

Object Goal Navigation using Goal-oriented Semantic Exploration

Winner CVPR 2020 Habitat ObjectNav Challenge

Team Arnold (SemExp)



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Webpage: <https://devendrachaplot.github.io/projects/semantic-exploration>

Object Goal Navigation

Object Goal Navigation



Object Goal: dining table

Object Goal Navigation



Object Goal: dining table

Passive

Geometric Scene Understanding



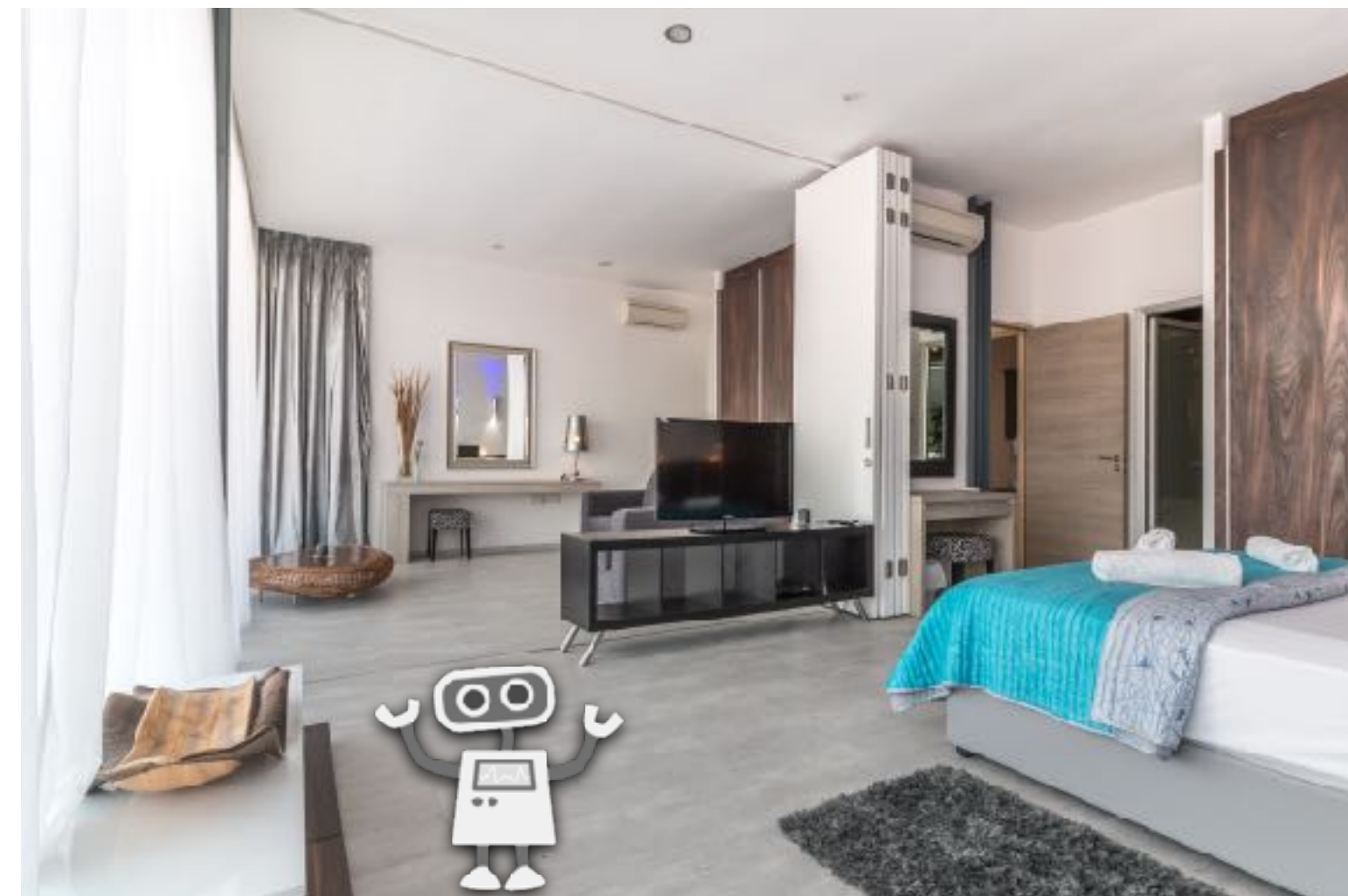
Understanding navigable space

Semantic Scene Understanding



Object detection and segmentation

Object Goal Navigation



Object Goal: dining table

Passive

Geometric Scene Understanding



Understanding navigable space

Semantic Scene Understanding



Object detection and segmentation

Active

Learning Semantic Priors



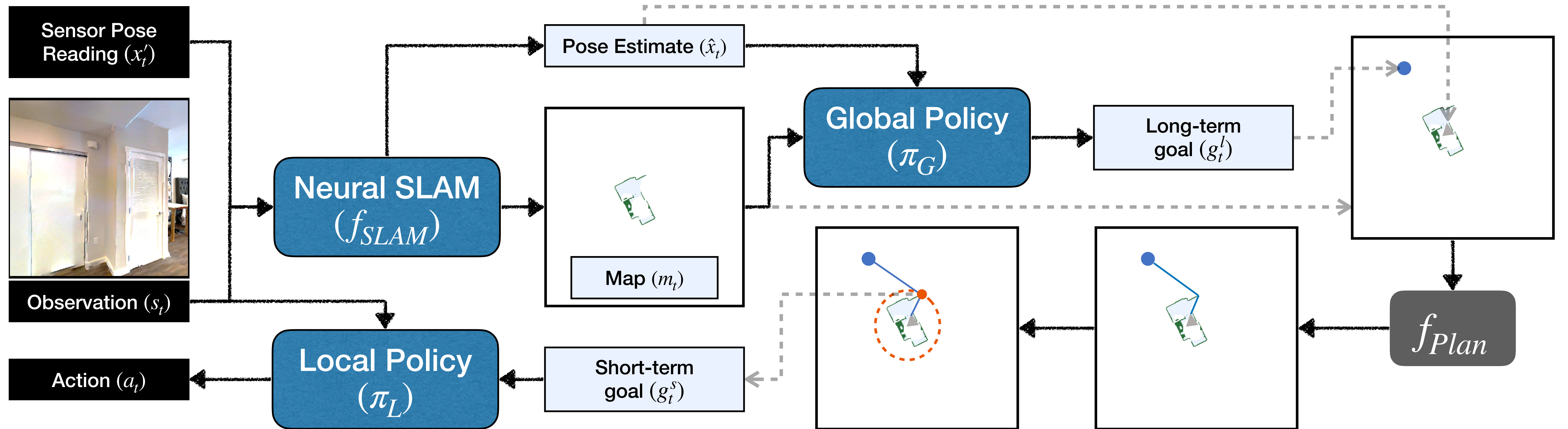
Where is 'dining table' more likely to be found?

Episodic Memory

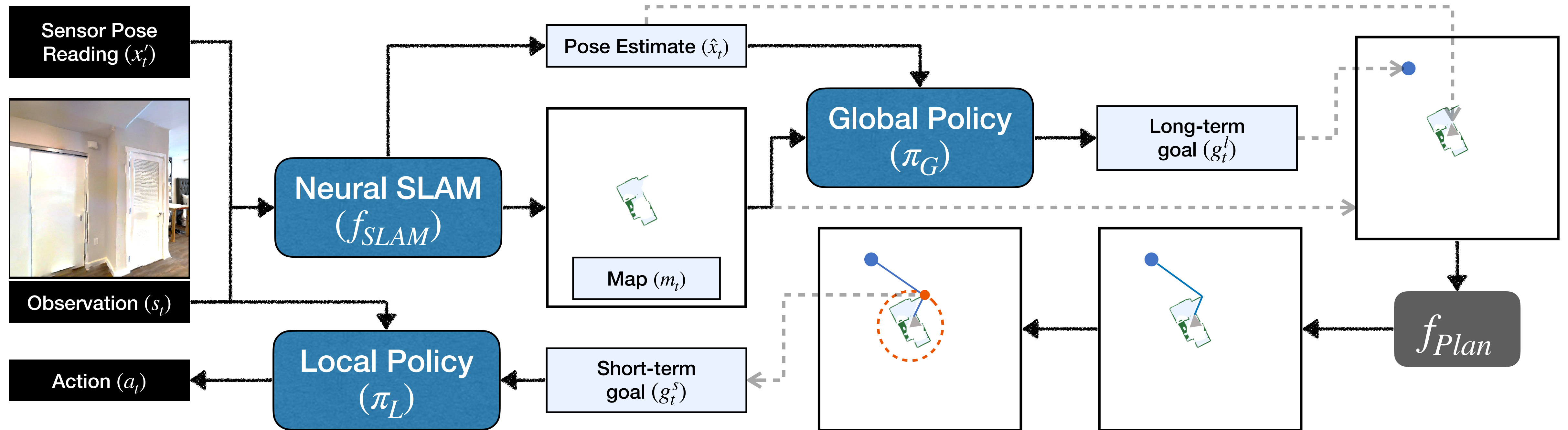


Keeping track of explored and unexplored areas

Active Neural SLAM



Active Neural SLAM



[Chaplot et al. ICLR-20]

Incorporating Semantics

Obstacle Map Representation (Active Neural SLAM)

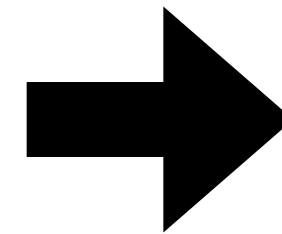
Obstacle Map ($2 \times M \times M$)



Incorporating Semantics

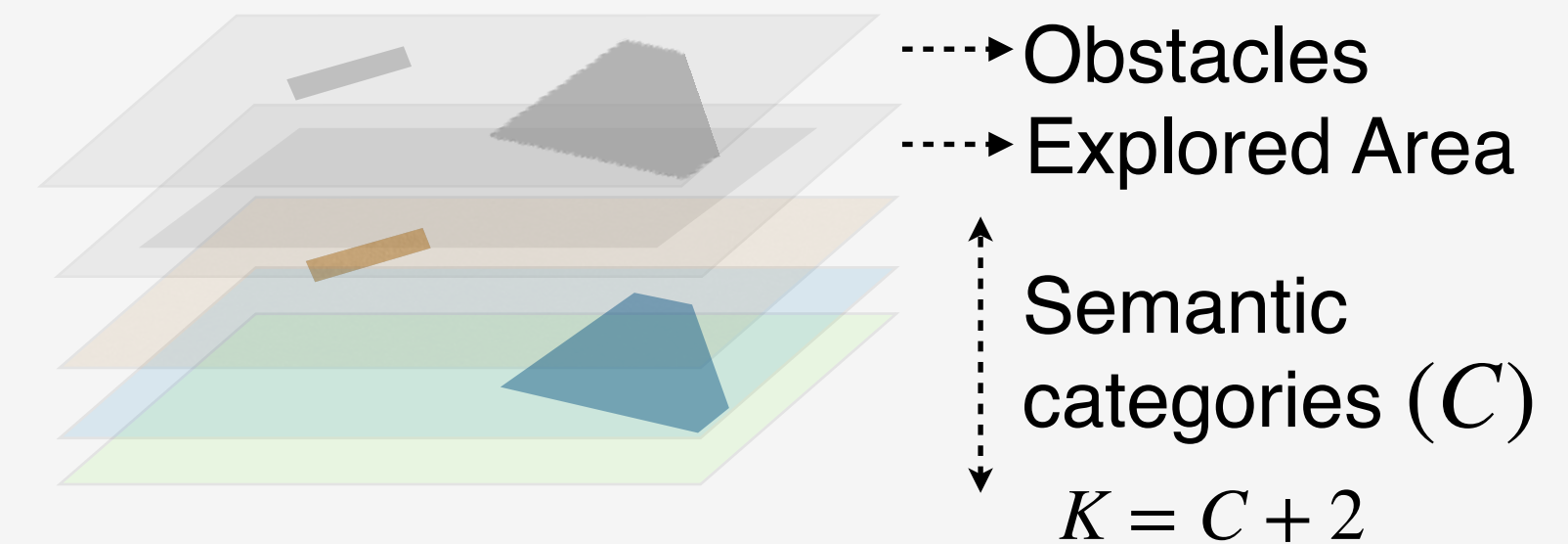
Obstacle Map Representation (Active Neural SLAM)

Obstacle Map ($2 \times M \times M$)



Semantic Map Representation (SemExp)

Semantic Map ($K \times M \times M$)



Semantic Mapping

RGB (I_t)



Depth (D_t)



Semantic Mapping

RGB (I_t)



Mask
RCNN

First-person
Semantic Predictions



Depth (D_t)



Semantic Mapping

RGB (I_t)



Mask
RCNN

First-person
Semantic Predictions



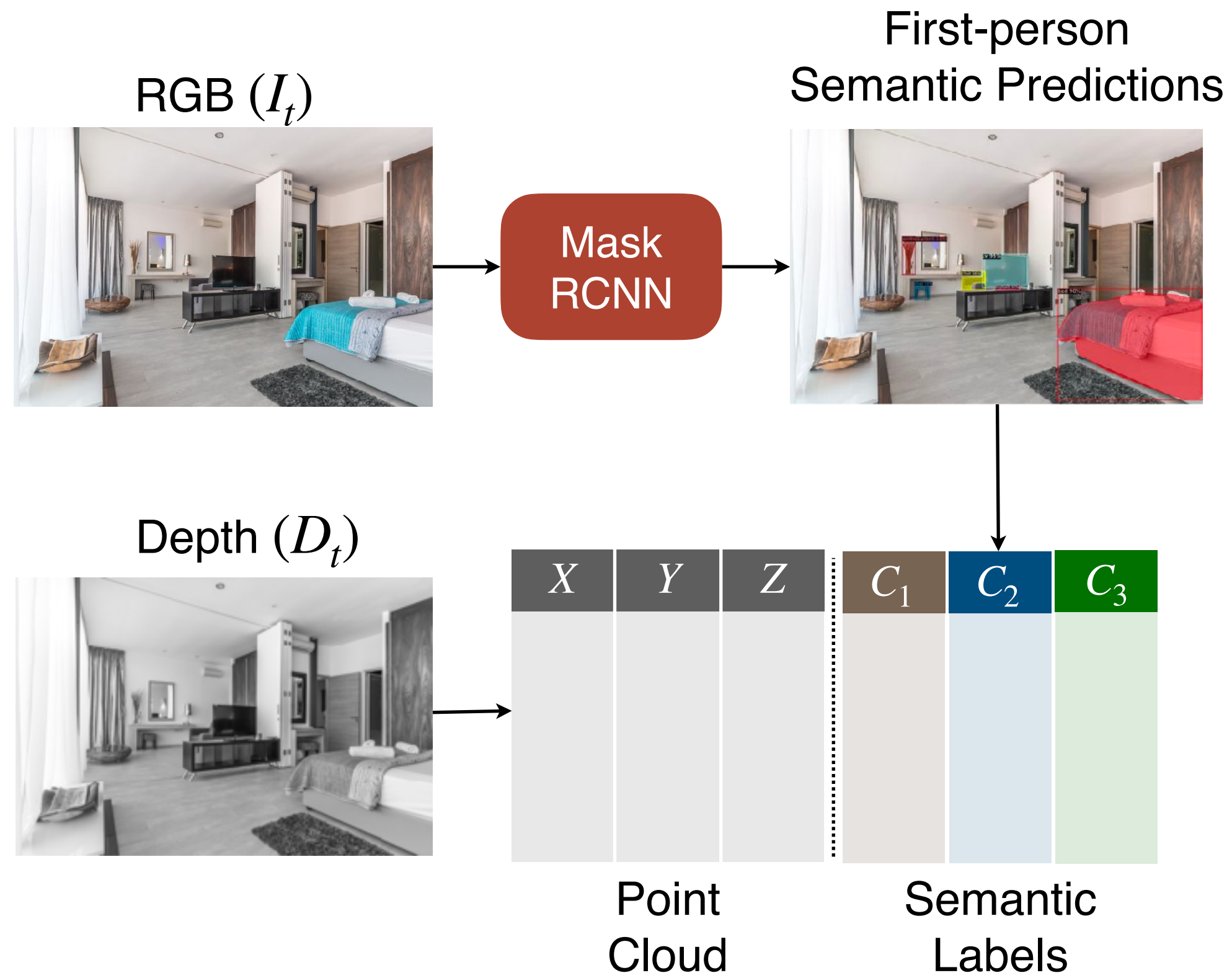
Depth (D_t)



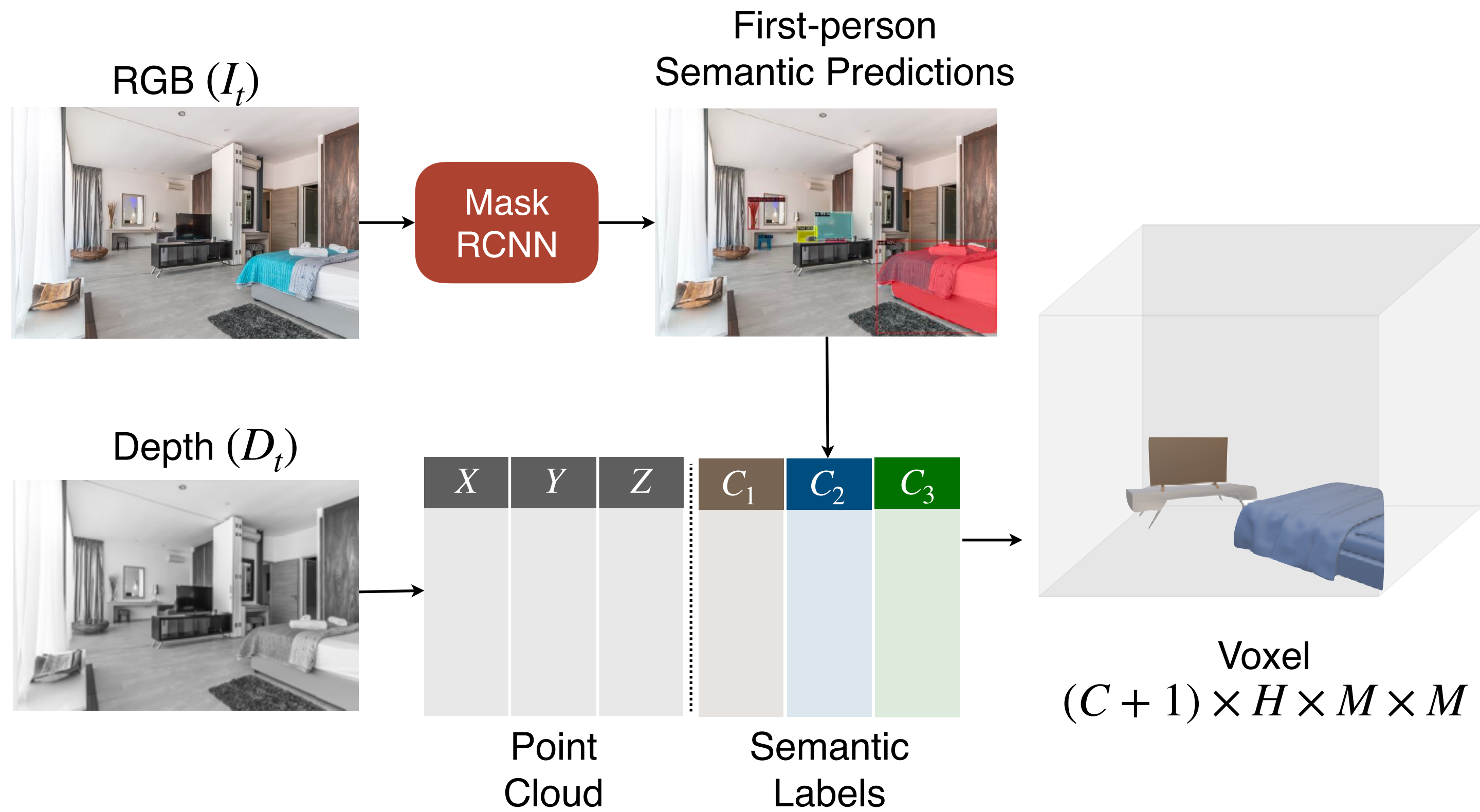
X	Y	Z

Point
Cloud

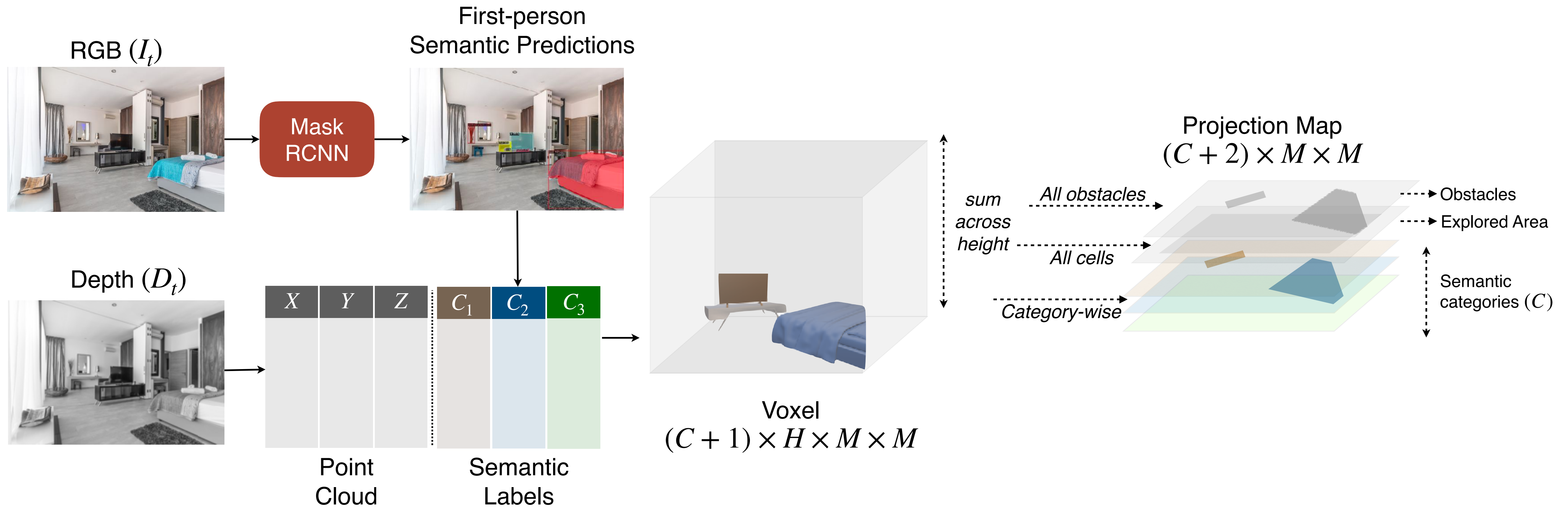
Semantic Mapping



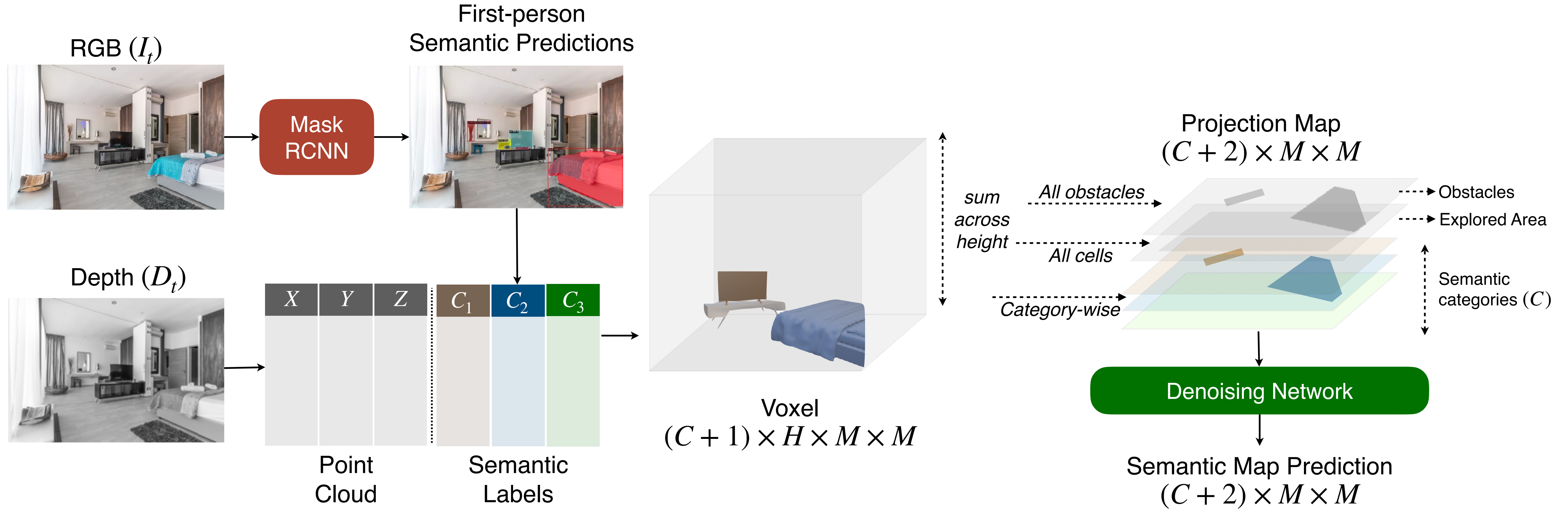
Semantic Mapping



Semantic Mapping



Semantic Mapping



SemExp Model Overview

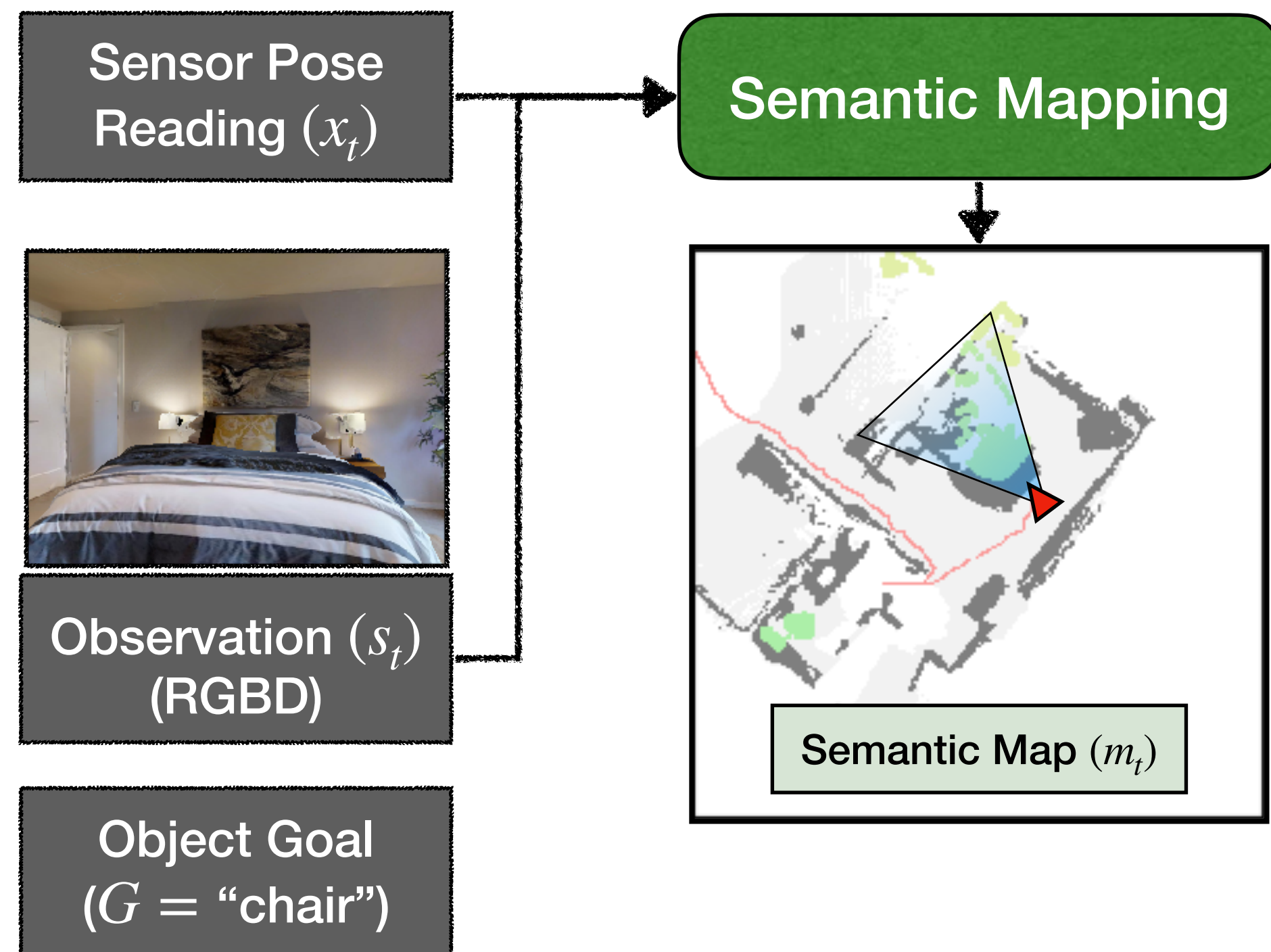
Sensor Pose
Reading (x_t)



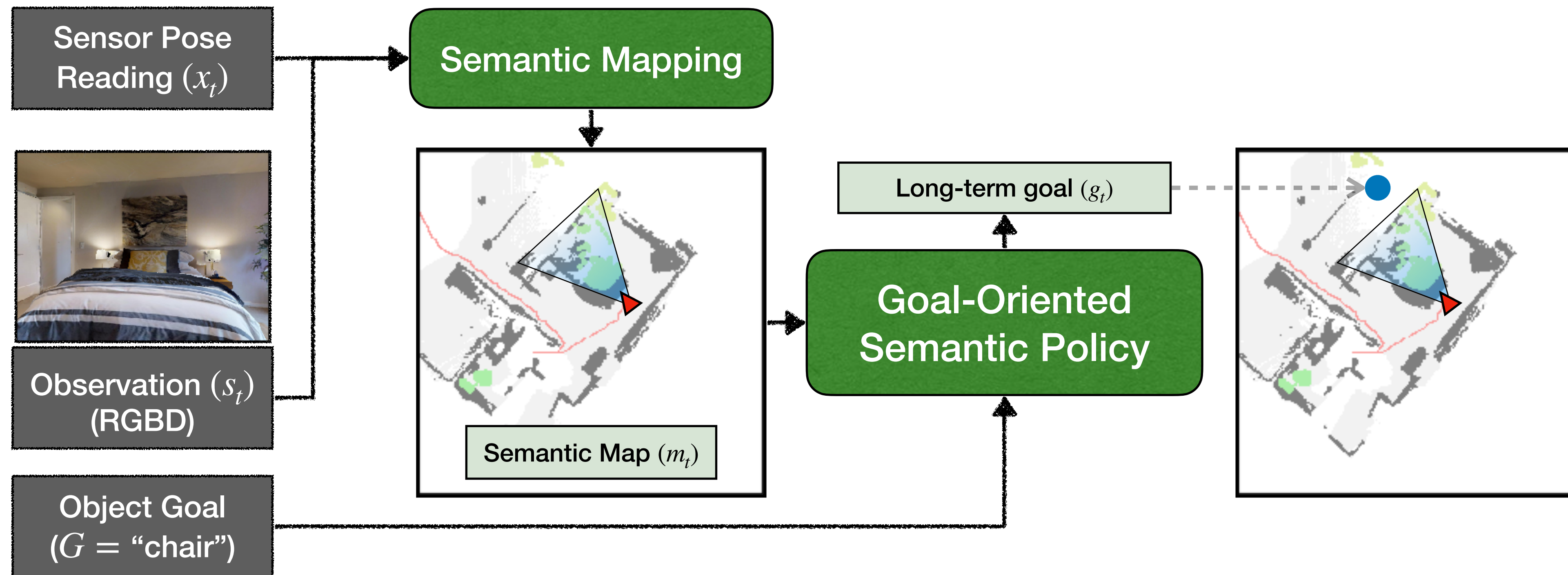
Observation (s_t)
(RGBD)

Object Goal
($G = \text{"chair"}$)

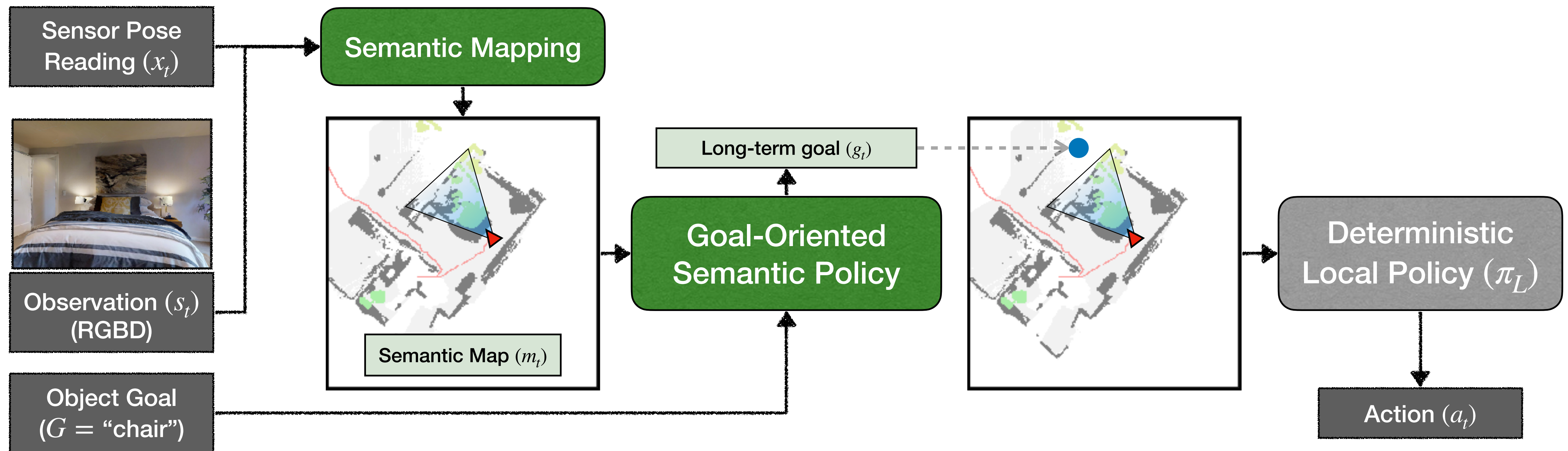
SemExp Model Overview



SemExp Model Overview

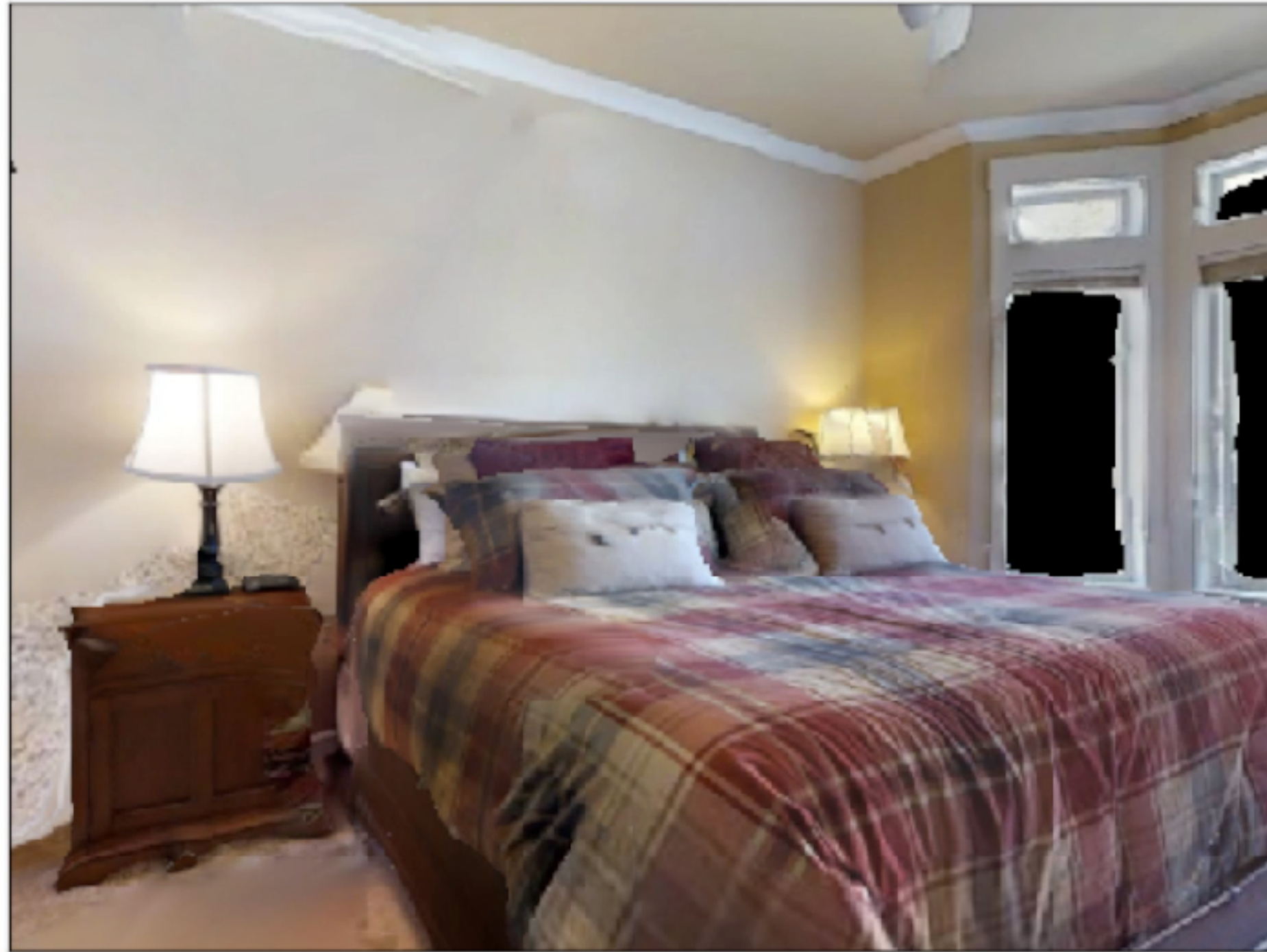


SemExp Model Overview



Demo Video

Observation (Goal: bed)



Predicted Semantic Map



Ground Truth



1: Navigable Area

0: chair

1: couch

2: potted plant

3: bed

4: toilet

5: tv

6: dining-table

7: oven

8: sink

9: refrigerator

10: book

11: clock

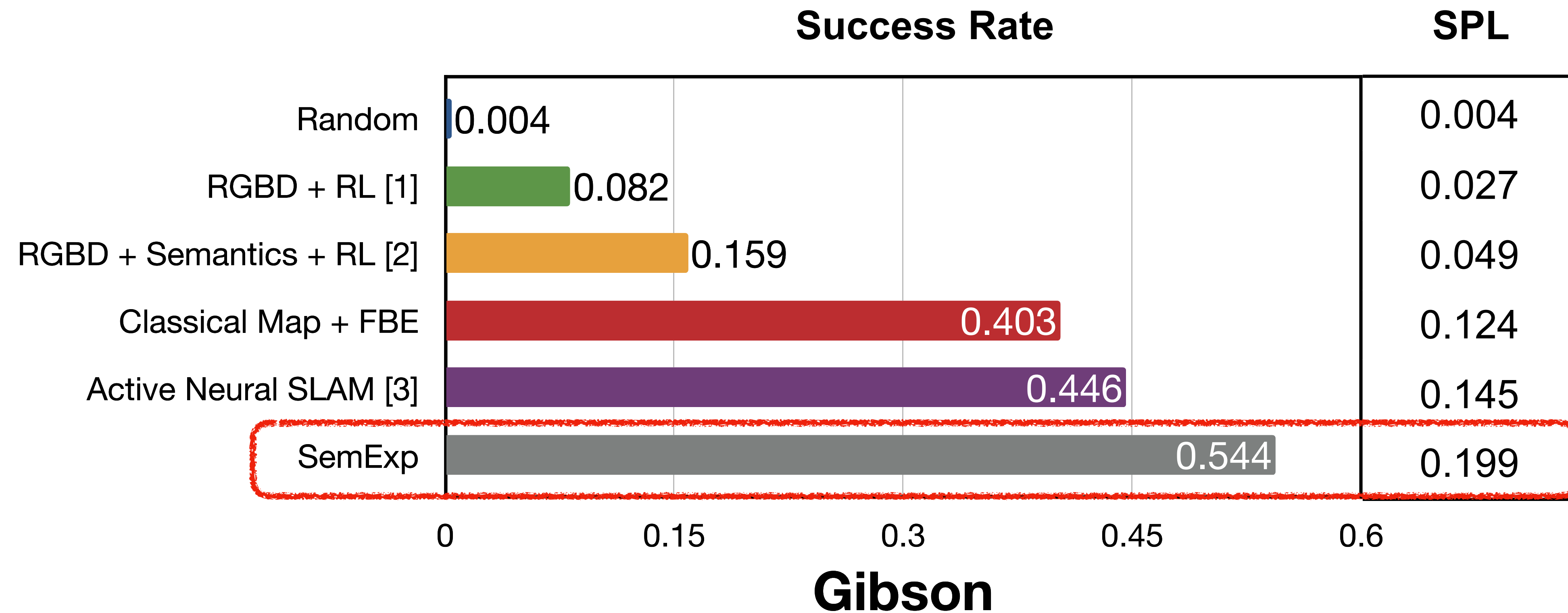
12: vase

13: cup

14: bottle

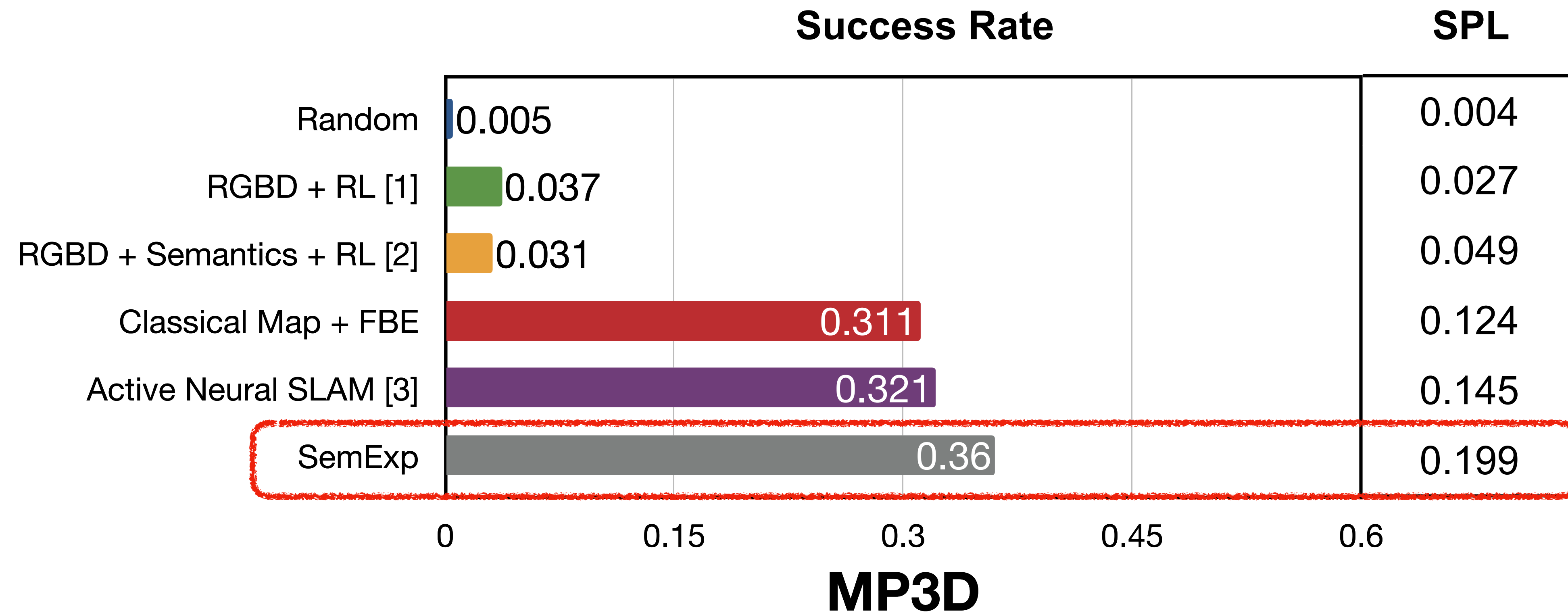
ObjectGoal Navigation Results

ObjectGoal Navigation Results



**Adapted from [1] Savva et al. ICCV-19, [2] Mousavian et al. ICRA-19, [3] Chaplot et al. ICLR-20*

ObjectGoal Navigation Results

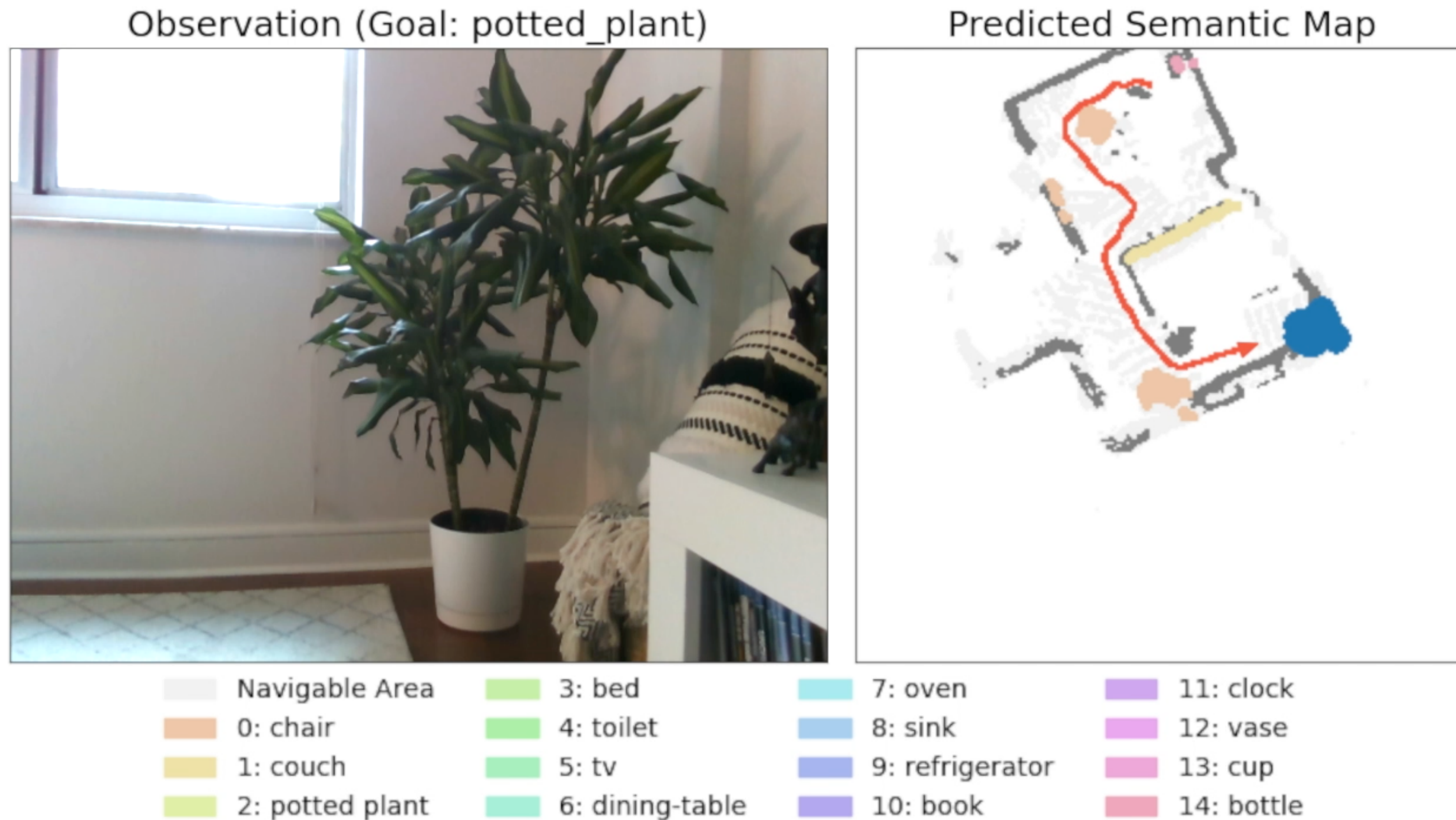


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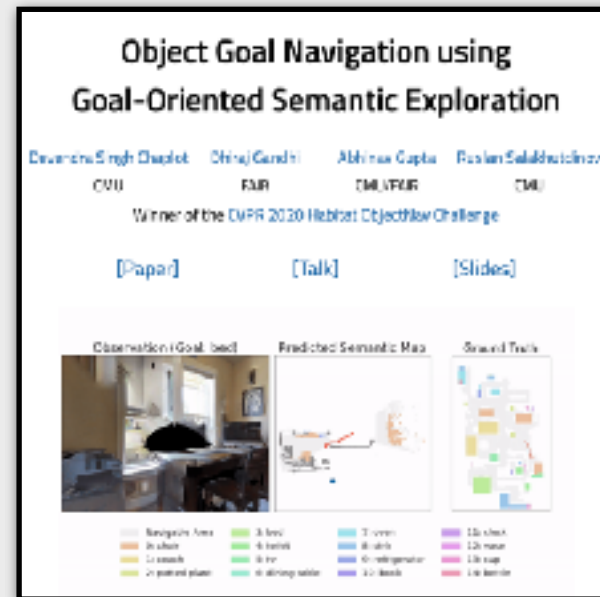
Habitat Challenge Leaderboard

Method	Test-standard			Minival		
	SPL	Success	Dist	SPL	Success	Dist
Arnold (SemExp)	0.071	0.179	8.818	0.246	0.467	3.334
Active Exploration	0.041	0.089	9.461	0.108	0.167	5.079
DD-PPO	0.021	0.062	9.316	-	-	-
Blue Ox	0.017	0.060	8.903	0.083	0.133	4.254
SRCB-robot-sudoer	0.002	0.004	10.276	0.124	0.233	4.848
PPO RGBD	-	-	-	0	0	6.055
Random	0.000	0.000	10.330	0	0	6.379

Real-world Transfer



See video at <https://devendrachaplot.github.io/projects/semantic-exploration>



Object Goal Navigation using Goal-oriented Semantic Exploration

Devendra Singh Chaplot, Dhiraj Gandhi, Abhinav Gupta, Ruslan Salakhutdinov

CVPR 2020

Webpage: <https://devendrachaplot.github.io/projects/semantic-exploration>

Thank you



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