**Curriculum Vitae – Ph.D. in Robotics**

# Nehar Poddar

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A mathematician and an engineer who loves to train neural networks.
Enthusiastic about writing algorithms, playing board games, solving puzzles, reading poetry, and nurturing plants.

## EDUCATION

**MSc in Applied Mathematics - Northeastern University (Boston, USA)** ***Aug 2019 - May 2021***
**BTech in Mechanical Engineering - NMIMS (Mumbai, India)** ***June 2015 - May 2019***

***Mathematics*** - Mathematical Modeling, Optimization and Complexity, Probability, Graph Theory, Stochastic Processes, Abstract Algebra, Advanced Linear Algebra, Multivariable Analysis, Real Analysis, Number Theory
***Computer Science*** - Algorithms, Machine Learning, Deep Learning, Reinforcement Learning, Computer Vision
***Engineering*** - Design of Machine Systems, Additive Manufacturing, Finite Element Analysis, Control Systems, Thermodynamics, Fluid Dynamics, Operations Research

## RESEARCH INTERESTS

My research interests revolve around improving the capabilities of autonomous mobile robots through advancements in 3D environment modeling and navigation of unknown terrains. I am keen on leveraging deep neural networks, graphical models, and optimization techniques to improve sensing and decision-making in these systems.

## EXPERIENCE

**Machine Learning Engineer - DEKA Research and Development Corp.** ***Jan 2021 - Present***

1. **Autonomous Delivery Robot - FedEx ROXO**

- Currently engaged in the development of a deep learning sensor fusion model aimed at creating a comprehensive global occupancy grid. This involves integrating data from lidar, radar, mono, and stereo cameras to enhance terrain analysis and drivability assessment.
- Created efficient active machine learning pipelines that streamlined data collection, model selection, model training, hyperparameter tuning, uncertainty estimation, and model deployment. Generated embedding maps to visualize and understand data better.
- Deployed a robust Encoder-Decoder approach for RGB-D Semantic Segmentation, achieving an 84% overall accuracy in categorizing different surfaces.
- Deployed a Self-Attention-based scene text recognizer for number plate identification achieving a 94% accuracy.
- Formulated algorithms to identify and fill depth holes caused by stereo cameras, encompassing the deprojection of 3D points to the base link frame, generation of normal maps, polarization, ray generation, and weighted interpolation. This resulted in accurate algorithmic segmentation of the scene to discern drivable and non-drivable surfaces.
- Executed RANSAC, PnP, and ICP algorithms in ROS and C++ to automate the extrinsic calibration process for all sensors, significantly reducing calibration time from 60 minutes to a mere 3 minutes.

2. **Insulin Pump - delivers precise doses of insulin to manage blood glucose levels in individuals with diabetes**

- Devised a personalized differential equation model for calculating basal and bolus insulin rates in individuals utilizing continuous glucose monitor readings. The model considers factors such as mealtimes, meal types, age, and gender to provide tailored insulin dosage recommendations.
- Currently investigating Reinforcement Learning , Transformer and GAN techniques on time series data to enhance the autonomy and reliability of the insulin pump. The aim is to optimize insulin delivery without relying on user-input meal information.

3. **Infusion Pump - delivers medications into a patient's body in a controlled manner.**

- Developed a comprehensive system that utilizes vision detection algorithms, specifically Hough transforms, to analyze RGB images captured by the camera within the pump. By detecting and tracking drops and streams, this system accurately calculates the flow rate of the liquid passing through the pump.
- Employed a versatile cost function to inform decision-making based on multiple detection outputs.
- Utilized dynamic time warping (DTW) and Fourier transforms for accurate time syncing of flow estimation outputs of the pump and ground truth (scale data).

**Machine Learning and Statistics Research Assistant - Nano-medicine Center (NEU)** ***Jan 2020 - May 2020***

- Implemented an automated method utilizing support vector machine (SVM) classification on whole-brain anatomical magnetic resonance imaging data to distinguish between patients with Alzheimer's disease and healthy elderly individuals. Achieved a mean correct classification rate of 83%
- Engineered a segmentation model that automatically partitioned 3D MR images into regions of interest (ROIs) and extracted significant gray matter characteristics.

**Teaching Assistant and Grader - Northeastern University**

- MATH 5131 - Introduction to Mathematical Methods and Modeling ***Fall 2020***
- MATH 1241 - Calculus 2 ***Spring 2020***
- MATH 1242 - Calculus 1 ***Fall 2019***

**Girls Angle Mentor - A supportive community for women and girls who study, use, and create mathematics.**

## SKILLS

***Programming Languages*** - Python, C++, MATLAB
***Software/Tools*** - PyTorch, CUDA, Pandas, NumPy, Scikit-Learn, OpenCV, ROS, Linux

## PROJECTS

**1. Exploring Attribute Distributions for Insights into the Capset Problem**

- Currently working on determining the size of capsets with 'n' attributes. Proposing that capsets follow specific distribution patterns, which, if identified, could lead to a breakthrough in determining their size.

**2. Mathematical Modeling of the Spread of Ideas**

- Developed a system of differential equations that combined SIR (Susceptible-Infectious-Recovered) and population growth models to simulate the dynamics of the spread of an idea. Explored the potential existence of cyclical patterns within the model.
- Conducted quantitative analysis for scenarios where user flow rates are both identical and varying, examining the impact on the overall behavior of the idea's diffusion.

**3. Analysis to Investigate the Association between Crime Count and Weather Conditions with Days of the Week**

- Conducted comprehensive statistical analysis on five years of hourly data for the city of Boston.
- Formulated clear objectives and designed hypothesis tests to investigate the statistical significance of high crime activities and adverse weather conditions as potential reasons for canceling outdoor plans on weekends.

**4. Probabilistic Algorithm to Solve the Sudoku**

- Implemented an algorithm for a solution to the Sudoku puzzle based on Sinkhorn balancing (an algorithm for projecting a matrix onto the space of doubly stochastic matrices). It demonstrates high efficacy in solving complex puzzle variants.
- Presented a proof of convergence for the algorithm, validating its reliability and effectiveness.

**5. A Data-Driven Approach to Predicting the Failures of a Drug (Kaggle Tabular Data Challenge)**

- Developed an innovative system that leverages a hybrid eXtreme Gradient Boosting (XGBoost) model with hyperparameter tuning to predict drug failure cases accurately and promptly.
- Designed the system with the primary goal of facilitating early identification of factors that may contribute to drug failure, ultimately reducing risks and enhancing patient safety.

**6. Book Recommendations for Users of The Manchester Public Library**

- Generated personalized book recommendations for users of The Manchester Public Library using collaborative filtering techniques on implicit library user data.
- Applied an alternating least-squares optimization process, iteratively refining user-factors and book-factors to minimize the cost function and enhance recommendation accuracy.
- Resulted in highly tailored suggestions, promoting user satisfaction and engagement with the library's collection.