Tanmay Shankar

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Research Interests

I am interested in enabling agents with the ability to imitate human demonstrators on par with that of humans, in turn enabling them to solve tasks. To do so, I aim to enable agents to learn and reason about composable abstractions or skills, understanding human and their own behaviors from a unified perspective. To that end, I am interested in discovering insights that bridge unsupervised machine learning, reinforcement and imitation learning and robotics.

Education

Carnegie Mellon University, Pittsburgh, USA. 2020 - Present
Ph.D. in Robotics, Robotics Institute.
Thesis Advisor: Jean Oh, Robotics Institute.
Thesis: Learning and Translating Temporal Abstractions across Humans and Robots.

Carnegie Mellon University, Pittsburgh, USA. 2016 - 2018
Masters in Robotics, Robotics Institute.
Thesis Advisors: Katharina Muelling & Kris Kitani, Robotics Institute.

Indian Institute of Technology Guwahati, Guwahati, India. 2012 - 2016
B. Tech., Mechanical Engineering, minor in Electronics and Communication Engineering

Work Experience

Facebook AI Research, Pittsburgh, USA 2018 - 2020
Research Engineer, working with Abhinav Gupta and Shubham Tulsiani.

Facebook AI Research, Pittsburgh, USA 2022 - 2022
Research Intern, working with Stuart Anderson, Yixin Lin, Aravind Rajeswaran, Vikash Kumar.

Research Experience

Learning Abstract Representations of Agent-Environment Interactions
Ph.D. Research Project, CMU *Advisor:* Jean Oh
Building Task Representations as Abstractions of Environment State Transformations
- Learnt abstract representations of object and environment state transformations.
- Explored using environment abstractions to build task representations from demonstrations.

Learning Unsupervised Skill Correspondences Across Humans and Robots [Website]
Ph.D. Research Project, CMU *Advisor:* Jean Oh
Translating Robot Skills via Unsupervised Representation Alignment
- Formulated unsupervised approach to translate skills across different morphological robots, inspired by unsupervised machine translation.
- Transferred skills and task-strategies across robots using unsupervised translation.

Dextrous Skill Transfer across Human and Robot Hands
Ph.D. Research Project, CMU *Advisor:* Jean Oh
Translating Dextrous Skills via Unsupervised Representation Alignment
- Applied above skill translation framework to translating dextrous manipulation skills.
- Explored transferring dextrous manipulation skills from human to robot hands.

Learning Robot Skills with Temporal Variational Inference [Website]
Research Project, FAIR *Advisor:* Abhinav Gupta
Unsupervised Hierarchical Policy Learning from Demonstrations
- Formulated an unsupervised temporal variational inference to learn hierarchical policies (options, represented as latent variables) from demonstrations, using ideas of consistency.

Discovering Motor Programs by Recomposing Demonstrations [Website]
Research Project, FAIR *Advisors:* Shubham Tulsiani & Abhinav Gupta
Unsupervised Skill Discovery from Robot Demonstrations by Recomposition

- Formulated an unsupervised loss to discover the space of motor primitives of a set of robot demonstrations, using ideas of recomposition, simplicity, parsimony, and plannability.
- Showed efficacy of primitives to accelerate downstream task learning on a Baxter robot.

Learning Neural Parsers via Deterministic Differentiable Imitation Learning [Website]
Graduate Research Thesis, CMU *Advisors:* Katharina Muelling & Kris Kitani
Learning to Parse via hybrid Imitation-Reinforcement Learning

- Introduced a novel Deterministic Policy Gradient DRAG, for the hybrid IL-RL setting, as a deterministic actor-critic variant of AggreVaTeD, or an imitation learning variant of DDPG.
- Applied DRAG to learn a neural parser by imitating an information-gain maximizing oracle.

Reinforcement Learning via Recurrent Convolutional Neural Networks [Website]
Bachelor's Thesis, IIT Guwahati *Advisors:* S. K. Dwivedy & Prithwijit Guha
Reinforcement Learning Networks - Fusing Learning and Planning

- Introduced a neural approximation to value iteration, by representing the expectation of the Bellman backup as convolutions, and iterations as temporal recurrence.
- Introduced the *QMDP-RCNN*, a learnable approximation to partially observable planning.

Publications

T. Shankar, Y. Lin, A. Rajeswaran, V. Kumar, S. Anderson, J. Oh, *"Translating Robot Skills: Learning Unsupervised Skill Correspondences Across Domains"*, (TRS), International Conference on Machine Learning, ICML 2022. [PDF]

T. Shankar, A. Gupta, *"Learning Robot Skills with Temporal Variational Inference"*, (TVI), International Conference on Machine Learning, ICML 2020. [PDF] [Code]

T. Shankar, S. Tulsiani, L. Pinto, A. Gupta, *"Discovering Motor Programs by Recomposing Demonstrations"*, (DMP), International Conference on Learning Representations, ICLR 2020. [PDF]

T. Shankar, N. Rhinehart, K. Muelling, K. Kitani, *"Learning Neural Parsers with Deterministic Differentiable Imitation Learning"*, (LNP), Conference on Robot Learning, CoRL 2018. [PDF]

T. Shankar, S.K. Dwivedy, P. Guha, *"Reinforcement Learning via Recurrent Convolutional Neural Networks"* (RLN), International Conference on Pattern Recognition, ICPR 2016. [PDF]

T. Shankar, S.K. Dwivedy, *"A Hybrid Assistive Wheelchair Exoskeleton"*, International Convention on Rehabilitation Engineering and Assistive Technology, i-CREATe 2015. [PDF]

T. Shankar, A. Biswas, V. Arun, *"Development of an Assistive Stereo Vision System"*, International Convention on Rehabilitation Engineering and Assistive Technology, i-CREATe 2015. [PDF]

Workshop Publications

T. Shankar, J. Oh, *"Learning Abstract Representations of Agent-Environment Interactions"*, (LIR), workshop on Aligning Human-Robot representations, Conference on Robot Learning, CoRL 2022.

Papers in preparation

T. Shankar, A. Hassan, J. Oh, *"Transferring Dextrous Manipulation Skills from Human to Robot Hands"*, (TDS), to be submitted to Robotics Science and Systems, RSS 2023.

Open Source

`github.com/facebookresearch/CausalSkillLearning`, `github.com/tanmayshankar/RCNN_MDP`

Mentoring	Mentor for Atmulwakel Hassan, a CMU undergraduate, on project on dextrous skill transfer.	2022
	Mentor for Nitya Bhat, a CMU undergraduate, on project on RL for dextrous robot hands.	2022
	Mentor for CMU Undergrad from underrepresented groups getting into AI Research.	2020
Leadership	Co-organizing a workshop submission to CoRL on Explainable AI in Robots.	2022
	Co-organizing a workshop submission to AAAI on User Centric AI.	2022
	Founded an AI and Robotics Research mentoring program for IITG Undergraduates.	2015 - 2016
Service	Reviewer for NeurIPS 2022, ICML 2022, ICLR 2020 & CVPR 2019.	2019 - 2022
Awards	Samsung Innovation Award, for excellence in research, IIT Guwahati.	2015
	Master R. Balakrishnan Memorial Award, Best All Rounder Student.	2011
	Dr. Lt. Col. T S Kalyanam Award, for the Best Outgoing Student.	2011
Teaching Experience	Teaching Assistant, Optimal Control & Reinforcement Learning, CMU	2021
	Teaching Assistant, Deep Reinforcement Learning, CMU	2018

Technical Skills	*Languages Known:*	Python, Familiar with C / C++, Matlab.
	Software Packages:	TensorFlow, PyTorch, OpenCV, PCL, MATLAB, LaTeX, Rviz, Gazebo, ROS
	Hardware:	Rethink Baxter & Sawyer, Odroid XU3, Pixhawk Autopilot.

Graduate Coursework	*Deep Learning*	*Language Grounding to Vision and Control*
	Deep Reinforcement Learning	*Machine Learning*
	Computer Vision	*Math Fundamentals for Robotics*
	Kinematics Dynamics and Controls	*Probabilistic Graphical Models*

References

Jean Oh, Associate Research Professor, CMU
Shubham Tulsiani, Assistant Professor, CMU & former Research Scientist, Meta AI
Stuart Anderson, Senior Research Engineering Manager, Meta AI