Neel P. **Bhatt**

Postdoctoral Research Scientist · Center for Autonomy · Oden Institute

The University of Texas at Austin, Texas, USA

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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 *Sept 2018 - May 2023*

Doctor of Philosophy (PhD) - Mechatronics Engineering (Advisors: A Khajepour and E Hashemi) *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 *Sept 2014 - June 2018*

Bachelor of Applied Science (BASc) with High Honours - Mechanical Eng. - Robotics Minor - GPA: 3.97/4 *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 *Sept 2023 - Present*

Research Scientist (Since Jul 2025); Postdoctoral Fellow (Prev.), Center for Autonomy, Oden Institute *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 UT Austin.
- Research centered at developing neurosymbolic architectures for generative AI, trustworthy sequential decision-making using multi-modal foundational models, and assured active perception for autonomous systems.
- Leading verification-centric perception and planning architectures for rapid transfer and scaling as part of **DARPA** ANSR and TIAMAT programs.

University of Waterloo *Sept 2018 - Sept 2023*

Lead Research Scientist, WATonoBus Autonomous Shuttle *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 *Jan 2021 - Present*

Visiting Research Scholar, NODE Lab *Edmonton, AB - Canada*

- Worked with Professor Ehsan Hashemi on several research projects covering RL-based decision making for human-autonomous system handover, visual and interial 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 *May 2019 - Sept 2019*

AV Software Engineering Intern, GM Global R&D Tech Center *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 *May 2018 - Aug 2019*

Perception Team Core Member, GM AutoDrive Challenge *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 *May 2017 - Sept 2017*

Applications Engineering Intern, Research and Development Center *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 *May 2016 - Sept 2016*

Research Intern, Robotics Institute (NSERC USRA) *Toronto, ON - Canada*

- 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.

University of Toronto *May 2015 - Sept 2015*

Research Intern *Toronto, ON - Canada*

- 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.

Publications

* 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 (NucLeaR) Workshop @ AAAI, 2024, Vancouver, Canada

[C7] WATonoBus: Field-Tested All-Weather Autonomous Shuttle Technology
Neel P. Bhatt, Ruihe Zhang, Minghao Ning, Alghooneh 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

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

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 Adavanced 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

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 Fourm, 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

Queen Elizabeth II Graduate Scholarship in Science and Technology (QEII-GSST) *2022 - 2023 & 2019 - 2020*
Government of Ontario *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) *2021 - 2022 & 2020 - 2021*
Government of Ontario *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) *2020 - 2021*
University of Waterloo *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 *May 2017 - Sept 2017*
National Sciences and Engineering Research Council (NSERC) *Waterloo, ON - Canada*
Received for conducting R&D at Clearpath Robotics as part of an internship.

NSERC Undergraduate Research Award *May 2016 - Sept 2016*
National Sciences and Engineering Research Council (NSERC) *Toronto, ON - Canada*
Received for conducting research with Professor Yu Sun during undergradute studies.

President's Scholar Award *2014 - 2015*
University of Toronto *Toronto, ON - Canada*
Received for being one of the top 150 highly qualified students applying to first year of direct-entry undergraduate studies.

Service

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

Machine Learning	**Pytorch**, **Transformers**, Hugging Face, TensorFlow, Keras, **OpenCV**, scikit-learn.
Programming	Python, C++, **ROS**, CUDA, Linux, Shell (Bash/Zsh), LaTeX, 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.