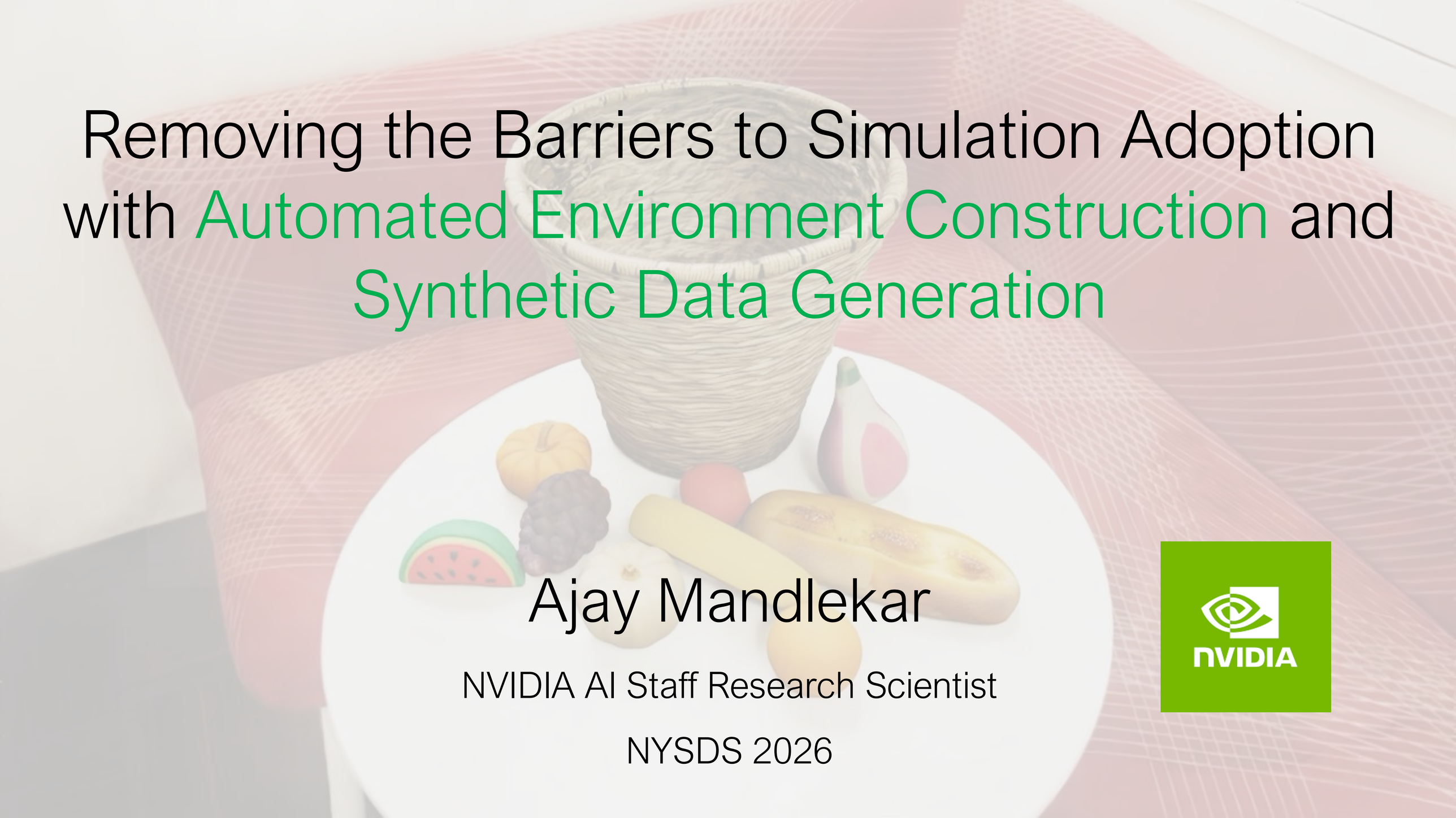
Removing the Barriers to Simulation Adoption with Automated Environment Construction and Synthetic Data Generation



Ajay Mandlekar

NVIDIA AI Staff Research Scientist

NYSDS 2026

The Promise of Generalist Robot Policies



$\pi_{0.7}$ (Physical Intelligence)



Gemini Robotics 1.5 (Google)



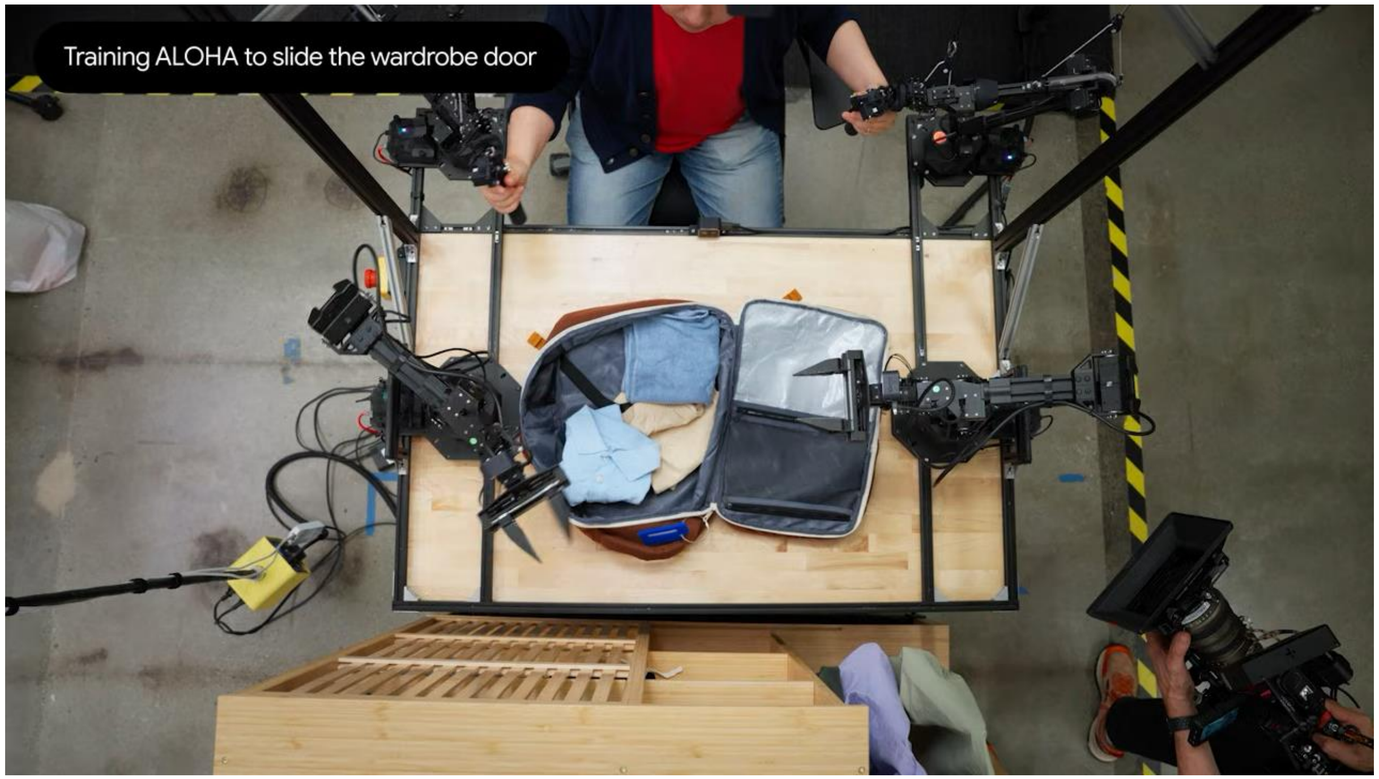
Helix (Figure)



GR00T-N1.6 (NVIDIA)

Reality: Generalist Robot Policies Require Tons of Human Effort

Training data still comes from humans



Gemini Robotics 1.5 (Google)

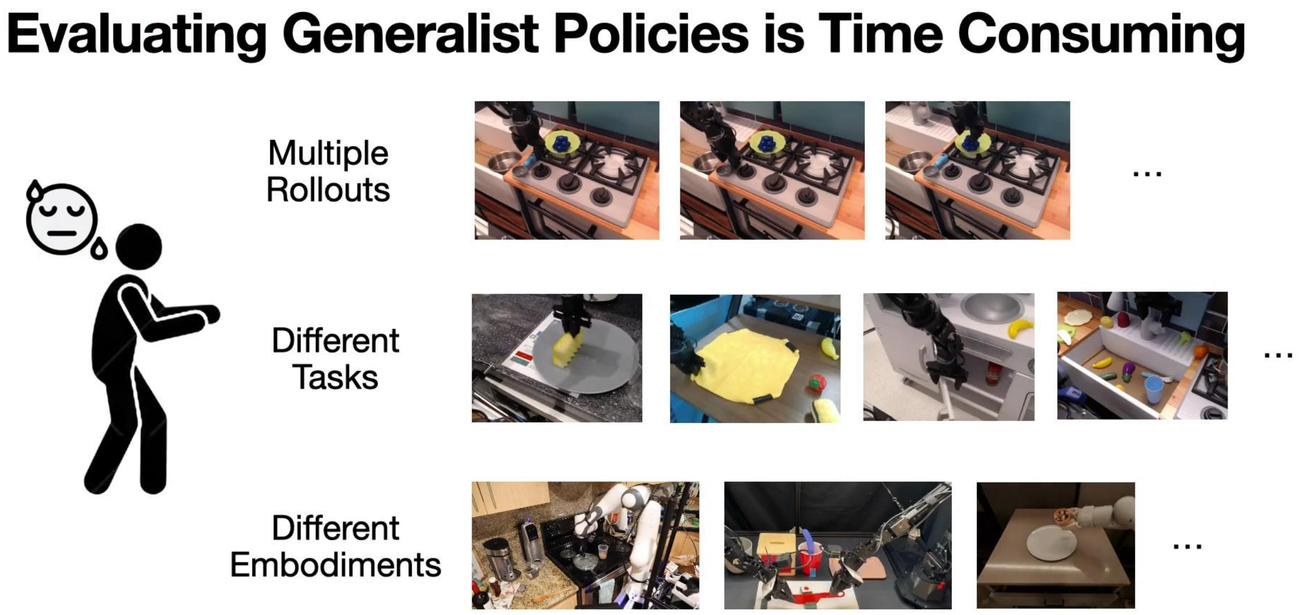
Modern generalist policies are trained on

1000s of hours

of human demonstration data

Reality: Generalist Robot Policies Require Tons of Human Effort

Real-world policy evaluation scales painfully



2,500+
real-world rollouts

4
robot setups

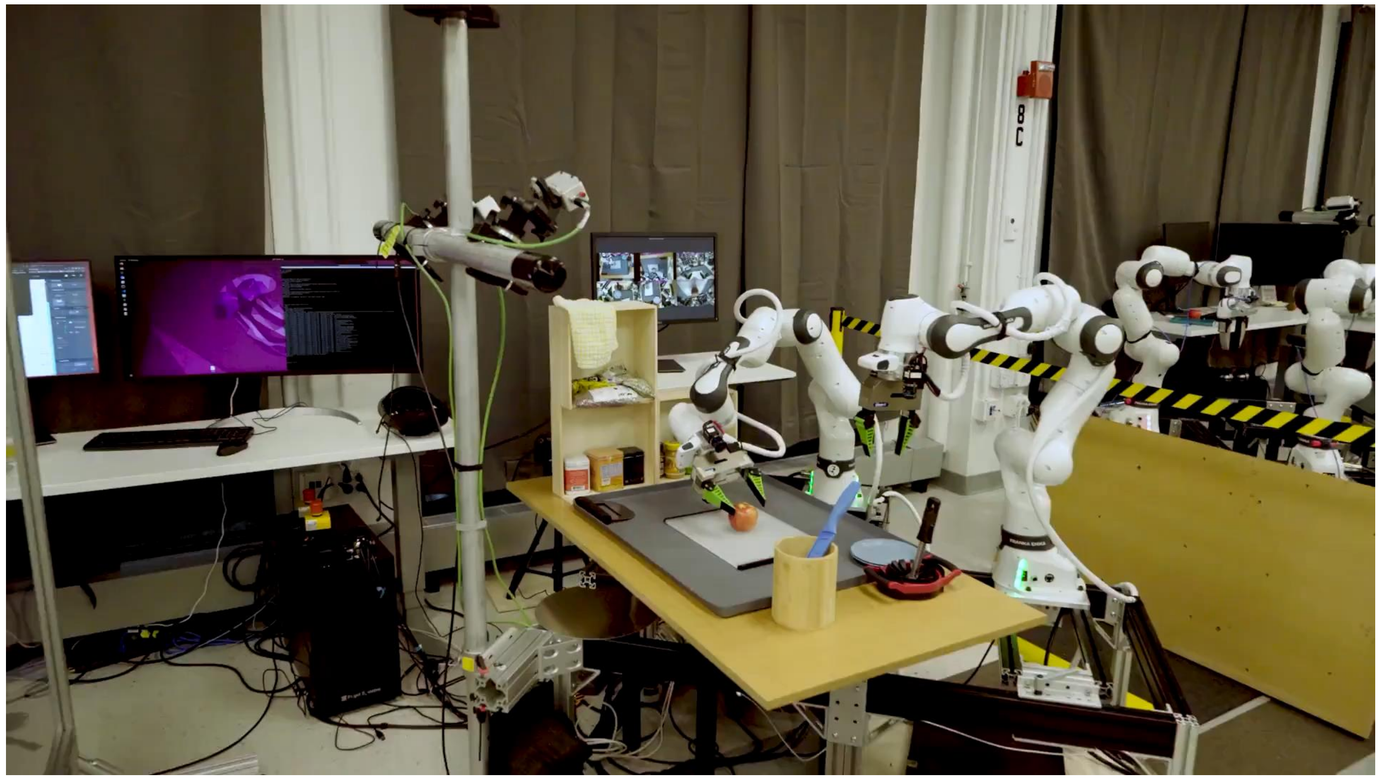
3
institutions

100+
hours of human effort

Zhou et al, “AutoEval: Autonomous Evaluation of Generalist Robot Manipulation Policies in the Real World”

Reality: Generalist Robot Policies Require Tons of Human Effort

Even careful evaluations are expensive and noisy



1,800

real-world rollouts

50

rollouts per task / policy / condition

20-30 pt

success-rate uncertainty can remain

3 min

per successful long-horizon rollout

TRI LBM Team, “A Careful Examination of Large Behavior Models for Multitask Dexterous Manipulation”

Simulation can greatly accelerate robot policy development

Large-Scale Data Generation

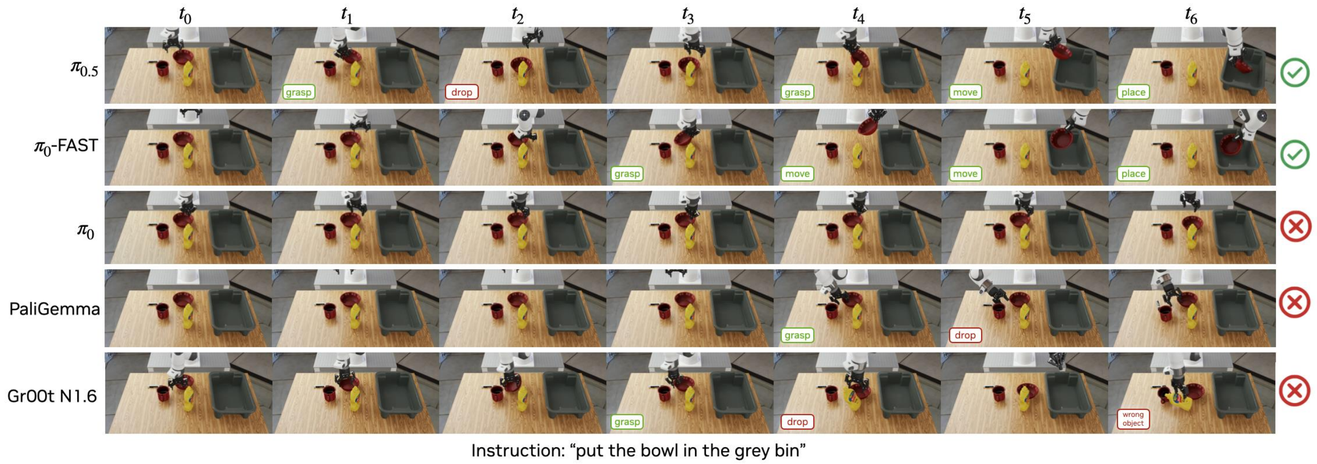
Synthesize simulation scenes and diverse, high-quality robot demonstrations autonomously



[Nasiriany et al. 2024]

Automated Policy Evaluations

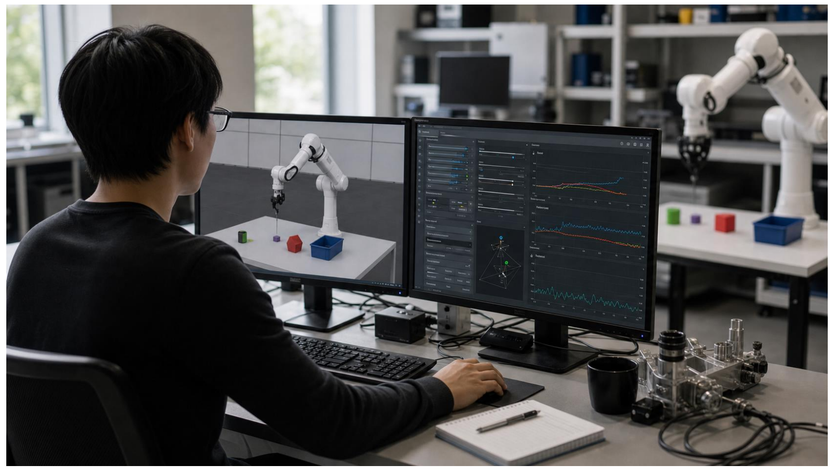
Reliably evaluate several policies across large numbers of tasks with high number of evaluations



[Yang et al. 2026]

What prevents widespread simulation adoption?

High Engineering Burden



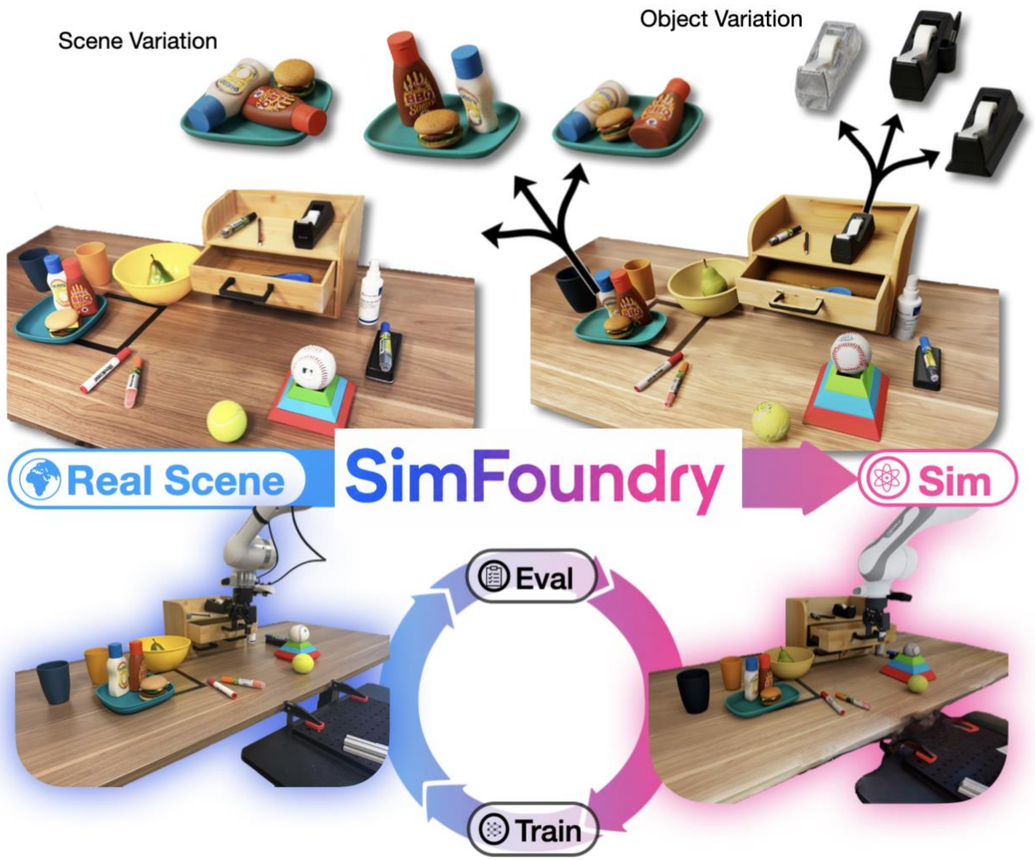
- Manual creation of scenes and tasks
- Painful alignment of visuals and physics to align with real-world

Limited Scope



- Hard to create and simulate realistic scenes (e.g. clutter, deformable objects, transparent materials)

This Talk: Removing the Barriers to Simulation Adoption



Making simulation creation easy, with low engineering burden, and high-fidelity, with strong real-world correspondence

SimFoundry converts real-world videos to sim-ready digital twins

Real-World Video



Digital Twin



Ranawaka and Wong et al. “SimFoundry: Modular and Automated Scene Generation for Policy Learning and Evaluation”, CoRL 2026

SimFoundry creates natural and diverse digital cousins



Digital Twin

SimFoundry creates natural and diverse digital cousins



Digital Cousin

SimFoundry generates simulation for challenging cluttered scenes



Real-World

SimFoundry generates simulation for challenging cluttered scenes



Digital Twin

SimFoundry generates simulation for challenging cluttered scenes



Digital Cousin

SimFoundry generates simulation for challenging cluttered scenes



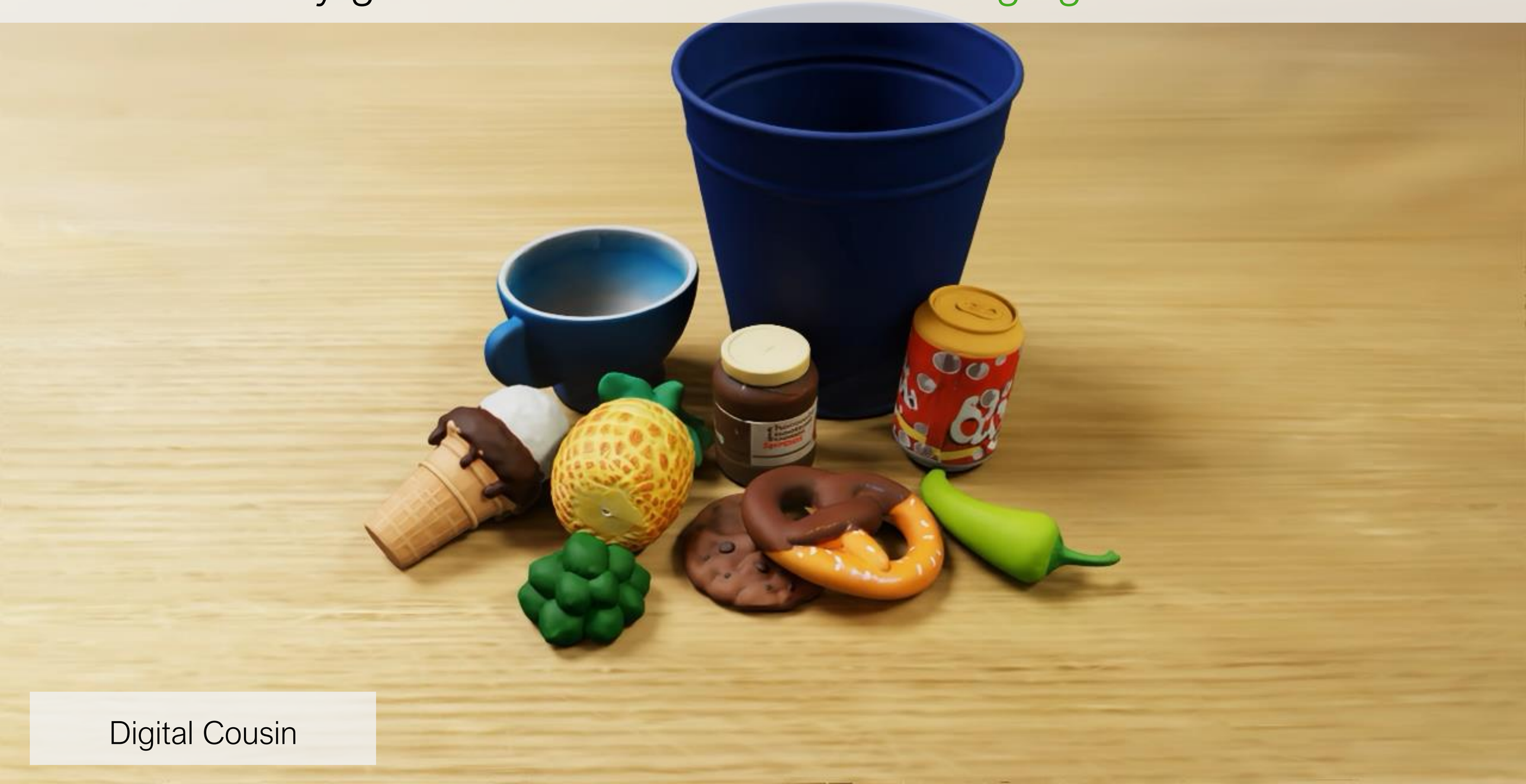
Real-World

SimFoundry generates simulation for challenging cluttered scenes



Digital Twin

SimFoundry generates simulation for challenging cluttered scenes



Digital Cousin

SimFoundry generates simulation for challenging cluttered scenes



Real-World

SimFoundry generates simulation for challenging cluttered scenes



Digital Twin

SimFoundry generates simulation for challenging cluttered scenes



Digital Cousin

SimFoundry generates simulation for challenging cluttered scenes



Real-World

SimFoundry generates simulation for challenging cluttered scenes



Digital Twin

SimFoundry generates simulation for challenging cluttered scenes



Digital Cousin

SimFoundry generates simulation for challenging cluttered scenes



Real-World

SimFoundry generates simulation for challenging cluttered scenes



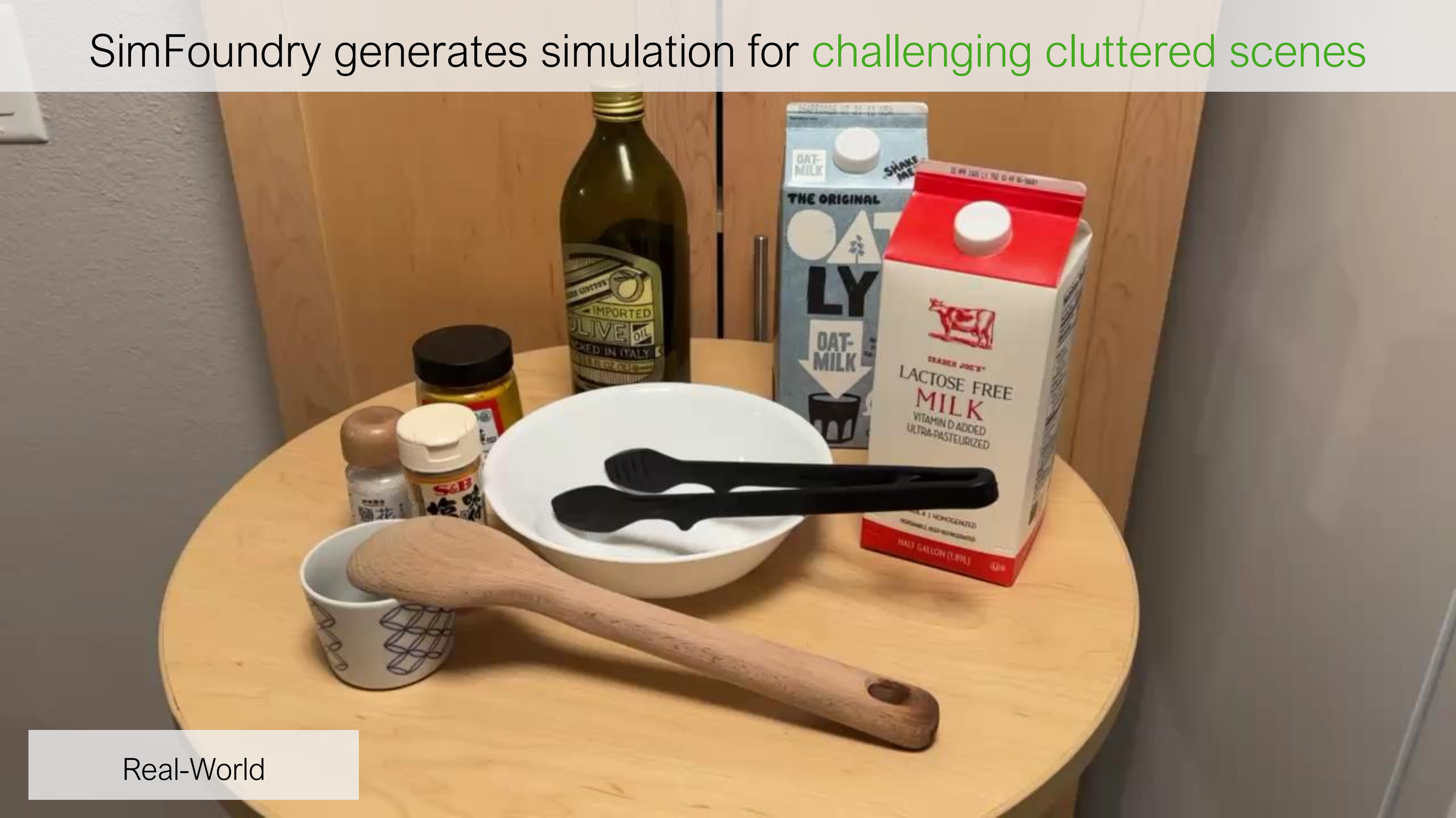
Digital Twin

SimFoundry generates simulation for challenging cluttered scenes



Digital Cousin

SimFoundry generates simulation for challenging cluttered scenes



Real-World

SimFoundry generates simulation for challenging cluttered scenes



Digital Twin

SimFoundry generates simulation for challenging cluttered scenes



Digital Cousin

SimFoundry Digital Cousins Have Meaningful Semantic and Geometric Variations



SimFoundry generates articulated objects

Trash Can



Toaster Oven

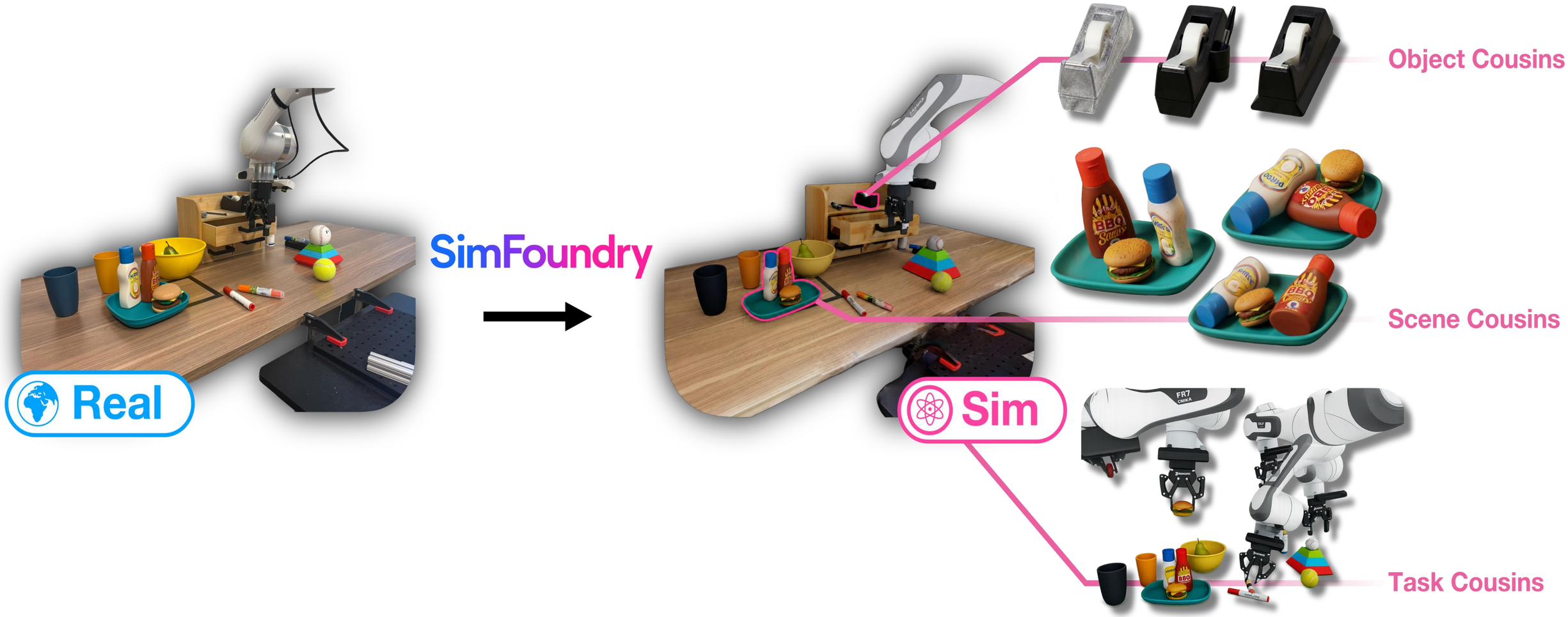


Drawers



Ranawaka and Wong et al. “SimFoundry: Modular and Automated Scene Generation for Policy Learning and Evaluation”, CoRL 2026

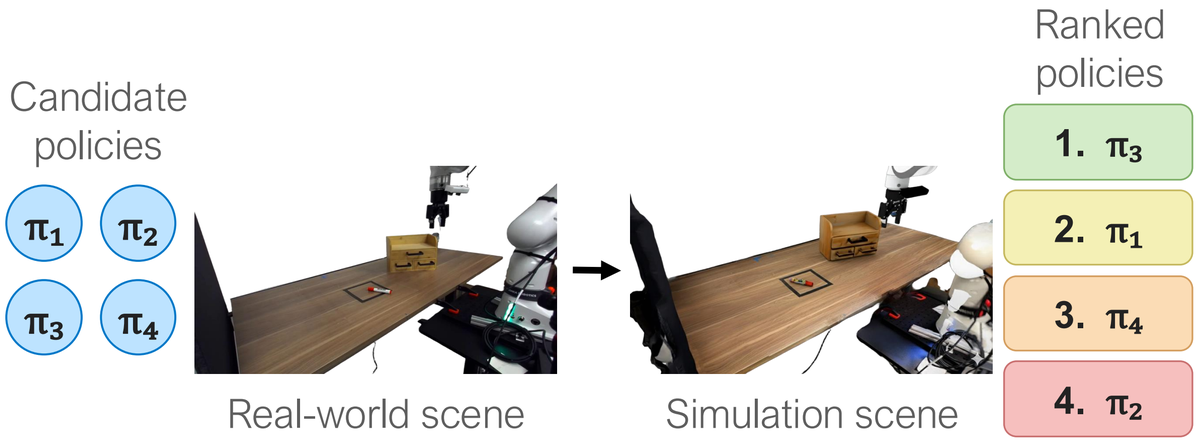
SimFoundry Generates Diverse Digital Cousins in Grounded Scenes



Ranawaka and Wong et al. “SimFoundry: Modular and Automated Scene Generation for Policy Learning and Evaluation”, CoRL 2026

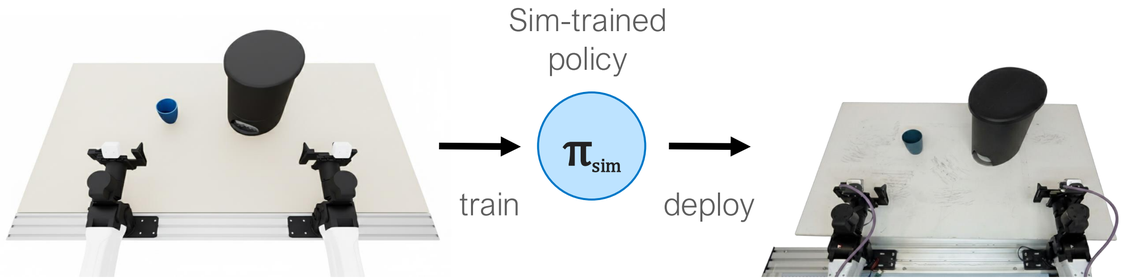
SimFoundry Enables Two Key Applications

Real-to-Sim Policy Evaluation



Evaluate and rank real-world policies in simulation without manual human effort

Sim-to-Real Policy Training

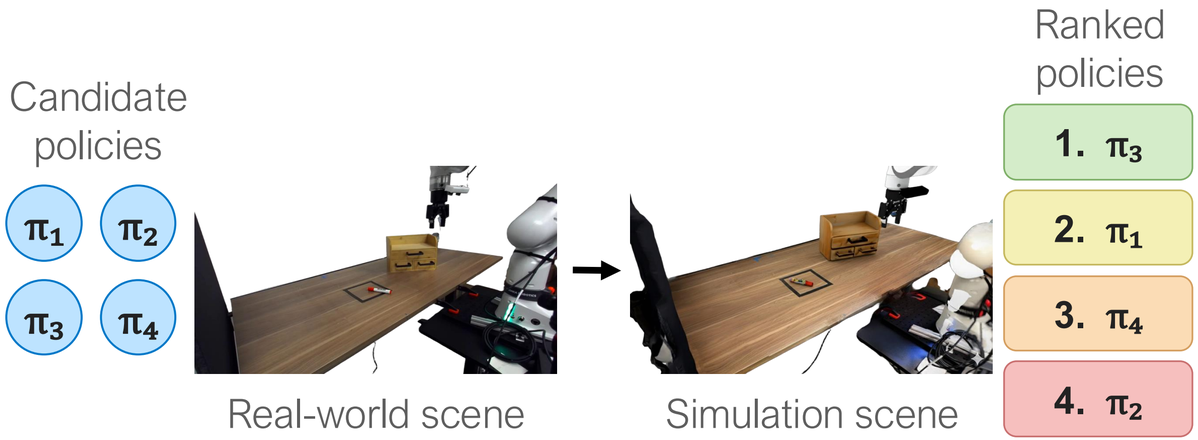


Train policies from synthetic simulation demonstrations and deploy in the real-world

Ranawaka and Wong et al. “SimFoundry: Modular and Automated Scene Generation for Policy Learning and Evaluation”, CoRL 2026

SimFoundry Enables Two Key Applications

Real-to-Sim Policy Evaluation



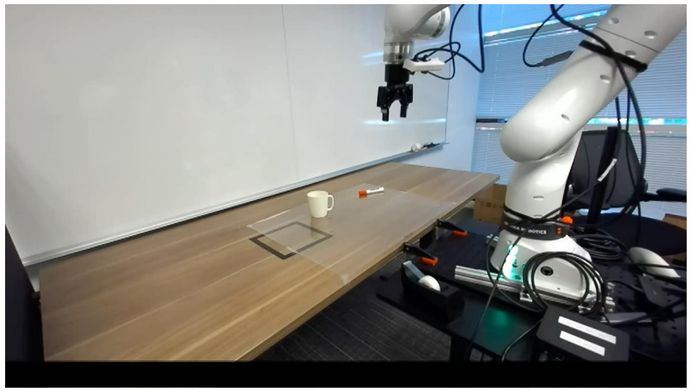
Evaluate and rank real-world policies in simulation without manual human effort

Sim-to-Real Policy Training

Train policies from synthetic simulation demonstrations and deploy in the real-world

SimFoundry Accurately Evaluates Off-the-Shelf Generalist Policies

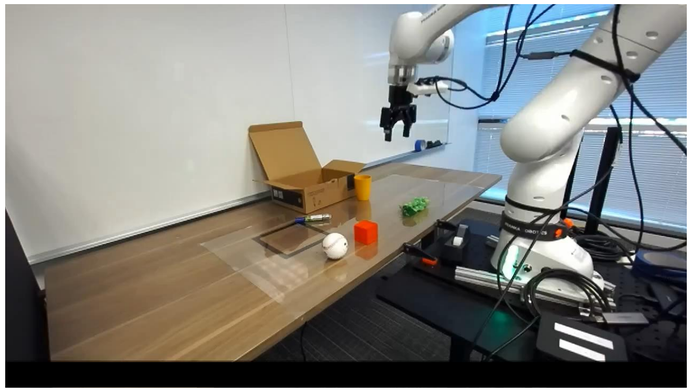
Marker in Cup



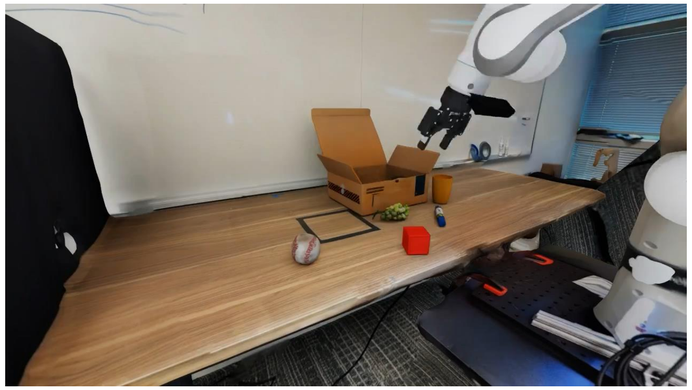
Real: 92%
Sim: 88%



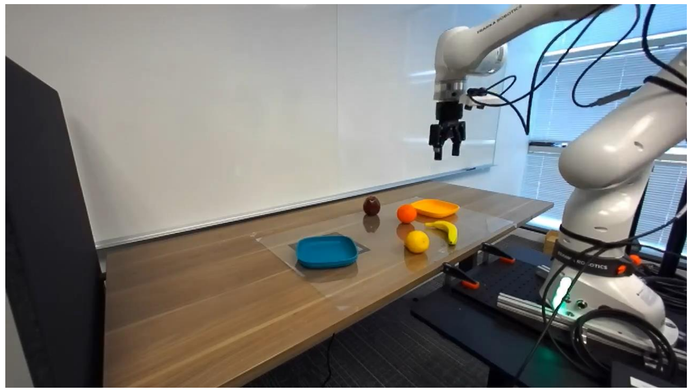
Clear Table



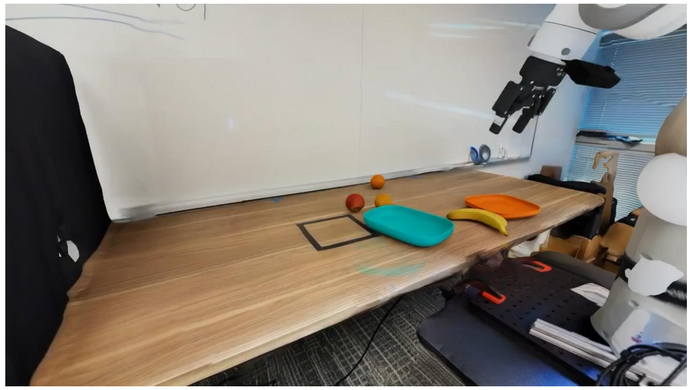
Real: 40%
Sim: 36%



Serve Fruits

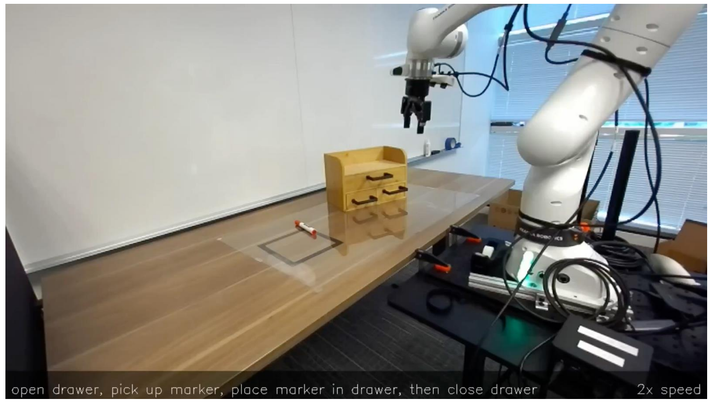


Real: 72%
Sim: 80%



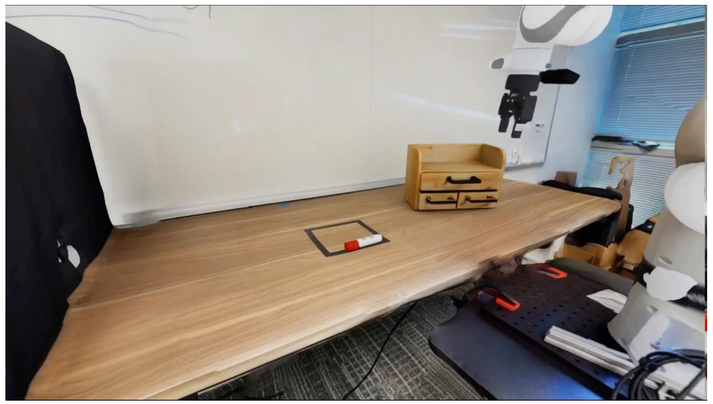
SimFoundry evaluation correlations hold for more challenging scenarios

Store Marker

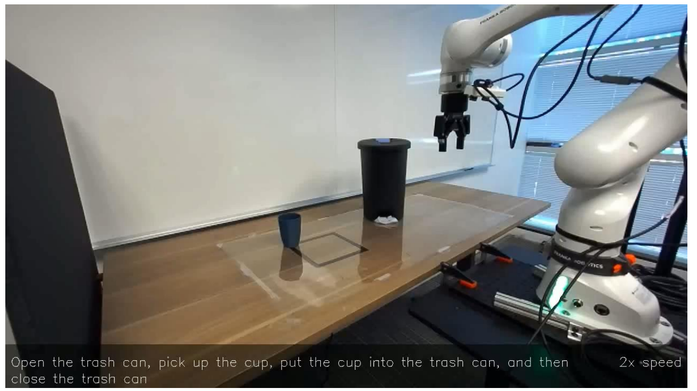


Real 60% $\pi_{0.5}$ > 48% π_0 > 32% GN1.6

Sim 20% $\pi_{0.5}$ > 4% π_0 > 0% GN1.6



Put Away Trash

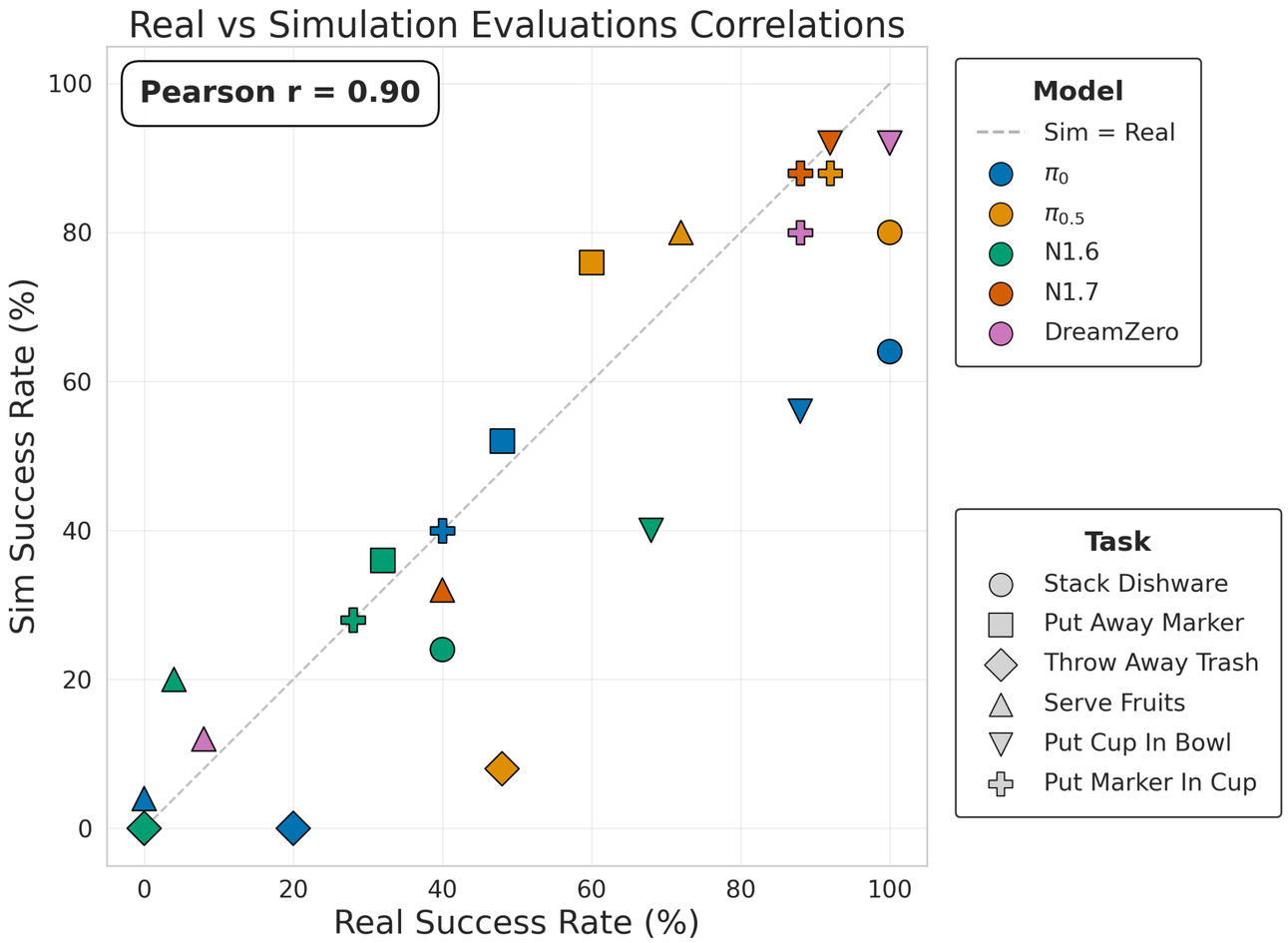


Real 48% $\pi_{0.5}$ > 20% π_0 > 0% GN1.6

Sim 4% $\pi_{0.5}$ > 0% π_0 = 0% GN1.6



SimFoundry Evaluation Strongly Correlates with Real-World Evaluation



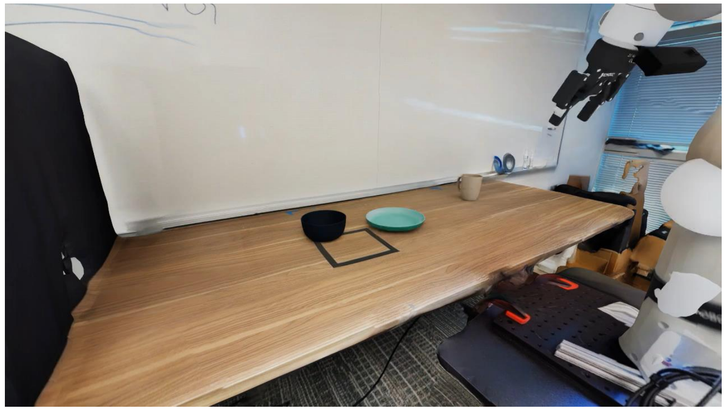
- Policy evaluations in real-world and SimFoundry sim are strongly correlated.
- Correlations hold across 5 different policy types and 6 tasks.
- Correlations hold across pre-trained policies (zero-shot) and fine-tuned policies (trained on real-world task-specific data).

SimFoundry outperforms state-of-the-art alternatives

	PolaRiS	SimFoundry
Real-to-Sim Policy Evaluation	✓	✓
Articulated Objects	✗	✓
Automatic Scene Reconstruction	✗	✓
Sim-to-Real Training	✗	✓

Stack Dishware

SimFoundry



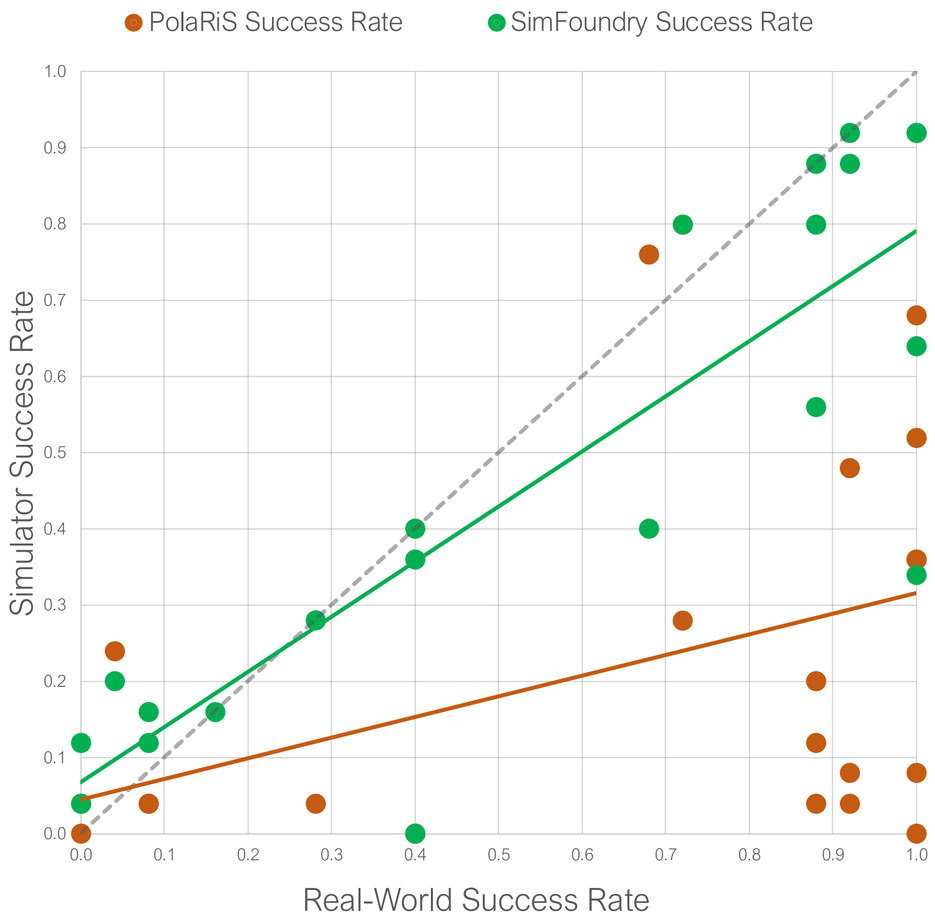
PolaRiS

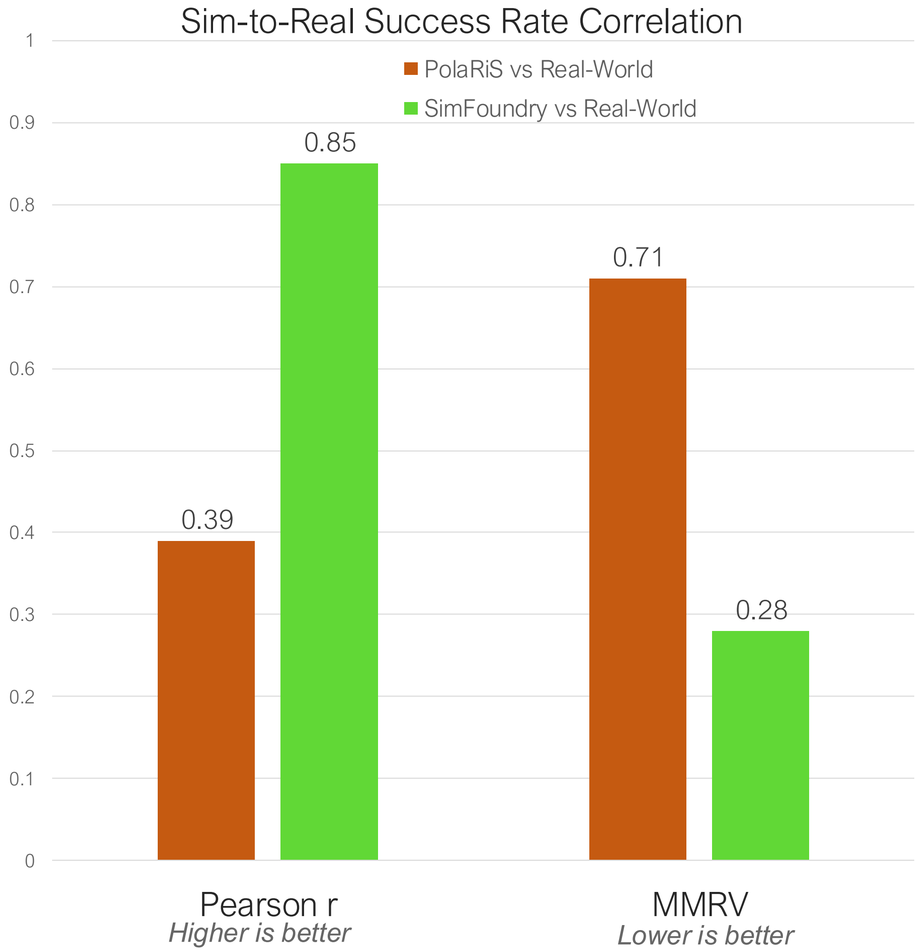


Jain et al, “PolaRiS: Scalable Real-to-Sim Evaluations for Generalist Robot Policies”

SimFoundry outperforms state-of-the-art alternatives

Policies: π_0, $\pi_{0.5}$, Gr00t N1.6, Gr00t N1.7, DreamZero
Tasks: Stack Dishware, Cup in Bowl, Marker in Cup, Serve Fruits, Clear Table



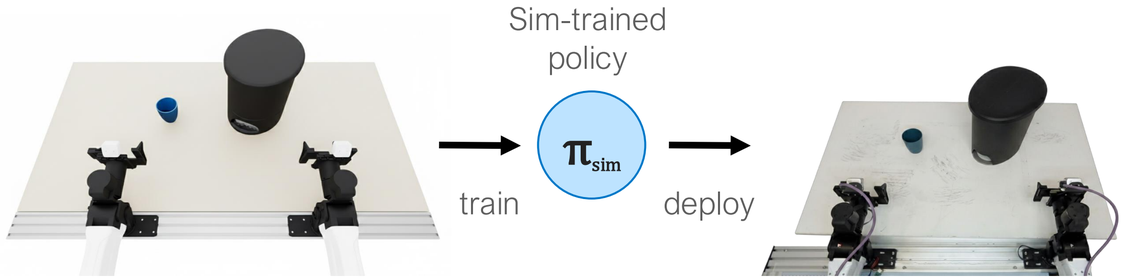


SimFoundry Enables Two Key Applications

Real-to-Sim Policy Evaluation

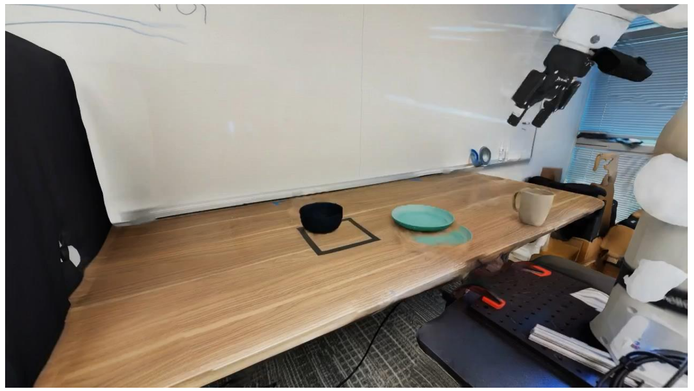
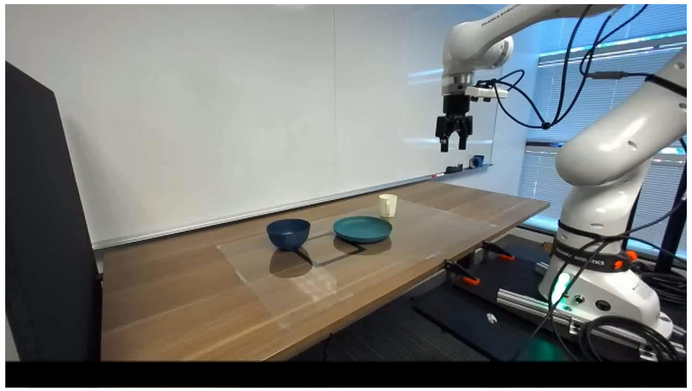
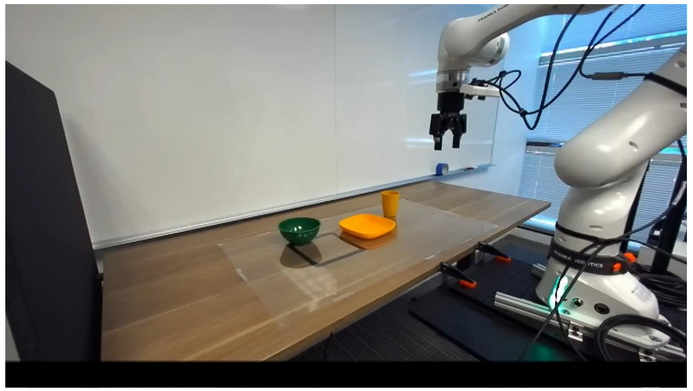
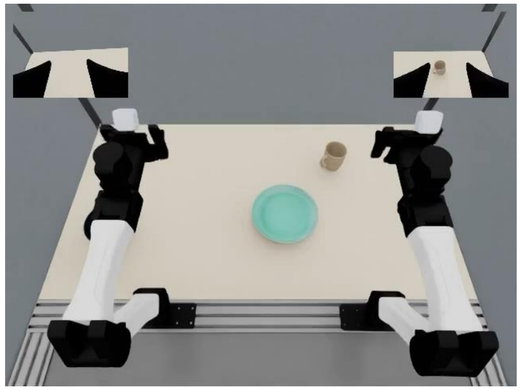
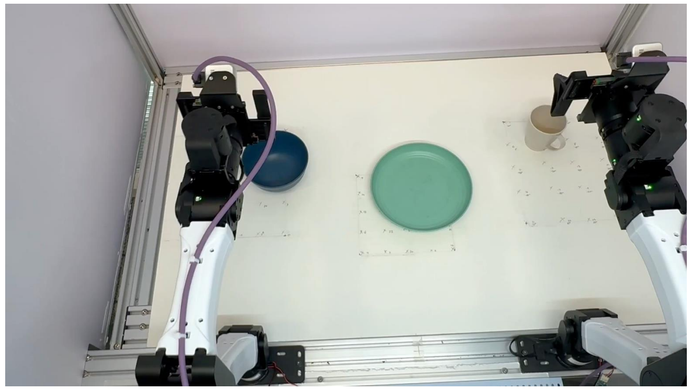
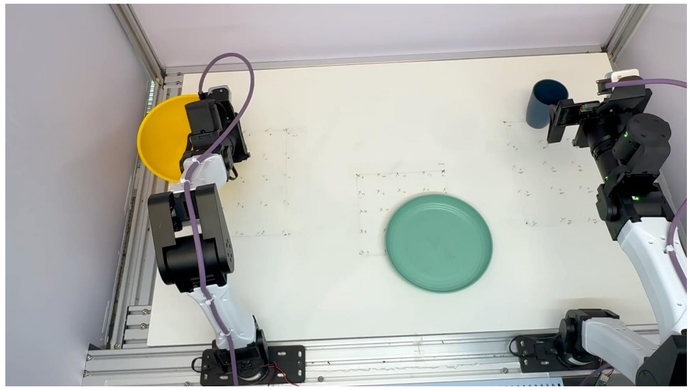
Evaluate and rank real-world policies in simulation without manual human effort

Sim-to-Real Policy Training



Train policies from synthetic simulation demonstrations and deploy in the real-world

Policies Trained on SimFoundry Data Transfer Zero-Shot to Real-World

Simulation Eval	Real-World Eval	Real Eval (New Objects)
		
Success Rate: 100%	Success Rate: 96%	Success Rate: 100%
		
Success Rate: 92%	Success Rate: 43%	Success Rate: 42%

Real-to-Sim-to-Real Synthetic Data Generation Workflow

1 Real-World Video to Digital Twin

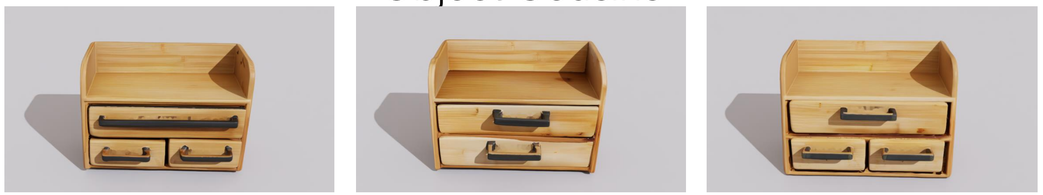


2 Generate Digital Cousins

Scene Cousins

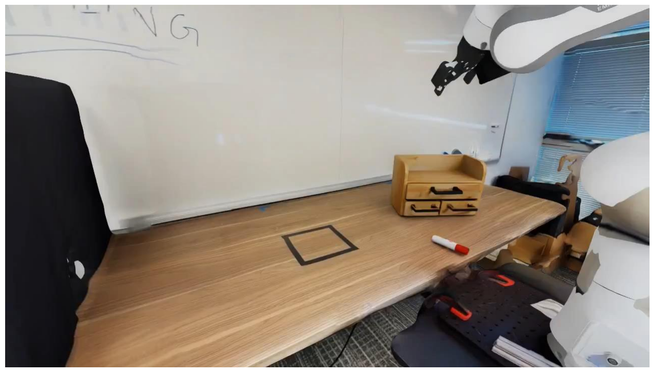


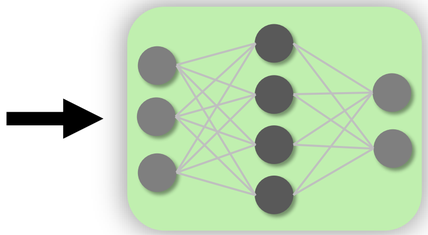
Object Cousins



3 Synthetic Data Generation and Policy Training

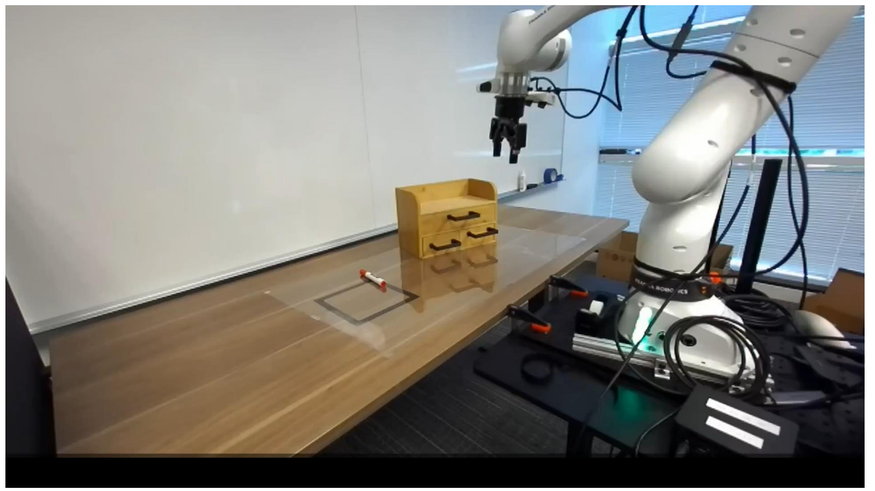
MimicGen





Policy π_θ

4 Real-World Policy Deployment



SimFoundry Digital Cousins Enable Policy Generalization to Novel Objects

Twin



Cousins

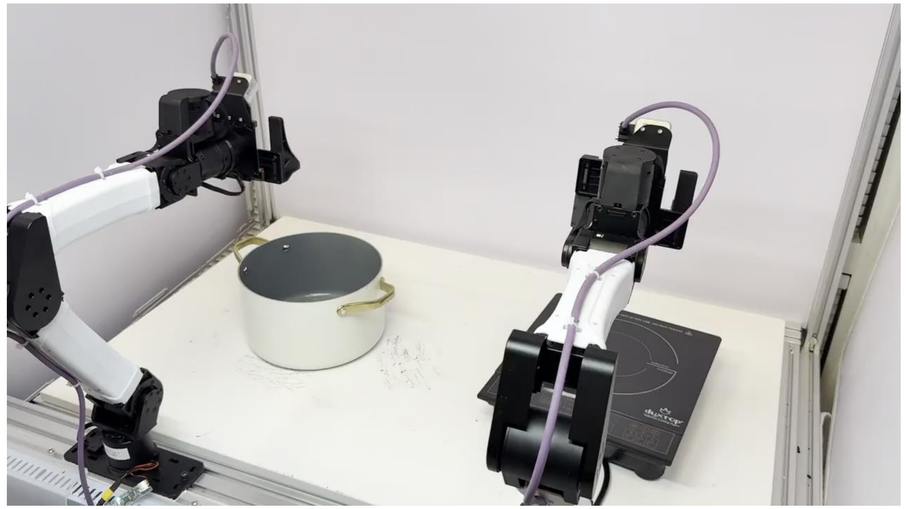






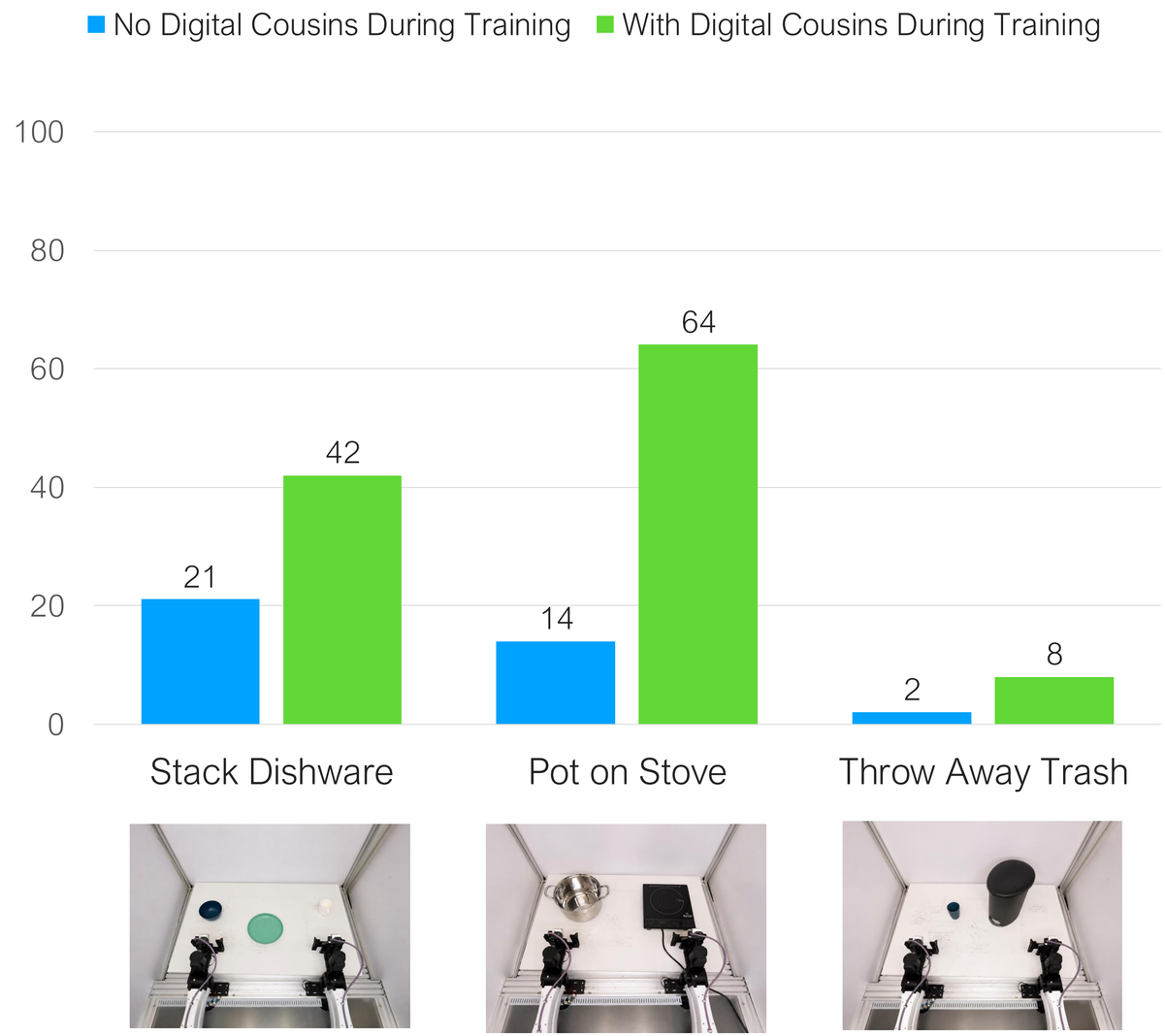
SimFoundry Digital Cousins Enable Policy Generalization to Novel Objects

New Pot

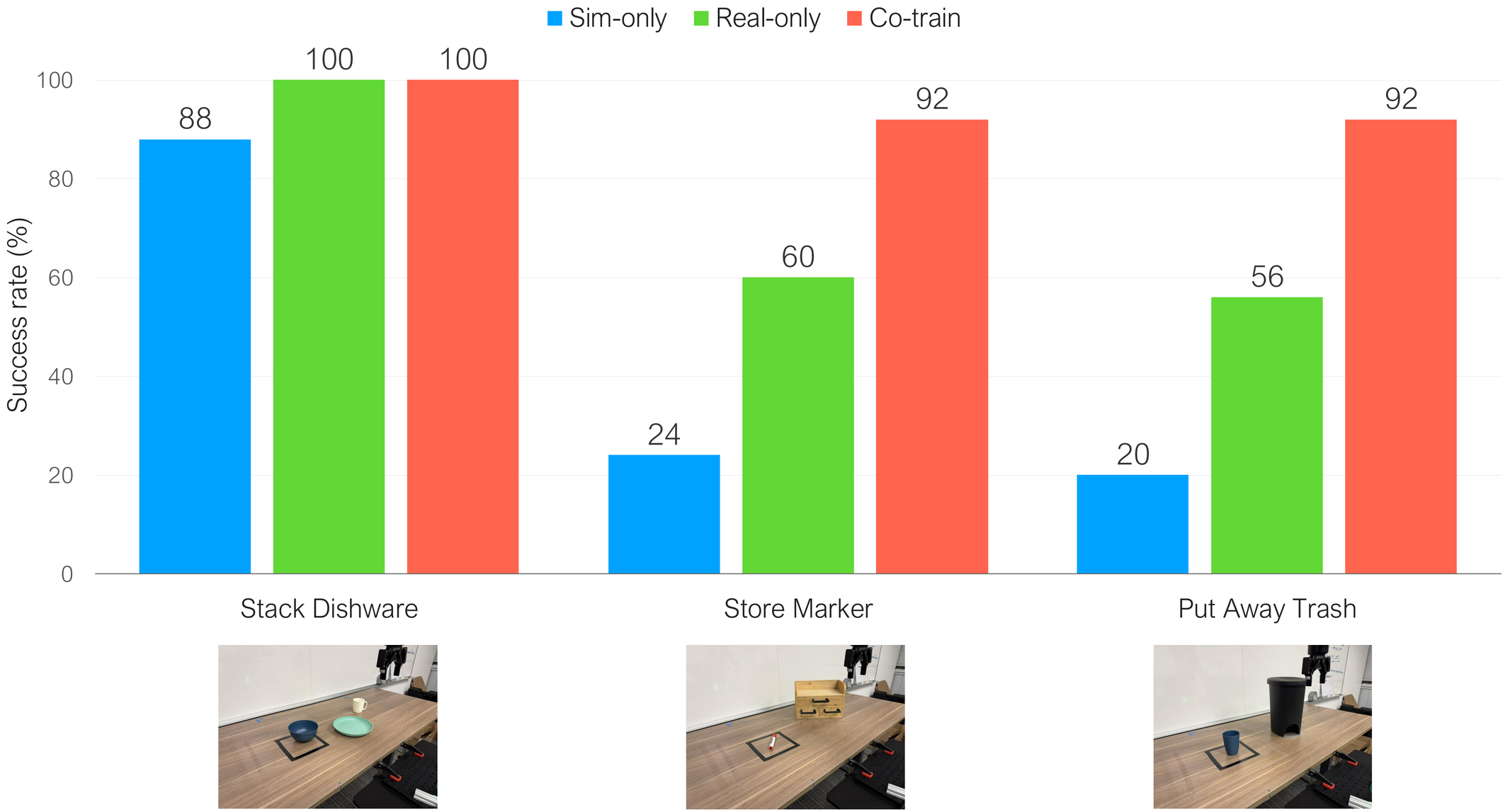


New Trash Container



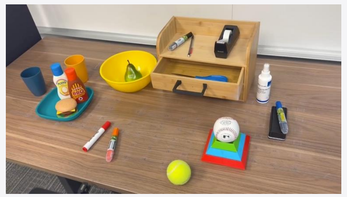


Co-Training with Large Amounts of SimFoundry Sim Data and Small Amounts of Real Data Produces Even Better Policies



SimFoundry generates meaningful tasks that facilitate policy generalization

Real Scene



SimFoundry Scene



Task Prompt

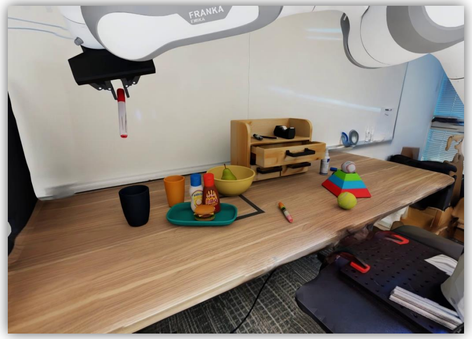
vlm_prompt.txt

```
# task proposer prompt

Propose {num_tasks} distinct tasks a {robot_type} arm can perform in this scene, using
only the listed objects.

Each task must have a clear goal condition.
```

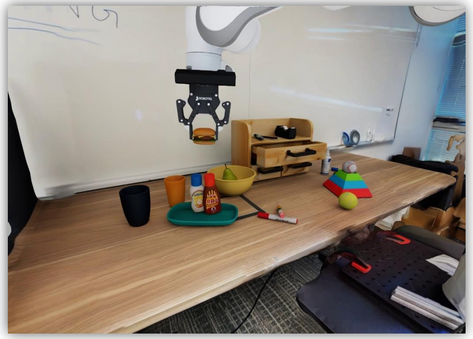
Task Proposals and Goal Conditions

```
> Place red marker in blue cup
> Place burger in bowl
> Place tennis ball in bowl
# ...with goal conditions
```

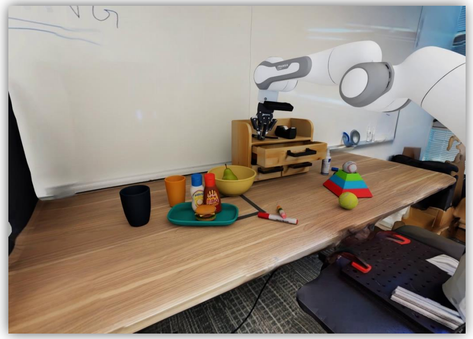
Generated Tasks



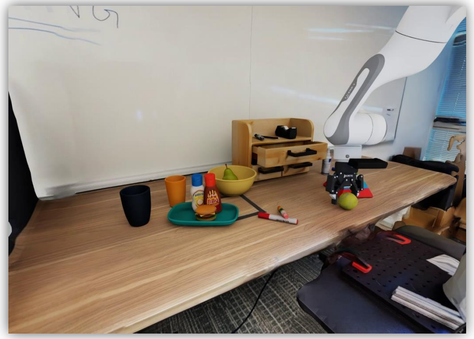
Place red marker in blue cup



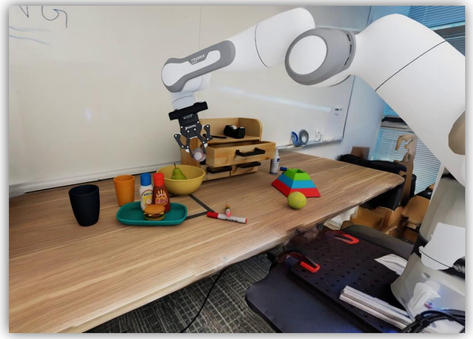
Place burger in bowl



Place black marker on plate

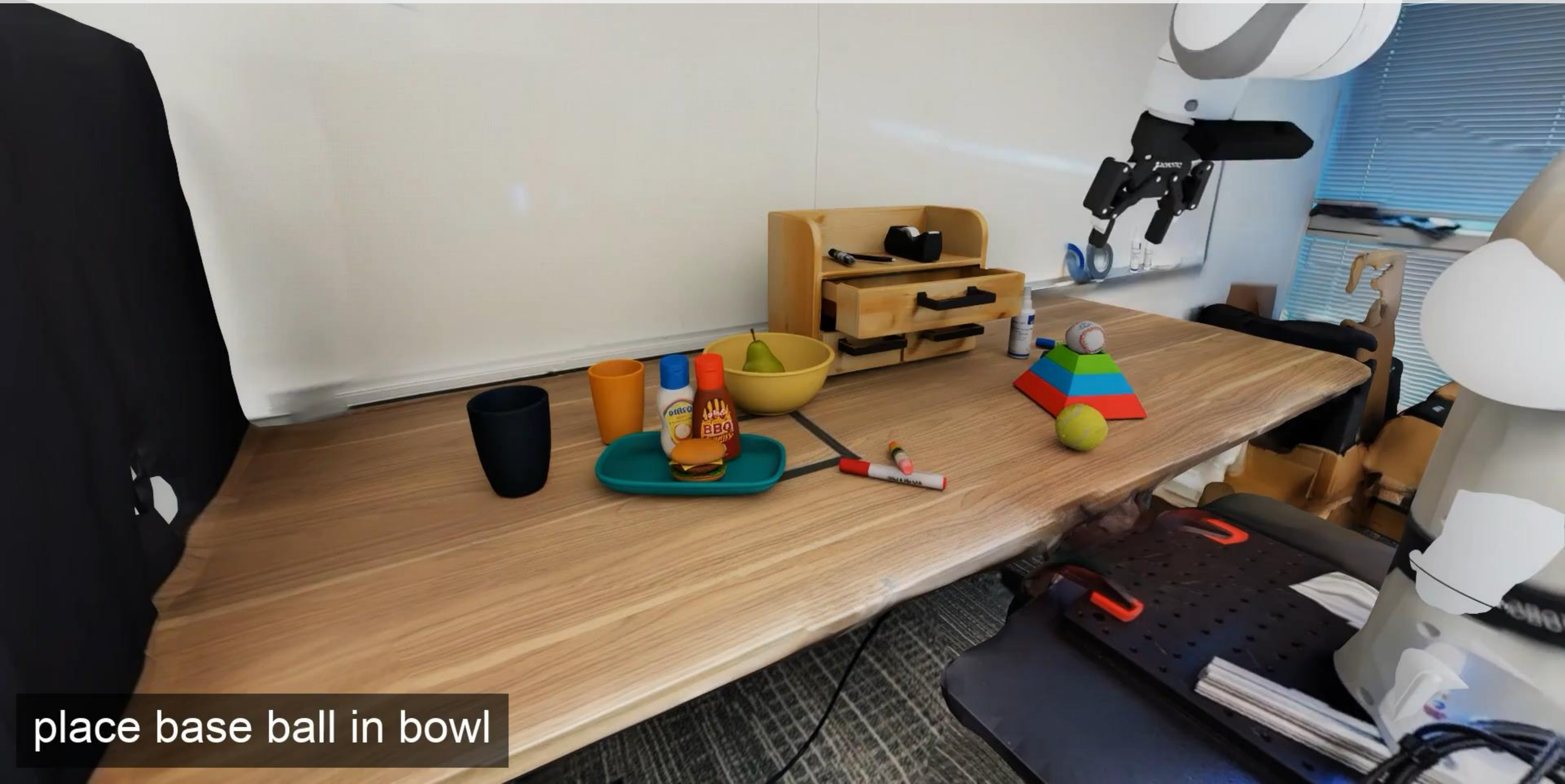


Place tennis ball in bowl

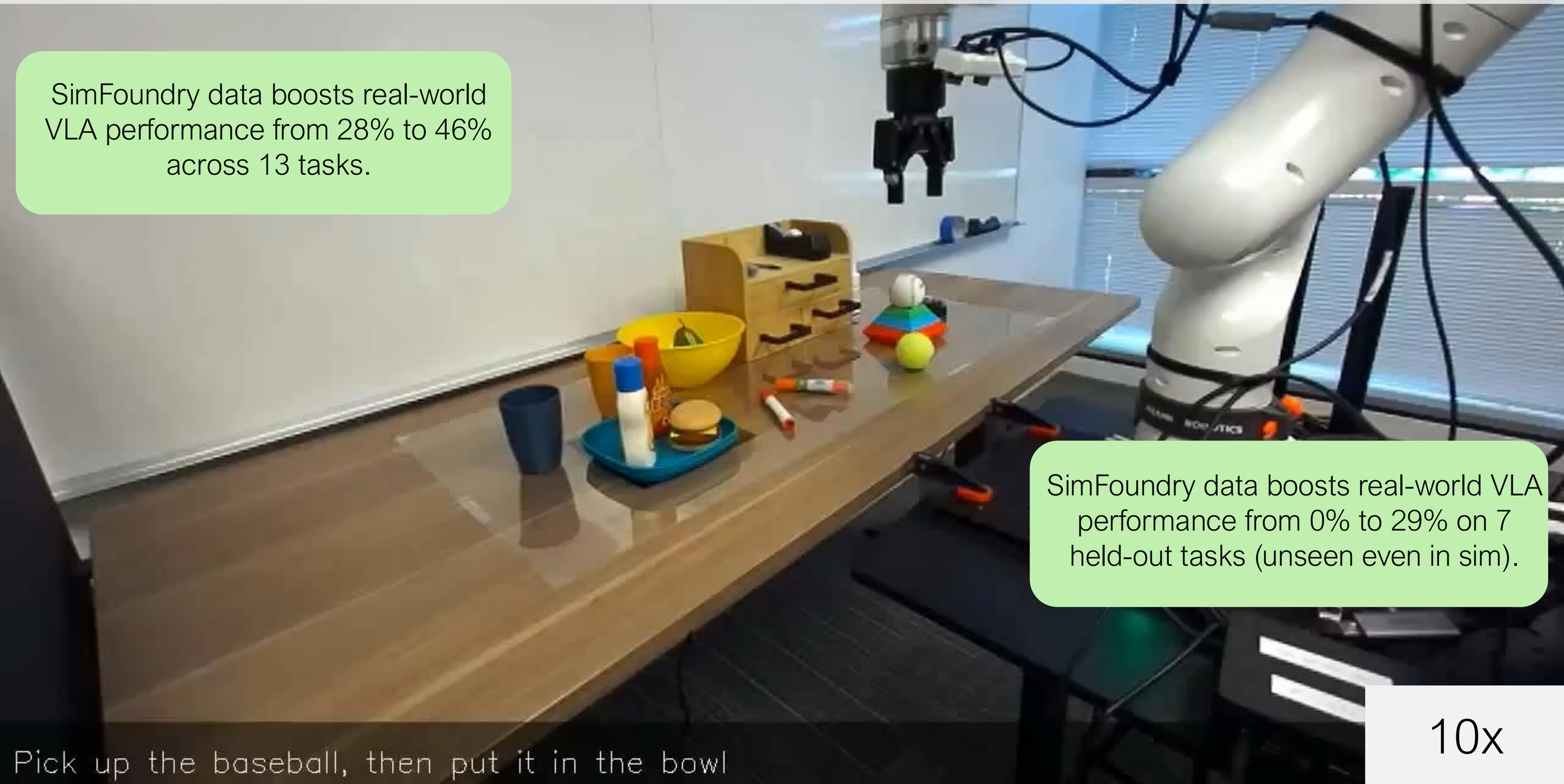


Place baseball in bowl

SimFoundry produces large multi-task synthetic data from generated task cousins



SimFoundry Multi-Task Synthetic Data Improves Generalist Policies

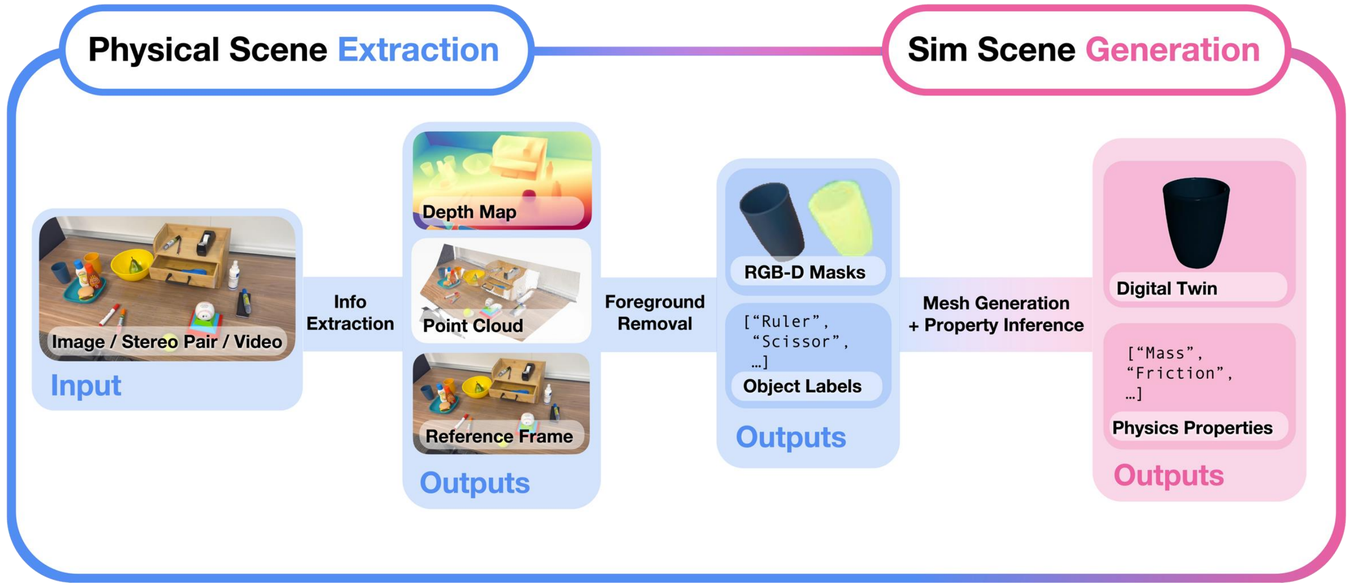


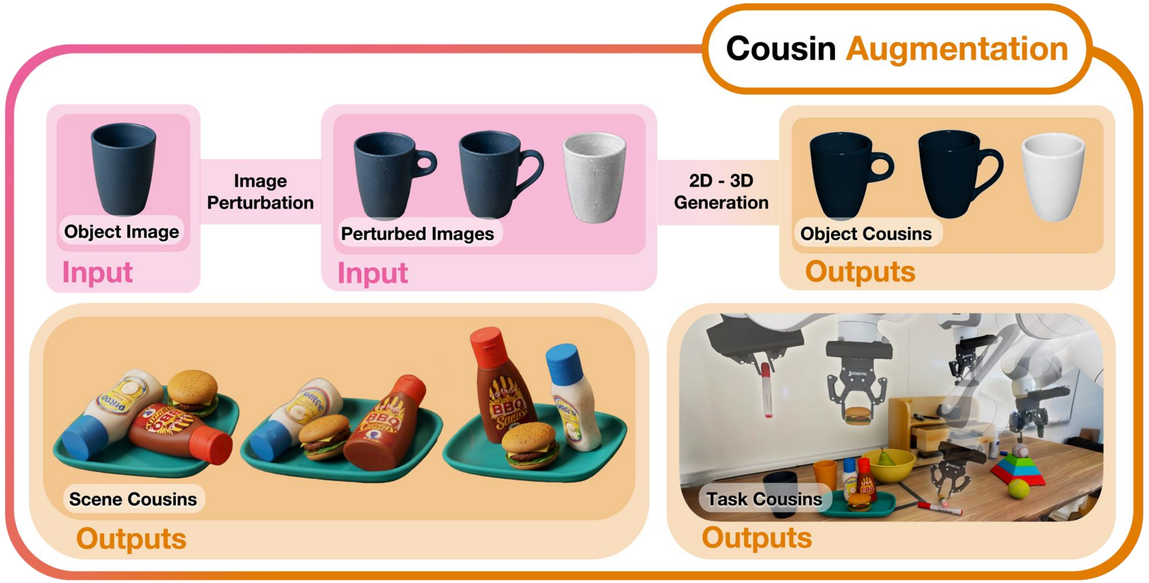
SimFoundry: How It Works

Real-World Video

Digital Twin Reconstruction

Digital Cousin Generation





SimFoundry

1 Real-World Extraction



What objects are in this image?

banana, plate, ,ruler

SimFoundry

1 Real-World Extraction



What objects are in this image?

banana, plate, ,ruler

least occluded

SimFoundry

1 Real-World Extraction



ruler

SAM3

Depth Inpaint

Nano Banana



SimFoundry

1 Real-World Extraction



ruler

SAM3

Depth Inpaint

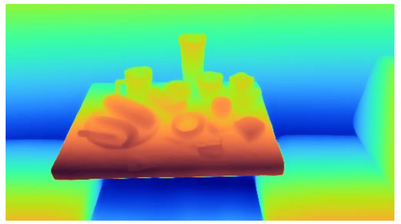
Nano Banana



Inpainted Image



Segmented Mask



Inpainted Depth

SimFoundry

1 Real-World Extraction



scissors

SAM3

Depth Inpaint

Nano Banana





ruler

SimFoundry

1 Real-World Extraction



SAM3

Depth Inpaint

Nano Banana



SimFoundry

1 Real-World Extraction



gauge

SAM3

Depth Inpaint

Nano Banana





SimFoundry

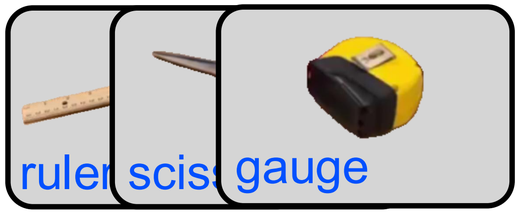
1 Real-World Extraction



SAM3

Depth Inpaint

Nano Banana



SimFoundry

1 Real-World Extraction



blue tape

SAM3

Depth Inpaint

Nano Banana





SimFoundry

1 Real-World Extraction



SAM3

Depth Inpaint

Nano Banana



SimFoundry

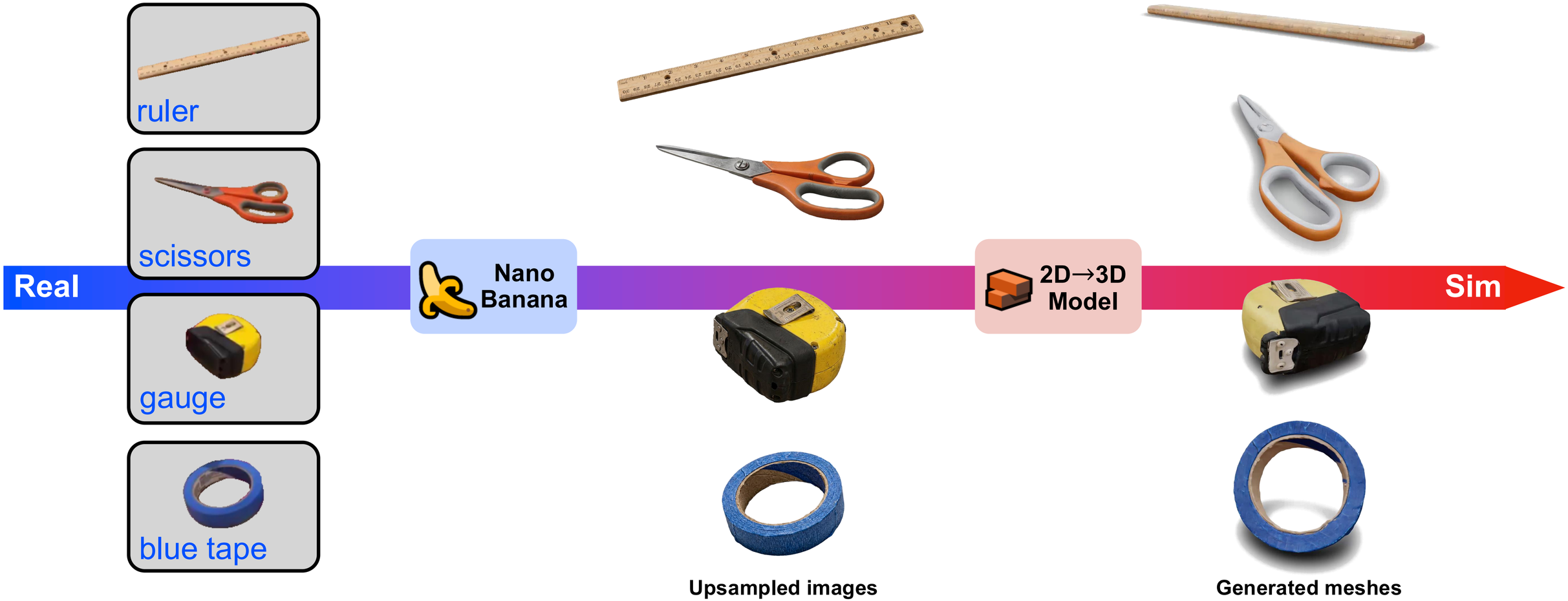
1 Real-World Extraction





SimFoundry

2 Simulated Generation



SimFoundry

2 Simulated Generation

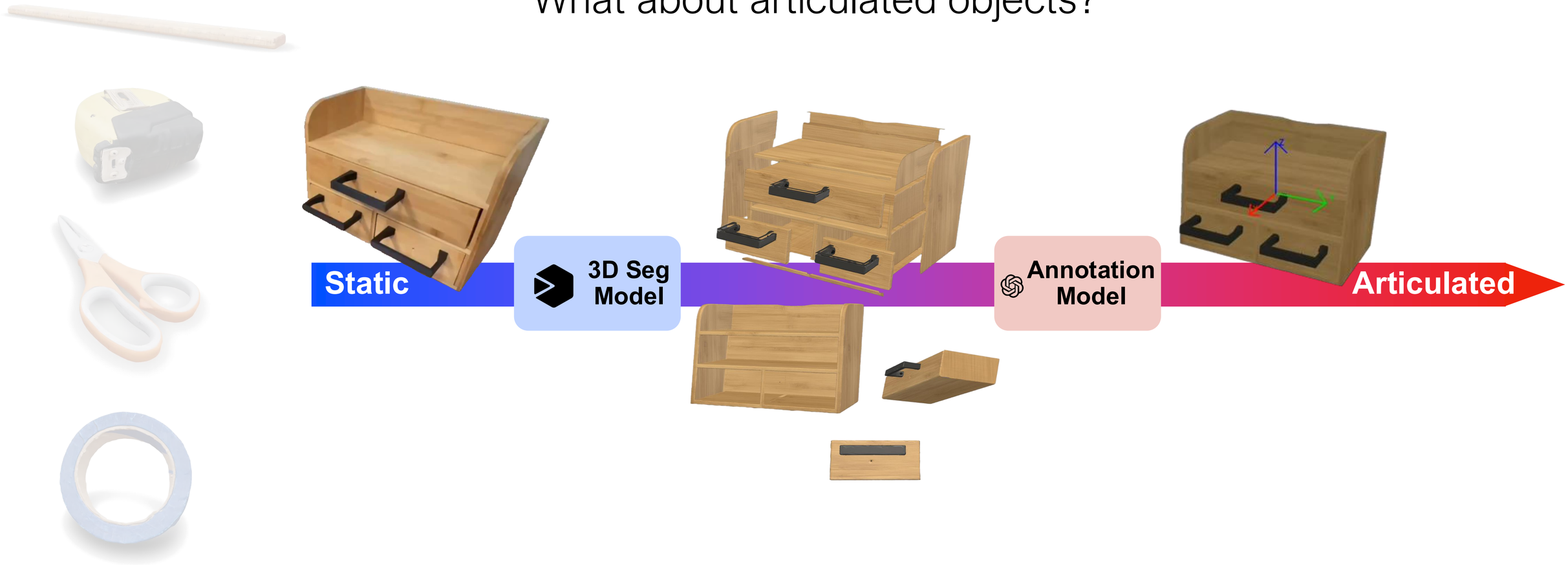
What about articulated objects?



SimFoundry

2 Simulated Generation

What about articulated objects?



SimFoundry

2 Simulated Generation



mass = 0.04kg, friction = 0.3





mass = 0.4kg, friction = 0.6



mass = 0.1kg, friction = 0.7



mass = 0.06kg, friction = 0.5

SimFoundry

2 Simulated Generation



+ +



Reconstructed Background

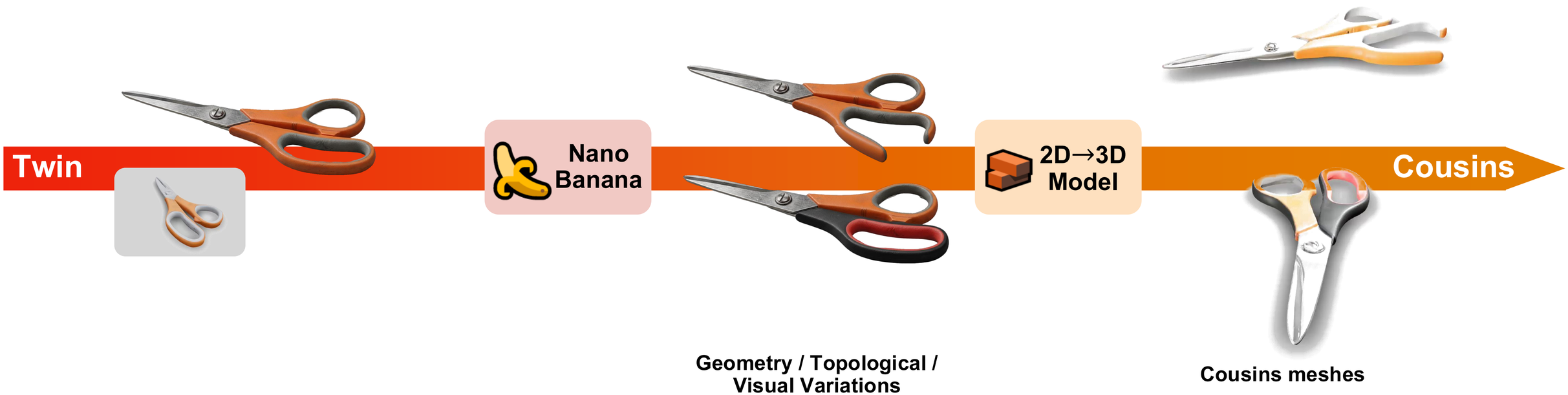
Physics Check



Generated Scene

SimFoundry

3 Augmented Cousins

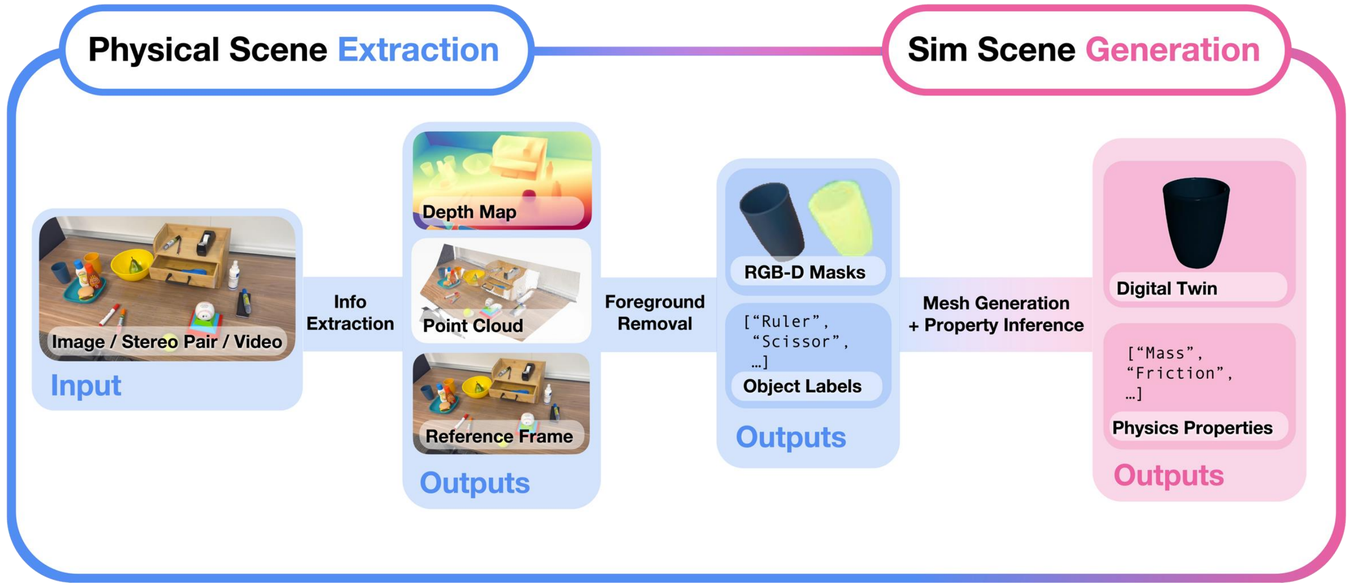


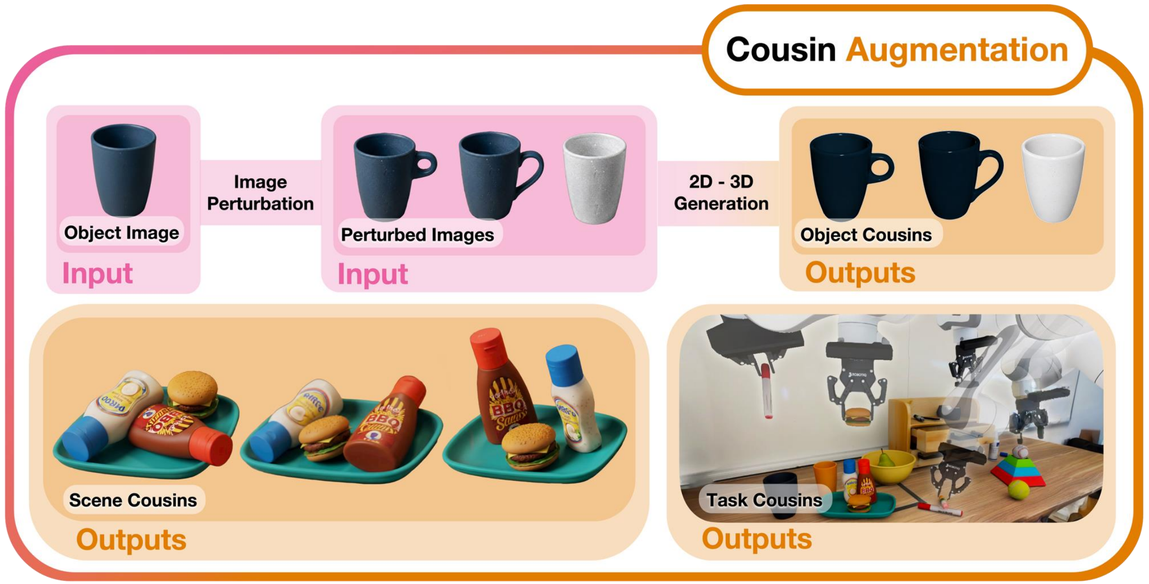
SimFoundry is Modular and Future-Proof

Real-World Video

Digital Twin Reconstruction

Digital Cousin Generation





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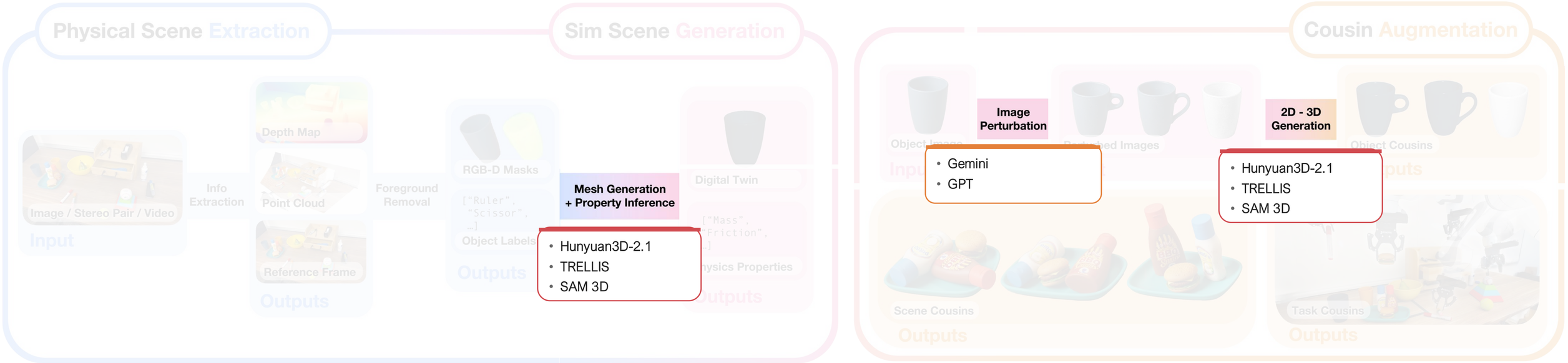
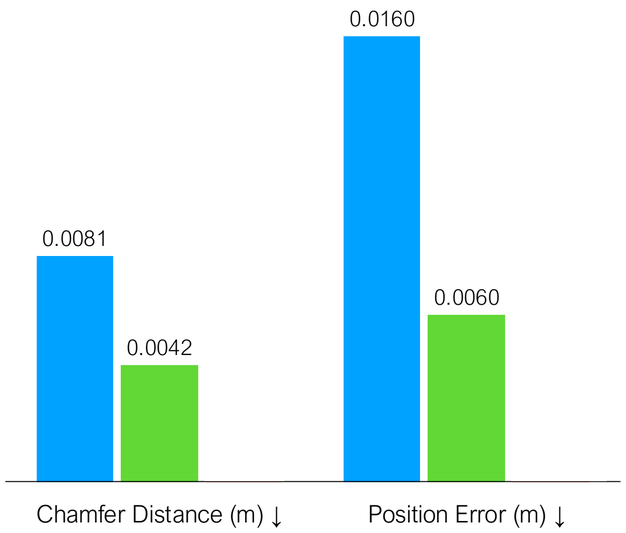


SimFoundry outperforms state-of-the-art reconstruction

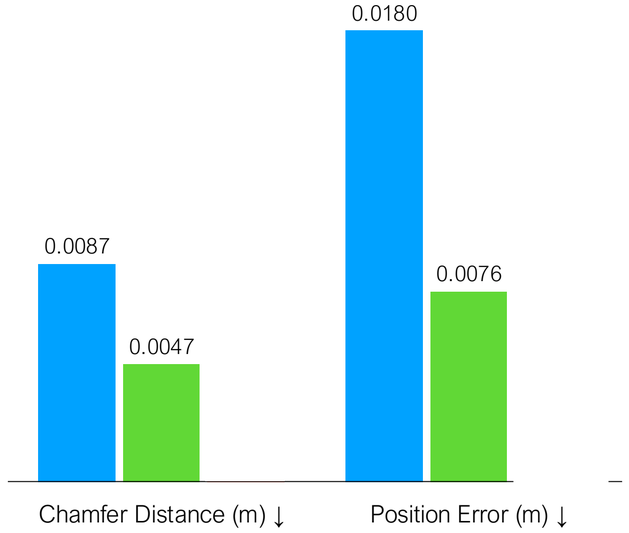
“Easy” Scenes





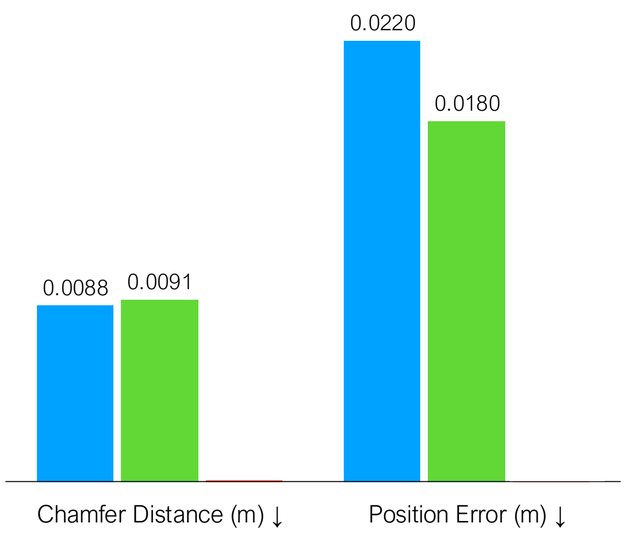
“Medium” Scenes





“Hard” Scenes





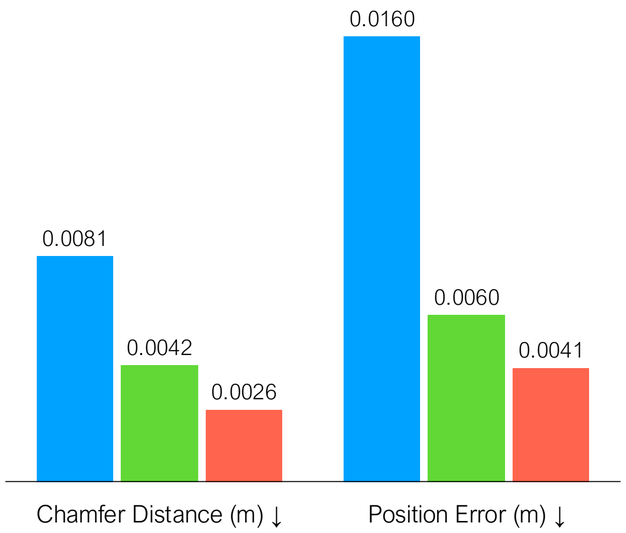
SAM3D Zero-Shot

SimFoundry Zero-Shot

Human Interaction Improves Fidelity in Minutes

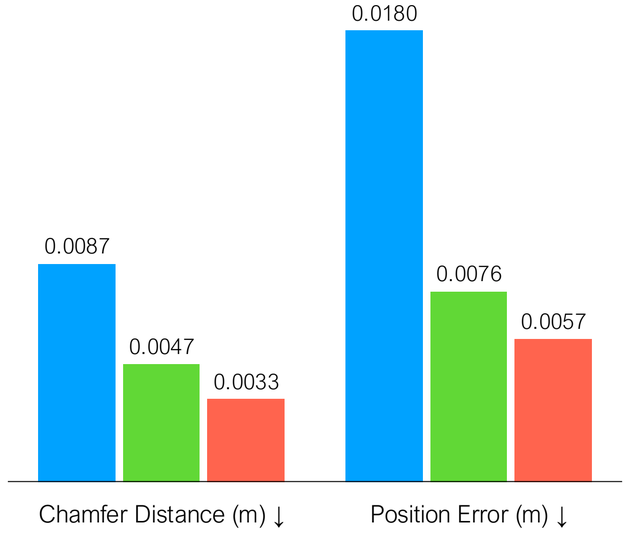
“Easy” Scenes





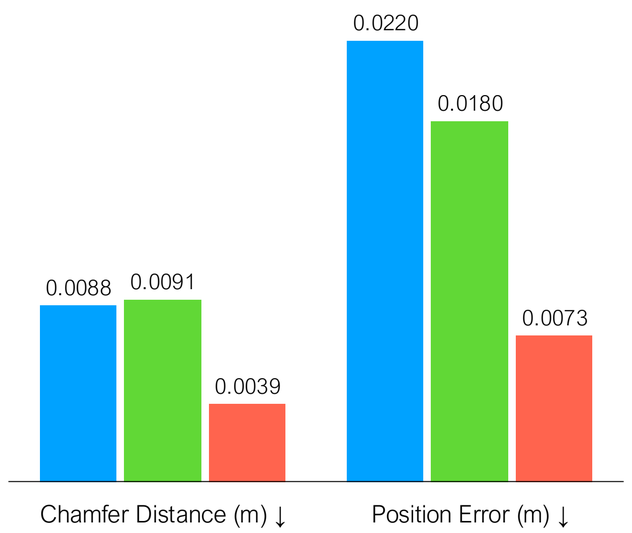
“Medium” Scenes





“Hard” Scenes





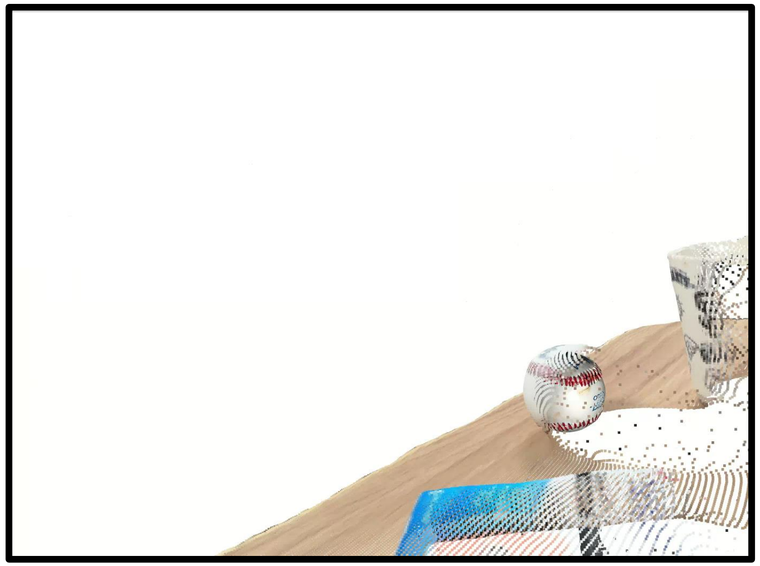
SAM3D Zero-Shot

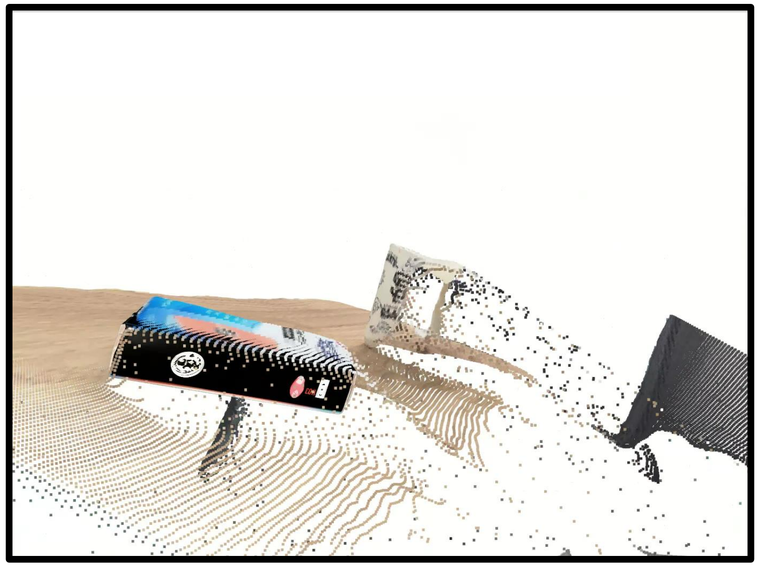
SimFoundry Zero-Shot

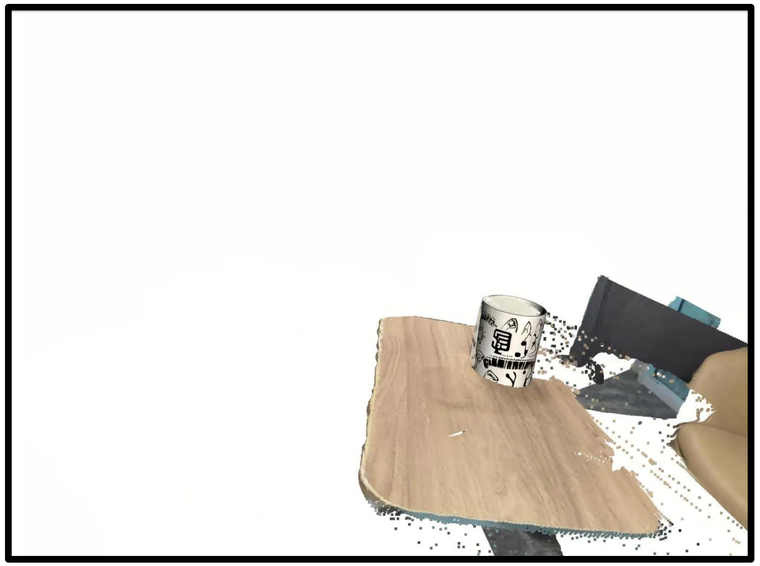
SimFoundry Tuned

Human Interaction Improves Fidelity in Minutes

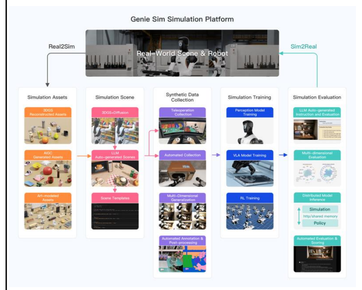
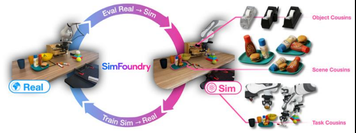
Users can apply light edits to object sizes and positions to further improve fidelity







Comparing SimFoundry to other research work

	GSWorld [Jiang et al.]	SAGE [Xia et al.]	MolmoSpaces [Kim et al.]	GenieSim [Yin et al.]	WorldComposer [Lu et al.]	SimFoundry (ours)
						
Sim-to-real training	✓	✗	✓	✓	✓	✓
Real-to-sim policy evaluation	✓	✗	✓	✗	✓	✓
Automatic scene construction	✓	✓	✗	✓	✓	✓
Articulated objects	✗	✓	✓	✓	✓	✓
Multi-embodiment	✓	✗	✓	✗	✗	✓
Asset and Cousins generation	Only asset generation	No task cousins	No asset generation or task cousins	✓	No asset generation or task cousins	✓
Background reconstruction	✓	✗	✗	✗	✓	✓

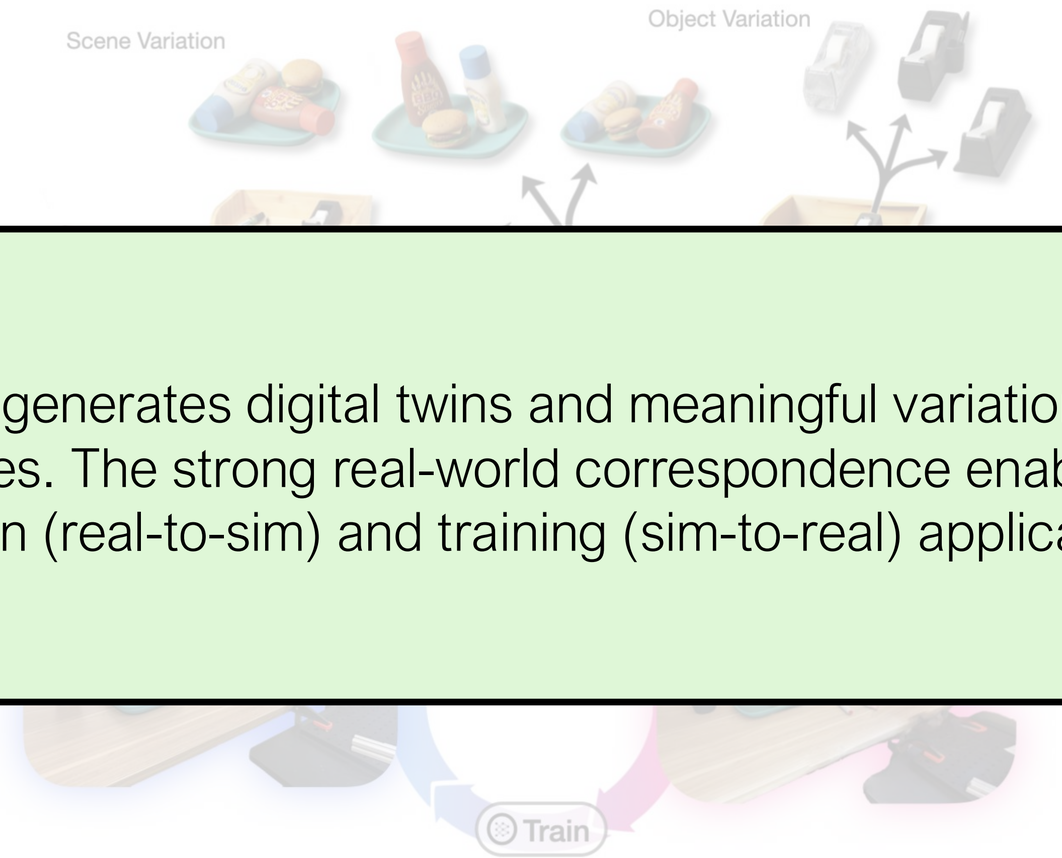


SimFoundry

Nadun Ranawaka*, Josiah Wong*, Wei-Lin Pai, Wei-Teng Chu,
Tianyuan Dai, Masoud Moghani, Hang Yin, Yunfan Jiang,
Wesley Durbano*, Brandon Huynh*, Yu Fang, Linxi Fan, Danfei Xu,
Ruohan Zhang, Li Fei-Fei, Bowen Wen, Ajay Mandlekar†, Yuke Zhu†

https://research.nvidia.com/labs/gear/simfoundry

Recap: Removing the Barriers to Simulation Adoption



SimFoundry generates digital twins and meaningful variations of real-world scenes. The strong real-world correspondence enables both evaluation (real-to-sim) and training (sim-to-real) applications.

Making simulation creation easy, with low engineering burden, and high-fidelity, with strong real-world correspondence

Coding Agents Will Make Simulation Design Even Easier…

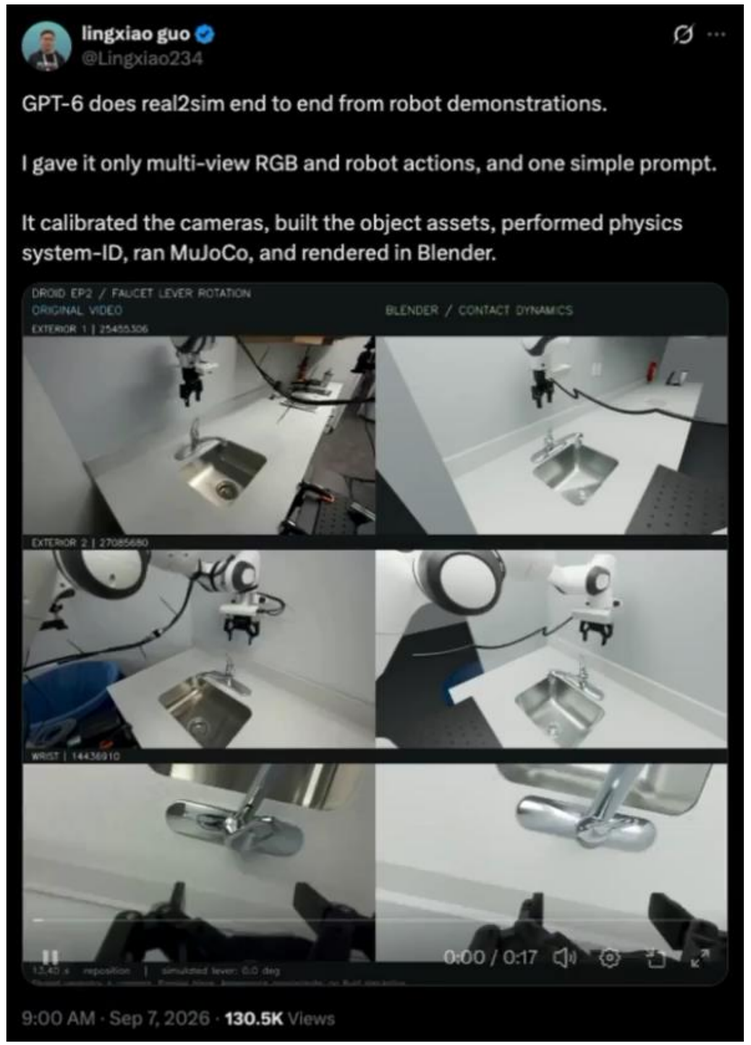
Researcher



uses coding agents to build sims

Claude
[Anthropic]

Codex
[OpenAI]



Credit: Lingxiao Guo & Twitter

…but it is still important to ground simulation in real-world application

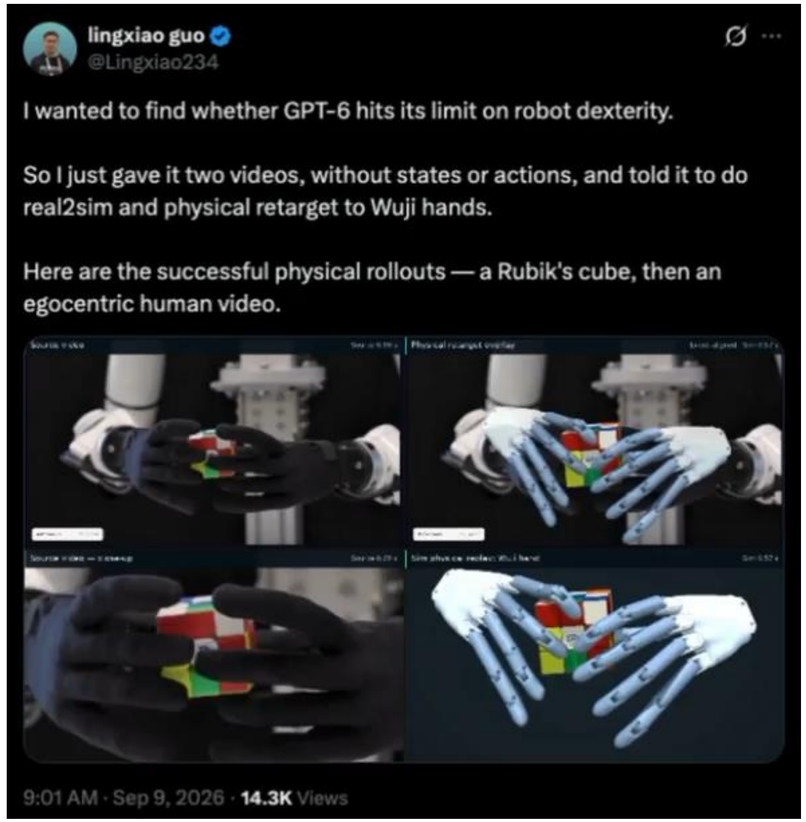
Researcher



uses coding agents to build sims

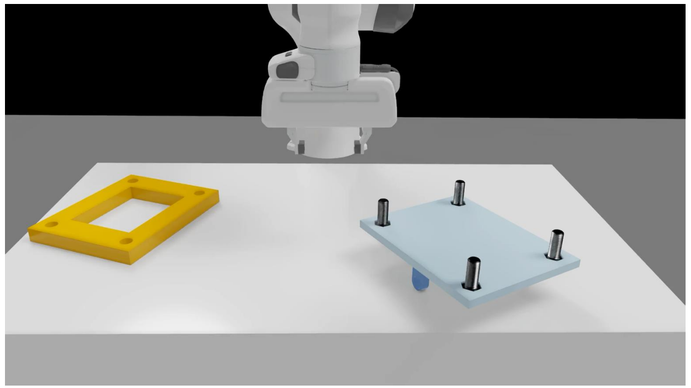
Claude
[Anthropic]

Codex
[OpenAI]

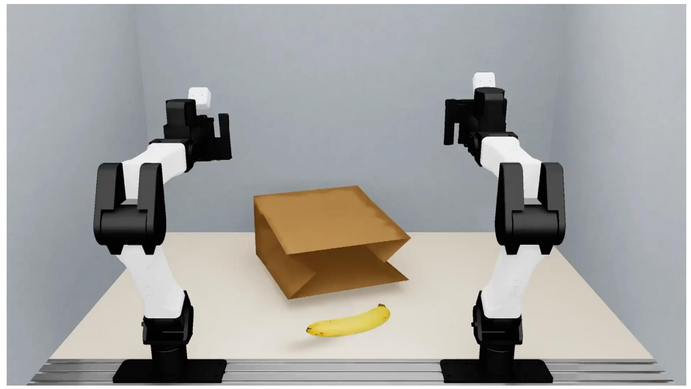


Credit: Lingxiao Guo & Twitter

Increasing the Scope of Synthetic Data Generation and Simulation



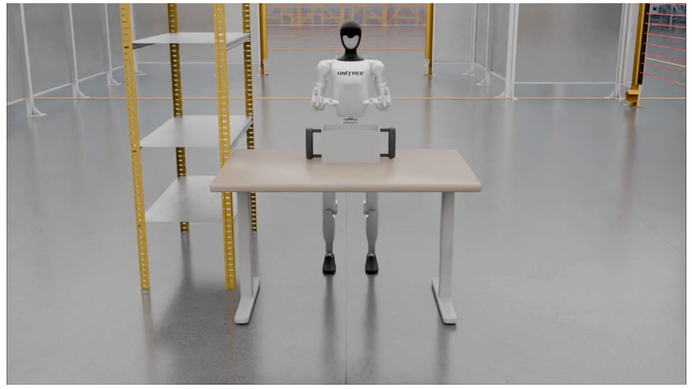
MimicGen (CoRL 2023)



SoftMimicGen (ICRA 2026)



DexMimicGen (ICRA 2025)



HumanoidMimicGen (CoRL 2026)

Thanks to the entire SimFoundry Team


Nadun Ranawaka


Josiah Wong


Wei-Lin Pai


Wei-Teng Chu


Tianyuan Dai


Masoud Moghani


Hang Yin


Yunfan Jiang


Wesley Durbano


Brandon Huynh


Yu Fang


Jim Fan


Danfei Xu

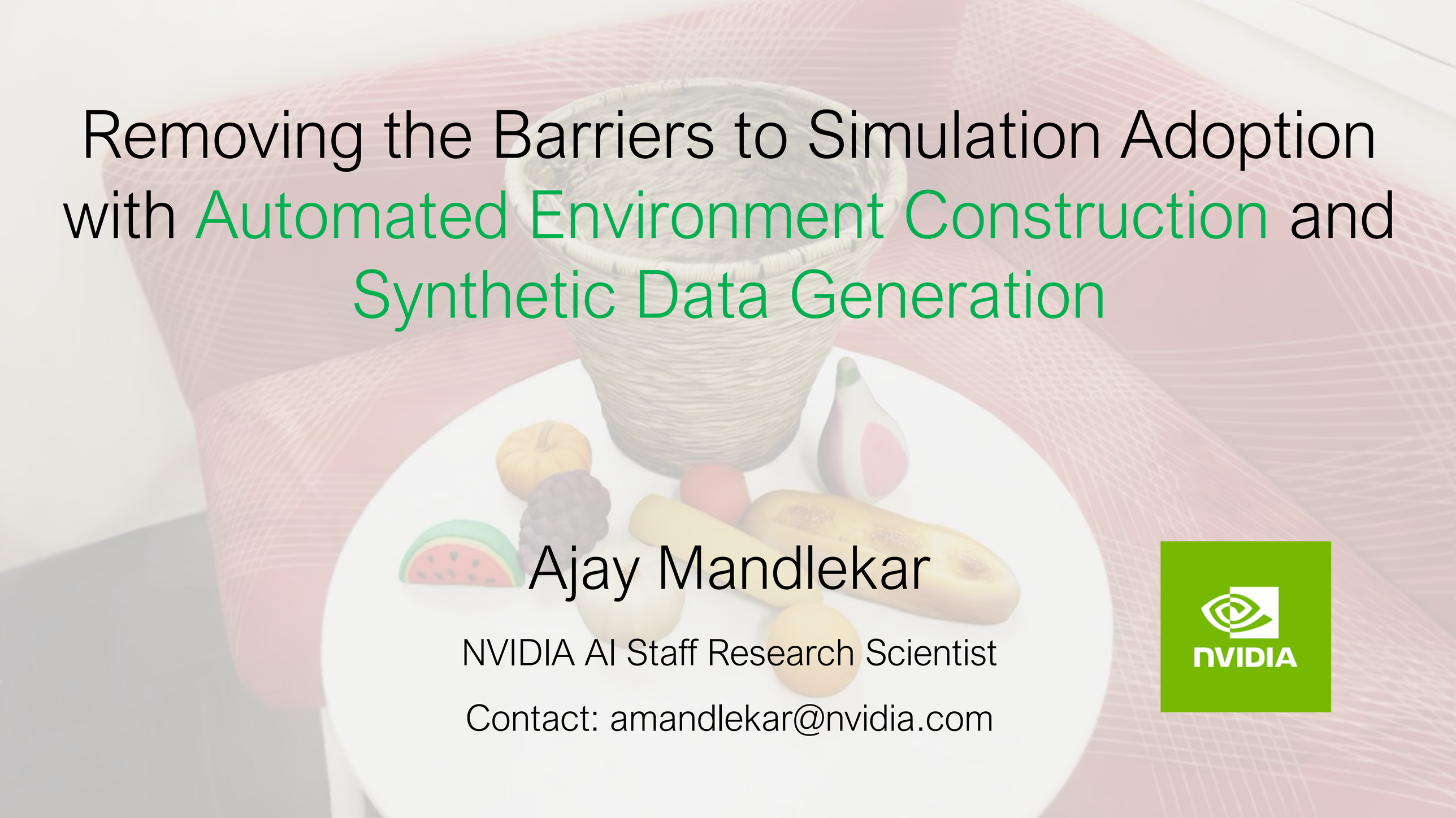

Ruohan Zhang


Fei-Fei Li


Bowen Wen


Yuke Zhu

Removing the Barriers to Simulation Adoption with Automated Environment Construction and Synthetic Data Generation



Ajay Mandlekar

NVIDIA AI Staff Research Scientist

Contact: amandlekar@nvidia.com