

# Boris Ivanovic

RESEARCH SCIENTIST · NVIDIA AUTONOMOUS VEHICLE RESEARCH GROUP

Santa Clara, California, USA

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## Education

### Stanford University

September 2018 - December 2021

Doctor of Philosophy (PhD) - Aeronautics and Astronautics

Stanford, CA - USA

- Conducted research at the intersection of robotics and deep learning under Prof. Marco Pavone, focusing on autonomous vehicles.
- Head Course Assistant for AA 274A: *Principles of Robot Autonomy I*.

### Stanford University

September 2016 - June 2018

Master of Science (MS) - Computer Science

Stanford, CA - USA

- Conducted research in machine learning, computer vision, robotics, and data science.
- Course Assistant for CS231A: *Computer Vision From 3D Reconstruction to Recognition*.

### University of Toronto

September 2012 - June 2016

Bachelor of Applied Science (BASc) with High Honours - Engineering Science - GPA: 3.93

Toronto, ON - Canada

- Undergraduate thesis with Professors Raquel Urtasun and Sanja Fidler in Visual SLAM and 3D Scene Segmentation.
- Award-winning TA for CSC411: *Introduction to Machine Learning*.
- Won the final AER201: *Engineering Design* competition.
- Ranked in the top 10% of Engineering Science students.

## Publications

### Journal Articles

- [J1] Multimodal Deep Generative Models for Trajectory Prediction: A Conditional Variational Autoencoder Approach  
**B. Ivanovic\***, K. Leung\*, E. Schmerling, M. Pavone (\* denotes equal contribution)  
*IEEE Robotics and Automation Letters (RA-L)* 6.2 (Apr. 2021) pp. 295–302. 2021

### Conference Papers

- [C24] Expanding the Deployment Envelope of Behavior Prediction via Adaptive Meta-Learning  
**B. Ivanovic**, J. Harrison, M. Pavone  
*IEEE International Conference on Robotics and Automation (ICRA)*, 2023, London, UK
- [C23] BITS: Bi-level Imitation for Traffic Simulation  
D. Xu, Y. Chen, **B. Ivanovic**, M. Pavone  
*IEEE International Conference on Robotics and Automation (ICRA)*, 2023, London, UK
- [C22] Tree-structured Policy Planning with Learned Behavior Models  
Y. Chen, P. Karkus, **B. Ivanovic**, X. Weng, M. Pavone  
*IEEE International Conference on Robotics and Automation (ICRA)*, 2023, London, UK
- [C21] Planning with Occluded Traffic Agents using Bi-Level Variational Occlusion Models  
F. Christianos, P. Karkus, **B. Ivanovic**, S. V. Albrecht, M. Pavone  
*IEEE International Conference on Robotics and Automation (ICRA)*, 2023, London, UK
- [C20] Robust and Controllable Object-Centric Learning through Energy-based Models  
R. Zhang, T. Che, **B. Ivanovic**, R. Wang, M. Pavone, Y. Bengio, L. Paull  
*International Conference on Learning Representations (ICLR)*, 2023, Kigali, Rwanda
- [C19] DiffStack: A Differentiable and Modular Control Stack for Autonomous Vehicles  
P. Karkus, **B. Ivanovic**, S. Mannor, M. Pavone  
*Conference on Robot Learning (CoRL)*, 2022, Auckland, New Zealand
- [C18] Task-Relevant Failure Detection for Trajectory Predictors in Autonomous Vehicles  
A. Farid, S. Veer, **B. Ivanovic**, K. Leung, M. Pavone  
*Conference on Robot Learning (CoRL)*, 2022, Auckland, New Zealand
- [C17] Heterogeneous-Agent Trajectory Forecasting Incorporating Class Uncertainty  
**B. Ivanovic**, K-H. Lee, P. Tokmakov, B. Wulfe, R. McAllister, A. Gaidon, M. Pavone  
*IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2022, Kyoto, Japan

- [C16] Injecting Planning-Awareness into Prediction and Detection Evaluation  
**B. Ivanovic**, M. Pavone  
*IEEE Intelligent Vehicles Symposium (IV)*, 2022, Aachen, Germany
- [C15] MTP: Multi-hypothesis Tracking and Prediction for Reduced Error Propagation  
X. Weng, **B. Ivanovic**, M. Pavone  
*IEEE Intelligent Vehicles Symposium (IV)*, 2022, Aachen, Germany
- [C14] Sample-Efficient Safety Assurances using Conformal Prediction  
R. Luo, S. Zhao, J. Kuck, **B. Ivanovic**, S. Savarese, E. Schmerling, M. Pavone  
*Workshop on the Algorithmic Foundations of Robotics (WAFR)*, 2022, College Park, MD, USA
- [C13] Whose Track Is It Anyway? Improving Robustness to Tracking Errors with Affinity-Based Prediction  
X. Weng, **B. Ivanovic**, M. Pavone  
*IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 2022, New Orleans, USA
- [C12] ScePT: Scene-consistent, Policy-based Trajectory Predictions for Planning  
Y. Chen, **B. Ivanovic**, M. Pavone  
*IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 2022, New Orleans, USA
- [C11] Propagating State Uncertainty Through Trajectory Forecasting  
**B. Ivanovic**, Y. Lin, S. Shrivastava, P. Chakravarty, M. Pavone  
*IEEE International Conference on Robotics and Automation (ICRA)*, 2022, Philadelphia, USA
- [C10] Leveraging Neural Network Gradients within Trajectory Optimization for Proactive Human-Robot Interactions  
S. Schaefer, K. Leung, **B. Ivanovic**, M. Pavone  
*IEEE International Conference on Robotics and Automation (ICRA)*, 2021, Xi'an, China
- [C9] MATS: An Interpretable Trajectory Forecasting Representation for Planning and Control  
**B. Ivanovic**, A. Elhafi, G. Rosman, A. Gaidon, M. Pavone  
*Conference on Robot Learning (CoRL)*, 2020, Virtual
- [C8] Evidential Sparsification of Multimodal Latent Spaces in Conditional Variational Autoencoders  
M. Itkina, **B. Ivanovic**, R. Senanayake, M. J. Kochenderfer, M. Pavone  
*Advances in Neural Information Processing Systems (NeurIPS)*, 2020, Virtual
- [C7] Risk-Sensitive Sequential Action Control with Multi-Modal Human Trajectory Forecasting for Safe Crowd-Robot Interaction  
H. Nishimura, **B. Ivanovic**, A. Gaidon, M. Pavone, M. Schwager  
*IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2020, Virtual
- [C6] Trajectron++: Dynamically-Feasible Trajectory Forecasting With Heterogeneous Data  
T. Salzmann\*, **B. Ivanovic\***, P. Chakravarty, M. Pavone (\* denotes equal contribution)  
**3rd place in the ICRA 2020 nuScenes Prediction Challenge**  
*European Conference on Computer Vision (ECCV)*, 2020, Virtual
- [C5] Map-Predictive Motion Planning in Unknown Environments  
A. Elhafi, **B. Ivanovic**, L. Janson, M. Pavone  
*IEEE International Conference on Robotics and Automation (ICRA)*, 2020, Virtual
- [C4] The Trajectron: Probabilistic Multi-Agent Trajectory Modeling with Dynamic Spatiotemporal Graphs  
**B. Ivanovic**, M. Pavone  
*IEEE/CVF International Conference on Computer Vision (ICCV)*, 2019, Seoul, South Korea
- [C3] BaRC: Backward Reachability Curriculum for Robotic Reinforcement Learning  
**B. Ivanovic**, J. Harrison, A. Sharma, M. Chen, M. Pavone  
*IEEE International Conference on Robotics and Automation (ICRA)*, 2019, Montreal, Canada
- [C2] Generative Modeling of Multimodal Multi-Human Behavior  
**B. Ivanovic**, E. Schmerling, K. Leung, M. Pavone  
*IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2018, Madrid, Spain
- [C1] ADAPT: Zero-Shot Adaptive Policy Transfer for Stochastic Dynamical Systems  
J. Harrison, A. Garg, **B. Ivanovic**, Y. Zhu, S. Savarese, L. Fei-Fei, M. Pavone  
*International Symposium on Robotics Research (ISRR)*, 2017, Puerto Varas, Chile

## Theses

[T2] Trajectory Forecasting in the Modern Robotic Autonomy Stack

**B. Ivanovic**

*Stanford University, 2021*

[T1] Streamlining the Training of 3D Scene Segmentation Models

**B. Ivanovic**

*University of Toronto, 2016*

## Blog Posts

[B2] Back to the Future: Planning-Aware Trajectory Forecasting for Autonomous Driving

**B. Ivanovic**

*Stanford Artificial Intelligence Lab (SAIL) Blog, 2020*

[B1] How to Deploy Deep Learning Models with AWS Lambda and TensorFlow

**B. Ivanovic, Z. Ivanovic**

**5th most viewed blog post in all of AWS in 2018**

*Amazon Web Services (AWS) AI Blog, 2017*

## Invited Talks

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**Effectively Integrating Behavior Prediction within the Modern Robotic Autonomy Stack**

*Waterloo.AI Seminar Series, November 2022*

**Integrating Prediction Within the Autonomous Vehicle Stack**

*ICRA Workshop on Long-term Human Motion Prediction, May 2022*

## Experience

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### **NVIDIA Research**

Research Scientist

*January 2022 - Present*

*Santa Clara, CA - USA*

- Working in the Autonomous Vehicle Research Group on novel trajectory forecasting methods and their integration within the autonomy stack.

### **NVIDIA Research**

Research Scientist Intern

*March 2021 - September 2021*

*Santa Clara, CA - USA*

- Worked in the Autonomous Vehicle Research Group on novel trajectory forecasting methods and their integration within the autonomy stack.

### **Toyota Research Institute**

Research Scientist Intern

*June 2020 - September 2020*

*Los Altos, CA - USA*

- Worked with Adrien Gaidon on novel trajectory forecasting methods in the Machine Learning Research team.

### **Amazon.com**

Prime Air SDE Intern

*June 2017 - September 2017*

*Seattle, WA - USA*

- Worked with Principal Research Scientist Ishay Kamon in the Autonomy team.
- Designed and implemented a novel state-of-the-art deep learning approach for a specific computer vision task within the team, outperforming existing models by 10x. The project was completed successfully and a full-time Research Scientist return offer was extended.

### **Amazon.com**

Prime Air SDE Intern

*May 2016 - August 2016*

*Seattle, WA - USA*

- Worked with former NASA Astronaut Neil Woodward in the Flight Test team.
- Designed and built fault-tolerant, scalable software and hardware to autonomously collect and process relevant flight test data from numerous locations for internal consumption.

### **ETH Zurich**

Summer Research Intern

*May 2015 - August 2015*

*Zurich - Switzerland*

- Worked with Professor Raffaello D'Andrea in the Institute for Dynamic Systems and Control, specifically the Flying Machine Arena.
- Removed superfluous code from an open source motor controller and implemented new features such as motor calibration, emergency safety states, and a better motor startup routine in C. Simulated dynamic motor and propeller system responses in Python.

## Amazon.com

May 2014 - July 2014

### SDE Intern

Seattle, WA - USA

- Worked in the Demand Forecasting team creating a real-time demand forecasting simulation tool. Used the Hadoop MapReduce framework to process large amounts of simulation data generated by a machine learning module. The project was completed successfully and a return offer was extended.

## Awards

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### NSERC Doctoral Canada Graduate Scholarship (CGS-D)

May 2020 - December 2021

#### National Sciences and Engineering Research Council (NSERC)

Canada

The CGS-D Program promotes continued excellence in Canadian research by rewarding high-calibre Canadian doctoral students pursuing studies at home or abroad.

### Engineering Science Award of Excellence

May 2016

#### University of Toronto

Toronto, ON - Canada

Received for maintaining a CGPA greater than 3.90.

### Computer Science TA Award

May 2016

#### University of Toronto

Toronto, ON - Canada

Received for being the best Computer Science TA in the Winter 2016 semester.

### NSERC Master's Postgraduate Scholarship (CGS-M) (Declined)

April 2016

#### National Sciences and Engineering Research Council (NSERC)

Canada

The CGS-M Program provides financial support to high-calibre scholars who are engaged in eligible master's programs in Canada.

### Dean's Honour List

September 2012 - June 2016

#### University of Toronto

Toronto, ON - Canada

Placed on the Dean's Honour List for all undergraduate semesters.

### University of Toronto Scholarship

September 2012

#### University of Toronto

Toronto, ON - Canada

Received for being one of the top 300 entrants to the University of Toronto in 2012.

## Skills

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<b>Programming</b>	Python, Java, C/C++, MATLAB, R, Scala, Verilog, Assembly, Web (HTML5/CSS3/JavaScript)
<b>Learning &amp; Robotics</b>	PyTorch, TensorFlow, MXNet, Theano, MuJoCo, Box2D, MazeBase, ROS
<b>Data Science</b>	NumPy, Pandas, Seaborn, Matplotlib, StatsModels
<b>Libraries/SDKs</b>	Amazon Web Services SDK, Hadoop, Spark, Node.js, Google Web Tools, Android SDK

## Service

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<b>Reviewing</b>	ICLR (2022), CVPR (2021, 2022, 2023), ECCV (2022), ICML (2020, 2021, 2022, 2023), NeurIPS (2019, 2020, 2021, 2022), L4DC (2023), RSS (2020, 2021), ICRA (2020, 2021, 2022, 2023), IROS (2021, 2022), CDC (2021), Humanoids (2020), IV (2021, 2022), ITSC (2019), TPAMI (2020, 2022), RA-L (2020, 2021, 2022), L-CSS (2021), TMLR (2023), Nature MI (2022)
<b>Fellowships</b>	NVIDIA (2023)
<b>Workshops</b>	Workshop on Long-term Human Motion Prediction (ICRA 2023)