

TANMAY SHANKAR

E-mail: tanmay.shankar@gmail.com
Phone: 412-537-1968

Web: <https://tanmayshankar.github.io/>
Github: <https://github.com/tanmayshankar>

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 [Website]
Ph.D. Research Project, CMU *Advisor:* Jean Oh
Building Task Representations as Abstractions of Environment State Transformations

- Learnt abstract representations to build task representations from demonstrations.
- Deployed framework to solve compositional tasks on real world X-Arm Robot.

Translating EMG signals to Robotic and Prosthetic Hand Skills
Ph.D. Research Project, CMU *Advisors:* Jean Oh & Minas Liarkopis
Building abstract representations of EMG signals for Robotic and Prosthetic Hand Control

- Learnt abstract representations of EMG of people demonstrating day-to-day tasks.
- Exploring transferring EMG abstractions to robotic and prosthetic hand skills.

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 recombination, 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 & Prithwiji 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]

PAPERS IN SUBMISSION

T. Shankar, C. Chawla, J. Oh, “Learning Abstract Representations of Agent-Environment Interactions”, (**LIR**), submitted to International Conference on Robotics and Automation, ICRA 2024.

PAPERS IN PREPARATION

T. Shankar, A. Hassan, J. Oh, “Transferring Dexterous Manipulation Skills from Human to Robot Hands”, (**TDS**), to be submitted to Robotics Science and Systems, RSS 2024.

OPEN SOURCE	github.com/facebookresearch/CausalSkillLearning , github.com/tanmayshankar/RCNN_MDP	
MENTORING	Mentor for Chaitanya Chawla, a T.U. Munich undergraduate student, on project on learning and transferring interaction abstractions.	2023
	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
	Volunteer for IROS and CoRL	2023
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	Teaching Assistant, Introduction to Robot Learning, CMU	2023
EXPERIENCE	Teaching Assistant, Optimal Control & Reinforcement Learning, CMU	2021
	Teaching Assistant, Deep Reinforcement Learning, CMU	2018
TECHNICAL SKILLS	<i>Languages Known:</i> Python, Familiar with C / C++, Matlab. <i>Software Packages:</i> TensorFlow, PyTorch, OpenCV, PCL, MATLAB, L ^A T _E X, Rviz, Gazebo, ROS <i>Hardware:</i> Rethink Baxter & Sawyer, Odroid XU3, Pixhawk Autopilot.	
GRADUATE	<i>Deep Learning</i>	<i>Language Grounding to Vision and Control</i>
COURSEWORK	<i>Deep Reinforcement Learning</i>	<i>Machine Learning</i>
	<i>Computer Vision</i>	<i>Math Fundamentals for Robotics</i>
	<i>Kinematics Dynamics and Controls</i>	<i>Probabilistic Graphical Models</i>
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	