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 of Behavior 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

Translating Temporally Abstract Behaviors across Humans and Robots in the Wild
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 recomposition, 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 & Prithwijit 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, *"Learning Abstract Representations of Agent-Environment Interactions"*, (LIA), workshop on Aligning Human Robot Representations, Conference on Robot Learning, CoRL 2023. |

PAPERS IN PREPARATION	**T. Shankar**, J. Oh, *"Learning and Translating Temporal Abstractions of Behaviors Across Humans and Robots"*, to be submitted to IEEE Robotics and Automation Letters (RA+L) Journal, 2024.
	T. Shankar, B. Guan, R. Vilela, J. Oh, M. Liarkopis, *"Translating EMG Control Signals to Dextrous Robotic and Prosthetic Hands"*, (TEG), to be Conference on Robot Learning, CoRL 2024.
	L. Chen, L. Coleman, P. Schaldenbrand, **T. Shankar**, J. Oh, *"Learning Painting Skills by Exploring Stroke Representations"*, (LPS), to be submitted to Conference on Robot Learning, CoRL 2024.

| 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 EXPERIENCE	Teaching Assistant, Introduction to Robot Learning, CMU	2023
	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, XArm Lite6.

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
	Amy Zhang, Assistant Professor, CMU & Research Scientist, Meta AI