and Electrical Communication Engineering**,   2020 - Expect. 2025
Indian Institute of Technology, Kharagpur | India

Research Interests: Reinforcement Learning, Computer Vision, Efficient Deep Learning, Robotics
Fellowships: Summer@EPFL 2024 for working at **EPFL**. DAAD-WISE 2023 for working at **MPI-IS**. MITACS GRI 2024 to work at **UofT**, Canada

Research Experience

Multi-Objective Optimization Using RL | Prof. Caglar Gulcehre | EPFL, Switzerland   May'24 - Aug'24
- Multi-objective optimization with RL agents covering the entire **Pareto Front** using linear and **non-linear scalarizations** of vector objectives
- Designed an RL pipeline utilizing parallelized environments, re-wrote **efficient replay buffers**, and derived theory for **Expected Utility PPO**
- Reduced training time by **50x** while maintaining performance comparable to baseline methods, even in complex continuous environments

Adaptive RL for Robot Control | Prof. Aamir Ahmed | MPI Intelligent Systems, Germany   May'23 - Nov'23
- Developed **policy composition** and **successor feature** based algorithms for multi tasking using RL agents that can transfer to unseen tasks
- Implemented memory-efficient, parallelized environments for **NVIDIA's IsaacGym**, and vectorized loop operations, achieving a **4x speedup**
- Implemented **Temporal Convolutional Networks** (TCN) to encode complex dynamics, augmenting the observation space for stable learning

Barrier Function Based Reward Shaping | Prof. Shishir Kolathaya | IISc Bangalore   Dec' 22 - March'23
- Developed easy-to-implement reward shaping formulations for **faster**, more **efficient**, and **safer** RL training in physical systems like robots
- **Formulated novel barrier functions** to enhance system safety by constraining physical quantities like joint angles and angular velocities
- Achieved up to **50% more energy efficiency** and **156% higher** training speed on both simulation and hardware (**Unitree Go1 quadruped**)

Defense Against Backdoor Attacks on Self-Supervised Learning | Bachelor Thesis | Prof. Somesh Kumar   Dec'23 - March'24
- Developed two **novel defense strategies** against frequency-based backdoor attacks on SSL, reducing Attack Success Rate (ASR) by **over 60%**
- Designed an **inference-time** defense using the luminance channel, achieving **near-random ASR** without compromising prediction accuracy
- Showed that contrastive training with **blur** enhances **robustness**, increasing classification accuracy by **5-10%** and reducing ASR by **60-85%**

Automated Geometry Problem Solver | Advisor: Prof. Aritra Hazra | IIT Kharagpur   March' 22 - Aug' 22
- Developed a solver for **SAT level** geometry problems by parsing text and diagrams into **formal language** and applying a set of theorems
- Used **RetinaNet** with **focal loss** to tackle **class imbalance** in detection, enhancing the parsing of diagrams by detecting symbols & numerals
- Achieved **4.16% higher** accuracy than SOTA while using **0.33 (avg.) fewer** theorems by predicting theorem sequences with a **BART** model

Interpretable Uncertainty Quantification for VQA | Prof. Moloud Abdar | Deakin University, Australia   May' 22 - July' 22
- Worked on **Uncertainty Quantification** and **Explainability** of Deep Learning models for application in sensitive tasks like medical VQA
- Reviewed recent papers on VQA, Uncertainty Quantification, **Bayesian Neural Networks**, and model-agnostic **XAI** techniques like **LIME**

Publications

[3] **Towards Adversarial Robustness And Backdoor Mitigation in SSL** [arXiv] [code]
Nilaksh*, Aryan Satpathy*, Dhruva Rajwade*, Somesh Kumar, under review at **NeurIPS** 2024 Workshop on Self-Supervised Learning

[2] **Adaptive Reinforcement Learning for Robot Control** [paper] [code]
Yu Tang Liu, **Nilaksh**, Aamir Ahmad, Full paper will appear in 2024 IEEE International Conference on Intelligent Robots and Systems (**IROS**)

[1] **Barrier Functions Inspired Reward Shaping for Reinforcement Learning** [doi] [paper] [code]
Nilaksh, A. Ranjan, S. Agrawal, A. Jain, P. Jagtap and S. Kolathaya, 2024 IEEE International Conference on Robotics and Automation (**ICRA**)

Key Projects

TinyCompiler For BASIC Compilation | Personal Project   Dec' 23
- Developed a compiler with lexical and syntactic analysis, and **recursive descent parsing**, transforming a BASIC-like language into C code
- Designed and implemented a **lexer** to validate and tokenize source code, a **parser** to generate the parse tree, and an **emitter** to produce C code. Generated the **abstract syntax tree** (AST) to perform optimizations such as **tail-call elimination** to save stack space

Fast Semantic Image Retrieval | Information Retrieval Term Project   Feb'22-March'22
- Developed an image retrieval system using **ResNet-50** to learn hierarchical embeddings that capture both **csemantic** and **visual** information
- Extracted coarse and fine **binary hash codes** from embeddings and used **VP trees** for efficient retrieval, reducing space and time complexity

Vehicle Routing Problem (VRP) | Inter IIT Tech Meet 10.0   March'22
- Worked on solving **Multiple TSP** for VRP with clustering, maximum spanning trees, and an **MI-NLP optimization** using the **Gurobi** solver
- Contributed to the **Gold-winning** contingent that achieved a **46% higher score** than the first runner-up IIT in the **national level** competition

Positions of Responsibility and Teaching

- **Software Team Head, Swarm Robotics:** Led the software team, trained new members, and developed solutions for drones & swarm systems
- **Core Member, Kharagpur Data Analytics Group:** Co-organized national level hackathons with over 2000 participants and gave ML talks
- **Teaching Assistant, Networks Laboratory:** Assisted students in practical lab sessions, and guided them through circuit design and analysis
- **Undergrad Student Mentor, IIT Kharagpur:** Guided first-year students in academics and campus life, providing various kinds of support

Skills

Programming	Python (PyTorch, OpenCV, JAX), C++ (STL, pthreads), C, Bash, LaTex, MATLAB, 8051 Assembly, Arduino, Verilog, HTML / CSS
Technologies	Linux, Git, Docker, Gurobi, Jupyter, make, GDB, OpenAI Gym, Nvidia IsaacGym, Google Brax, MuJoCo, Blender
Relevant Courses	Algorithms, Networks, Probability, Statistics, Linear Algebra, Numerical Methods, Advanced Calculus, Computer Architecture, Learning Theory, DL, RL, Computer Vision, Multi Modal ML, Image and Video Processing, Digital Signal Processing, Controls