

# NICHOLAS RHINEHART

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## RESEARCH INTERESTS

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*For systems to become generally intelligent, they must be able to reason about the future—How should we learn, quantify, and use models that reason about the future?*

**Fields:** Computer Vision, Machine Learning, Robotics. **Topics:** Activity Forecasting, Activity Analysis, First-Person Vision, Visual Recognition, Imitation Learning, Reinforcement Learning, Inverse Reinforcement Learning, Generative Modeling, Autonomous Vehicles

## EDUCATION

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<b>Carnegie Mellon University</b> Doctor of Philosophy, The Robotics Institute within The School of Computer Science Thesis: <i>Jointly Forecasting and Controlling Behavior by Learning from High-Dimensional Data</i> Adviser: Kris Kitani	Aug 2014 – Sep 2019
<b>Carnegie Mellon University</b> Master of Science, The Robotics Institute within The School of Computer Science Thesis: <i>Imitation Learning for Sequential Region-Based Object Detection</i> Adviser: Drew Bagnell	Jan 2013 – Aug 2014
<b>Swarthmore College</b> Bachelor of Science, Department of Engineering Bachelor of Arts, Department of Computer Science Advisers: Matt Zucker, Rich Wicentowski	Aug 2008 – May 2012

## RESEARCH EXPERIENCE

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<b>Berkeley Artificial Intelligence Research (BAIR)</b> Postdoctoral Fellow with Sergey Levine	Sep 2019 – Present
<b>Berkeley Artificial Intelligence Research (BAIR)</b> Visiting Researcher with Sergey Levine	Jun 2018 – Nov 2018
<b>NEC Labs America</b> Research Assistant with Paul Vernaza, Manmohan Chandraker	May 2017 – Sep 2017
<b>Uber Advanced Technologies Group (ATG)</b> Research Engineer with Drew Bagnell	Jun 2016 – Sep 2016
<b>The University of Tokyo I.I.S.</b> Visiting Researcher with Ryo Yonetani, Yoichi Sato	Jun 2015 – July 2015
<b>Carnegie Mellon University Robotics Institute (RI)</b> Doctoral Student Researcher with Kris Kitani	Aug 2014 – Sep 2019
<b>Carnegie Mellon University Robotics Institute (RI)</b> M.S. Student Researcher with Drew Bagnell	Jan 2013 – Aug 2014
<b>Carnegie Mellon University Robotics Institute (RI)</b> Undergraduate Research Intern with Debadeepta Dey and Drew Bagnell	Jun 2011 – Aug 2011
<b>George Washington University Physics Department</b> Undergraduate Research Intern with Kalvir Dhuga	May 2009 – Aug 2009

## ACADEMIC HONORS

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### PAPER AWARDS

- Best Paper Award, ICML 2019 Workshop on AI for Autonomous Driving** 2019  
Awarded to PRECOG (Rhinehart et al.), and received an NVIDIA Titan V GPU
- Best Paper Honorable Mention Award (Top 3 of 2,143 Submissions), ICCV 2017** 2017  
Awarded to First-Person Activity Forecasting (Rhinehart et al.), and received \$3,000

### FELLOWSHIP AWARDS

- PhD Fellowship, Center for Machine Learning and Health** 2018  
Awarded full tuition and funds totaling \$80,000 for *Automatic Forecasting and Understanding of Behavior* research proposal
- IBM PhD Fellowship Finalist (CMU R.I.) 2017  
Nominated as one of three CMU Robotics Institute candidates for the IBM PhD Fellowship
- The Robert E., Elizabeth, and Walter Lamb Scholarship, Swarthmore College 2011, 2012  
Awarded scholarships on the bases of academic merit and financial need.

### SERVICE AWARDS

- Top Reviewer Award, NeurIPS 2019 2019  
Awarded free conference registration for reviewing contributions.

### TRAVEL AND HARDWARE AWARDS

- Travel Grants (5): NeurIPS, CMU Provost, ICRA {2018, 2015}, {2017, 2016}, 2017  
Awarded travel funding.
- Hardware Grants (1): NVIDIA 2014  
Awarded hardware funding.

## PUBLICATIONS

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### JOURNAL PUBLICATIONS

- [1] First-Person Activity Forecasting from Video with Online Inverse Reinforcement Learning  
**N. Rhinehart**, K. M. Kitani.  
IEEE Transactions on Pattern Analysis and Machine Intelligence (**TPAMI**), 2018

### CONFERENCE PUBLICATIONS

- [2] PRECOG: PREDiction Conditioned On Goals in Visual Multi-Agent Settings  
**N. Rhinehart**, R. McAllister, K. M. Kitani, S. Levine  
IEEE International Conference on Computer Vision (**ICCV**), [25% *accepted*], 2019
- [3] Directed-Info GAIL: Learning Hierarchical Policies from Unsegmented Demonstrations using Directed Information  
M. Sharma, A. Sharma, **N. Rhinehart**, K. M. Kitani  
International Conference on Learning Representations (**ICLR**), [31% *accepted*], 2019
- [4] R2P2: A Reparameterized Pushforward Policy for Diverse, Precise Generative Path Forecasting  
**N. Rhinehart**, K. M. Kitani, P. Vernaza  
European Conference on Computer Vision (**ECCV**), [32% *accepted*], 2018
- [5] Learning Neural Parsers with Deterministic Differentiable Imitation Learning  
T. Shankar, **N. Rhinehart**, K. Muelling, K. M. Kitani  
Conference on Robot Learning (**CORL**), [31% *accepted*], 2018

- [6] [Human-Interactive Subgoal Supervision for Efficient Inverse Reinforcement Learning](#)  
X. Pan, E. Ohn-Bar, **N. Rhinehart**, Y. Xu, Y. Shen, K. M. Kitani  
International Conference on Autonomous Agents and Multiagent Systems (**AAMAS**), [25% *accepted*], 2018
- [7] [N2N Learning: Network to Network Compression via Policy Gradient Reinforcement Learning](#)  
A. Ashok, **N. Rhinehart**, F. Beainy, K. M. Kitani  
International Conference on Learning Representations (**ICLR**), [34% *accepted*], 2018
- [8] [Predictive-State Decoders: Encoding the Future into Recurrent Networks](#)  
**N. Rhinehart**<sup>\*</sup>, A. Venkatraman<sup>\*</sup>, W. Sun, L. Pinto, M. Hebert, B. Boots, K. M. Kitani, J. A. Bagnell  
Neural Information Processing Systems (**NIPS**), [21% *accepted*], 2017
- [9] [First-Person Activity Forecasting with Online Inverse Reinforcement Learning](#)  
**N. Rhinehart**, K. M. Kitani.  
IEEE International Conference on Computer Vision (**ICCV**), **Oral**, [29% *accepted*], [2% *accepted for Oral*], 2017  
**Best Paper Honorable Mention Award** (3 of 2,143 submissions)
- [10] [Learning Action Maps of Large Environments via First-Person Vision](#)  
**N. Rhinehart**, K. M. Kitani  
Computer Vision and Pattern Recognition (**CVPR**), [30% *accepted*], 2016
- [11] [Visual Chunking: A List Prediction Framework for Region-Based Object Detection](#)  
**N. Rhinehart**, J. Zhou, M. Hebert, J. A. Bagnell  
International Conference on Robotics and Automation (**ICRA**), [41% *accepted*], 2015

#### PRE-PRINTS

- [12] [Generative Hybrid Representations for Activity Forecasting with No-Regret Learning](#)  
J. Guan, Y. Yuan, K. M. Kitani, **N. Rhinehart**  
*arXiv:1904.06250*, 2019
- [13] [Deep Imitative Models for Flexible Inference, Planning, and Control](#)  
**N. Rhinehart**, R. McAllister, S. Levine  
*arXiv:1810.06544*, 2018
- [14] [Learning Gibbs-Regularized Pushforward Density Estimators with a Symmetric KL Objective](#)  
**N. Rhinehart**, A. Liu, K. Sohn, P. Vernaza  
*In preparation*, 2018

#### REFEREED WORKSHOP AND SYMPOSIA PUBLICATIONS

- [15] [PRECOG: PREDiction Conditioned On Goals in Visual Multi-Agent Settings](#)  
**N. Rhinehart**, R. McAllister, K. M. Kitani, S. Levine  
International Conference on Machine Learning (**ICML**), AI for Autonomous Driving, **Best Paper Award**, 2019  
Bay Area Machine Learning Symposium (**Baylearn**), **Oral Presentation**, 2019
- [16] [Deep Imitative Models for Flexible Inference, Planning, and Control](#)  
**N. Rhinehart**, R. McAllister, S. Levine  
Neural Information Processing Systems (**NeurIPS**), Prob. RL & Structured Control, **Oral (top 6 of 27 papers)**, 2018  
Neural Information Processing Systems (**NeurIPS**), MLITS, **Oral (top 3 of 25 papers)**, 2018
- [17] [Learning Gibbs-Regularized Pushforward Density Estimators with a Symmetric KL Objective](#)  
**N. Rhinehart**, A. Liu, K. Sohn, P. Vernaza  
Bay Area Machine Learning Symposium (**Baylearn**), 2018

- [18] R2P2: A Reparameterized Pushforward Policy for Diverse, Precise Generative Path Forecasting  
**N. Rhinehart**, K. M. Kitani, P. Vernaza  
 European Conference on Computer Vision (**ECCV**), Anticipating Human Behavior, 2018
- [19] Learning Hierarchical Policies from Unsegmented Demonstrations using Causal Information  
 M. Sharma, A. Sharma, **N. Rhinehart**, K. M. Kitani  
 Robotics: Science and Systems (**RSS**), Causal Imitation in Robotics, 2018
- [20] Human-Interactive Subgoal Supervision for Efficient Inverse Reinforcement Learning  
 X. Pan, E. Ohn-Bar, **N. Rhinehart**, Y. Xu, Y. Shen, K. M. Kitani  
 International Joint Conference on Artificial Intelligence (**IJCAI**), Autonomy in Teams, 2018
- [21] Predictive-State Decoders: Encoding the Future into Recurrent Networks  
**N. Rhinehart**<sup>\*</sup>, A. Venkatraman<sup>\*</sup>, W. Sun, L. Pinto, M. Hebert, B. Boots, K. M. Kitani, J. A. Bagnell  
 Conference on Robot Learning (**CORL**), [33% *accepted*], 2017
- [22] Fine-Grained Detection via Efficient Extreme Classification  
**N. Rhinehart**, J. Zhou, M. Hebert, J. A. Bagnell  
 Neural Information Processing Systems (**NIPS**) Workshop on Extreme Classification, 2013  
 Mid-Atlantic Computer Vision (**MACV**) Poster, 2014

## PATENTS

- [23] Generative Adversarial Inverse Trajectory Optimization for Probabilistic Vehicle Forecasting  
 P. Vernaza, W. Choi, **N. Rhinehart**  
*US20190094867A1, Pending*, 2018

## ACADEMIC AND PROFESSIONAL TALKS

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### INVITED INSTITUTIONAL TALKS

<b>Argo A.I.</b> , Invited talk, Pittsburgh, Pennsylvania	Jul 2019
<b>iSee</b> , Invited talk, Pittsburgh, Pennsylvania	May 2019
<b>Zoox</b> , Invited talk, San Francisco, California	Jan 2019
<b>Google Waymo</b> , Invited talk, Mountain View, California	Nov 2018
<b>U.C. Berkeley</b> , Invited talk at the Robotic Artificial Intelligence and Learning Lab, Berkeley, California	Jun 2018
<b>U.C. Berkeley</b> , Invited talk at the Berkeley Deep Drive Group, Berkeley, California	Aug 2018

### INVITED WORKSHOP TALKS

<b>ICCV 2019</b> , Workshop on Autonomous Driving - Beyond Single Frame Prediction, Seoul, South Korea	Oct 2019
<b>CVPR 2018</b> , Tutorial on Human Activity Forecasting, Salt Lake City, Utah	Jun 2018
<b>ACCV 2018</b> , Attention/Intention Understanding Workshop, Perth, Australia	Dec 2018

### TUTORIALS

<b>CVPR 2018</b> , Organizer and Speaker, Tutorial on Inverse RL for Computer Vision, Salt Lake City, Utah	Jun 2018
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### CONTRIBUTED CONFERENCE TALKS

<b>Baylearn 2019</b> , Single-Track Oral Presentation, San Francisco, California	Oct 2019
<b>ICCV 2017</b> , Single-Track Oral Presentation, Venice, Italy	Oct 2017

### CONTRIBUTED WORKSHOP TALKS

<b>NeurIPS 2018</b> , Probabilistic RL and Structured Control Workshop, Montreal, Canada	Dec 2018
<b>NeurIPS 2018</b> , ML for Intelligent Transportation Systems Workshop, Montreal, Canada	Dec 2018

MACV 2016, Oral Presentation, Baltimore, Maryland	May 2016
NeurIPS 2013, Workshop on Extreme Classification, Lake Tahoe, Nevada	Dec 2013

## GUEST LECTURES

CMU, Guest Lecture in Statistical Techniques of Robotics, Pittsburgh, Pennsylvania	May 2019
CMU, Guest Lecture in Deep RL and Control (10-703), Pittsburgh, Pennsylvania	Nov 2018
CMU, Introduction to Computer Vision, Guest Lecture, Pittsburgh, Pennsylvania	Apr 2018
CMU, Graduate Statistical Techniques in Robotics, Guest Lecture, Pittsburgh, Pennsylvania	Apr 2018
CMU, Graduate Statistical Techniques in Robotics, Guest Lecture, Pittsburgh, Pennsylvania	Sep 2017

## INTERNAL TALKS

CMU, PhD Thesis Defense, Pittsburgh, Pennsylvania	Aug 2019
CMU, PhD Thesis Proposal, Pittsburgh, Pennsylvania	Jun 2018
NEC Labs America, Research highlight, Cupertino, California	Jun 2017
The University of Tokyo IIS, Sato Laboratory, Tokyo, Japan	Jun 2015
CMU, Misc-Read Vision Group, Pittsburgh, PA	Nov 2015

## ACADEMIC ACTIVITY & SERVICE

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### TEACHING

#### Tutorials and Guest Lectures

Statistical Techniques in Robotics (16-831), CMU. Instructor: Kris Kitani	Spring 2019
Deep RL and Control (10-703), CMU. Instructors: K. Fragkiadaki, T. Mitchell	Fall 2018
Organizer and Speaker at CVPR '18 Tutorial on Inverse Reinforcement Learning for Computer Vision	Summer 2018
Computer Vision (16-720), CMU. Instructor: Kris Kitani	Spring 2018
Statistical Techniques in Robotics (16-831), CMU. Instructor: David Held	Spring 2018
Statistical Techniques in Robotics (16-831), CMU. Instructor: Kris Kitani	Fall 2017

#### Teaching Assistance

Geometry-based Methods in Vision (16-822), CMU.	Fall 2016
Data Structures and Algorithms (CPSC 035), Swarthmore College.	Fall 2011
Data Structures and Algorithms (CPSC 035), Swarthmore College.	Spring 2011
Introduction to Computer Science (CPSC 021), Swarthmore College.	Spring 2010

#### Tutoring

Fundamentals of Digital Systems (ENGR 015, CS 038), Swarthmore College	Fall 2011
Grade 6–12 Mathematics and Physics	Spring 2009 – Spring 2012

### RESEARCH MENTORING

#### Graduate students

Yifei Huang (UTokyo I.I.S. PhD visitor). Co-authored CORL '19 submission with Yifei.	2019
Mohit Sharma (CMU MS RI, now PhD at CMU). Co-authored ICLR '19 paper with Mohit.	2018
Arjun Sharma (CMU MS RI, now at Vicarious). Co-authored ICLR '19 paper with Arjun.	2018
Tanmay Shankar (CMU MS RI, now at FAIR). Co-authored CORL '18 paper with Tanmay.	2018
Anubhav Ashok (CMU MS CV, now at Niantic). Co-authored ICLR '18 paper with Anubhav.	2017
Xinlei Pan (UC Berkeley PhD EECS visitor). Co-authored AAMAS '18 paper with Xinlei.	2017

#### Undergraduate students

Jiaqi Guan (Tsinghua University visitor, now PhD at UIUC). Last-authored Pre-Print '19 with Jiaqi.	2018 – 2019
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## Industry visitors

Teerapat Rojanaarpa (DENSO Corp.)	2018
Ryozo Yamashita (DENSO Corp.)	2017 – 2018

## PROFESSIONAL ACTIVITY

### Organizer

<i>Co-organizer: NeuRIPS '19 Workshop on Machine Learning for Autonomous Driving</i>	2019
<i>Primary organizer: ICML '19 Workshop on Imitation, Intent, and Interaction (I3)</i>	2019
<i>One of three organizers: CVPR '18 Tutorial on Inverse RL for Computer Vision [recording has &gt;3,500 views]</i>	2018

### Conference and Journal Reviewing

BMVC 19, CVPR '19, ICML '19, ICCV '19, ICRA '19, NeurIPS '19, TPAMI '19, IJCV '19	2019
CVPR '18, ECCV '18, IJCV '18, IJRR '18, IROS '18	2018
CVPR '17, ICCV '17	2017
CVPR '16	2016

### Workshop Reviewing

ICML '19 Exploration in RL, CVPR '19 Precognition: Seeing through the Future, ICCV '19 EPIC	2019
NeurIPS '18 Deep Reinforcement Learning, NeurIPS '18 Imitation Learning and Robotics	2018
ECCV '18 EPIC, ECCV '18 Anticipating Human Behaviors	2018
ICML '18 Exploration in RL, ACCV '18 Attention/Intention Understanding, ACM IUI SymCollab '18	2018
WACV '17 Human Activity Analysis, CVPR '16 Egocentric Behavior	2016 – 2017

## UNIVERSITY ACTIVITY

<b>Ph.D. Admissions Committee</b> , CMU Robotics Institute	2017
<b>M.S. Admissions Committee</b> , CMU Robotics Institute	2015, 2016
<b>Robotics Institute Representative</b> , CMU Graduate Student Association	2015 – 2017
<b>Co-Chair</b> , Swarthmore Philanthropy Council	2011 – 2012
<b>Class Treasurer</b> , Swarthmore College	2011 – Present

## THESIS COMMITTEES

### M.S. Robotics, CMU

Tanmay Shankar, Learning Neural Parsers with Deterministic Differentiable Imitation Learning	2018
Arjun Sharma, Integrating Structure with Deep Reinforcement and Imitation Learning	2018
Mohit Sharma, Inverse Reinforcement Learning with Conditional Choice Probabilities	2018

## CONSULTING EXPERIENCE

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<b>Machine Learning Consultant</b> , University of Pittsburgh Department of Biology	Jan 2019 – Present
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## GRADUATE COURSEWORK

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Machine Learning, Computer Vision, Mechanics of Manipulation, Statistical Techniques in Robotics, Learning-Based Methods in Computer Vision, Geometry-Based Methods in Computer Vision, Adaptive Control and Reinforcement Learning.