# Patrick Emami

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## Research Statement

I am a machine learning researcher working on scene representation learning, reinforcement learning, and AI for social good. My research has spanned topics including object-centric deep generative modeling, low-resource multi-object tracking, and traffic signal control. Mostly, I am curious about developing agents capable of learning challenging behaviors by reasoning about the world at the level of objects, like humans do.

## Education

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| 2016–2021[†] | **University of Florida**, Gainesville, FL<br>Ph.D., Computer Science (Machine Learning)<br><small>Thesis: Neural algorithms for object-centric scene understanding</small> | Advisor: Dr. Sanjay Ranka |
| Summer 2019 | **University College London**, London, UK<br>Machine Learning Summer School (MLSS) | Marc Deisenroth &<br>Arthur Gretton |
| 2012–2016 | **University of Florida**, Gainesville, FL<br>B.Sc., Computer Engineering | Cum Laude, GPA: 3.74/4.0 |

## Research Experience

**National Renewable Energy Lab (NREL), Research intern**. May 2021–August 2021

• *Regional Mobility*.

Developed deep reinforcement learning algorithms for NEMA-compliant traffic control using a "digital twin" of the Chattanooga, Tennessee road network.

**MALT Lab, Graduate Research Assistant**. 2016–present

• *EfficientMORL. ICML'21* [Github].

We re-interpret iterative assignment of pixels to object-centric slots as bottom-up inference in a hierarchical variational autoencoder. EfficientMORL has three key components: bottom-up inference with transformer-like attention to estimate an initial posterior over slots, a top-down prior to regularize and disentangle the slots, and lightweight iterative refinement to stabilize training. It is the first object-centric generative model to learn symmetric and disentangled representations while being computationally efficient.

• *Stochastic object-centric world models. NeurIPS '20 ORLR Workshop Spotlight.* [Github]

Proposed a latent state space model based on variational autoencoders for jointly learning object-centric representations and dynamics for stochastic real-world video. Formulated the integration of a stochastic latent dynamics model with segmentation-based object discovery and a novel sampling-based variational objective to fit environment stochasticity. Demonstrated superior object decomposition and stochastic future prediction on a robotic manipulation benchmark compared to prior work.

**UF Transportation Institute (UFTI), Graduate Research Assistant**. 2017–present.

• *Sensible. NSF Grant 1446813, 2017–present*. [Open source release forthcoming]

Software engineering lead for Sensible, a distributed Python framework for real-time multi-sensor multi-object tracking at traffic intersections. Supports V2X communication and intersections with multiple roads each equipped with multiple sensors such as Econolite cameras and Smartmicro radars. Achieves GPU-less video tracking with a novel deep convolutional network running on PyTorch. Integrates with a real-time traffic signal optimizer for advanced adaptive signal control.

# Publications

**Peer-Reviewed Journals**

[1] He, P., & **Emami, P.**, & Ranka, S., & Rangarajan, A. Learning Scene Dynamics From Point Cloud Sequences. IJCV Special Issue on 3D Vision. 2021.

[2] **Emami, P.**, & Elefteriadou, L., & Ranka, S. Long-range Multi-Object Tracking at Traffic Intersections on Low-Power Devices. IEEE Transactions on Intelligent Transportation Systems. 2021. [UFTI article]

[3] **Emami, P.**, & Pardalos, P. M., & Elefteriadou, L., & Ranka, S. Machine Learning Methods for Data Association in Multi-Object Tracking. ACM Computing Surveys, 53, 4, Article 69. 2020.

[4] Pourmehrab, M., **Emami, P.**, Martin-Gasulla, M., Wilson, J., Elefteriadou, L., Ranka, S. Signalized Intersection Performance with Automated and Conventional Vehicles: A Comparative Study. Journal of Transportation Engineering, Part A: Systems 146.9. 2020.

**Peer-Reviewed Conferences and Workshops**

[1] He, P., **Emami, P.**, Ranka, S., Rangarajan, A. Self-Supervised Robust Scene Flow Estimation via the Alignment of Probability Density Functions. AAAI'22. **15% acceptance rate**.

[2] **Emami, P.**, He, P., Ranka, S., Rangarajan, A. Efficient Iterative Amortized Inference for Learning Symmetric and Disentangled Multi-Object Representations. International Conference on Machine Learning (ICML'21). 2021. **21.5% acceptance rate**.

[3] **Emami, P.**, He, P., Rangarajan, A., Ranka, S. A Symmetric and Object-Centric World Model for Stochastic Environments. 34th Conference on Neural Information Processing Systems Workshop on Object Representations for Learning and Reasoning (NeurIPS '20). 2020. **Spotlight**.

[4] **Emami, P.\***, Vargas, L.\*, Traynor, P. On the Detection of Disinformation Campaign Activity with Network Analysis. CCSW 2020: The ACM Cloud Computing Security Workshop. 2020. *\*Equal contribution*

[5] **Emami, P**., Pourmehrab, M., Martin-Gasulla, M., Ranka, S., Elefteriadou, L. A Comparison of Intelligent Signalized Intersection Controllers Under Mixed Traffic. IEEE Intelligent Transportation Systems Conference, 2018.

[6] Omidvar, A., Pourmehrab, M., **Emami, P**., Kiriazes, R., Esposito, J., Letter, C., Elefteriadou, L., Ranka, S., Crane, C. Deployment and Testing of Optimized Autonomous and Connected Vehicle Trajectories at a Closed-Course Signalized Intersection. Transportation Research Board's 97th, 2018.

[7] **Emami, P**., & Pourmehrab, M., & Elefteriadou, L., & Ranka, S., & Crane, C. A Demonstration of Fusing DSRC and Radar for Optimizing Intersection Performance. Automated Vehicles Symposium (AVS'17), 2017.

[8] **Emami, P**., Elefteriadou, L., Ranka, S. Tracking Vehicles Equipped with Dedicated Short-Range Communication at Traffic Intersections. 7th ACM International Symposium on Design and Analysis of Intelligent Vehicular Networks and Applications (DIVANet'17), 2017.

[9] Hamlet, A., **Emami, P**., Crane, C. The Cognitive Driving Framework: Joint Inference for Collision Prediction and Avoidance in Autonomous Vehicles. In the 15th International Conference on Control, Automation and Systems (ICCAS), pp. 1714-1719. IEEE, 2015.

[10] Hamlet, A., **Emami, P**., Crane, C. A Gesture Recognition System for Mobile Robots That Learns Online. In the 2014 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS'14), pp. 2114-2119. IEEE, 2014.

**Preprints**

[1] **Emami, P.**, & Ranka, S. Learning Permutations with Sinkhorn Policy Gradient. arXiv:1805.07010 [cs.LG], 2018.

[2] **Emami, P.**, & Panos M. P., & Elefteriadou, L., & Ranka, S. Machine Learning Methods for Solving Assignment Problems in Multi-Target Tracking. Under review at ACM Computing Surveys. arXiv:1802.06897 [cs.CV], 2018.

**Blog Posts**

[1] **Emami, P**. Deep Deterministic Policy Gradients in Tensorflow. http://pemami4911.github.io/blog/2016/08/21/ddpg-rl.html. 2016. > 100K unique views (Google Analytics). [Github]

# Professional Activities

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| 2022 | **Computer Vision and Pattern Recognition (CVPR)**, Reviewer |
| 2022 | **International Conference on Learning Representations (ICLR)**, Reviewer |
| 2021 | **Computer Vision and Image Understanding (CVIU)**, Reviewer |
| 2021 | **International Conference on Computer Vision (ICCV)**, Reviewer |
| 2021 | **Neural Information Processing Systems (NeurIPS)**, Reviewer |
| 2021 | **International Conference on Machine Learning (ICML)**, Reviewer |
| 2021 | **IEEE Intelligent Transportation Systems Conference (ITSC)**, Reviewer |
| 2021 | **Transportation Research Record (TRR)**, Reviewer |
| 2020 | **NeurIPS Workshop on Interp. Inductive Biases and Phys.**, Reviewer |
| 2020 | **Transportation Research Board Annual Meeting (TRBAM)**, Reviewer |
| 2020 | **Optimization Letters**, Reviewer |
| 2019 | **UF Informatics Institute Student Data Analysis Seminar**, Co-Organizer |
| 2018 | **UF Informatics Institute Student Data Analysis Seminar**, Co-Organizer |
| 2018 | **International Conference on Machine Learning and Data Science**, Reviewer |
| 2018 | **IEEE Intelligent Transportation Systems Conference**, Special Session Chair |
| 2018 | **IEEE Intelligent Transportation Systems Conference (ITSC)**, Reviewer |
| 2017 | **International Conference on Machine Learning and Data Science**, Reviewer |
| 2017 | **UF Informatics Institute Student Data Analysis Seminar**, Co-Organizer |
| 2016–2018 | **UF Machine Learning Reading Group**, Organizer |

# Professional Societies

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| 2018–present | Alpha Epsilon Lambda Graduate Honor Society, member |
| 2017–present | ACM, student member |
| 2016–present | IEEE, student member |
| 2014–present | IEEE Eta Kappa Knu Honor Society, member |

## Selected Honors and Awards

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| 2021 | Top 10% Reviewer at ICML'21 |
| 2020 | Student of the Year USDOT STRIDE Center (10 universities) ($1,000) |
| 2016–present | McKnight Doctoral Fellowship ($65,000) |
| 2016–present | CISE Department Graduate Research Fellowship ($150,000) |
| 2016 | President's Honor Roll |
| 2015–2016 | Northrop Grumman Engineering Scholarship ($1,000) |
| 2014–2015 | University Scholars Program Research Grant ($1,750) |
| 2014 | IROS'14 Best Entertainment Robots and Systems Paper Finalist |

## Mentoring

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|---|---|---|
| Fall 2019–2021 | Yury Lebedev (Ph.D.) | Univ. of Florida |
| Fall 2018–2021 | Kevin Chow (B.Sc., now Ph.D. at Tsinghua Univ.) | Univ. of Florida |
| Fall-Summer 2018 | Anuran Rouchowdhury (M.Sc) | Univ. of Florida |
| Summer 2018 | Ian Pelakh (B.Sc.) | Univ. of Florida |
| Fall 2017 | Shalaka Naik (M.Sc), Individual Study | Univ. of Florida |
| Fall 2017 | Vivek Gade (M.Sc), Individual Study | Univ. of Florida |
| Summer 2017 | Jabari Wilson (SURF Fellow, now Ph.D. at Univ. of Florida) | Univ. of Alabama |

## Teaching & Volunteering

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| 2021 | **Junior Science, Engineering, and Humanities Symposium**, Reviewer |
| | Reviewed papers written by high school students for the speaker competition |
| Summer 2018 | **Student Science Training Program**, Instructor |
| | Designed & taught a 6-week short course on machine learning basics |
| 2017–2018 | **Teaching Youth Programming Essentials**, Curriculum Lead |
| | Responsible for designing and improving the UF TYPE programming curriculum |
| 2016–2017 | **Teaching Youth Programming Essentials**, Instructor |
| | Teach an after school Intro to Programming course at local high schools |
| 2014–2015 | **Association of Computer Engineers**, Co-Founder and Project Manager |
| | Organized and presented at technical and professional development workshops for undergraduate computer engineering students |