From Imitation Learning to Instruction learning: A New Paradigm for Efficient Motion Learning

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ABSTRACT

Recent years have witnessed many successful trials in the robot learning field. For contact-rich robotic tasks, it is challenging to learn coordinated motor skills by reinforcement learning. Imitation learning solves this problem by using a mimic reward to encourage the robot to track a given reference trajectory. However, imitation learning is not so efficient and may constrain the learned motion. We propose instruction learning, which is inspired by the human learning process and is highly efficient, flexible, and versatile for robot motion learning. Instead of using a reference signal in the reward, instruction learning applies a reference signal directly as a feedforward action, and it is combined with a feedback action learned by reinforcement learning to control the robot. Besides, we propose the action bounding technique and remove the mimic reward, which is shown to be crucial for efficient and flexible learning. We compare the performance of instruction learning with imitation learning, indicating that instruction learning can greatly speed up the training process and guarantee learning the desired motion correctly. The effectiveness of instruction learning is validated through a bunch of motion learning examples for a biped robot and a quadruped robot, where skills can be learned typically within several million steps.
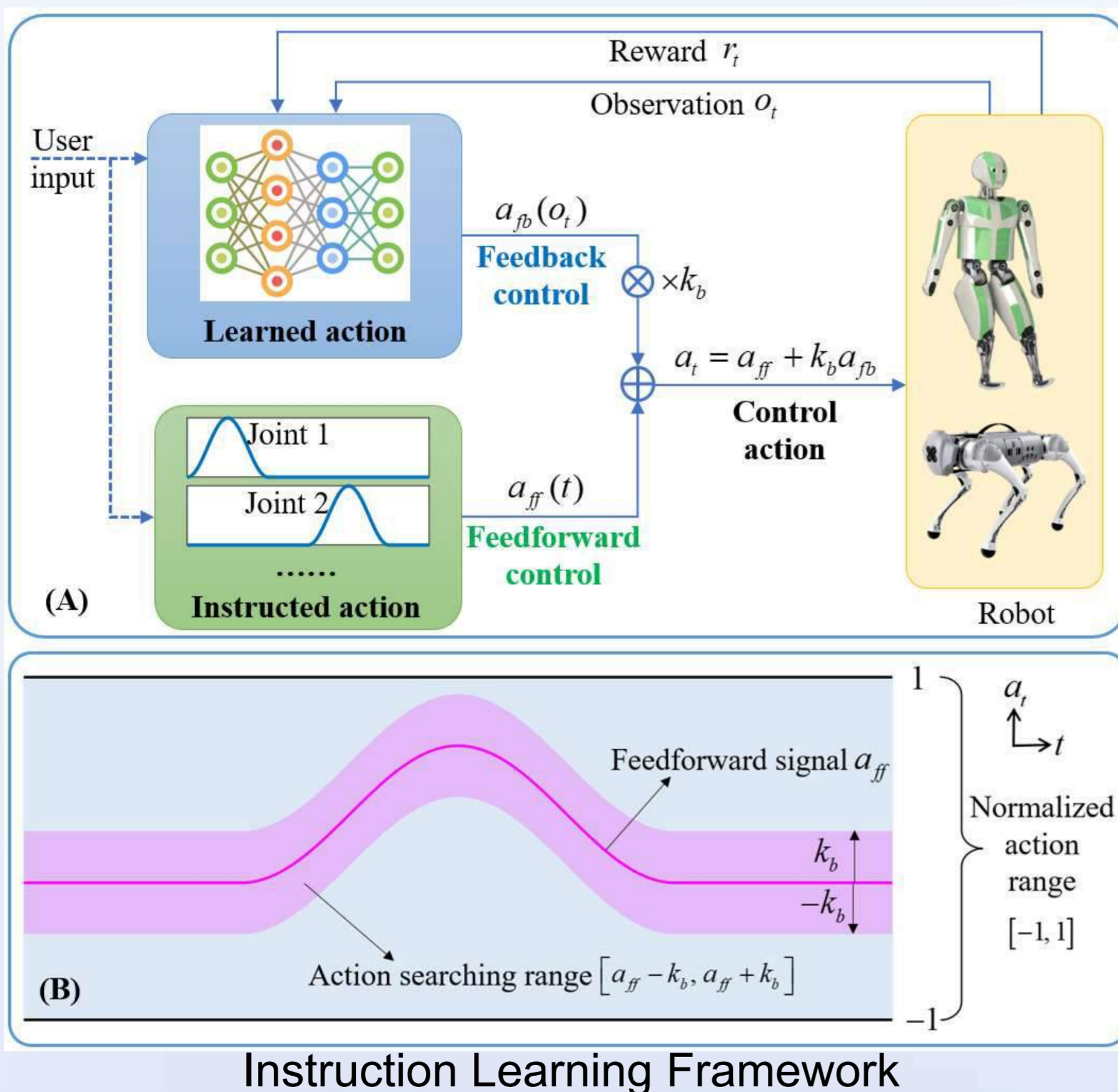
INTRODUCTION

Inspired by the motion skill learning process of humans, we propose the instruction learning framework. The core of instruction learning is "knowing-to-doing", where the robot starts from an instructed action and improves it through training. Compared to imitation learning, which uses a reference signal in the reward, instruction learning uses the reference signal directly in the action as feedforward and applies reinforcement learning to make corrections to achieve a given goal. The learning mechanism makes instruction learning inherently more efficient and less constrained.
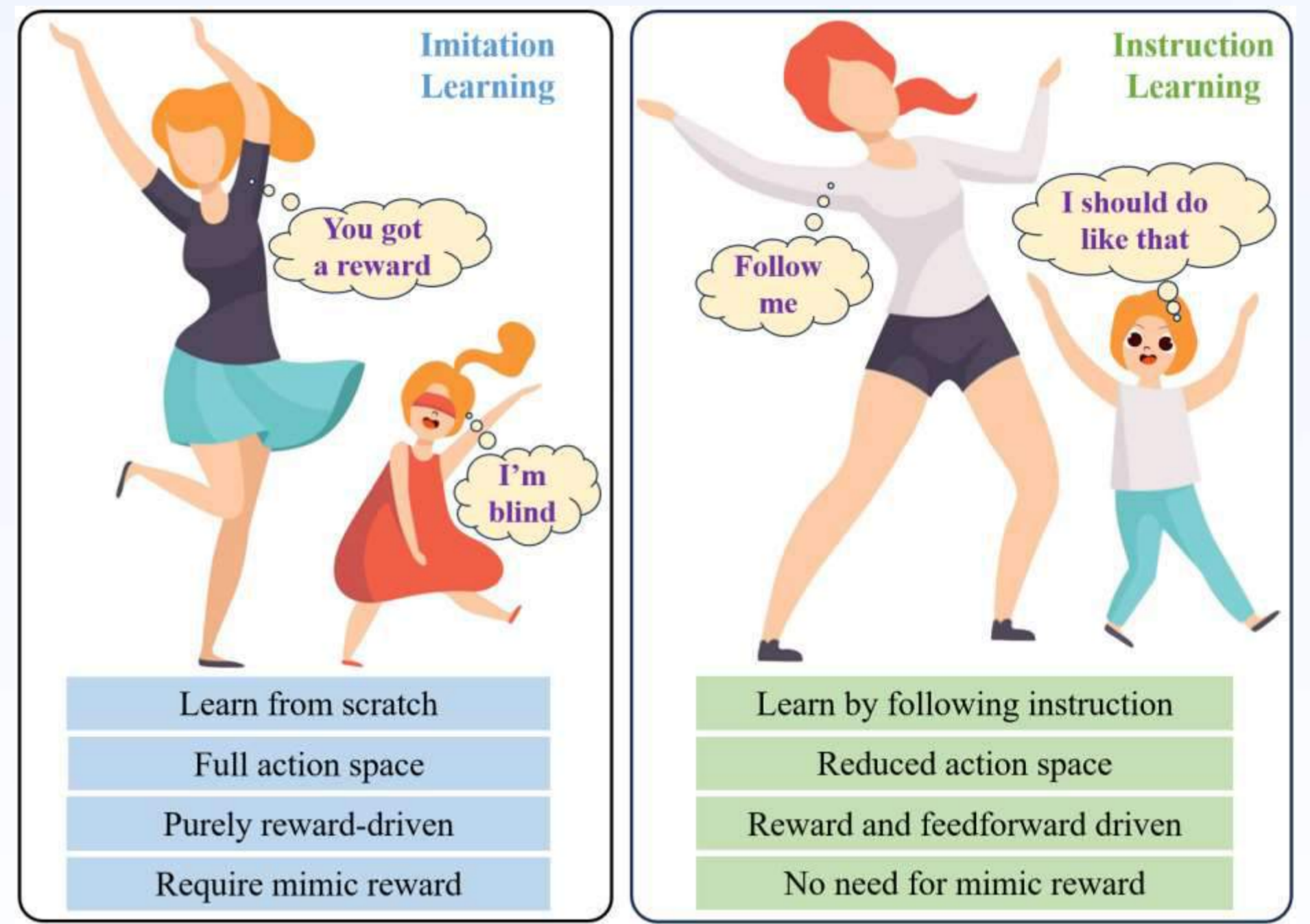

Imitation Learning vs. Instruction Learning

METHODS
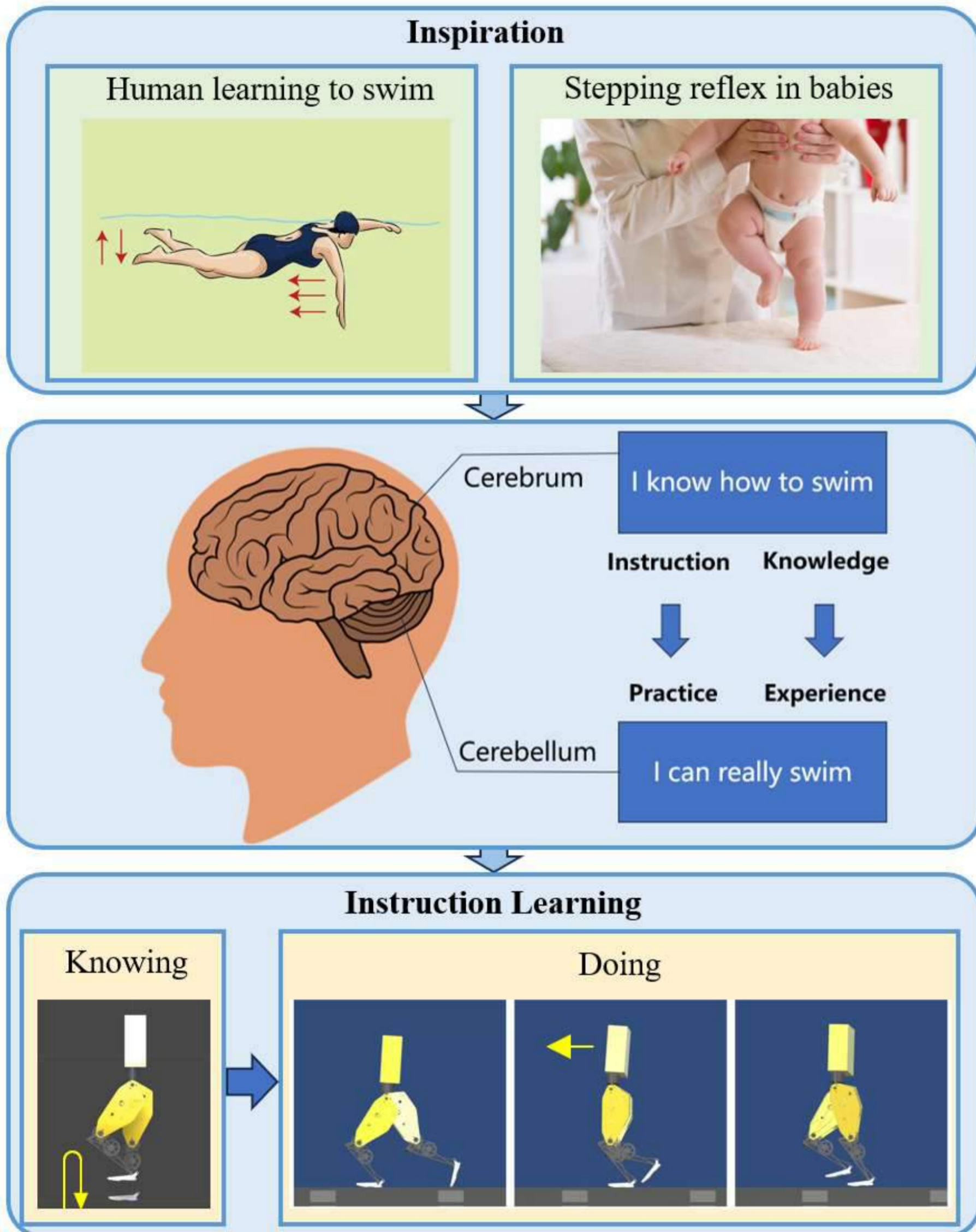
Inspiration from Human Learning

Instruction Learning Framework

RESULTS

Biped Robot Walks in Home Environments

Biped Robot Tracks Foot Targets on Stairs

Attached Video

Our Website