Shreyas Kowshik

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Interests

Machine Learning, Statistics, Time Series Analysis, Probabilistic Reasoning, Deep Generative Modelling

Education

Indian Institute of Technology Kharagpur Kharagpur, WB

Integrated Msc. in Mathematics and Computing *Expected May 2022*

- Micro Specialization in Optimization Theory and Applications
- CGPA : 9.28/10
- Department Rank 2/56

PUBLICATIONS

1. **Independence-Based Learning of Structured-Decomposable Probabilistic Circuit Ensembles**, *Published at the Tractable Probabilistic Models Workshop in UAI, 2021*
2. **Graph representation learning for road type classification**, *Published in Pattern Recognition Journal*
3. **Multi Output Learning using Task Wise Attention for Predicting Binary Properties of Tweets : Shared-Task-On-Fighting the COVID-19 Infodemic**, *Published at the NLP4IF workshop in NAACL, 2021*
4. **Real-Time Lane Detection, Fitting and Navigation for Real-Time Applications in Unstructured Environments**, *Published at the International Conference On Image,Video Processing and Artificial Intelligence, 2019*
5. **Traffic Sign Classification Using Hybrid HOG-SURF Features and CNNs**, *Published at the International Conference On Pattern Recognition Applications and Methods, 2019*

Research and Industry Experience

Change in Mean Detection of a Time Series [Master's Thesis] August 2021 - Present

Guide : Prof. Buddhananda Banerjee, Department of Mathematics *IIT Kharagpur*

- Surveyed literature and formulated the problem as a hypothesis test. Read about convergence, brownian motion, self-normalization and non-monotonic power problems in such statistics.
- Proposed a self-normalizing statistic that achieves a sharper power rise compared to prior propositions
- Derived the self-normalizer for the proposed statistic and constructed consistent kernel-based estimators

Independence Based Learning of Probabilistic Circuit Ensembles May 2020 - April 2021

Guide : Prof. Guy Van den Broeck, Yitao Liang, StarAI Lab *University of California, Los Angeles*

- Worked on Structure-Learning of **Probabilistic-Circuits**, a class of **tractable probabilistic models**.
- Proposed a theoretical framework to reason about a circuit's performance in terms of its captured independences.
- Developed a novel initialization strategy for EM-based circuit ensembles using the above framework.
- Designed a **GPU-Kernel** to obtain **10x improvement** in pairwise-mutual-information computation.
- The proposed algorithm obtained **State of the Art** results on **14/20 density estimation benchmarks**.
- Work accepted at the **Tractable Probabilistic Models Workshop, UAI'21**.

Audio-Visual Automatic Speech Recognition May 2021 - June 2021

Mentor : Basil Abraham *Microsoft IDC, Hyderabad*

- Worked in the STCI Speech Group on **Audio-Visual Automatic Speech Recognition**.
- Extracted different features for video and audio modalities including frequency and embedding based features.
- Developed a **proof of concept** for **improving ASR** performance under **noisy scenarios** by incorporating visual information in the model. Experimented with different architectures and feature incorporation approaches.
- Obtained a **6% relative WER improvement** over the baseline having no visual features after experimentation.

Graph Representation Learning for Road Networks April 2020 - July 2020

Guide : Prof. Michael Felsberg, Computer Vision Lab *Linkoping University, Sweden*

- Worked on the problem of **Graph Representation Learning** for real world road networks.
- Trained various variants of GraphSAGE, Graph-Attention-Networks, GraphGANs and Gated-Attention-Networks.
- Formulated and implemented a **DFS-based aggregation** scheme to capture community structures in graphs.
- Work accepted at **Pattern Recognition Journal**.

Google Summer Of Code May 2019 - August 2019

Mentors : Dhairya Gandhi, Elliot Saba *Remote*

- Was among **15** students worldwide to be selected under **The Julia Language** for **GSoC 2019**.
- Worked on creating open-source machine-learning paper implementations in Julia.
- Implemented and trained **pix2pix**, **Cycle-GAN**, and **Image Captioning** networks **from scratch**.
- Created a library for reinforcement learning with from scratch implementations of **PPO** and **TRPO**.
- Added the **Group Normalization** feature to **Flux.jl**, the machine learning library of **Julia**.

Autonomous Ground Vehicle Research Group May 2018 - May 2020

Guide : Prof. Debashish Chakravarty *IIT Kharagpur*

- Team Autonomous Ground Vehicle (AGV) is a multi-disciplinary research group working on varied modules like Control Systems, Planning, SLAM, Computer Vision, etc. for autonomous vehicles.
- Implemented **MobileNet-SSD** for **traffic sign detection**. Proposed a two stage detection-classification approach using the German-Traffic Sign Benchmark to account for the sparse datasets on Indian Signs. Obtained **real-time** performance of **50+ FPS** by integrating the with the **Object Tracking Module**.
- Trained **adversarial and non-adversarial models** for end-to-end **lane-detection and road-segmentation**. Pipeline worked at real-time speeds of **30+FPS on a 970mx GPU**.
- Designed and implemented the **planning and perception module** for autonomous mobile robots **Eklavya 6.0 and Eklavya 7.0** which could autonomously navigate in constrained environments while avoiding obstacles and following GPS waypoints winning **runners-up** in **IGVC'18&19**.

Key Technical Projects

Uncertainty Estimation in Deep Neural Networks

Advanced Machine Learning Course Project

- Surveyed papers on uncertainty estimation in neural networks, understanding their theoretical motivations.
- Implemented multiple methods like Monte-Carlo Dropout, SGLD, pSGLD and Bayes by Backprop .
- Evaluated networks on out-of-distribution data to get uncertainty estimates as a proof-of-concept.

Machine Learning for Portfolio Optimization

Optimization Methods in Finance Course Project

- Built forecasting models to predict future stock prices of 30 stocks using LSTMs, LR and SVR.
- Selected the top four stocks based on predicted returns to develop a portfolio.
- Built a Markowitz Model with a varianace minimzation optimization objective for portfolio weight allocation.
- Portfolio that included predictive information got better sharpe-ratios on test-data compared not one not using it.

Predicting Binary Properties of Tweets

Self Participation in NAACL'21 Shared Task

- Problem was to answer 7 binary questions on a given tweet pertaining to its authenticity/impact.
- Formulated multi-question-answering as a multi-task-learning problem.
- Proposed a multi-head-attention based architecture for inter-task information aggregation.
- Entry won runners-up position leading to publication in workshop proceedings.

Regression Analysis for Medical Cost Estimation

Regression and Time Series Analysis Course Project

- Built statistical linear regression models to predict medical costs of patients.
- Improved R-squared value of the fit by implementing and analysing residuals-vs-fitted, scale-location, residuals-vs-leverage and normal-qq plots.

128-Bit AES-Feistel Cipher

Cryptography and Network Security Course Project

- Implemented a hybrid block cipher for encrypting inputs of length 128-bits.
- The first 5 rounds are AES followed by a custom designed Feistel Cipher with variable number of rounds. Finally 5 rounds of AES follow.

Technical Skills

Programming Languages: C, C++, Python, Julia, R, SQL, LaTeX
Libraries and Tools: OpenCV, STL, Numpy, Tensorflow, Pytorch, Scikit-Learn, CUDA, ROS, GDB

Major Honors and Awards

- **Runners-Up** in the Shared Task in the **NLP4IF workshop, NAACL'21**.
- **Inter IIT Technology Meet, 2021** : Part of the team winning **Bronze** in the Bosch Traffic Sign Recognition Challenge and the overall **Bronze winning contingent** of IIT Kharagpur.
- Part of the **National Finalist** team among 13 teams for the Mahindra Rise Prize Driverless Car Challenge.
- Part of **Runners-Up** team in Auto-Nav Challenge at the Intelligent Ground Vehicle Competition, 2019.
- Hold a **Department Rank Of 2** among **56** students and academically among **top 5 percent/1300**.
- **Pan-IIT Hackathon'19** : Among the only UG sophomore team from the institute to qualify for the national final round.
- **Runners-Up** in Pixelation, a computer-vision hackathon in NSSC, 2018.
- **Second Runners-Up** in Fortress, a computer-vision hackathon in Kshitij'18.
- Cleared the **Indian National Chemistry Olympiad** [National rank **35/40000**].
- Cleared the **National Physics & Astronomy Olympiads** Stage-1. [**Top-1%(Country) / 40000**]
- Recipient of the prestegious **KVPY scholarship** [National rank **18 / 0.1million**].
- Recipient of the **Inspire scholarship** from the Government Of India.
- Placed **712 / 0.2million** in **JEE-Advanced, 2017** and **210 / 1.3million** in **JEE-Mains, 2017**.

Course Work

Statistics and Optimization: Probability&Statistics, Operations Research, Advanced Numerical Techniques, Regression and Time Series, Stochastic Processes, Non-Linear Programming, Optimization Methods in Finance
Mathematics: Linear Algebra, Abstract Algebra, Discrete Mathematics, Partial Differential Equations, Real Analysis
Computer Science: Design & Analysis of Algorithms, Object Oriented Systems, Machine Learning, Advanced Machine Learning, Operating Systems and Systems Programming, Computer Organization and Architecture, Computer Networks, Parallel Programming, Natural Language Processing, Image Processing, Soft-Computing Tools, Database Systems
Online: CS231n, Reinforcement Learning by David Sliver, Financial Markets by Yale

Leadership and Extra Curriculars

- **Entertainment Cup Captain** of **Nehru Hall of Residence**. Managed a budget of INR 80k.
- Mentored 1st year freshers in a week long **IEEE certified Winter Workshop** on **Image Processing**.
- Won **Bronze** in Intra-University event **Open-IIT Instrumentals** for playing the keyboards.
- Wrote a blog on game development using Unity-3D capturing over **2k** views overall.