Semantically Modulated joint Episodic-Procedural Associative Memory

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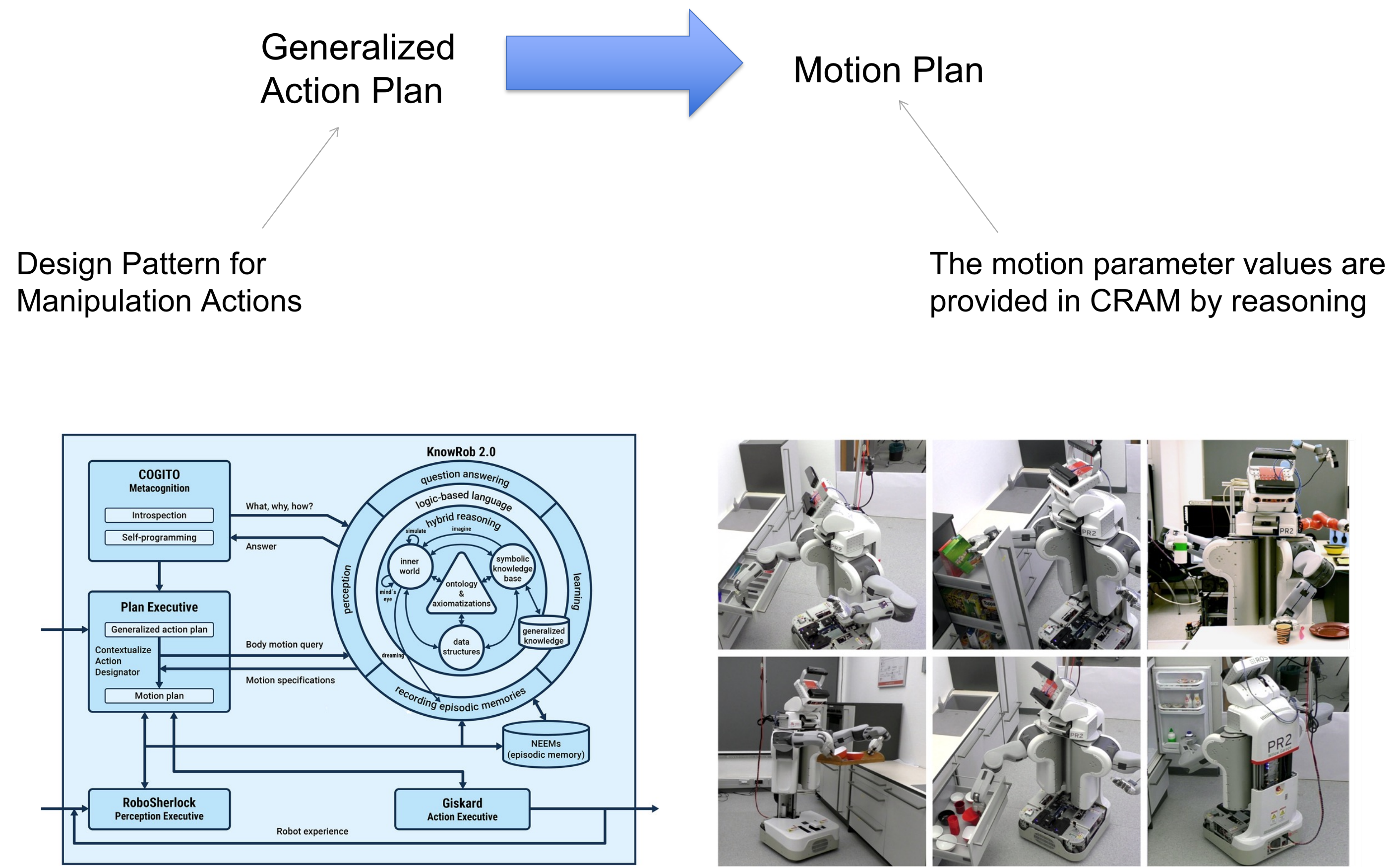Carnegie Mellon University Africa, Kigali, Rwanda

Overview

The goal of this research is to give the CRAM Robot Cognitive Architecture the ability to automatically perform new everyday pick-and-place tasks (Vernon et al., 2021). This is achieved by integrating three schools of thought in cognitive science.

1. The situation model framework: composable behavioural episodes, dual process theory (System 1 & 2), working memory, and cognitive maps (Schneider et al., 2020).

2. Ideo-motor theory: goal-directed, prospectively-guided action and joint episodic-procedural memory (Stock and Stock, 2004)

3. Semantically-primed episodic future thinking: episodic memory is used to imagine future states (Atance and O'Neill, 2001, Schacter et al. 2012)).
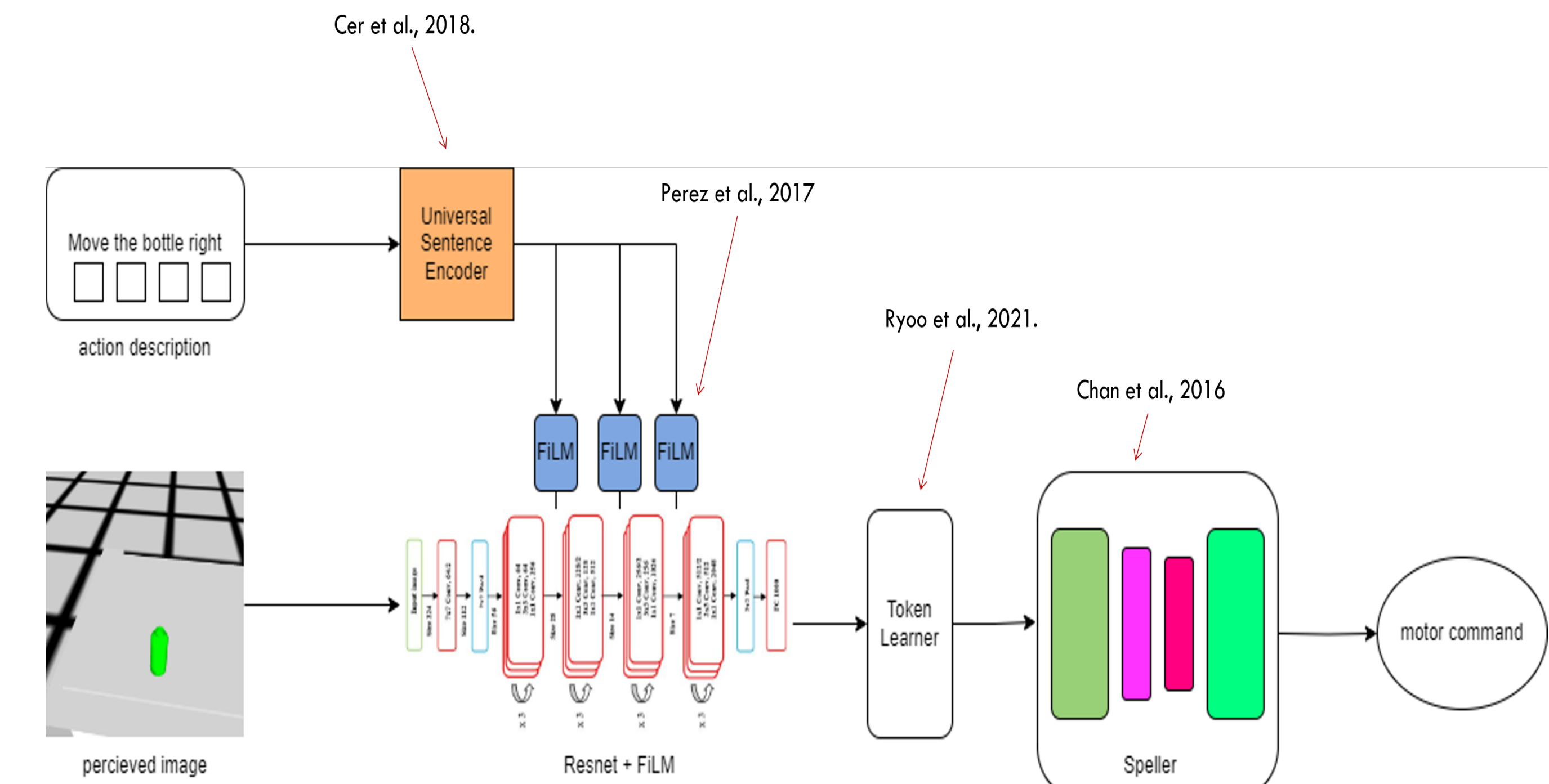
The is achieved using a deep multi-modal neural network. This memory produces composable behavioural episodes in the form of the parameters of a CRAM generalized action plan. This allows CRAM to automatically perform new pick-and-place tasks on the basis of an image of the current scene (as perceived by the robot) and a quasi-natural language action description.
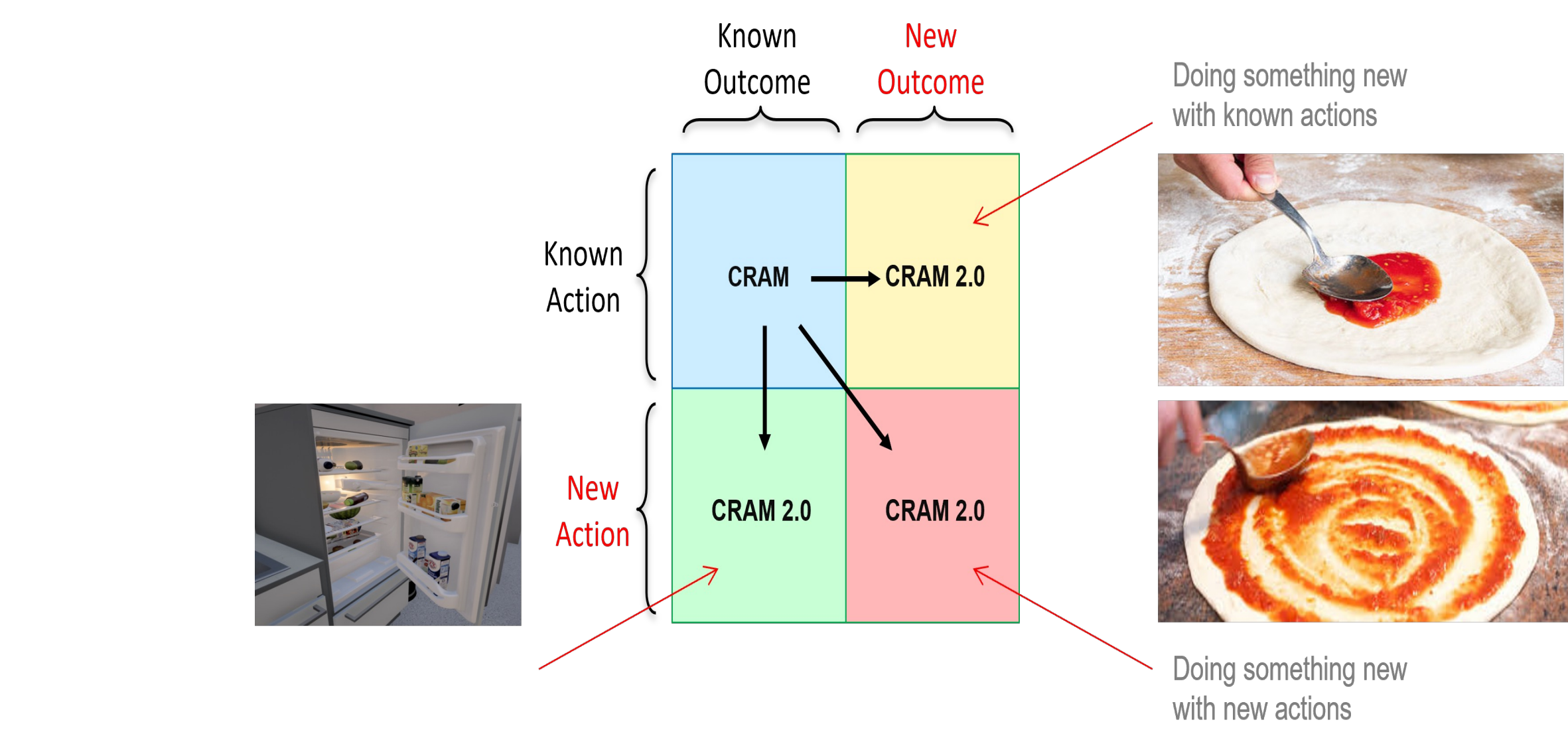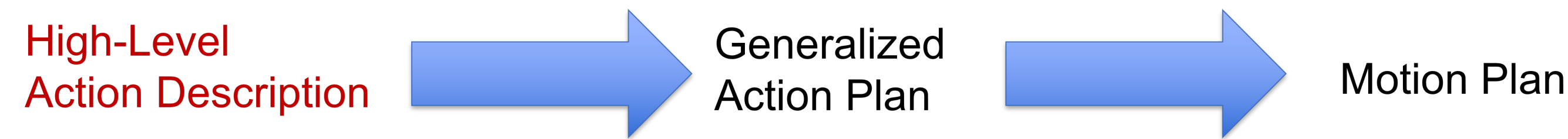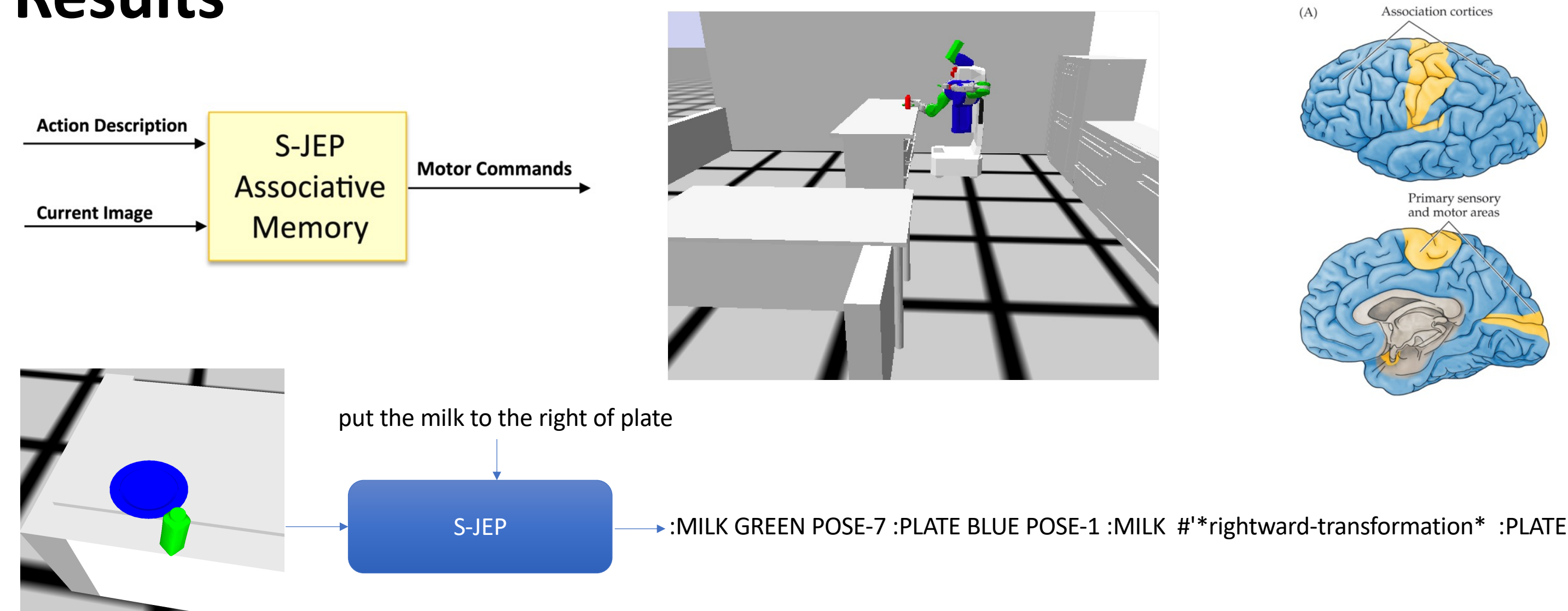
Methodology

Generalized Action Plan → Motion Plan

Design Pattern for Manipulation Actions

The motion parameter values are provided in CRAM by reasoning

Method

Model

Cer et al., 2018.

Move the bottle right — Universal Sentence Encoder

action description

Perez et al., 2017

Ryoo et al., 2021.

Chan et al., 2016

perceived image — Resnet + FiLM — Token Learner — Speller — motor command

Technique

High-Level Action Description → Generalized Action Plan → Motion Plan

Known Outcome / New Outcome

Known Action: CRAM → CRAM 2.0

New Action: CRAM 2.0 / CRAM 2.0

Doing something new with known actions

Doing something new with new actions

Results

Action Description / Current Image → S-JEP Associative Memory → Motor Commands

put the milk to the right of plate

S-JEP → :MILK GREEN POSE-7 :PLATE BLUE POSE-1 :MILK #*rightward-transformation* :PLATE

Results

Teacher Force rate

valid_distance

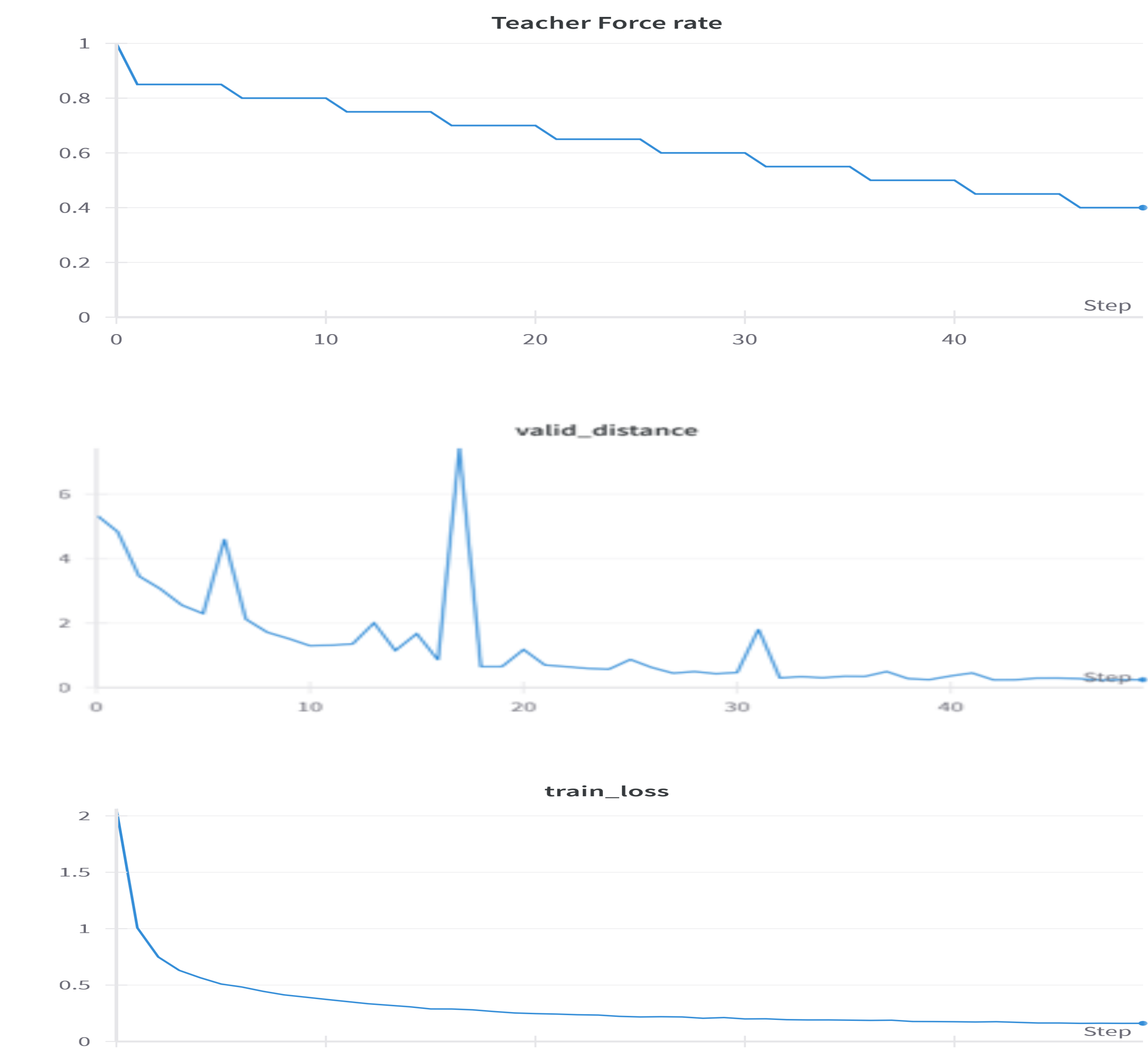train_loss

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