

Patrick Emami

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Research Statement

I like to think about building computational visual frameworks for extracting object-centric views of the world like humans do. Specifically, these systems would have the ability to reason about alternative futures by manipulating individual objects. This research could have an immediate impact in robotics where agents need to consider the relative safety of future action plans. Throughout my Ph.D., I developed novel unsupervised models for learning object-centric video representations. Additionally, I am passionate about interdisciplinary research with a positive social impact. This has led me to collaborate on projects in both transportation engineering (multi-object tracking for traffic signal optimization) and cybersecurity (disinformation detection).

Education

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| 2016–present | University of Florida , Gainesville, FL Ph.D., Computer Science (Machine Learning) | Advisors: 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

MALT Lab, Graduate Research Assistant. 2016–present

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

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.* [[Github](#)]

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.* [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. 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] 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., 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., & 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

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| 2021 | International Conference on Machine Learning (ICML) , 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 , 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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| 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–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

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