Jayabrata Chowdhury

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Summary

- Working on predictive planning algorithm for autonomous systems using **Deep Learning** techniques
- Experience in converting real-world problems in autonomous systems in a **modular Machine Learning based problem** with an accepted paper at **Annual AAAI Conference on Artificial Intelligence, 2024**
- Currently developing scalable uncertainty-aware Deep Learning based algorithm; **Received Qualcomm Innovation Fellowship for project**
- Having industrial modular ML-based project experience with **WIPRO IISc Research Innovation Network (WIRIN); Received RBCCPS PhD Fellowship and best poster award for this work**
- **Received Gold Level certificate in WorldQuant Challenge** for developing a probabilistic model for prediction of uncertain real-world financial market using proprietary simulation environment WorldQuant Brain
- **Experience in Deep Unsupervised Learning, Deep Reinforcement Learning, Optimization, Natural Language Processing (NLP), and finetuning Large Language Models (LLMs)**

Education

Robert Bosch Centre for Cyber-Physical Systems, Indian Institute of Science — *Bangalore, India*

PH.D. IN CYBER-PHYSICAL SYSTEMS — *Aug. 2019 - Present*

- Working on Uncertainty-aware predictive motion planning for autonomous vehicles using Deep Learning
- Related coursework
  - Linear Algebra
  - Stochastic Models and Applications
  - Computational Methods of Optimization
  - Machine learning
  - Introduction to Deep Learning
  - Deep Reinforcement Learning
  - Control Systems Design

Kalyani Government Engineering College — *Kalyani, India*

B.TECH IN ELECTRICAL ENGINEERING — *Aug. 2014 - Jul. 2018*

- Worked on electrical smart grids

Honors & Awards

2023	**Gold Level**, **WorldQuant Challenge 2023**,→certificate	*Bangalore, India*
2023	**Qualcomm Innovation Fellowship**, Academic year: 2023-2024,→link	*Bangalore, India*
2022	**Best Poster Award**, **Sixth Annual Symposium on Cyber-Physical Systems (CyPhySS 2022)**,→certificate	*Bangalore, India*
2021	**RBCCPS Ph.D. Fellowship**, Academic year: 2021-2022	*Bangalore, India*

Research Projects

Imitation-based Predictive Maneuver Planning (PMP) for Autonomous Vehicles — *Completed*

SKILLS: DATA ANALYSIS, PREDICTIVE MODELING, SUPERVISED LEARNING, UNCERTAINTY ESTIMATION, PYTHON, PYTORCH, MATLAB

- Designed trajectory **prediction module** using a **Memory Neuron Network (MNN)** without HD maps
- The uncertainty in the trajectory prediction module has been encoded in the predictive occupancy map of the surrounding context.
- Highly imbalanced real-world NGSIM US-101 and I-80 highway datasets are employed for evaluating the model.
- **Imitation learning (supervised learning)** method has been used for training
- **Datasets are highly imbalanced long-tail datasets. Special data pruning methods are developed to prevent network overfitting**

Data-driven Reinforcement Learning (RL) based PMP for AVs *Completed*

Skills: Data Analysis, Reinforcement Learning, Predictive Modeling, Python, PyTorch

- Imitation learning can suffer from the **data distribution shift**. Also, it can suffer from **long-tail corner cases**
- Hence, an RL-based decision-making system with **Double Deep Q Network** has been designed for high-level lateral and longitudinal decisions
- A dynamics model of the ego vehicle changes the high-level discrete decisions to continuous decisions
- **The sparse reward problem of the RL has been addressed with the dense reward design with an imitation learning of human driving behaviors**
- A simulation environment creation based on NGSIM data for open loop evaluation
- Compared to the imitation learning-based method, the results show an improvement of 35.69% and 51.20% in passenger comfort (less jerking).

Predictive Planning for AVs Using Graph-based Interaction Model *Completed*

Skills: Unsupervised Learning, Deep Reinforcement Learning, Uncertainty Estimation, Graph modeling, Python, PyTorch

- Driving in a complex urban environment requires safe planning in **Out-Of-Distribution** scenarios
- This work models the interaction between traffic participants as a **dynamic graph model**
- A **Conditional Variational Auto-Encoder (C-VAE)** has been developed to understand the behaviors of different pedestrians and vehicles
- The C-VAE network outputs the parameters for a **Gaussian Mixture Model (GMM)** with standard deviation as uncertainty in trajectory prediction
- These predictions are incorporated in the observation space, and a **Proximal Policy Optimization (PPO) algorithm** has been trained for steering and throttle commands for the AV in the CARLA simulation environments
- Observed improved CARLA Leaderboard, and No crash benchmarks compared to previous **Graph Convolutional Network (GCN)** and **Graph Attention Network (GAT)** model-based motion planning.
- **Received the prestigious Qualcomm Innovation Fellowship for this work**

Attention-oriented Interpretable Planning with Deep Reinforcement Learning *Currently working*

Skills: Attention modeling, Deep Reinforcement Learning, Python, PyTorch

- Safe driving requires different attention to different traffic participants to **interpret the decisions**
- This work **models attention mechanism to help the self-driving vehicle for motion planning**
- The evaluation is going to be done with real-world scenarios inside SMARTS simulation engine

Publications

Graph-based Prediction and Planning Policy Network (GP3Net) for scalable self-driving in dynamic environments using Deep Reinforcement Learning *Submitted and Accepted, 2023*

Accepted Conference: 38^{th} Annual AAAI Conference on Artificial Intelligence, 2024

- Accepted at 38^{th} Annual AAAI Conference, 2024. Acceptance rate: 23.75%→PDF
- Related project: **Predictive Planning for AVs Using Graph-based Interaction Model**

An efficient Deep Spatio-Temporal Context Aware decision Network (DST-CAN) for Predictive Manoeuvre Planning *submitted, 2022*

Journal: IEEE Transactions on Intelligent Transportation Systems

- Submitted to the journal. Currently under final revision. →PDF
- Related to the project: **Imitation-based Predictive Maneuver Planning (PMP) for Autonomous Vehicles**

Predictive Maneuver Planning with Deep Reinforcement Learning (PMP-DRL) for Comfortable and Safe Autonomous Driving *Submitted, 2023*

Journal: IEEE Transactions on Intelligent Transportation Systems

- Submitted to the journal for review. Currently under first revision. →PDF
- Related to the project: **Data-driven Reinforcement Learning (RL) based PMP for AVs**

Technical skills

Machine Learning related skills

Skills

- Probabilistic Modelling, Deep Learning, Reinforcement Learning, Generative AI, Uncertainty Estimation, Predictive Analysis, Data Science

Programming

Skills

- Python, C++, Bash

Software Utilities

Skills

- Git, Visual Studio Code, LATEX, Robot Operating System (ROS), MATLAB

Machine Learning Related Libraries

Skills

- Numpy, PyTorch, Matplotlib, OpenAI Gym, HuggingFace, Pytorch Lightning, TensorFlow

Operating System

Skills

- Linux, Windows

Certificates

2023	**1. Uncertainty Quantification for Risk-Informed Decision Making**, offered by Axis Bank Centre for Mathematics and Computing→certificate	*IISC*
2023	**2. Machine Learning Specialization**, offered by Stanford Online and DeepLearning.AI→certificate	*Coursera*
2023	**3. Unsupervised Learning, Recommenders, Reinforcement Learning**, offered by Stanford Online and DeepLearning.AI→certificate	*Coursera*
2023	**4. Natural Language Processing with Classification and Vector Spaces**, offered by DeepLearning.AI→certificate	*Coursera*
2023	**5. Visual Perception for Self-Driving Cars**, offered by University of Toronto→certificate	*Coursera*
2023	**6. Advanced Learning Algorithms**, offered by Stanford Online and DeepLearning.AI→certificate	*Coursera*
2023	**7. Python and Statistics for Financial Analysis**, offered by The Hong Kong University of Science and Technology→certificate	*Coursera*
2022	**8. Introduction to Self-Driving Cars**, offered by University of Toronto→certificate	*Coursera*
2022	**9. Supervised Machine Learning: Regression and Classification**, offered by Stanford Online and DeepLearning.AI→certificate	*Coursera*
2022	**10. Improving Deep Neural Networks: Hyperparameter Tuning, Regularization and Optimization**, offered by DeepLearning.AI →certificate	*Coursera*
2022	**11. Neural Networks and Deep Learning**, offered by DeepLearning.AI →certificate	*Coursera*
2021	**12. Introduction to Intel Distribution of OpenVINO toolkit for Computer Vision Applications**, offered by Intel →certificate	*Coursera*
2021	**13. Robot Operating System: File system, Topics and Services**, offered by Artificial Intelligence and Robotics Park (ARTPARK), Bangalore →certificate	*ARTPARK*