



# **ARPA-E Rapid Simulation and Modeling Project**

Extracting Building Floor Plans and 2.5D  
Models from 3D Point Clouds

# Example Indoor Model



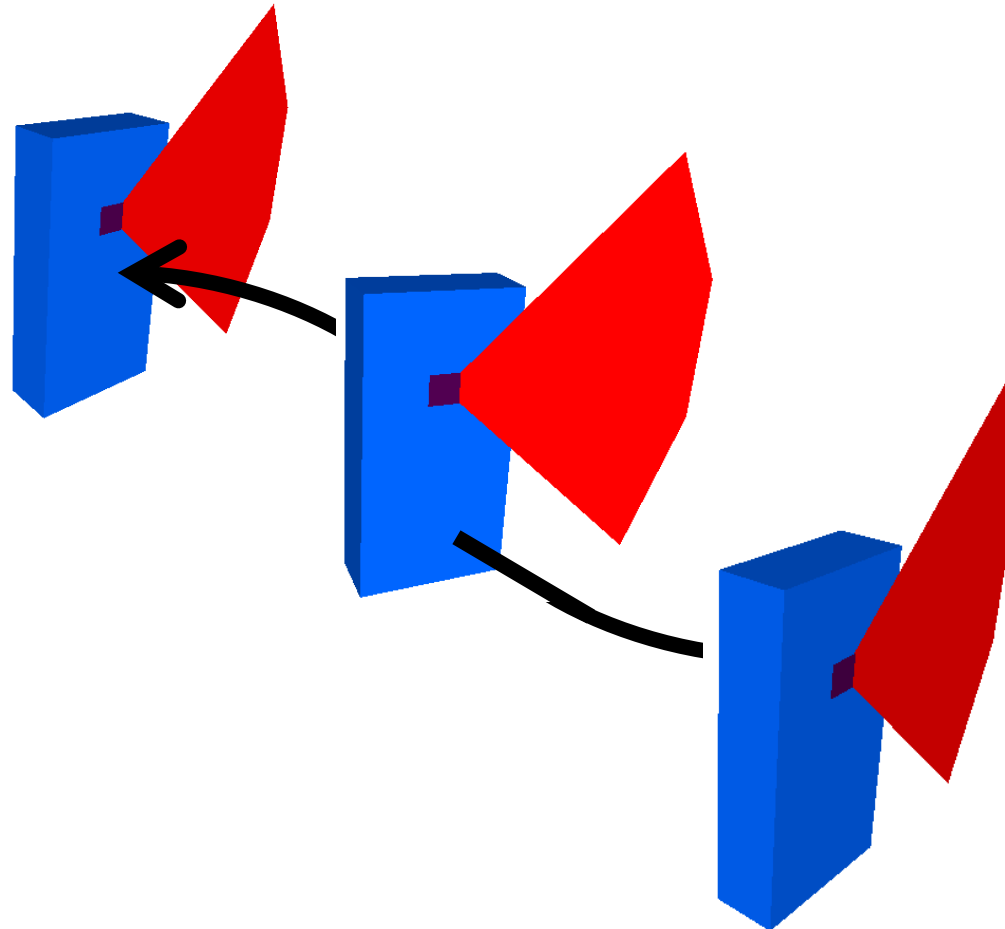
# Point-cloud Generation

- Acquisition System



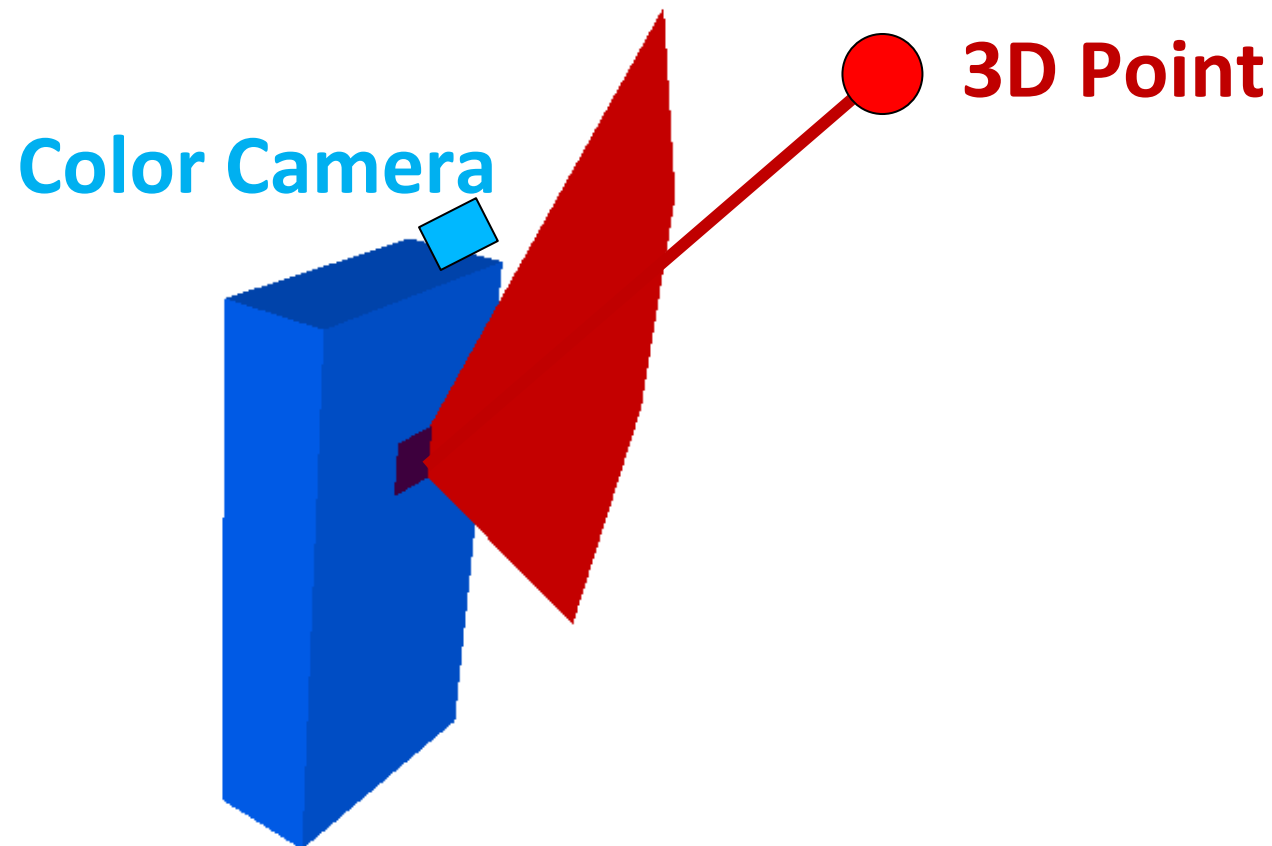
# Point-cloud Generation

- Motion of scanner



# Point-cloud Generation

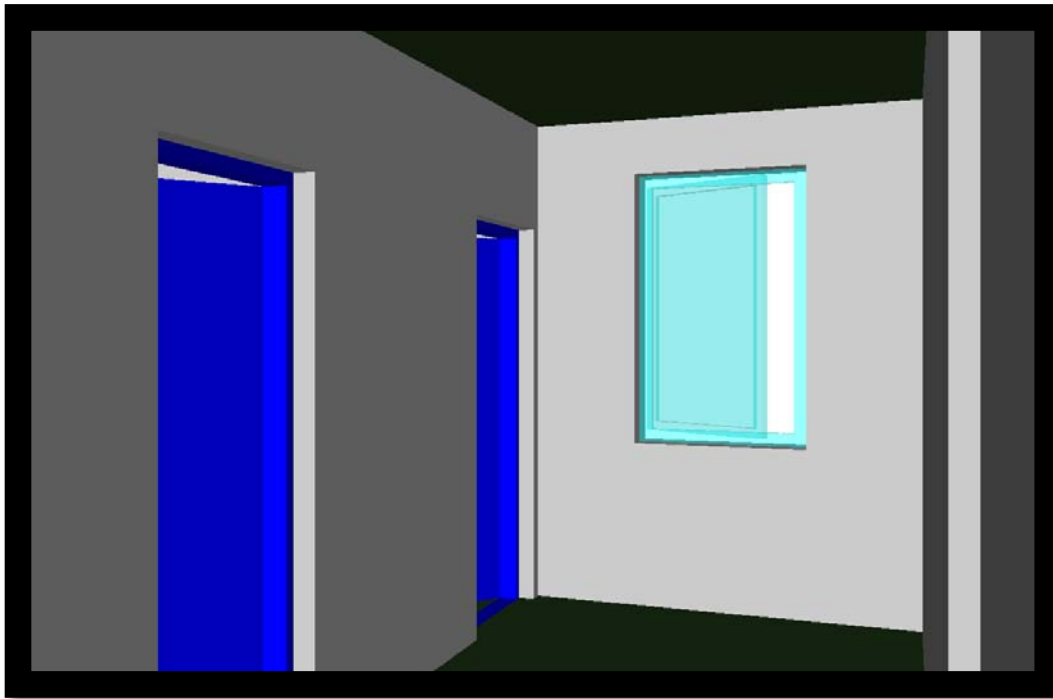
- Capturing and coloring points



# Example Point-cloud

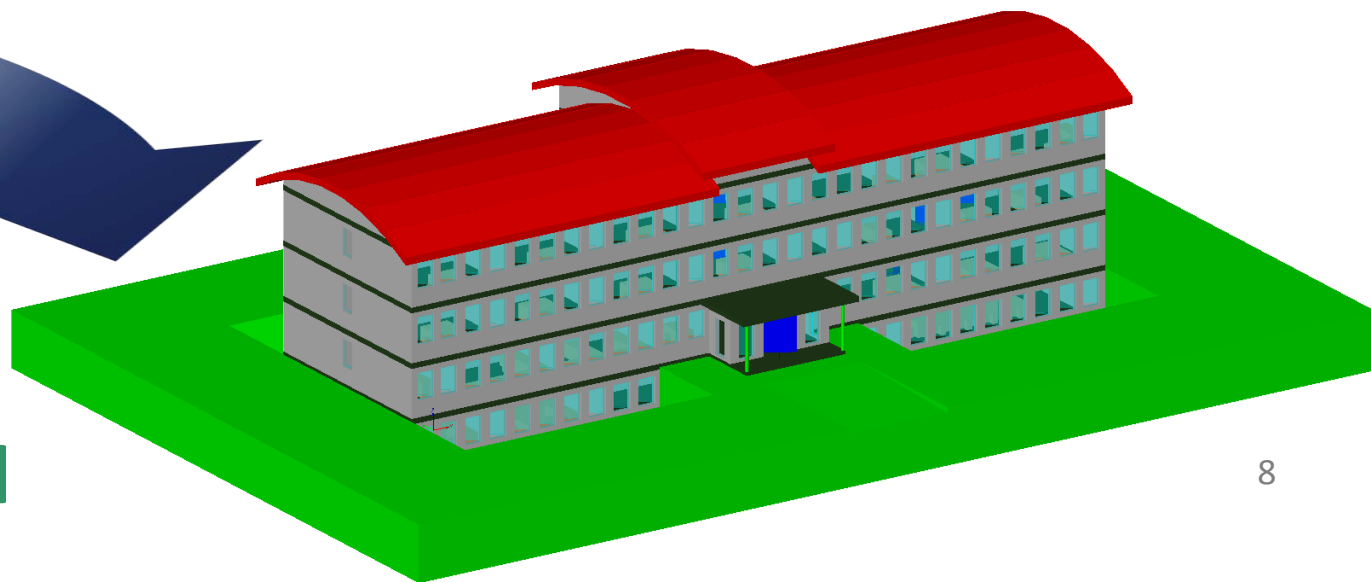


# Desirable Model Features



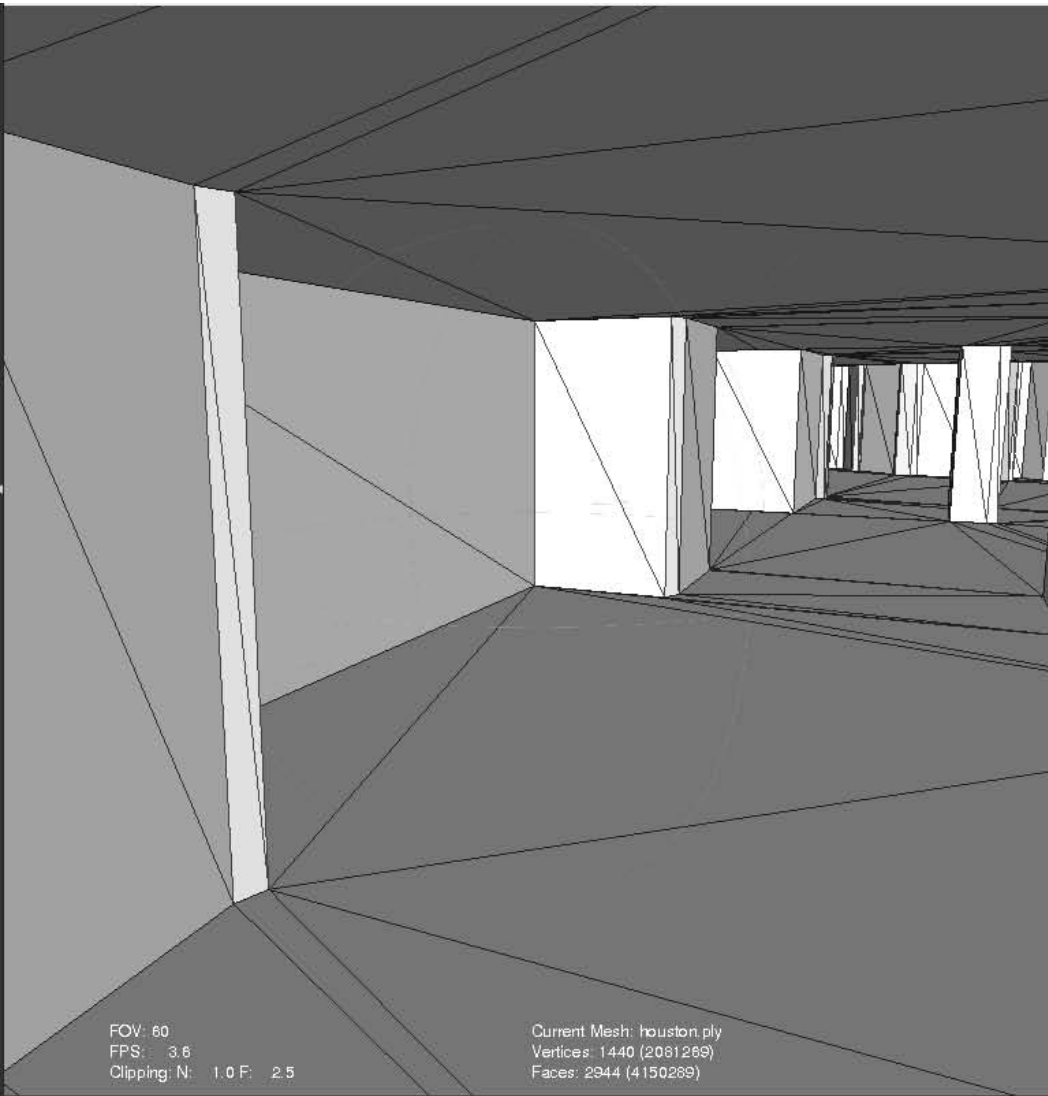
- Define **building elements**
  - *Floors, walls, ceilings, windows, etc.*
- Define **thermal zones**
  - *One zone per room*
- Simple geometry

Example Energy  
Simulation Model

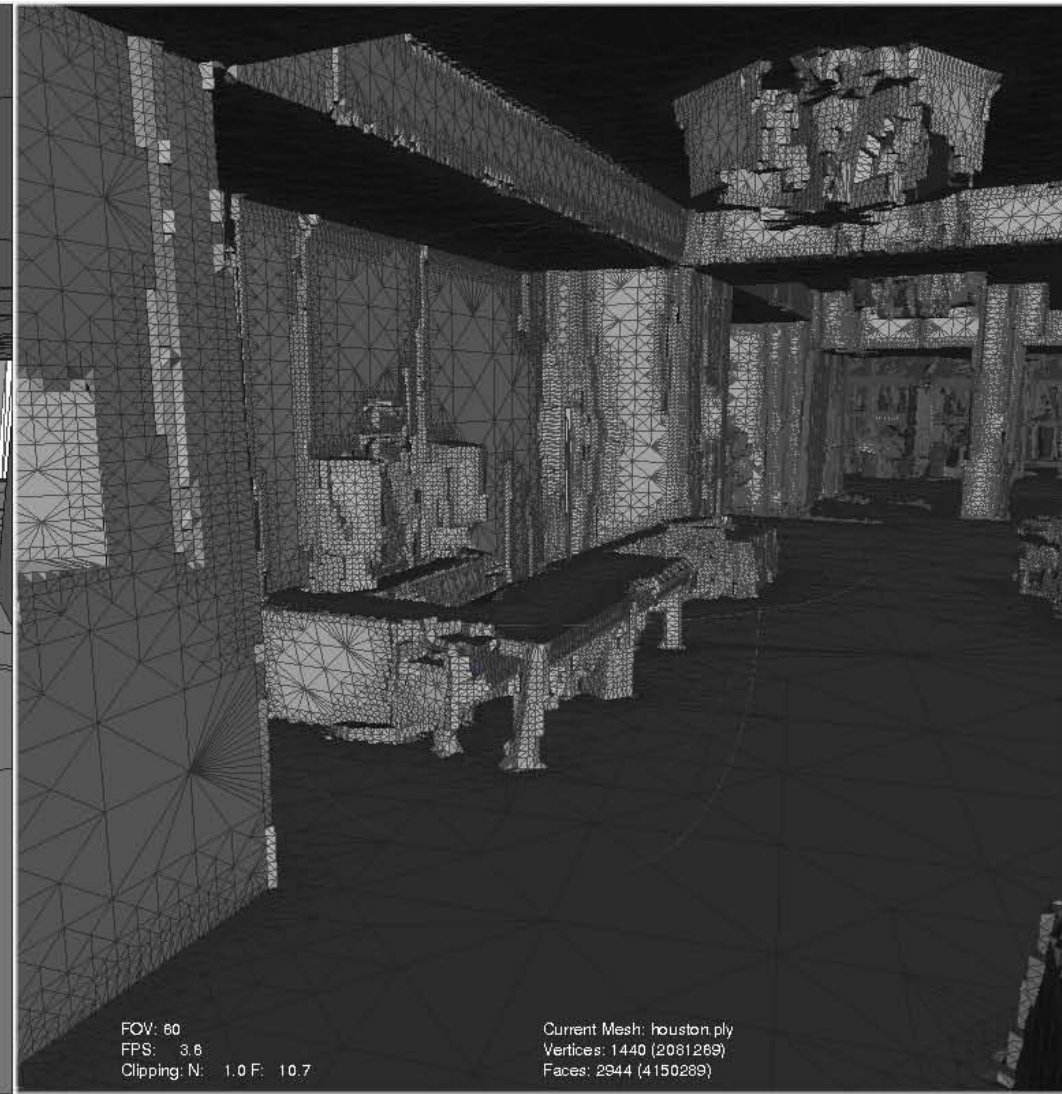




# Simplicity Comparison



## 2.5D Model

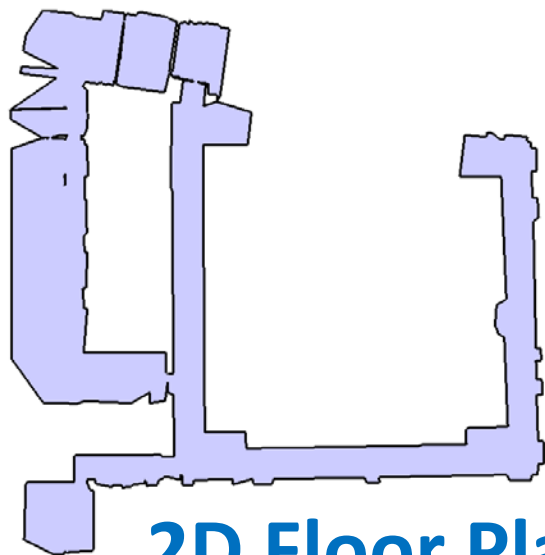


## 3D Model

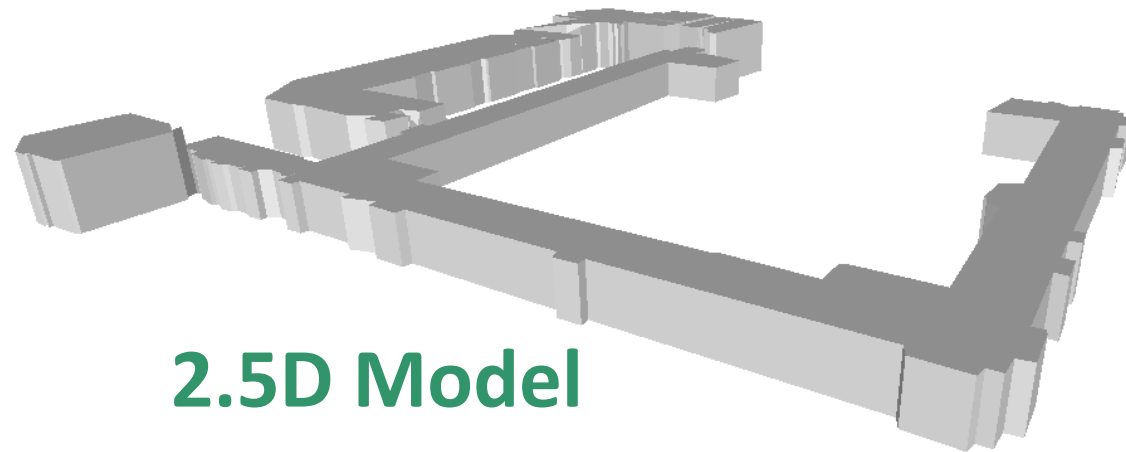


# Approach

- Create **2.5D model** with **2D floor plan**



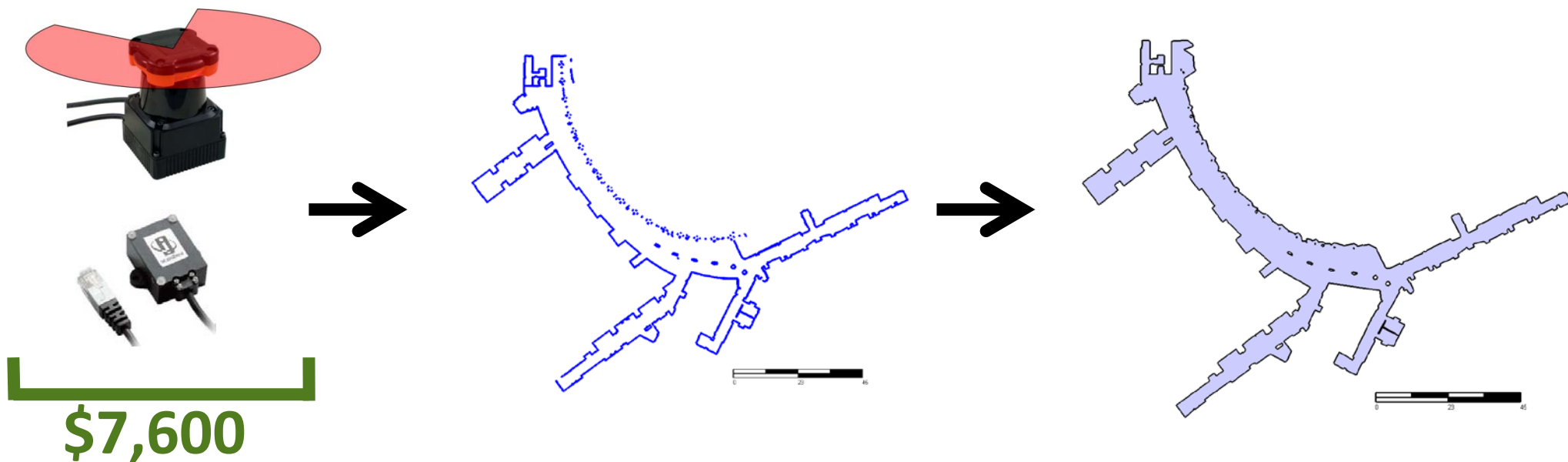
**2D Floor Plan**



**2.5D Model**

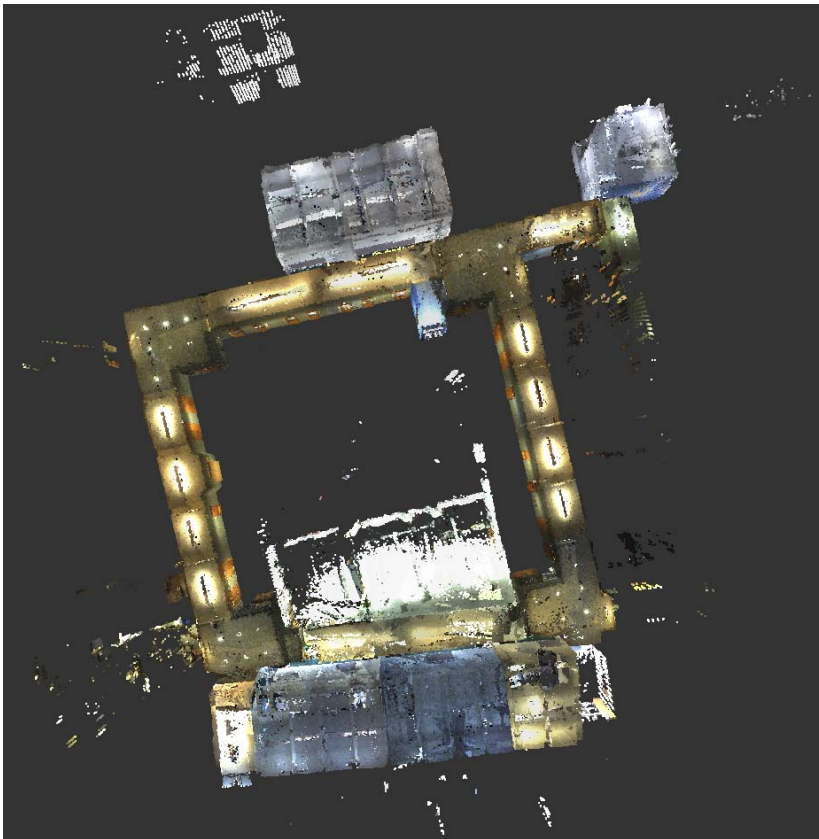
# Approach

- Minimalist **2D floor plans**

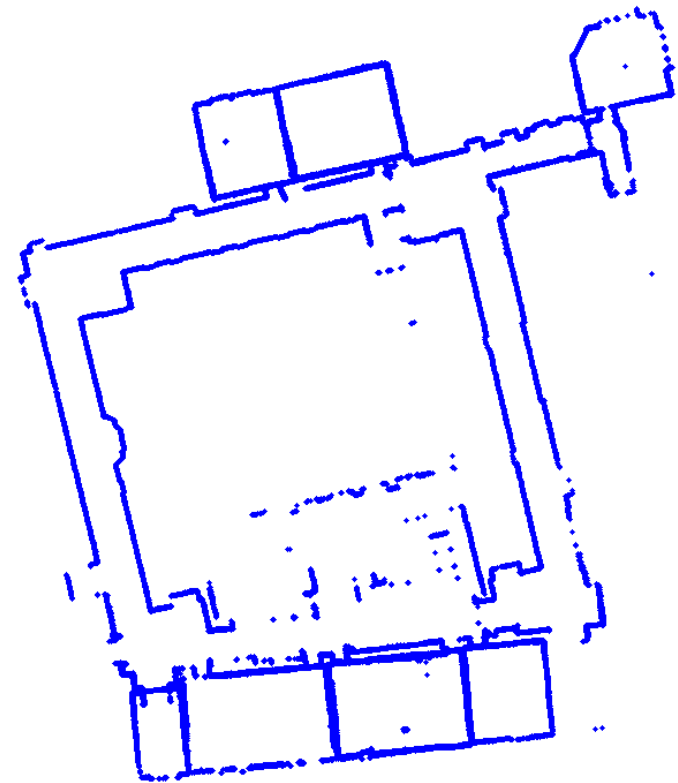


# Generating Floor Plans

- For 3D information, **point clouds** can be used



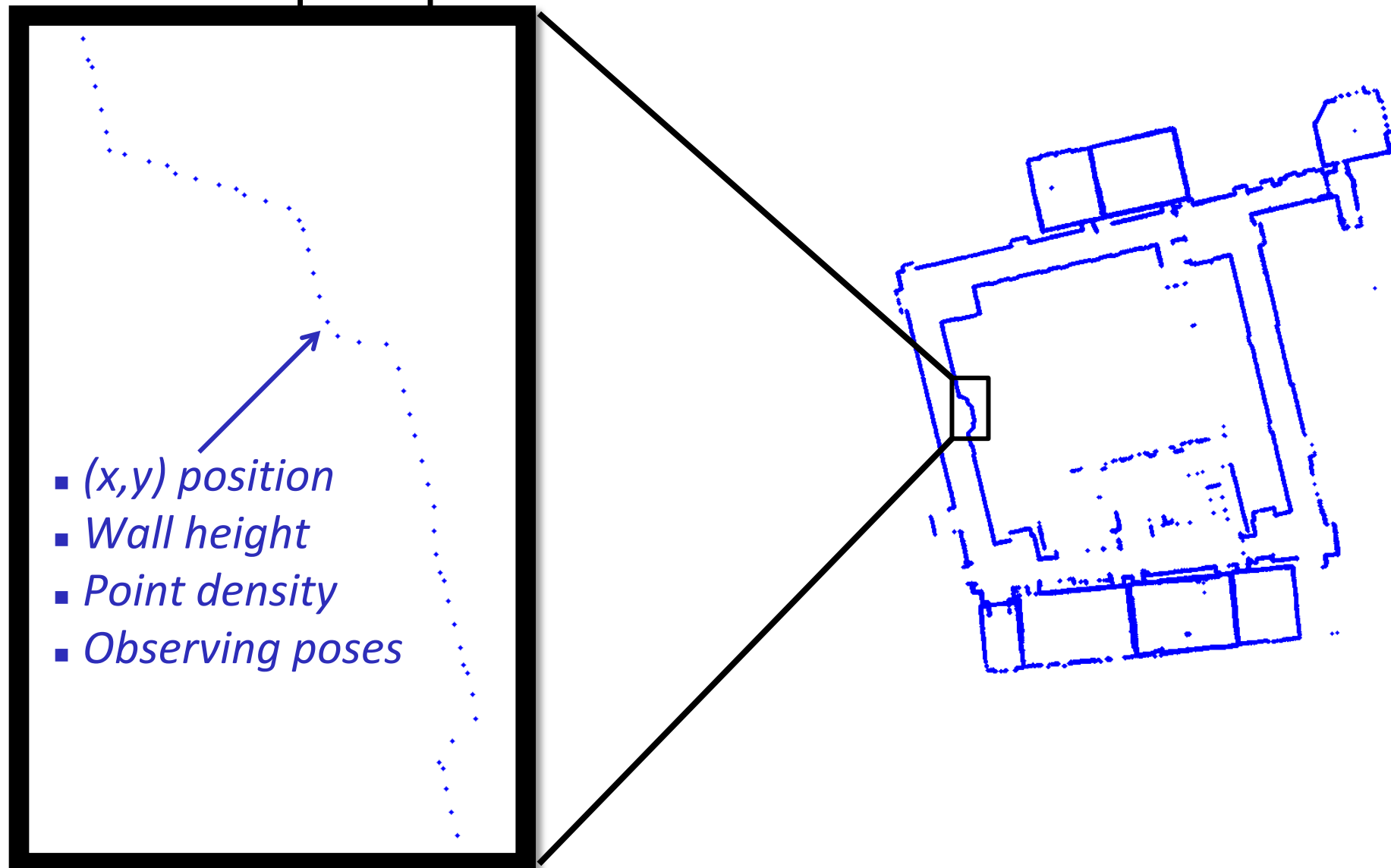
**45 Million Points**



**19,000 Wall Samples**<sup>12</sup>

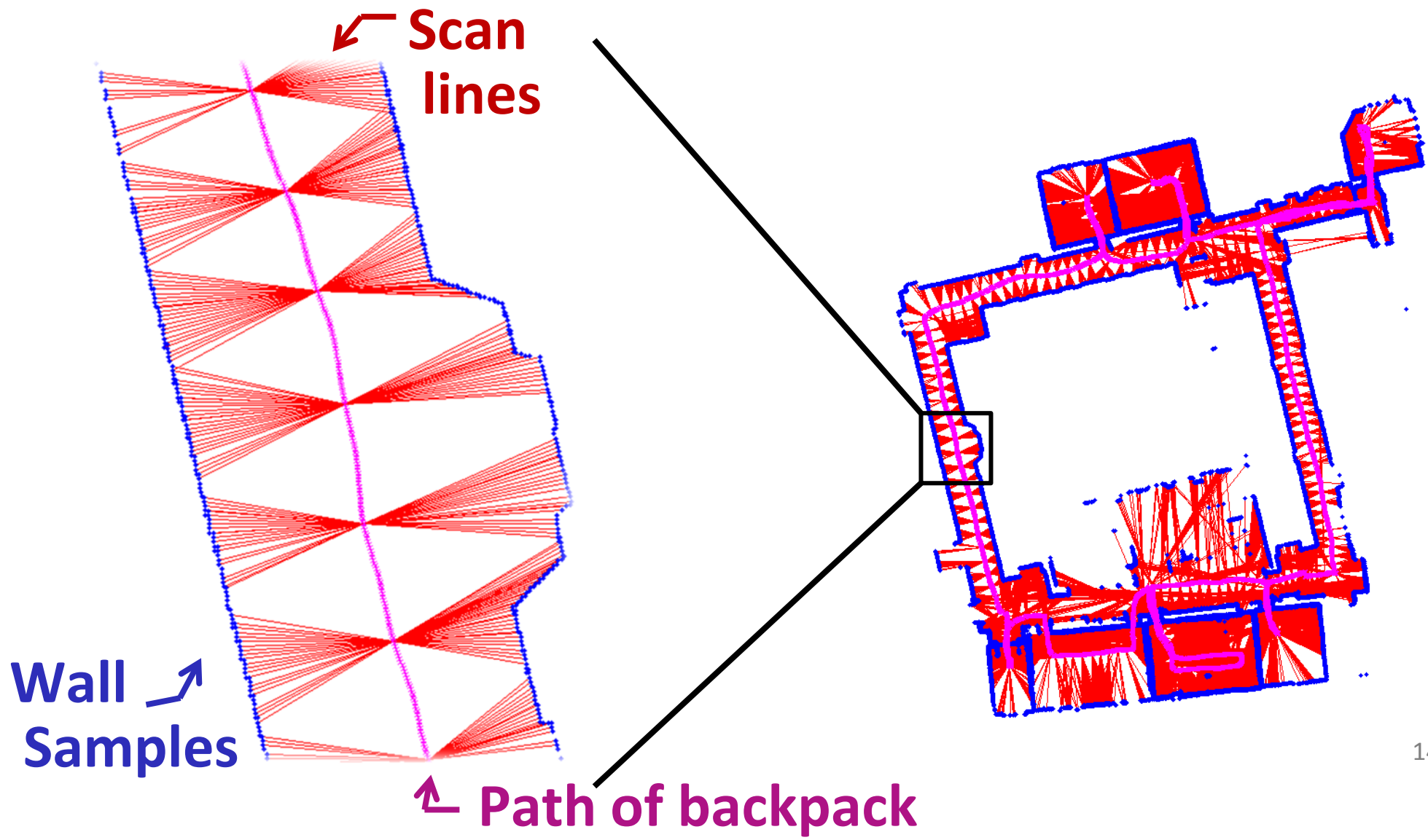
# Generating Floor Plans

- Each sampled position contains wall information



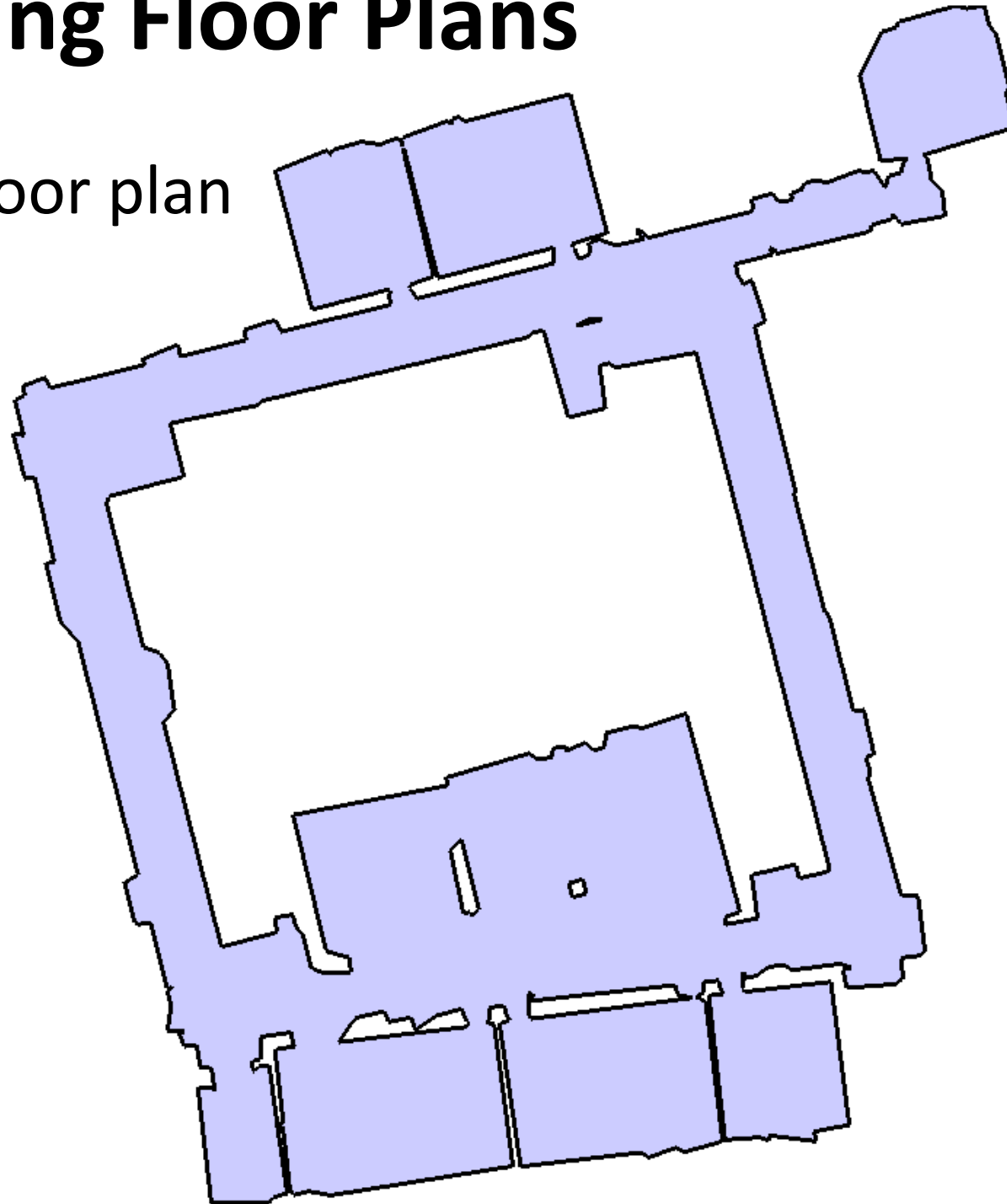
# Generating Floor Plans

- Labeling interior volume

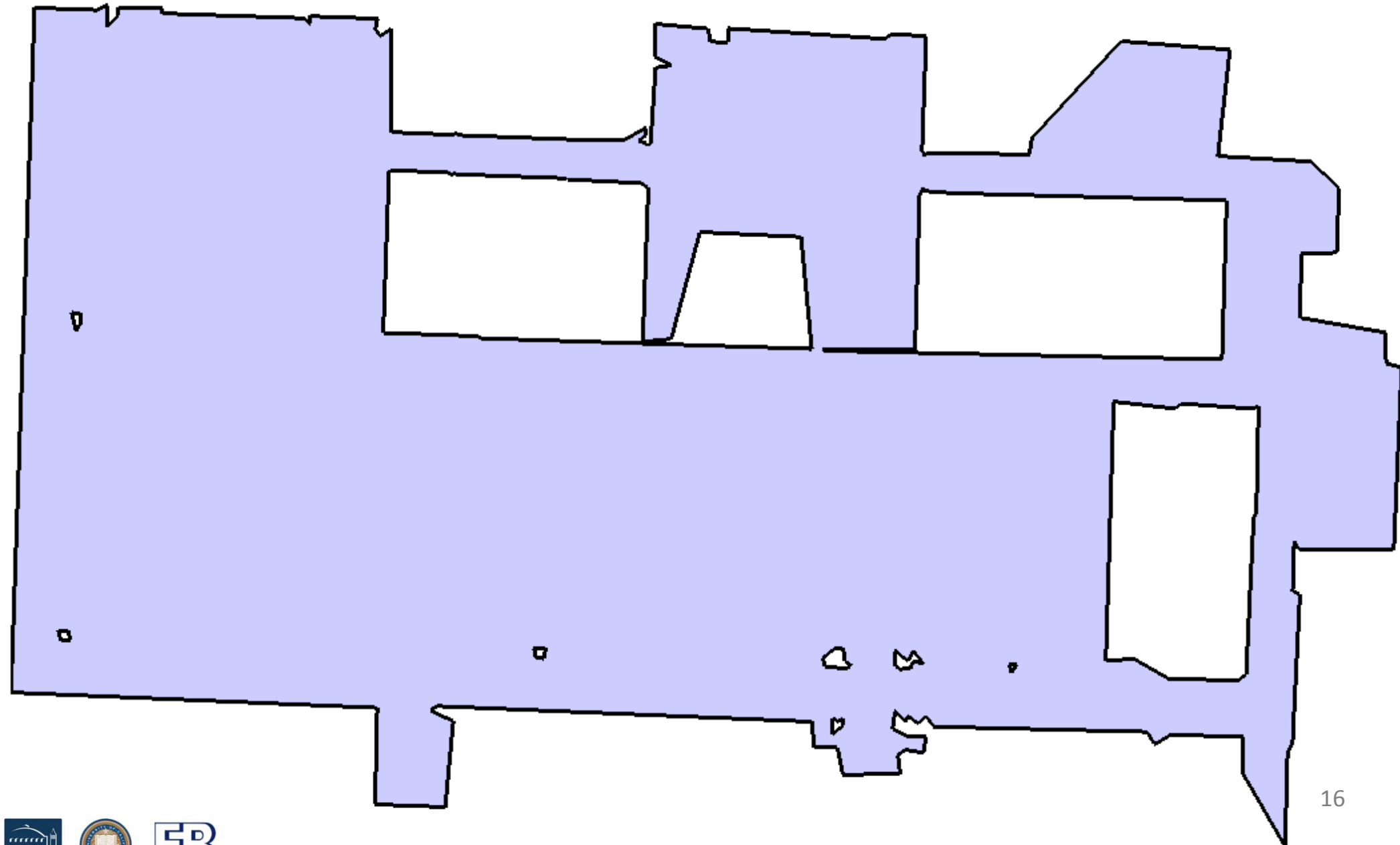


# Generating Floor Plans

- Example floor plan

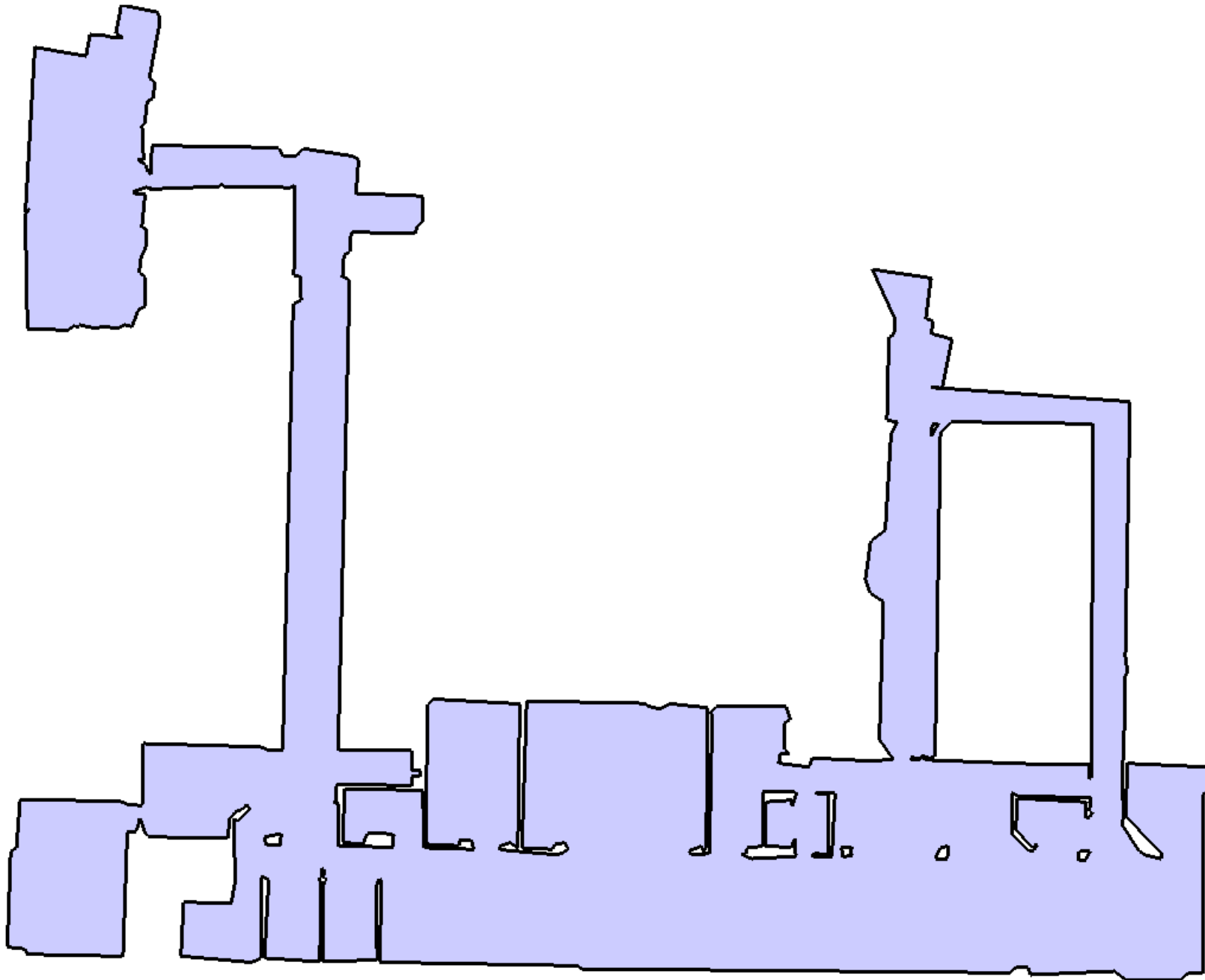


# Example Floor Plans from 2D System



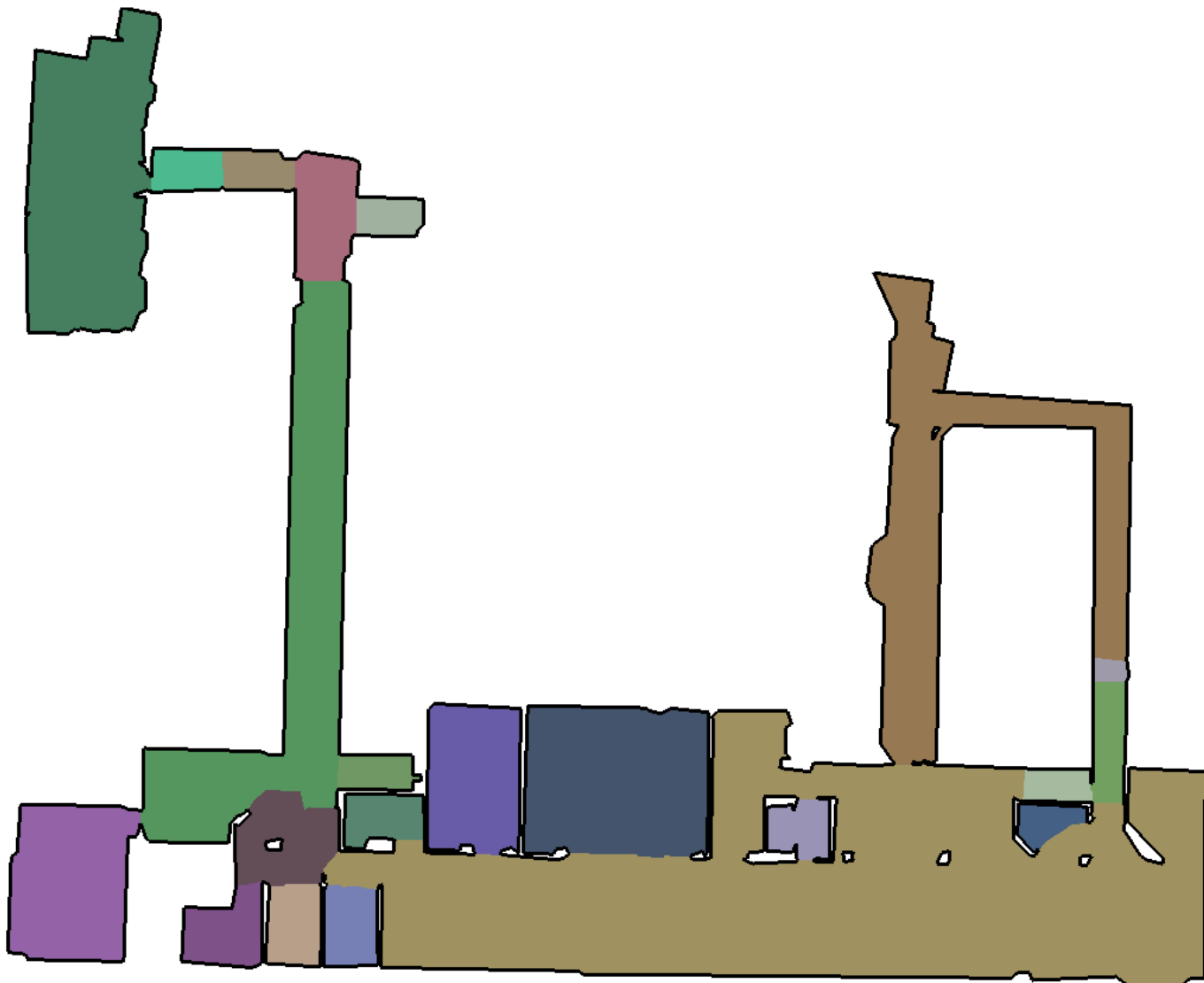


# Example Floor Plans from 2D System



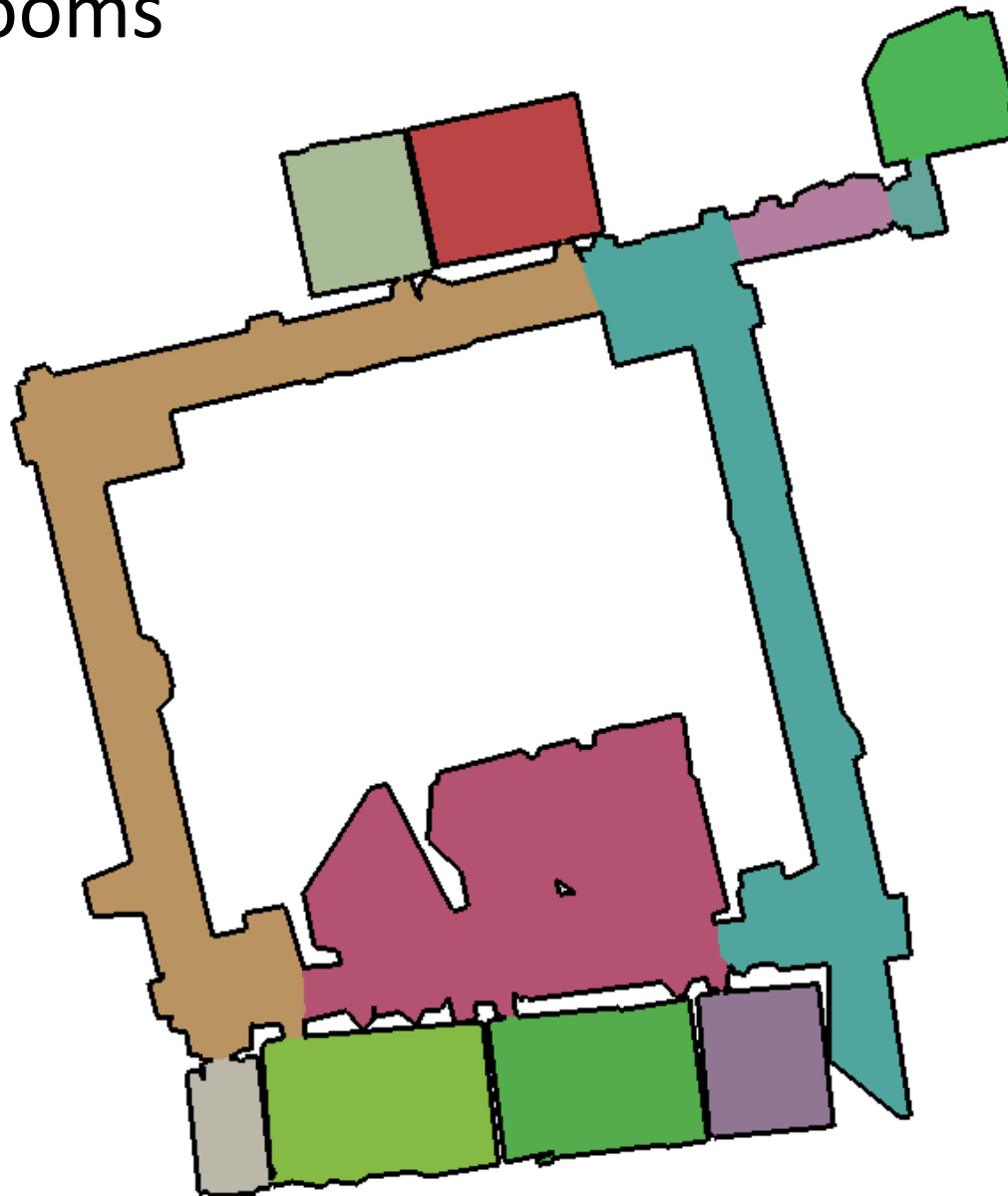
# Generating Floor Plans

## ■ Partitioning Rooms



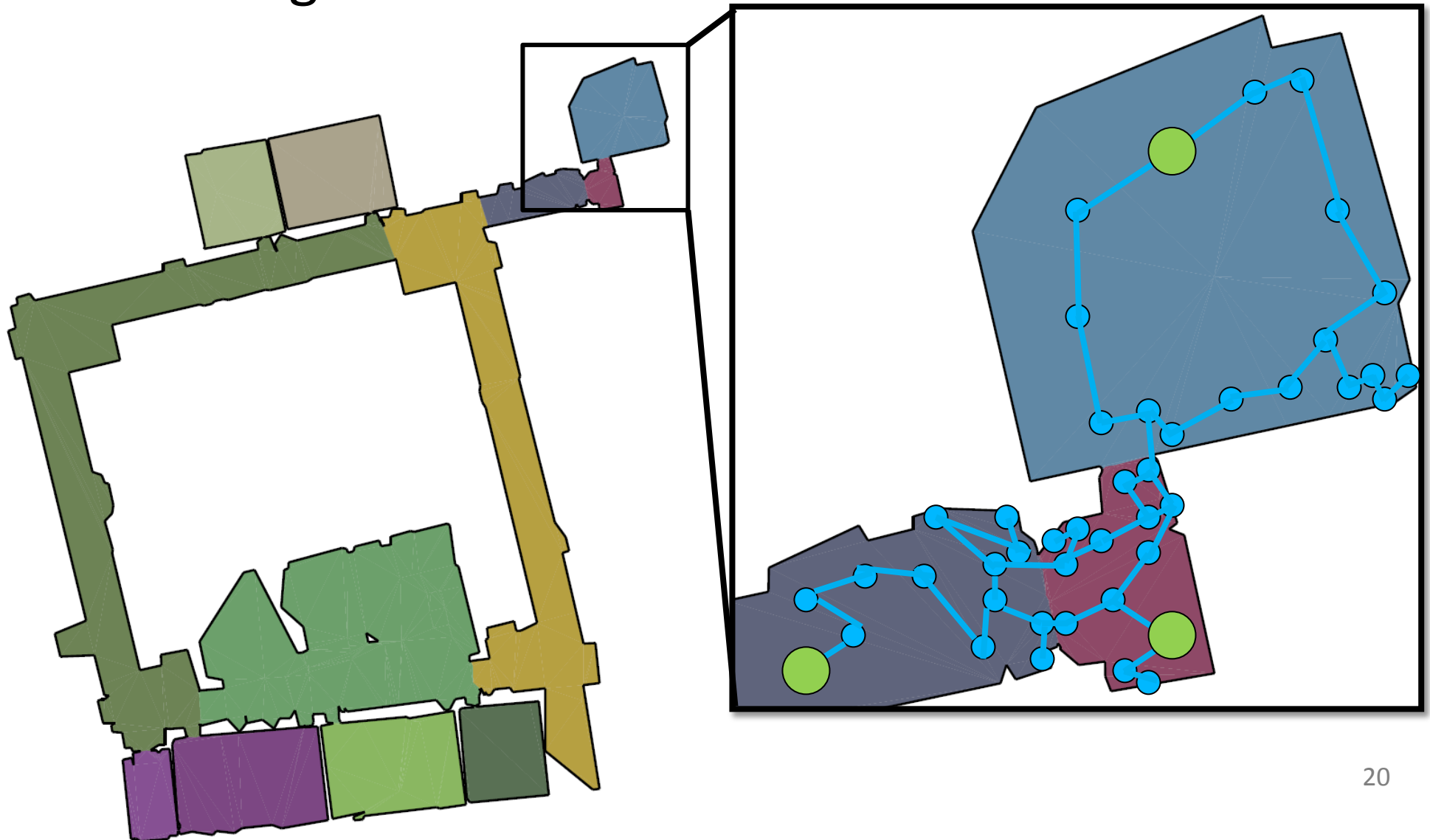
# Generating Floor Plans

- Partitioning Rooms



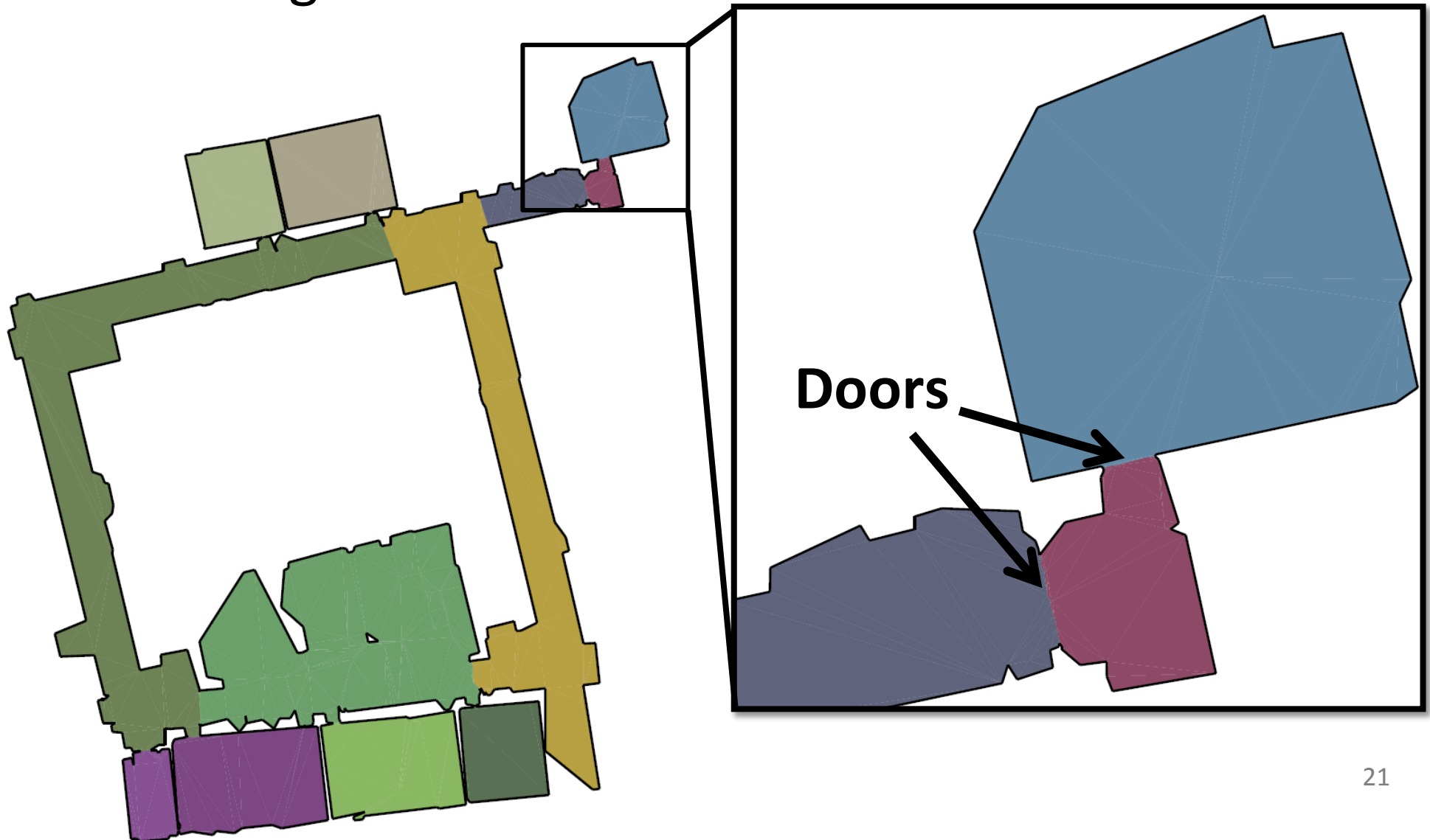
# Generating Floor Plans

## ■ Partitioning Rooms



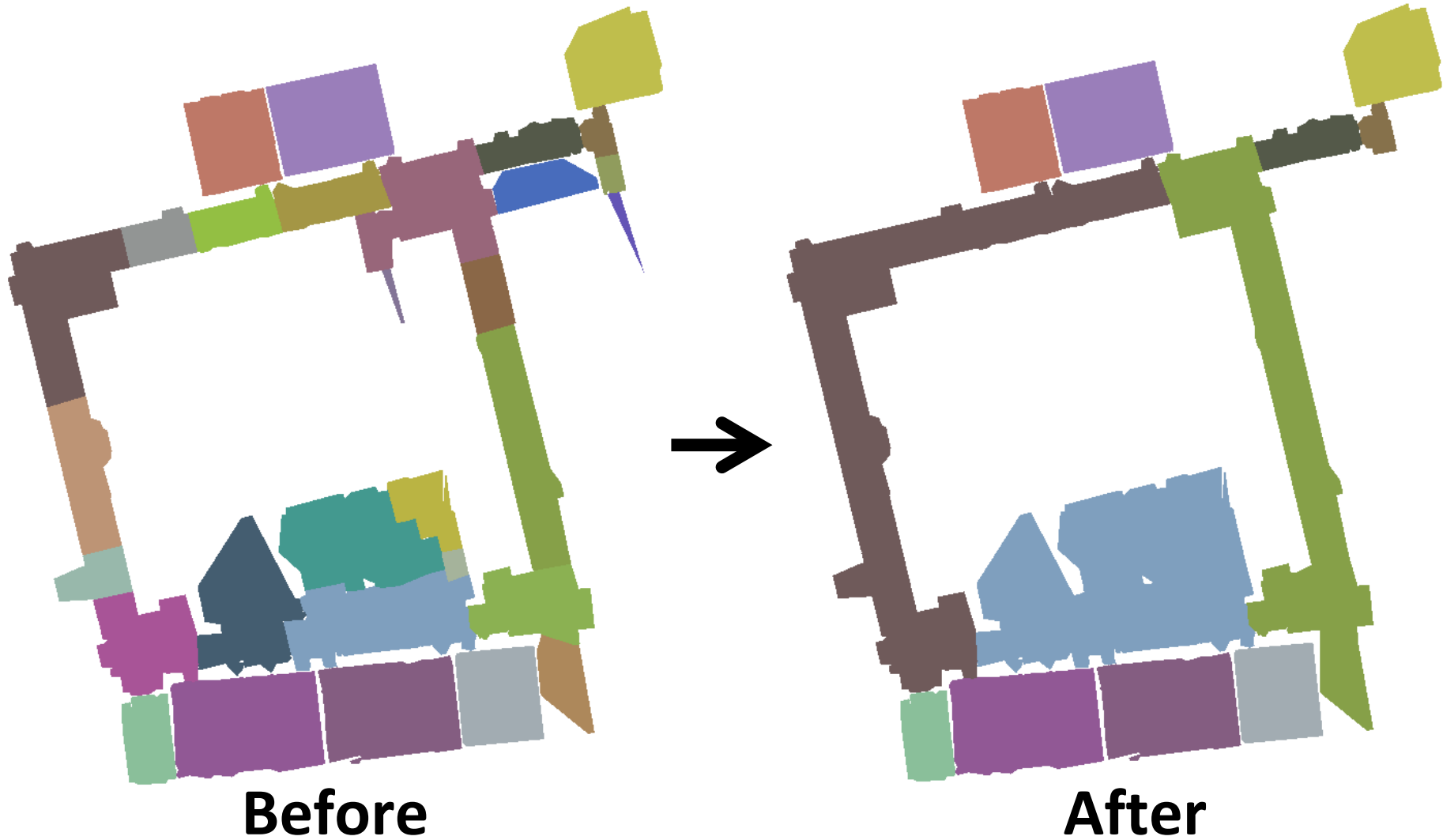
# Generating Floor Plans

## ■ Partitioning Rooms

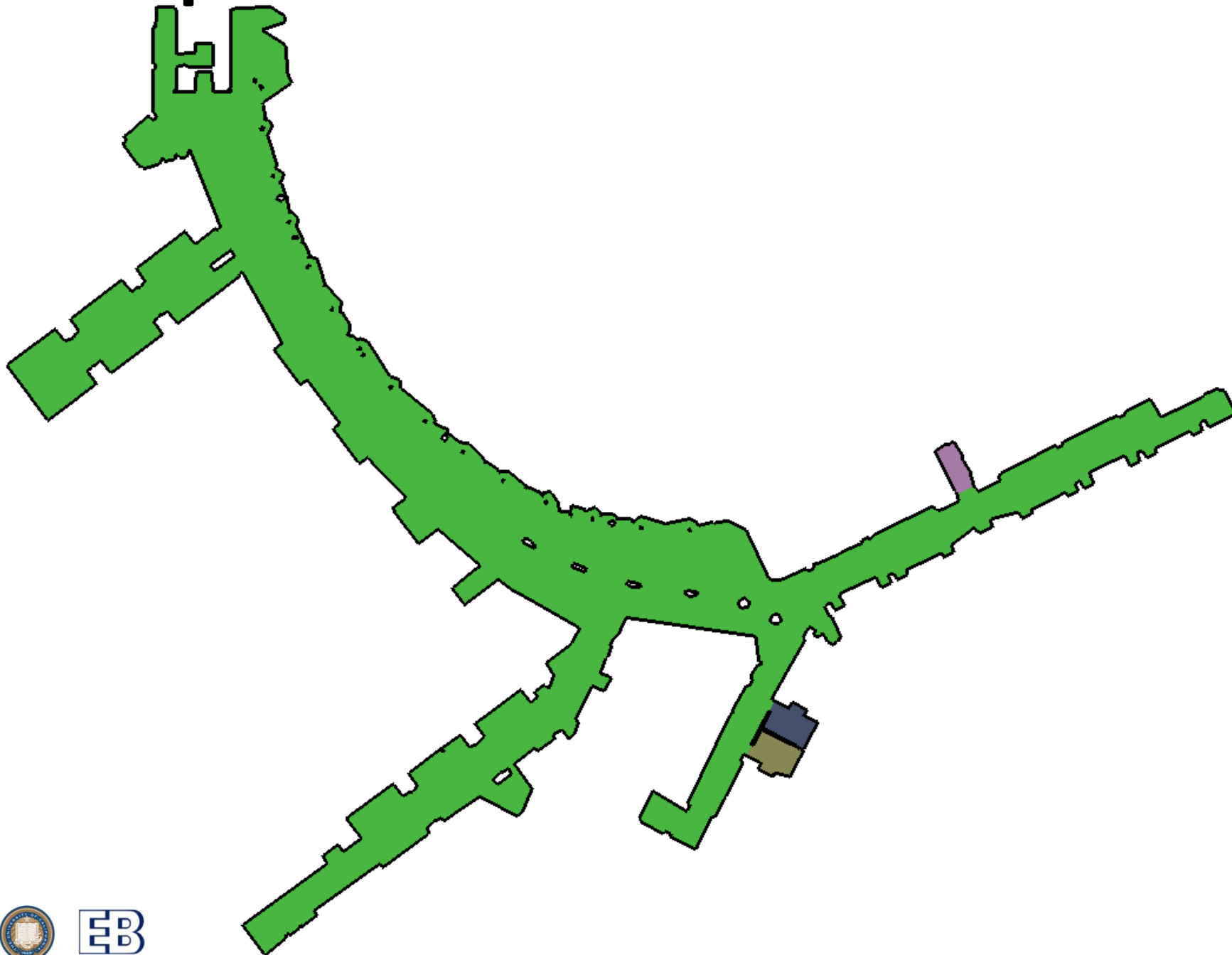


# Generating Floor Plans

- Improving models

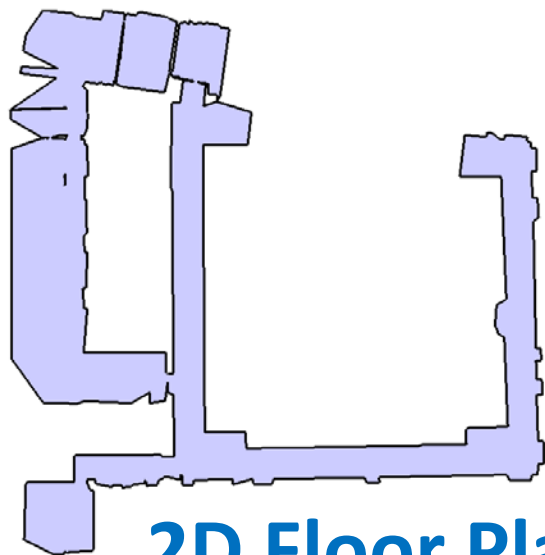


# Example Labeled Floor Plans

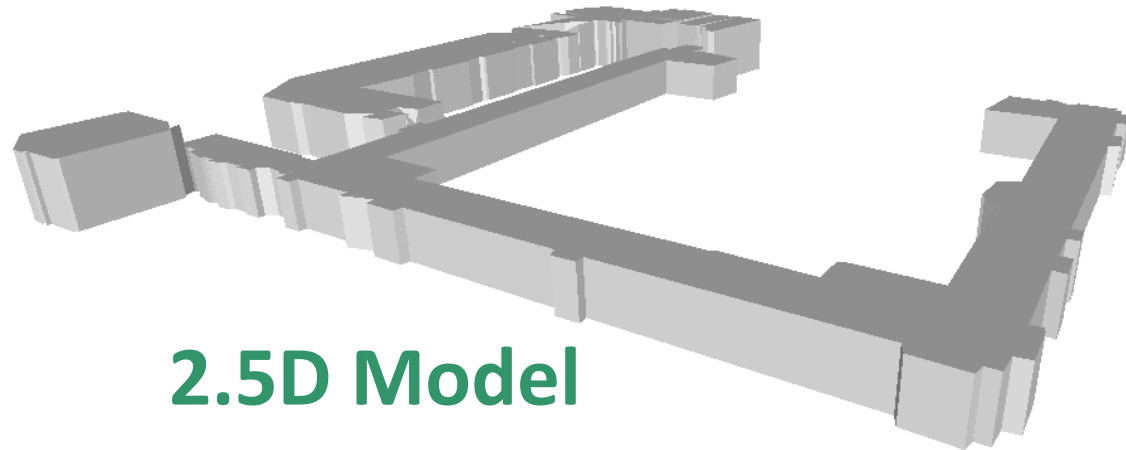




# Add Height Information



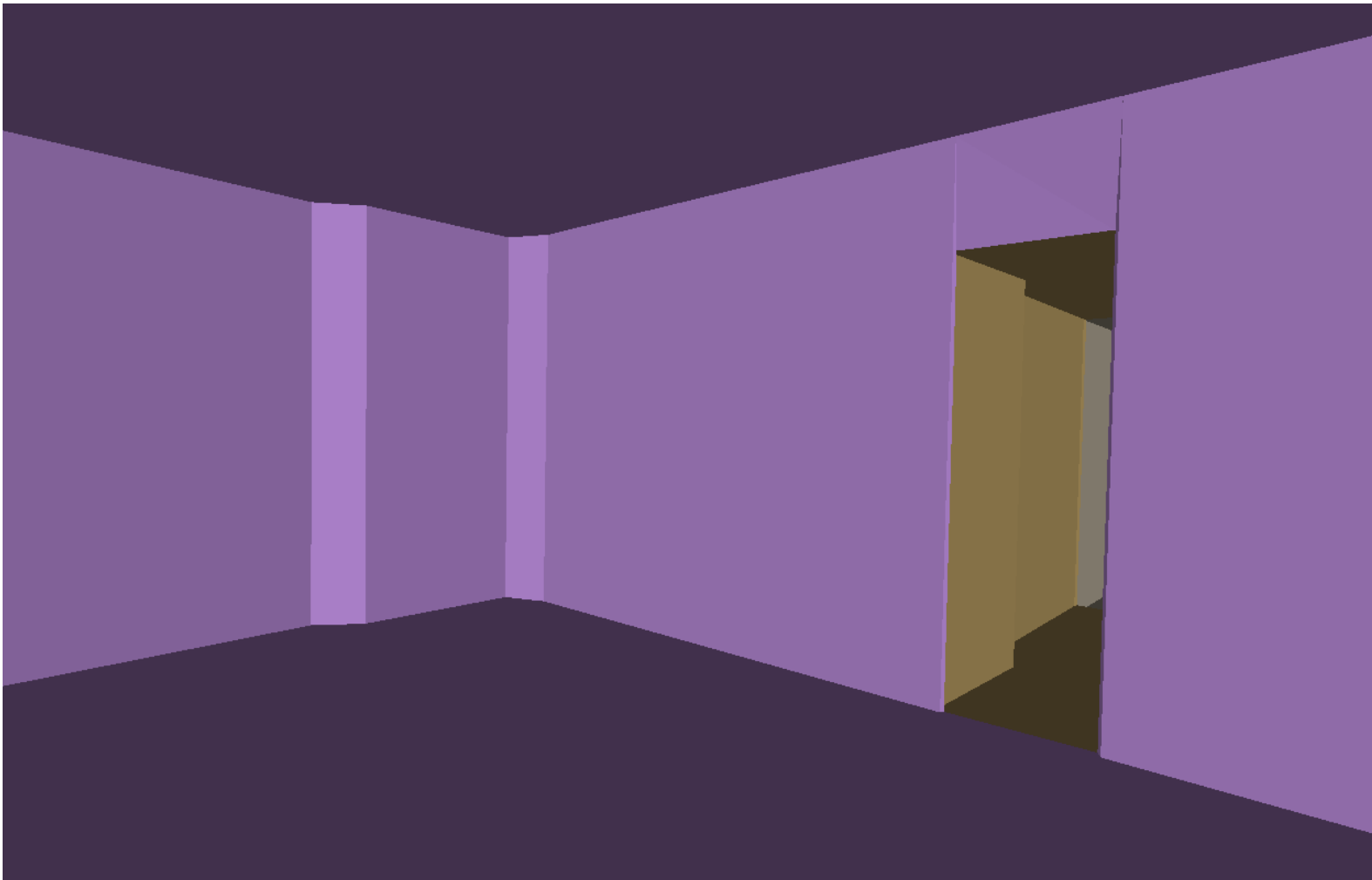
2D Floor Plan



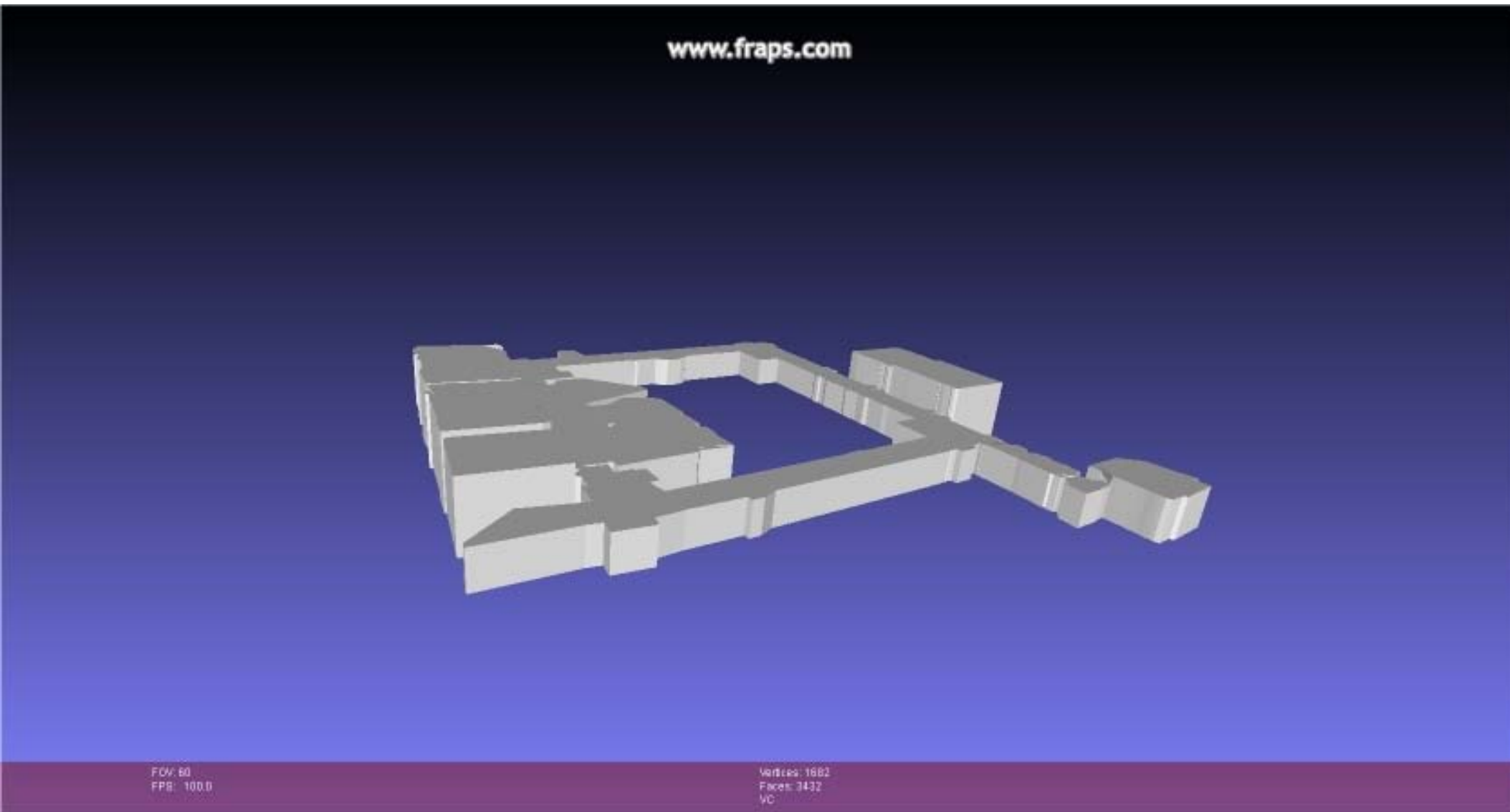
2.5D Model

# Generating Models

- Extruding to 3D



# Generating Models



# Generating Models

www.fraps.com

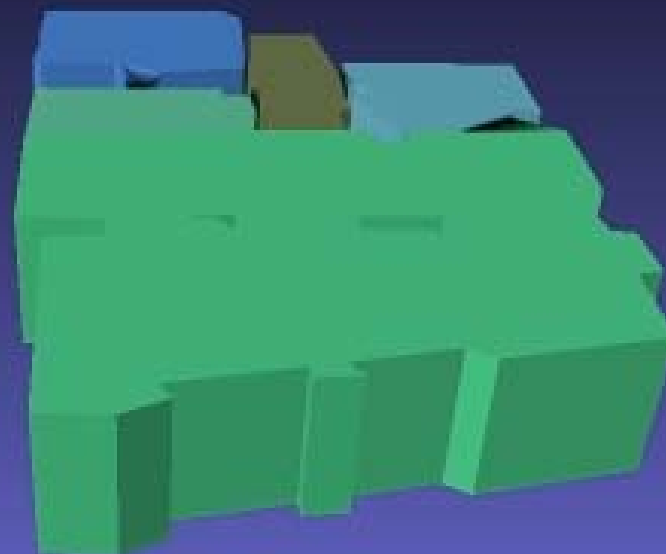
A 3D perspective view of a long, dark corridor. The walls and floor are dark gray, and the ceiling is a slightly lighter shade of gray. The corridor is composed of several rectangular sections that recede into the distance. At the far end of the corridor, there is a bright, glowing yellow-green light source, possibly a doorway or a window, which illuminates the surrounding area. The overall style is low-poly and minimalist.

FOV: 60  
Clipping: N: 16.0 F: 36.8

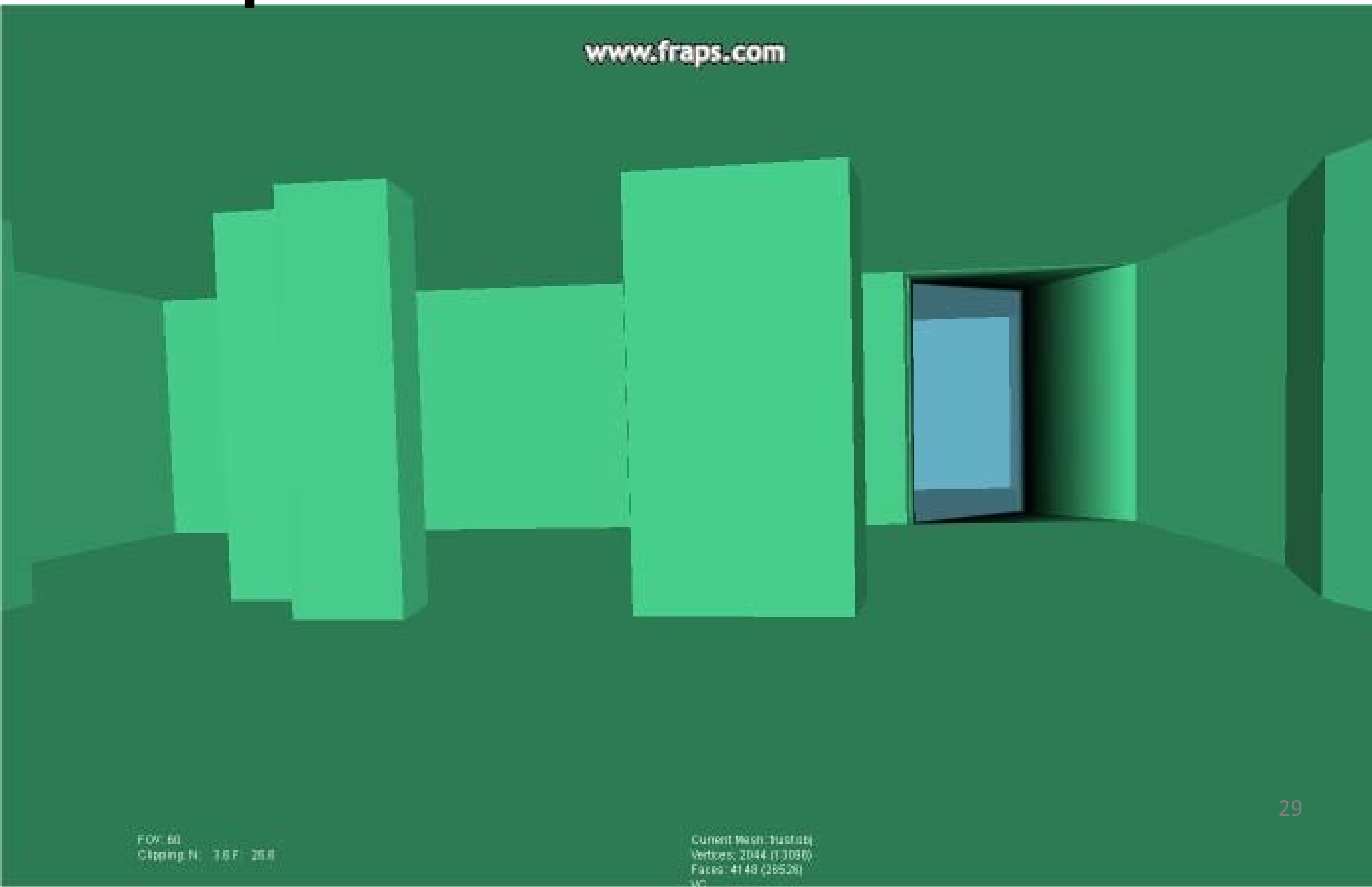
Current Mesh: frust.obj  
Vertices: 2044 (13096)  
Faces: 4148 (26528)  
VC:

# Examples

[www.fraps.com](http://www.fraps.com)



# Examples

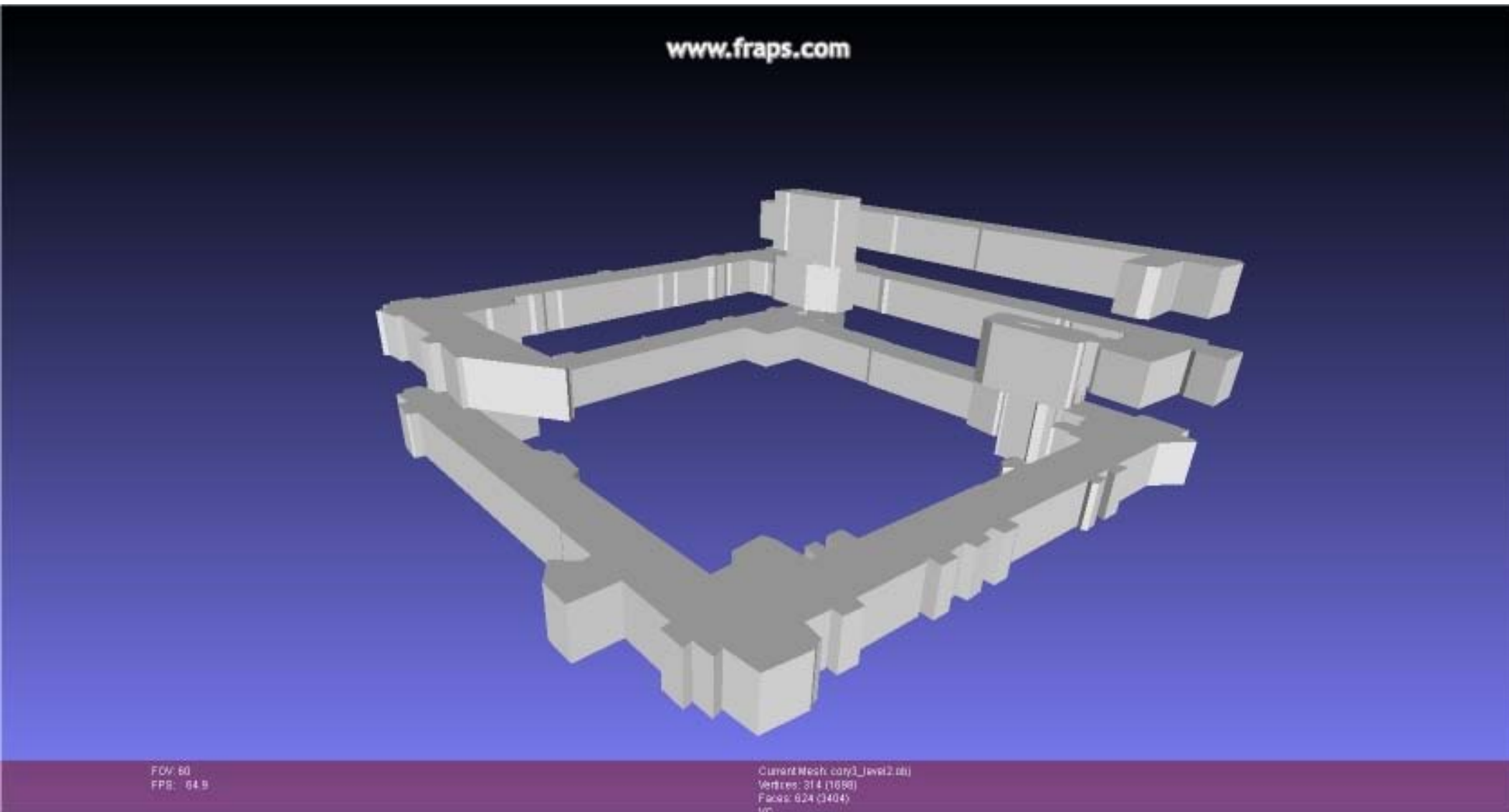


# Examples





# Examples – Multi-story

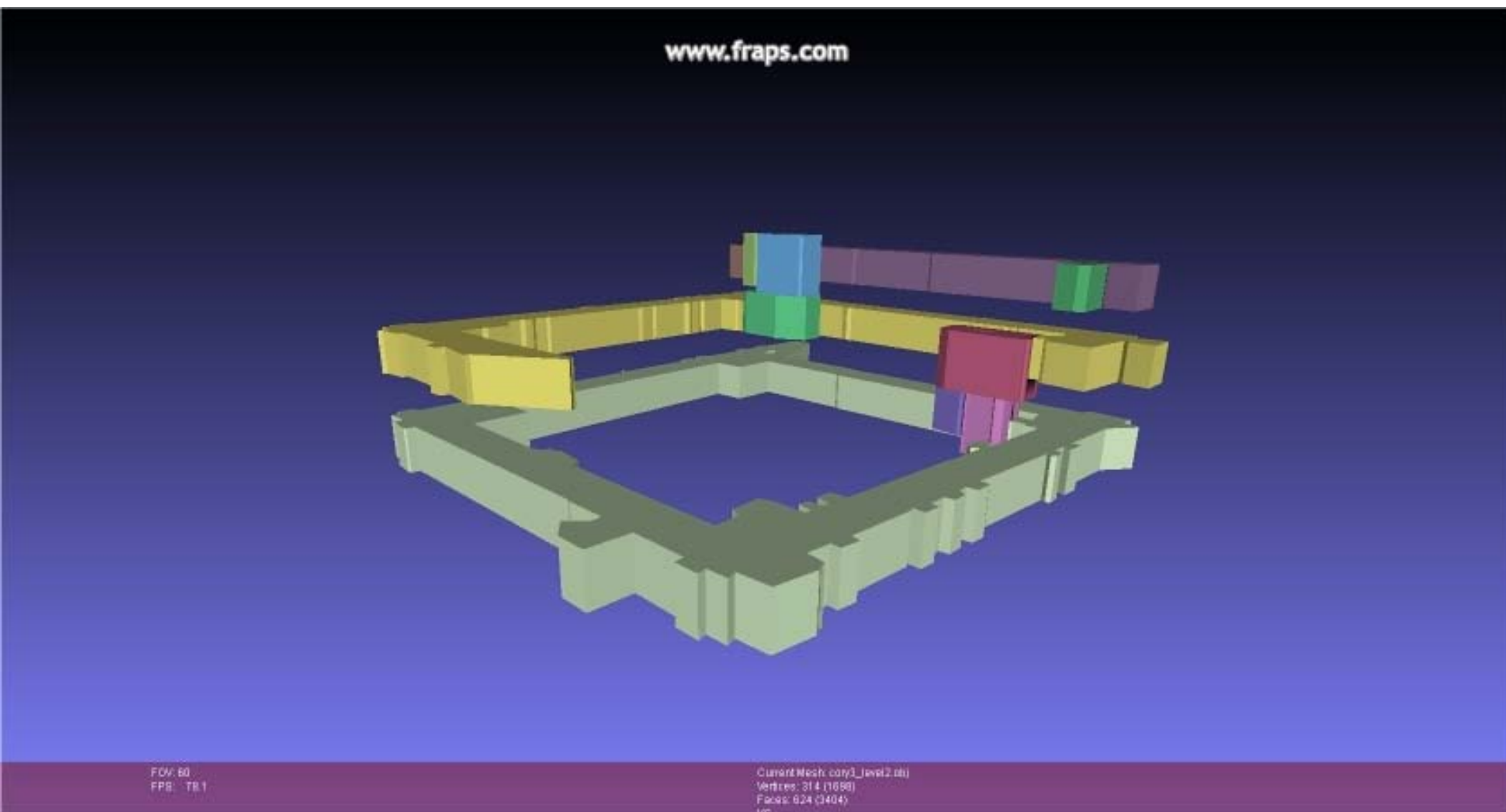


# Examples – Multi-story

[www.fraps.com](http://www.fraps.com)



# Examples – Multi-story



# Loading into EnergyPlus

The screenshot displays the EnergyPlus Simergy software interface. The 'Active Project Model' tree on the left shows the project structure, including the 'Building' and 'HVAC Systems' sections. The central 3D view shows a building model. The right panel displays the 'Spaces And Zones' table, which lists various spaces and their associated properties.

Project/Site/Context	Spaces And Zones	Systems	Simulations	Building Elements						
	Stories	Identification And Other Data	Required Properties	Geometry	Space Bounds	Zone	Zone Group	Loads (People, Lights, Equip)	Conditions	Constructions
	Floor 1									
	Occupied Spaces									
	Space Room_0									
	Space Room_1									
	Space Room_2									
	Space Room_3									
	Space Room_4									
	Unoccupied Spaces									

The interface also includes a 'Run Simulation' button at the bottom right and a status bar at the bottom showing '0 %' and 'Library siml'.

# Future Work

- *Windows*
- *Doors*
- *Lights*
- *Plug loads*
- *Sun Exposure*
- *Thermal Transfer*
- *Simplification*
- *Material*

# Thank You