



# Interactive Gibson Environment: a Simulator for Embodied Visual Agents

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# iGibson

## Team and collaborators



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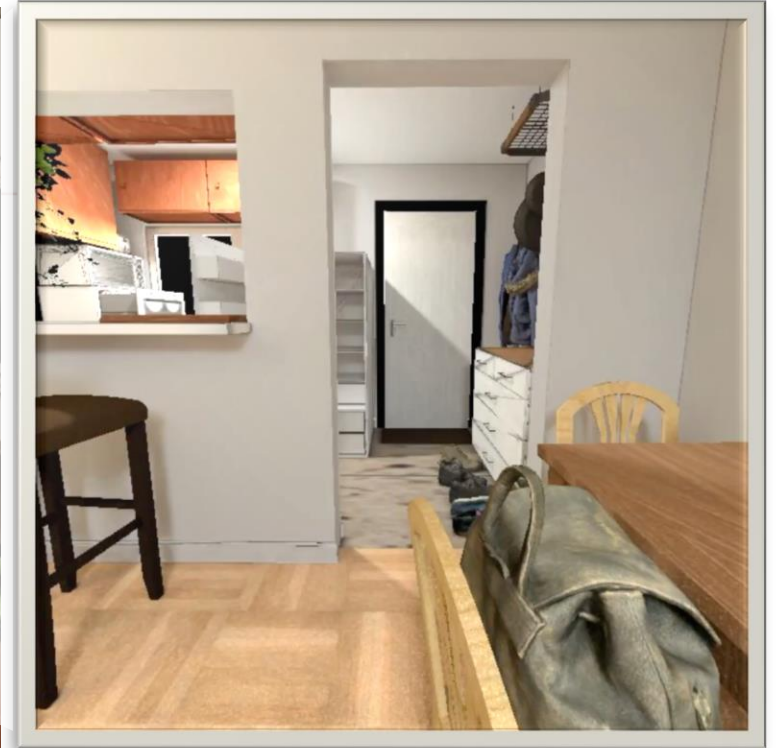


iGibson is a virtual environment



iGibson is a virtual environment

- to simulate robotic agents,



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- to simulate robotic agents,
- with realistic virtual images,



iGibson is a virtual environment

- to simulate robotic agents,
- with realistic virtual images,
- with multiple large environments reconstructed from real world houses,



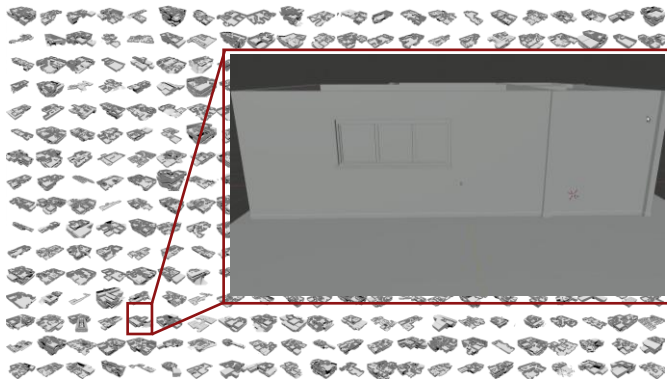
iGibson is a virtual environment

- to simulate robotic agents,
- with realistic virtual images,
- with multiple large environments reconstructed from real world houses,
- and realistic physics simulation

# iGibson at a Glance

## Features and characteristics

### Large Dataset of Real-World Reconstructed Buildings



572 full buildings  
211,000 m<sup>2</sup>  
1400+ floors  
10 partially interactive  
1 fully interactive (+9 soon)

### Physically Realistic Simulations of Active Agents



14 realistic models of robots  
Rigid body physics [Bullet]  
Navigation & manipulation  
Virtual reality for humans

### Realistic Fully Interactive Environments to Explore Free



Real world object distribution  
500+ surface materials  
Physical properties (mass, inertia...)  
Per interactive environment:  
- 30+ articulated objects  
- 200+ textured models



# James J. Gibson, 1904-1979

*An ecological and interactive view of perception and agency*

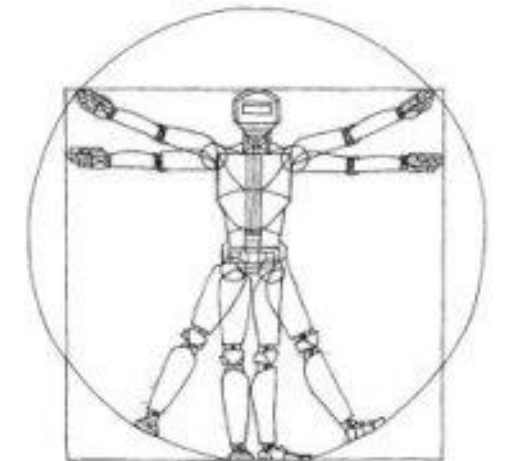
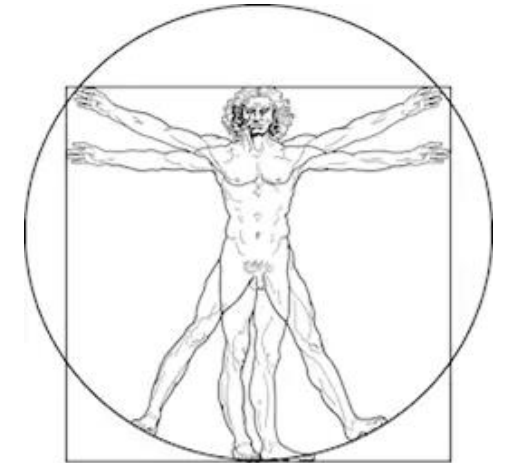


“Ask not what’s inside your head,  
but what your head’s inside of.”

[William W. Mace to summarize Gibson’s Theories, 1977]

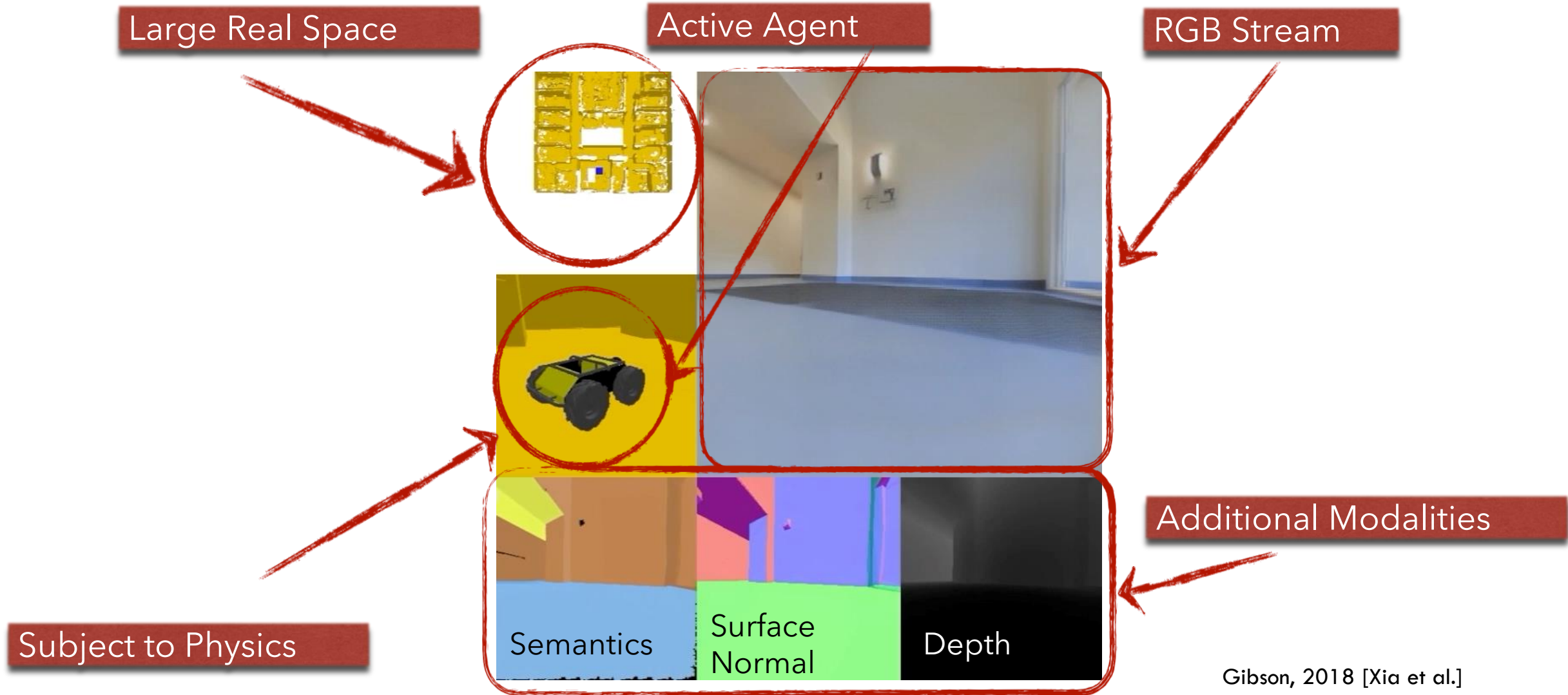
# Our Goal:

*Create an interactive environment where robotic agents can perform interactive tasks*



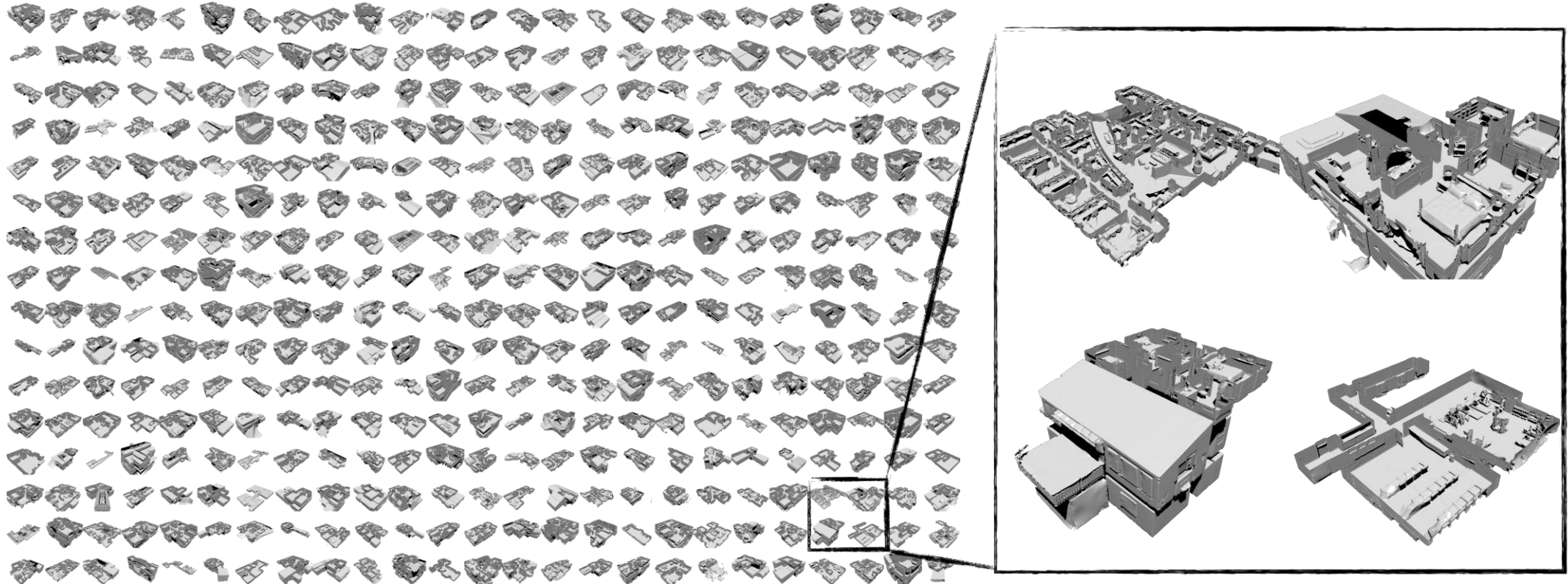
# Gibson v1

*Real-world perception for embodied agents based on 3D reconstructed full environments*



# Gibson v1

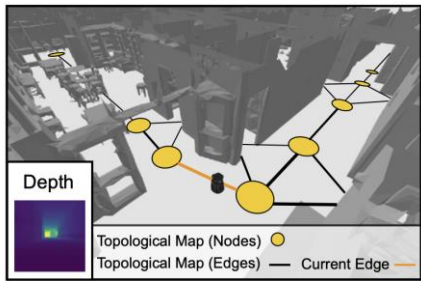
*Large database of 3D reconstructed large environments that maintain real-world distributions*



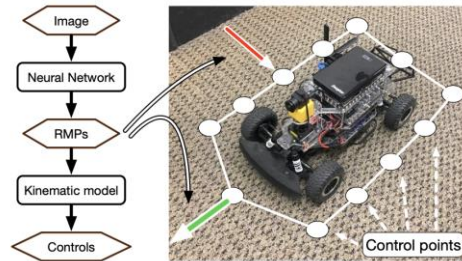
572 full buildings. Real spaces, scanned with 3D scanners.  
211,000 m<sup>2</sup>. 1400+ floors.

# Gibson v1

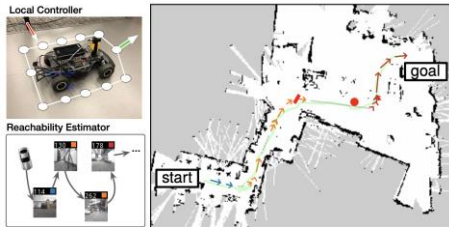
A very useful simulation environment for the community



[A behavioral approach to visual navigation with graph localization networks, Chen et al., RSS19]



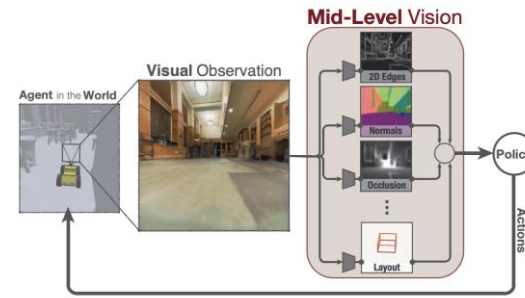
[Neural Autonomous Navigation with Riemannian Motion Policy, Meng et al., ICRA19]



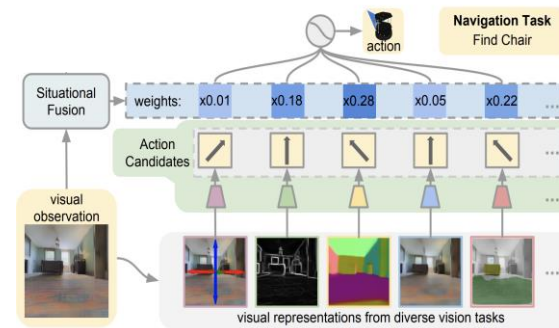
[Scaling Local Control to Large-Scale Topological Navigation, Meng et al., 2019]



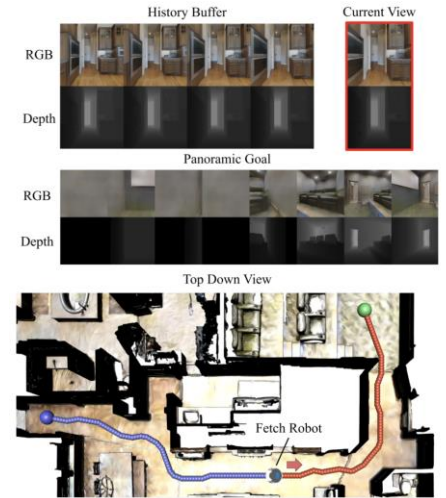
[Generalization through Simulation: Integrating Simulated and Real Data into Deep Reinforcement Learning for Vision-Based Autonomous Flight, Kang et al., ICRA19]



[Mid-Level Visual Representations Improve Generalization and Sample Efficiency for Learning Visuomotor Policies, Sax et al., 2018]



[Situational Fusion of Visual Representation for Visual Navigation, Shen et al., CVPR19]



[Learning Your Way Without Map or Compass: Panoramic Target Driven Visual Navigation, Watkins-Valls et al., 2019]



[Deep Visual MPC-Policy Learning for Navigation, Hirose et al., RAL2019]



# The Need of a New Simulation Environment

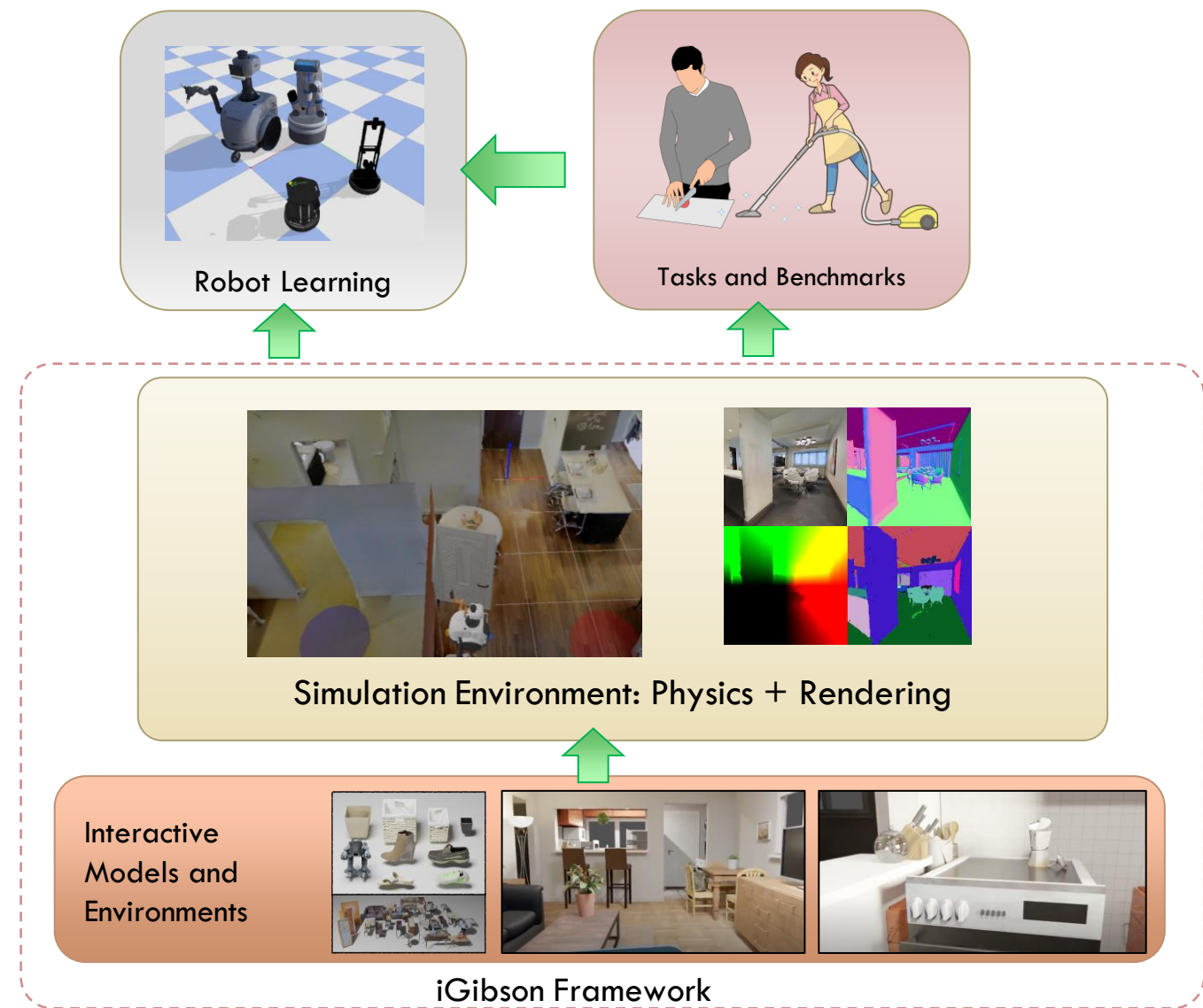
*iGibson: A realistic full environment with free interactions and visual realism*

Simulator	Challenge	Physics Realism and Interaction Type	Changing Object State beyond poses	Visual Quality	Type of Environment	Speed vs. real-time*
Atari	visuo-motor coordination	videogame	yes	1990s graphic	videogame	2x
Dota2	multi-unit planning	videogame	yes	synthetic	videogame	N/A
Mujoco, Bullet	visuo-motor coordination (manipulation)	kinematic manipulation	no	synthetic	tabletop	30x
RLBench, Meta-world	meta-learning motion planning	kinematic manipulation	no	synthetic	tabletop	30x
Sapien	visuo-motor coordination (manipulation)	kinematic manipulation	no	synthetic	few objects in an artificial room	30x
Gibson v1	visuo-motor coordination (navigation)	locomotion	no	reconstructed (LQ)	full real building	3x
Habitat	visuo-motor coordination (navigation)	locomotion	no	reconstructed (HQ)	full real building	30x
AI2Thor	task planning	scripted manipulation	yes	synthetic	full artificial building	2-3x
iGibson	visuo-motor coordination (nav.+man.) task planning	kinematic manipulation and locomotion	no (but planned)	reconstructed + synthetic	full real building	20x

\*Real time is defined as 30 frame per second rendering speed

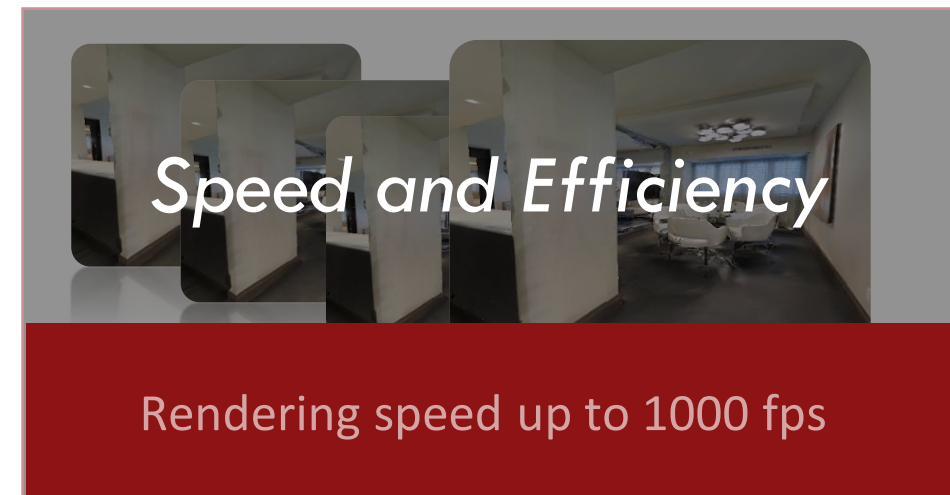
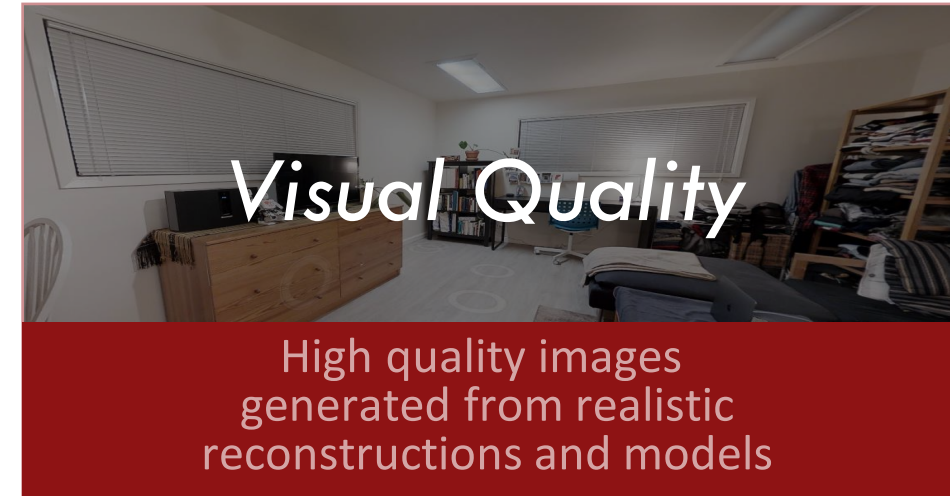
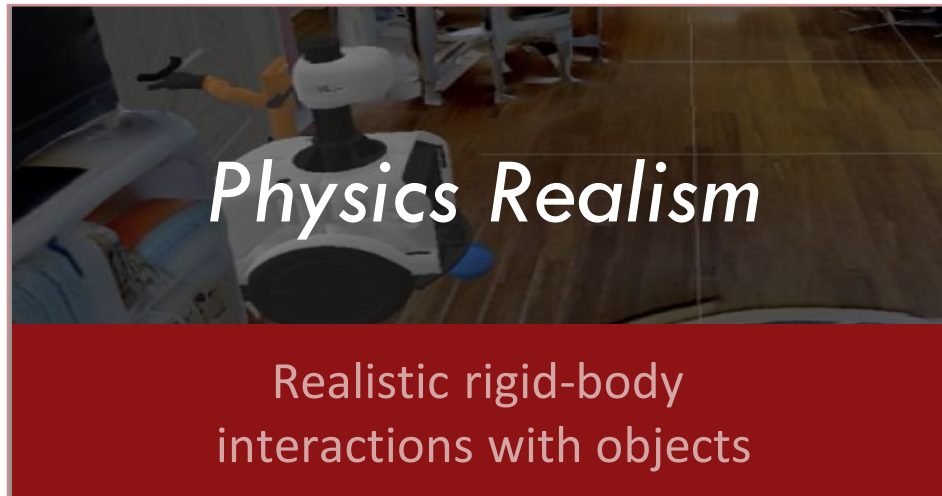
# iGibson system overview

Three-level hierarchy from assets to tasks



# Features of iGibson

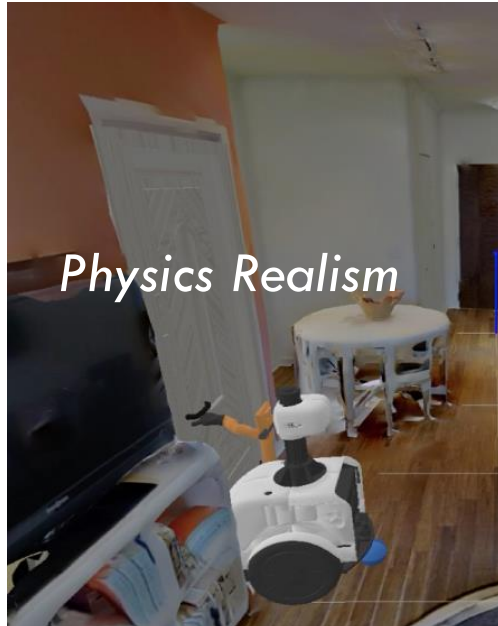
*Physically realistic large environments with free interactions and fast high-quality images*



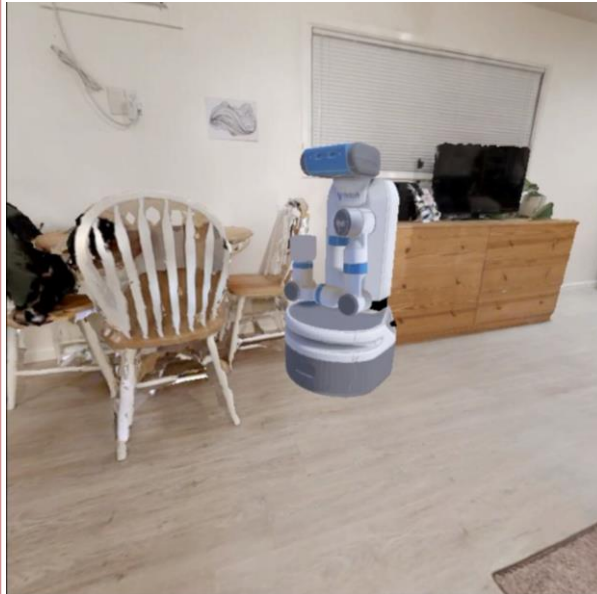


# iGibson - Physics Realism

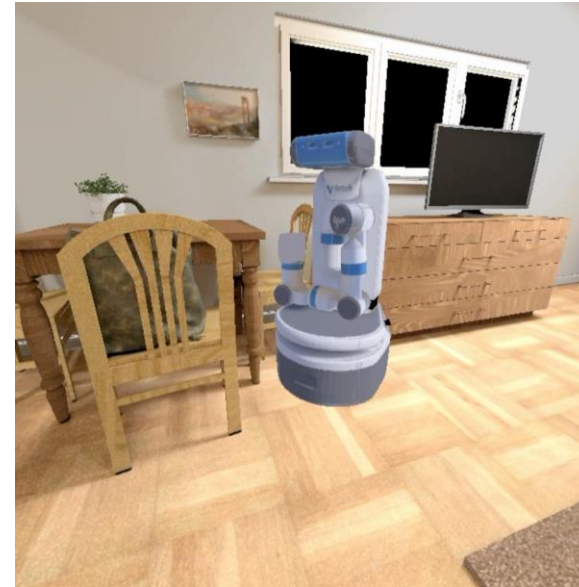
*Unconstrained rigid-body interaction with objects*



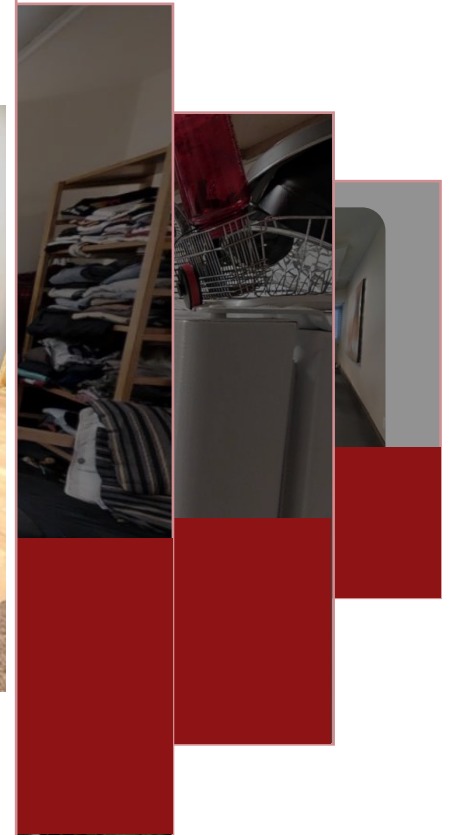
Realistic rigid-body interactions with objects



Gibson V1  
Static Environment



iGibson  
Interactive Environment



# iGibson - Physics Realism

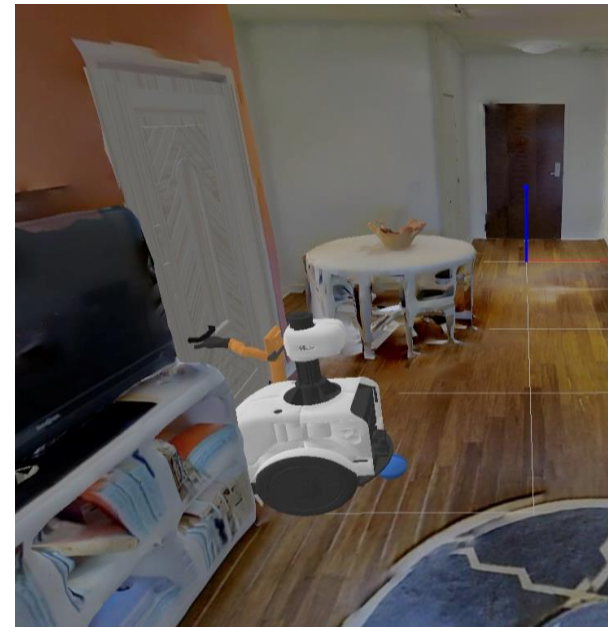
*Unconstrained rigid-body interaction with objects*



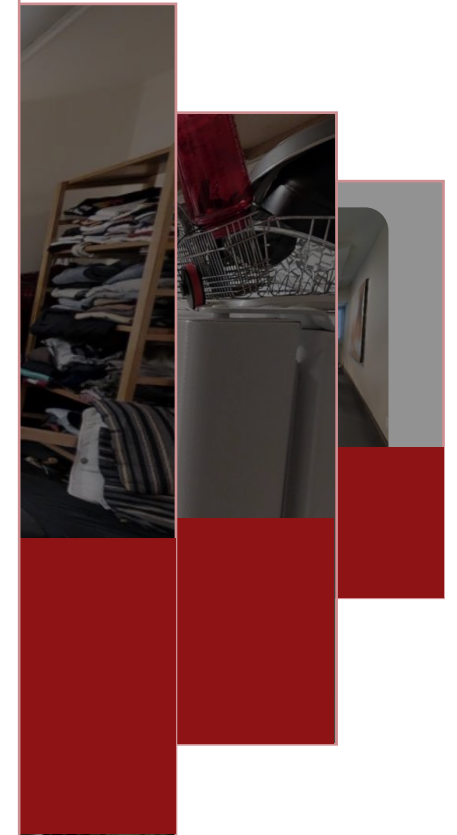
Realistic rigid-body interactions with objects



Push objects



Open doors



# iGibson - Visual Realism

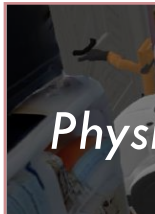
*Scenes reconstructed and modeled from real world and rendered with high quality*



Visual Quality



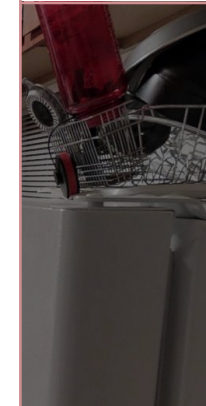
Real World



Physi

Re  
intera

High quality images  
generated from realistic  
reconstructions and models



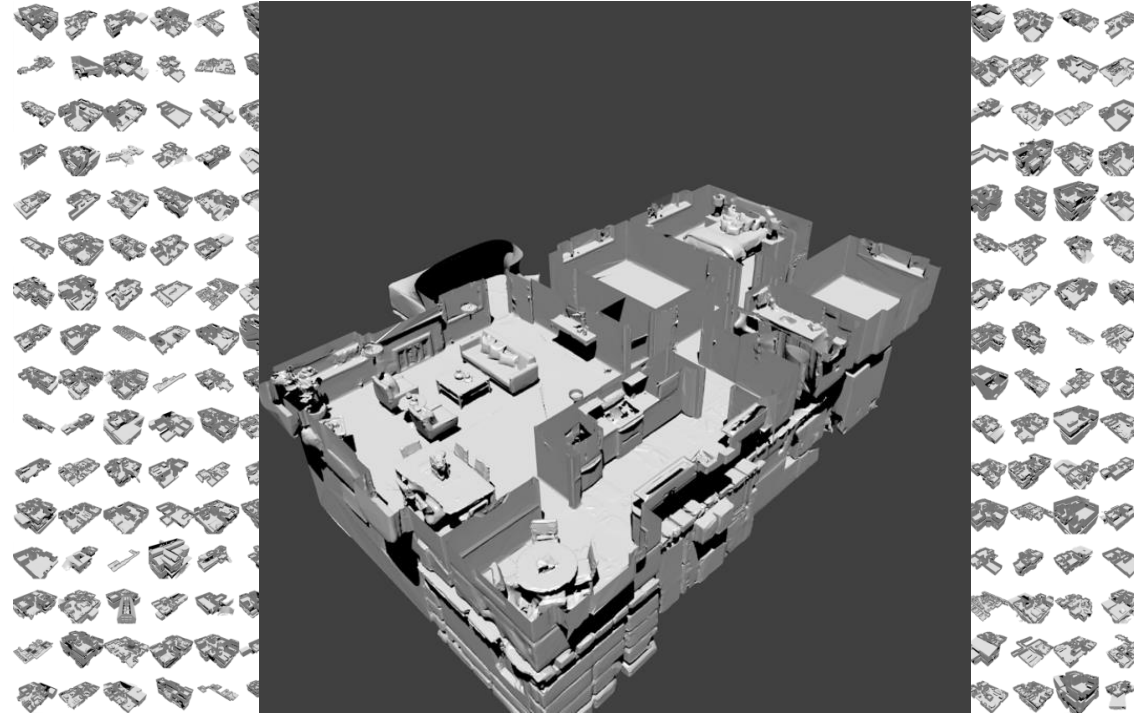
# iGibson - Ecological Scenes

*iGibson scenes have ecological semantic distribution*



Ecological Scenes

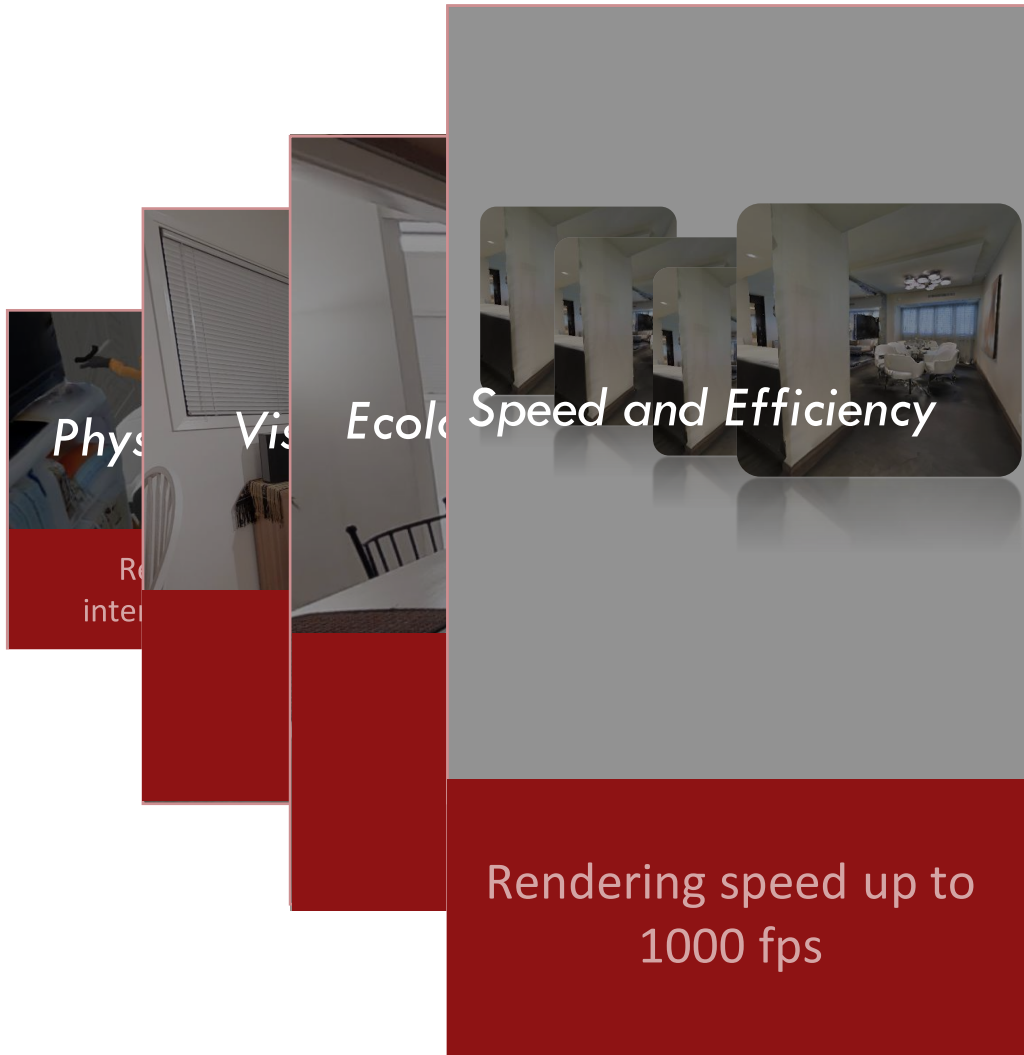
Ecological distribution of  
objects and clutters



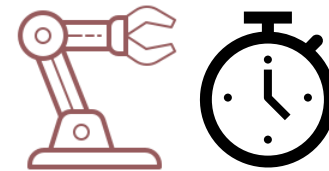
- iGibson comes with 572 high-quality full 3D reconstructed real environments
- Distributions of objects and rooms come from real world
- Tasks are defined in entire environments

# iGibson - Simulation Speed

*Accelerating robot learning and enabling virtual reality*



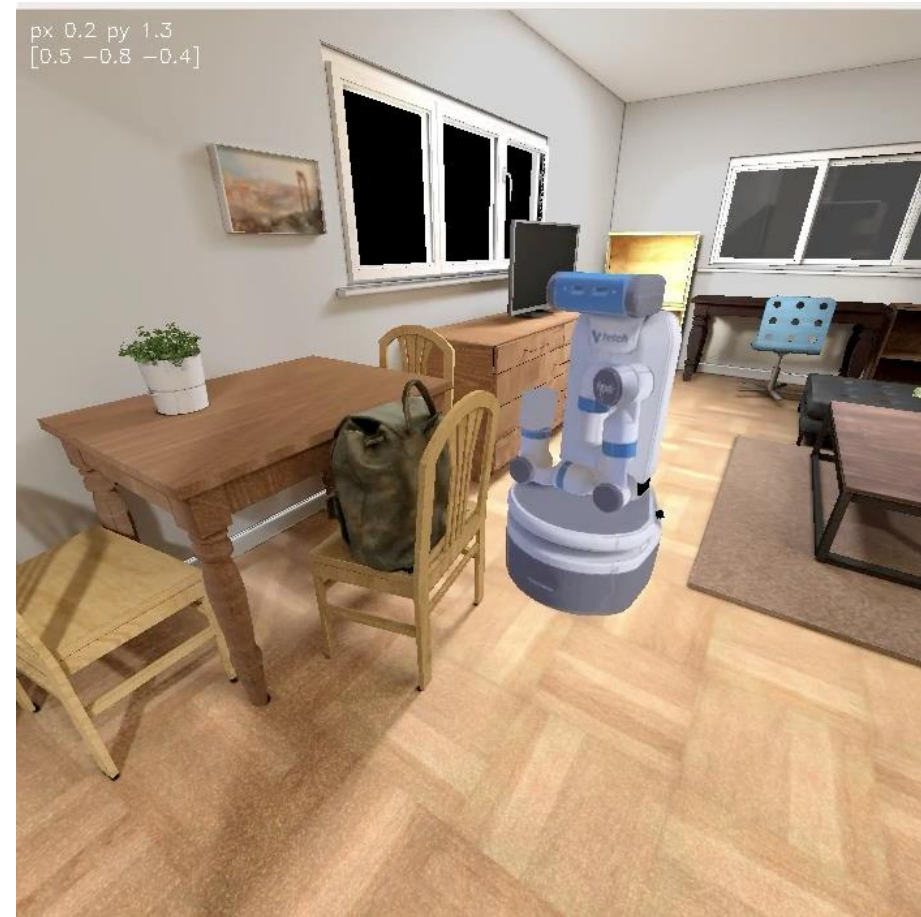
Computation	Render Target	
	GPU Tensor	CPU Memory
Physics Simulation + Rendering RGB Image	421 fps	205 fps
Rendering RGB Images	778 fps	265 fps
Rendering Surface Normal Images	878 fps	266 fps



Robot Learning:  
Weeks → Hours

# iGibson - Next Step

*Transforming more environments into fully interactive*



We include a cleaned environment with fully interactive set of objects.  
We are working on releasing 9 more.

# Summary



- iGibson is a state-of-the-art simulator to train robots for visuo-motor tasks: navigation and manipulation
- Includes hundreds of model of real-world large environments with interactive objects
- Enables easier sim2real transference of learned strategies
- We continue improving iGibson in multiple fronts. Check it out!

# Download iGibson and try it yourself!



StanfordVL / iGibsonEnvV2

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Code Issues 15 Pull requests 1 Actions Projects 0 Wiki Security Insights Settings

Simulator for interactive navigation <http://svl.stanford.edu/igibson2/> Edit

Manage topics

1,476 commits 7 branches 0 packages 0 releases 10 contributors MIT

Branch: master New pull request Create new file Upload files Find file Clone or download

File	Commit	Time
docs	update	3 months ago
examples	yaml radian to degree change	3 months ago
igibson2	change floor height	3 months ago
misc	gcp guide	17 months ago
test	yaml radian to degree change	3 months ago
.dockerignore	update download instructions	2 years ago
.gitignore	add renderer	15 months ago
.gitmodules	add renderer	15 months ago
.style.yapf	yapf style	10 months ago
.yapfignore	yapf style	10 months ago
LICENSE	Initial commit	2 years ago
README.md	motion planning libraries, internalize tinyobjloader, and cleanups	4 months ago
clean.sh	add topdown shader for plotting	6 months ago
setup.py	tensor renderer revived	4 months ago

Interactive Gibson Environment



iGibson Code



iGibson Website

## Interactive Gibson Environment

Large Scale Virtualized Interactive Environment for Learning Robot Manipulation and Navigation

HOME FEATURES DEMOS TEAM DOCS

### Introduction

Interactive Gibson is a fast simulator and a dataset for indoor navigation and manipulation. It was first released in June 2019. It allows for complicated interactions between the agent and the environment, such as picking up and placing objects, or opening doors and cabinets. This environment opens up new venues for jointly training base and arm policies, allowing researchers to explore the synergy between manipulation and navigation.

If you use Interactive Gibson Simulator or Interactive Gibson assets, please consider citing the following paper:

Fei Xia, Chengshu Li, Kevin Chen, William B. Shen, Roberto Martin-Martin, Noriaki Hirose, Amir B. Zamir, Li Fei-Fei, and Silvio Savarese. "Gibson env V2: Embodied Simulation Environments for Interactive Navigation." 2019. [Simulator] [Documentation] [Tech report (outdated)] [Dataset] [New tech report coming soon] [BibTeX]

### Physics Interaction with Articulated Objects

300+ door annotations  
support articulated objects (cabinets, doors, fridge, oven, window etc.)

#### Feature set

- Dataset site: Interactive Gibson dataset contains 572 buildings, 1400 floors, and 21k square meters of indoor spaces.
- Interactive Objects: We augment 106 scenes with 1984 interactable CAD model alignments of 5 different object categories: chairs, desks, doors, sofas, and tables.
- URDF Robot support: Support Mujoco humanoid and ant, Freight, Husky and Turibot v2, MiniStar, Fetch and JackRabbit v1/v2 and a quadcopter.
- Articulated Objects: We can simulate articulated objects such as doors and cabinets.

<https://github.com/StanfordVL/iGibson>



<http://svl.stanford.edu/igibson>





# Install it with “pip”



```
fei@deepFei: ~  
(py35) ~ »  fei@deepFei
```



# Install it with “pip”

```
python -m gibbon2.envs.demo_interactive
, 0.0) (0.0, 0.0, 0.0, 1.0) (1.0, 1.0, 1.0, 1.0) (1.0, 1.0, 1.0)
attrib.vertices = 1020
Num materials: 1
material_0
[1.0, 1.0, 1.0]
Num shapes: 1
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0.0) (0.0, 0.0, 0.0, 1.0) (1.0, 1.0, 1.0)
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)
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material_0
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Num shapes: 1
```



# Thank you!

*iGibson Team and collaborators*



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