LISA: Learning Interpretable Skill Abstractions from Language

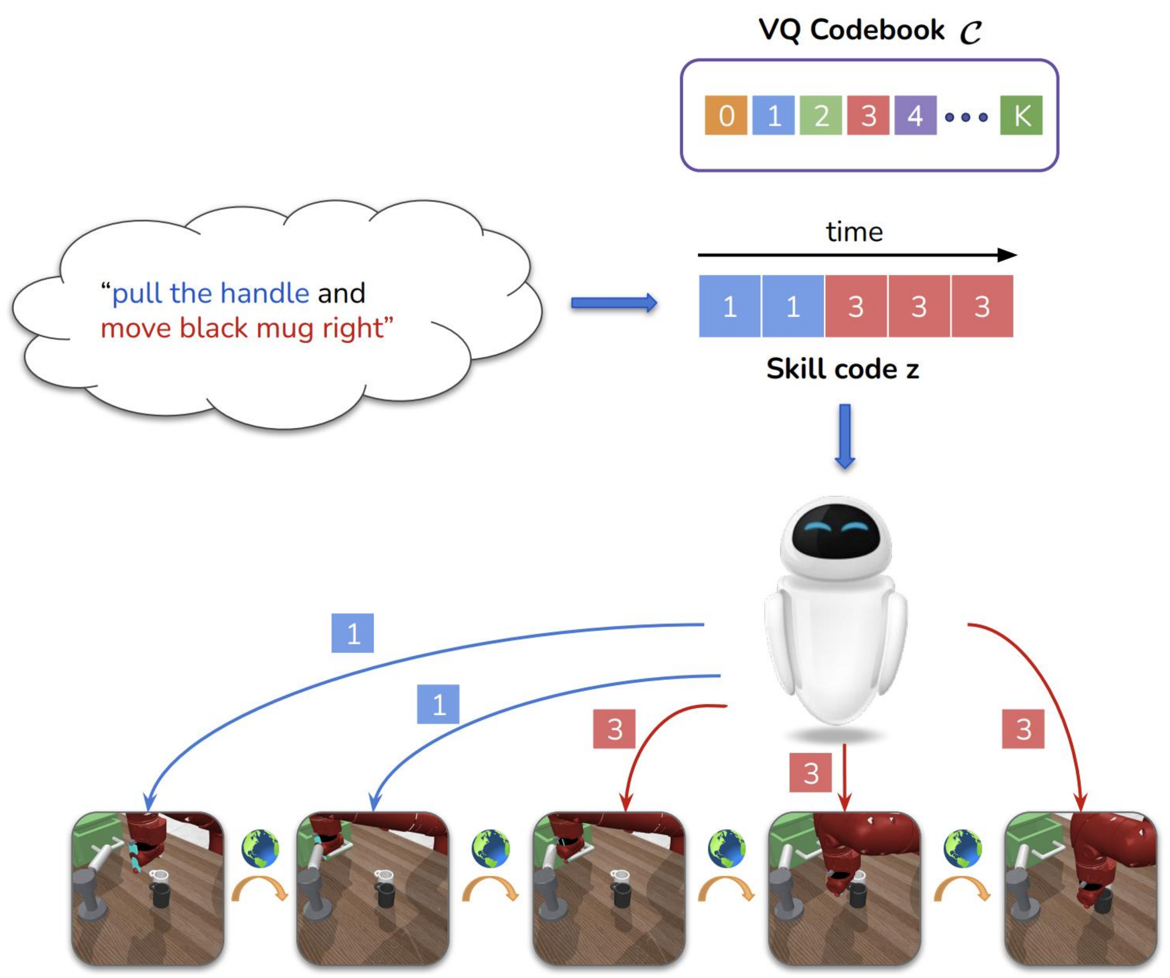
Divyansh Garg*, Skanda Vaidyanath*, Kuno Kim, Jiaming Song, Stefano Ermon

NEURAL INFORMATION PROCESSING SYSTEMS

SCAN ME

LISA

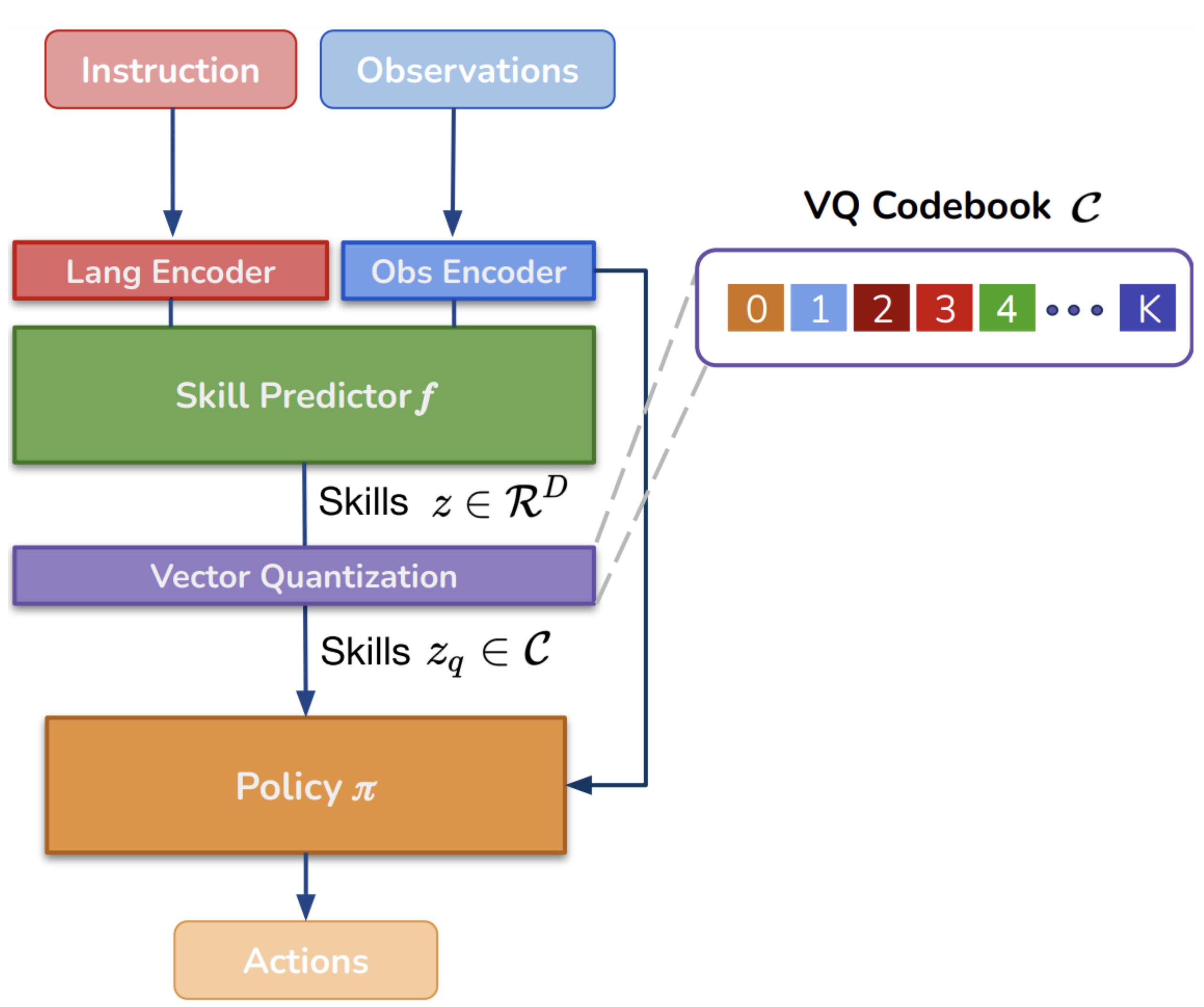
Goal: Enable agents to follow language instructions in complex multi-task environments



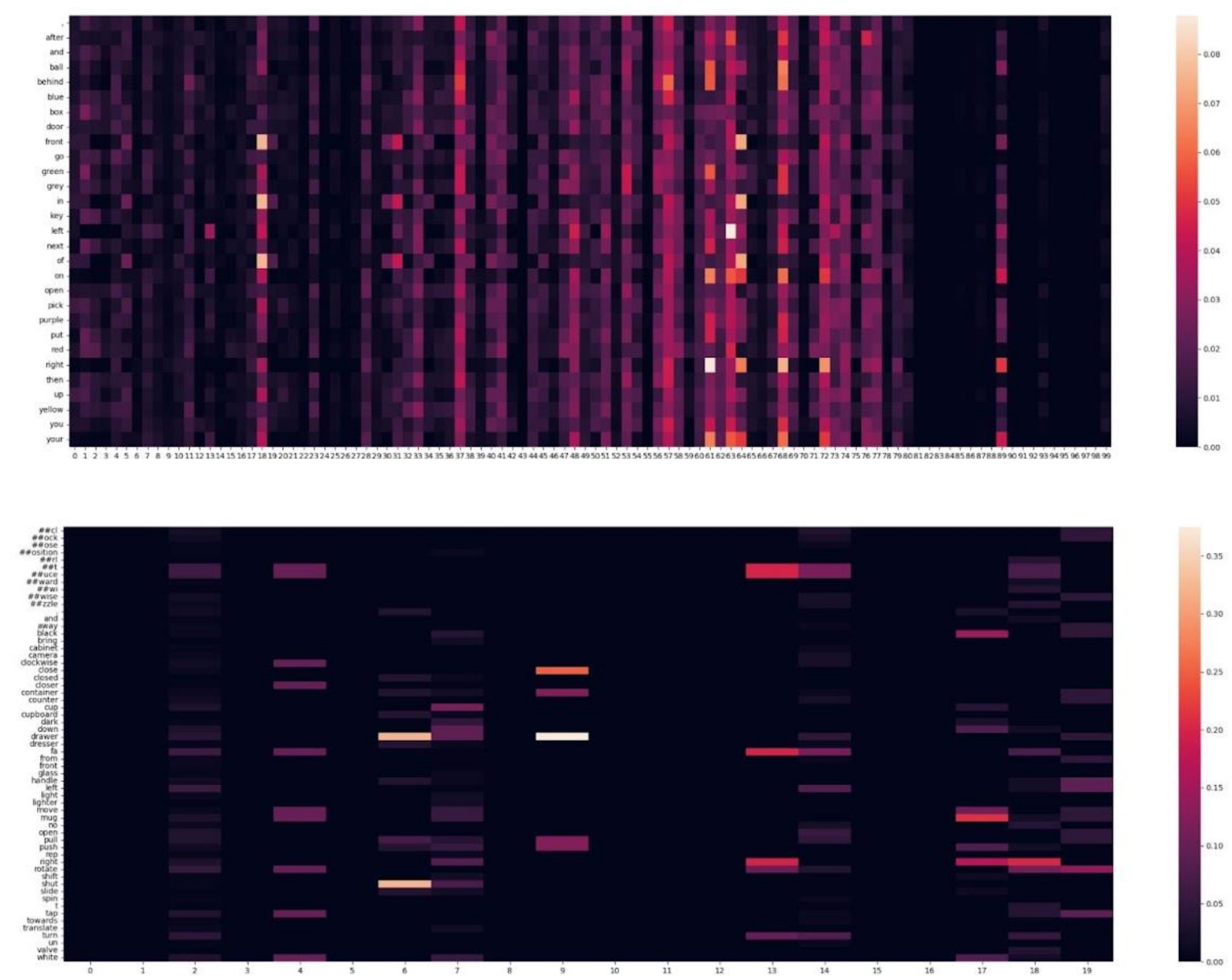
LISA: Learn interpretable high-level skills + low-level policy

- Skill codes are quantized and interpretable
- Skill codes can be composed to get desired behavior
- Generalize to very long-range & unseen tasks
- Works very well in the low-data regime

Architecture



Interpretable Skill Codes

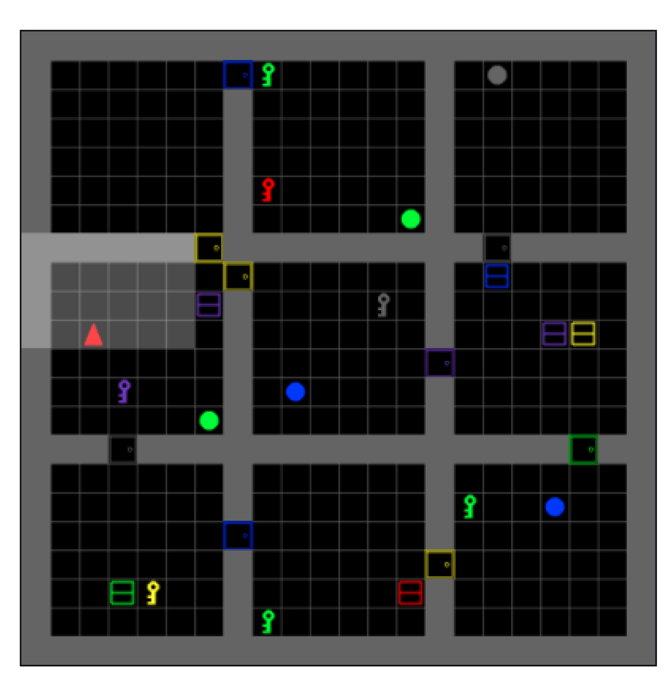


Skill Heat Maps

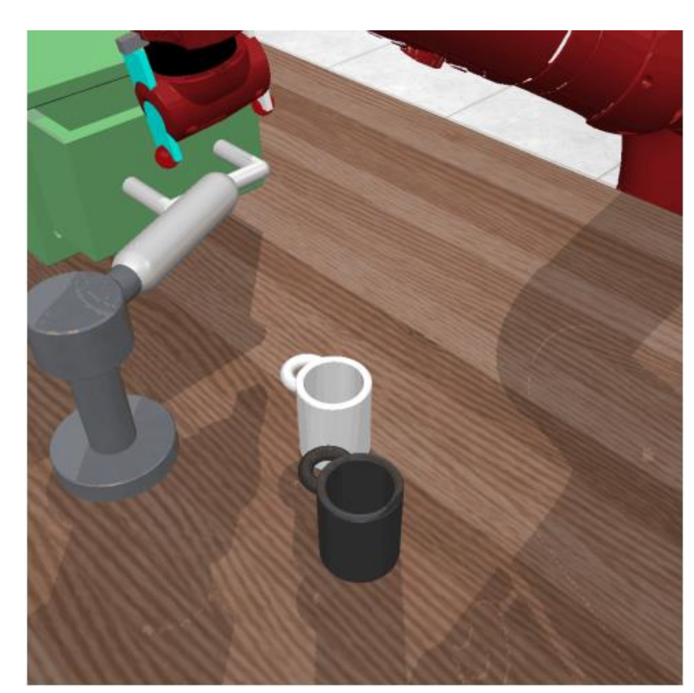
$z = 14$

Figure 3: **Behavior with fixed LISA options.** We show the word clouds and the behavior of the policy obtained by using a fixed skill code $z = 14$ for an entire episode. We find that this code encodes the skill "closing the drawer", as indicated by the word cloud. The policy executes this skill with a high degree of success when conditioned on this code for the entire trajectory, across different environment initializations and seeds.

Environments



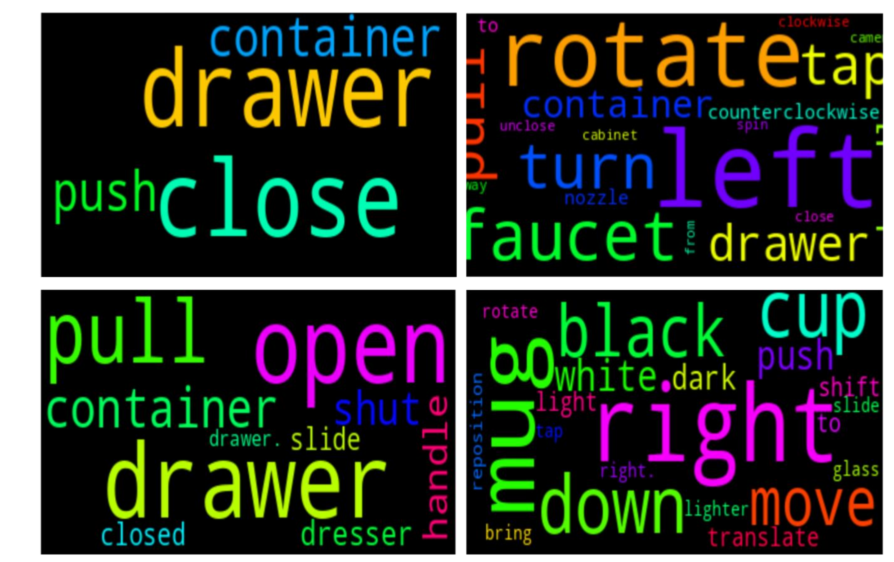
BabyAI



LORL

Learnt Skills

Figure 5: **Word clouds on LOReL**: We show the most correlated words for 4 different learnt skill codes on LOReL. We can see that the codes represent interpretable and distinguishable skills. For e.g, the code on the top left corresponds to closing the drawer. (note that container is a synonym for drawer in the LOReL dataset)



Results

Table 1: **Imitation Results:** We show our success rates (in %) compared to the original method and a flat non-hierarchical baseline on each dataset. LISA outperforms all other methods in the low-data regime, and reaches similar performance as the number of demonstrations increases. Best method shown in **bold**.

Task	Num Demos	Original	Flat Baseline	LISA
BabyAI GoToSeq	$1k$	33.3 ± 1.3	49.3 ± 0.7	$\mathbf{59.4 \pm 0.9}$
BabyAI GoToSeq	$10k$	40.4 ± 1.2	62.1 ± 1.2	$\mathbf{65.4 \pm 1.6}$
BabyAI GoToSeq	$100k$	47.1 ± 1.1	74.1 ± 2.3	$\mathbf{77.2 \pm 1.7}$
BabyAI SynthSeq	$1k$	12.9 ± 1.2	42.3 ± 1.3	$\mathbf{46.3 \pm 1.2}$
BabyAI SynthSeq	$10k$	32.6 ± 2.5	52.1 ± 0.5	$\mathbf{53.3 \pm 0.7}$
BabyAI SynthSeq	$100k$	40.4 ± 3.3	$\mathbf{64.2 \pm 1.3}$	61.2 ± 0.6
BabyAI BossLevel	$1k$	20.7 ± 4.6	44.5 ± 3.3	$\mathbf{49.1 \pm 2.4}$
BabyAI BossLevel	$10k$	28.9 ± 1.3	$\mathbf{60.1 \pm 5.5}$	58 ± 4.1
BabyAI BossLevel	$100k$	45.3 ± 0.9	$\mathbf{72.0 \pm 4.2}$	69.8 ± 3.1
LOReL - States (fully obs.)	$50k$	$6 \pm 1.2^{\dagger}$	33.3 ± 5.6	$\mathbf{66.7 \pm 5.2}$
LOReL - Images (partial obs.)	$50k$	29.5 ± 0.07	15 ± 3.4	$\mathbf{40 \pm 2.0}$

Outperform non-hierarchical methods in **low-data regime**

Composition Tasks

Table 2: **LISA Composition Results:** We show our performance on the LOReL Sawyer environment on 15 unseen instructions compared to baselines

Method	Success Rate (in %)
Flat	13.33 ± 1.25
LOReL Planner	18.18 ± 1.8
LISA (Ours)	$\mathbf{20.89 \pm 0.63}$

Test on long composition instructions like ***"close the drawer, turn the faucet left and move black mug right"***

Outperforms flat baseline by nearly **2x**