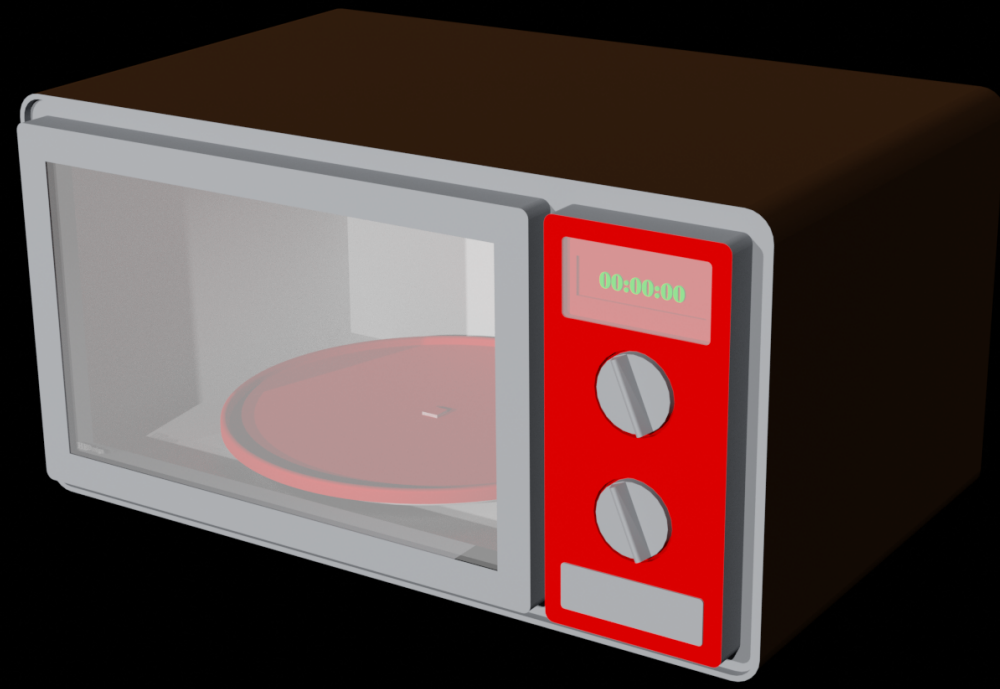


SAPIEN

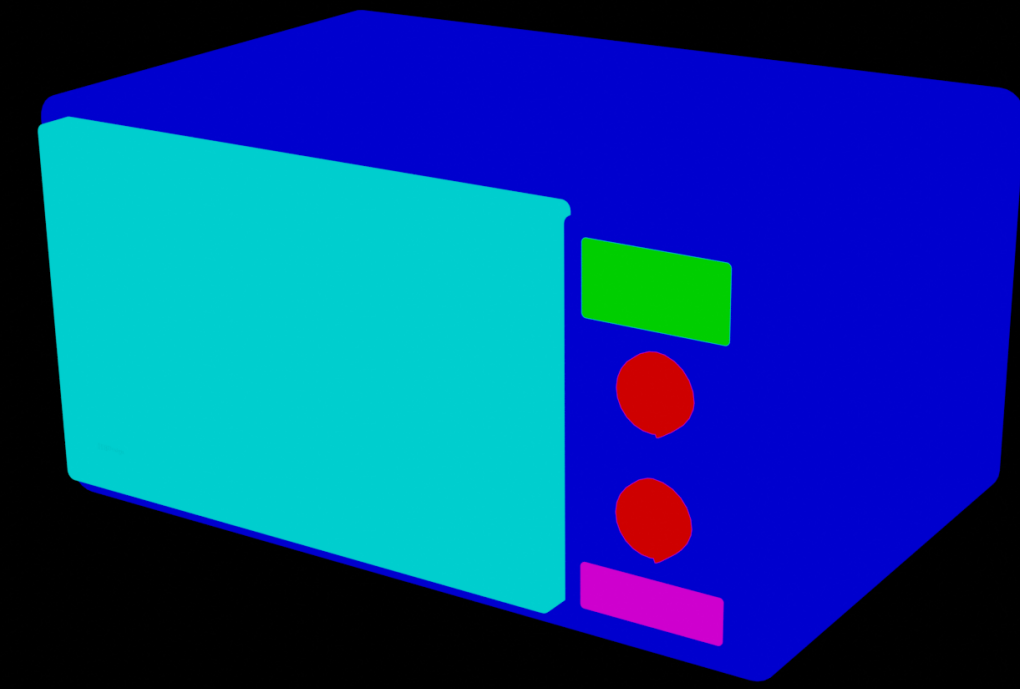
A SimulAted Part-based Interactive ENvironment

Fanbo Xiang¹ Yuzhe Qin¹ Kaichun Mo² Yikuan Xia¹ Hao Zhu¹
Fangchen Liu¹ Minghua Liu¹ Hanxiao Jiang³ Yifu Yuan⁵ He Wang² Li Yi⁴
Angel X. Chang³ Leonidas J. Guibas² Hao Su¹

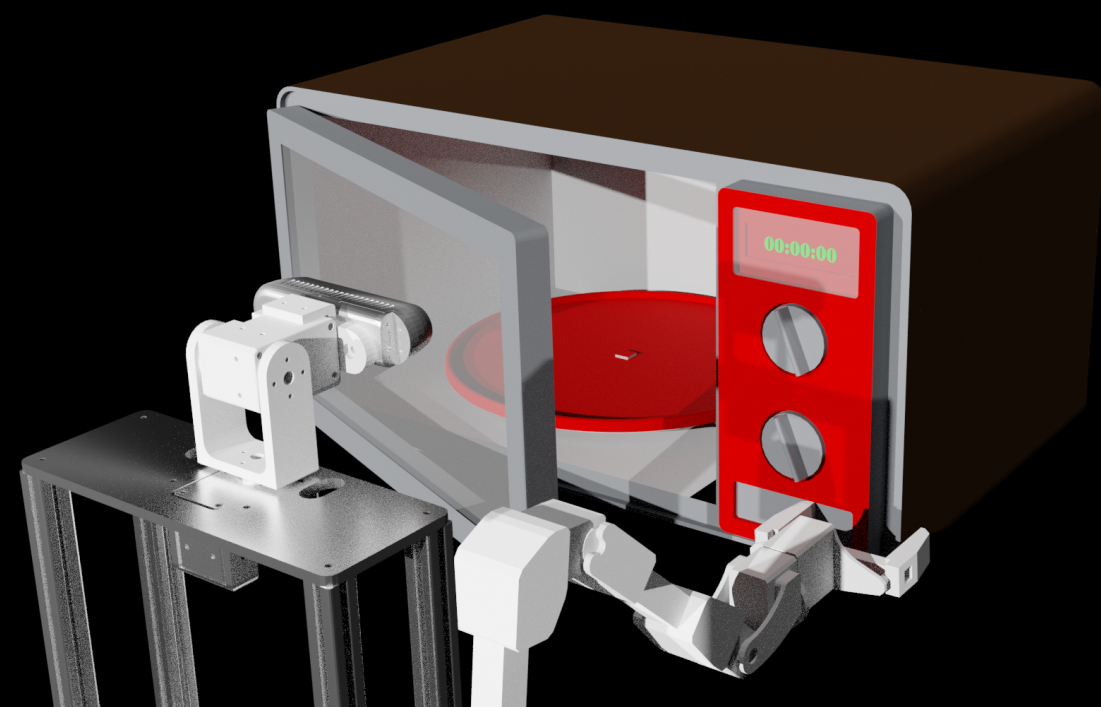
¹UC San Diego ²Stanford University ³Simon Fraser University ⁴Google Research ⁵UC Los Angeles



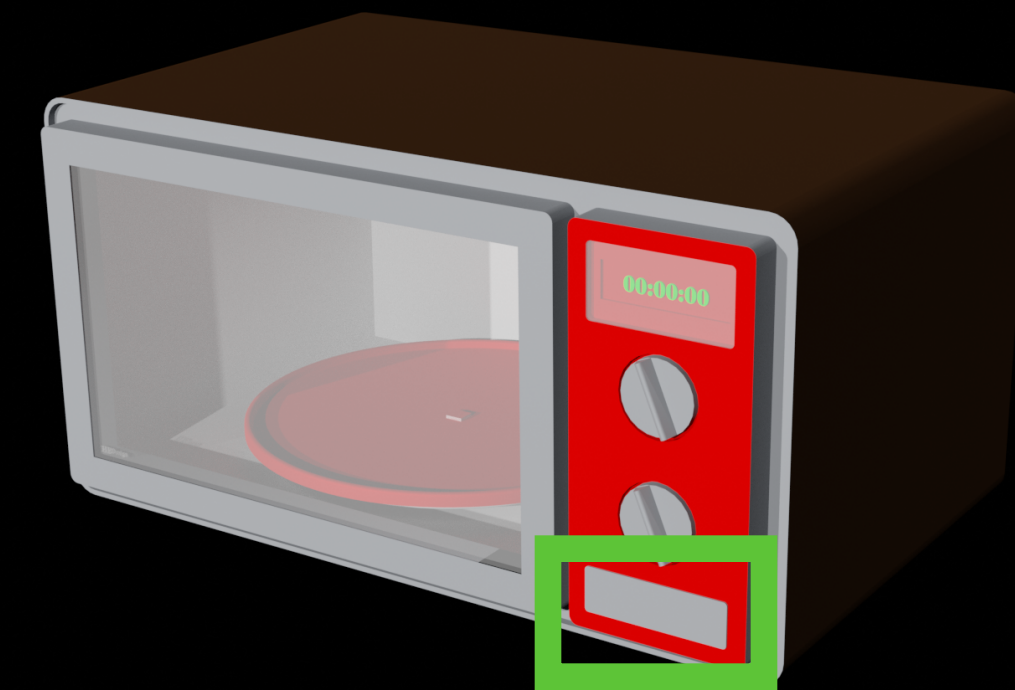
Perceive information

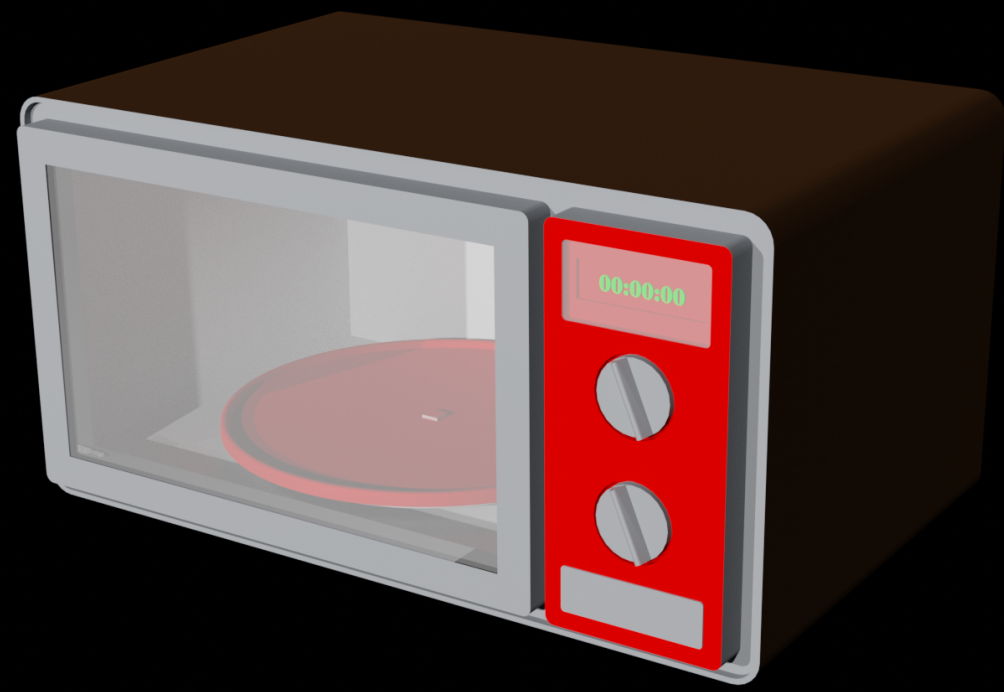


Intelligent Agent

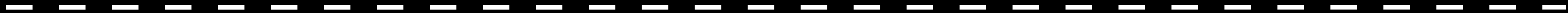
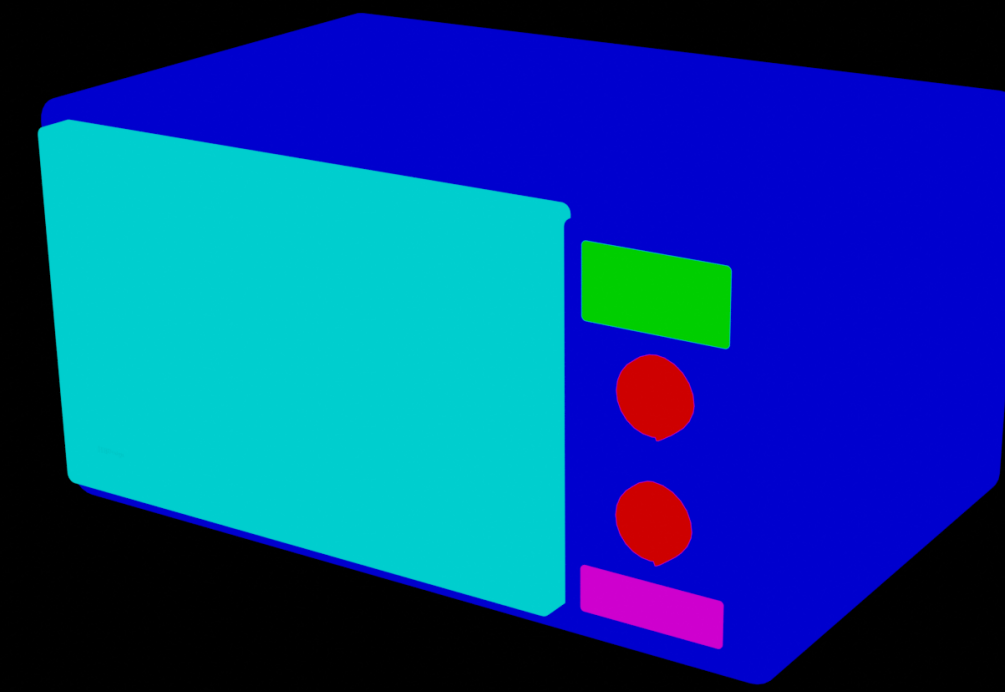


Adapt behavior



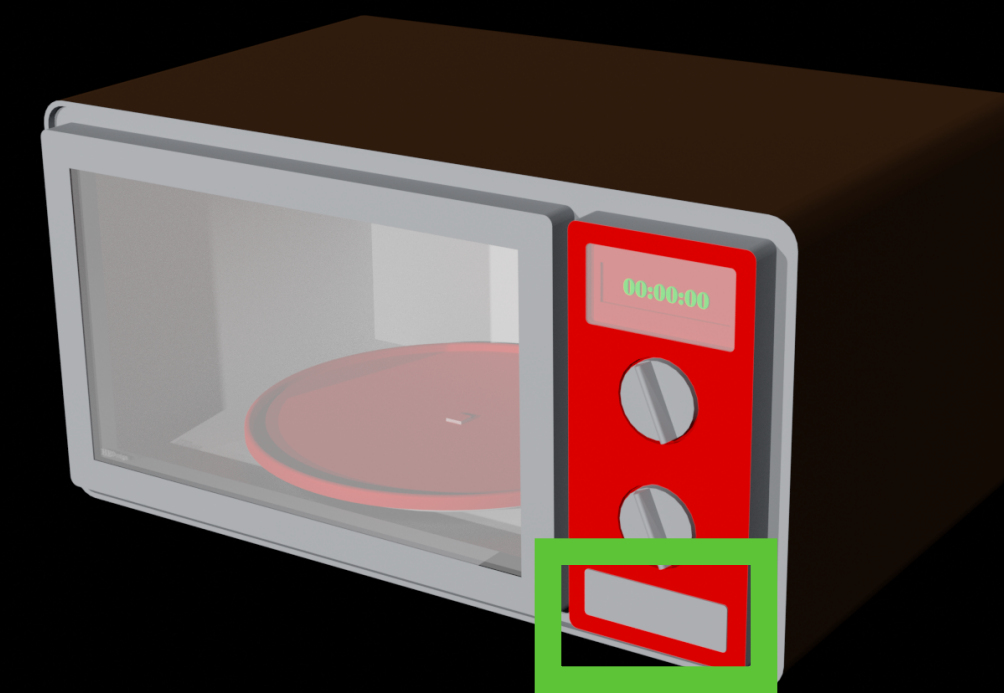
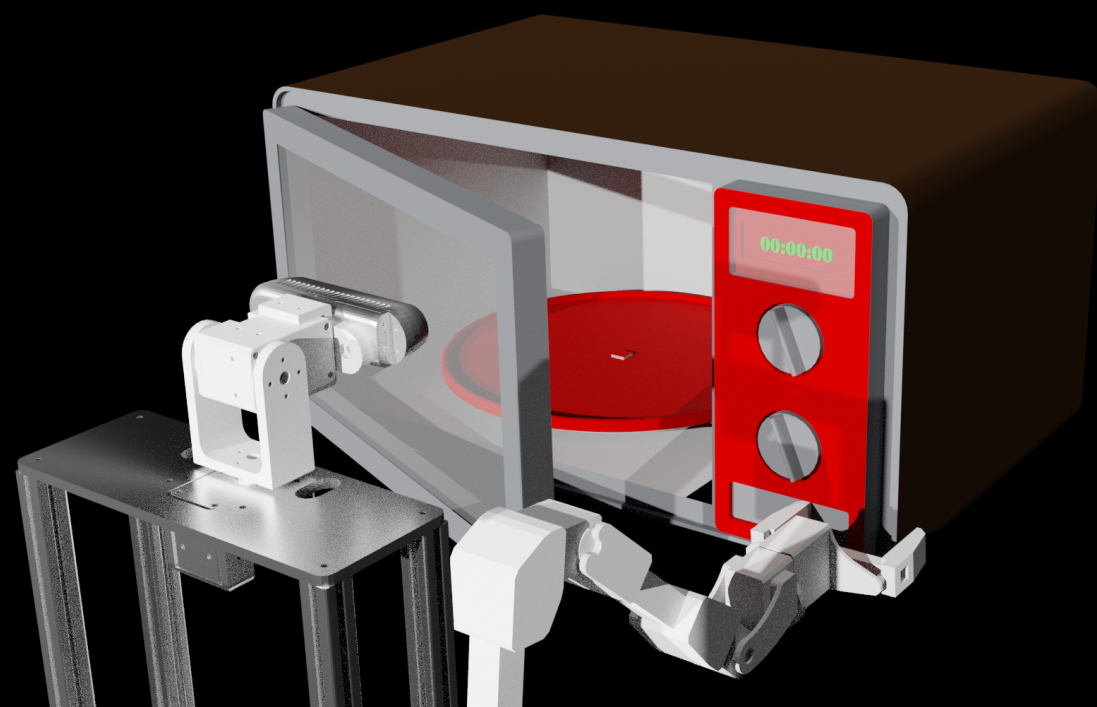


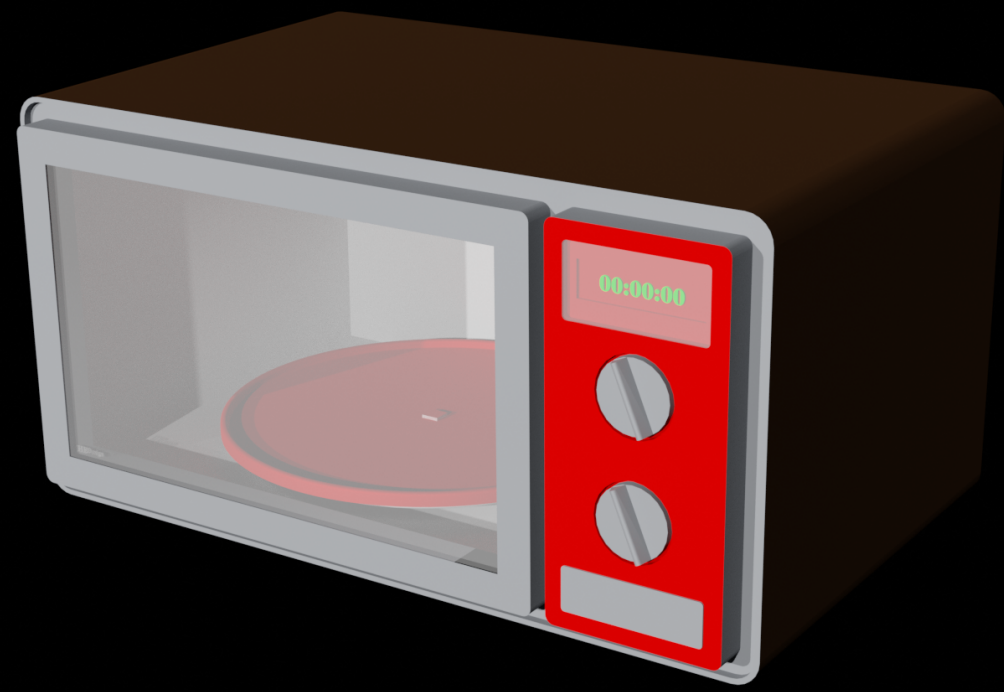
Perceive information
Computer vision



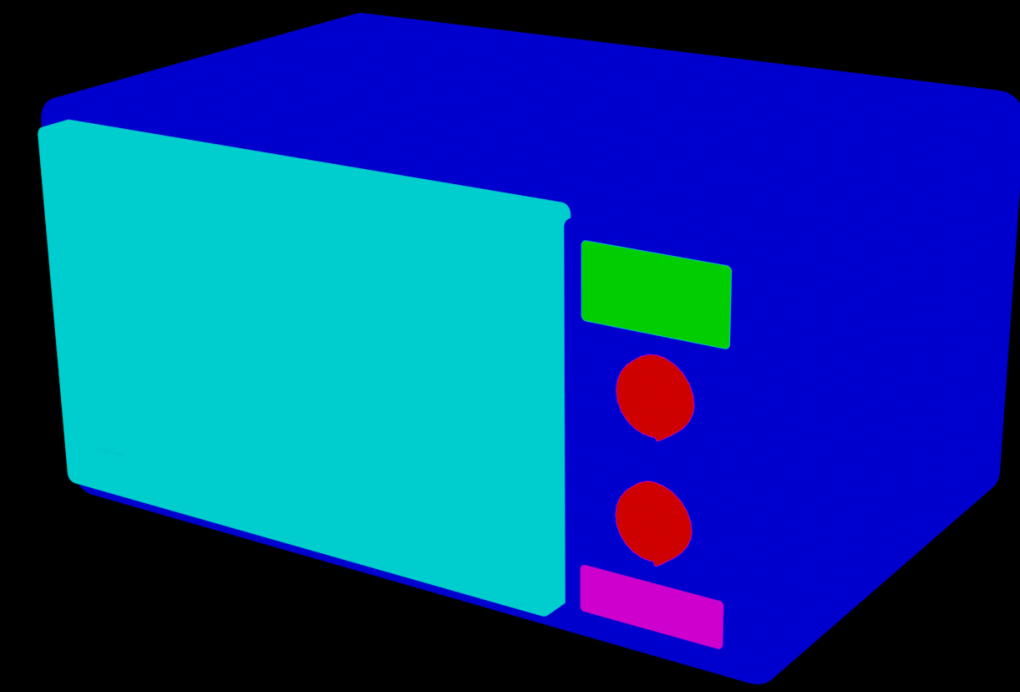
Robotics control

Adapt behavior

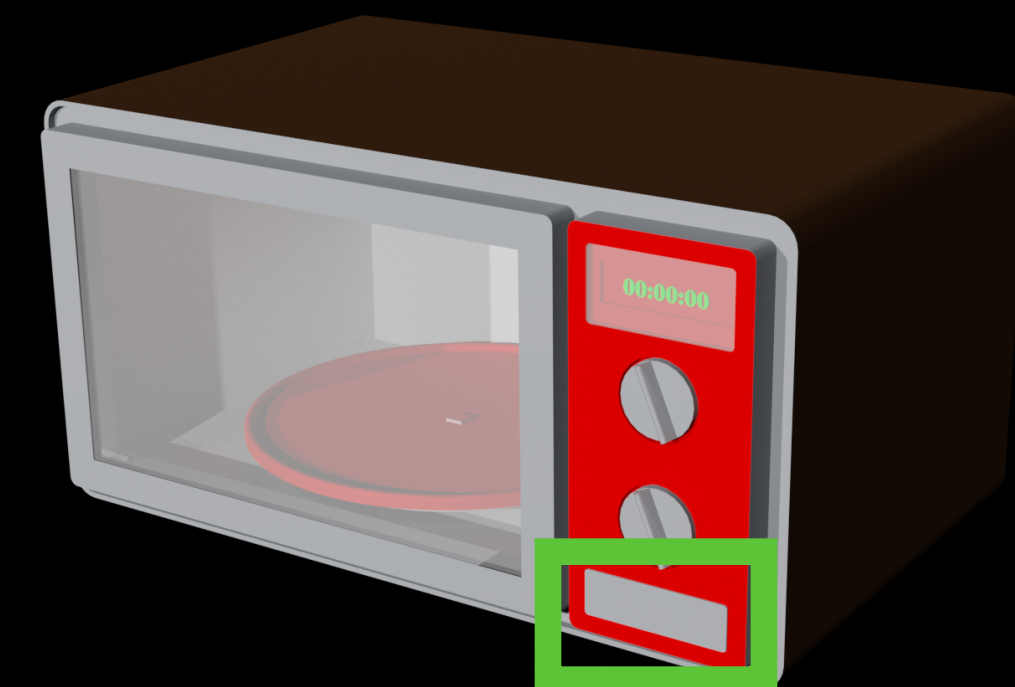




Perceive information
Computer vision

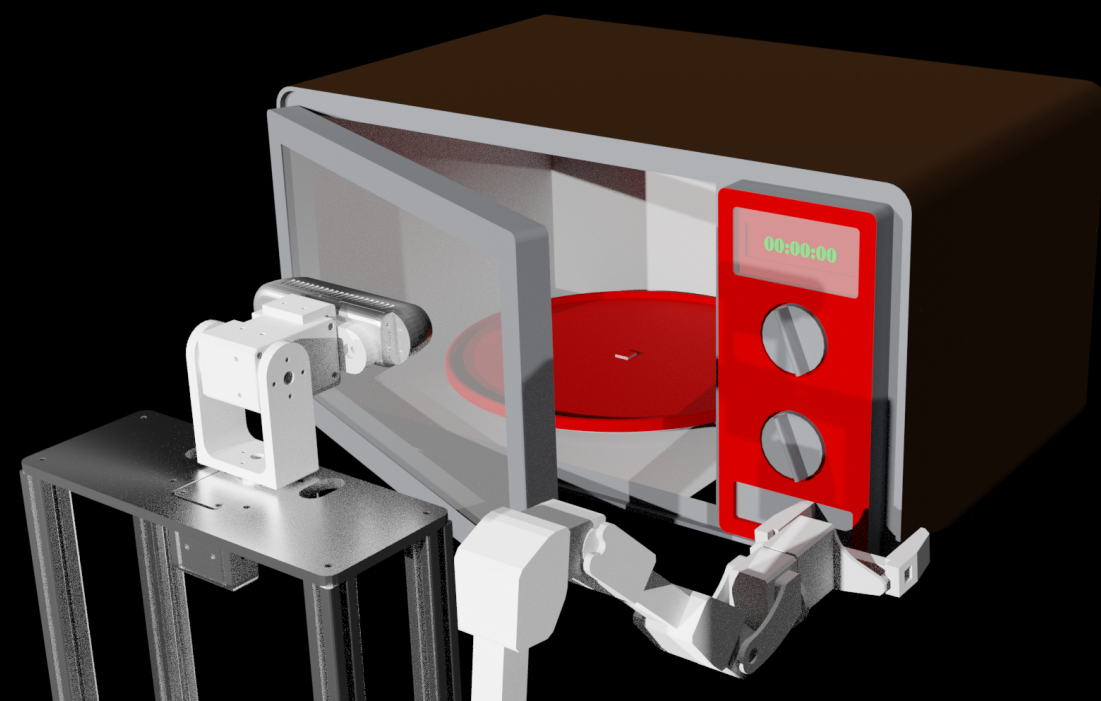
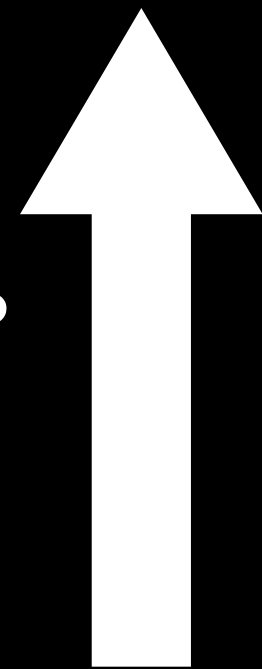


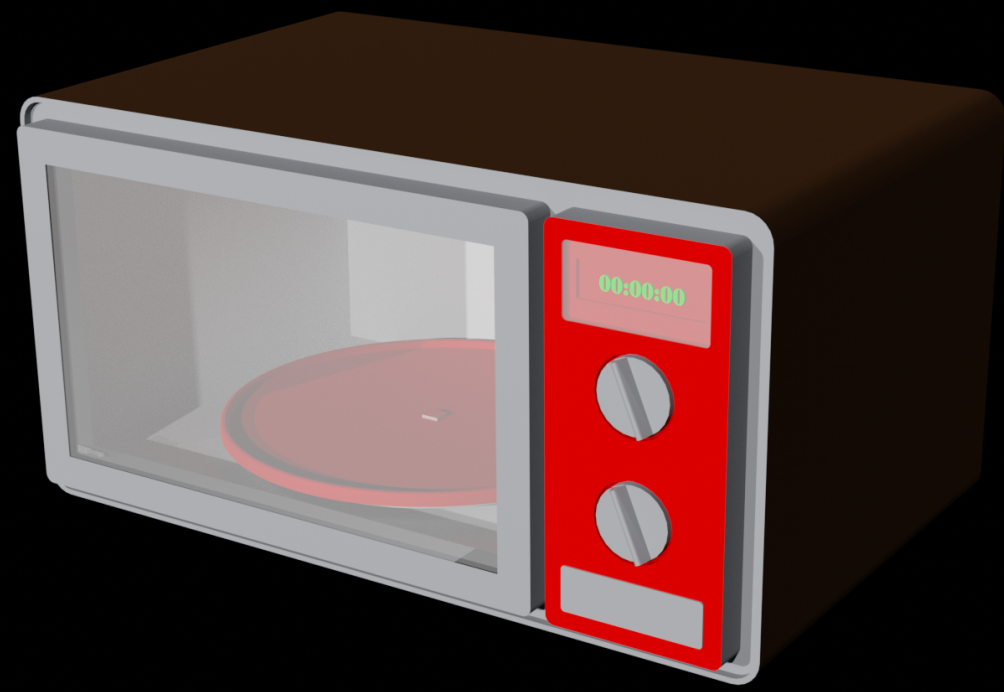
Planning?



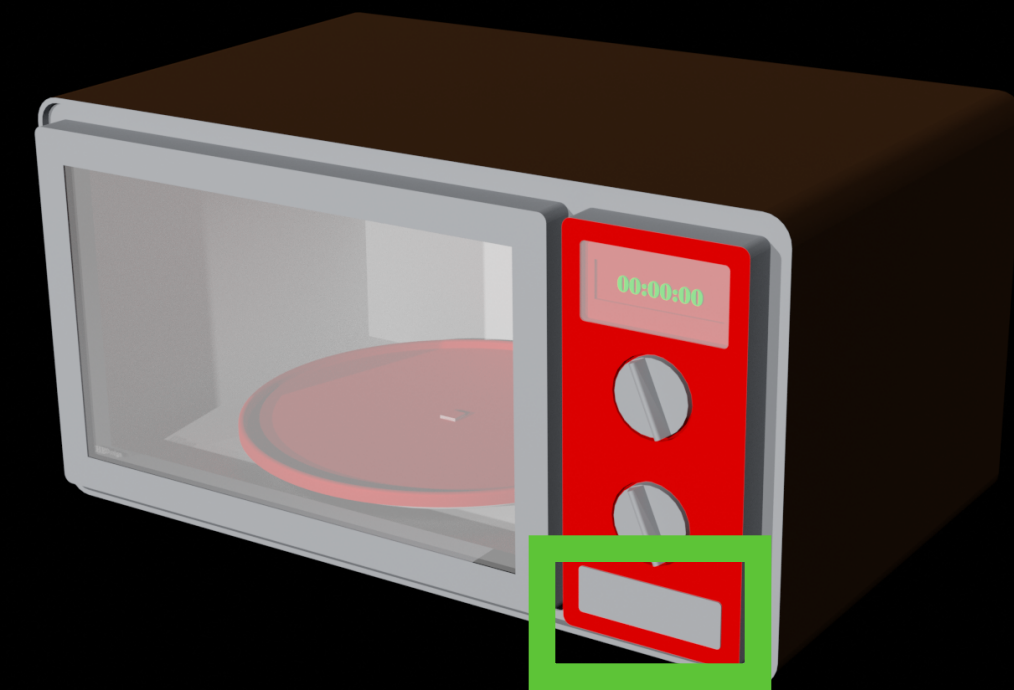
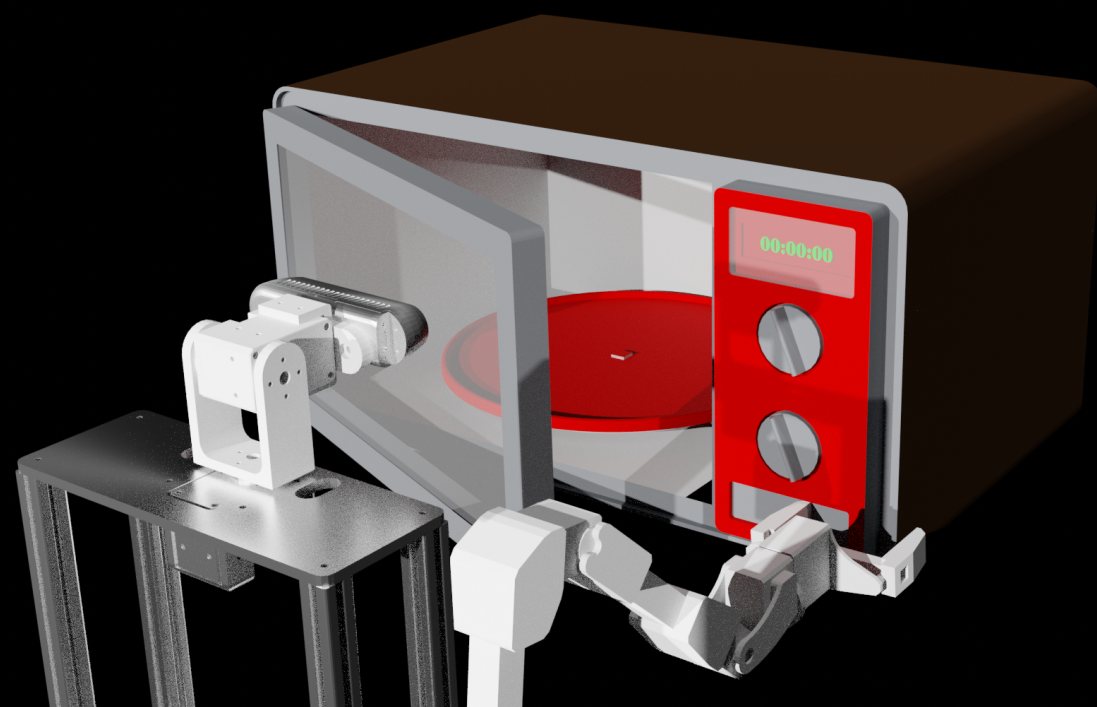
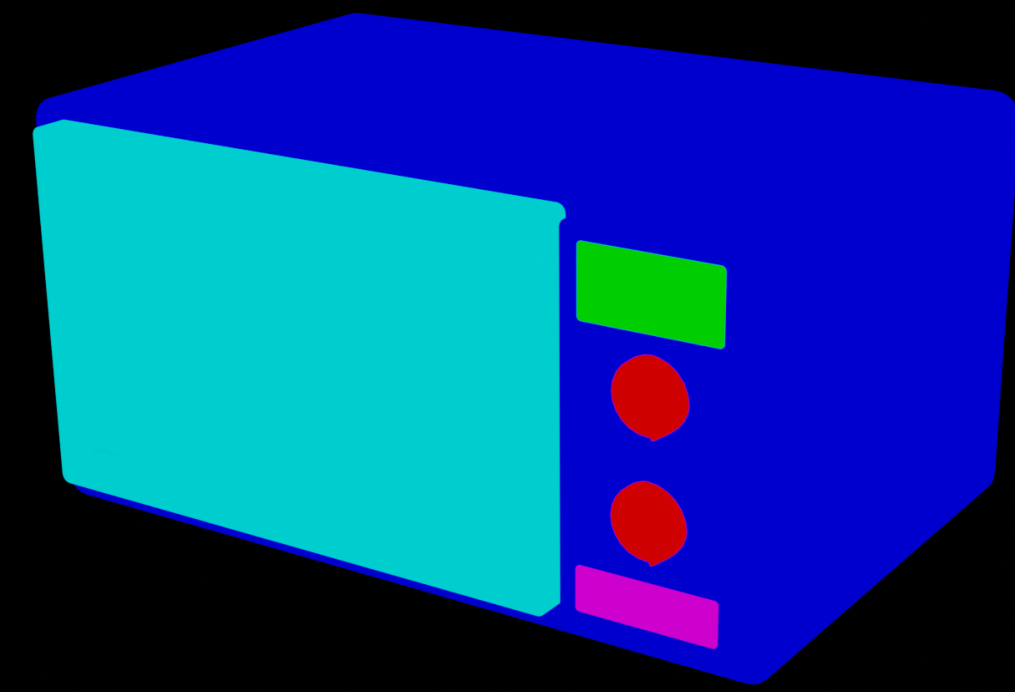
Robotics control
Adapt behavior

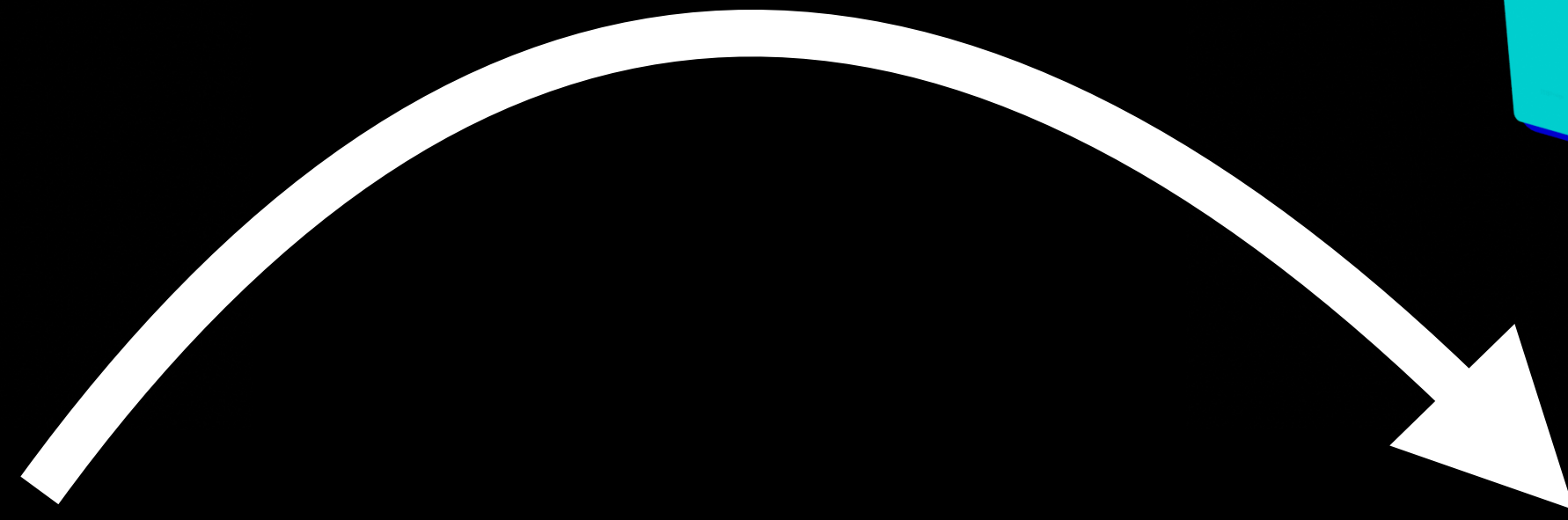
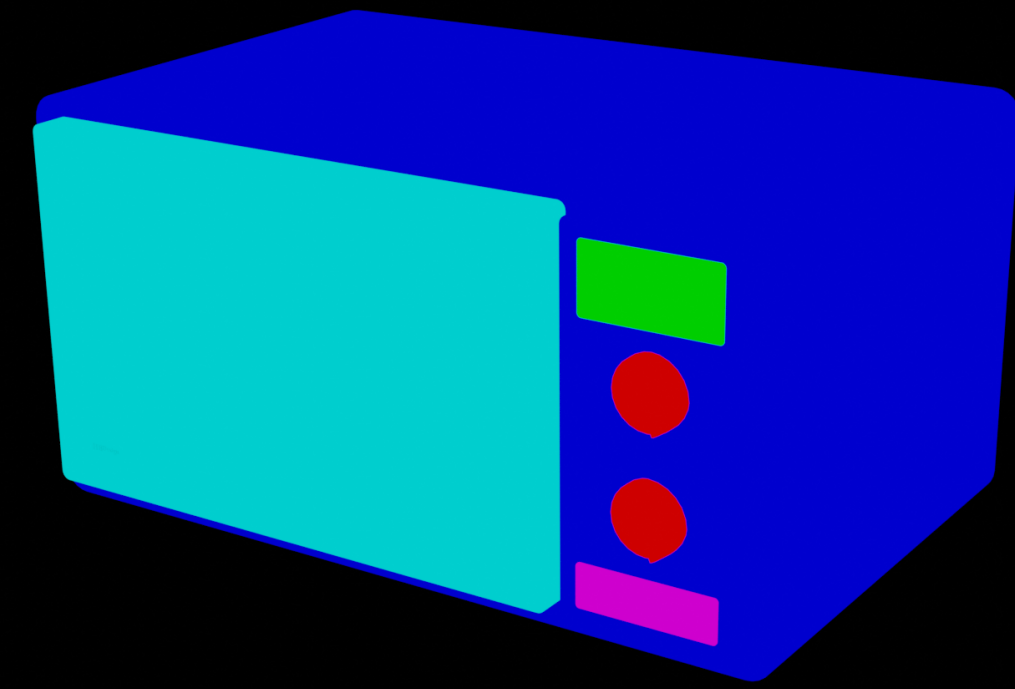
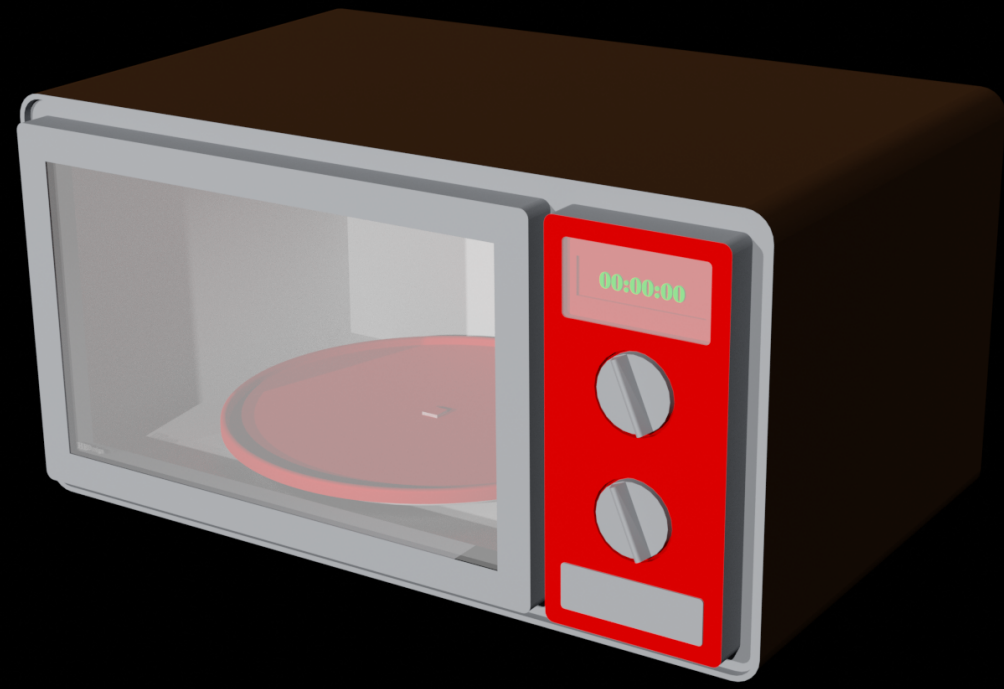
Active perception?



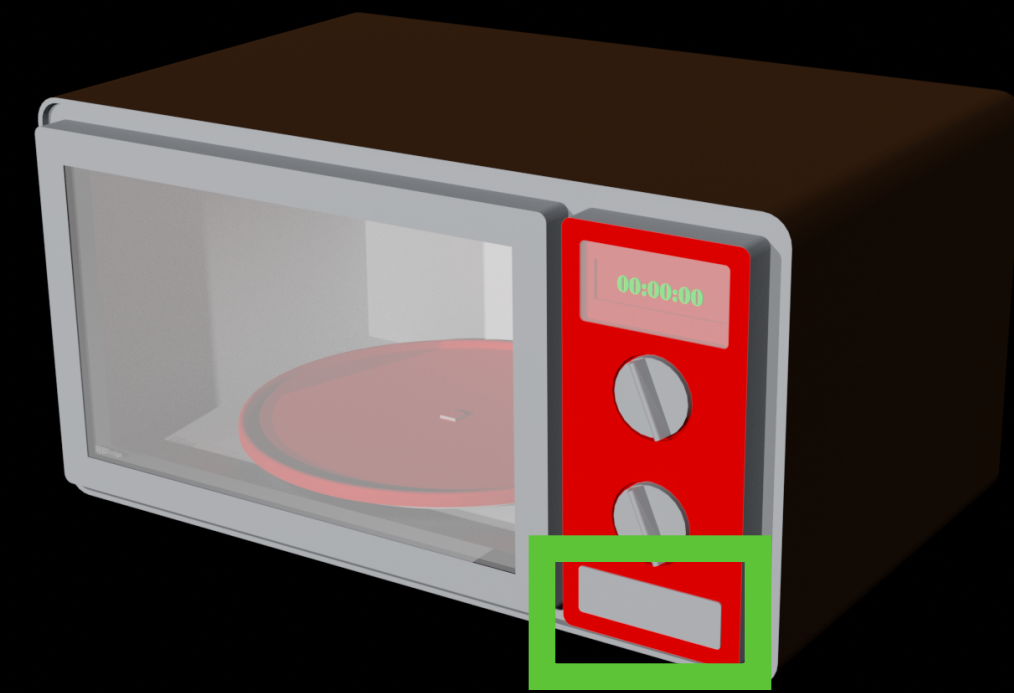
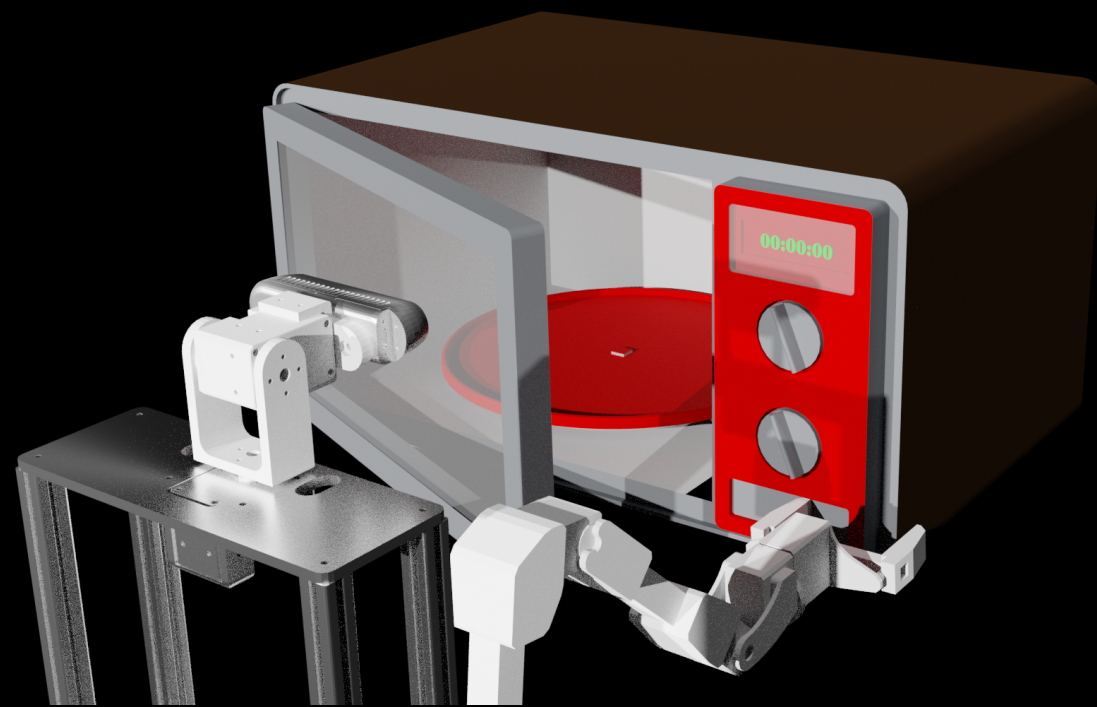


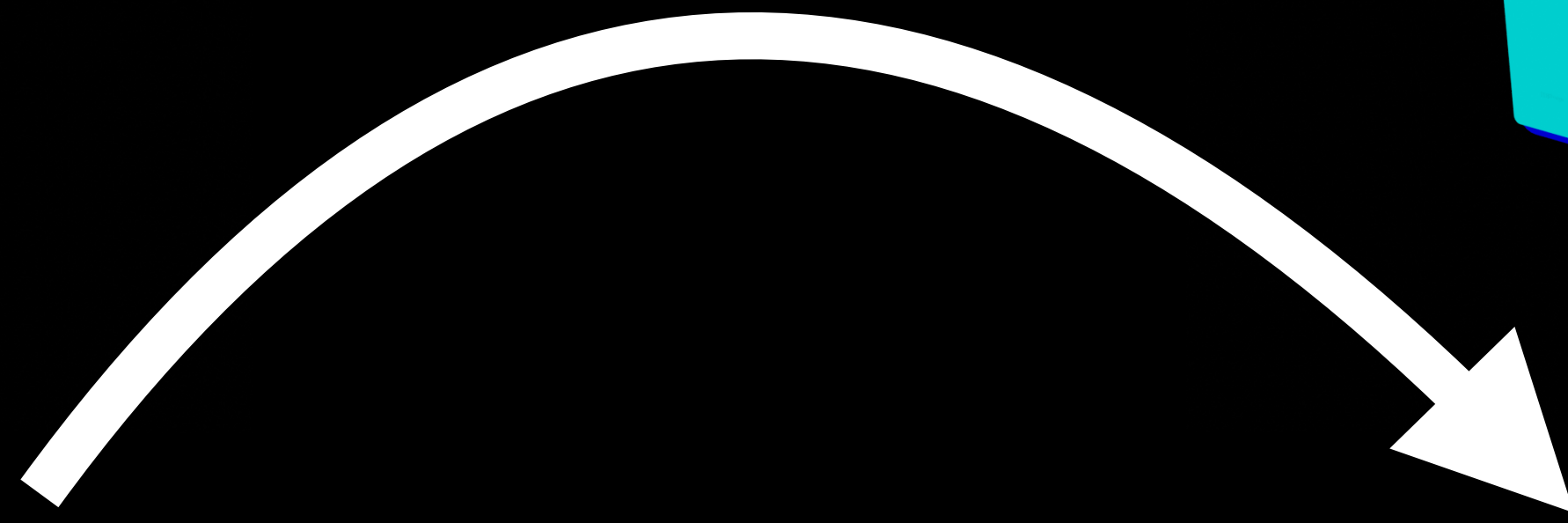
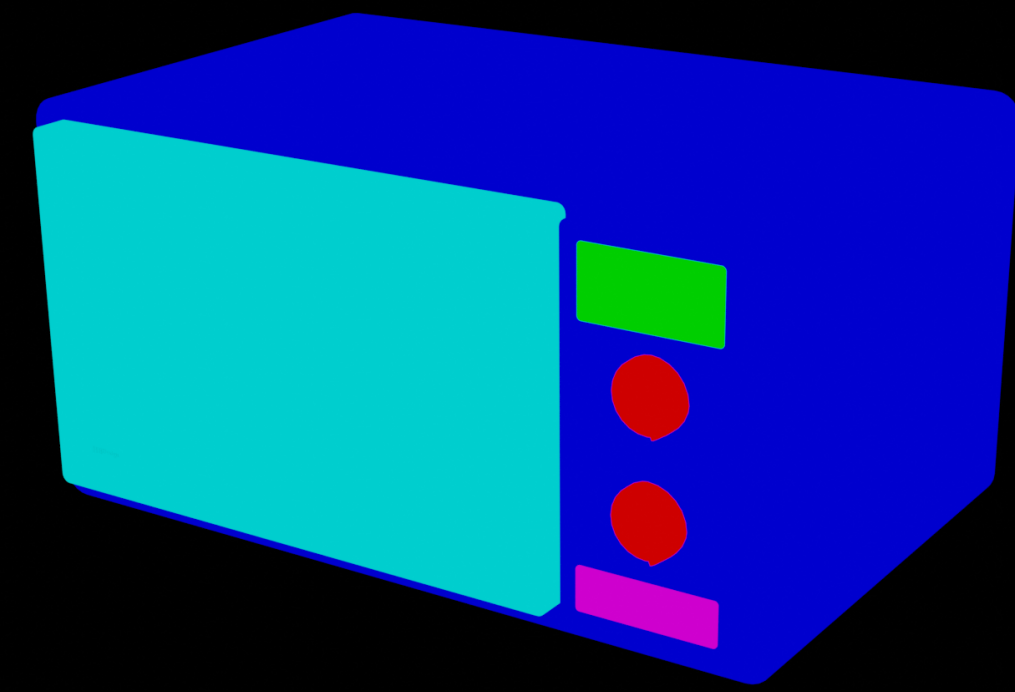
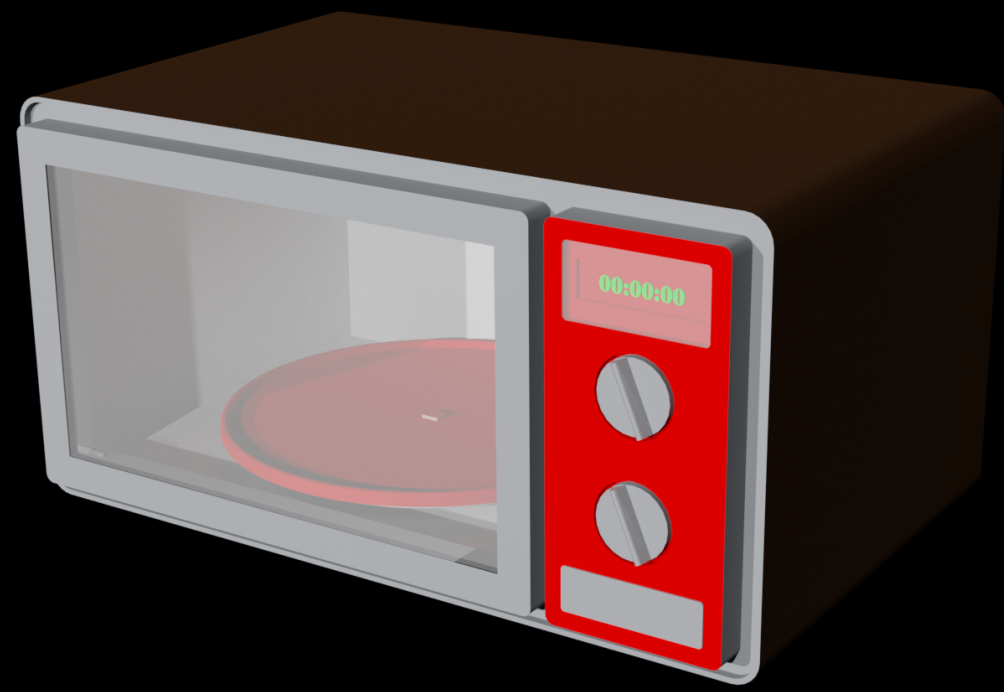
Data driven approaches



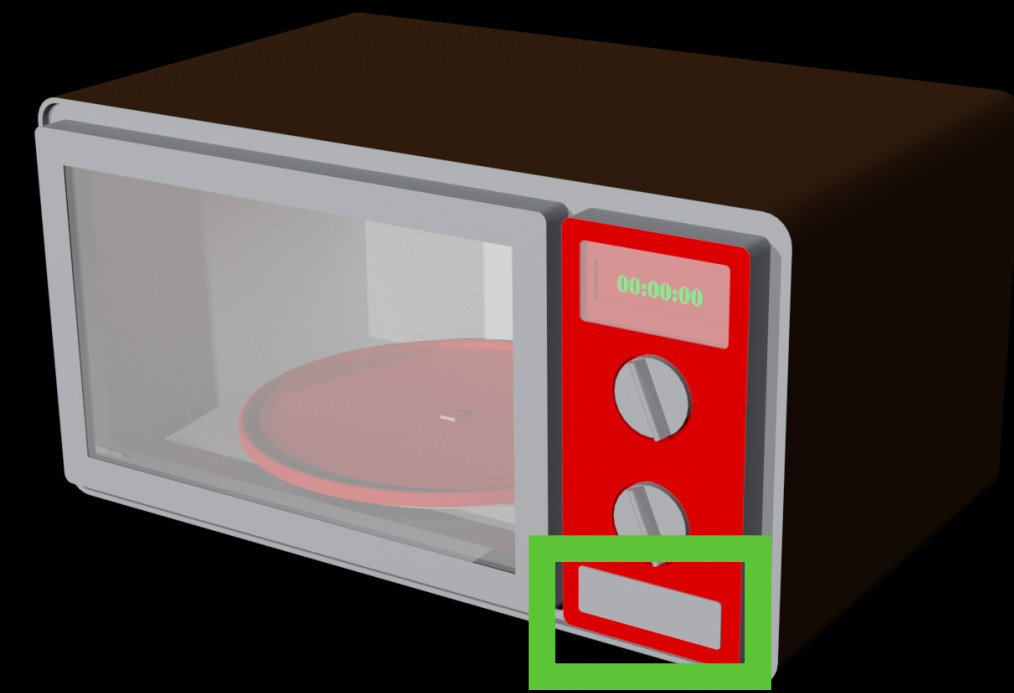
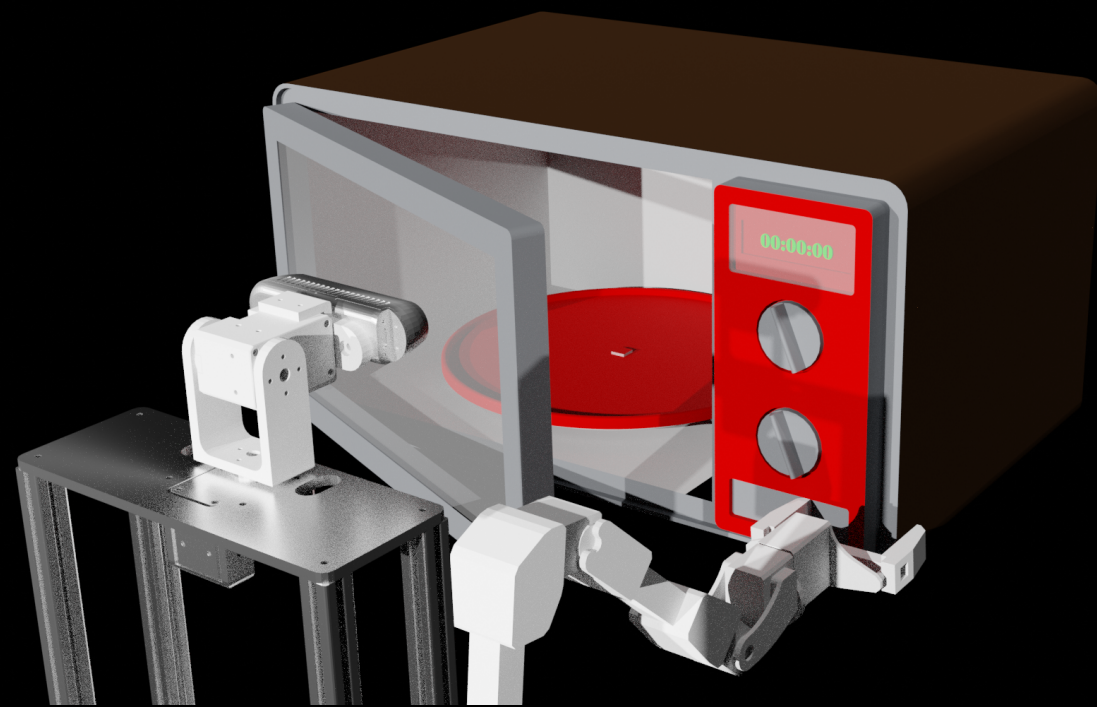


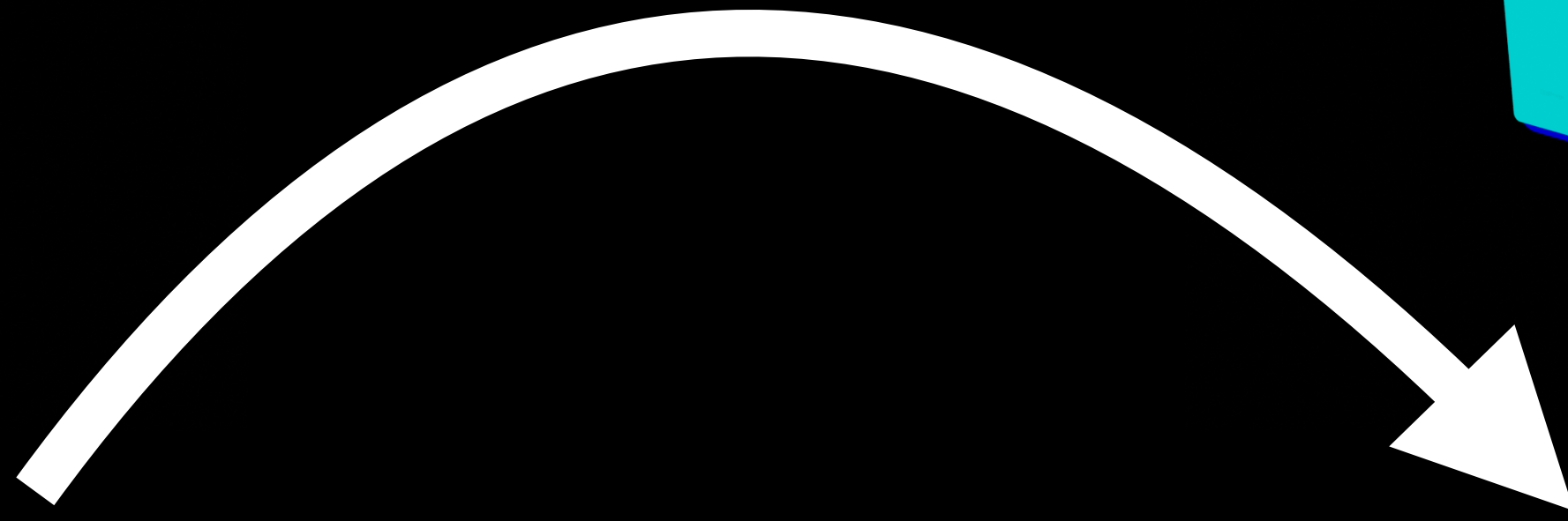
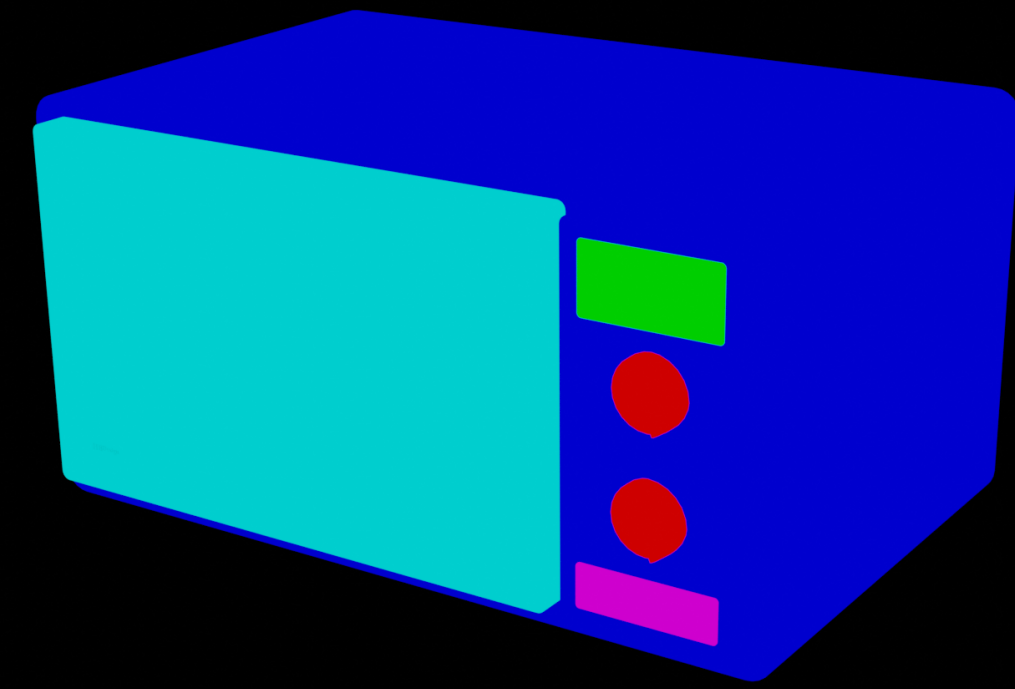
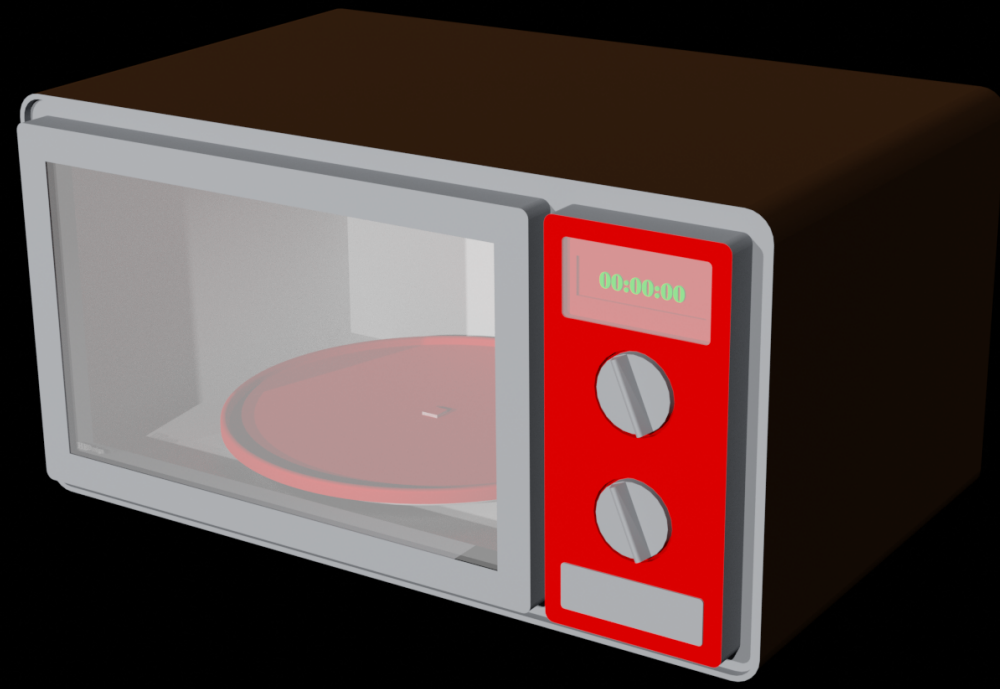
Learn from data?



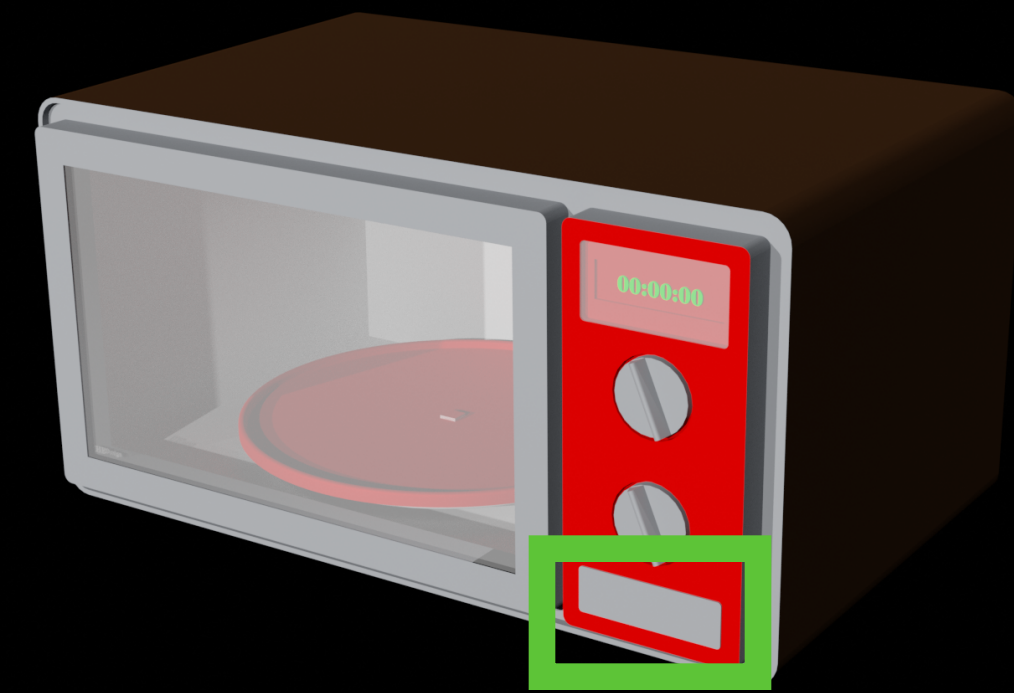
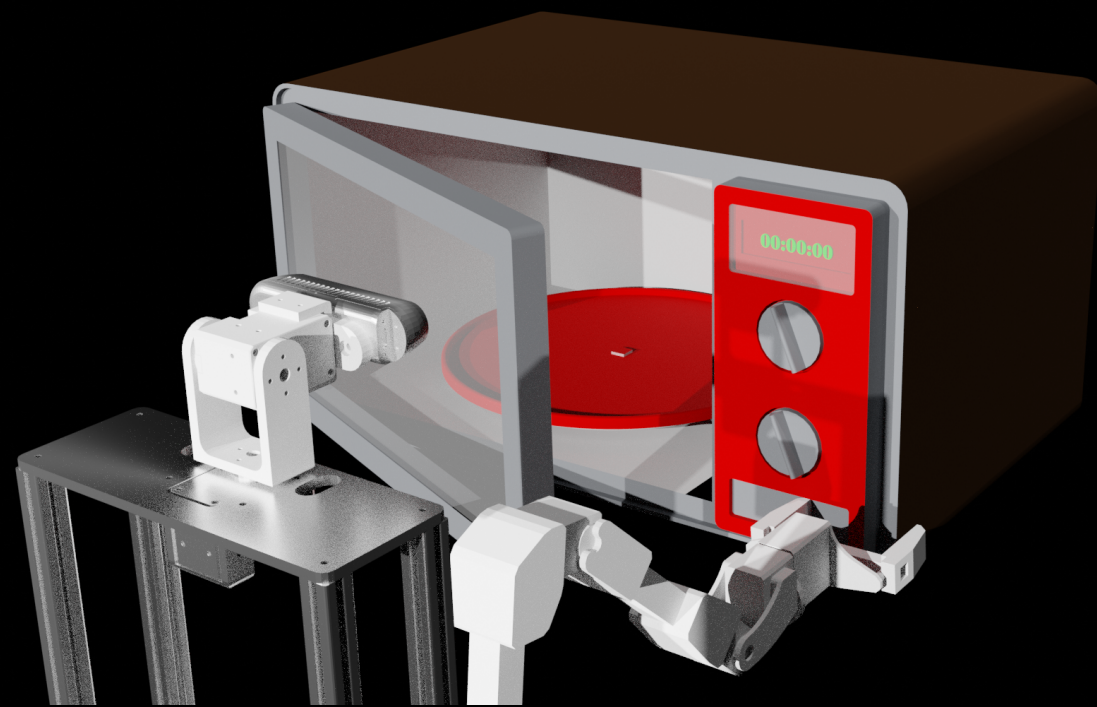


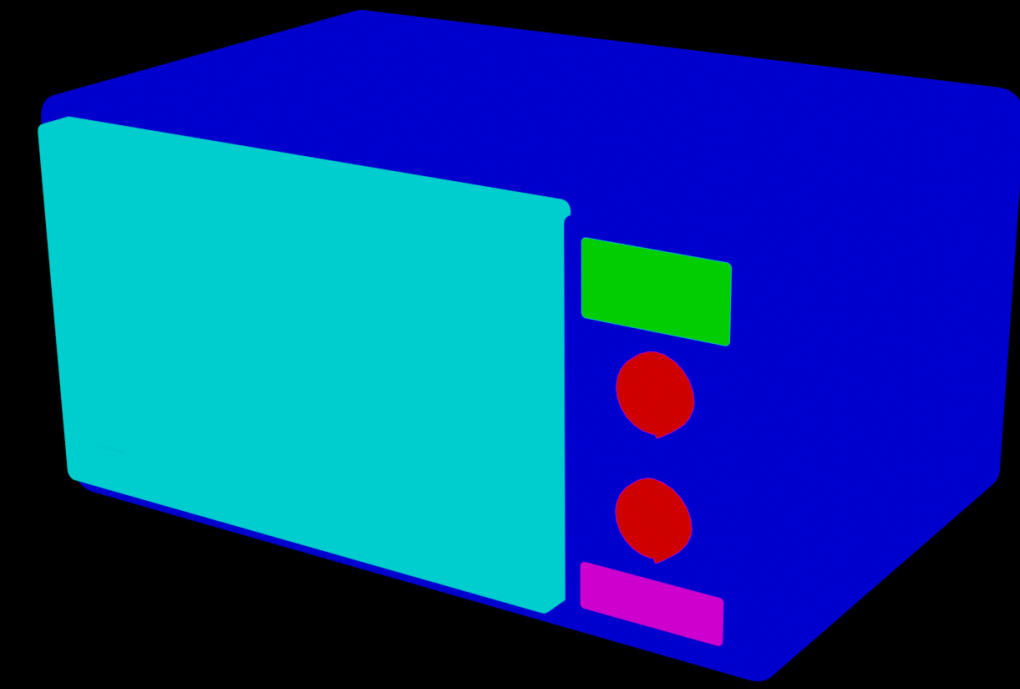
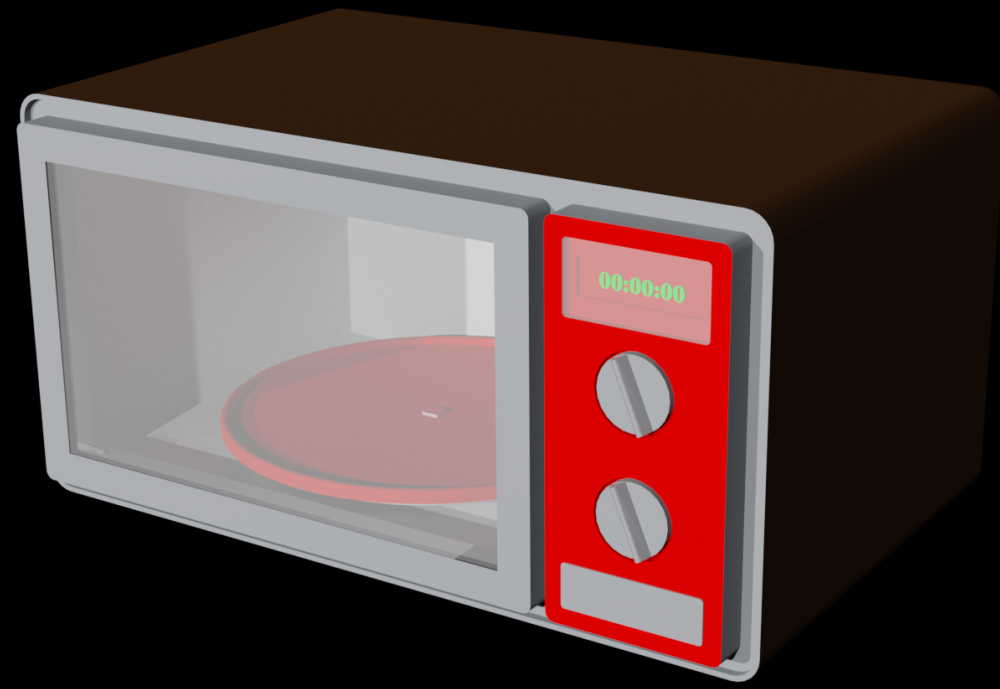
Real-world data collection





**Reinforcement Learning?
Manual data collection?**



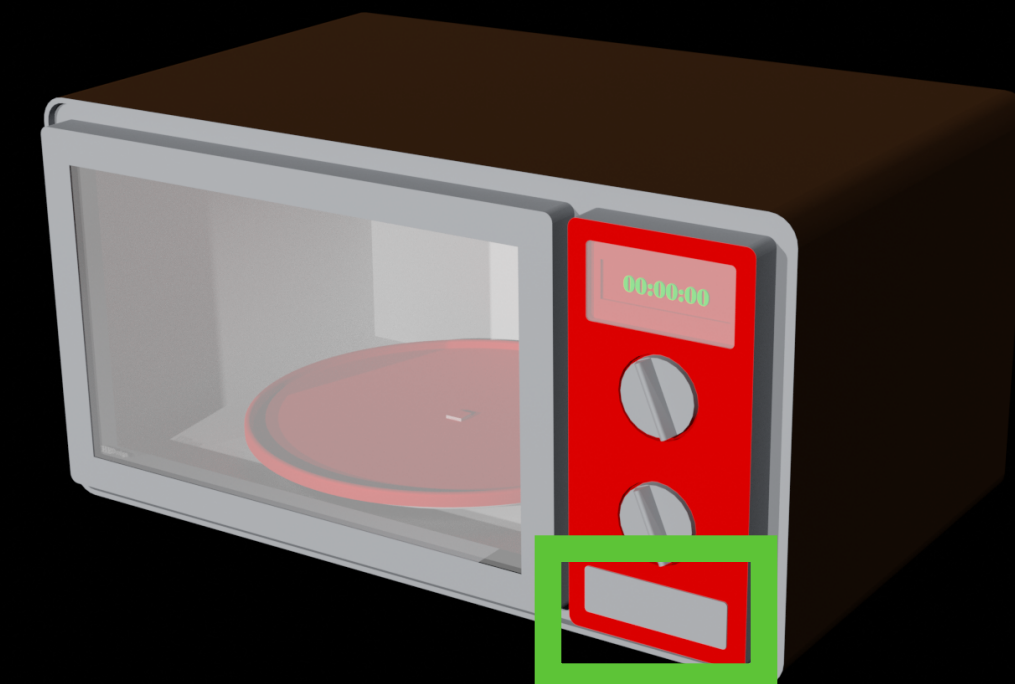
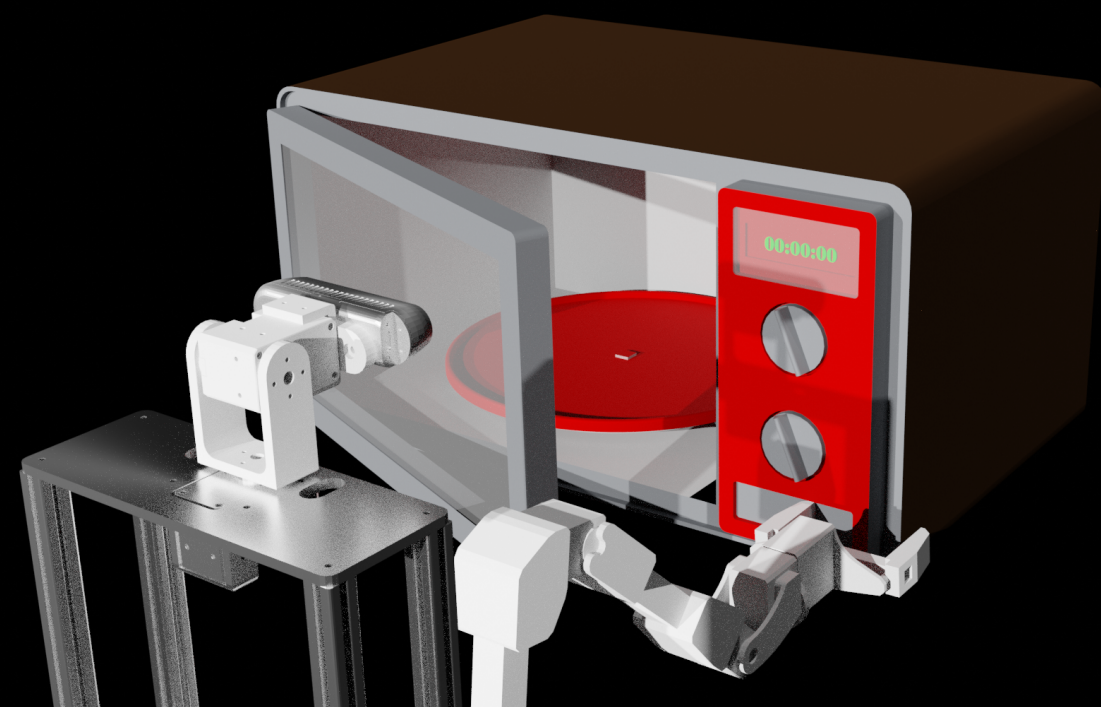


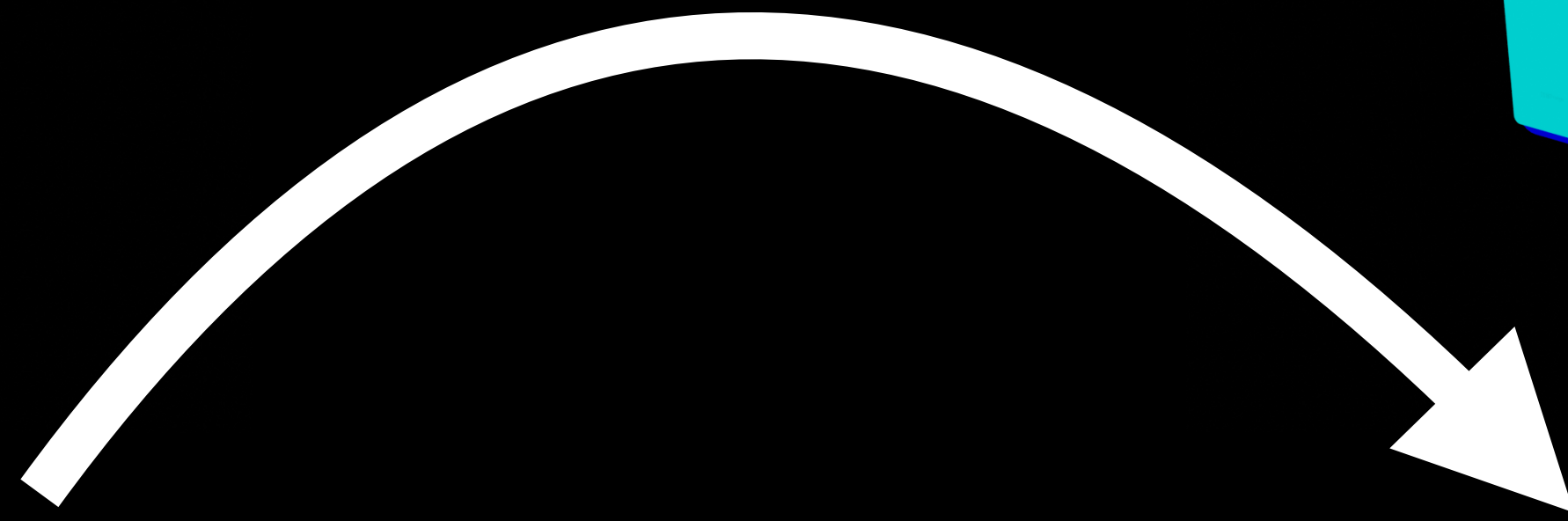
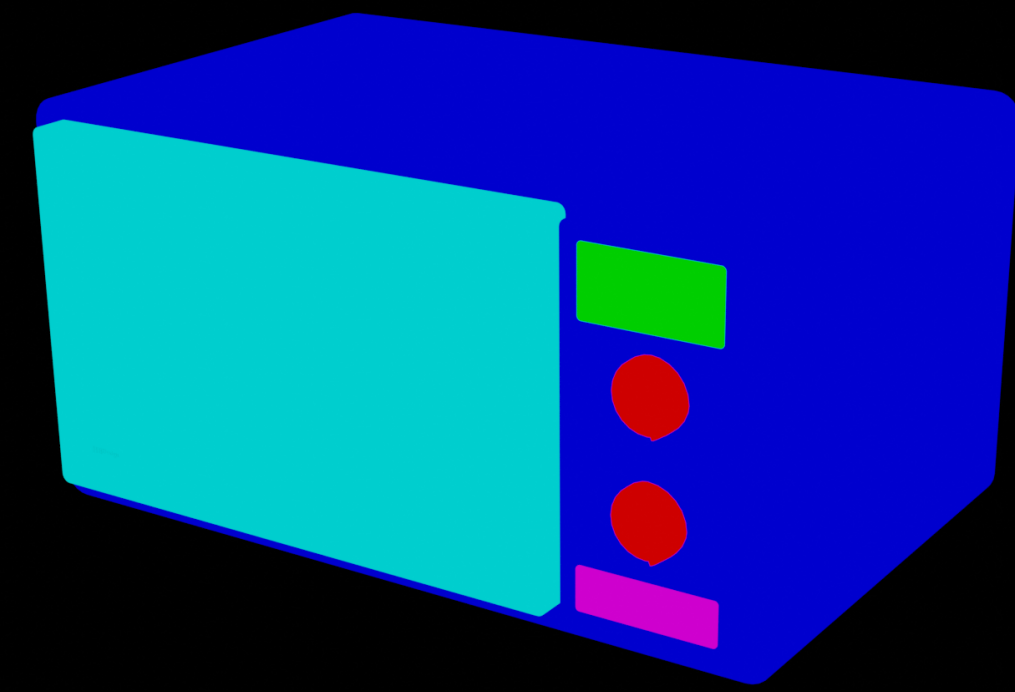
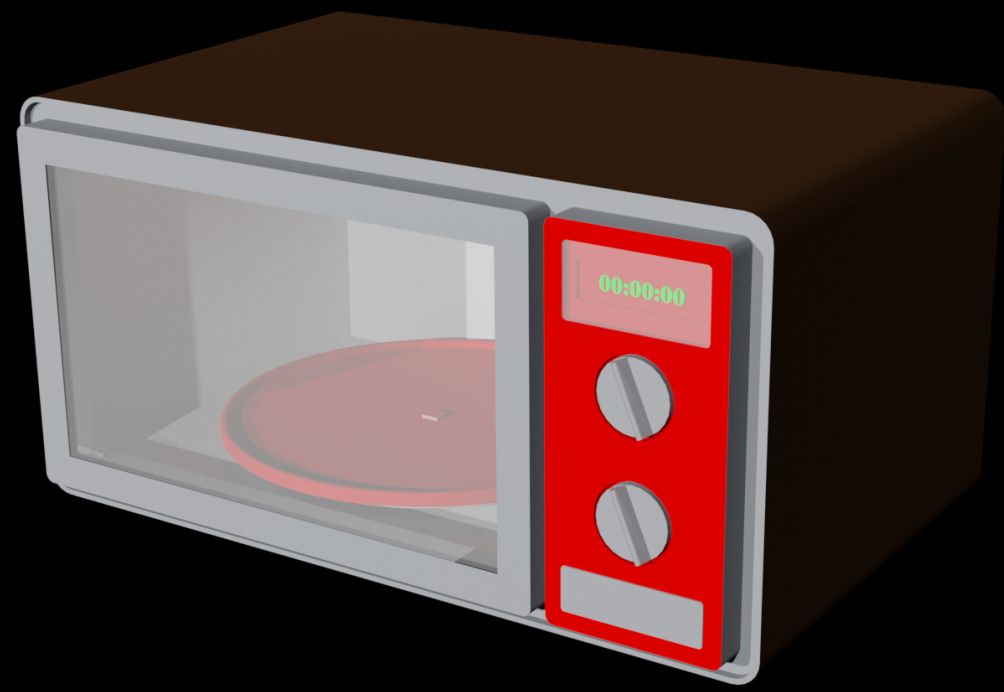
Reinforcement learning?

1. Expensive hardware
2. Slow data collection
3. Low sample efficiency
4. Overfit to specific agent

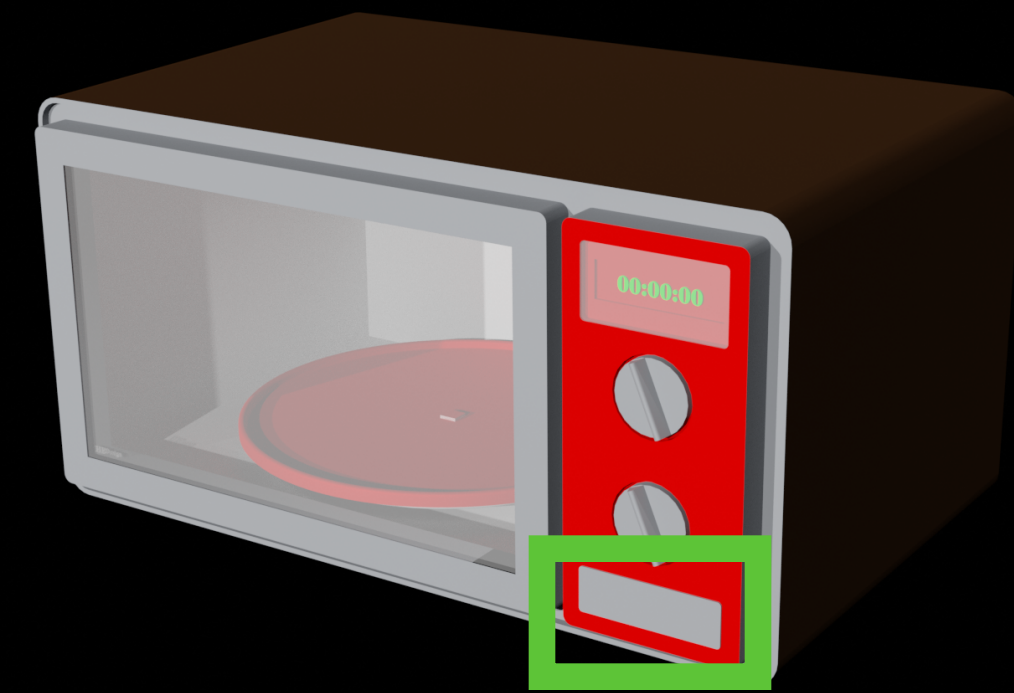
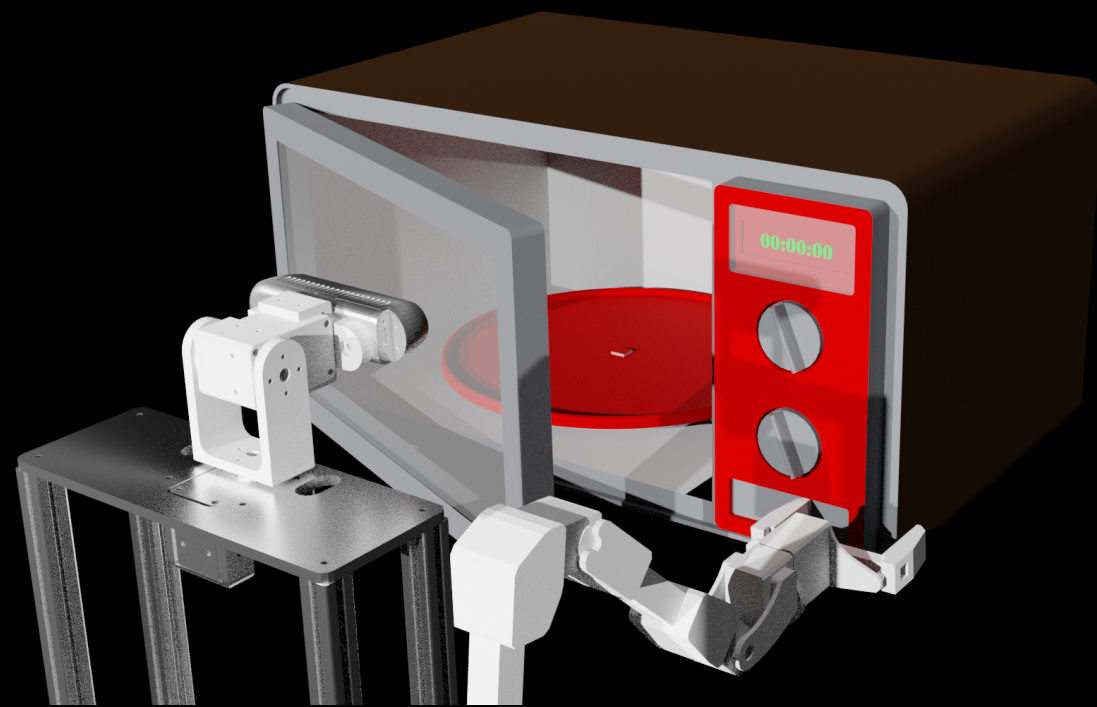
Manual data collection?

1. Unintuitive control
2. May not be optimal
3. Expertise

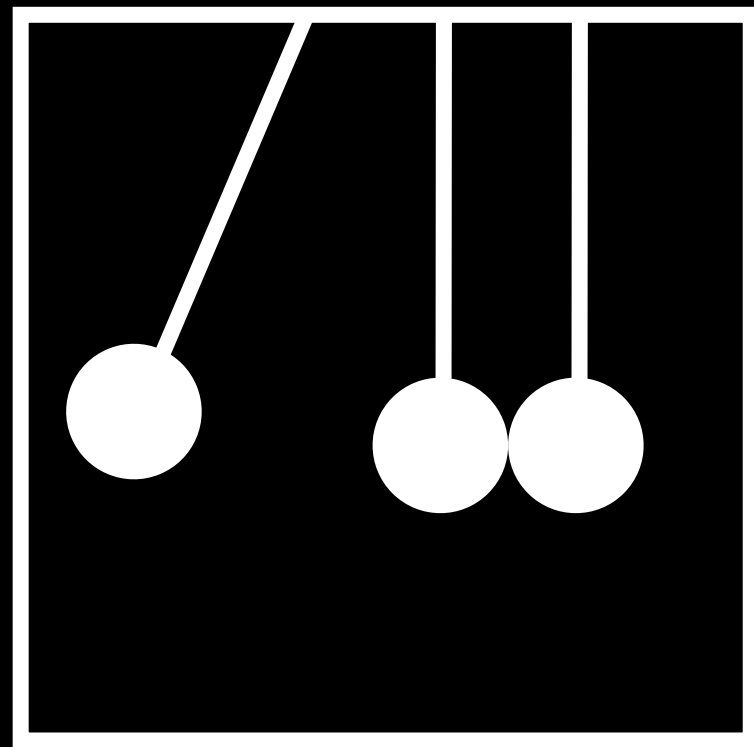




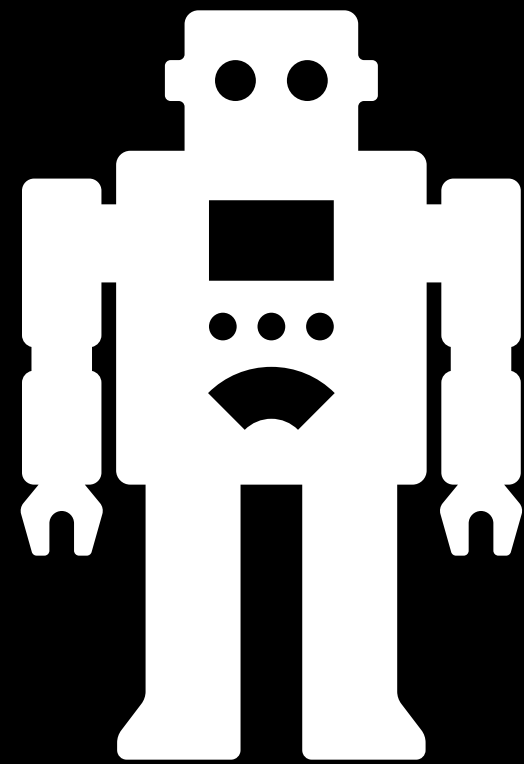
Simulated Environment



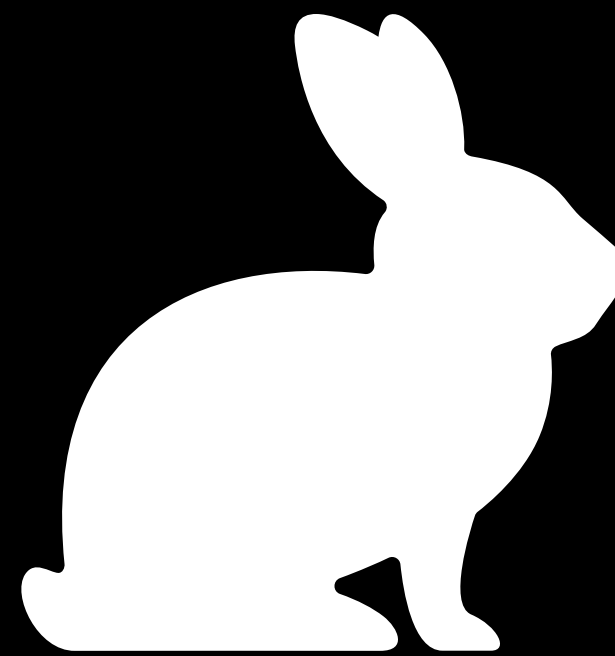
Simulated Environment



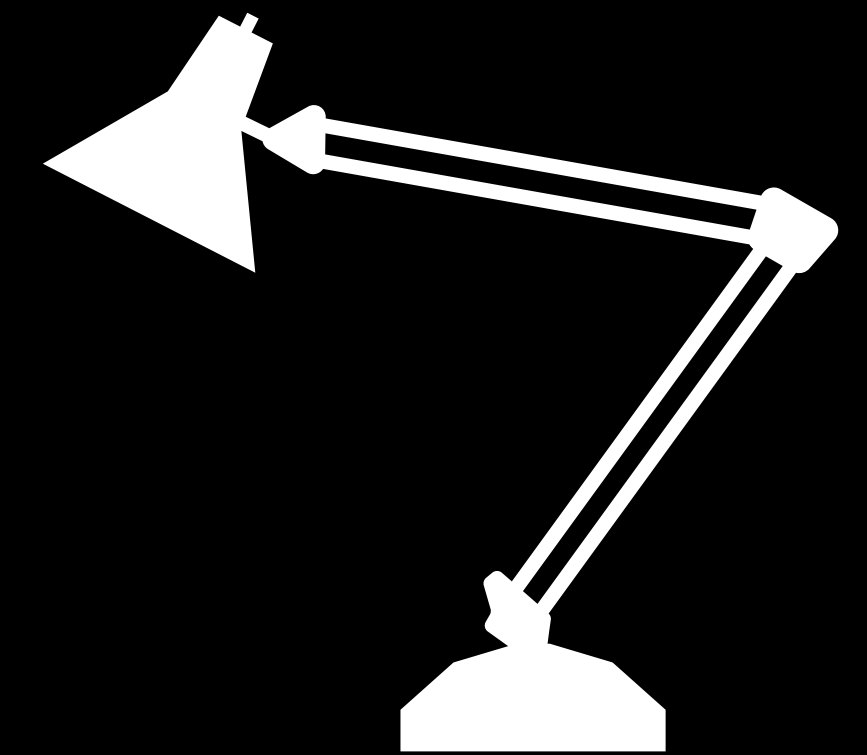
Physics



Robotics

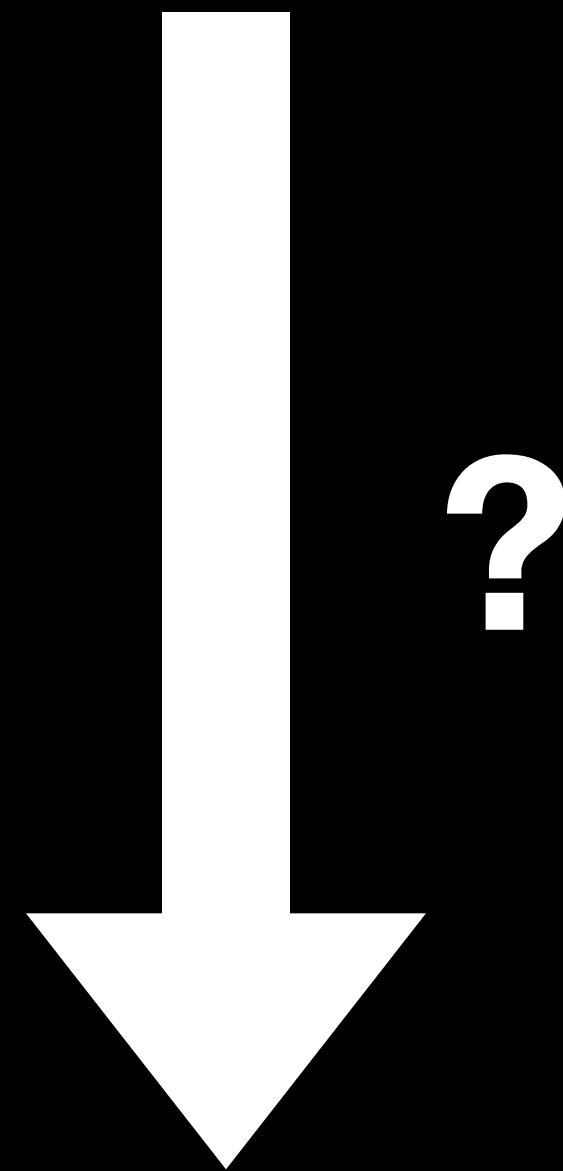


Rendering



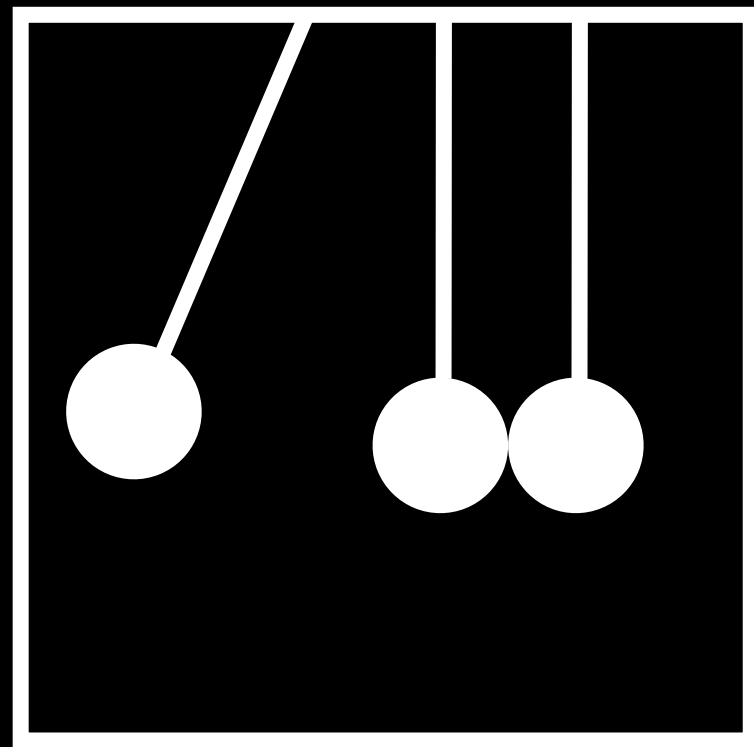
Simulation Content

Simulated Environment

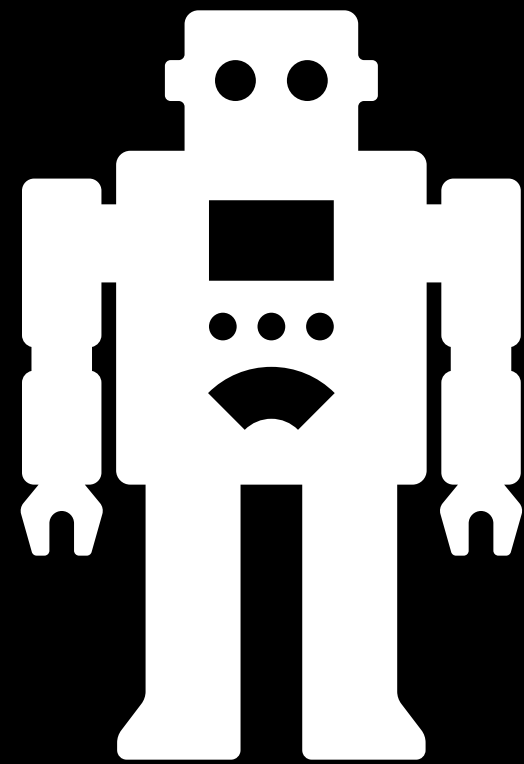


Real World

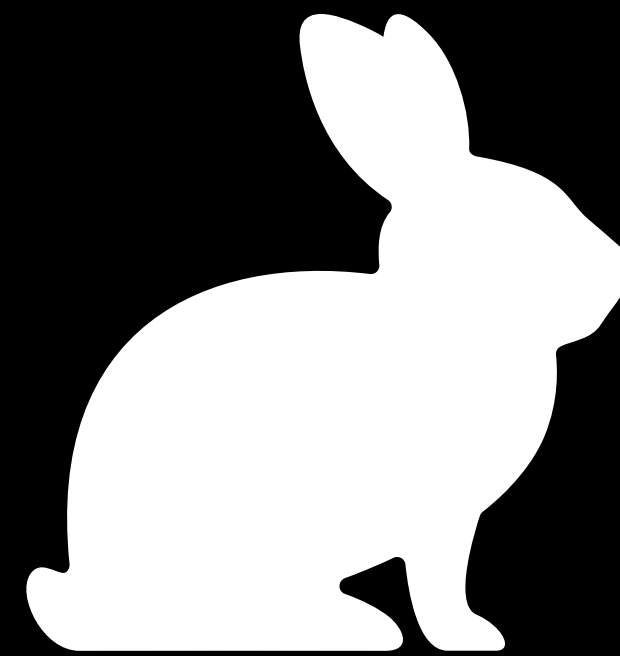
Simulated Environment



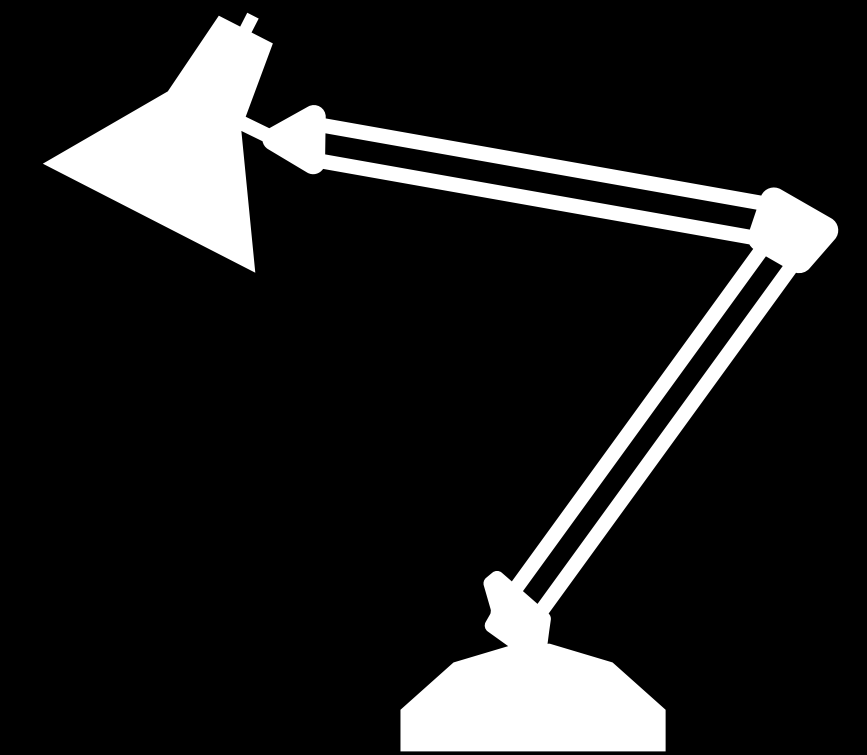
Physics



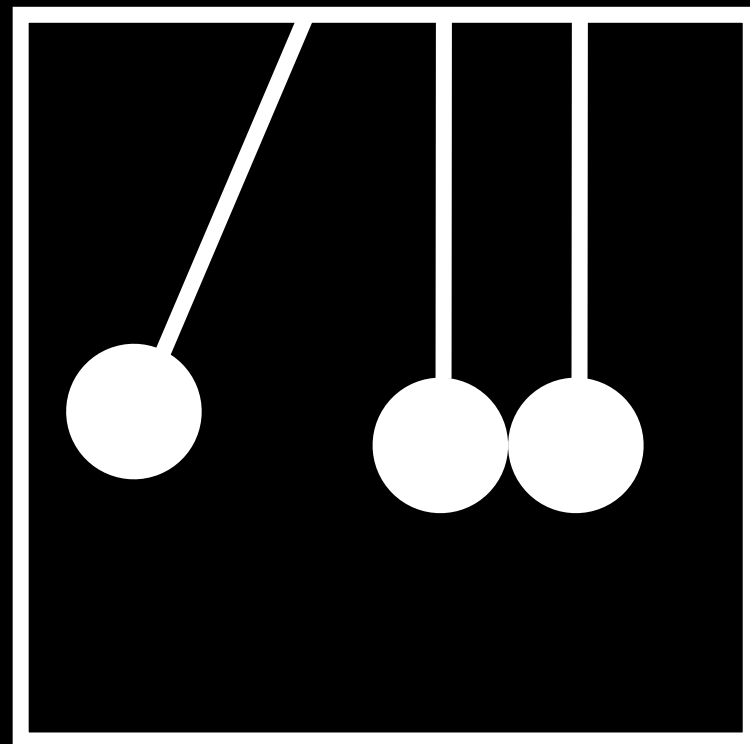
Robotics



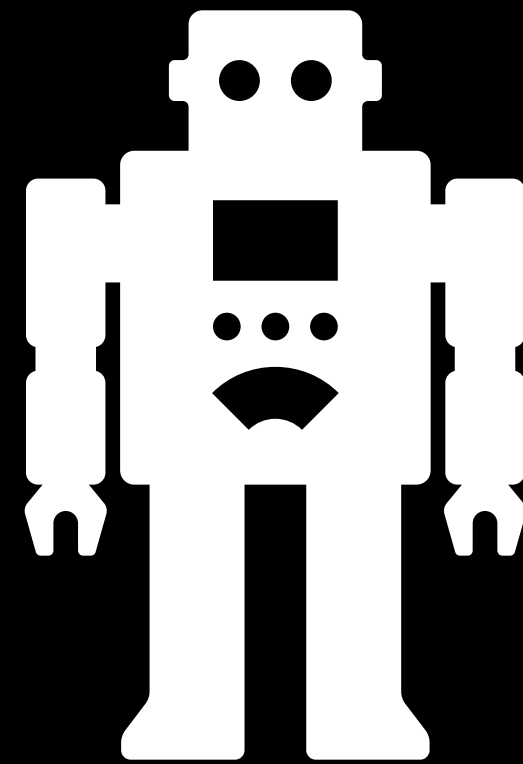
Rendering



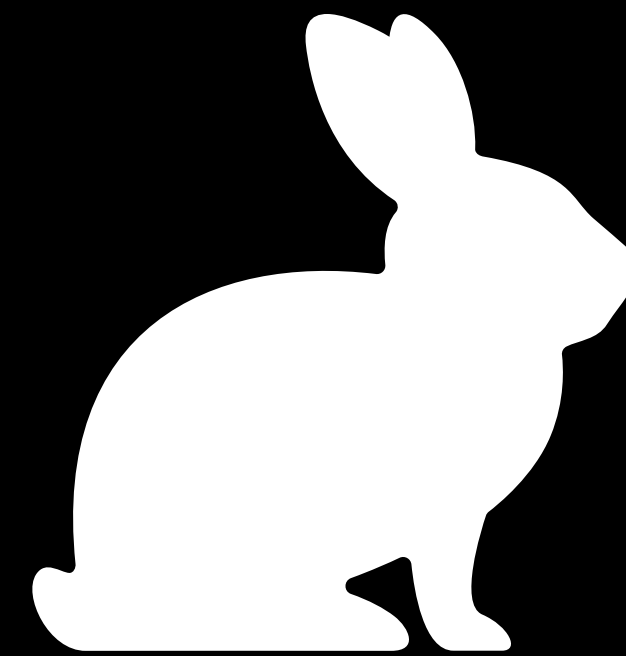
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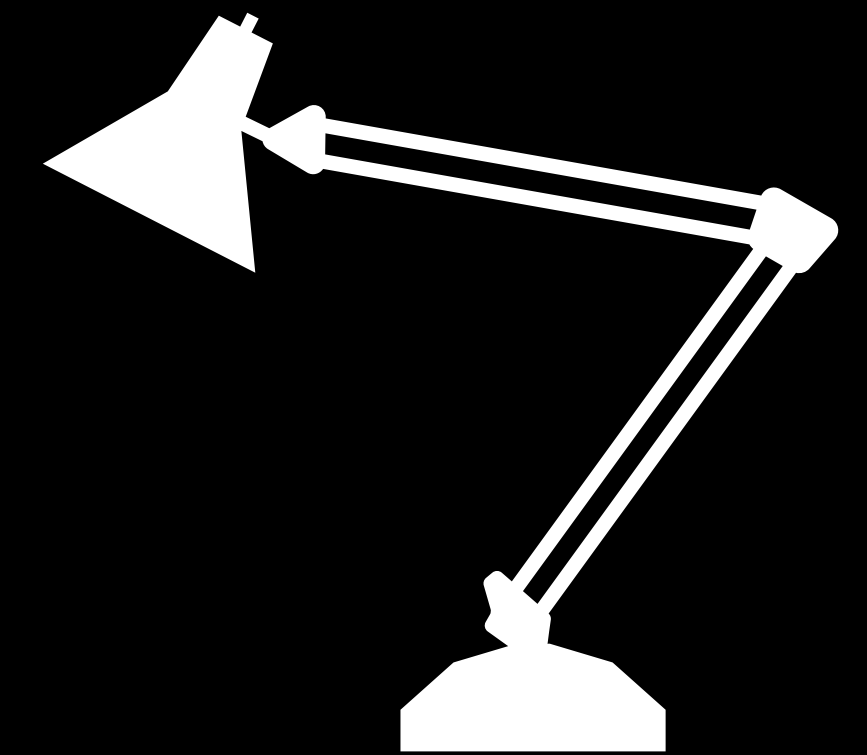
Physics



Robotics



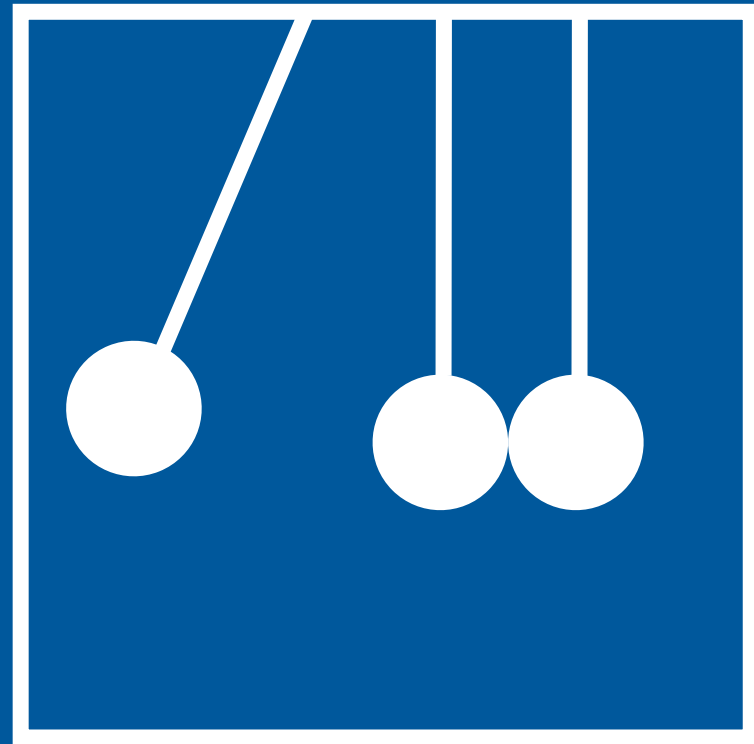
Rendering



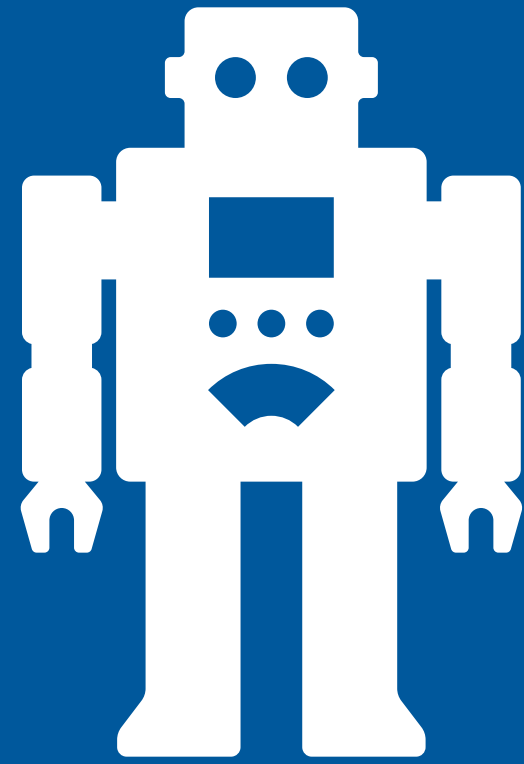
Simulation Content

SAPIEN

SAPIEN Engine

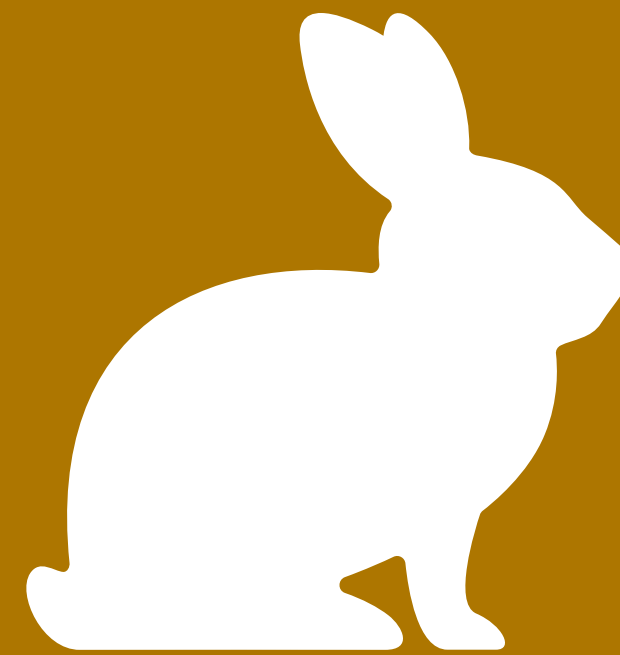


Physics



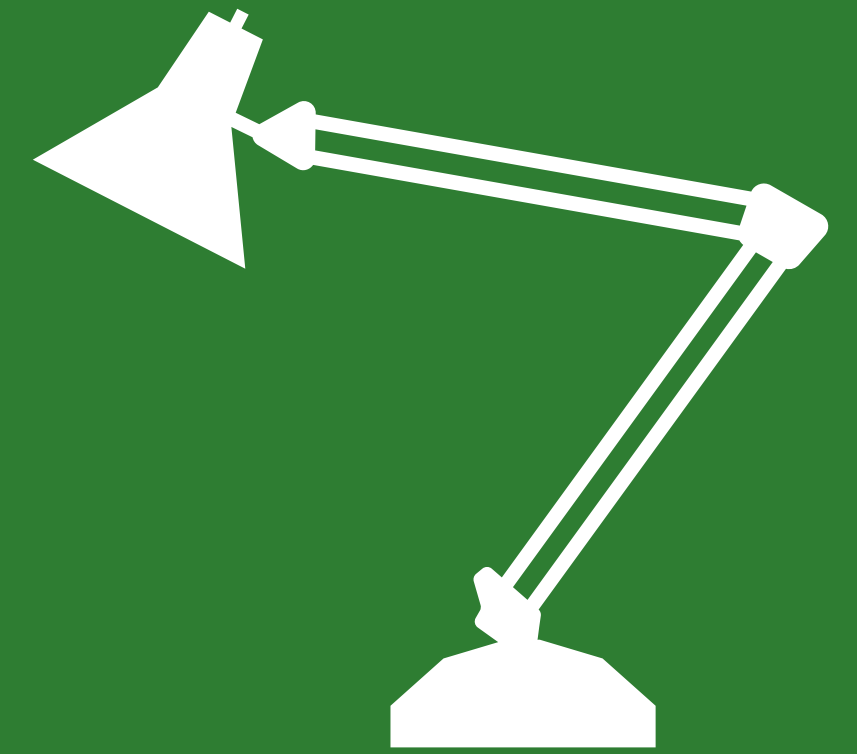
Robotics

SAPIEN Renderer



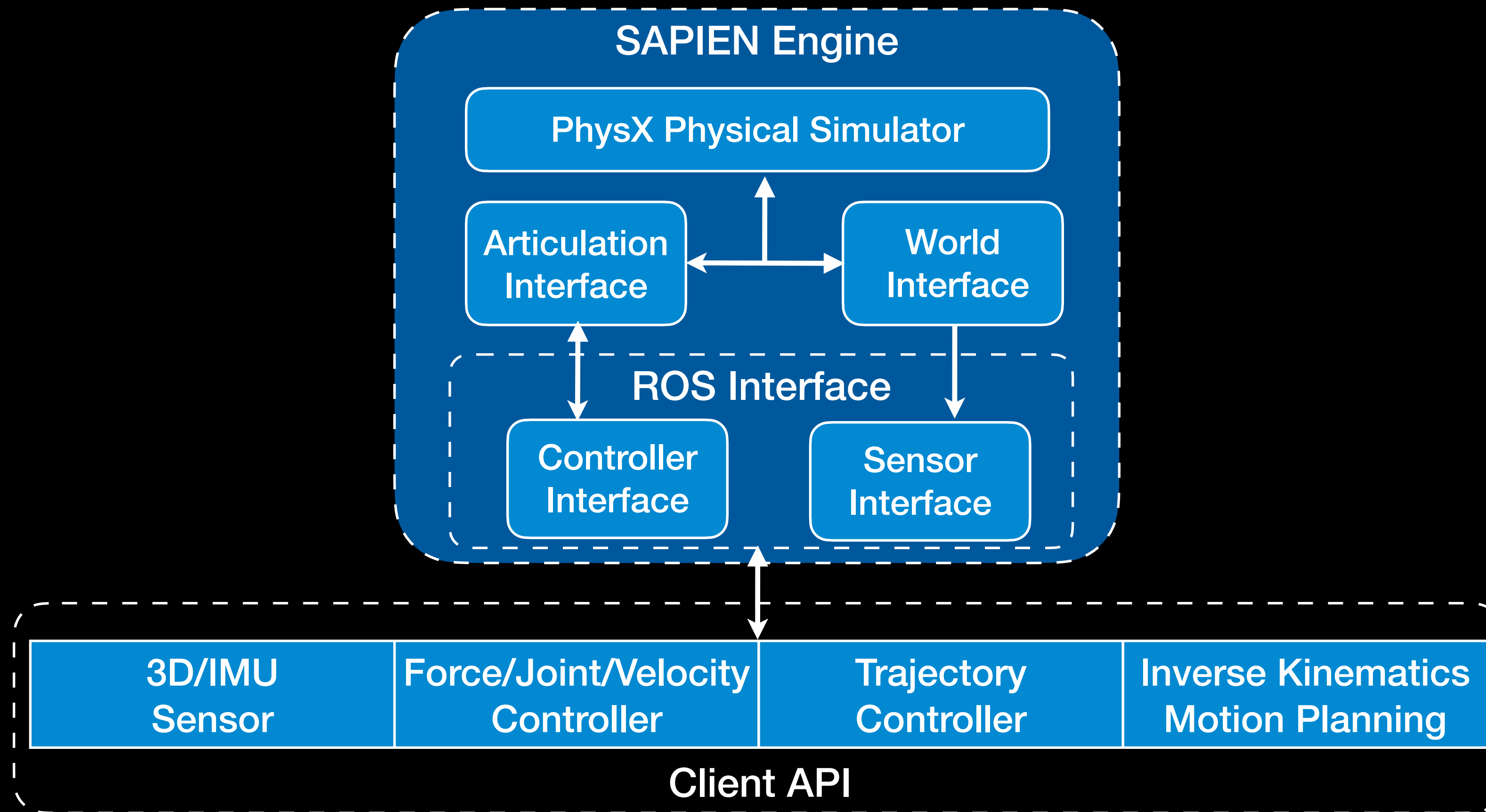
Rendering

SAPIEN Asset

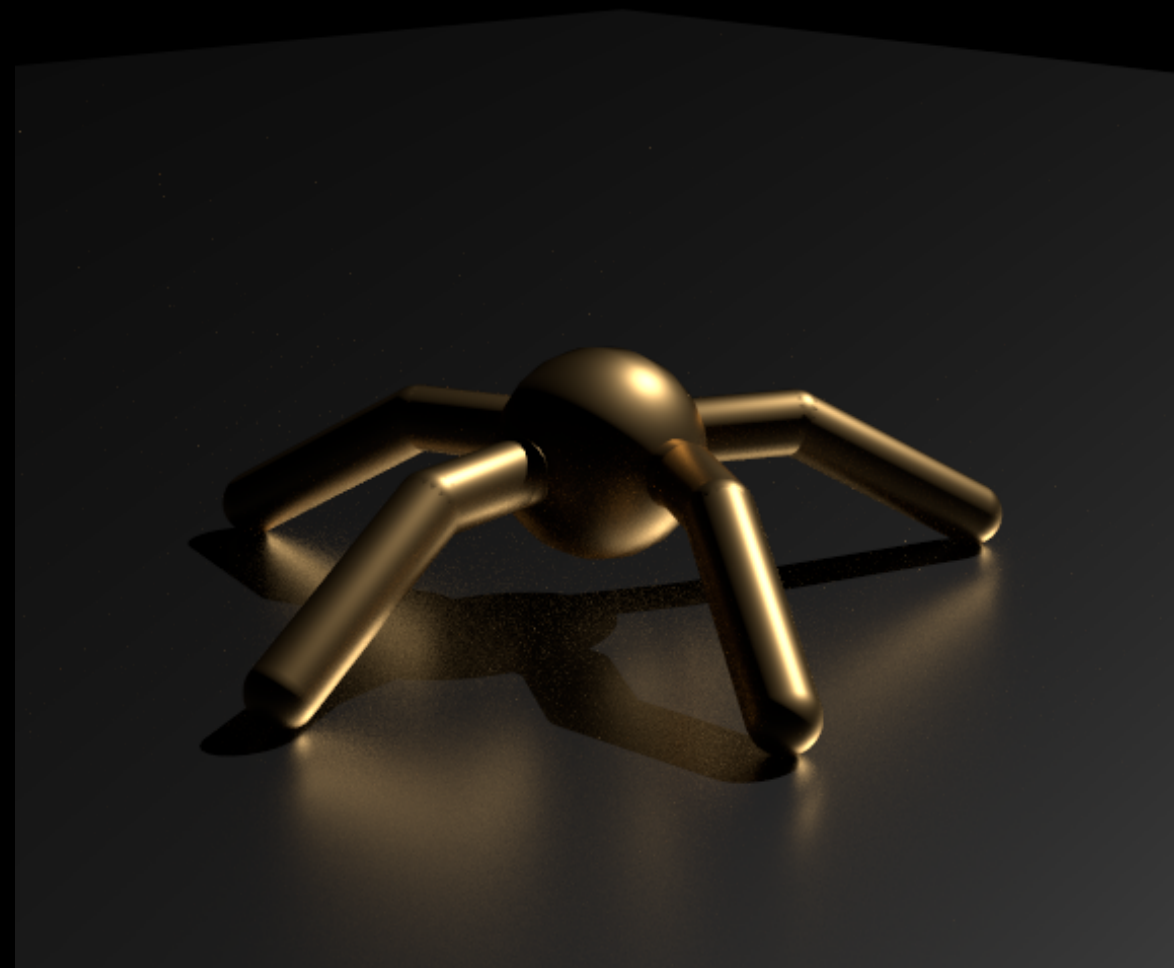


Simulation Content

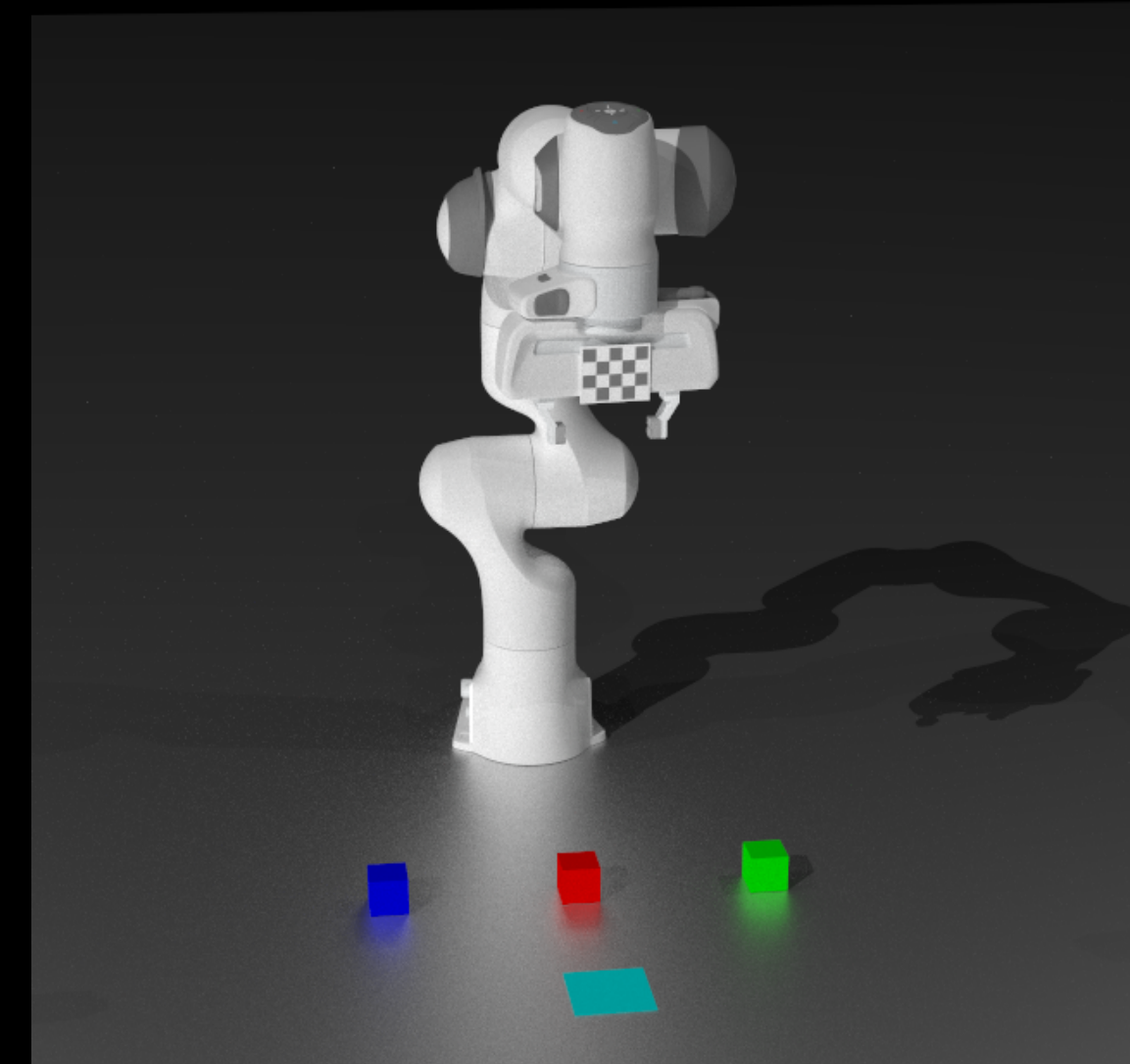
SAPIEN Engine



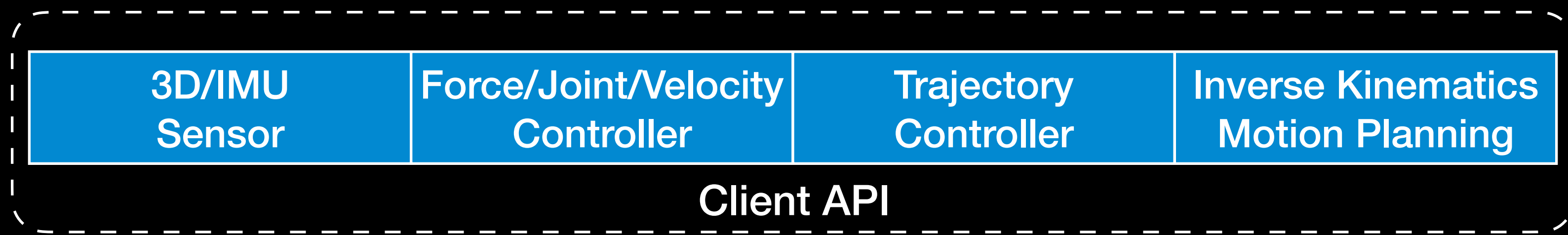
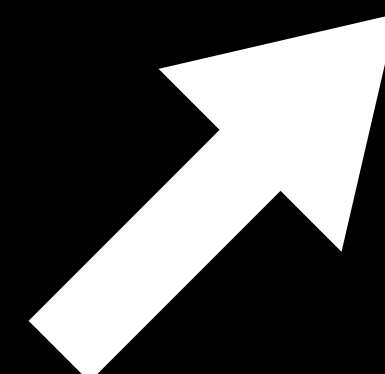
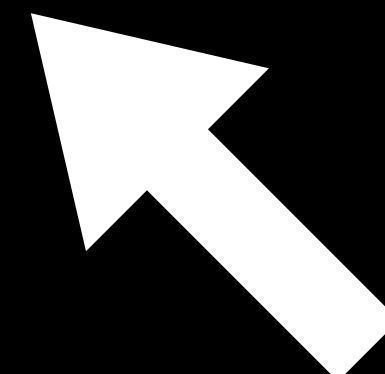
SAPIEN Engine



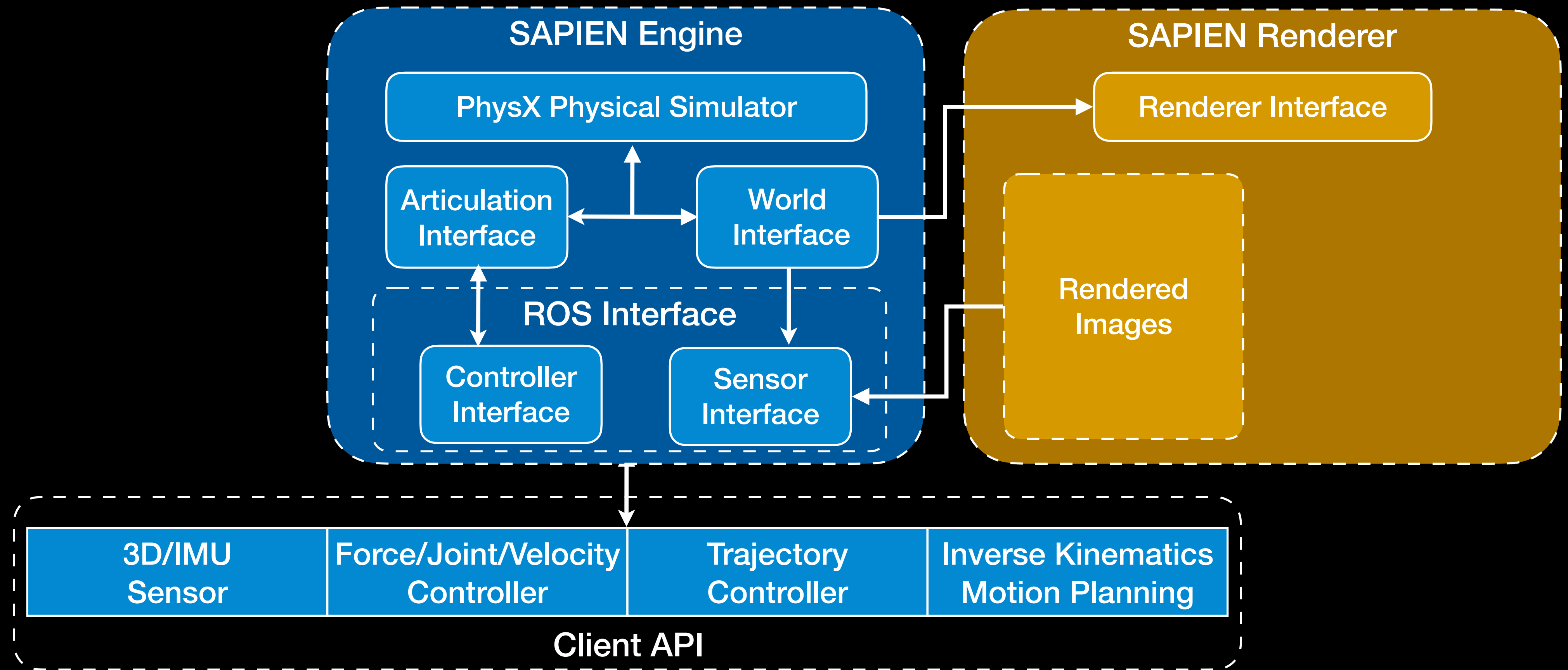
Reinforcement Learning



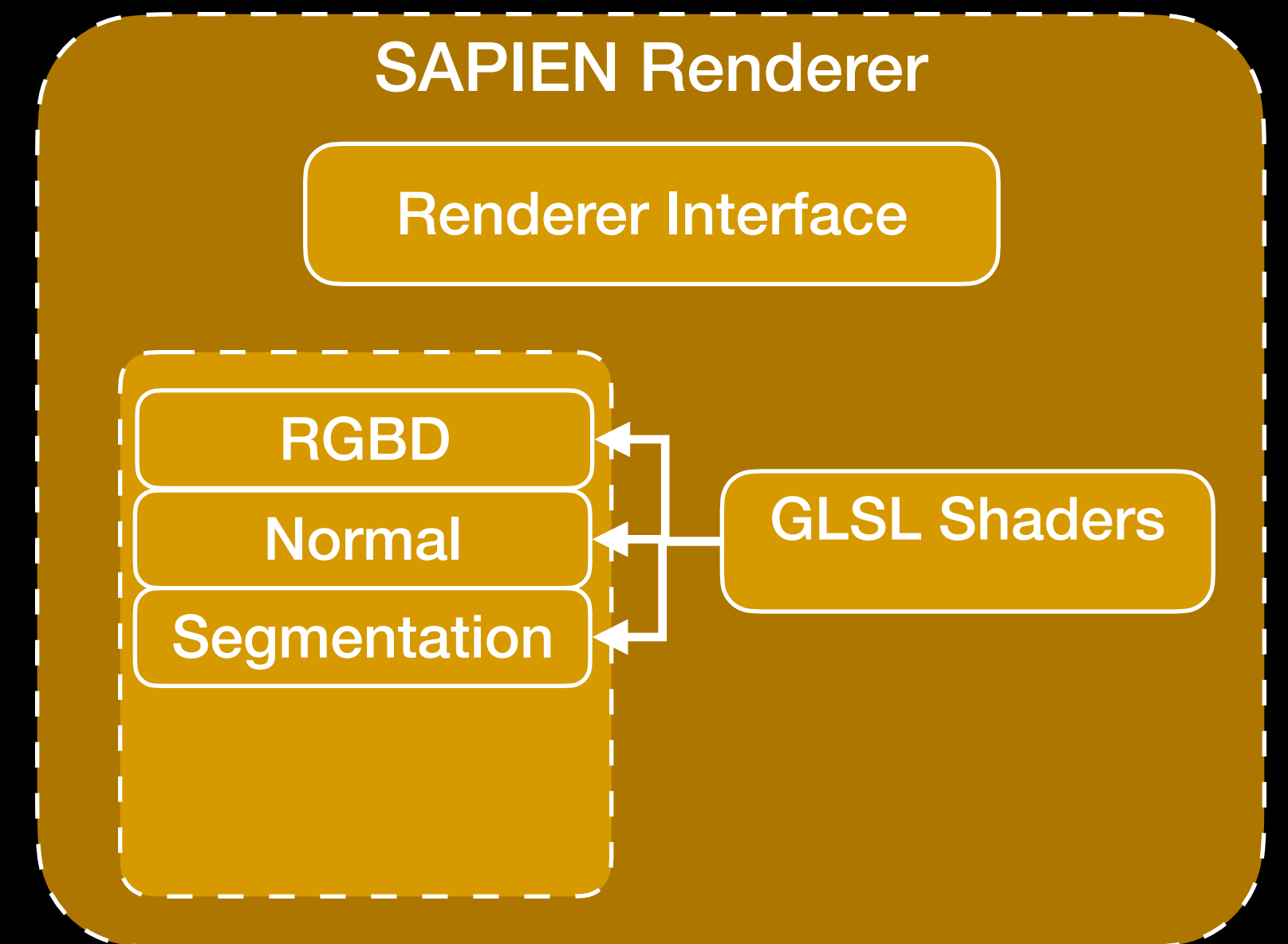
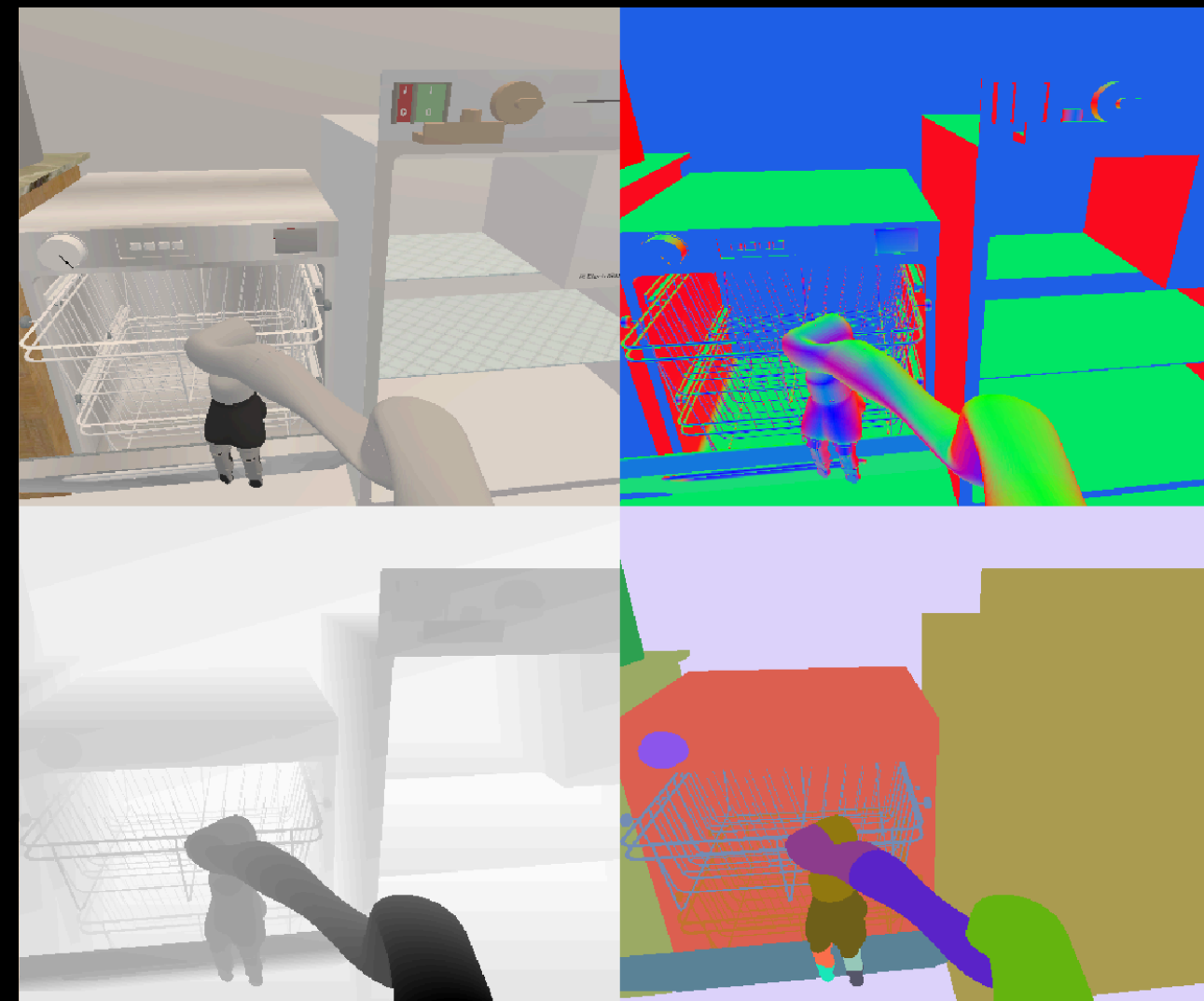
Robot Tasks



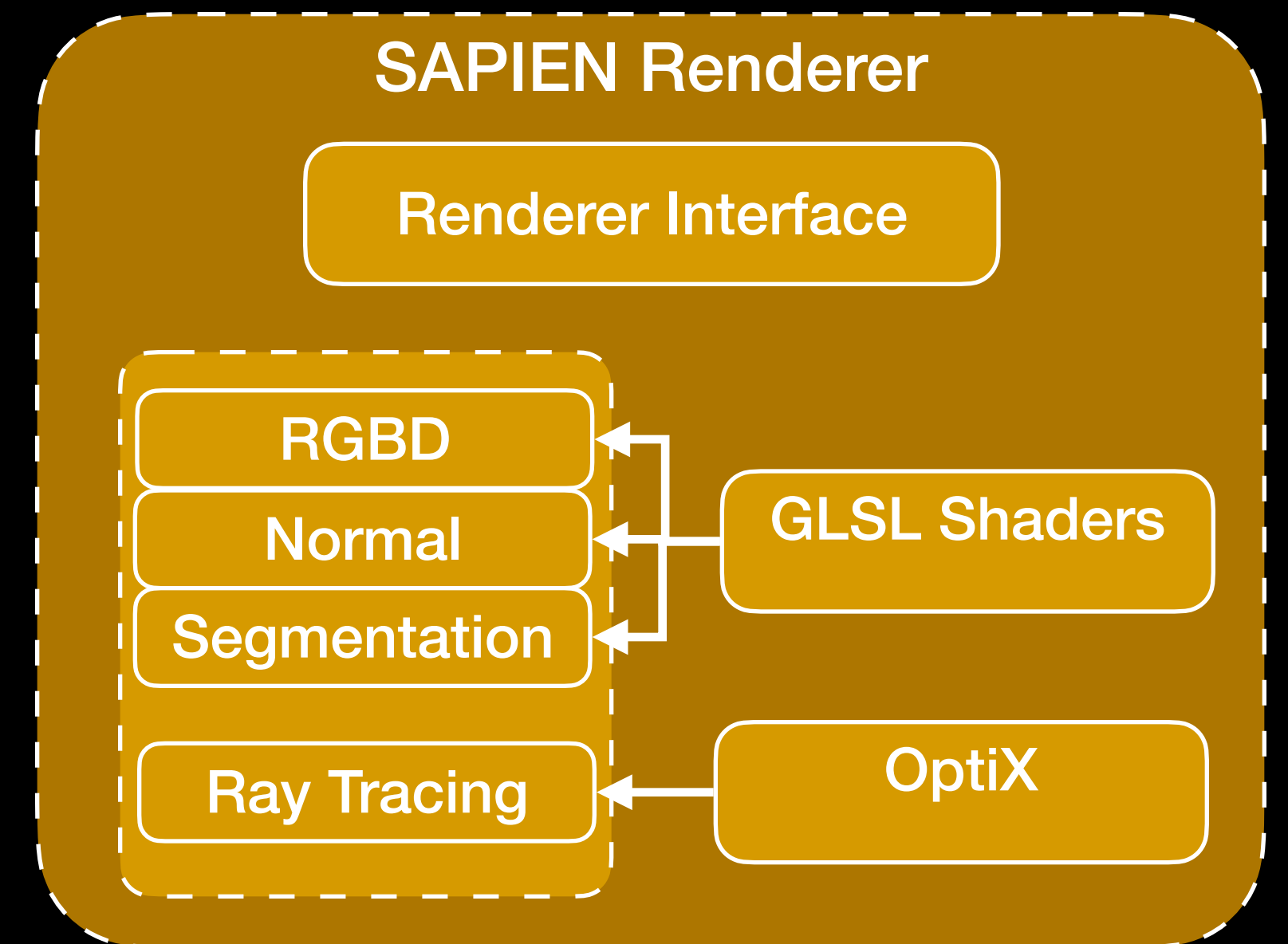
SAPIEN Renderer



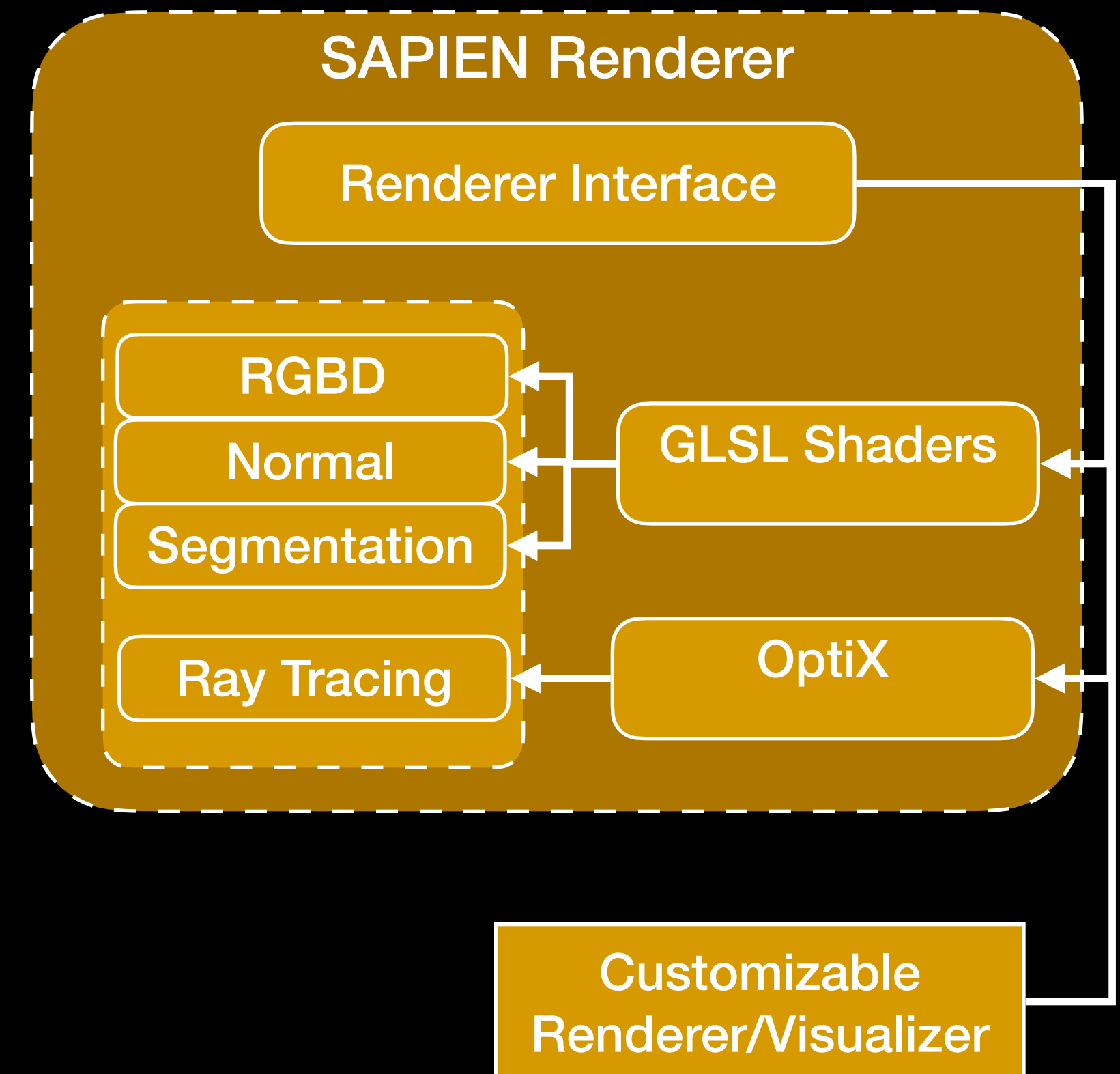
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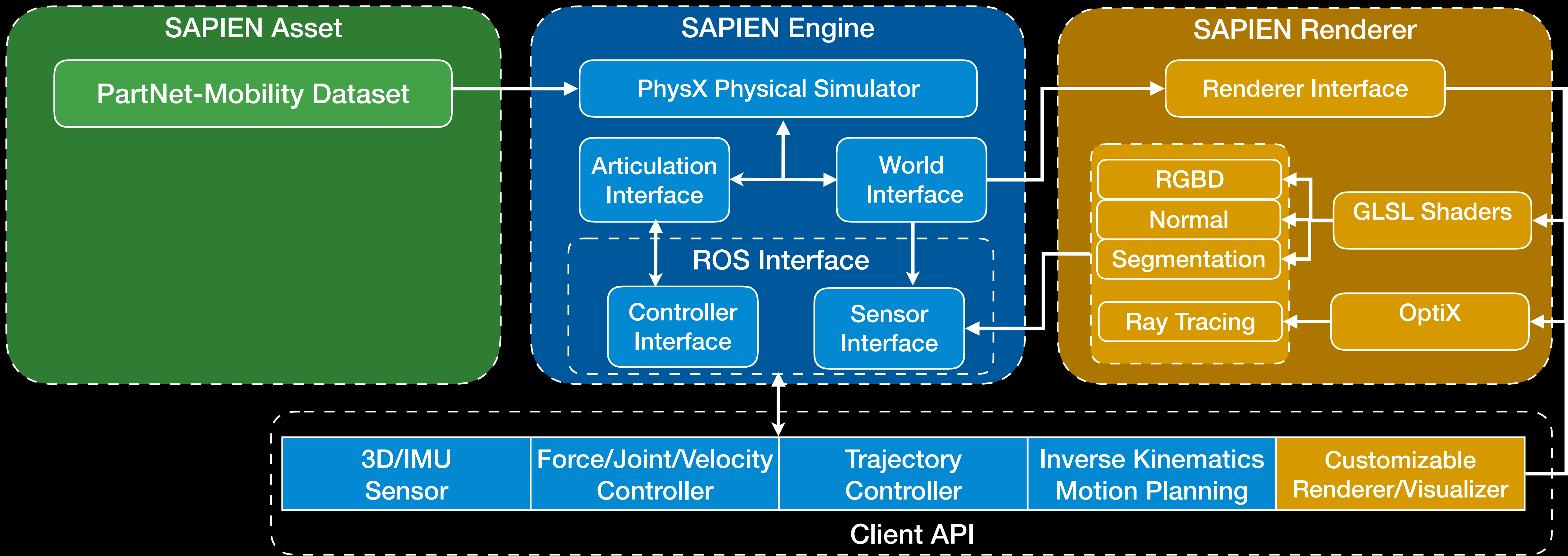
SAPIEN Renderer



SAPIEN Renderer



SAPIEN Asset

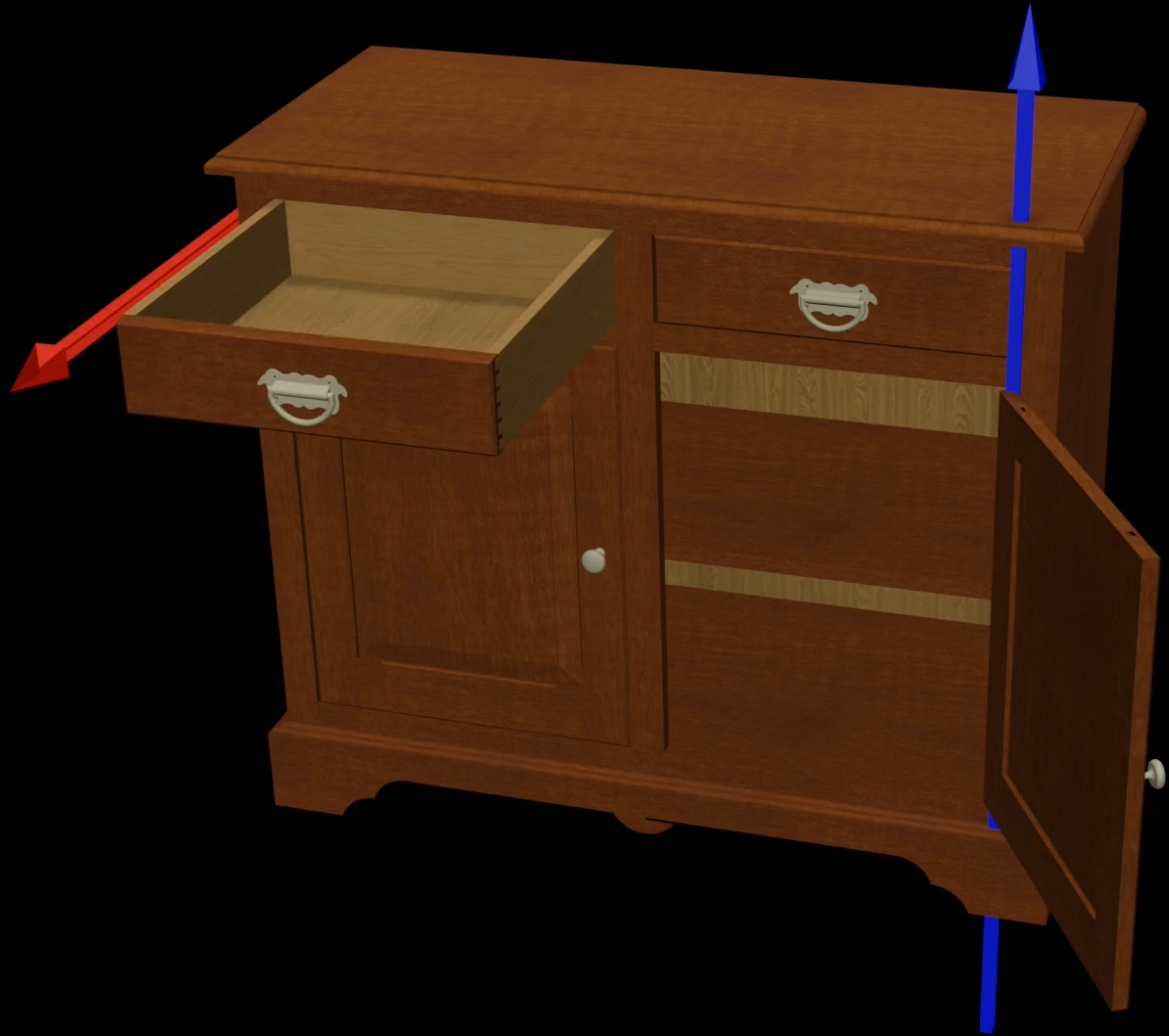


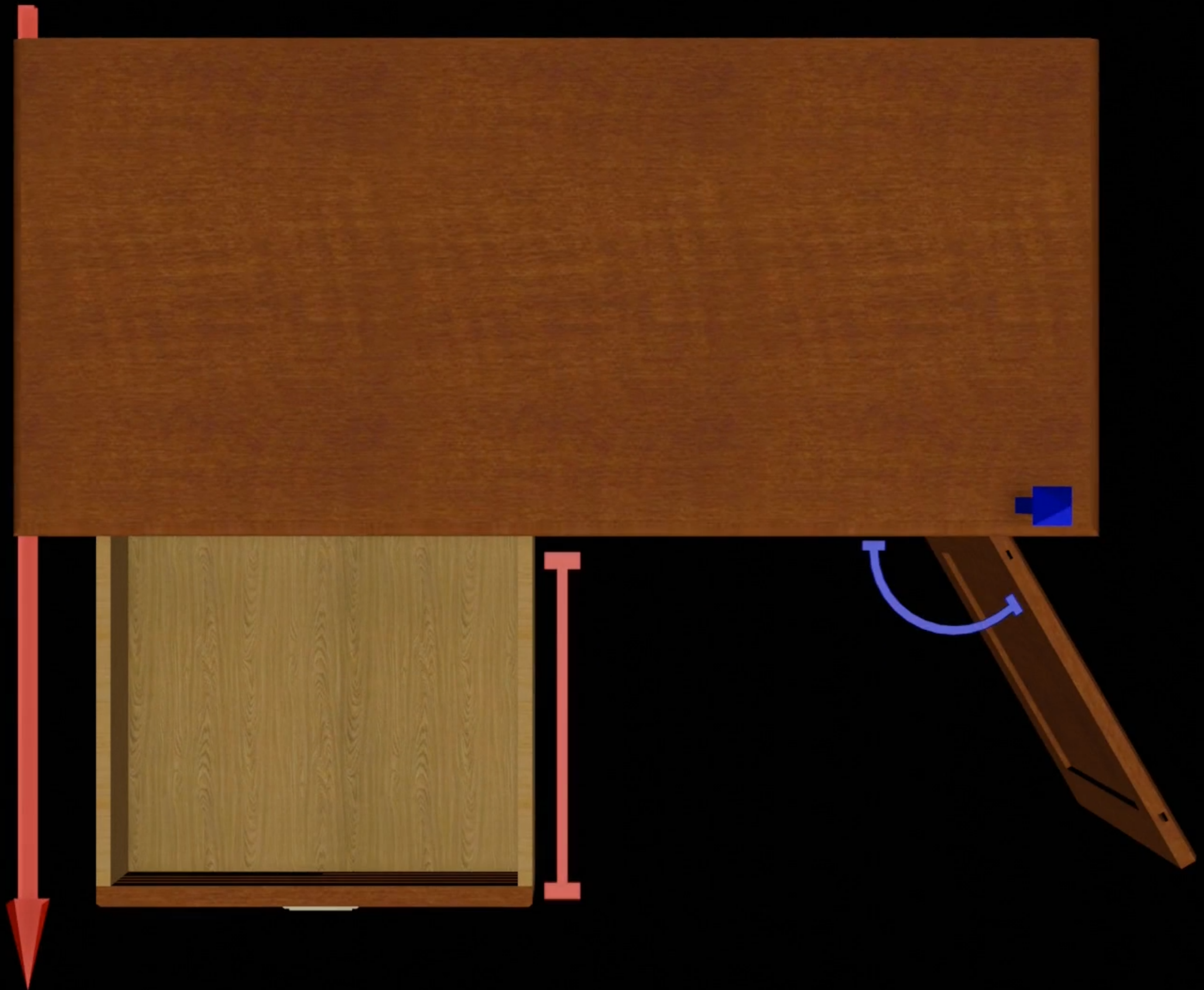
SAPIEN Asset

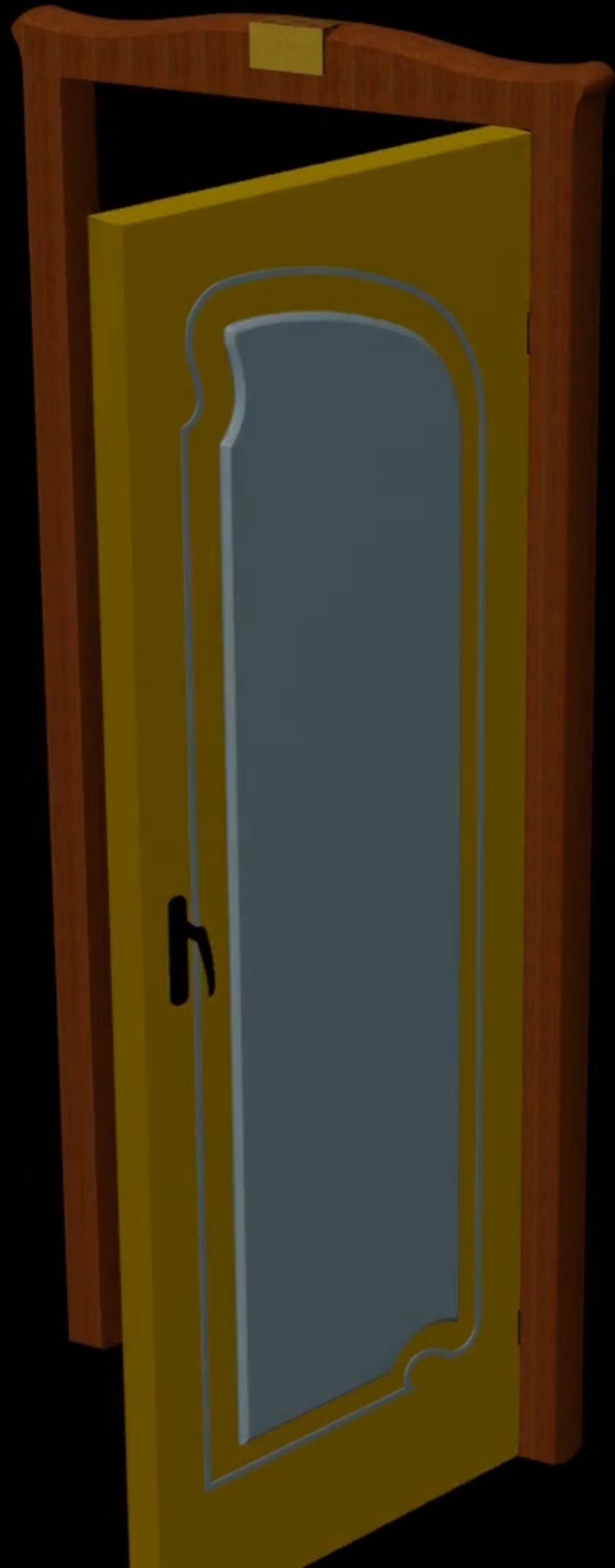


Motion Annotation

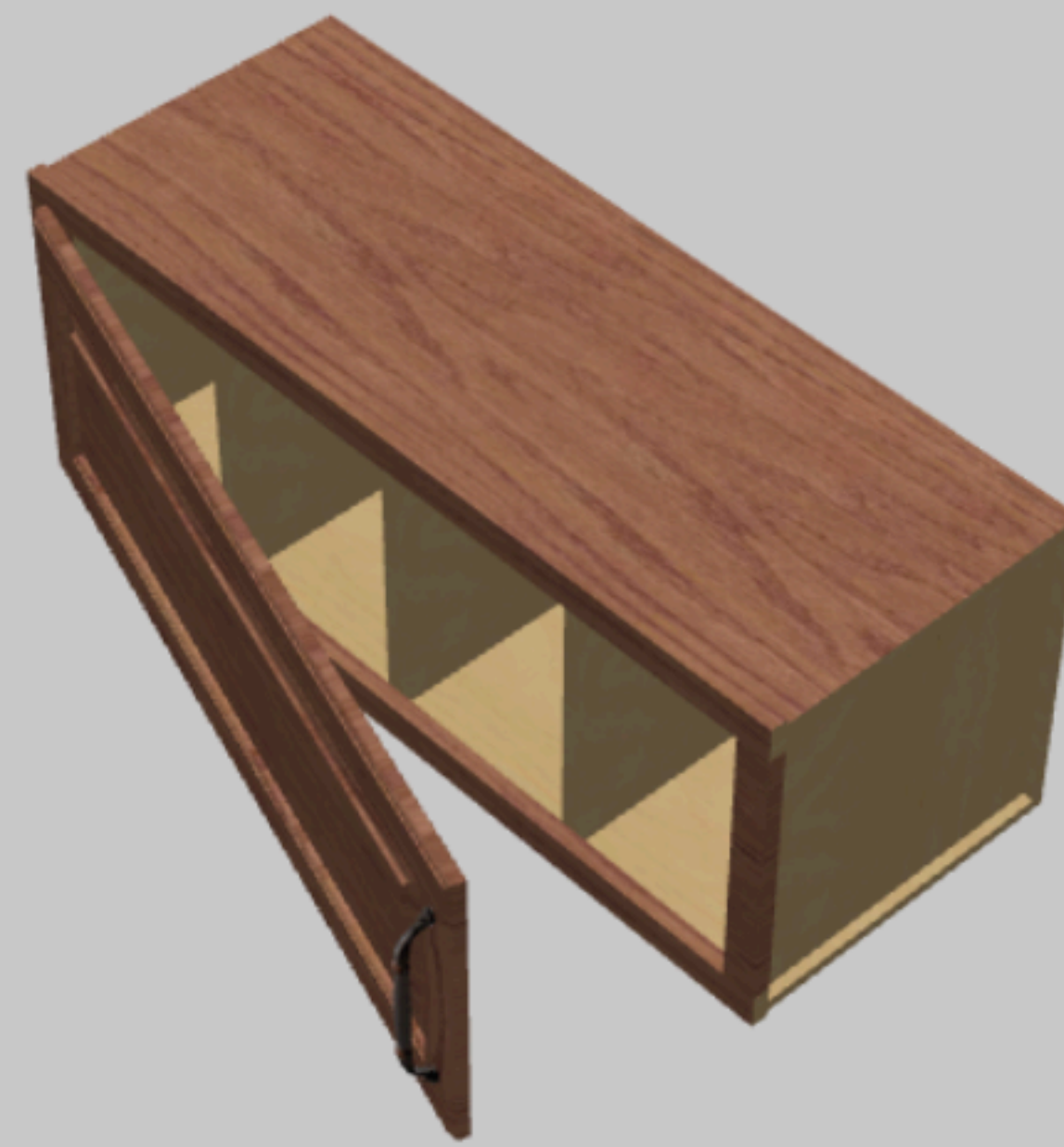
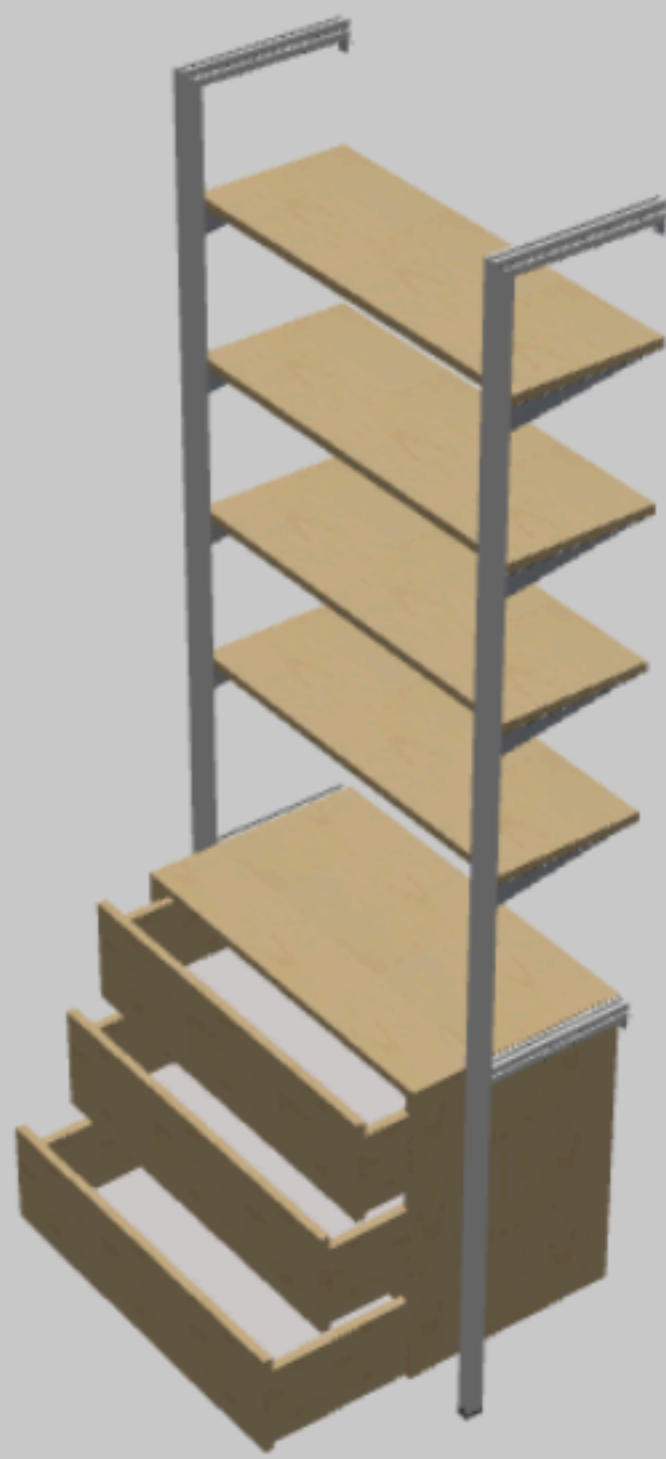
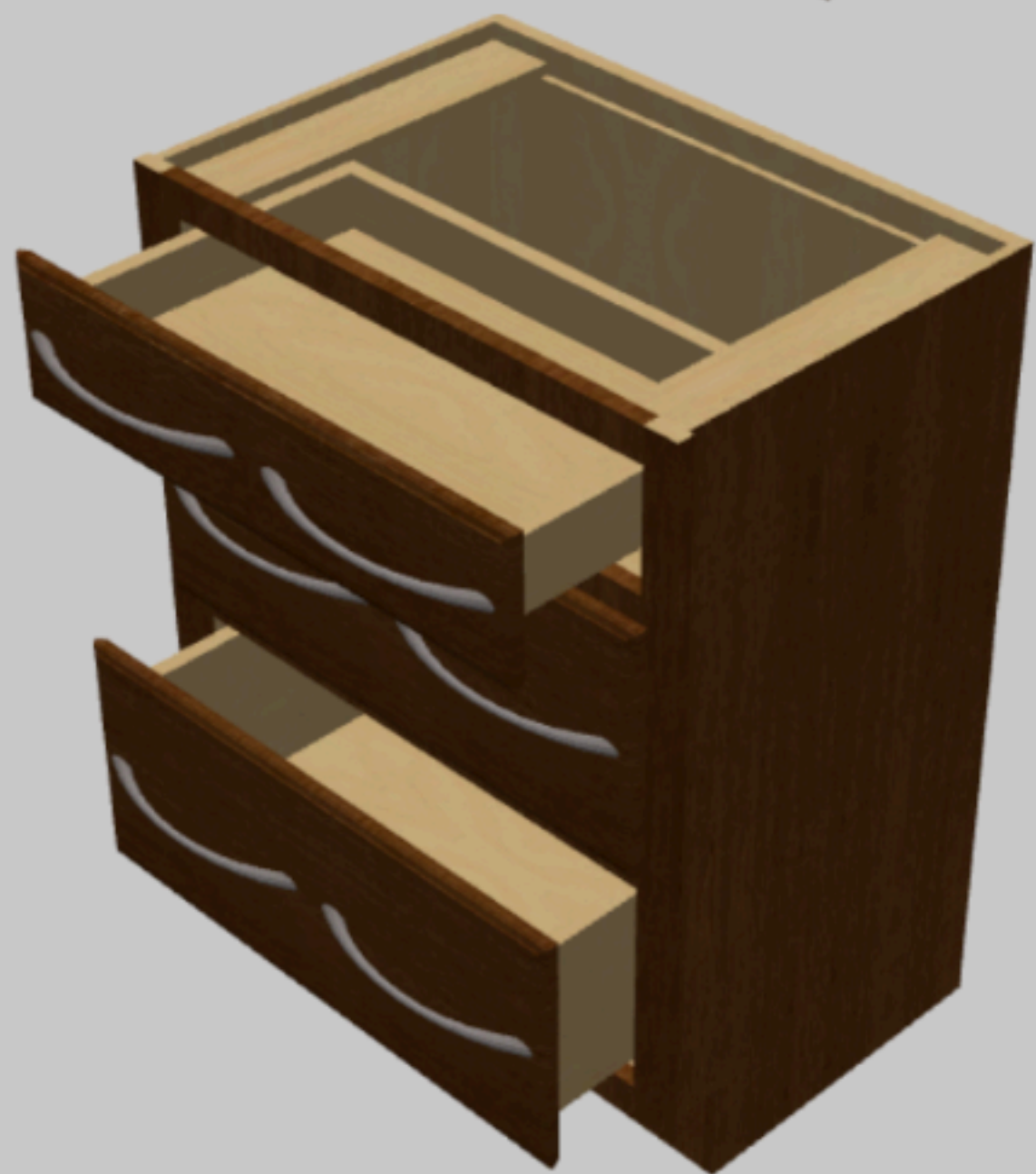
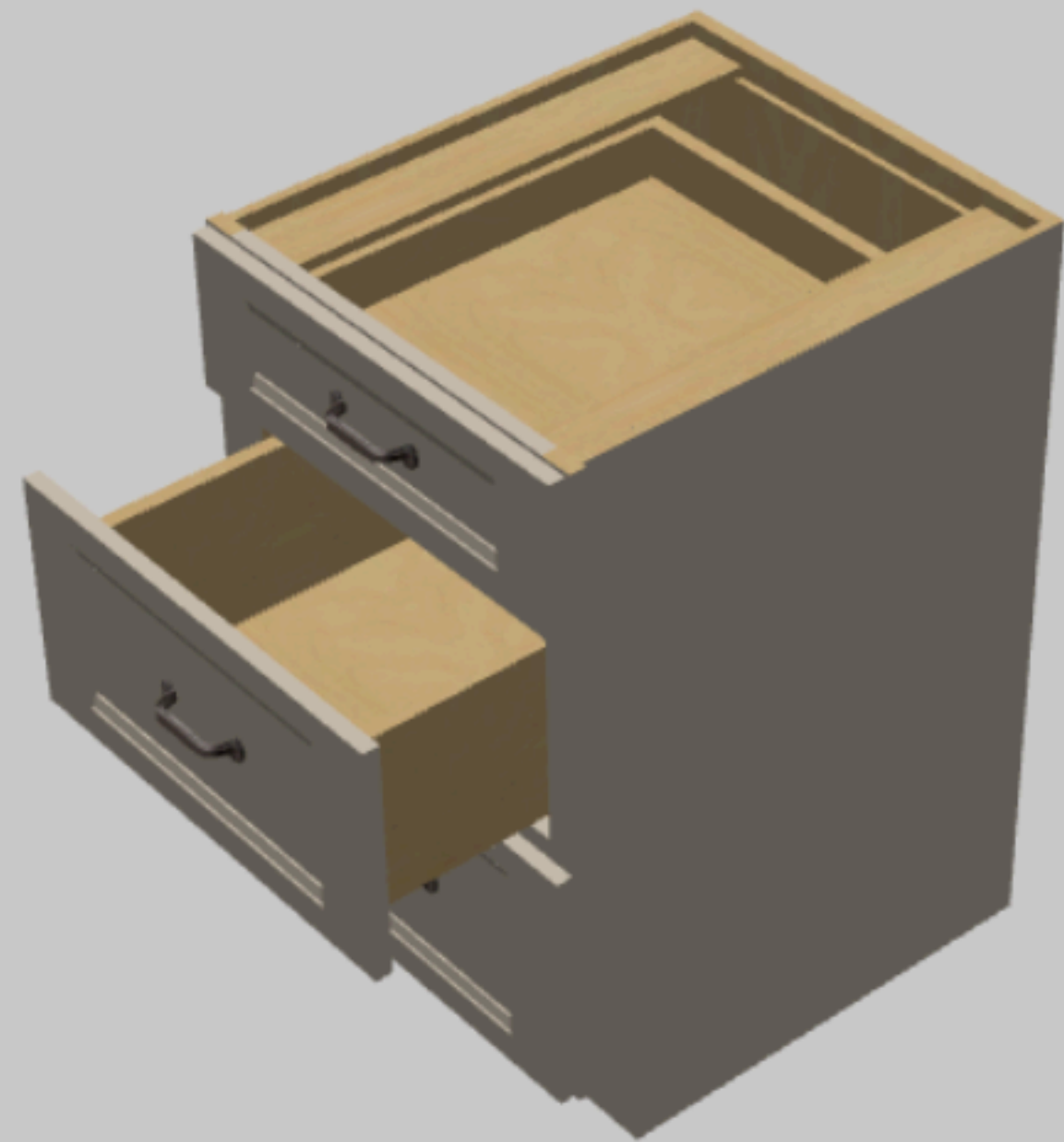


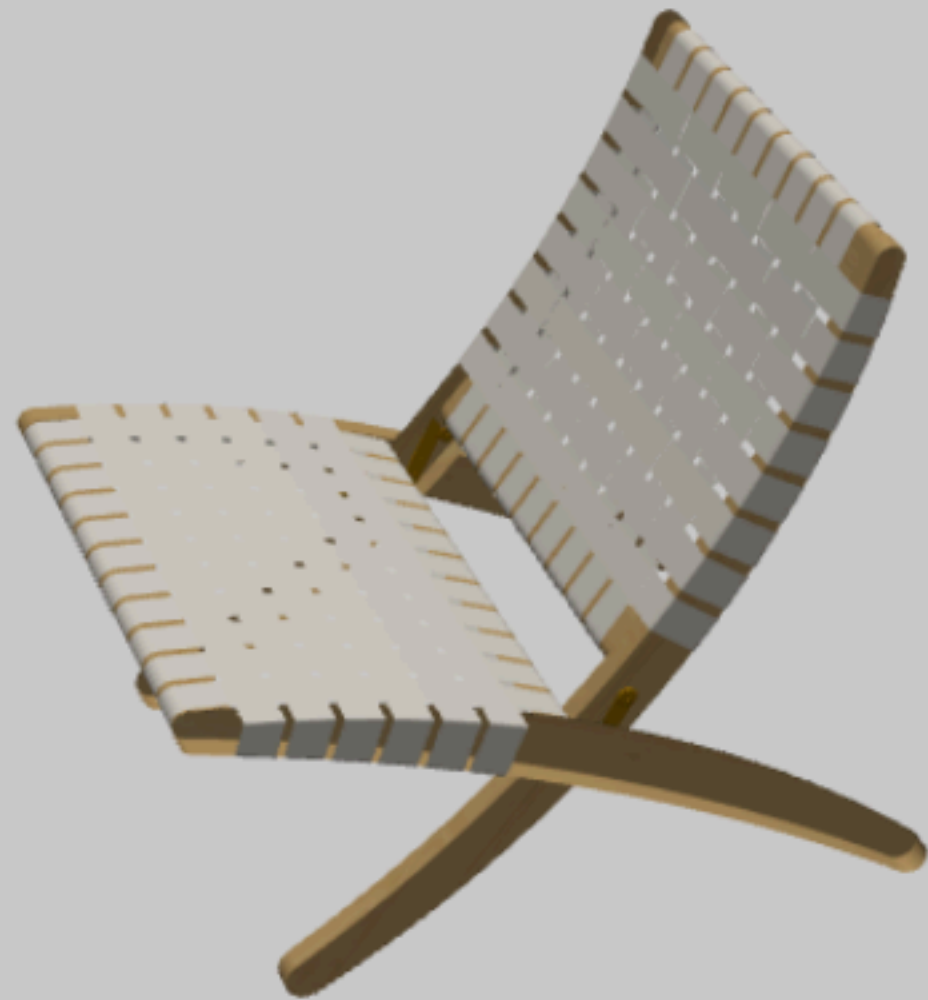












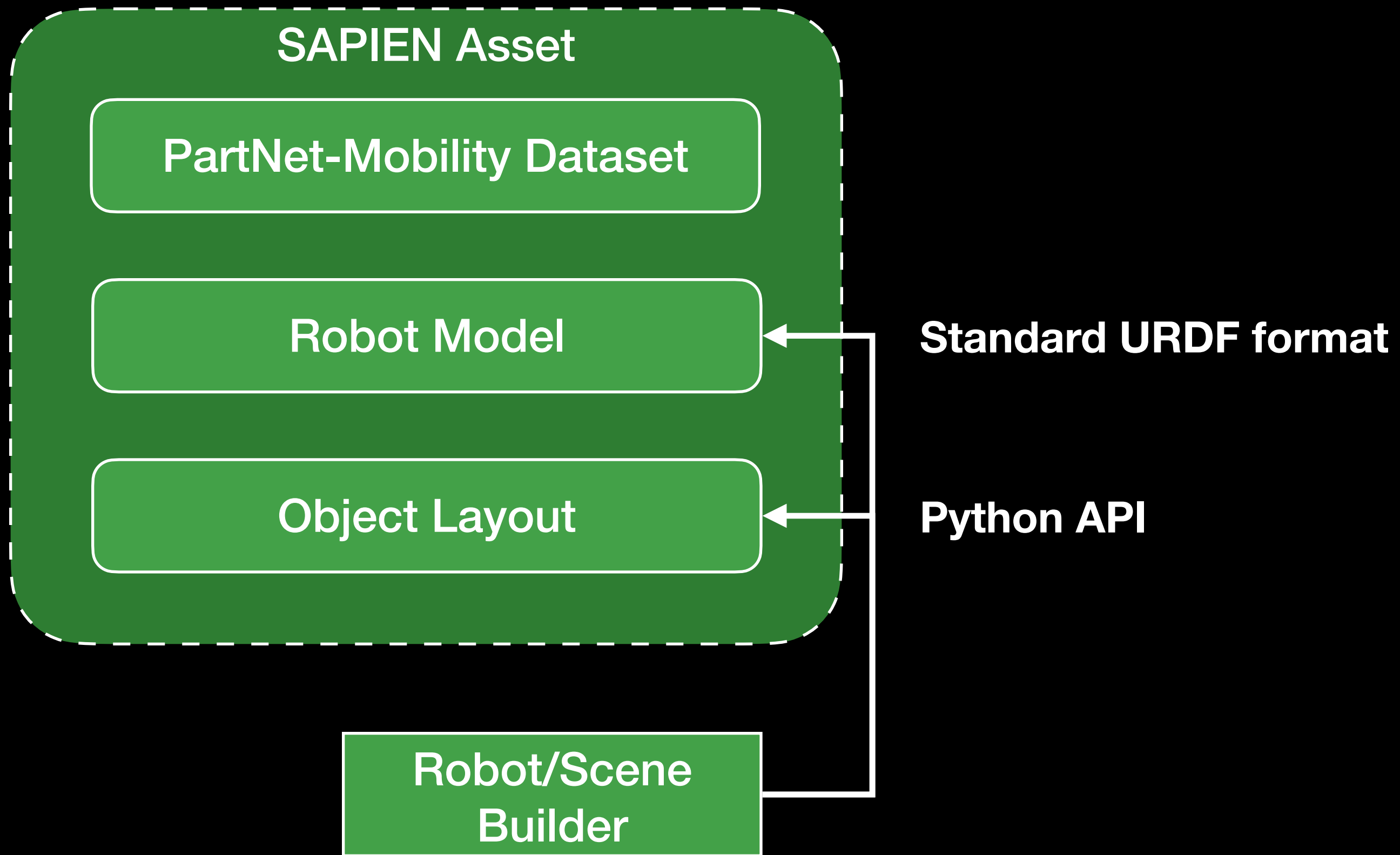


Training

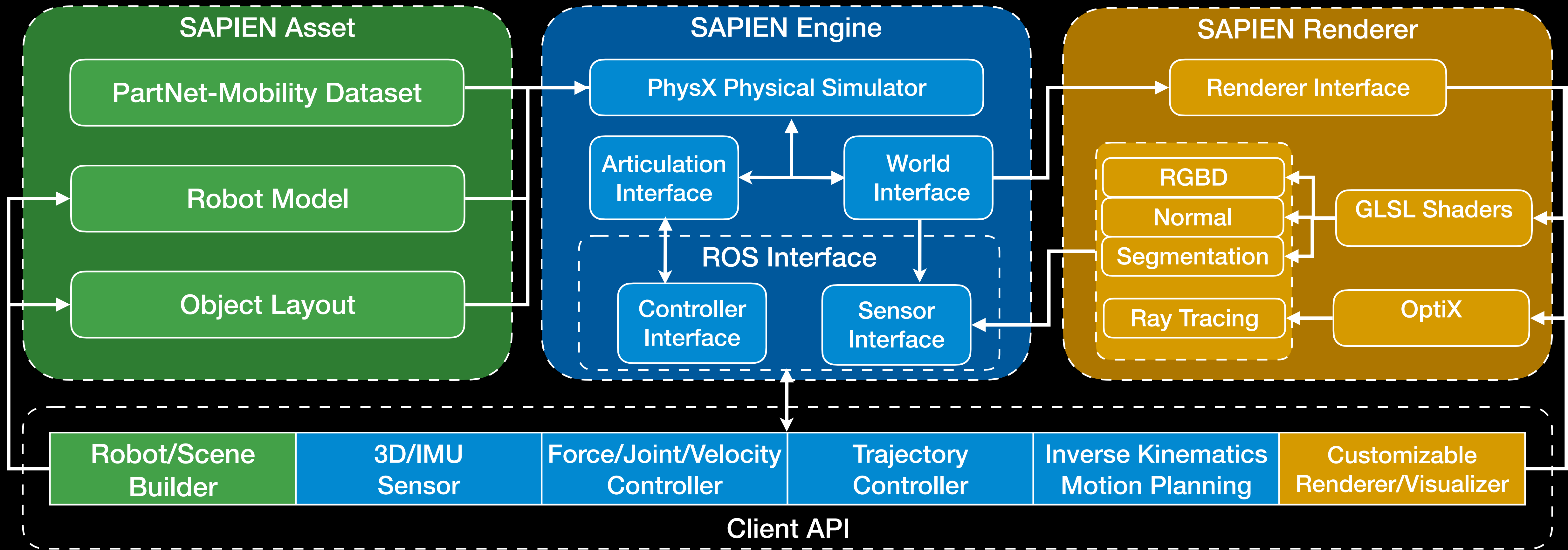
Generalize

Testing

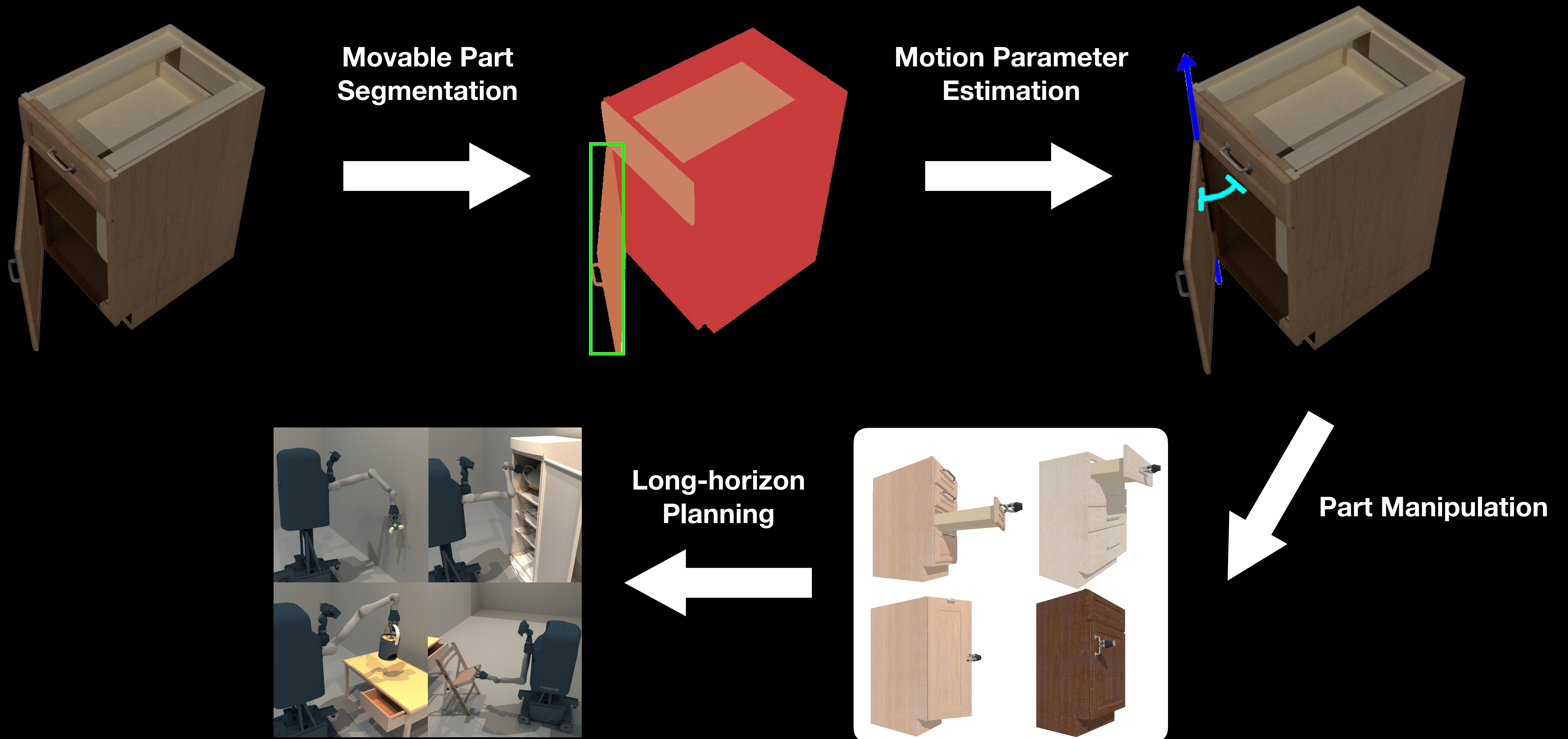
SAPIEN Asset

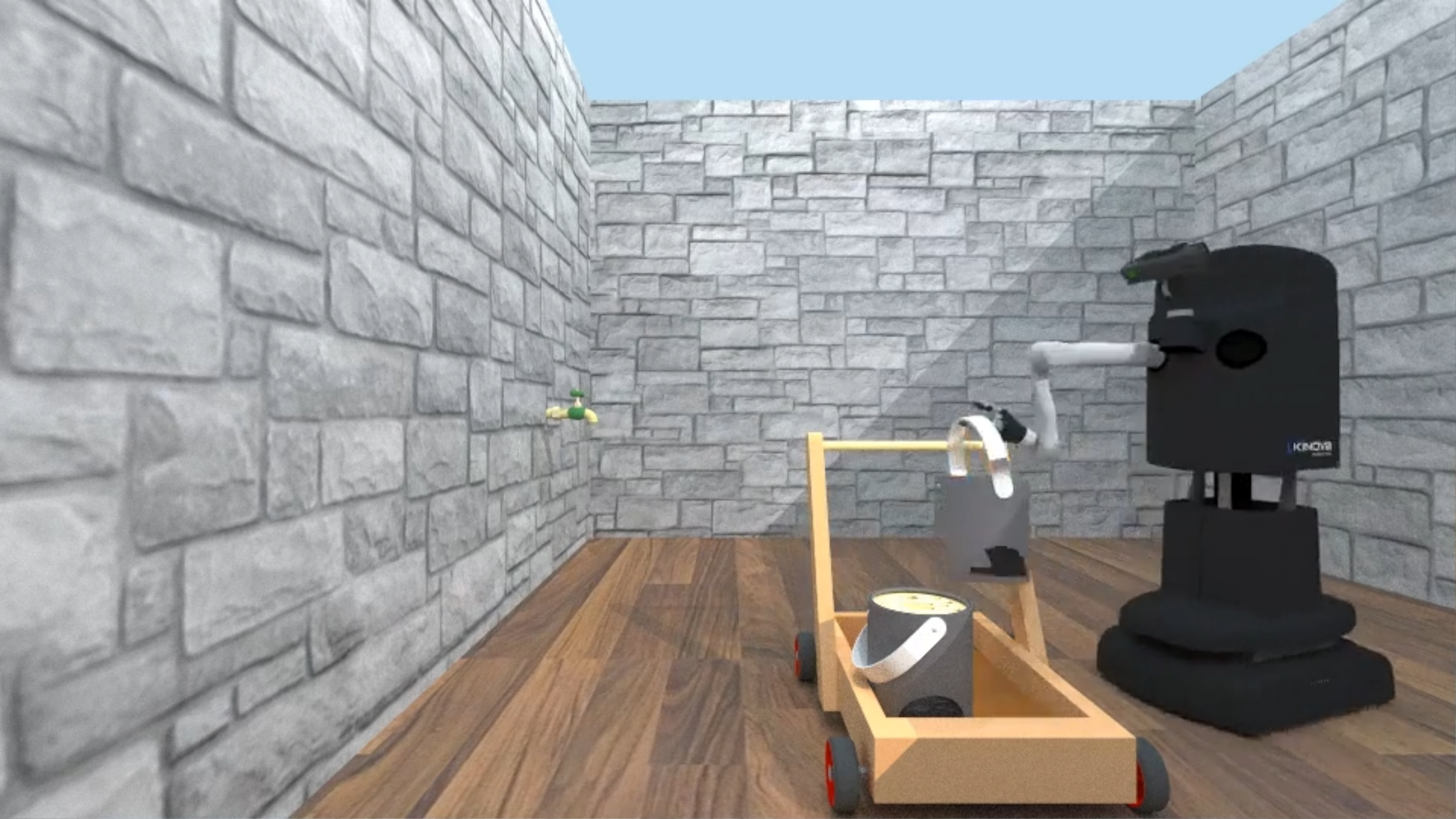


SAPIEN



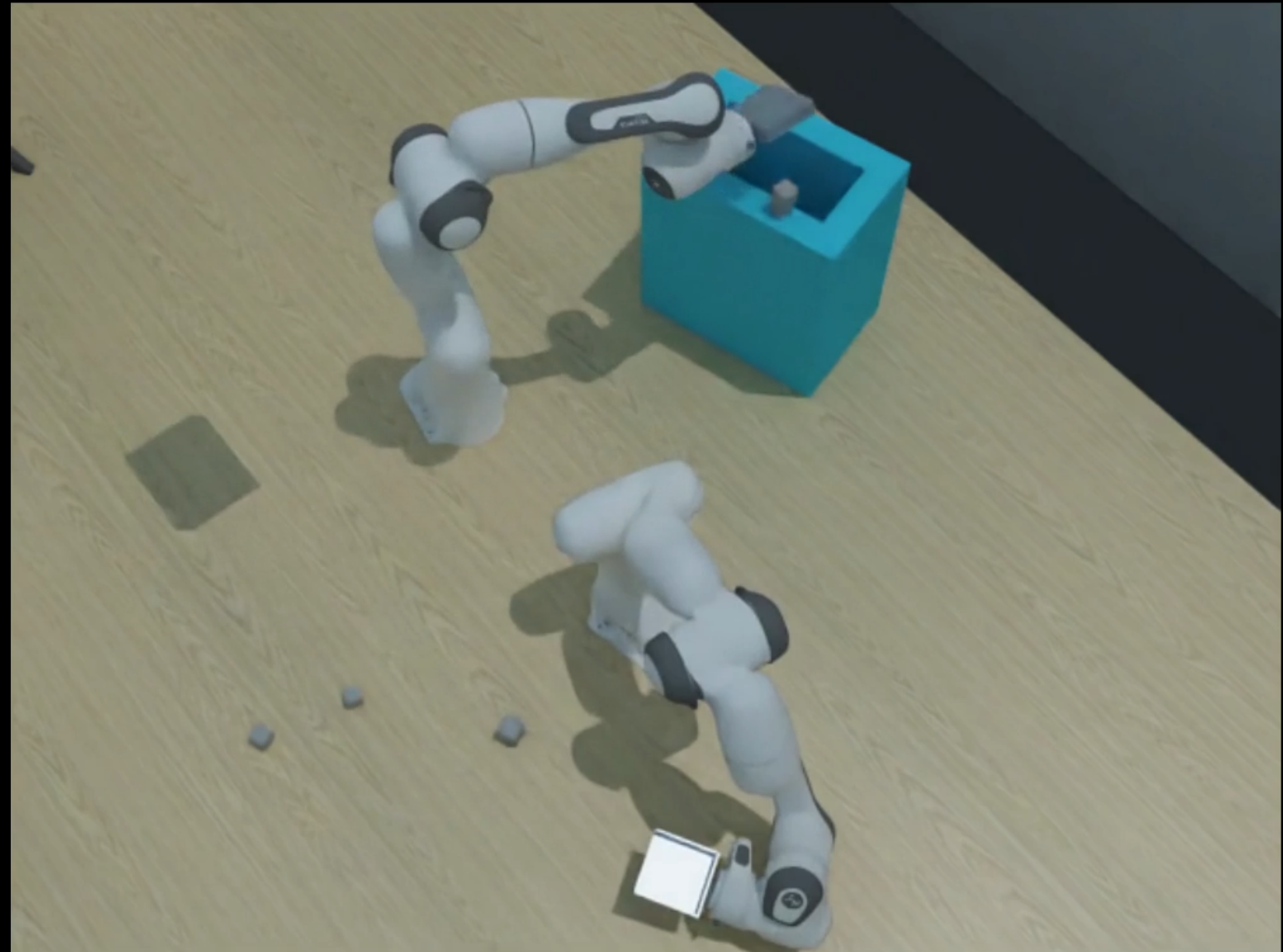
Task Demonstrations





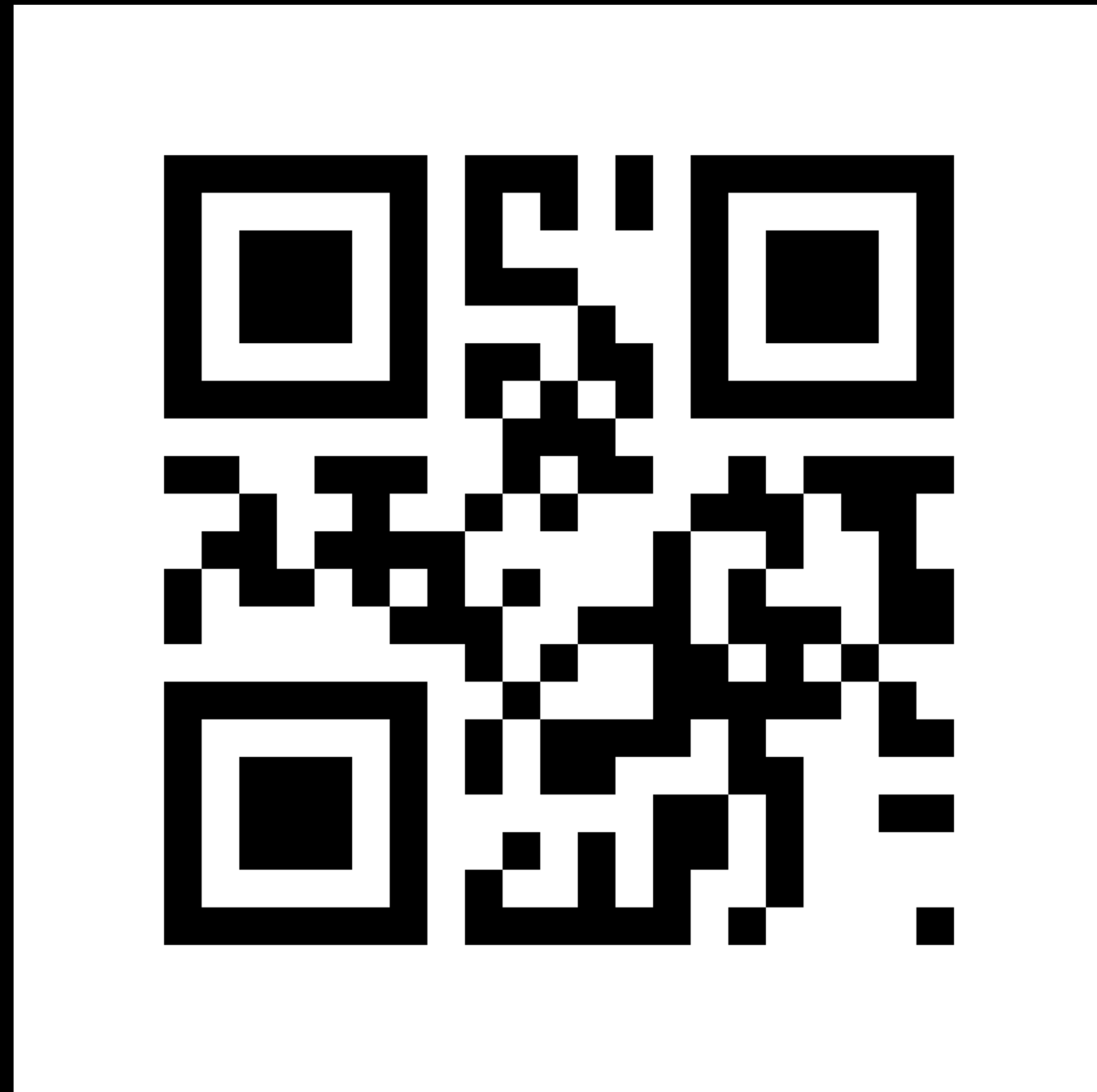
Future Plans/Applications

- Benchmark Platform
 - Vision tasks
 - Manipulation tasks
- Education Platform
 - Control Algorithms
 - Robot Learning



Summary

- SAPIEN provides simulation and rendering for vision and manipulation.
- SAPIEN hosts a large-scale dataset for articulated objects.
- SAPIEN is open source.
- `pip install sapien`



<https://sapien.ucsd.edu>