HOLODECK: Language Guided Generation of 3D Embodied AI Environments

Yue Yang*[1], Fan-Yun Sun*[2], Luca Weihs*[4], Eli VanderBilt[4], Alvaro Herrasti[4], Winson Han[4], Jiajun Wu[2], Nick Haber[2], Ranjay Krishna[3], Lingjie Liu[1], Chris Callison-Burch[1], Mark Yatskar[1], Aniruddha Kembhavi[4], Christopher Clark[4]
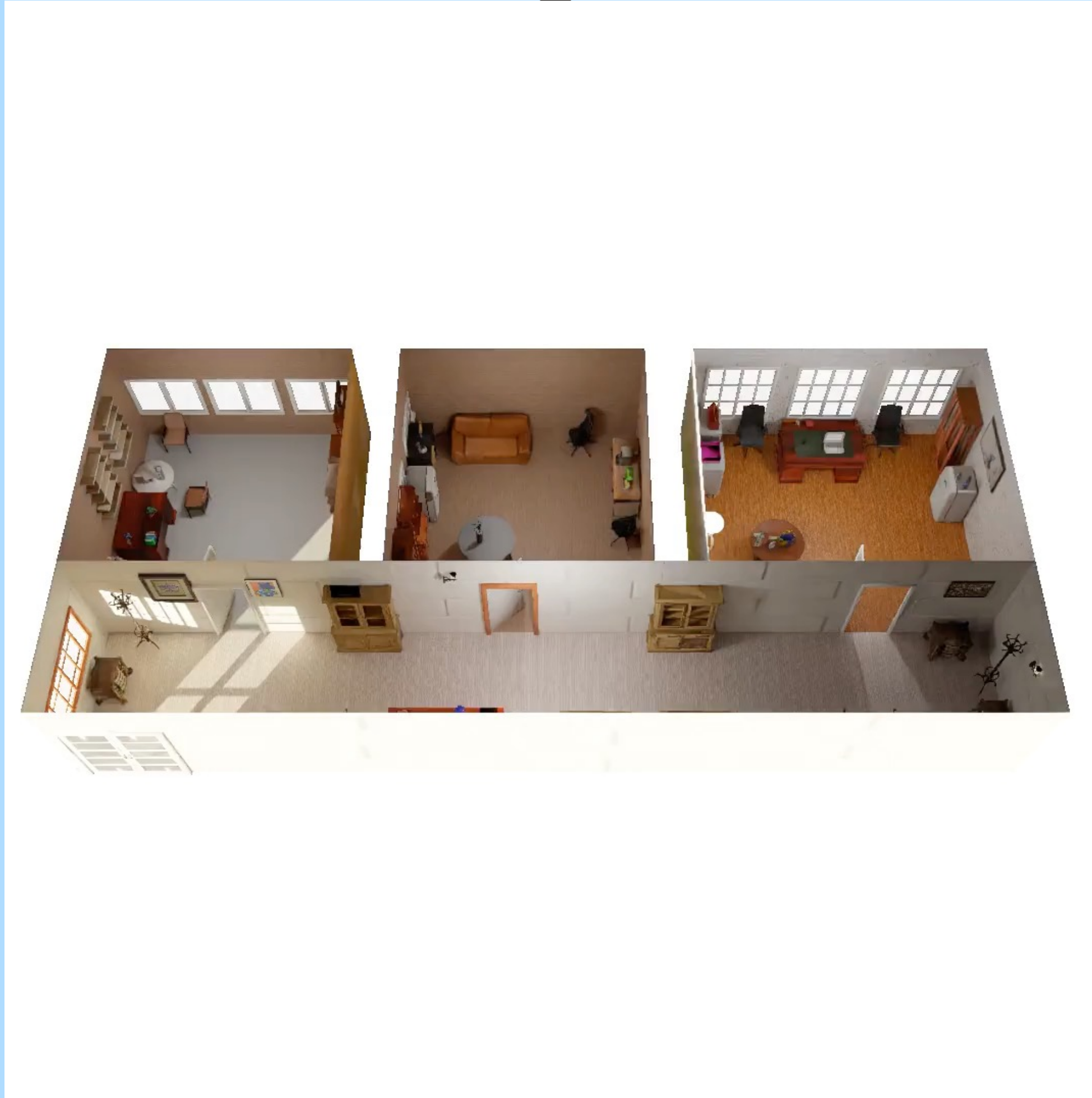
*Equal technical contribution.

[1]University of Pennsylvania, [2]Stanford University, [3]University of Washington, [4]Allen Institute for Artificial Intelligence

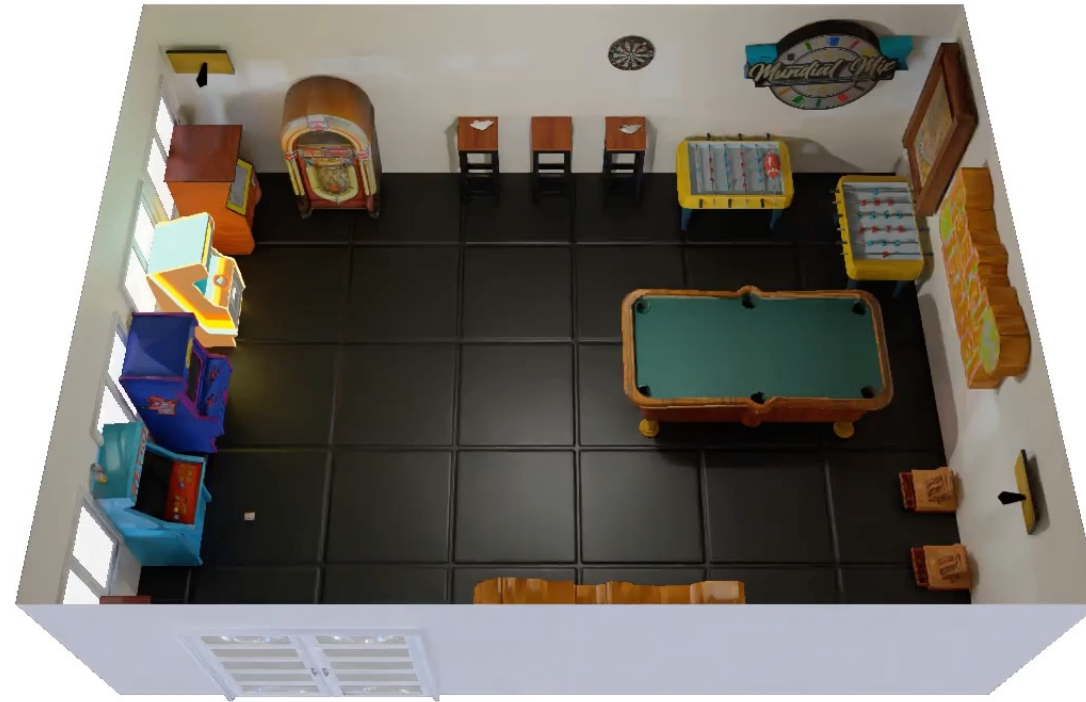https://yueyang1996.github.io/holodeck/

Three professors' office connected to a long hallway, the professor in office-1 is a **fan of Star Wars**.
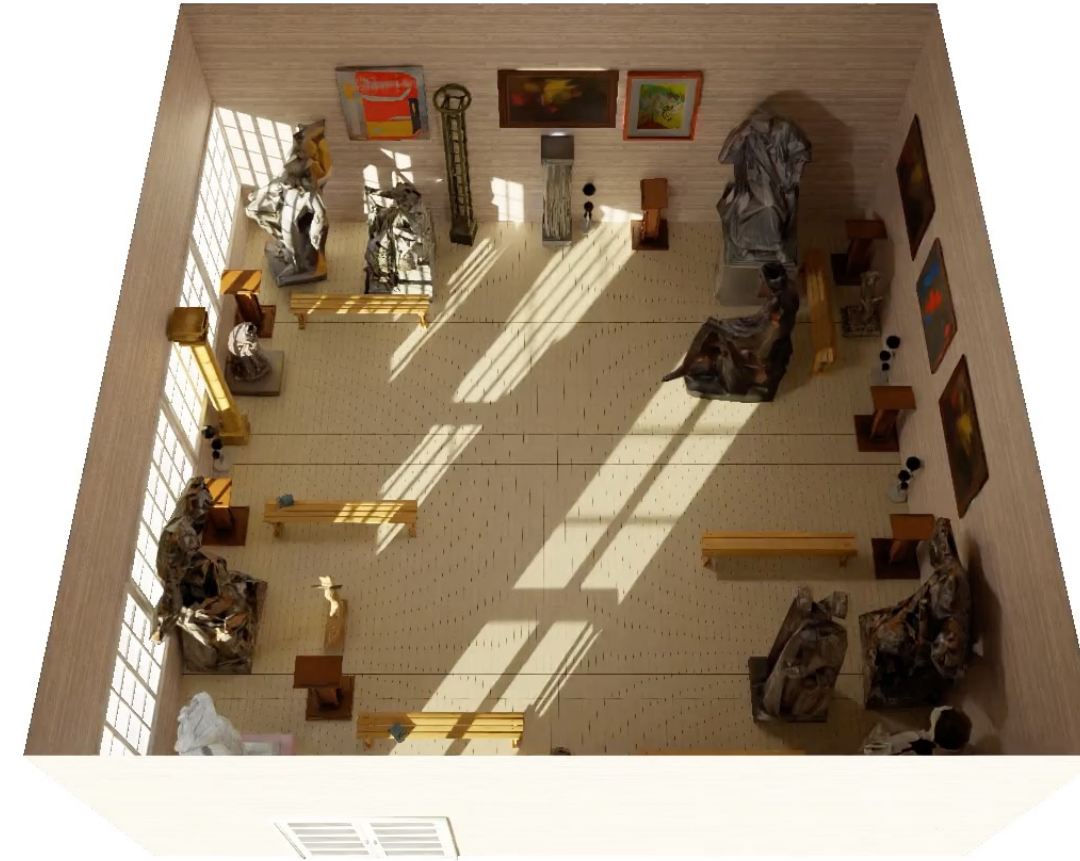
a 1b1b apartment of a researcher
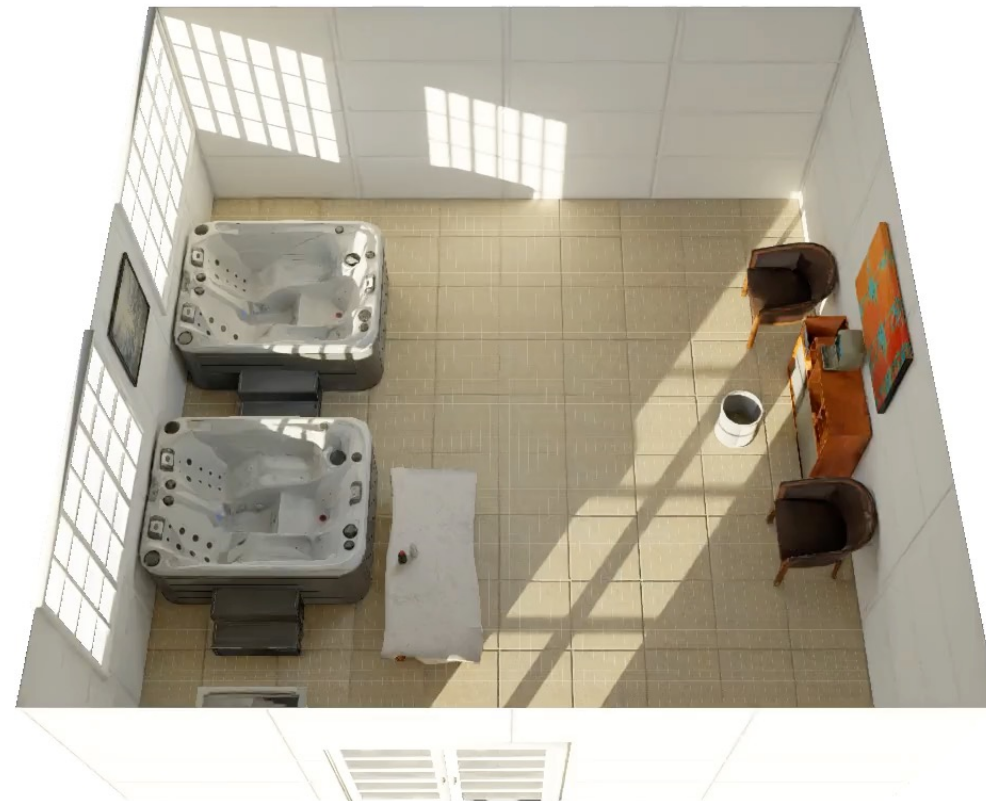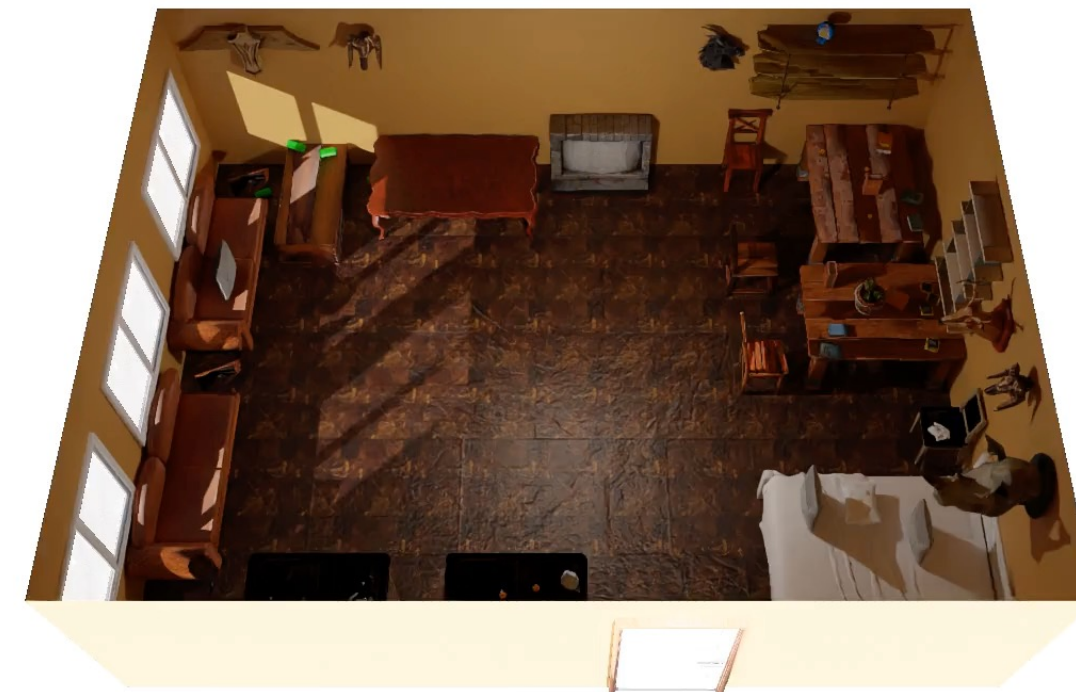## who **has a cat**

arcade room

sculpture museum

spa

hunter cabin

modern style

Victorian style

Bohemian style

Industrial style

Prompt | LLM Response

Floor Module & Wall Modules

Please design the **floor plan** with the following format:
room type | floor material | wall material | vertices

1. living room | oak hardwood | cream-colored stucco | [(0, 0), (0, 6), (7, 6), (7, 0)]
2. kitchen | blue marble tile…

Room Vertices

Select Materials

oak hardwood

Doorway & Window Modules

Please design the **doorway** with the following format:
room 1 | room 2 | connection type | size | style

1. living room | bathroom | doorway | single | wooden door with black handle
2. living room | kitchen | open

Please design the **window** with the following format:
room | direction | type | size | quantity | height (in cm)

1. living room | west | hung | (130, 130) | 4 | 80
2. kitchen | south | slider | (150, 92) | 2 | 100 …

Object Selection Module

Please help **select** the objects with the following format
category | description | size | quantity | children objects

1. coffee table | large round wood | (100, 100, 45) | 1 | mug
2. cat tower | multi-level | (60, 60, 180) | 1 | cat toy

Retrieve Assets: multi-level cat tower

Objaverse

Layout Design Module

Please tell me how to **arrange** these objects using constraints.
object-name | constraint-1 | constraint-2 | ……

1. sofa | edge
2. coffee table | middle | near sofa | face to, sofa
3. tv stand | edge | face to sofa

Spatial Relational Constraints

painting-1 · painting-2 · mug · tv stand · coffee table · sofa

above · above · on top of · near · face to, far
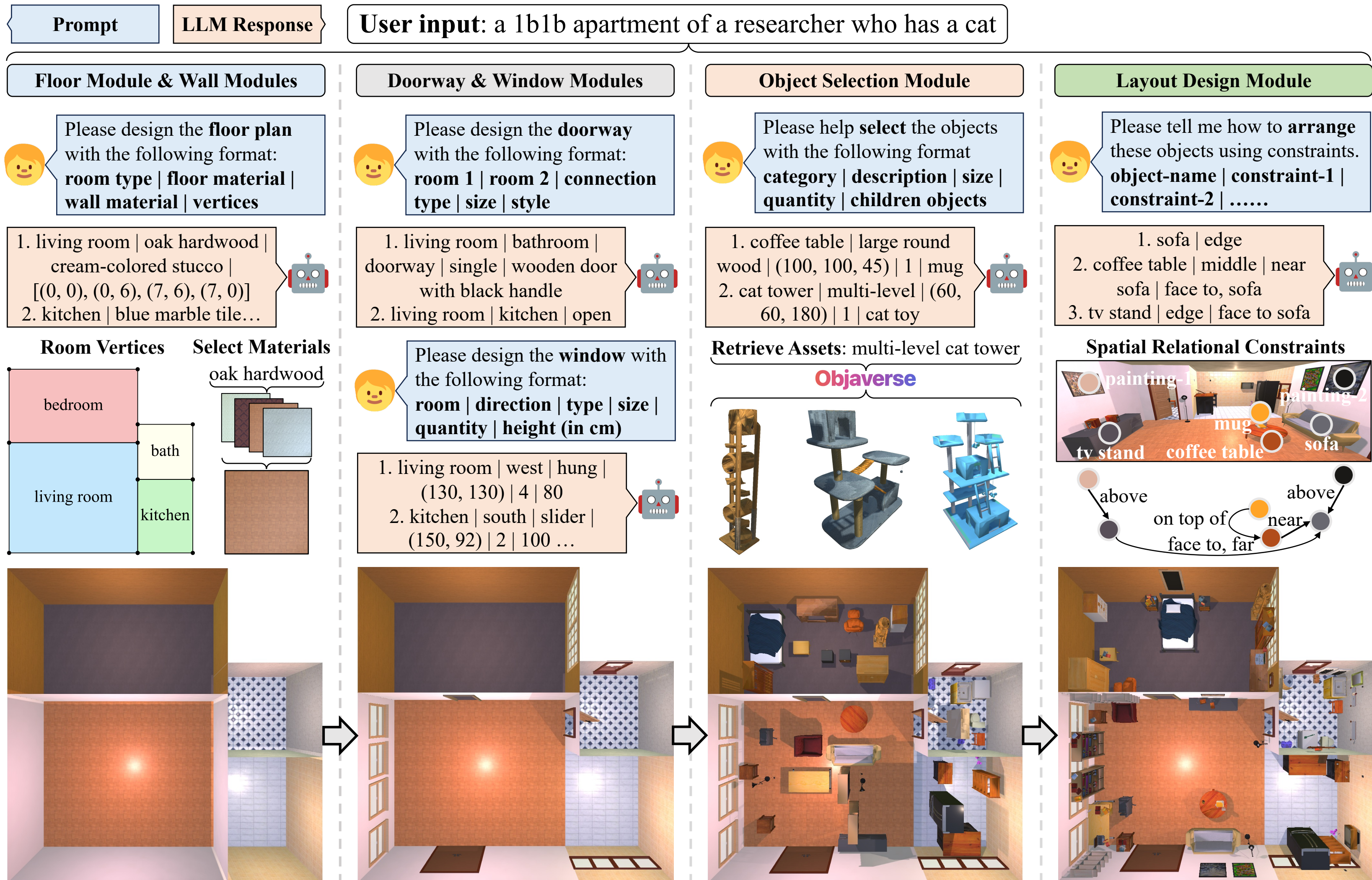
Customize Floorplan

a high school building with six classrooms connected
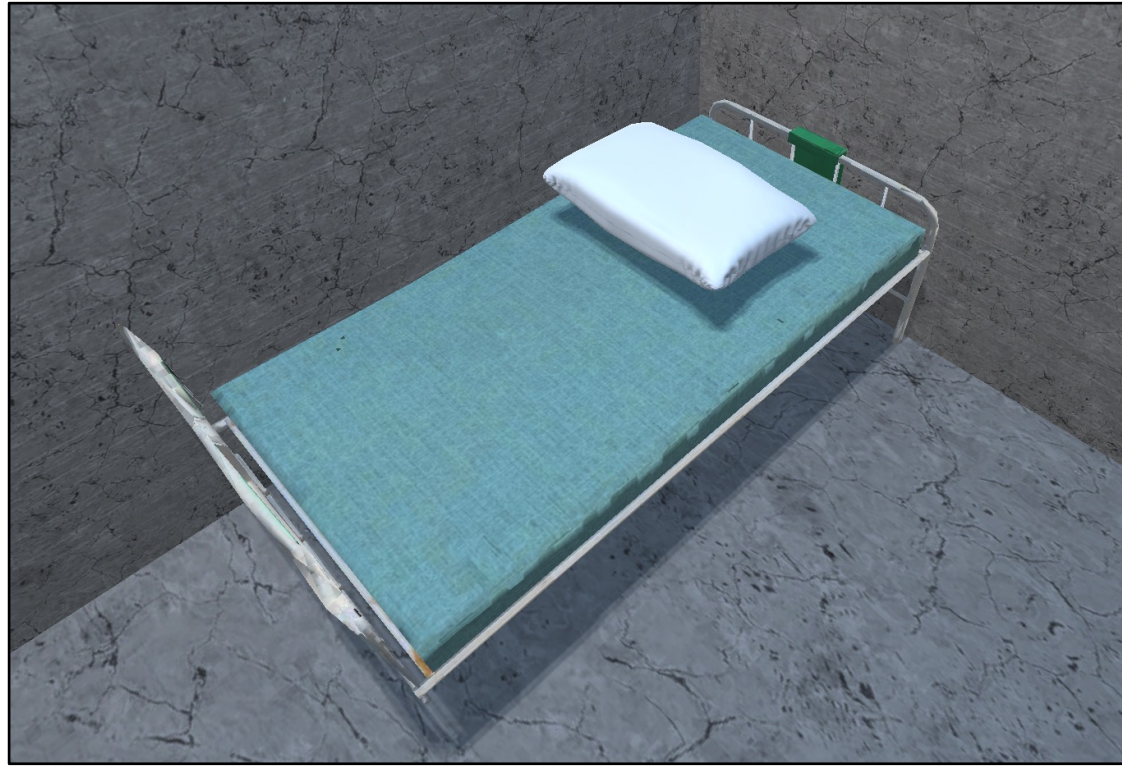to the two sides of a long hallway

☐ classrooms
☐ hallway
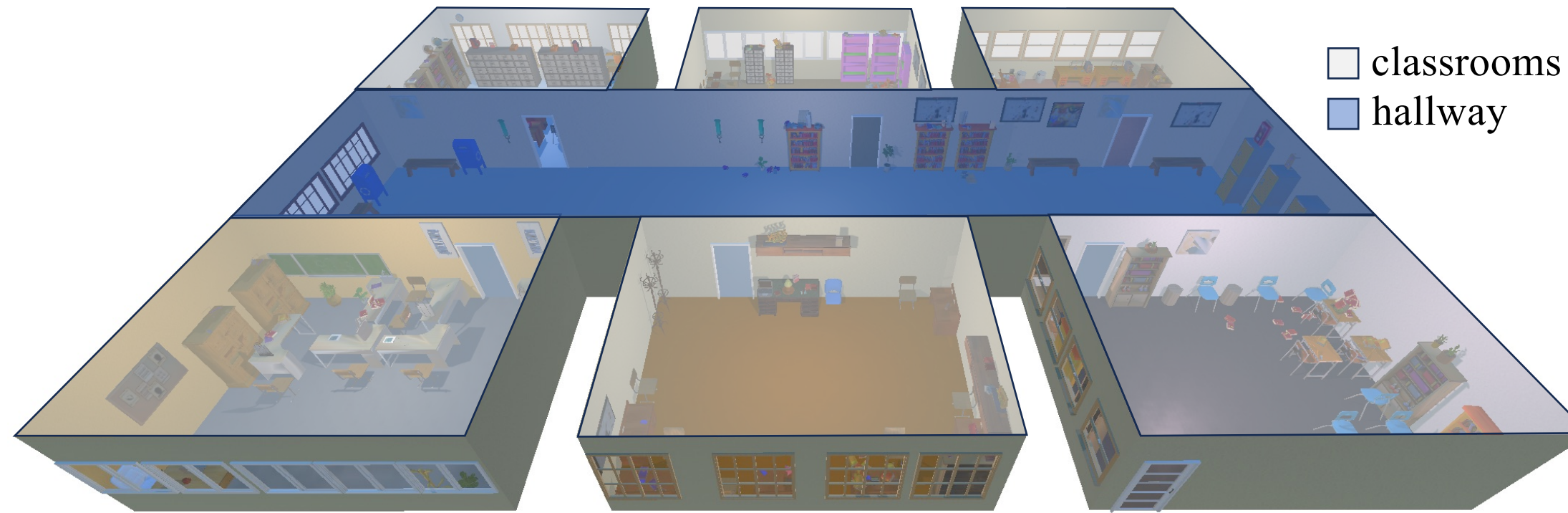
a house with a living room in the center and four bedrooms connected to each side of the
living room, shaped like a cross, each bedroom is connected to a bathroom

☐ living room
☐ bathrooms
☐ bedrooms
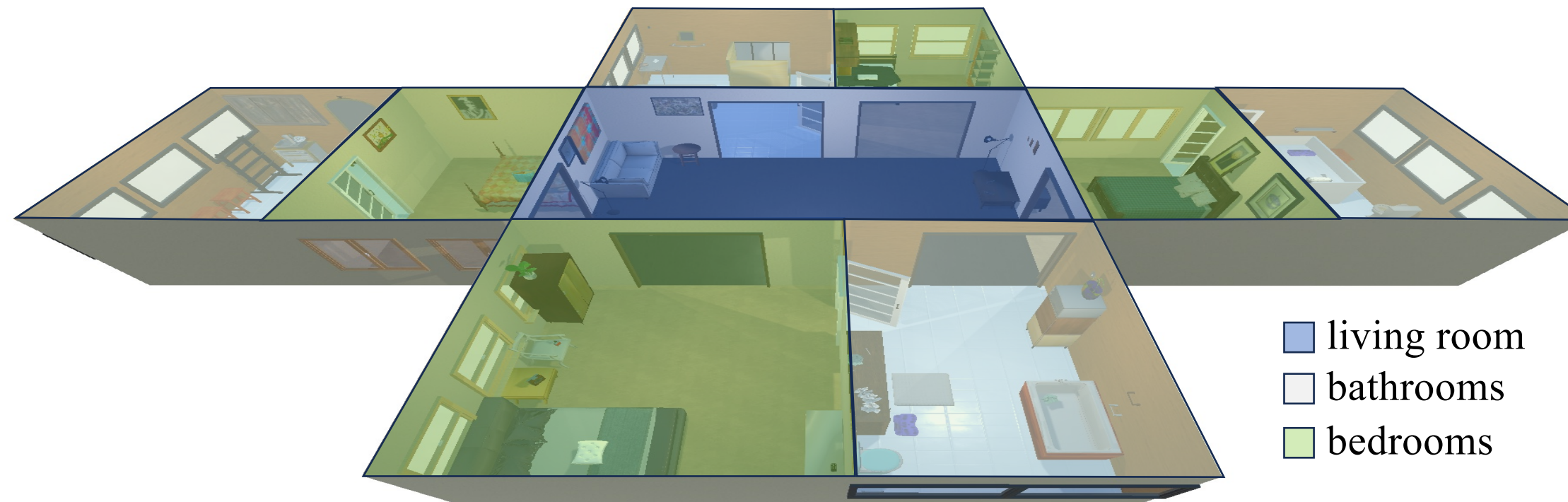
Customize Materials

a prison cell

a bedroom of a girl who loves the **pink color**

a wine cellar with **red wall bricks**

a 80s bar with **checkered** flooring

Customize Doorways & Windows

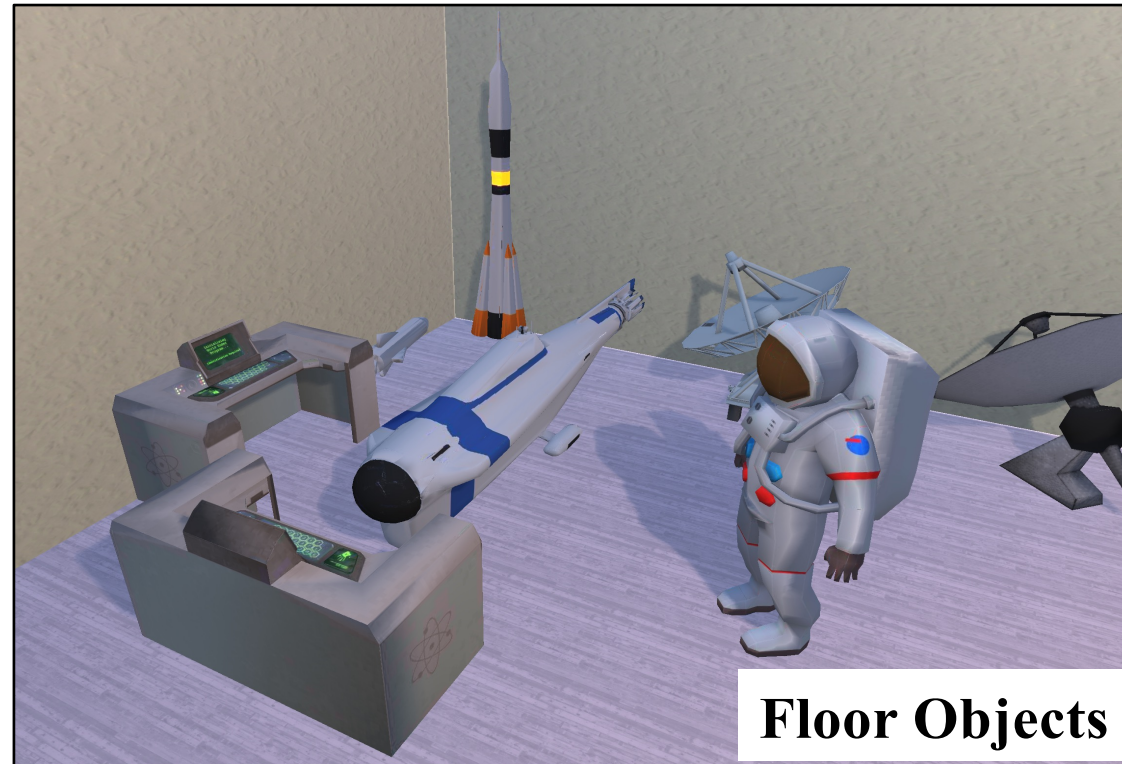an apartment for a disabled person who needs to use wheelchair

a sunroom with floor-to-ceiling windows covering all walls
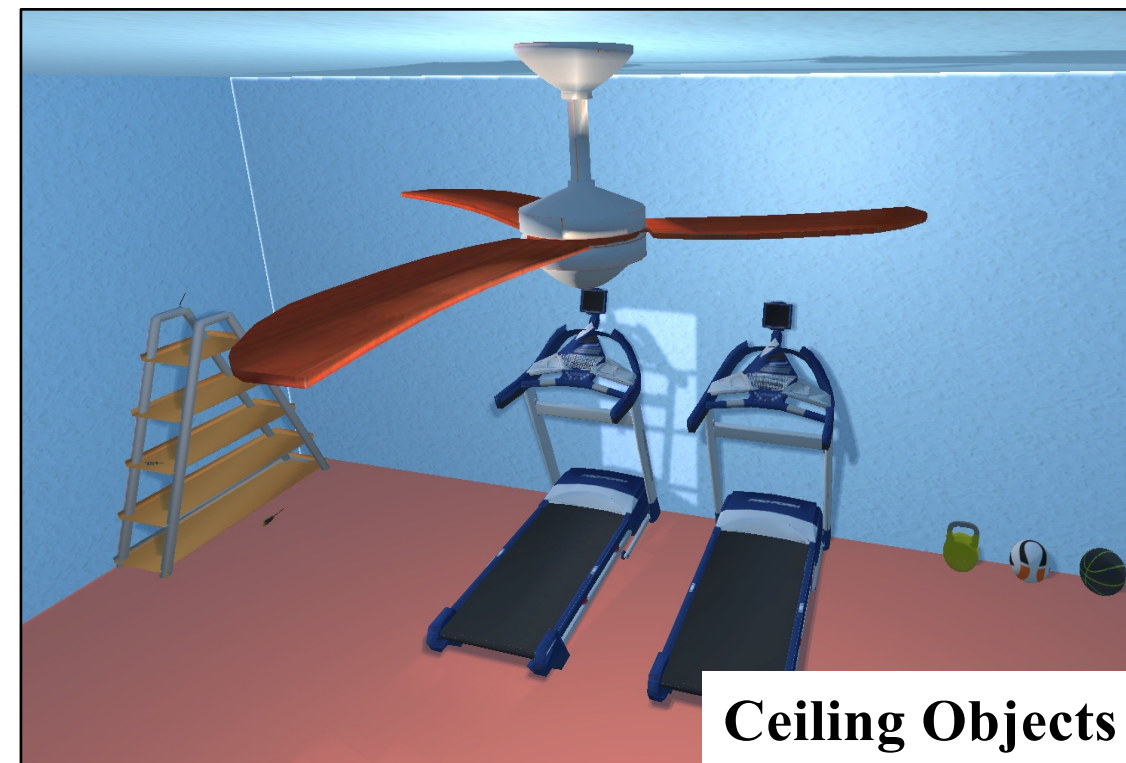
Customize Objects

an **aerospace** exhibition hall

Floor Objects

a hunter cabinet with **wall-mounted animals**

Wall Objects

a study room of a boy who likes **Pokémon**

Small Objects

a compact home gym with **a ceiling fan**

Ceiling Objects

Humans Prefer Holodeck Scenes
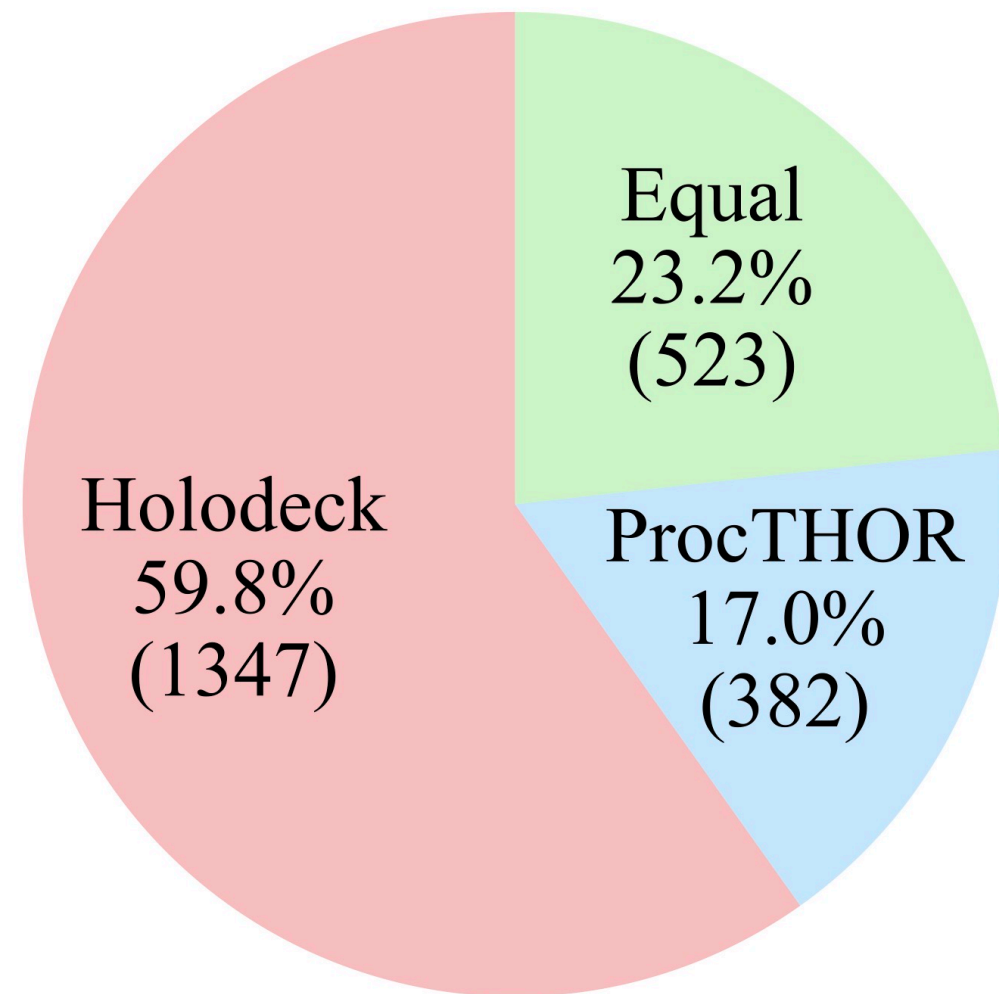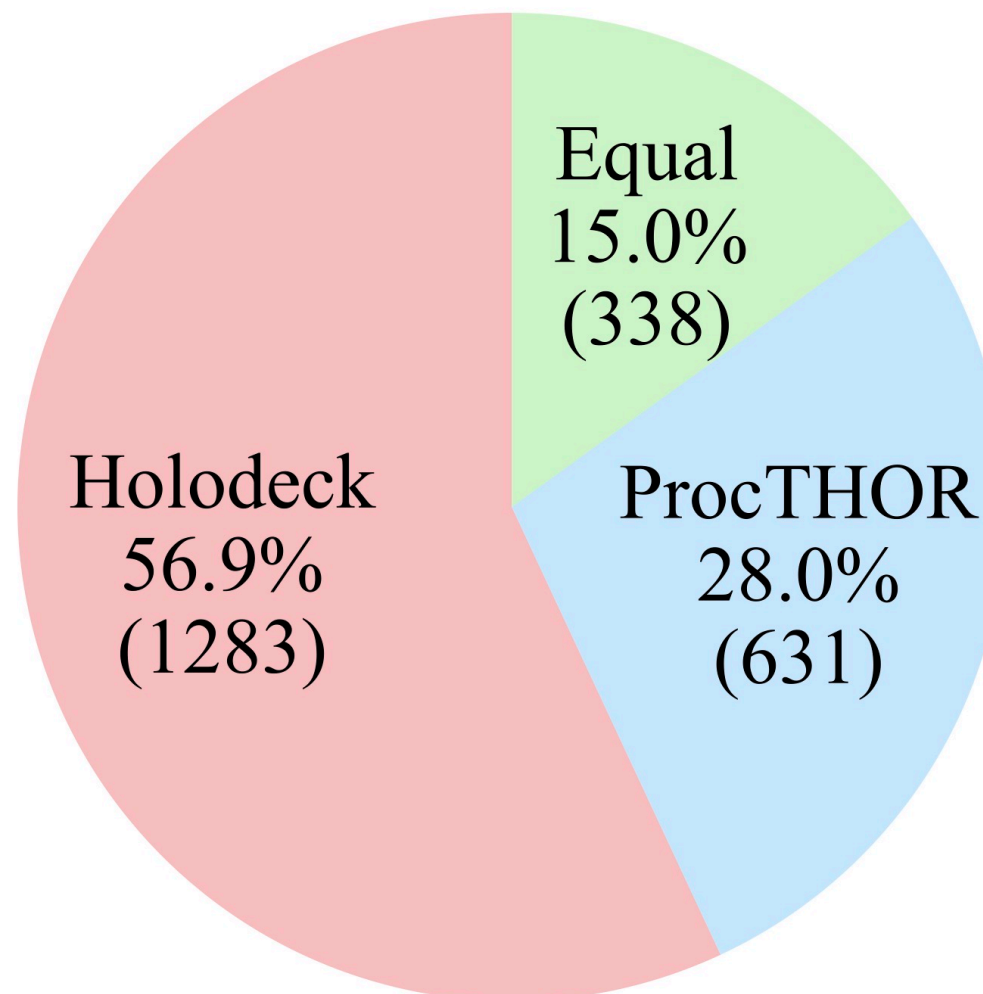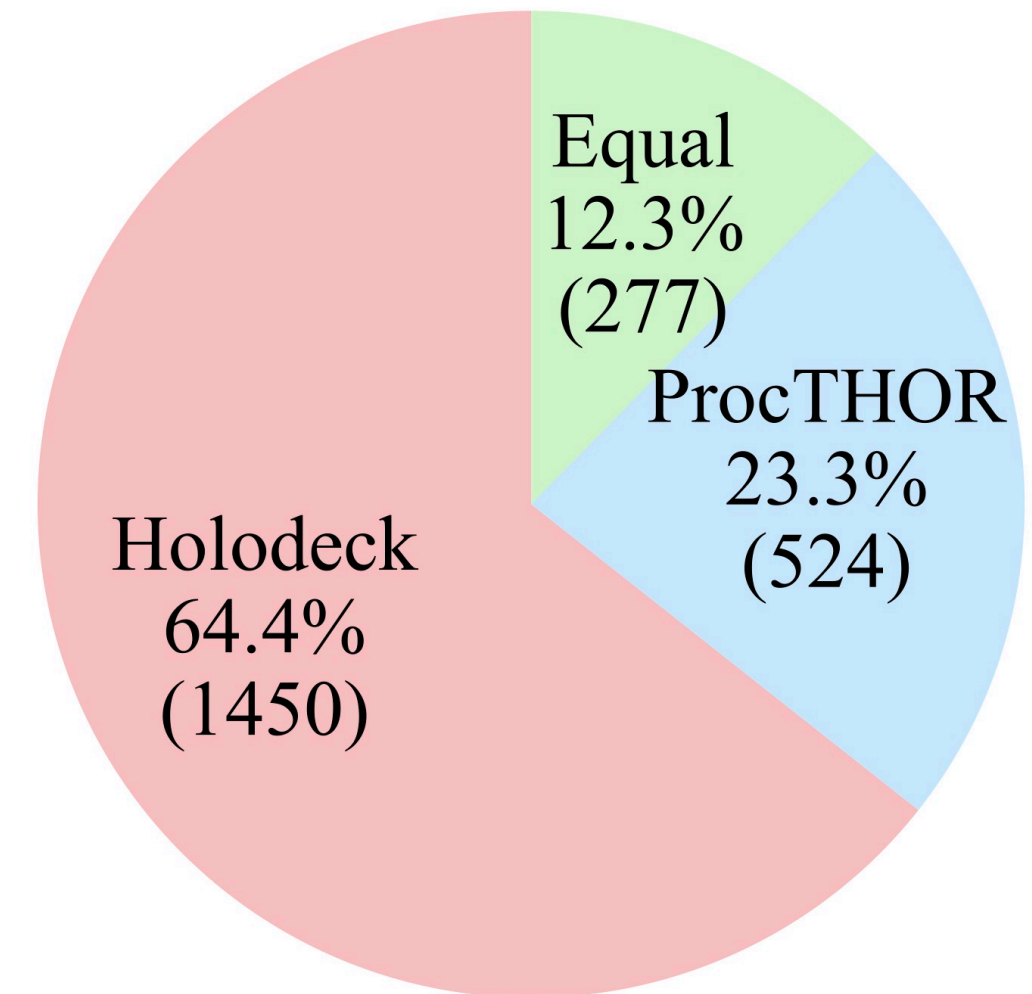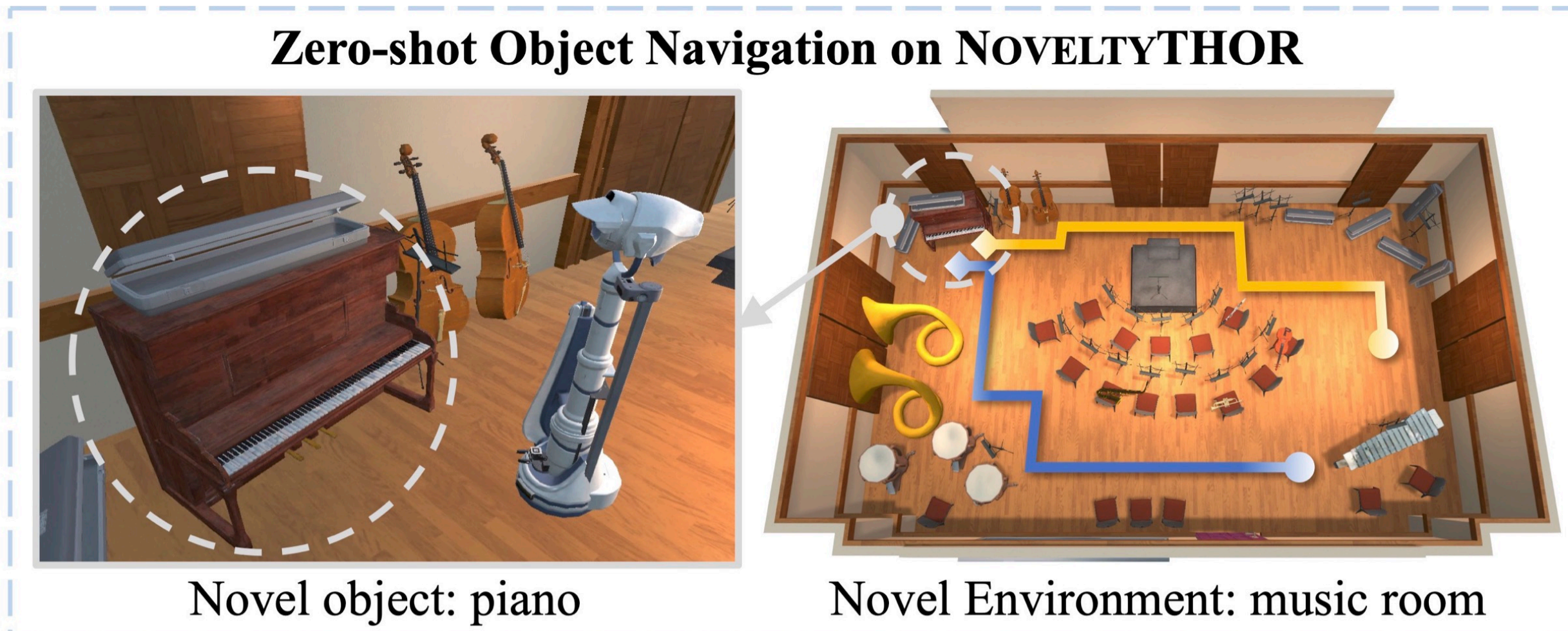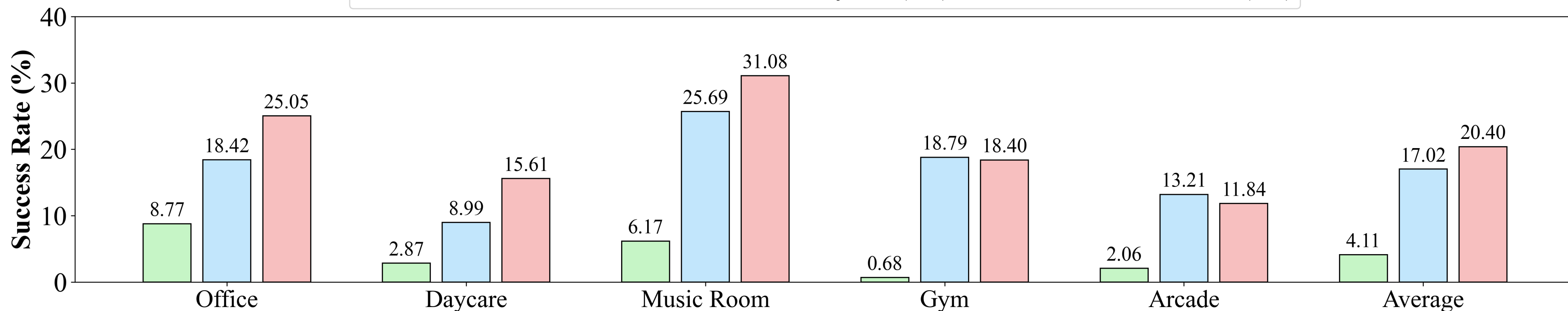

Deitke et al., ProcTHOR: Large-Scale Embodied AI Using Procedural Generation, 2022.

Object Navigation in Novel Environments

Pretraining on PROCTHOR

Fine-tuning on HOLODECK

Zero-shot Object Navigation on NOVELTYTHOR

Novel object: piano

Novel Environment: music room

Legend:
- Pretrain on ProcTHOR
- ProcTHOR + Objaverse (ours)
- ProcTHOR + Holodeck (ours)

Success Rate (%)

Environment	Pretrain on ProcTHOR	ProcTHOR + Objaverse (ours)	ProcTHOR + Holodeck (ours)
Office	8.77	18.42	25.05
Daycare	2.87	8.99	15.61
Music Room	6.17	25.69	31.08
Gym	0.68	18.79	18.40
Arcade	2.06	13.21	11.84
Average	4.11	17.02	20.40

Thank you!

https://yueyang1996.github.io/holodeck/