

# Neel P. Bhatt

RESEARCH SCIENTIST · CENTER FOR AUTONOMY · ODEN INSTITUTE

The University of Texas at Austin, Texas, USA

[✉ npbhatt@utexas.edu](mailto:npbhatt@utexas.edu) | [💻 neel1302.github.io](https://github.com/neel1302) | [🔗 linkedin.com/in/neelbhattportfolio](https://linkedin.com/in/neelbhattportfolio) | [CID ORCID](https://orcid.org/0000-0002-1349-134X) | [Google Scholar](https://scholar.google.com/citations?user=000000021349134X&hl=en) | [YouTube](https://www.youtube.com/channel/UCtPjyfzrJLcOOGdXWVQDw)

## Research Interests

Verification-Centric AI, Neurosymbolic Learning, Multi-Modal Generative Models, Assured Perception and Planning for Robotics, Computer Vision, Uncertainty Quantification, State Estimation, Sequential Decision-Making, Autonomous Systems, Real-World Deployment.

## Education

### University of Waterloo

Doctor of Philosophy (PhD) - Mechatronics Engineering (Advisors: [A Khajepour](#) and [E Hashemi](#))

Sept 2018 - May 2023

Waterloo, ON - Canada

- Research focus: Spatially-aware [multi-agent object motion prediction](#) for autonomous driving using RL and potential fields
- Project Lead: [WATonoBus: First Canadian all weather autonomous shuttle in operation on public roads](#)
- Head Course TA for [ME780: Autonomous Driving](#)
- **Courses:** ML, RL, DL, Robotics, Autonomous Driving, Adaptive Control, Tools for Software Eng., Mechatronics System Integration

### University of Toronto

Bachelor of Applied Science (BASc) with High Honours - Mechanical Eng. - Robotics Minor - GPA: 3.97/4

Sept 2014 - June 2018

Toronto, ON - Canada

- Among the [top 3](#) winners for the [capstone design project competition](#) across the department
- Ranked in the [top 5%](#) of all students in the department

- **Courses:** Robotics, Mechatronics Principles, Mechatronics Systems: Design and Integration, Control Systems

## Experience

### The University of Texas at Austin

Research Scientist (Since Jul 2025); Postdoctoral Fellow (Prev.), [Center for Autonomy, Oden Institute](#)

Sept 2023 - Present

Austin, TX - USA

- Working with Professor [Atlas Wang](#) and [Ufuk Topcu](#) as a part of the [Autonomous Systems Group](#) and the [VITA Research Group](#) at the University of Texas at Austin.
- Research centered at developing neuro-symbolic architectures for generative AI, trustworthy sequential decision-making using multi-modal foundational models, and assured active perception for autonomous systems.
- Developing neuro-symbolic perception and planning architectures for rapid transfer and scaling as part of [DARPA ANSR](#) and [TIAMAT](#) programs.

### University of Waterloo

Lead Research Scientist, [WATonoBus Autonomous Shuttle](#)

Sept 2018 - Sept 2023

Waterloo, ON - Canada

- Developed and implemented hardware and software architecture for perception, prediction, and decision-making including auto startup launch scripts, custom packages and drivers (Python/C++), multi-sensor fusion, system integration (ROS), and visualization.
- Led a team of several graduate students [achieving permit for daily operation and testing on public roads](#) as part of ministry's pilot program.

### University of Alberta

Visiting Research Scholar, [NODE Lab](#)

Jan 2021 - Present

Edmonton, AB - Canada

- Worked with Professor [Ehsan Hashemi](#) on several [research projects](#) covering RL-based decision making for human-autonomous system handover, visual and inertial odometry, SLAM, object detection, cooperative perception, and supervised several graduate students.
- Developed and implemented hardware and software architecture for NODE Lab's autonomous vehicle.

### General Motors R&D

AV Software Engineering Intern, [GM Global R&D Tech Center](#)

May 2019 - Sept 2019

Detroit, MI - USA

- Designed and implemented a novel real-time supervisory DL framework for vehicle velocity estimation consisting of a LSTM-based network architecture achieving > 95% accuracy on a large test set (Python, PyTorch) – ROI for patent submitted.
- Automated data generation and augmentation to ensure class balance and generalizability.

### WATonomous Self-Driving Vehicle

Perception Team Core Member, [GM AutoDrive Challenge](#)

May 2018 - Aug 2019

Waterloo, ON - Canada

- Worked on the [WATonomous](#) self-driving vehicle, training TensorFlow based object detection models with data augmentation to classify traffic lights and achieved higher accuracy on test images specific to application.

### Clearpath Robotics

Applications Engineering Intern, [Research and Development Center](#)

May 2017 - Sept 2017

Waterloo, ON - Canada

- Conducted [robot simulations](#) with Gazebo and ROS for line/person following demos presented at IROS 2017.
- Design focused on addressing needs of robot autonomy team for effective image processing, recognition, and control.

## University of Toronto

Research Intern, **Robotics Institute (NSERC USRA)**

- Worked with [Professor Yu Sun](#) at the [Robotics Institute](#), specifically at the Advanced Micro and Nanosystems Lab.
- Designed and fabricated an easy to use and maintain system for vibration and acoustic isolation of one of a kind Atomic Force Microscope (AFM) with resolution better than 0.05 nm.

May 2016 - Sept 2016

Toronto, ON - Canada

## University of Toronto

Research Intern

- Worked with [Professor Chul B. Park](#) and analyzed discrete event procedures and algorithms, studied mathematical structures behind, and designed experiments toward parametric study and simulation of relevant parameters that govern the geometry of cellular plastic structures.

May 2015 - Sept 2015

Toronto, ON - Canada

## Publications

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\* Denotes equal contribution and co-first authorship

### Journal Articles

- [J1] [Neurosymbolic AI as an Antithesis to Scaling Laws](#)  
Alvaro Velasquez, **Neel P. Bhatt**, Ufuk Topcu, Zhangyang Wang, Simon Stepputtis, Sandeep Neema, Gautam Vallabha  
*Proceedings of the National Academy of Sciences (PNAS) Nexus*, 2025
- [J2] [Privacy-Constrained Video Streaming](#)  
Minkyu Choi\*, Yunhao Yang\*, **Neel P. Bhatt\***, Kushagra Gupta, Sahil Shah, Aditya Rai, David Fridovich-Keil, Ufuk Topcu, Sandeep Chinchali  
Accepted at *Transactions on Machine Learning Research (TMLR)*, 2025
- [J3] [Adaptive and Soft Constrained Vision-Map Vehicle Localization Using Gaussian Processes and Instance Segmentation](#)  
Bruno Henrique Groenner Barbosa, **Neel P. Bhatt**, Amir Khajepour, Ehsan Hashemi  
*Expert Systems with Applications*, 2025
- [J4] [DynaNav-SVO: Dynamic Stereo Visual Odometry With Semantic-Aware Perception for Autonomous Navigation](#)  
Marcelo Cabrera, **Neel P. Bhatt**, Ehsan Hashemi  
*IEEE Transactions on Intelligent Vehicles (T-IV)*, 2024
- [J5] [A Survey on 3D Object Detection in Real-time for Autonomous Driving](#)  
Marcelo Cabrera, Aayush Jain, **Neel P. Bhatt**, Arunava Banerjee, Ehsan Hashemi  
*Frontiers in Robotics and Artificial Intelligence*, 2024
- [J6] [Consensus-Based Information Filtering in Distributed LiDAR Sensor Network for Tracking Mobile Robots](#)  
Isabella Luppi, **Neel P. Bhatt**, Ehsan Hashemi  
*Sensors*, 2024
- [J7] [Object Reconstruction and Localization in Indoor Environments Using Infrastructure Sensor Node](#)  
Soham Dasgupta, Venkata Devarakonda, Yifeng Cao, Minghao Ning, **Neel P. Bhatt**, Yufeng Yang, Ehsan Hashemi, Amir Khajepour  
*IEEE Sensors Journal*, 2024
- [J8] [MPC-PF: Socially and Spatially Aware Object Trajectory Prediction for Autonomous Driving Systems Using Potential Fields \[SOTA\]](#)  
**Neel P. Bhatt**, Amir Khajepour, Ehsan Hashemi  
*IEEE Transactions on Intelligent Transportation Systems (T-ITS)*, 2023
- [J9] [Integrated Inertial-LIDAR based Map Matching Localization for Varying Environments](#)  
Xin Xia, **Neel P. Bhatt**, Amir Khajepour, Ehsan Hashemi  
*IEEE Transactions on Intelligent Vehicles (T-IV)*, 2023
- [J10] [Infrastructure-Aided Localization and State Estimation for Autonomous Mobile Robots](#)  
Daniel Flögel, **Neel P. Bhatt**, Ehsan Hashemi  
*Robotics*, 2022

### Conference Papers

- [C1] [Comp4D: LLM-Guided Compositional 4D Scene Generation](#)  
Dejia Xu, Hanwen Liang, **Neel P. Bhatt**, Hezhen Hu, Hanxue Liang, Konstantinos N Plataniotis, Zhangyang Wang  
Accepted at the Winter Conference on Applications of Computer Vision (WACV), 2026
- [C2] [Know Where You're Uncertain When Planning with Multimodal Foundation Models: A Formal Framework \[1 of 61 accepted papers\]](#)  
**Neel P. Bhatt\***, Yunhao Yang\*, Rohan Siva, Daniel Milan, Ufuk Topcu, Zhangyang Wang  
*Conference on Machine Learning and Systems (MLSys)*, 2025, Santa Clara, USA
- [C3] [On The Planning Abilities of OpenAI's o1 Models: Feasibility, Optimality, and Generalizability \[65K YouTube Views\]](#)  
Kevin Wang\*, Junbo Li\*, **Neel P. Bhatt\***, Yihan Xi, Qiang Liu, Ufuk Topcu, Zhangyang Wang  
*Language Gamification Workshop @ NeurIPS*, 2024, Vancouver, Canada
- [C4] [Fine-Tuning Language Models Using Formal Methods Feedback: A Use Case in Autonomous Systems \[1 of 37 accepted papers\]](#)  
Yunhao Yang\*, **Neel P. Bhatt\***, Tyler Ingebrand\*, William Ward, Steven Carr, Zhangyang Wang, Ufuk Topcu  
*Conference on Machine Learning and Systems (MLSys)*, 2024, Santa Clara, USA
- [C5] [MM3DGS SLAM: Multi-modal 3D Gaussian Splatting for SLAM Using Vision, Depth, and Inertial Measurements \[Oral Pitch Finalist\]](#)  
Lisong C. Sun\*, **Neel P. Bhatt\***, Jonathan C. Liu, Zhiwen Fan, Zhangyang Wang, Todd E. Humphreys, Ufuk Topcu  
*IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2024, Abu Dhabi, UAE

- [C6] [Fine-Tuning Language Models Using Formal Methods Feedback](#)  
 Yunhao Yang\*, **Neel P. Bhatt\***, Tyler Ingebrand\*, William Ward, Steven Carr, Zhangyang Wang, Ufuk Topcu  
*Neuro-Symbolic Learning and Reasoning in the Era of Large Language Models (NuLeaR) Workshop @ AAAI, 2024, Vancouver, Canada*
- [C7] [WATonoBus: Field-Tested All-Weather Autonomous Shuttle Technology](#)  
**Neel P. Bhatt**, Ruihe Zhang, Minghao Ning, Algooneh Ahmad, Chen Sun, Pouya Panahandeh, Ehsan Mohammadbagher, Ted Ecclestone, Ben MacCallum, Ehsan Hashemi, Amir Khajepour  
*IEEE Intelligent Transportation Systems Conference (ITSC), 2024, Edmonton, Canada*
- [C8] [LiDAR-Based Navigation Using Normal Distributions Transform Filter](#)  
 Ali Shafiezadeh, **Neel P. Bhatt**, Ehsan Hashemi  
*IEEE Intelligent Transportation Systems Conference (ITSC), 2024, Edmonton, Canada*
- [C9] [A Stereo Visual Odometry Framework with Augmented Perception for Dynamic Urban Environments](#)  
 Marcelo Cabrera, **Neel P. Bhatt**, Ehsan Hashemi  
*IEEE Intelligent Transportation Systems Conference (ITSC), 2023, Bilbao, Spain*
- [C10] [MPC-PF: Social Interaction Aware Trajectory Prediction of Dynamic Objects for Autonomous Driving Using Potential Fields](#)  
**Neel P. Bhatt**, Amir Khajepour, Ehsan Hashemi  
*IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2022, Kyoto, Japan*
- [C11] [Augmented Visual Localization Using a Monocular Camera for Autonomous Mobile Robots](#)  
 Ali Salimzadeh, **Neel P. Bhatt**, Ehsan Hashemi  
*IEEE International Conference on Automation Science and Engineering (CASE), 2022, Mexico City, Mexico*
- [C12] [Real-time Pedestrian Localization and State Estimation Using Moving Horizon Estimation](#)  
 Ehsan Mohammadbagher\*, **Neel P. Bhatt\***, Ehsan Hashemi, Baris Fidan, Amir Khajepour  
*IEEE Intelligent Transportation Systems Conference (ITSC), 2020, Rhodes, Greece*

## Preprints

- [P1] [UNCAP: Uncertainty-Guided Planning Using Natural Language for CAVs](#)  
**Neel P. Bhatt**, Po-han Li, Kushagra Gupta, Rohan Siva, Daniel Milan, Alexander T. Hogue, Sandeep Chinchali, David Fridovich-Keil, Zhangyang Wang, Ufuk Topcu  
 Under submission at International Conference on Autonomous Agents and Multiagent Systems (AAMAS), 2026
- [P2] [VLN-Zero: Rapid Exploration and Cache-Enabled Neurosymbolic Vision-Language Planning for Zero-Shot Transfer in Robot Navigation](#)  
**Neel P. Bhatt**, Yunhao Yang, Rohan Siva, Pranay Samineni, Daniel Milan, Zhangyang Wang, Ufuk Topcu  
 Under submission at IEEE International Conference on Robotics and Automation (ICRA), 2026
- [P3] [RepV: Safety-Separable Latent Spaces for Scalable Neurosymbolic Plan Verification](#)  
 Yunhao Yang, **Neel P. Bhatt**, Runjin Chen, Zhangyang Wang, Ufuk Topcu  
 Under submission at Conference on Machine Learning and Systems (MLSys), 2026
- [P4] [Joint Verification and Refinement of Language Model for Safety-Constrained Planning](#)  
 Yunhao Yang, **Neel P. Bhatt**, William Ward, Zichao Hu, Joydeep Biswas, Ufuk Topcu  
 Under submission at Transactions on Machine Learning Research (TMLR), 2025
- [P5] [Neurosymbolic LoRA: Why and When to Tune Weights vs. Rewrite Prompts](#)  
 Kevin Wang\*, **Neel P. Bhatt\***, Junbo Li, Runjin Chen, Yihan Xi, Alvaro Velasquez, Ufuk Topcu, Zhangyang Wang  
 Under submission at Transactions on Machine Learning Research (TMLR), 2025

## Book Chapters

- [B1] [Neuro-symbolic AI: Foundations and Applications - Toward Verifiable and Scalable In-context Fine-tuning in Neurosymbolic AI](#)  
**Neel P. Bhatt**  
 Wiley, 2025

## Thesis

- [T1] [Socially and Spatially Aware Motion Prediction of Dynamic Objects for Autonomous Driving](#)  
**Neel P. Bhatt**  
 University of Waterloo, 2023

## Patents

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### **Monocular Camera System Performing Depth Estimation Surrounding a Vehicle**

US Patent Pub No.: US2024/0338837 A1, Filing Date: Oct 22, 2022

### **Deep Learning Supervisory Framework for Vehicle State Estimation**

Patent Application Pending

## Grants

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Verification-Guided and Belief-Certified Agentic AI Control for Data Centers

### [Amazon Research Awards \(ARA\) - Agentic AI](#)

Under submission, Role: PI

Principled Uncertainty Quantification and Mitigation for LLMs in Planning

[DARPA I2O Artificial Intelligence Quantified \(AIQ\)](#)

Role: Co-PI

Compositional and Scalable Learning for Multi-Agent Systems Under Uncertainty

[Lockheed Martin Advanced Technologies Lab \(ATL\)](#)

Amount awarded: \$0.5M (2024-2026), Role: Team Lead

Compositional Transfer in Neurosymbolic Reinforcement Learning

[DARPA I2O Transfer from Imprecise and Abstract Models to Autonomous Technologies \(TIAMAT\)](#)

Amount awarded: \$3.7M (2024-2027), Role: Team Lead

Neuro-Symbolic Perception, Action, and Reasoning (NeuroSPAR)

[DARPA I2O Assured Neuro-symbolic Learning and Reasoning \(ANSR\)](#)

Amount awarded: \$3.25M (2023-2025), Role: Team Lead

Infrastructure Sensors-based Automated Driving: Development and Demonstration

[Mitacs and S2e Technologies Co.](#)

Amount awarded: \$310k (2020-2022), Role: Team Lead

Visual-Inertial Monitoring System for Discoveries on Safe Human-Autonomy Interactions in Dynamic Environments

[NSERC Research Tools and Instruments grants program \(RTI\)](#)

Amount awarded: \$143k (2022-2023), Role: Team Lead

WATonoBus - All Weather Waterloo Autonomous Shuttle Bus: A Testbed for Automated Driving and V2X Connectivity

[NSERC Research Tools and Instruments grants program \(RTI\)](#)

Amount awarded: \$150k (2021-2022), Role: Team Lead

Infrastructure Sensors-based Automated Driving: Development and Demonstration

[Mitacs and S2e Technologies Co.](#)

Amount awarded: \$310k (2020-2022), Role: Team Lead

## Invited Talks

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### In-context Refinement of LLMs and VLMs Using Verification and Uncertainty Feedback

Invited Talk at [MIT Lincoln Lab](#), 2025

Invited Talk at [FM4Control Workshop](#), 2025

Invited Talk at University of Colorado Boulder, 2025

Invited Talk at [CMU Robotics Institute - Neurosymbolic AI Seminar](#), 2025

Invited Talk at [USC Automatic Control Lab](#), 2025

### Fine-tuning Language Models Using Formal Methods Feedback

Invited Talk at [Hewlett Packard AI Labs](#), 2024

Invited Talk at [DESTION Workshop](#), 2024

Industry Talk for [Lockheed Martin Artificial Intelligence Center - Assured Autonomy Systems](#), 2024

Invited Talk at [Autonomous Mobile Robotics Lab](#), 2023

### MM3DGS SLAM: Multi-modal 3D Gaussian Splatting for SLAM Using Vision, Depth, and Inertial Measurements

Poster Presentation at [National AI Institute for Foundations of Machine Learning \(IFML\)](#), 2024

Industry Talk at [NXP Innovation Lab](#), 2024

Poster Presentation at [Machine Learning Lab Symposium](#), 2024

Poster Presentation at [6G@UT Fourn](#), 2024 and 2023

### DARPA Assured Neuro Symbolic Learning and Reasoning (ANSR) PI Meetings

Research Talk at CMU, 2024

Research Talk at UC Berkeley, 2023

### Reliable State Estimation and Distributed Controls in Intelligent Vehicular Networks

Tutorial [Presenter and Organizer](#) for IEEE Intelligent Vehicles (IV), 2023

### WATonoBus - Algorithms and Software Structure for an All Weather Shuttle

Guest Lecture for ECE495 at University of Waterloo, 2023

### Object Detection with ROS and OpenCV, Multi-Modal Data Acquisition, and Visualization

Guest Lecture for MECE788 at University of Alberta, 2023

### An Overview of the WATonoBus - Canada's First Autonomous 5G Shuttle

[Guest Lecture](#) at University of Waterloo, 2022

## Awards

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### Queen Elizabeth II Graduate Scholarship in Science and Technology (QEII-GSST)

Government of Ontario

2022 - 2023 & 2019 - 2020

Waterloo, ON - Canada

QEII-GSST is a merit-based scholarship program based on academic excellence, research ability and potential in program of study, and communication and leadership abilities targeted specifically towards students in a research-based graduate program in STEM disciplines.

### Ontario Graduate Scholarship (OGS)

Government of Ontario

2021 - 2022 & 2020 - 2021

Waterloo, ON - Canada

OGS is a merit-based scholarship program for Ontario's best graduate students in all disciplines of academic study.

### Engineering Excellence Doctoral Fellowship (EEDF)

University of Waterloo

2020 - 2021

Waterloo, ON - Canada

EEDF is awarded to student researchers who were admitted directly to the PhD program from a Bachelor's degree.

### NSERC Industrial Experience Award

National Sciences and Engineering Research Council (NSERC)

May 2017 - Sept 2017

Waterloo, ON - Canada

Received for conducting R&D at Clearpath Robotics as part of an internship.

### NSERC Undergraduate Research Award

National Sciences and Engineering Research Council (NSERC)

May 2016 - Sept 2016

Toronto, ON - Canada

Received for conducting research with Professor Yu Sun during undergraduate studies.

### President's Scholar Award

University of Toronto

2014 - 2015

Toronto, ON - Canada

Received for being one of the top 150 highly qualified students applying to first year of direct-entry undergraduate studies.

## Service

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### Reviewing

ICLR ('25-'26), CVPR ('24-'26), CoRL ('24-'26), ECCV ('24-'26), IROS ('22-'26), ICRA ('21-'26), T-ITS ('20-'24), ITSC ('20-'24), IV ('20-'24), AAAI ('23), MSSP ('23), ICORR ('22), SMCS ('22-'23)

### Committee

Associate Editor, Awards, Registration, and Publicity Chair ITSC (2024)

### Fellowships

MITACS Accelerate (2021-2022)

### Tutorials

Reliable State Estimation and Distributed Controls in Intelligent Vehicular Networks (ITSC 2023)

### Teaching

Head course teaching assistant for ME780 - Special Topics in Mechatronics: Autonomous Driving

### Mentoring

Mentored > 15 PhD, 7 Masters, and 14 undergraduate students. Led 4th year senior design team to awards and FRC team to Worlds

## Skills

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### Machine Learning Programming

Pytorch, Transformers, Hugging Face, TensorFlow, Keras, OpenCV, scikit-learn.

Python, C++, ROS, CUDA, Linux, Shell (Bash/Zsh), L<sup>A</sup>T<sub>E</sub>X, Markdown, Firebase, Git.

### Simulation and Design

OpenAI Gym, CARLA, AirSim, Unreal, Gazebo, Simulink, SolidWorks, MasterCAM.

### Hardware Interfacing

LIDARs, Cameras, RADARs, GNSS, IMU, Embedded Computing (NVIDIA Jetsons), Time Sync., CAN Bus, Arduino.