

TANMAY SHANKAR

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RESEARCH INTERESTS

I'm interested in enabling robots to imitate human demonstrators perform a variety of tasks. My Ph.D. research aims to do so by learning and translating temporal abstractions of behaviors, or skills, across humans and robots, thereby understanding human and robot behaviors from a unified perspective. I'm also interested in applying these ideas to controlling prosthetic and robotic hands more intuitively, and from control signals such as EMG data.

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 of Behavior Across Humans and Robots.*

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

Translating Temporally Abstract Behaviors across Humans and Robots in the Wild [Website]
Ph.D. Research Project, CMU *Advisor:* Jean Oh

- Building unified representations of task strategies across humans and robots.
- Extending prior skill-learning and translation work to out-of-domain in-the-wild human videos.

Translating Agent-Environment Interactions across Humans and Robots [Website]
Ph.D. Research Project, CMU *Advisor:* Jean Oh

- Formulated *TransAct*, to learn temporal abstractions of agent-environment interactions, then translate interactions with similar environmental effects across humans and robots.
- Enabled zero shot in-domain transfer of human demonstrations to a real world robot.

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

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

Learning Unsupervised Skill Correspondences Across Humans and Robots [Website]
Ph.D. Research Project, CMU *Advisor:* Jean Oh

- Formulated unsupervised approach to translate skills across different morphological robots, inspired by unsupervised machine translation.
- Transferred skills and task-strategies across humans and robots using unsupervised translation.

Learning New Painting Skills by Exploring Paint Stroke Representations

Ph.D. Research Project, CMU

Advisor: Jean Oh

- Learnt latent representations of paint strokes collected on FRIDA the robot painter.
- Exploring interpolating in learnt representation space to construct new painting skills.

Learning Robot Skills with Temporal Variational Inference

[Website]

Research Project, FAIR

Advisor: Abhinav Gupta

- 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

- 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.

Learning Neural Parsers via Deterministic Differentiable Imitation Learning

[Website]

Graduate Research Thesis, CMU

Advisors: Katharina Muelling & Kris Kitani

- 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.

Reinforcement Learning via Recurrent Convolutional Neural Networks

[Website]

Bachelor's Thesis, IIT Guwahati

Advisors: S. K. Dwivedy & Prithwjit Guha

- Introduced a neural approximation to value iteration, by representing the expectation of the Bellman backup as convolutions, and iterations as temporal recurrence.

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, A. Hassan, J. Oh, “*Translating Agent-Environment Interactions across Humans and Robots*”, (LIR), submitted to International Conference on Intelligent Robots and Systems, IROS 2024.

WORKSHOP PAPERS	T. Shankar , J. Oh, <u>“Learning Abstract Representations of Agent-Environment Interactions”</u> , (LIA), workshop on Aligning Human Robot Representations, Conference on Robot Learning, CoRL 2023.	
PAPERS IN PREPARATION	T. Shankar , J. Oh, <u>“Learning and Translating Temporal Abstractions of Behaviors Across Humans and Robots”</u> , to be submitted to IEEE Robotics and Automation Letters (RA+L) Journal, 2024.	
	L. Chen, L. Coleman, P. Schaldenbrand, T. Shankar , J. Oh, <u>“Learning Painting Skills by Exploring Stroke Representations”</u> , (LPS), to be submitted to IEEE Robotics and Automation Letters (RA+L) Journal, 2024.	
	T. Shankar , B. Guan, R. Vilela, J. Oh, M. Liarkopis, <u>“Translating EMG Control Signals to Dextrous Robotic and Prosthetic Hands”</u> , (TEG), to be submitted to International Conference on Robotics and Automation, ICRA 2025.	
OPEN SOURCE	github.com/facebookresearch/CausalSkillLearning , github.com/tanmayshankar/RCNN_MDP	
MENTORSHIP	Lawrence Chen (B.S./M.S., CMU), - robot painting skills.	2023-2024
	Chaitanya Chawla (B.Tech., T.U. Munich) - transferring interaction abstractions.	2023-2024
	Atmulwakel Hassan, (B.S., CMU) - dextrous skill transfer.	2022-2024
	Kangni Liu (MRSD., CMU) - LLM guided skill transfer.	2024
	Nitya Bhat, (B.S., CMU) - RL for dextrous robot hands.	2022
	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, XArm Lite6.	
GRADUATE COURSEWORK	<i>Deep Learning</i>	<i>Language Grounding to Vision and Control</i>
	<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	
	Amy Zhang, Assistant Professor, CMU & Research Scientist, Meta AI	