

Patrick Emami

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Research Statement

I am a machine learning researcher studying deep generative modeling, reinforcement learning, and AI for climate change. My research aims to develop and understand learning frameworks for tackling pressing energy-related challenges in areas such as buildings, weather and power forecasting, protein engineering, and traffic control. Broadly, I am curious about training agents capable of reasoning about the world like humans do.

Education

2016–2021	University of Florida , Gainesville, FL Ph.D., Computer Science (Machine Learning) Thesis: Neural algorithms for object-centric scene understanding	Advisor: Dr. Sanjay Ranka
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) group.*

Lead two successful research projects from conceptualization to completion (protein engineering, multi-agent reinforcement learning) each with articles and open source code to be released soon. Secured Lab Directed Research & Development funding (\$300K/yr, FY23-24) to research foundation models for renewable energy systems within first year at NREL. Organized an internal workshop on Generative AI (January 2023). Helped establish new internal (PSEC) and external (PNNL, IBM) collaborations.

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

- *Complex Systems, Simulation, and Optimization Lab. Regional Mobility.*

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

MALT Lab, Graduate Research Assistant. 2016–2021

- *Segregate, Relate, Imagine. arXiv’22.*

Introduces two key ideas that improve the sample quality of slot-based variational autoencoders: using a global, scene-level latent variable as a slot prior and learning a consistent object generation order. Proposes an inference algorithm that aligns the inferred slot order to a sequence of slots generated by the prior.

- *EfficientMORL. ICML’21*

First object-centric generative model to learn symmetric *and* disentangled representations while being reasonably efficient. Unifies 1) bottom-up inference with attention to estimate a posterior distribution over slots, 2) top-down prior to regularize and disentangle the slots, and 3) iterative posterior refinement in a single model.

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

Proposes a stochastic latent state space model based on variational autoencoders for jointly learning object-centric representations and dynamics. Achieves superior segmentation and stochastic future prediction on a robotic manipulation dataset compared to prior work.

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

- *MobileDR & Sensible. T-ITS’21, NSF Grant 1446813.*

Lead software engineer for Sensible, a distributed Python framework for real-time multi-sensor multi-object tracking at traffic intersections. Integrates V2X, Econolite cameras, and Smartmicro radars and uses edge video tracking with a novel joint detection and re-identification deep convolutional network running on PyTorch.

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] **Emami, P.**, Perreault, A., Law, J., Biagioni, D., John, PCS. Plug & Play Directed Evolution of Proteins with Gradient-based Discrete MCMC. 36th Conference on Neural Information Processing Systems Workshop on Machine Learning in Structural Biology (NeurIPS'22 MLSB). 2022.
- [2] 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.**
- [3] **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.**
- [4] **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.**
- [5] **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*
- [6] **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.
- [7] 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.
- [8] **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.
- [9] **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.
- [10] 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.

- [11] 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.**, Perreault, A., Law, J., Biagioni, D., John, PCS. Plug & Play Directed Evolution of Proteins with Gradient-based Discrete MCMC. arxiv:2212.09925 [cs.LG, q-bio.BM], 2022.
- [2] He, P., **Emami, P.**, Ranka, S., Rangarajan, A. Learning Canonical Embeddings for Unsupervised Shape Correspondence with Locally Linear Transformations. arxiv:2209.02152 [cs.CV], 2022.
- [3] **Emami, P.**, He, P., Ranka, S., Rangarajan, A. Slot Order Matters for Compositional Scene Understanding. arXiv:2206.01370 [cs.LG], 2022.
- [4] **Emami, P.**, & Ranka, S. Learning Permutations with Sinkhorn Policy Gradient. arXiv:1805.07010 [cs.LG], 2018.
- [5] **Emami, P.**, & Panos M. P., & Eleftheriadou, L., & Ranka, S. Machine Learning Methods for Solving Assignment Problems in Multi-Target Tracking. 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

2023	AISTATS, Reviewer
2023	International Conference on Learning Representations (ICLR), Reviewer
2022	Neural Information Processing Systems (NeurIPS), Reviewer
2022	International Conference on Machine Learning (ICML), Reviewer
2022	Computer Vision and Pattern Recognition (CVPR), Reviewer
2022	International Conference on Learning Representations (ICLR), Reviewer (<i>Top Reviewer</i>)
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 (<i>Top 10% Reviewer</i>)
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

Skills

- Programming languages: Python, MATLAB, Java, C++, Bash
- ML frameworks: PyTorch, Tensorflow, RLlib, scikit-learn, OpenCV
- Data analysis: Jupyter, pandas, numpy, matplotlib, seaborn, Inkscape
- HPC: Slurm, torch.distributed
- Traffic Simulation: SUMO, Flow

Selected Honors and Awards

2022	Top Reviewer at ICLR'22
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

Summer 2022	Aidan Perreault (NREL Intern)	Stanford
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