NOIR 2.0
Neural Signal Operated Intelligent Robots
for Everyday Activities

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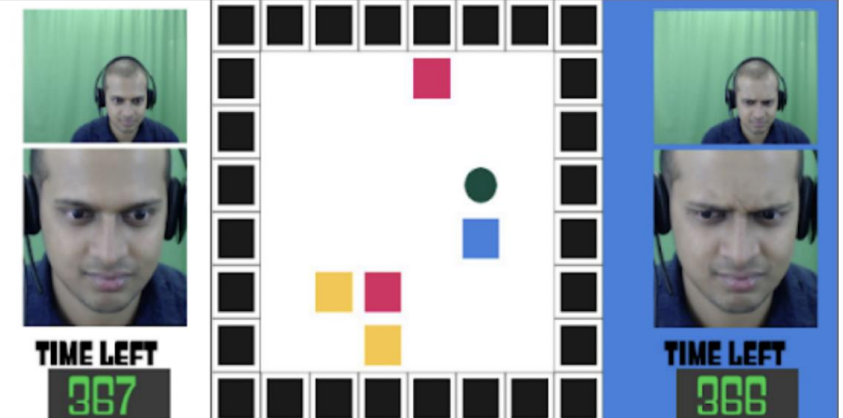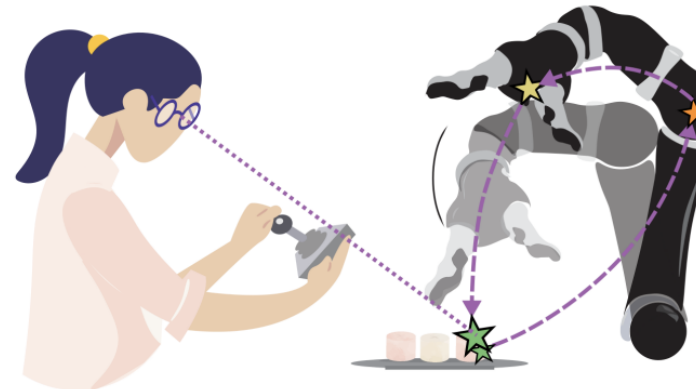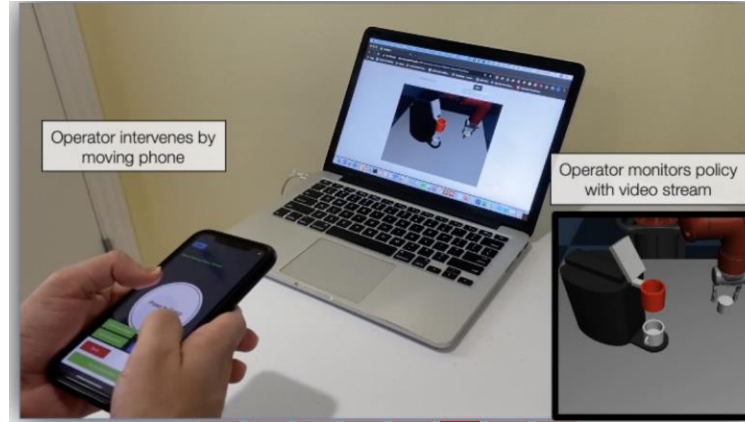# The ways humans communicate with robots

Teleoperation devices
Gesture
Gaze
Facial expression
Language
Brain signals?

Mandlekar et al., 2018; Aronson et al., 2021; Cui et al., 2021; Waldherr et al., 2000
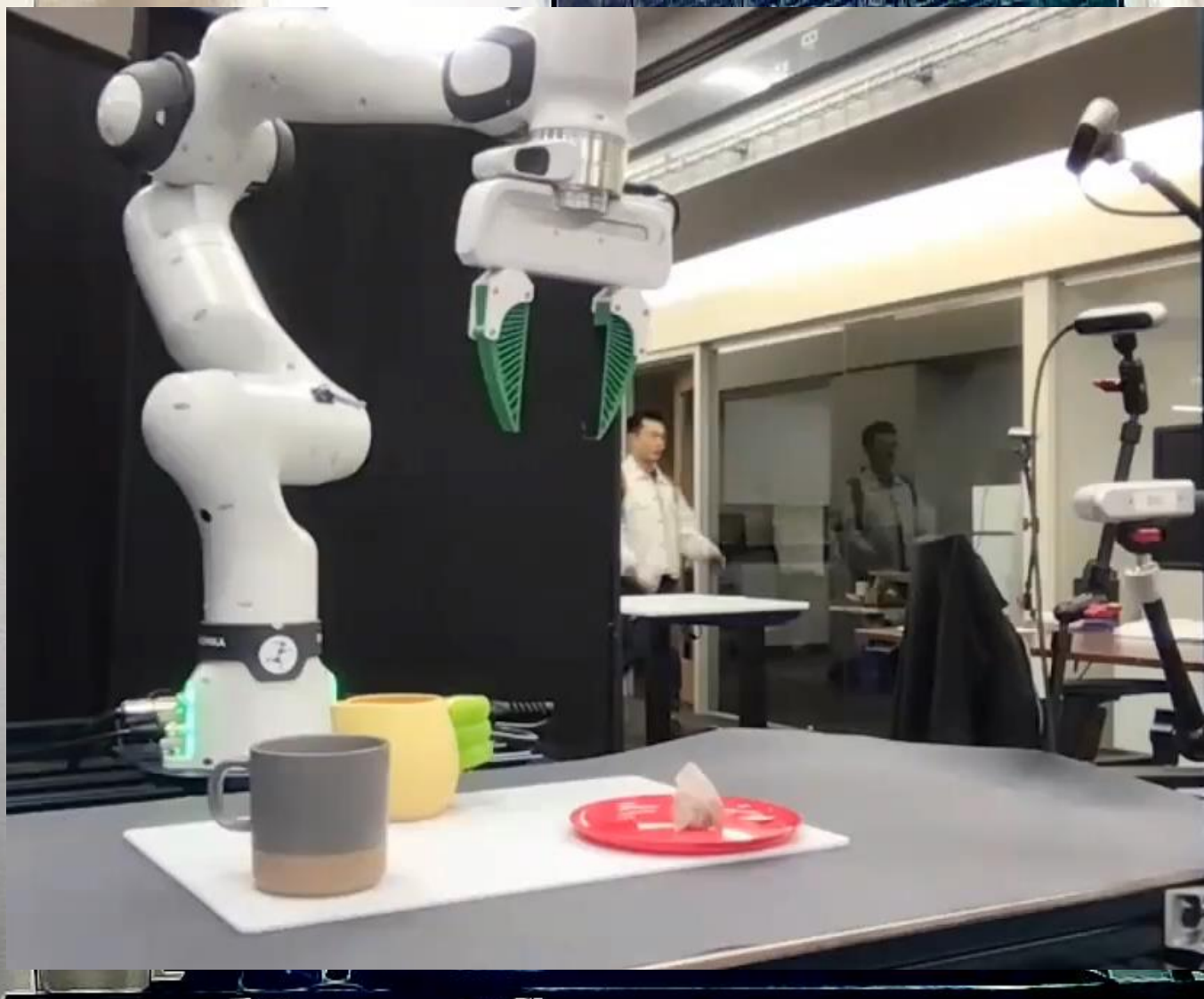
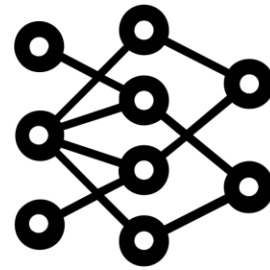Using brain signals to control a robot
to make tea (4x)

*Brain decoding wait period is omitted

alex hodges

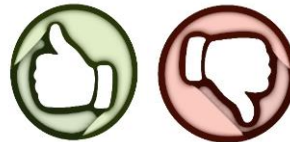# Neural Signal Operated Intelligent Robots

Participant's brain signals are recorded while they watch the robot

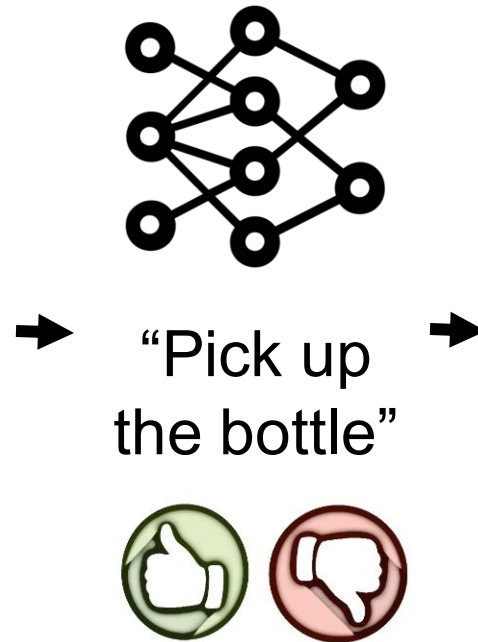# Neural Signal Operated Intelligent Robots

"Pick up the bottle"

Participant's brain signals are recorded while they watch the robot

Machine learning algorithms infer human intention and evaluation

Neural Signal Operated Intelligent Robots

Participant's brain signals are recorded while they watch the robot

"Pick up the bottle"

Machine learning algorithms infer human intention and evaluation

Intelligent robots with basic visuomotor skills learns to accomplish human goals

What's unique about this BRI generation?

"Pick up the bottle"

Pick (x, y, z)   Place (x, y, z)

Participant's brain signals are recorded while they watch the robot

Machine learning algorithms infer human intention and evaluation

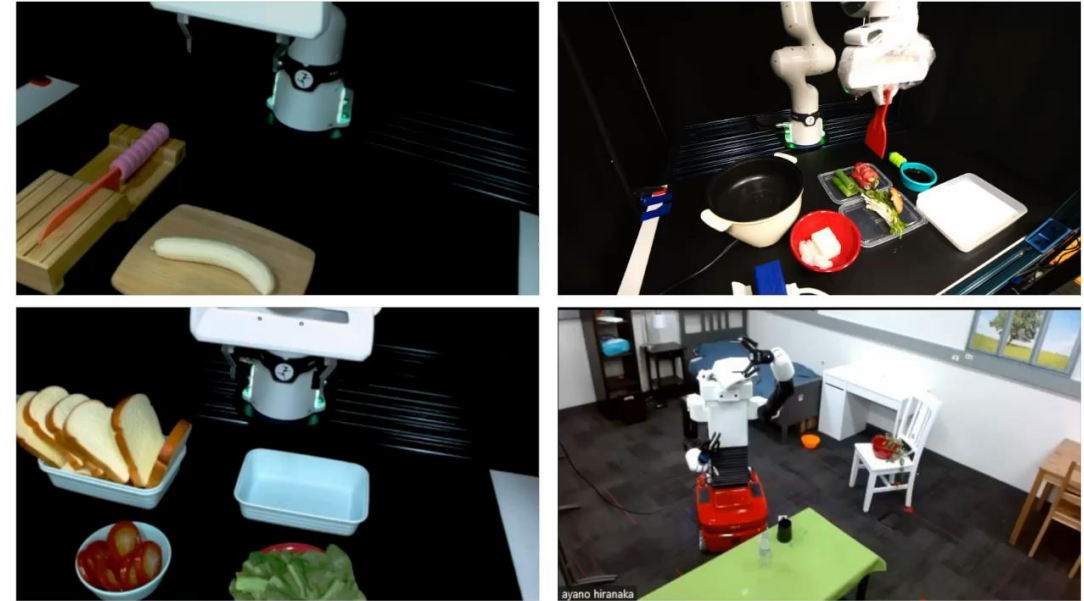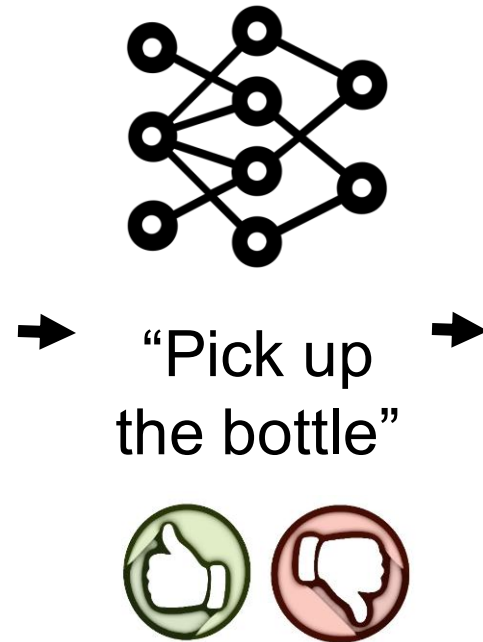Intelligent robots with basic visuomotor skills learns to accomplish human goals

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"Pick up the bottle"

Machine learning algorithms infer human intention and evaluation

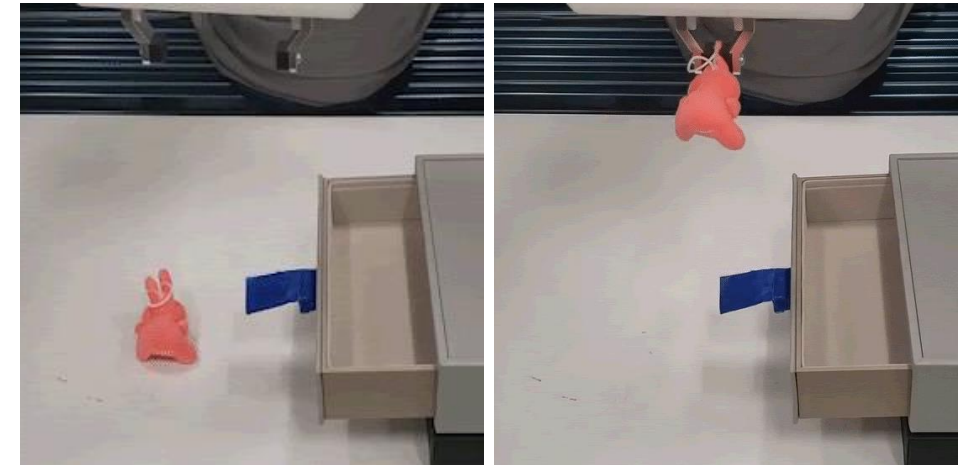Intelligent robots with basic visuomotor skills learns to accomplish human goals

How do we decode intent from the human brain?
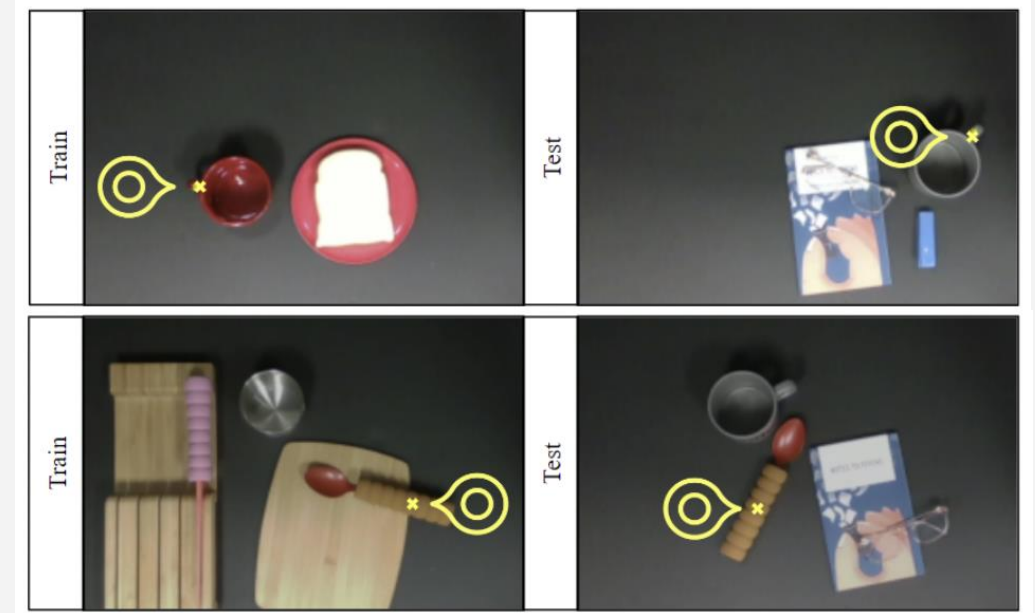

Environment display & EEG recordings

Human goal decoding

What object? **Bottle**
How to interact? **Pick**
Where to interact? O

Robots with primitive skills
+ Human goal prediction

NOIRv1 System Performance

- Task horizon: 4-15 skills

- Average attempts to succeed: 1.8

- Average task completion time: 20.3 minutes

- Human-decision and decoding time: ~80%

NOIRv2 System Performance

Task Name	Time (min.)			Human Time (min.)		
	NOIR	NOIR 2.0	NOIR 2.0+Learning	NOIR	NOIR 2.0	NOIR 2.0+Learning
WipeSpill	14.74	9.12	5.46	11.65	5.12	3.15
OpenBasket	15.90	6.79	5.80	13.04	2.60	1.52
PourTea	13.53	8.90	12.60	11.25	6.55	7.87
Avg. Time Reduced (%)	-	**43.82**	**45.97**	-	**60.30**	**65.11**

NOIRv2 New Features: Brain Decoding

- Faster and more accurate object and skill decoding
  - Object selection: 81% → 88%
  - Skill selection: 42% → 61%
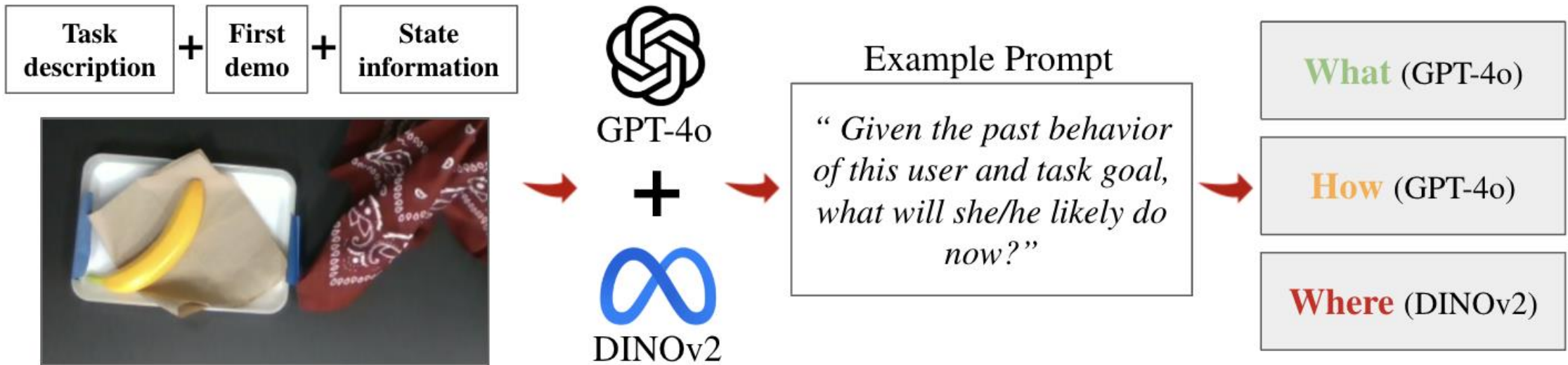- Continuous cursor control for skill parameter selection
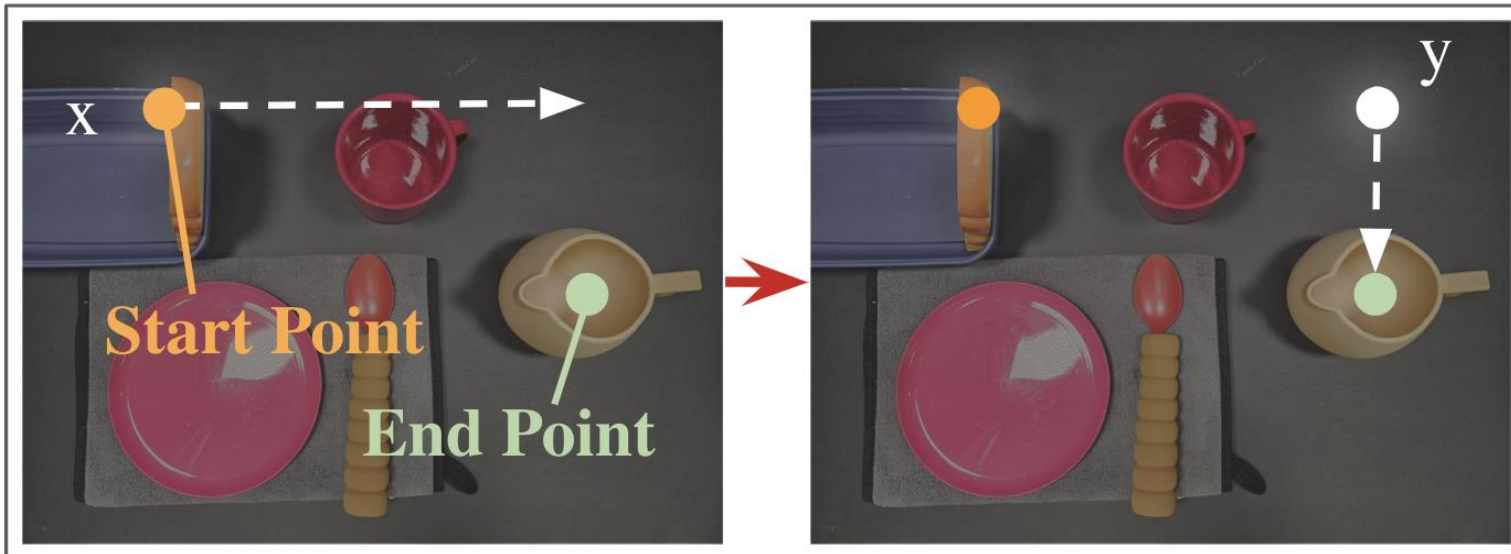
NOIRv1
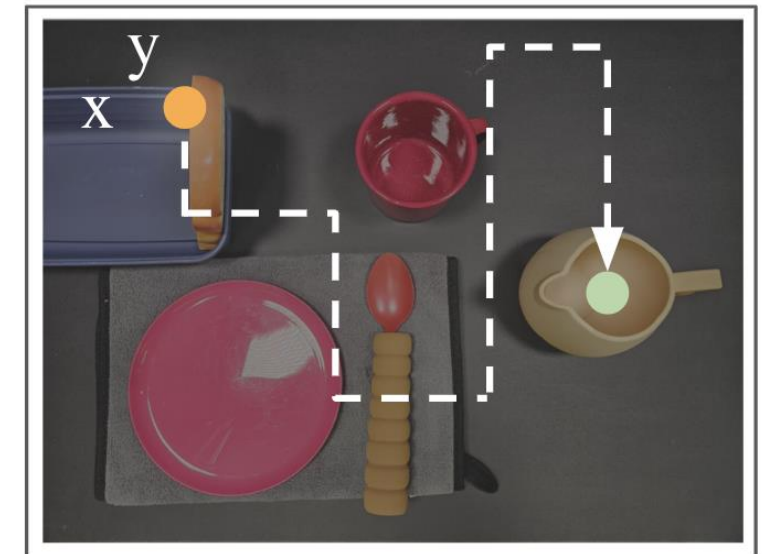
NOIRv2

NOIRv2 New Features: Robot Learning

- NOIRv1 used few-shot imitation learning for object and skill selection (requires ~15 demos)
- NOIRv2 uses in-context learning w/ GPT-4o (requires 1 demo)

Thank you!