# RT-Trajectory: Robotic Task Generalization via Hindsight Trajectory Sketches

Jiayuan Gu[1,2], Sean Kirmani[1], Paul Wohlhart[1], Yao Lu[1], Montserrat Gonzalez Arenas[1], Kanishka Rao[1], Wenhao Yu[1], Chuyuan Fu[1], Keerthana Gopalakrishnan[1], Zhuo Xu[1], Priya Sundaresan[3,4], Peng Xu[1], Hao Su[2], Karol Hausman[1], Chelsea Finn[1,3], Quan Vuong[1], Ted Xiao[1]

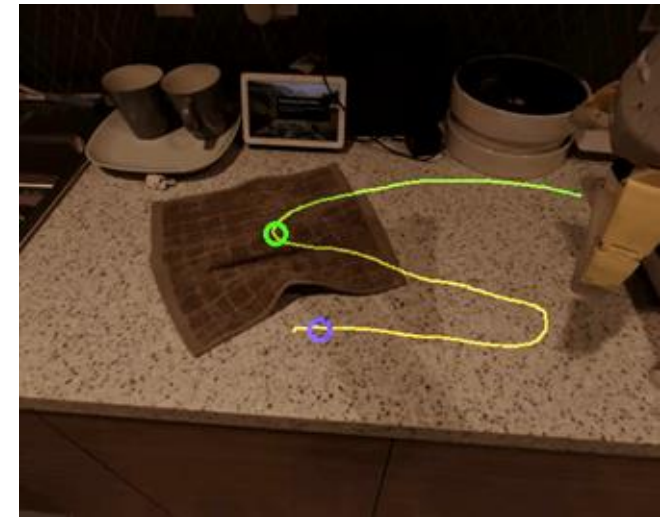Google DeepMind   UC San Diego   Stanford   Intrinsic

Robotic Task Generalization
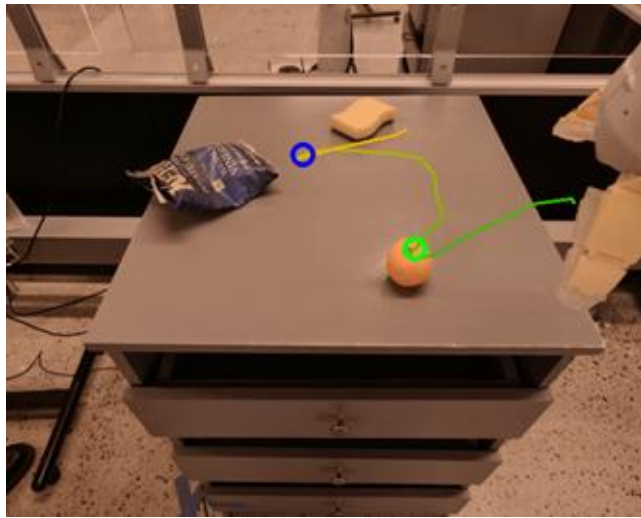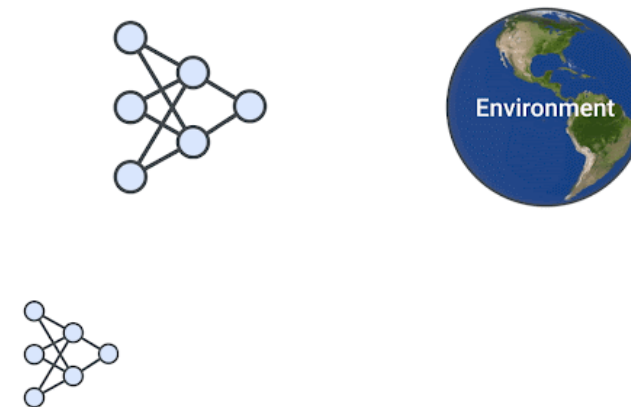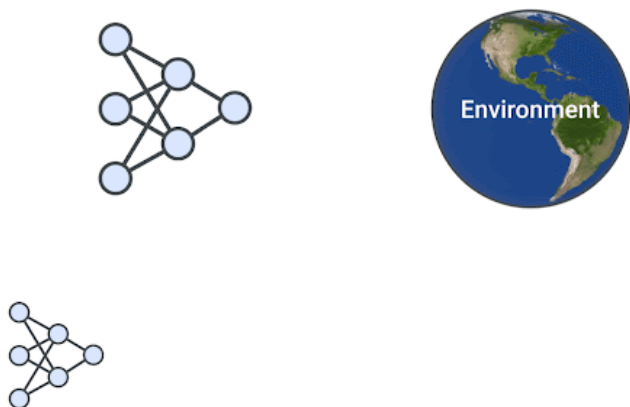

Training tasks
e.g., pick & place
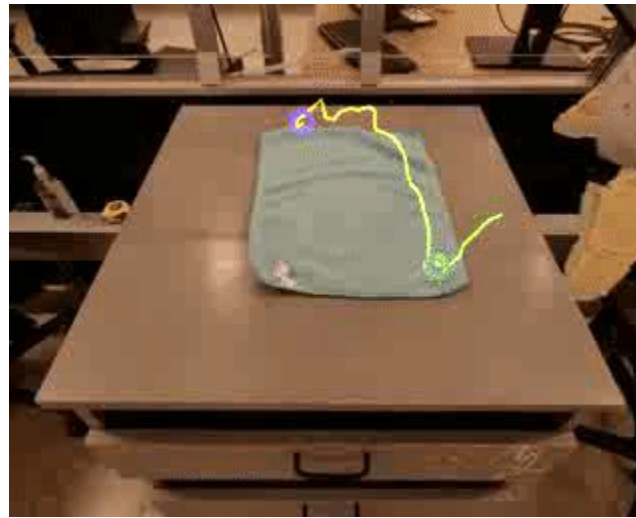
Unseen semantics
e.g., fold towel

Unseen motion
e.g., clean table

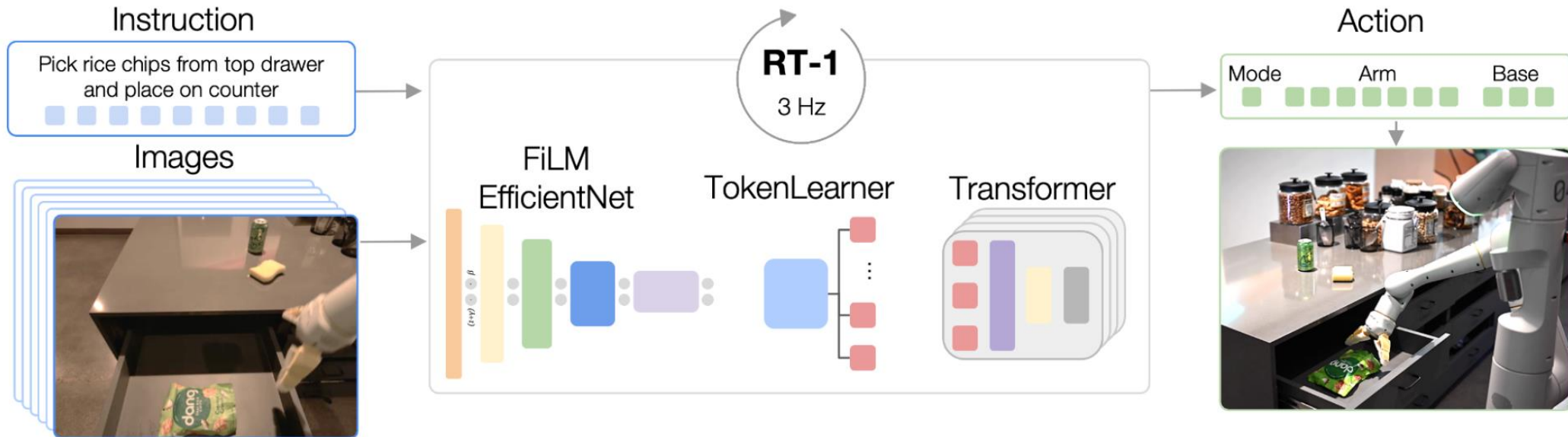**Can we use different policy conditioning to foster generalizability?**

Policy Conditioning Representations

Language: what to do and underspecified

Video: how to do and overspecified

Jang, Eric, et al. "Bc-z: Zero-shot task generalization with robotic imitation learning." CoRL 2022

Related Work: RT-1

Language conditioning (trained on 8 skills)

Brohan, Anthony, et al. "Rt-1: Robotics transformer for real-world control at scale." RSS 2023

Trajectory Conditioning

❌ Language-conditioned policies like RT-1 struggle to generalize to new scenarios: trained on "move objects", tested on "clean table"

✅ To this end, we propose **RT-Trajectory**, a robotic control policy conditioned on **trajectory sketches**:

- practical

- easy to specify

- allows effective generalization
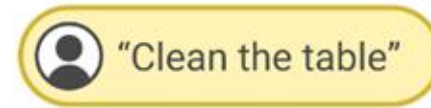
Trajectory Representation

Interaction Markers
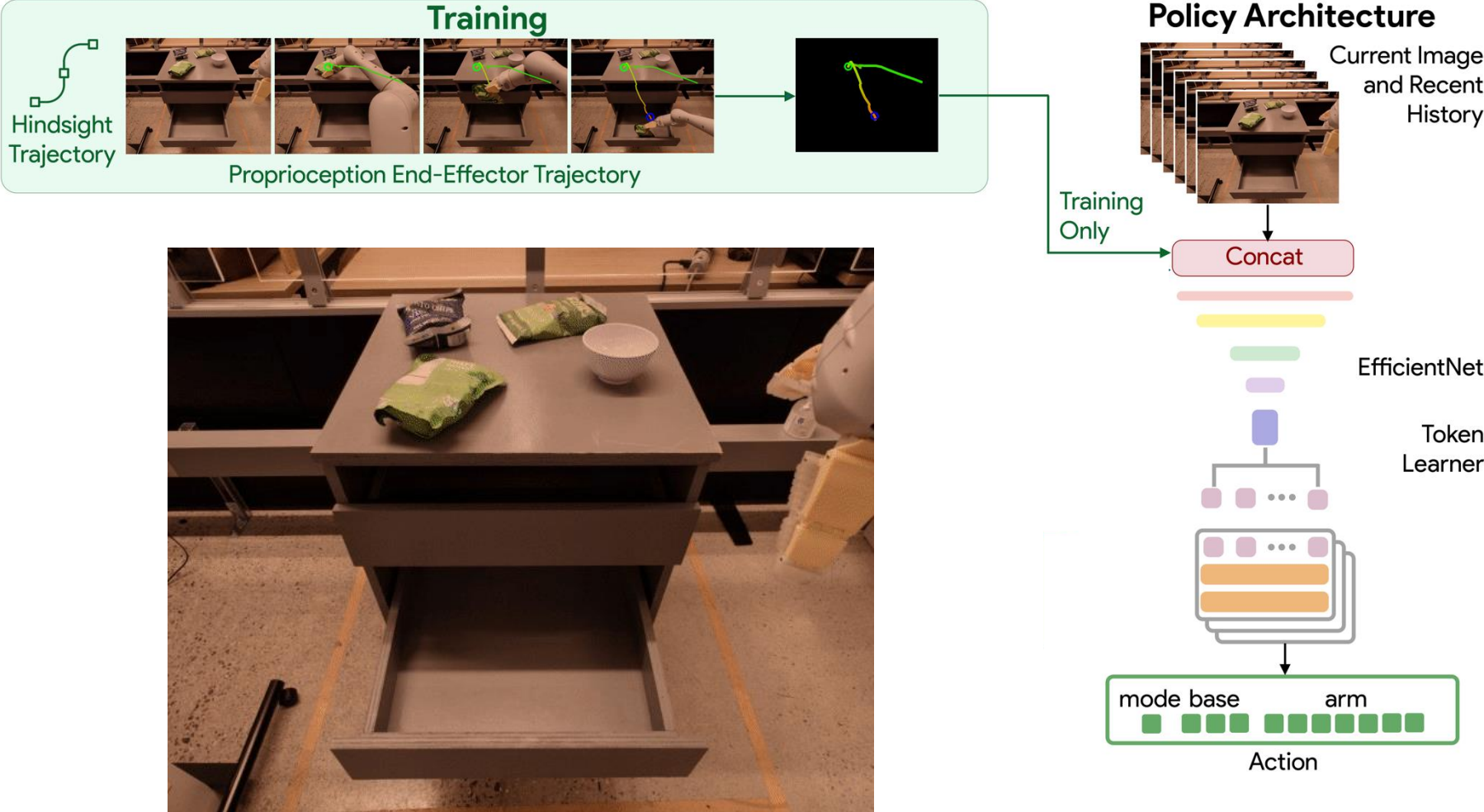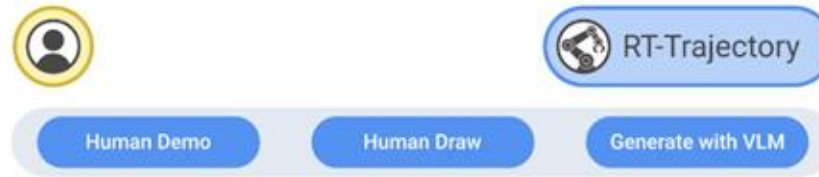closing/opening

Temporal

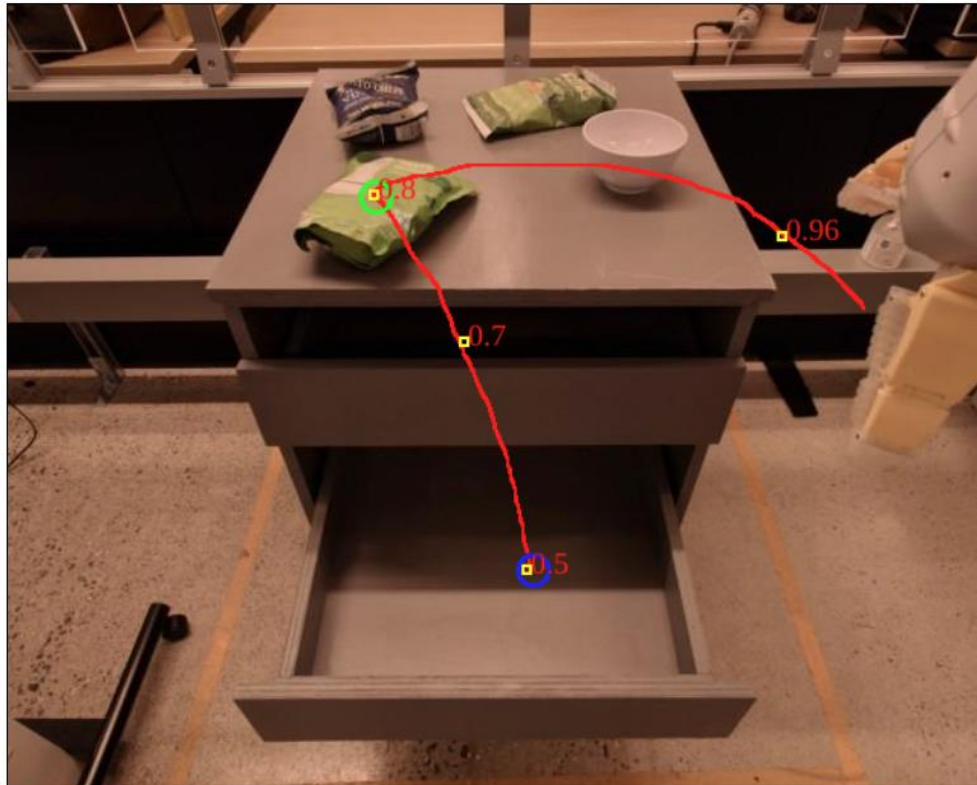Height

Color Grading

RT-Trajectory: Training

RT-Trajectory: Inference

Generalize to trajectories
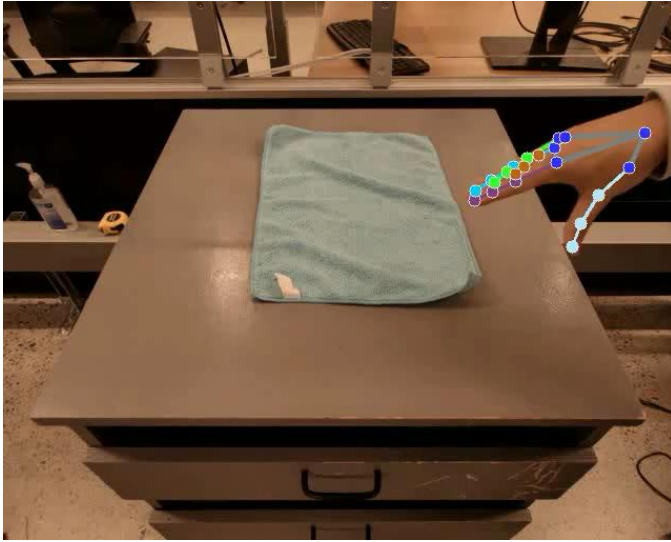generated by different methods

Approach 1: Human Drawings

Drawing UI

Approach 2: Human Demo Videos

Human demo with
hand-object interaction

RT-Trajectory rollout

Overlaid trajectory sketch

Video is played at 3x.

Approach 3: Text-guided Image Generation

"Pick green jalapeno chip bag"

"Move 7up can near blue plastic bottle"

"Pick orange can from top drawer"
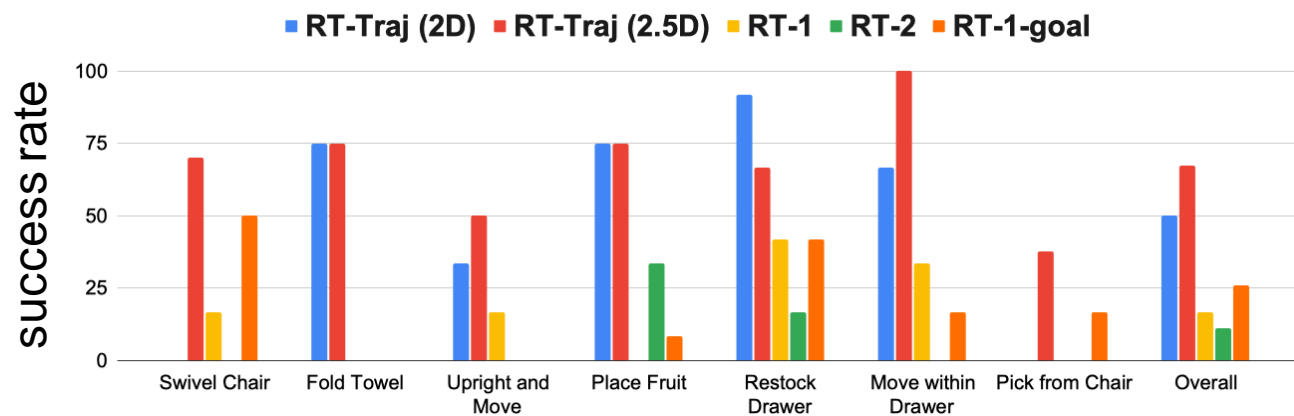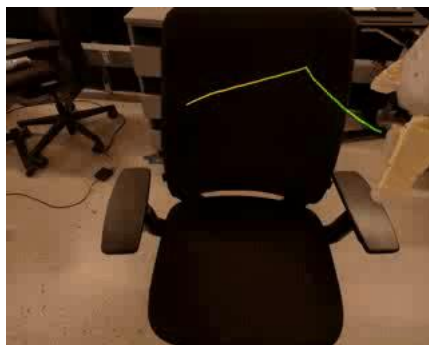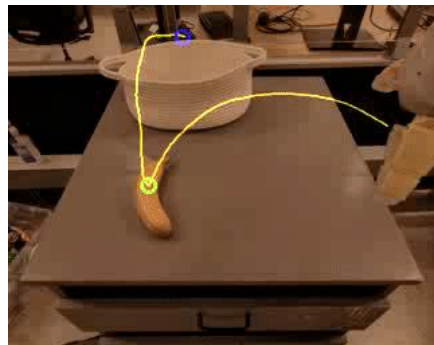
"Place orange can into middle drawer"

Video is played at 3x.

Quantitative Results

Generalize to unseen skills
(human drawing)

Swivel Chair

Place Fruit
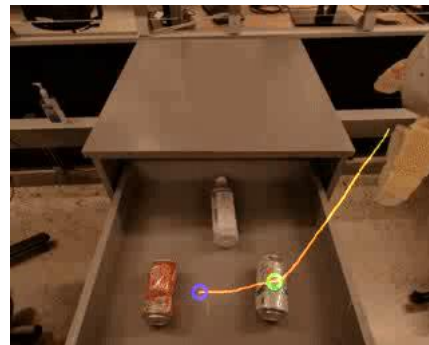
Move within Drawer

Pick from Chair
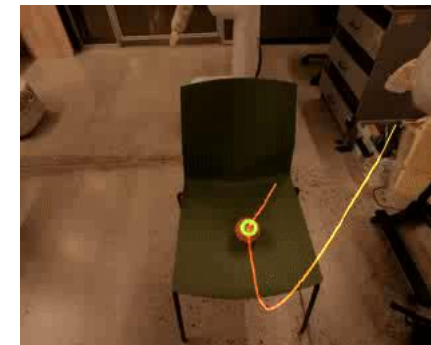
Video is played at 3x.

Emergent Capability: "Prompt Engineering"

"Place apple onto the top stage"

Failure: Not high enough

Success: Higher peak

Video is played at 3x.

Reacting to Visual Observations
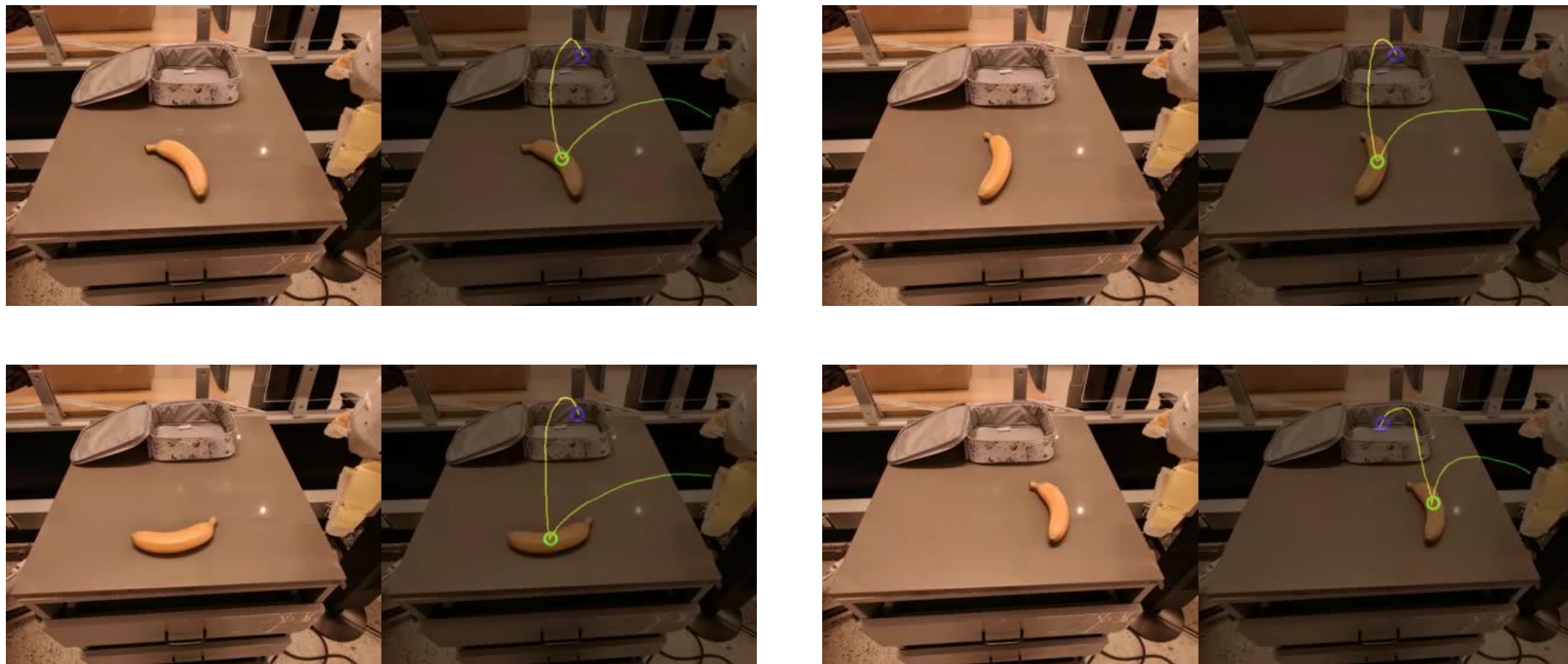
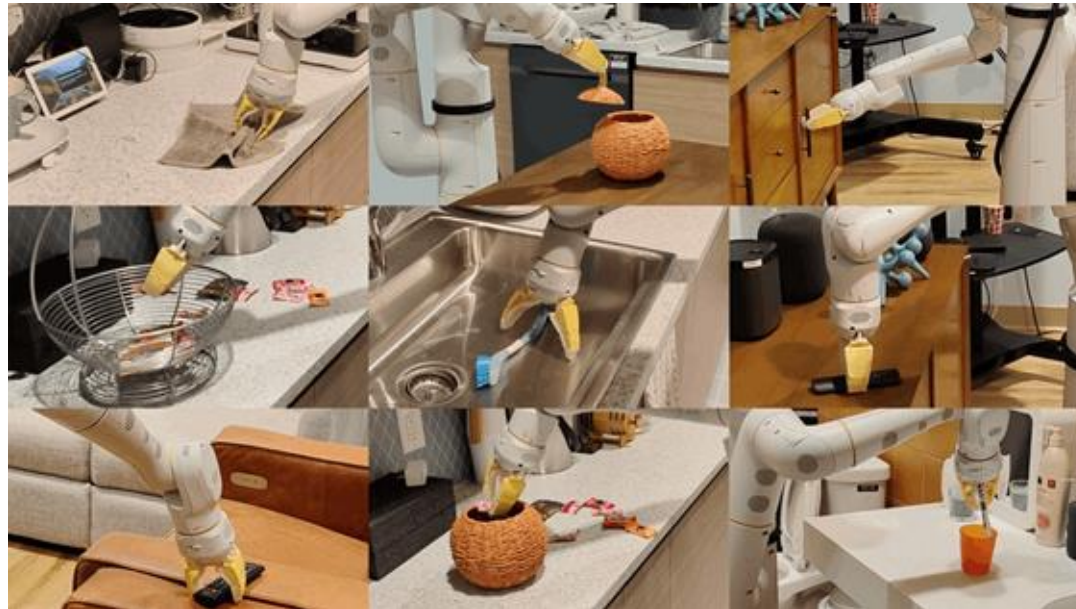"Place banana into lunch box"

Video is played at 3x.

Generalizing to Realistic Setting

Video is played at 3x.

Summary

- New policy conditioning: trajectory sketches

- Generalizing to tasks and motions beyond training data

- Promptable robot manipulation policy

More results at https://rt-trajectory.github.io/