Nirjhar Das

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ACADEMIC QUALIFICATION

Bachelor of Technology, Electrical Engineering *Jul '19 - May '23*
Specialization:- *Cognitive and Intelligent Systems* (AI focus area)
Indian Institute of Technology (IIT) Delhi
Department Rank:- 5
Cumulative GPA:- 9.38/10
Artificial Intelligence = 10/10, Computer Science* = 8.4/10, Mathematics* = 9.5/10*
(courses listed on page 3)*

PUBLICATIONS

Published:- **Nirjhar Das** and Arpan Chattopadhyay, *Inverse Reinforcement Learning with Constraint Recovery*, **International Conference on Pattern Recognition and Machine Intelligence 2023** (to appear in **Springer Lecture Notes in Computer Science (LNCS)**) (*https://arxiv.org/abs/2305.08130*)

Published:- Mustafa Chasmai, **Nirjhar Das**, Aman Bhardwaj and Rahul Garg, *A View Independent Classification Framework for Yoga Postures*, **Springer Nature Computer Science, Vol. 3**, September 2022 (*https://doi.org/10.1007/s42979-022-01376-7*)

Published:- Smriti Chawla, Anja Rockstroh, Melanie Lehman, Ellca Ratther, Atishay Jain, Anuneet Anand, Apoorva Gupta, Namrata Bhattacharya, Sarita Poonia, Priyadarshini Rai, **Nirjhar Das**, Angshul Majumdar, Jayadeva, Gaurav Ahuja, Brett G. Hollier, Colleen C. Nelson and Debarka Sengupta, *Gene expression based inference of cancer drug sensitivity*, **Nature Communications, 13**, September 2022 (*https://doi.org/10.1038/s41467-022-33291-z*)

ACADEMIC HONOURS AND ACHIEVEMENTS

Best BTech Project Award: Won the award among *160+* students in the EE department for research carried out in BTech Project
Amazon ML Challenge 2023: Achieved *6th* rank out of *5000+* teams by building a deep-learning model for the prediction of package length from item description
Research Week with Google 2023: Selected to attend the conference from *among 1000+ final year UG and PG students* across India
IIT Kanpur Cybersecurity Hackathon 2020: Achieved *3rd* rank out of *1200+* teams by building a machine learning pipeline for botnet detection
Top 7% Merit Award: Achieved in *4* semesters out of *8* semesters among *55 students* in the department
Swami Vivekananda Scholarship: Awarded by *Hon'ble Chief Minister* of West Bengal for excellent performance in Class XII Board Exam
JEE Advanced: Achieved rank of *721* out of *150000* students
KVPY (Kishore Vaigyanik Protsahan Yojana): Selected for Scholarship by *Dept of Science and Technology, Govt of India* and achieved ranks *94* and *175* in 2018 and 2017 respectively
ISC (Indian School Certificate): Achieved *2nd* rank all over India out of 100000 students in Class XII Board Exam with 99.75% marks

RESEARCH PROJECTS

Participatory Budgeting with Bandit Feedback *(Draft in preparation)* *Mar '23 – Present*
Guide:- Prof. Siddharth Barman (Dept. of Computer Science and Automation, IISc Bangalore)

- Developed a novel model for participatory budgeting with bandit feedback.
- Proposed a pure exploration algorithm and derived its 'simple regret' guarantee.
- Demonstrated better guarantees than vanilla linear bandits by exploiting the problem structure.
- Performing experiments with real-world data to demonstrate the effectiveness of our algorithm.

Sparse Posterior Sampling Reinforcement Learning *Jul '23 – Present*
Guide:- Prof. Furong Huang (Dept. of Computer Science, University of Maryland)

- Developing new theory using Kernelized Stein Discrepancy in PSRL for sparse environments.
- Work aims to provide theoretical guarantees on regret as well as strong empirical performance.

- Performing experiments to validate our theory with simulation benchmarks.

Linear Bandits with Rotting Rewards *Sep '22 – Present*
BTech Project Part 2, Guide:- Prof. Arpan Chattopadhyay (Dept. of Electrical Engineering, IIT Delhi)
- Formulated the problem of rotting multi-armed bandits in a linear reward setting.
- Developing a UCB-like algorithm for this problem with proper regret analysis.
- Creating simulations to test the performance of the developed algorithm in practice.

Inverse Reinforcement Learning with Constraint Recovery[Paper] *(Published in PReMI 2023, to appear in Springer Lecture Notes in Computer Science)* *Dec '21 – Dec'22*
BTech Project Part 1, Guide:- Prof. Arpan Chattopadhyay (Dept. of Electrical Engineering, IIT Delhi)
- Developed the problem formulation for inverse reinforcement learning along with constraint recovery in constrained Markov Decision Processes using Maximum Likelihood Estimation and Convex Optimization based on the Principle of Maximum Entropy.
- Developed a novel algorithm based on exponentiated gradient descent to obtain the solution of the constrained optimization.
- Work focuses on recovering both the reward and the constraint from demonstrations generated by an agent that follows an optimal policy in a CMDP.
- Developed various grid-world simulations to test the proposed algorithm empirically and demonstrate its efficacy. Paper link: `https://arxiv.org/abs/2305.08130`

A View Independent Classification Framework for Yoga Postures[Paper][Code] (*Published in Springer Nature Computer Science*) *Mar '21 – Jul'21*
Guide:- Prof. Rahul Garg (Dept. of Computer Science and Engineering, IIT Delhi)
- Built Yogasana classifier from video frame data using Deep Learning based Pose Estimation and Random Forest.
- Developed pipeline is simple and fast but performs better than all the existing methods with an **accuracy of over 98%**.
- Developed a novel tri-level evaluation framework that gives a better estimate of the generalizability of the models as the existing methods suffer from target leakage.
- Work has been published in *Springer Nature Computer Science*. Paper can be found at *https://doi.org/10.1007/s42979-022-01376-7*

Mini Project: Explorations in Machine Learning[Report][Code] *Aug'21 – Nov'21*
Guide:- Prof. Jayadeva (Dept. of Electrical Engineering, IIT Delhi)
- Extensively studied Tensor Factorization and its use in data compression and applied it in Minimal Complexity Machines to generate a faster and more interpretable pipeline.
- Developed a Separability based Classification Loss function for Neural Networks and demonstrated results on MNIST for classification tasks with better separation.

LightGBM based BotNet Detection Tool[Code] *Aug'20 – Aug'20*
Self Project as a part of Cybersecurity Hackathon organized by IIT Kanpur
- Developed a Botnet Detection Tool on network packet capture data using Gradient Boosted Decision Tree based LightGBM implementing feature extraction and feature design and compared it with AdaBoost and Random Forest
- Our pipeline was faster in training as well as inference while performing better in precision, recall and F1-score ($\sim 99\%$)
- Won the 3rd Prize for the tool among 1200+ participants from various countries

PROFESSIONAL EXPERIENCE

Reinforcement Learning in Large Action Spaces *Aug'23 – Present*
As a part of Research Internship at Microsoft Research India, Bengaluru, India
Manager:- Gaurav Sinha
- Working on problems related to reinforcement learning in large action spaces
- Currently developing novel algorithms for multi-armed bandits with large number of arms

Credit Card transactions frauds classifier using Semi-supervised Deep Learning *Jun'22 – Jul'22*
As a part of Industrial Internship at Mastercard AI Garage, Gurugram, India
- Developed a Semi-supervised Deep Learning Technique for Fraud Detection in credit card transactions
- Investigated the method using multiple ablation studies to demonstrate the effectiveness of each component of the proposed scheme

- Built an end-to-end pipeline on the company's internal dataset for real-time detection with high precision and recall
- Researched and implemented methods of Learning with Noisy Labels and its applications for better semi-supervised learning in class imbalanced data
- Validated the methods on public dataset demonstrating **high F1-score (0.78) and high recall (0.78)** under **extreme class imbalance** (class-wise training samples - 110000:190)

Designing a Question/Answer Recommender System Model *Sep'20 – Jan'21*
As a part of an internship at the start-up Creatospace, India
- Developed a Question/Answer Recommender System Model for Stack Overflow-like forums where users are recommended with questions to answer and with answers that may be relevant to their interests.
- Used Content-Based and Model-Based approaches as baseline and researched on SVD and Neural Network based approaches.

COURSE PROJECTS

Resource Monitoring and Scheduling Algorithms[Code] *Spring '22*
Course:- Operating System, Guide:- Prof. Smruti Sarangi (Dept. of Computer Science and Engineering, IIT Delhi)
- Created system calls for listing the running processes, the amount of memory available, and the number of context switches a process undergoes.
- Implemented 3 types of scheduling algorithm–First-come-first-serve, Multi-level-queue and Dynamic-multi-level-queue and obtained the process statistics like average ready, run and sleep duration.
- The project was developed on the popular xv6 operating system.

Graph UMAP *Spring '22*
Course:- Advanced Machine Learning, Guide:- Prof. Sandeep Kumar
- Developed the graph version of UMAP using Graph Convolution Networks to extend the method to Graph data so that data points can be projected from higher dimension to lower dimension while preserving the data geometry.
- Modified the UMAP Loss function to incorporate the pre-existing graph structure of the data to obtain a richer embedding that captures the data distribution well.
- Demonstrated the superiority of our method on standard Graph datasets like CORA and PubMed over vanilla UMAP by showing that the 2D projection of the data obtained by our method showed better cluster structure than the vanilla UMAP.

Linear Regression for Seasonal Data[Project Link] *Fall '21*
Course:- Machine Learning, Guide:- Prof. Sumeet Agarwal
- Designed a linear regression model in Python to fit a dataset displaying a seasonal pattern.
- Used Fourier basis function as the non-linear feature map to capture the seasonal component in the data.
- Tuned the hyperparameters of the model to obtain low RMSE loss on both train and unseen test data.
- Achieved *3rd position* in the leaderboard on Kaggle among the entire class

Car Suspension System Design *Spring '20*
Course:- Control Engineering, Guide:- Prof. Deepak Patil
- Mathematically modelled the suspension system of a car to obtain a simplified control system model.
- Analysed the stability of the system under various jerk profiles like step obstaclea and sinusoidal bumps.
- Modelled the system in MATLAB to obtain simulation reports for various parameters of the system so as to identify the best set of parameters for user comfort.

SKILLS

Languages: C, C++, Python, Java
Deep Learning: TensorFlow, Keras, PyTorch
Libraries: NumPy, SciPy, Matplotlib, Scikit Learn, Pandas, Cvxpy
Scientific Computing: High Performance Clusters (PBS), Amazon Web Services
Utilities: Linux, Git, Excel, LaTeX

RELEVANT COURSEWORK

Alphabet in the bracket indicates the grade (A = 10/10, A- = 9/10, B = 8/10, B- = 7/10, NP = Audit)

Artificial Intelligence: Online Learning and Optimization(A), Advanced Machine Learning(NP), Stochastic Control and Reinforcement Learning(A), Machine Intelligence and Learning(A)

Mathematics: Mathematics for Machine Learning(A), Convex Optimization(A), Probability and Stochastic Processes(B), Linear Algebra and Differential Equations(A), Calculus(A)

Computer Science: Concentration Inequalities and their Applications in CS(NP), Data Structure and Algorithms(NP), Operating System(A-), Computer Architecture(B-), Introduction to Programming(A-)

EXTRACURRICULAR ACTIVITIES

1. Teaching Assistant, IIT Delhi *Jan'23 – Present*

Course Name: Stochastic Control and Reinforcement Learning

- Guiding students in their course projects by providing them with suitable topics, solving their doubts and helping them understand current research trends.
- Evaluating assignment solutions on *Average Reward MDP* turned in by the students and providing constructive feedback.

2. Student Mentor, Board for Student Welfare, IIT Delhi *Jul'21 – Mar'22*

Board for Student Welfare is an autonomous student body under a faculty member working towards the well-being and guidance of students at IIT Delhi on various academic and extra-curricular activities so as to ensure their overall growth and development throughout the duration of their study.

- Mentored five Freshmen throughout their first year of study, helping them in their professional and personal growth and ensuring that they transition smoothly from high school to college.
- Played a key role in instilling a sense of pride and confidence among the students and orienting them to adjust to the academic and social aspects of the institute

3. Academic Mentor, Board for Student Welfare, IIT Delhi *Nov'21 – Mar'22*

- Selected among other students in 3rd and 4th years to help Fresher students in their course *Engineering Mechanics*
- Regularly organized tutorial classes discussing various problem-solving techniques and also the theoretical aspects of the course.

4. Journalist, Board for Student Publication, IIT Delhi *Sep'20 – Apr'21*

Board for Student Publication is the journalistic body run by students under a faculty member to investigate, report and collect data regarding any significant events happening on the campus pertaining to the campus community.

- Organized the annual Literary Fest; conducted interviews of the elected student representatives to assess their tenure; arranged talks by eminent personalities; conducted surveys on the demography of the Freshmen and interpreted the data to derive various insights.

5. Executive, Electrical Engineering Society, IIT Delhi *Sep'20 – Apr'21*

Electrical Engineering Society is the community of students and faculty members of the EE department of IIT Delhi. Its primary role is to act as a platform for the students to connect with the faculty members and the alumni.

- Organized talks, workshops, technical competitions, seminars and conducted interviews of successful alumni for the benefit of the students of the EE department.

6. Volunteer, National Services Scheme, IIT Delhi *Aug'19 – Oct'22*

- Taught mathematics to underprivileged children of various classes to kindle an interest in the subject and to help them perform well in their school as these students cannot afford private tutors.