

# Patrick Emami

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## Research statement

I like to think about computational visual frameworks that have the same object-centric view of the world as humans. Specifically, perception systems should have the ability to reason about alternative futures while taking into account dynamic objects. This research could have an immediate impact in robotics where agents need to consider the relative safety of future action plans. This has motivated me to design unsupervised models for learning object-centric video representations. I have also explored the relationship to the well-studied problem of video multi-object tracking. Additionally, I am passionate about interdisciplinary research with a positive social impact. This has lead me to collaborate on projects in both transportation engineering and cybersecurity.

## Education

2016–present	<b>University of Florida</b> , Gainesville, FL Ph.D., Computer Science (Machine Learning)	Advisor: Dr. Sanjay Ranka
Summer 2019	<b>University College London</b> , London, UK Machine Learning Summer School (MLSS)	Marc Deisenroth & Arthur Gretton
2012–2016	<b>University of Florida</b> , Gainesville, FL B.Sc., Computer Engineering	Cum Laude, GPA: 3.74/4.0

## Research experience

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

- *Stochastic object-centric world models. NeurIPS '20 ORLR Workshop Spotlight.*

Proposed a deep latent state space model 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.

- *SPG: Sinkhorn Policy Gradient. arXiv 2018.*

Introduced the first actor-critic neural network architecture for learning policies on permutation matrices. Demonstrated a technique for end-to-end training via a continuous relaxation of permutations using Sinkhorn balancing. Achieved competitive performance on combinatorial tasks such as sorting, maximum weight matching, and traveling salesperson.

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

- *Sensible. NSF Grant 1446813, 2017–present.*

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. GPU-less video tracking with a custom deep network running on PyTorch. Integrates with a real-time traffic signal optimizer for advanced adaptive signal control.

- *Survey on data association for multi-object tracking. ACM CSUR '20.*

Synthesized nearly one decade of research on learning-based algorithms for data association step in multi-object tracking. Provided a unifying perspective from the lens of combinatorial optimization. Highlighted the novel research direction of end-to-end learning of linear and multi-dimensional assignment for multi-object tracking.

## Publications

### Peer-Reviewed Journals

- [1] **Emami, P.**, & Elefteriadou, L., & Ranka, S. Long-range Tracking of Vehicles at Traffic Intersections Without a GPU. Transactions on Intelligent Transportation Systems. 2020. *Under review*. [[UFTI article](#)]
- [2] **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.
- [3] 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., Rangarajan, A., Ranka, S. Efficient Iterative Amortized Inference for Learning Symmetric and Disentangled Multi-Object Representations. 2021. *Under review*.
- [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., & 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).

### **Professional Activities**

2021	<b>International Conference on Machine Learning (ICML)</b> , Reviewer
2021	<b>Transportation Research Record (TRR)</b> , Reviewer
2020	<b>NeurIPS Workshop on Interp. Inductive Biases and Phys.</b> , Reviewer
2020	<b>Transportation Research Board Annual Meeting (TRBAM)</b> , Reviewer
2020	<b>Optimization Letters</b> , Reviewer
2019	<b>UF Informatics Institute Student Data Analysis Seminar</b> , Co-Organizer
2018	<b>UF Informatics Institute Student Data Analysis Seminar</b> , Co-Organizer
2018	<b>International Conference on Machine Learning and Data Science</b> , Reviewer
2018	<b>IEEE Intelligent Transportation Systems Conference</b> , Special Session Chair
2018	<b>IEEE Intelligent Transportation Systems Conference</b> , Reviewer
2017	<b>International Conference on Machine Learning and Data Science</b> , Reviewer
2017	<b>UF Informatics Institute Student Data Analysis Seminar</b> , Co-Organizer
2016–2018	<b>UF Machine Learning Reading Group</b> , 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

## Volunteering

2017–2018	<b>UF Teaching Youth Programming Essentials</b> , Curriculum Lead Responsible for designing and improving the UF TYPE programming curriculum
2016–2017	<b>UF Teaching Youth Programming Essentials</b> , Instructor Teach an after school Intro to Programming course at local high schools
2014–2015	<b>UF Association of Computer Engineers</b> , Co-Founder and Project Manager Organized and presented at technical and professional development workshops for undergraduate computer engineering students