MuLIP
Multimodal Learning, Interaction, and Perception Lab

CAREER: Learning and Sharing Transferable Grounded Object Knowledge for Collaborative Robots
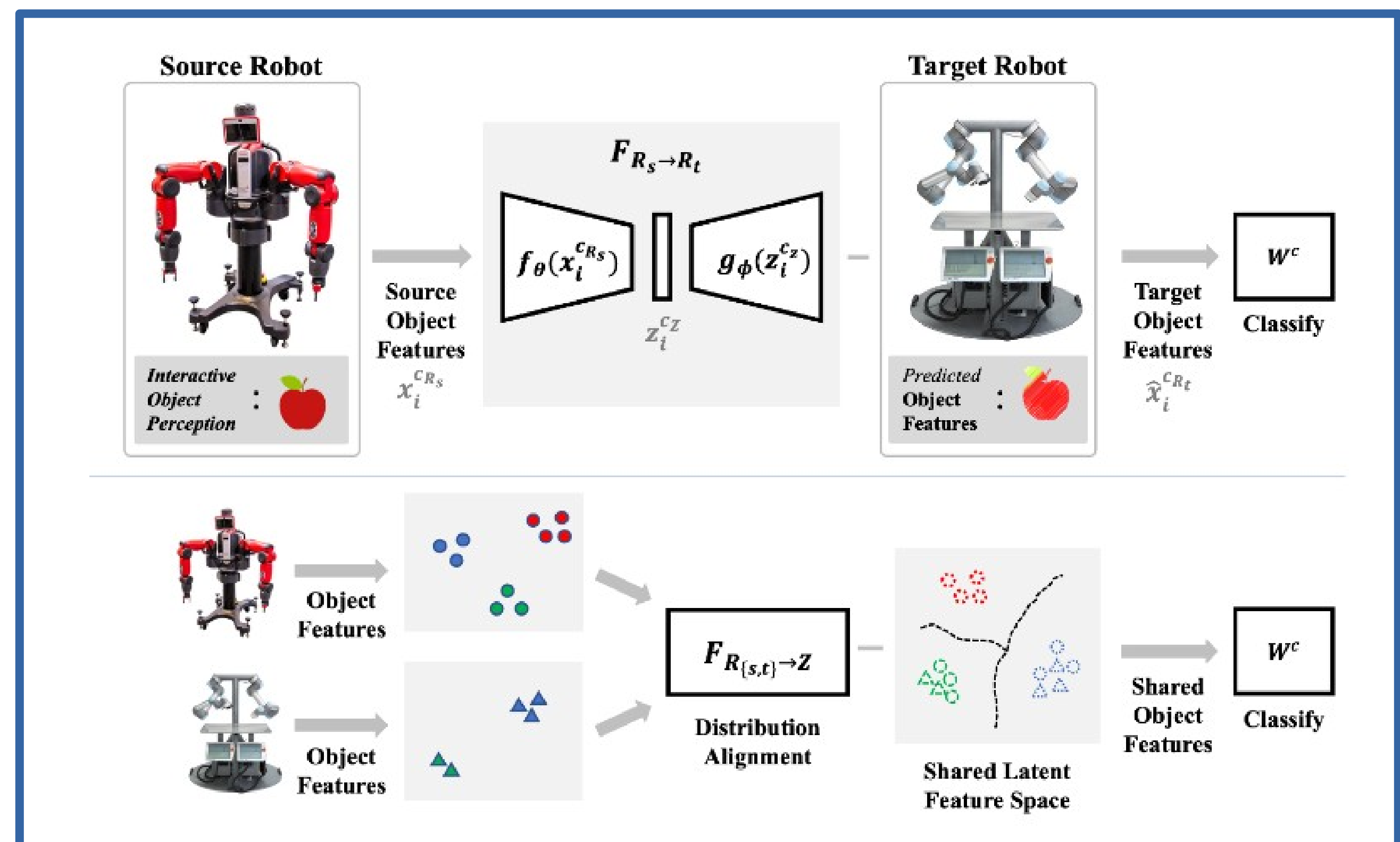
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Motivation

The tactile, haptic, and auditory modalities improve a robot's ability to manipulate objects and identify their properties.
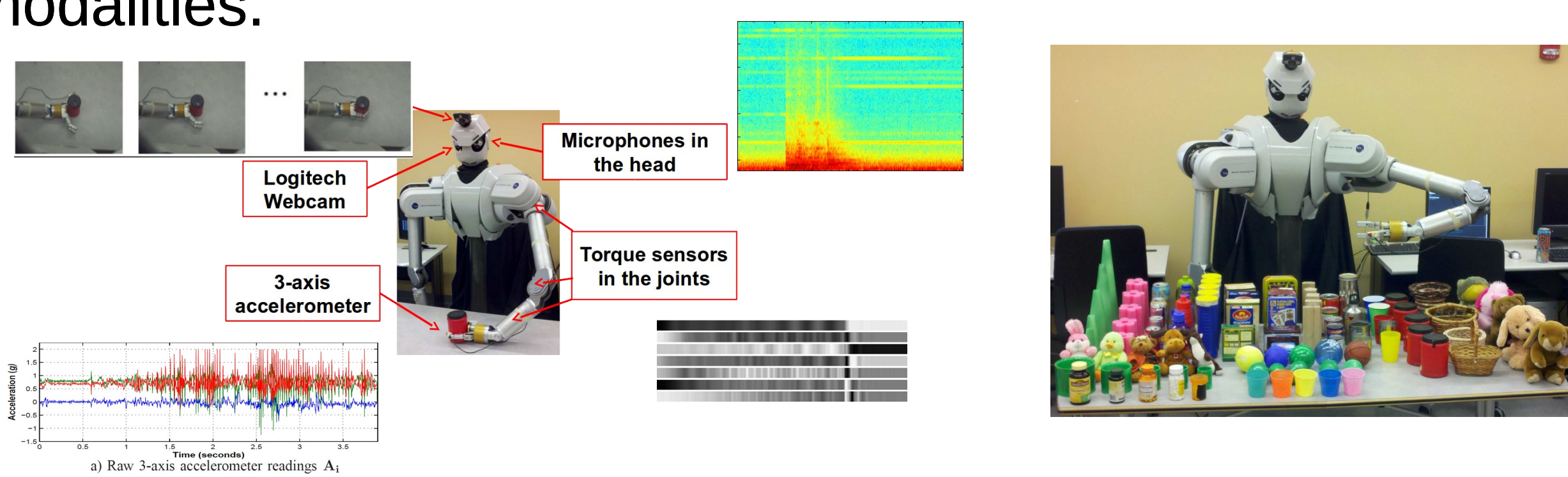
Real-world interaction experience with objects is time consuming and often prohibitively expensive to collect at scale.

Knowledge grounded in a robot's individual set of behaviors and sensors cannot directly be transferred to another robot with a different set of actions and sensory modalities
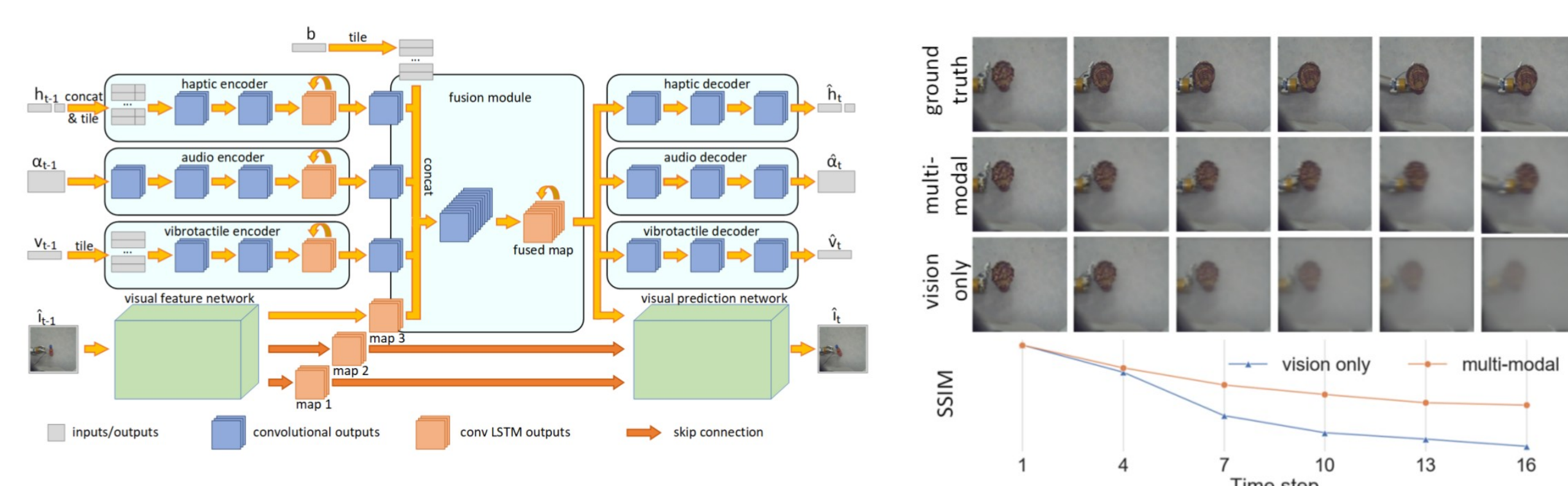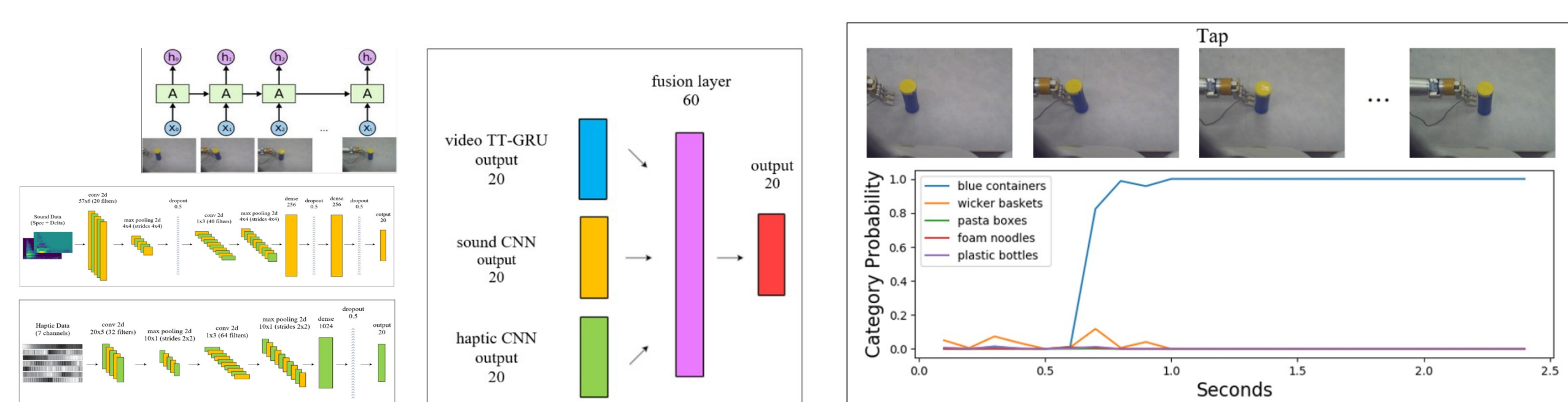

Multisensory Object Exploration

Preliminary results were computed over a data set in which the robot explored a large set of objects and recorded visual, auditory, haptic, and tactile sensory modalities.

Multisensory foresight is the ability of a robot to predict the future states of its sensors (e.g., the next image) as a result of its actions in its environment. Non-visual modalities improve visual foresight performance. Learning to predict future auditory, haptic, and tactile states improves visual foresight [ICRA 2021]:
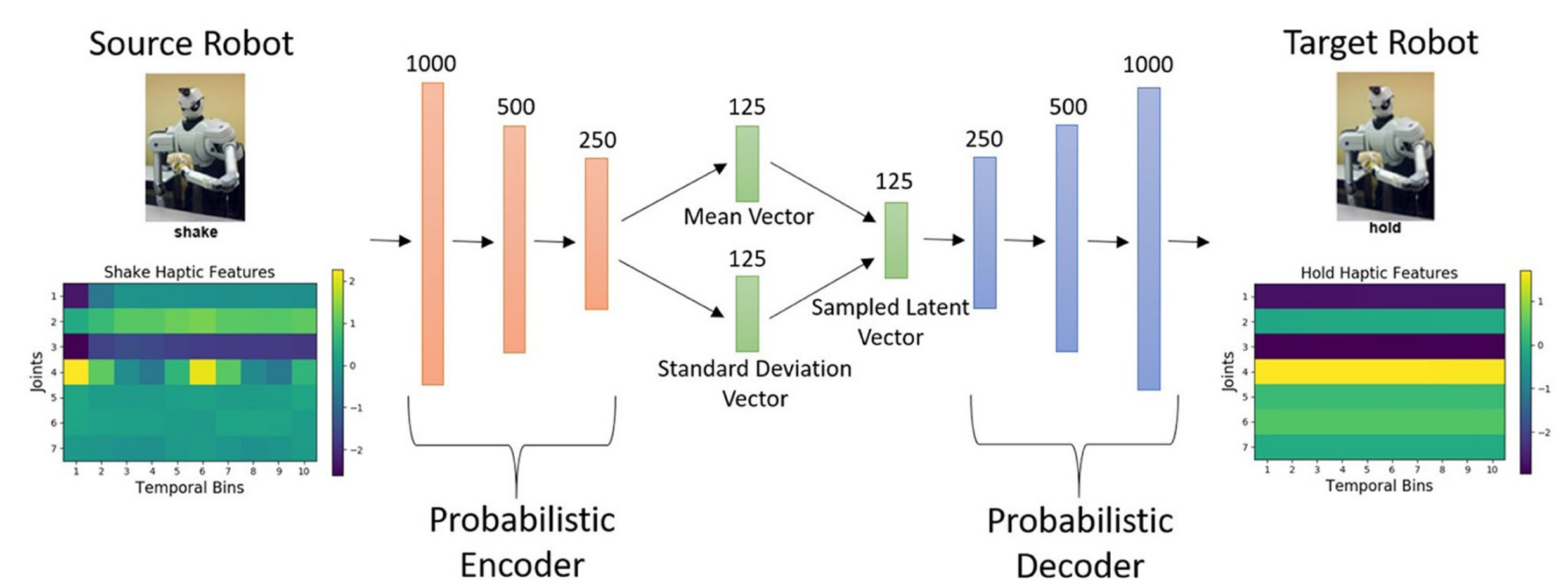

Deep multi-modal networks enabled the robot to recognize semantic categories of objects [ICRA 2019]:
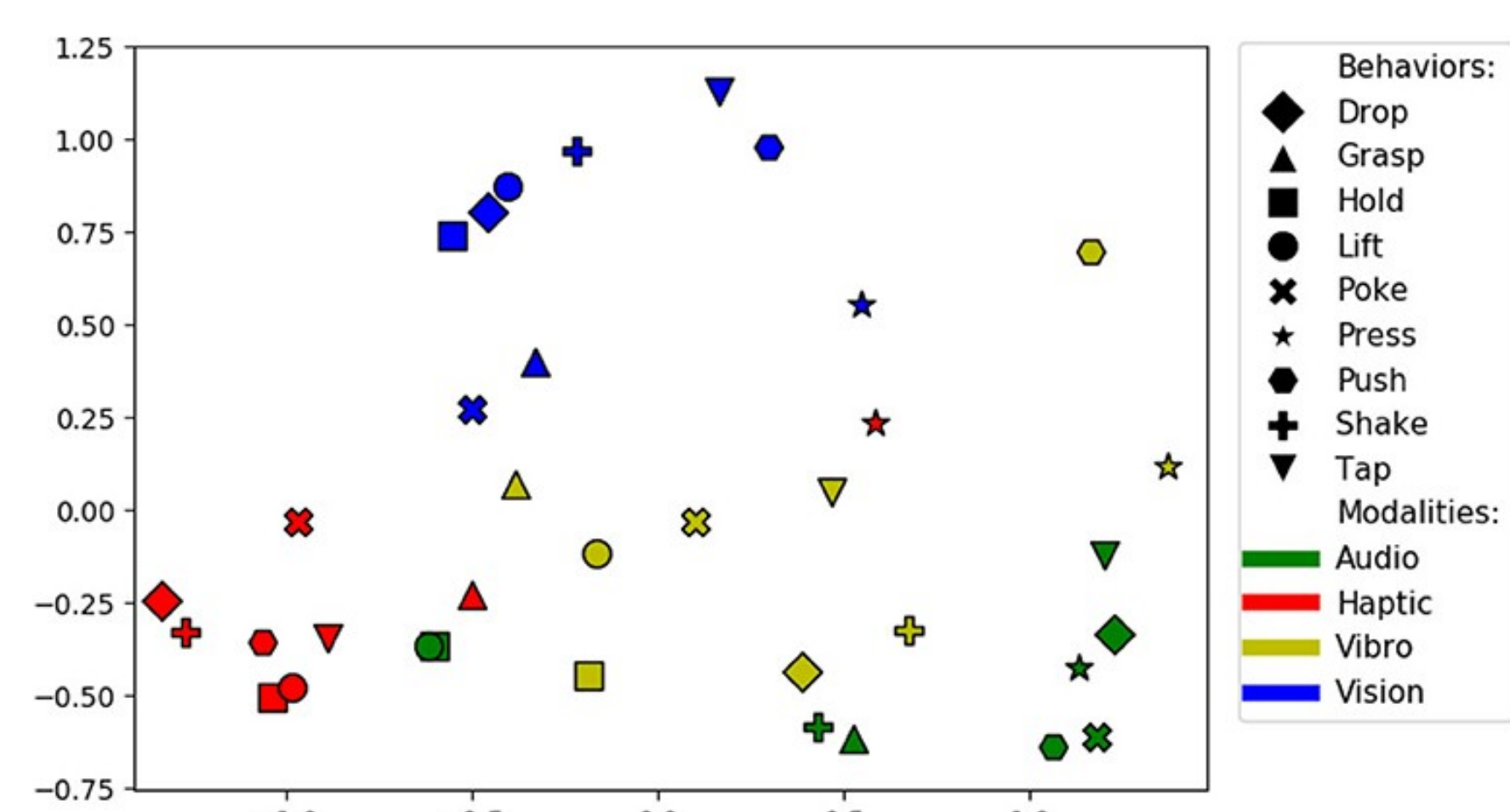

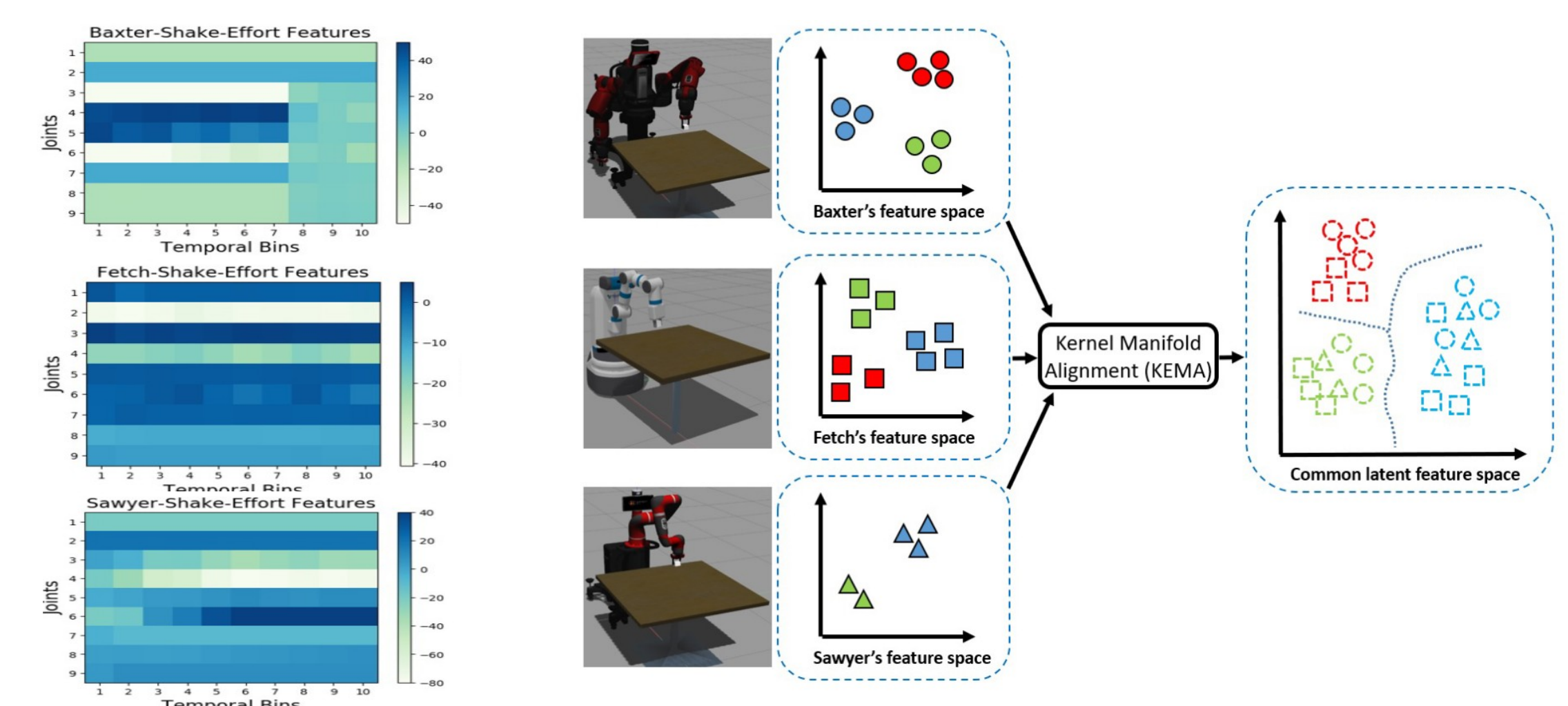## Cross-modal and Cross-behavior transfer

Preliminary results show that a robot can "imagine" what an object feels like in one context (e.g., when pushed), given data from another context (e.g., when lifted) [Frontiers in Robotics 2020]:

The quality of transfer varies depending on the source and target behaviors/modalities:

We have also developed methods where 2+ robots learn a shared latent haptic representation to share knowledge [IROS 2020]:

Scientific Contributions:

Algorithms for learning multisensory object representations

Algorithms for transferring knowledge between robots that is grounded in experience with different sensors and actions

Broader Impacts and Outreach:

This research will enable robots in industry, healthcare and home applications to make better use of non-visual sensory modalities

The research has been integrated with outreach programs run out of Tufts' Center for Engineering Education and Outreach