Patrick Emami

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Research Statement

I am a machine learning postdoctoral researcher working on neural 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, dynamic point cloud modeling, 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

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

Research Experience

National Renewable Energy Lab, Postdoctoral Researcher. January 2022–present

● *Artificial Intelligence, Learning, and Intelligent Systems (ALIS) Lab.*

Investigating constrained multi-agent reinforcement learning algorithms for energy-efficient building control and advancing our understanding of neural algorithms for large-scale black-box optimization.

National Renewable Energy Lab, Research Intern. May 2021–August 2021

● *Complex Systems, Simulation, and Optimization Lab. Regional Mobility.* [Paper and code forthcoming]

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

MALT Lab, Graduate Research Assistant. 2016–2021

● *EfficientMORL. ICML'21* [Github]

We present an interpretation of 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 a posterior distribution over slots, a top-down prior to regularize and disentangle the slots, and lightweight iterative posterior refinement to stabilize training. It is the first object-centric generative model to learn symmetric and disentangled representations while being reasonably 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. Demonstrated superior segmentation and stochastic future prediction on a robotic manipulation benchmark data compared to prior work.

UF Transportation Institute, Graduate Research Assistant. 2017–2021.

● *MobileDR & Sensible. NSF Grant 1446813, T-ITS'21*. [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 joint detection and re-identification deep convolutional network, MobileDR, 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

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

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

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

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

2021	**Junior Science, Engineering, and Humanities Symposium**, Reviewer
	Reviewed 7 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