

Patrick Emami

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Research Statement

I like to think about building computational visual frameworks that extract object-centric views of the world like humans do. These systems learn, without supervision, to decompose images and video into objects and reason about alternative futures by learning object-centric dynamics models. This research has immediate and long-term implications for robotics where agents need to consider the relative safety and utility of future action plans. Additionally, I am passionate about interdisciplinary research with a positive social impact. This has led me to collaborate on projects in both transportation engineering (intelligent traffic signal control) and cybersecurity (disinformation detection).

Education

2016–present	University of Florida , Gainesville, FL Ph.D., Computer Science (Machine Learning)	Advisor: Dr. Sanjay Ranka
Summer 2019	University College London , London, UK Machine Learning Summer School (MLSS)	Marc Deisenroth & 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 (NREL), PhD Intern. May 2021–present

- *Regional Mobility.*

Developing algorithms for large-scale traffic simulation calibration and deep reinforcement learning for traffic control with 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. 2021. *Under review*.
- [2] **Emami, P.**, & Elefteriadou, L., & Ranka, S. Long-range Tracking of Vehicles at Traffic Intersections Without a GPU. IEEE Transactions on Intelligent Transportation Systems. 2021. *Under review*. [[UFTI article](#)]
- [3] **Emami, P.**, & Panos M. P., & 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] **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**.
- [2] **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**.
- [3] **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*
- [4] **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.
- [5] 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.
- [6] **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.
- [7] **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.
- [8] 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.
- [9] 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., & Eleftheriadou, 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

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

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–present	Yury Lebedev (Ph.D.)	Univ. of Florida
Fall 2018–present	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

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