

MA Proposal: Cross-Embodiment Lifelong Learning via Non-Parametric Shared Representation Knowledge Space

Background

Embodied lifelong learning faces significant challenges in transferring knowledge across diverse robotic platforms. Differences in observation space dimensions, control signal formats, and dynamic characteristics make direct parameter transfer or policy sharing inefficient and often lead to catastrophic forgetting. Addressing these issues, this project aims to build a non-parametric, shared latent representation mechanism to enable dimension alignment and unified knowledge representation across heterogeneous embodiments. Leveraging non-parametric Bayesian clustering models, such as Dirichlet Process Mixture Models (DPMM), the project seeks to dynamically adapt input mappings during lifelong learning, allowing robots to efficiently decouple task representations and promote knowledge reuse across platforms.

Project Introduction

This project proposes assigning each embodiment its own input and output layers to align different observation and control spaces into a shared latent space. Throughout lifelong learning, a new input layer will be assigned to each new robot, ensuring its states are effectively mapped into the common space while the shared Transformer-based policy trunk remains platform-agnostic. Output layers will translate the shared decisions into platform-specific control signals, adapting to varying robot dynamics. Key tasks for participating students include (1) thorough literature review on lifelong cross-embodiment learning, (2) algorithm development for shared trunk policy lifelong learning, and (3) real-world deployment on various robotic platforms to validate the approach.

Requirements

We are looking for highly self-motivated students with a strong passion for embodied intelligence research. Applicants should meet the following criteria:

1. A strong interest in embodied AI and lifelong learning research, with high self-motivation.
2. Good academic record with **GPA < 2.3**

3. Proficiency in **Python** programming and experience working in **Linux**-based environments.
4. Solid foundations in **deep learning** (completion of course such as **Introduction to Deep Learning - i2dl** is required).
5. Good **English** communication and academic writing skills.
6. Availability to work **full-time** on the project for **at least 6 months**.

Contact

If you are interested in working on this exciting project, please contact Mr. Yuan Meng at y.meng@tum.de for further information.

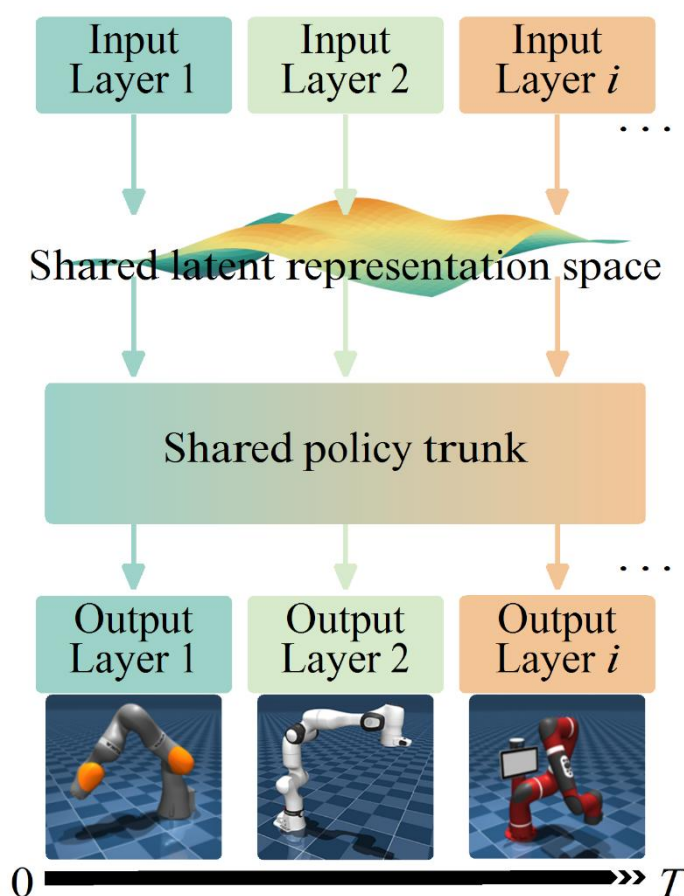


Figure 1 Framework overview of cross-embodiment lifelong learning framework.