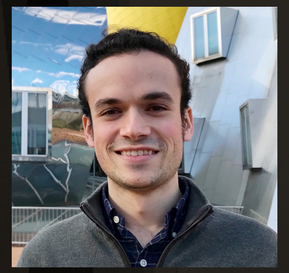
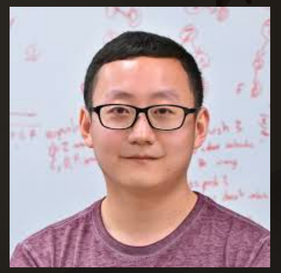
Watch-And-Help

A Challenge for Social Perception and Human-AI Collaboration


Xavier Puig


Tianmin Shu

Shuang Li

Zilin Wang

Yuan-Hong Liao

Josh Tenenbaum

Sanja Fidler

Antonio Torralba

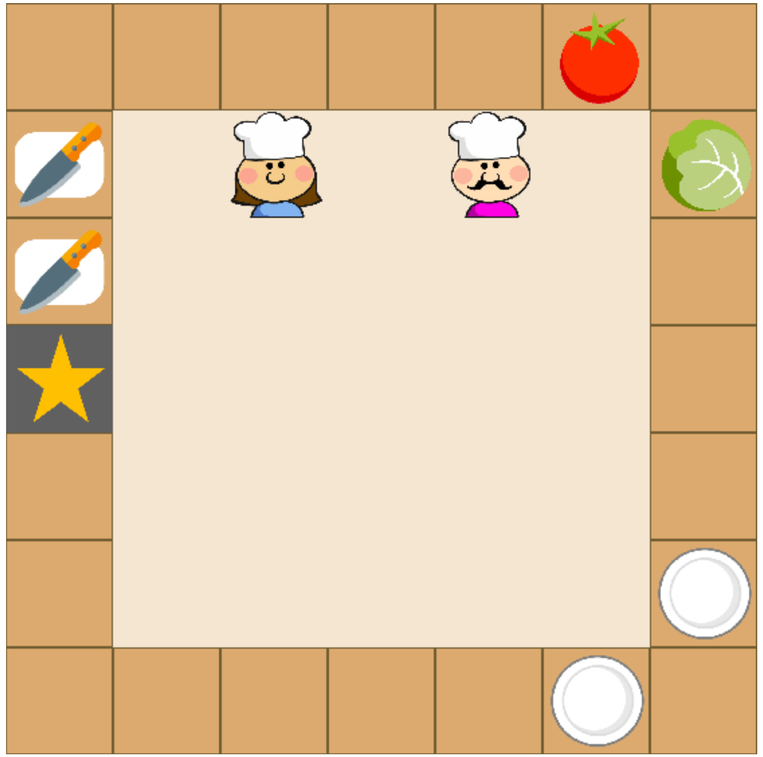
ICLR 2021
May 5th, 2020

Humans routinely help each other

Warneken & Tomasello, 2006

Such altruistic behavior requires

1. Fast and accurate goal inference
2. Planning and coordination



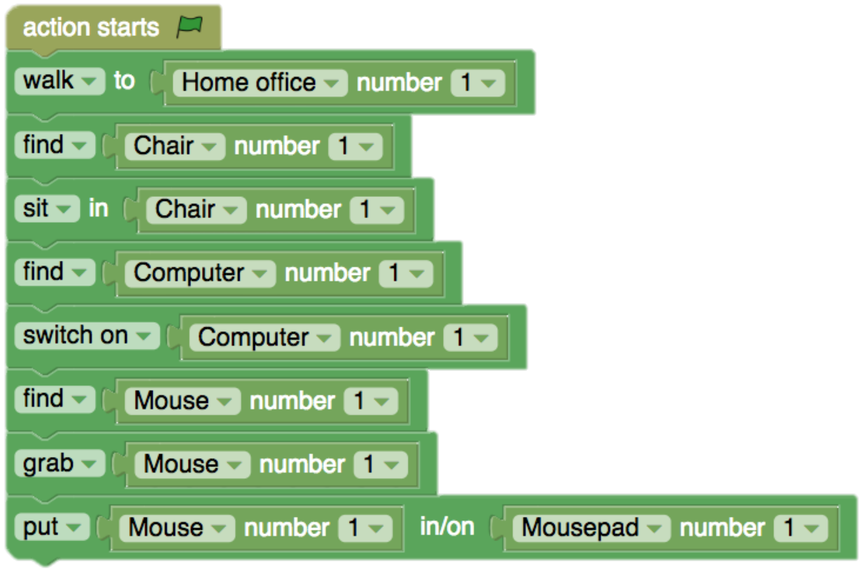
Wang et al., 2020

Unhelkar et al., 2019

VirtualHome-Social

Robots wikiHow to do anything... Knowledge Base of Household Tasks

Action: Work on computer	Action: Make coffee	Action: Read a book
Description: Turn on your computer and sit in front of it. Type on the keyboard, grab the mouse to scroll.	Description: Go to the kitchen and swith on the coffee machine. Wait until it's done and pour the coffee into a cup.	Description: Sit down in recliner. Pick up a novel off of coffee table. Open novel to last read page. Read.



Puig et al. 2018

Watch-And-Help Challenge

Main agent: setup a table

Helper agent: infer Main's goal

Watch-And-Help Challenge

Main agent: setup a table

Helper agent: infer Main's goal

Watch-And-**Help** Challenge

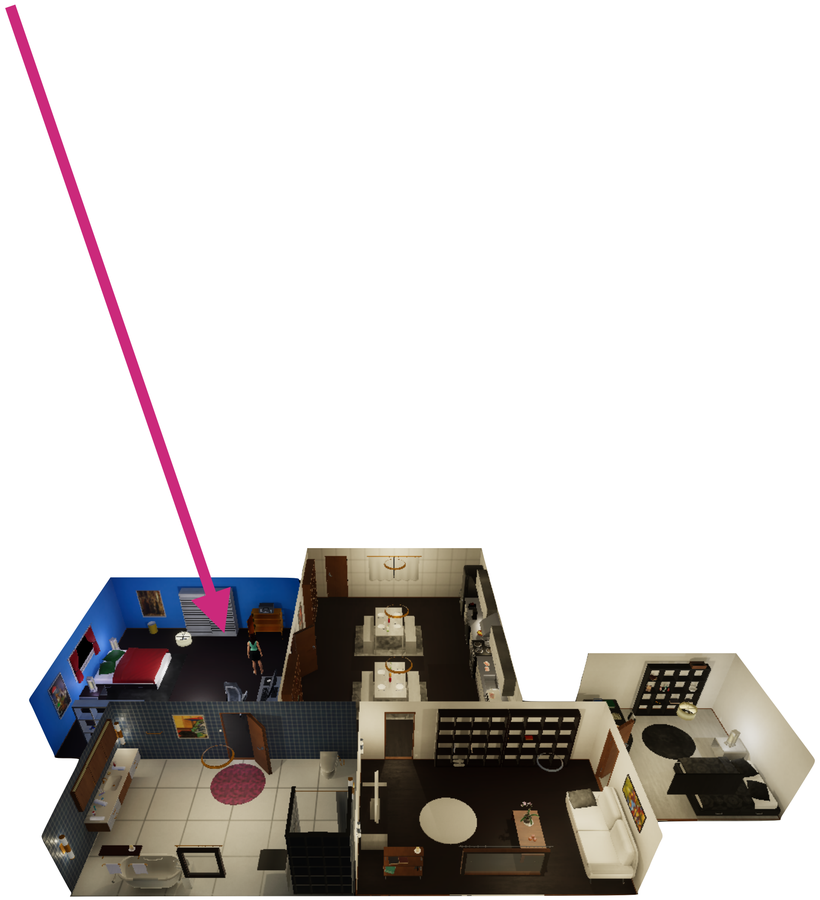
Main agent: setup a table

Helper agent: help on the **inferred** goal

Building planning-based agents

Main agent

Goal: Put Glasses in Dishwasher



Building planning-based agents

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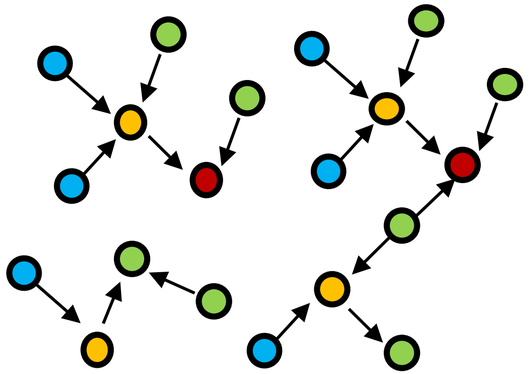

Building planning-based agents

Main agent

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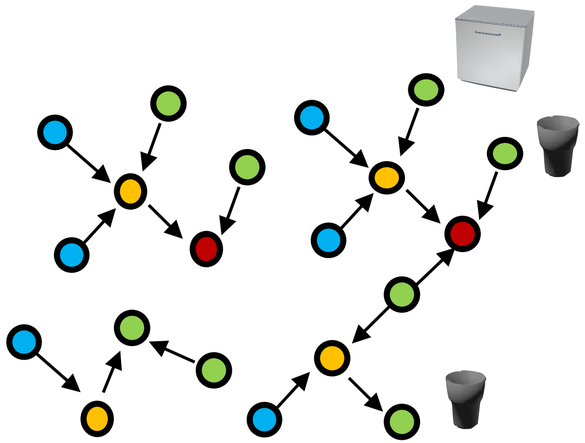

Building planning-based agents

Main agent

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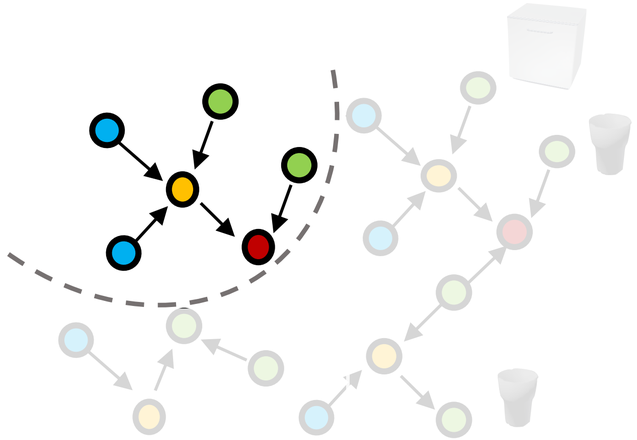
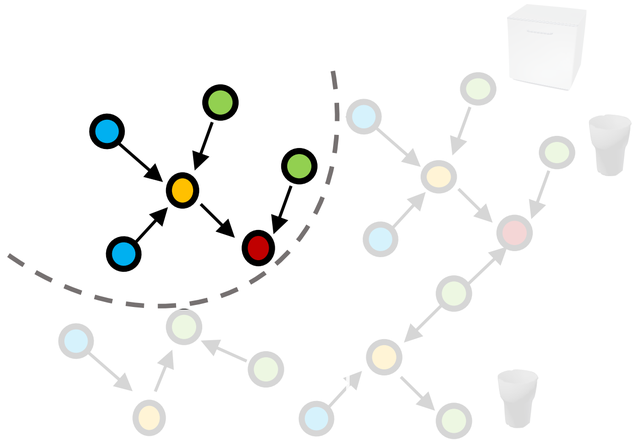


Building planning-based agents

Main agent

Goal: Put Glasses in Dishwasher

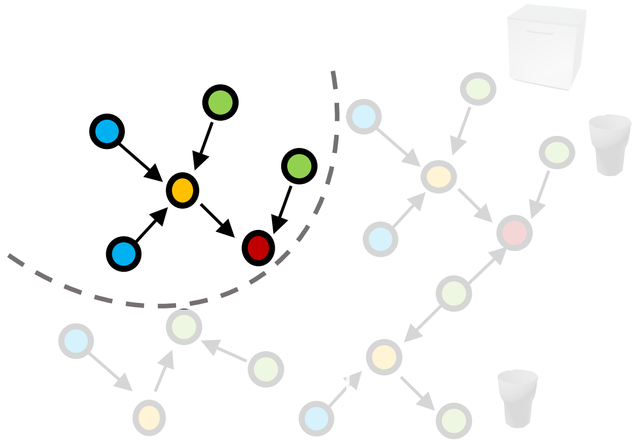


Belief

Building planning-based agents

Main agent

Goal: Put Glasses in Dishwasher



Prior

fork wine glass apple

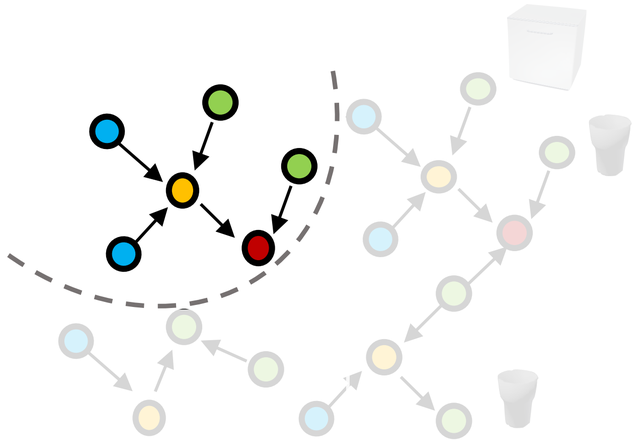
Location distribution of wine glass

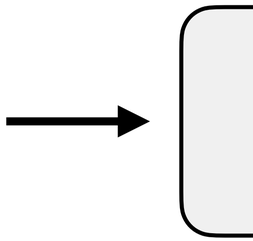
Drawer Fridge Counter Cabinet

Building planning-based agents

Main agent

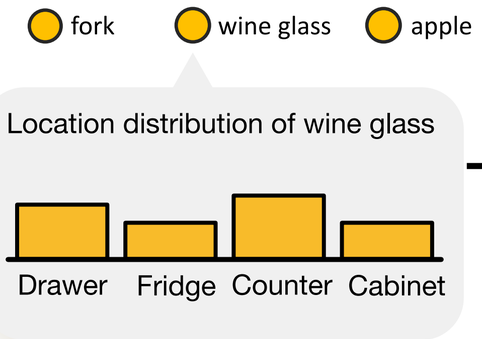
Goal: Put Glasses in Dishwasher



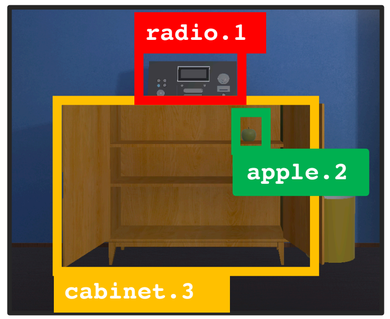


Belief

Prior



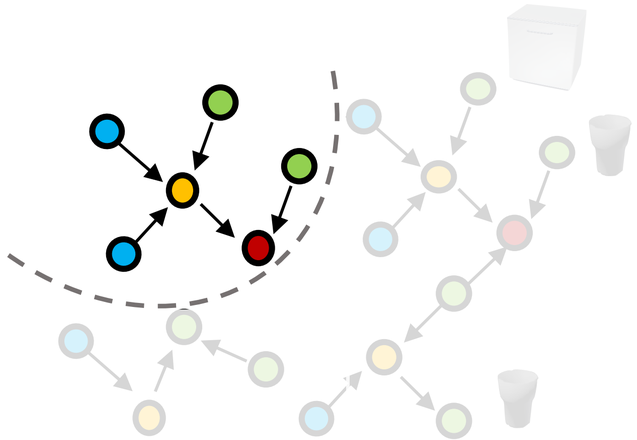
Observation



Building planning-based agents

Main agent

Goal: Put Glasses in Dishwasher



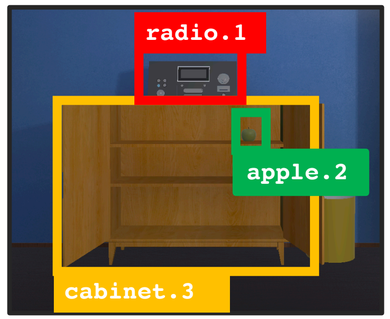
Belief

Prior

fork wine glass apple

Location distribution of wine glass

Drawer Fridge Counter Cabinet



Observation

Posterior

fork wine glass apple: in cabinet

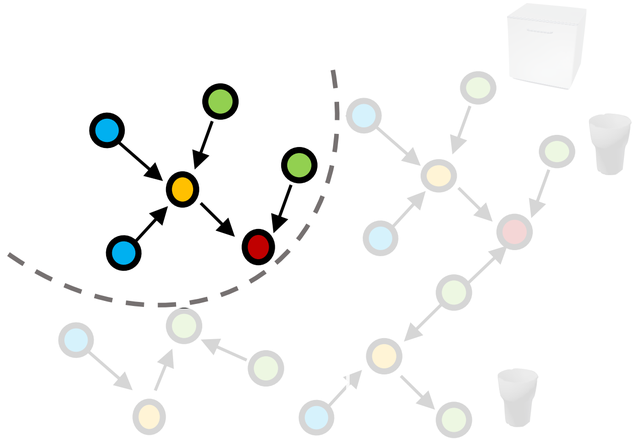
Location distribution of wine glass

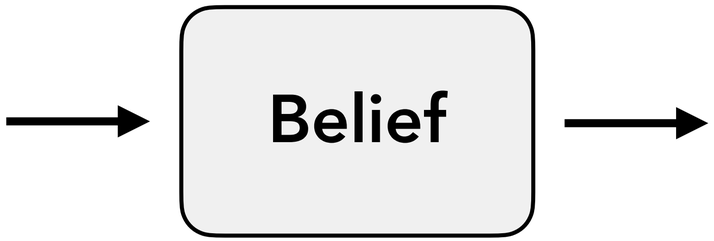
Drawer Fridge Counter Cabinet

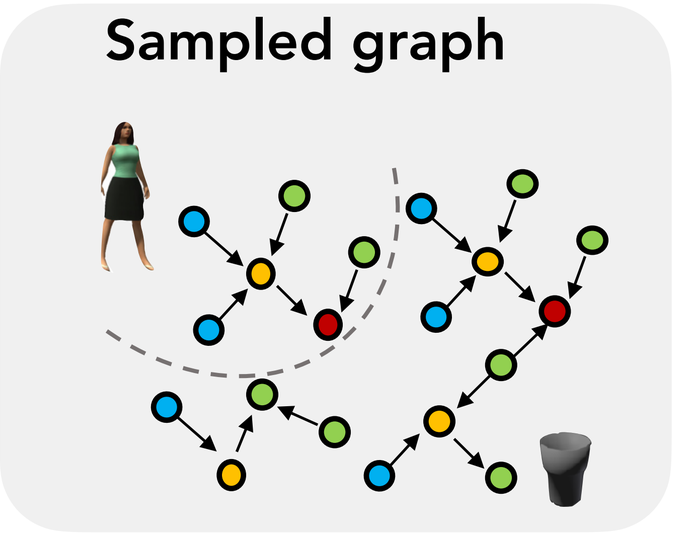
Building planning-based agents

Main agent

Goal: Put Glasses in Dishwasher



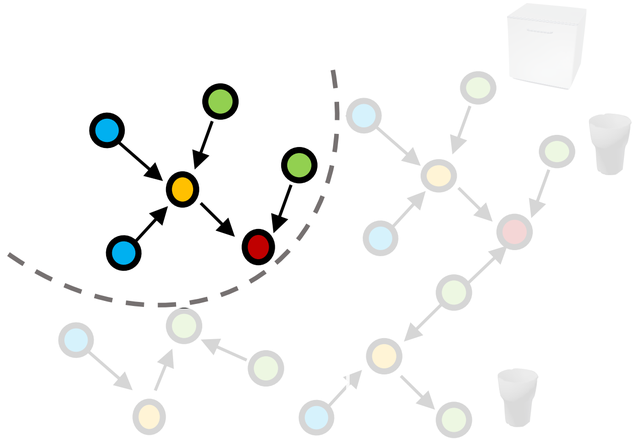




Building planning-based agents

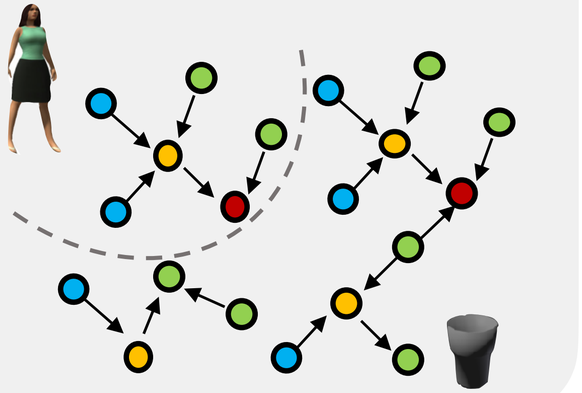
Main agent

Goal: Put Glasses in Dishwasher



Belief

Sampled graph



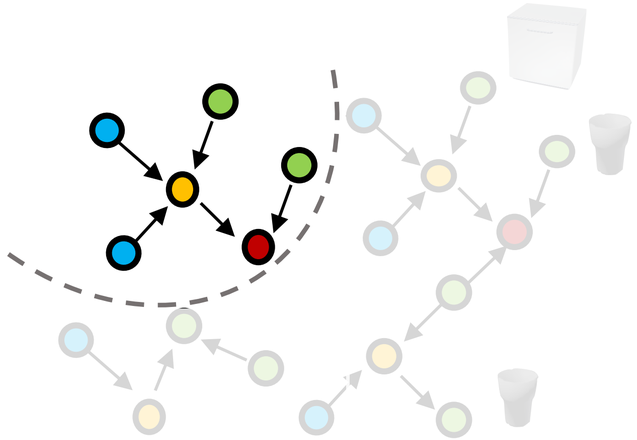
Activity Predicates

```
CLOSED(Dishw.)
IN(Cup, Dishw.)
IN(Glass, Dishw.)
```

Building planning-based agents

Main agent

Goal: Put Glasses in Dishwasher



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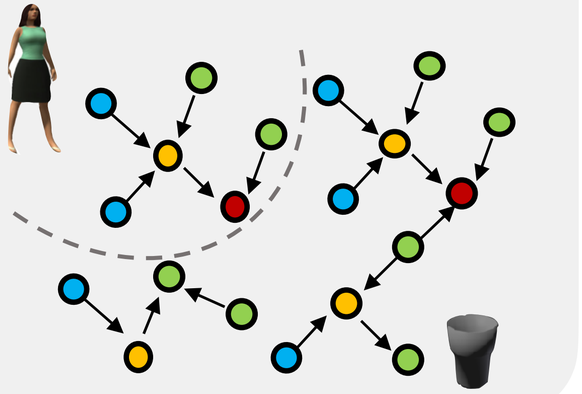
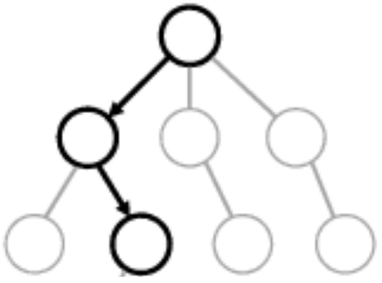


MCTS Planner

Activity Predicates

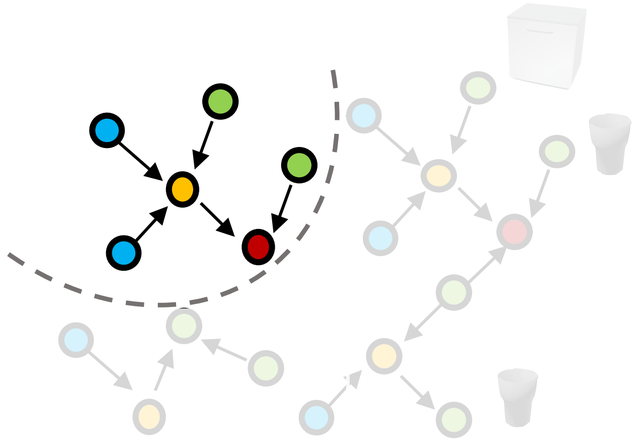
```
CLOSED(Dishw.)
IN(Cup, Dishw.)
IN(Glass, Dishw.)
```



Building planning-based agents

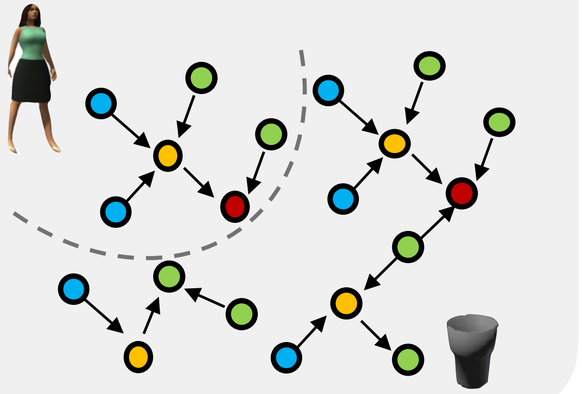
Main agent

Goal: Put Glasses in Dishwasher



Belief

Sampled graph



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Activity Predicates

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IN(Cup, Dishw.)
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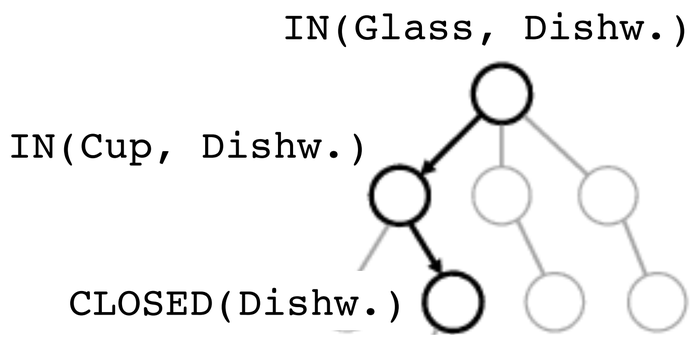
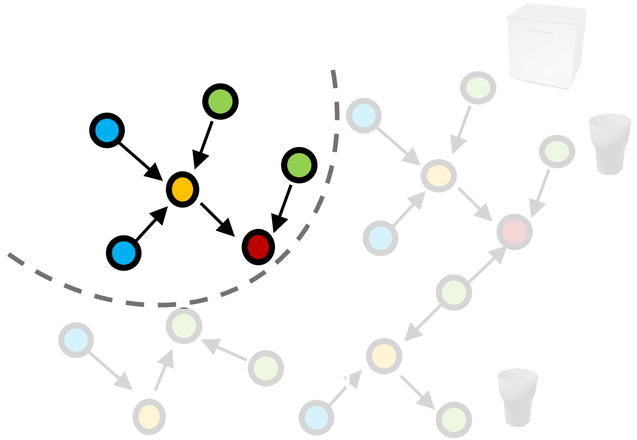


Building planning-based agents

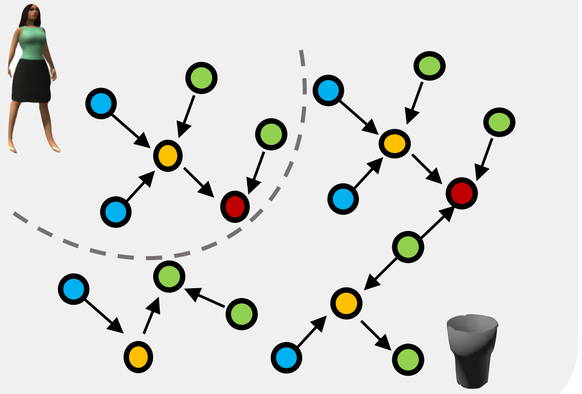
Main agent

Goal: Put Glasses in Dishwasher



Belief

Sampled graph

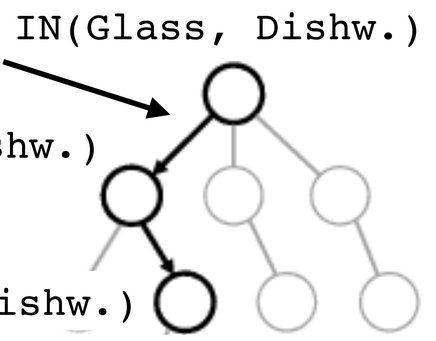


MCTS Planner

Activity Predicates

```
CLOSED(Dishw.)
IN(Cup, Dishw.)
IN(Glass, Dishw.)
```

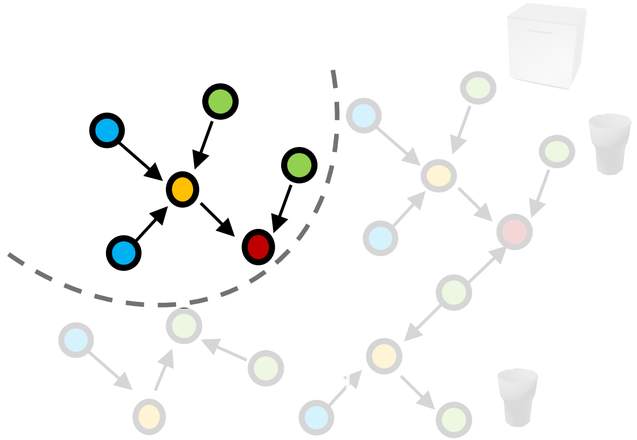
```
Put glass
1. walk glass
2. grab glass
3. walk dishwasher
```



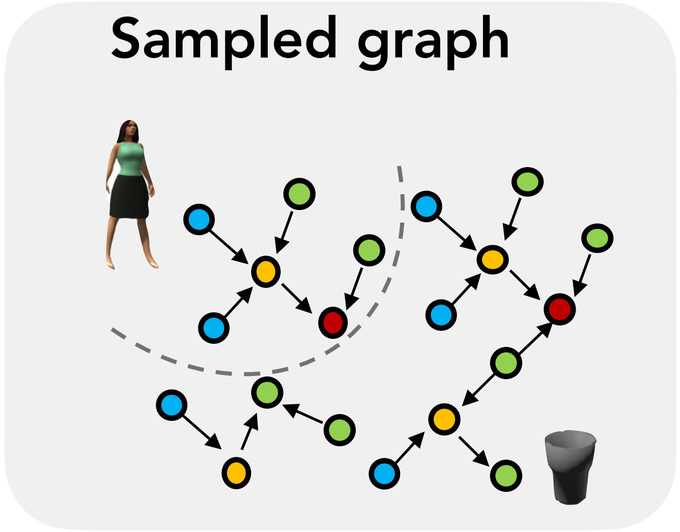
Building planning-based agents

Main agent

Goal: Put Glasses in Dishwasher



Belief



Step

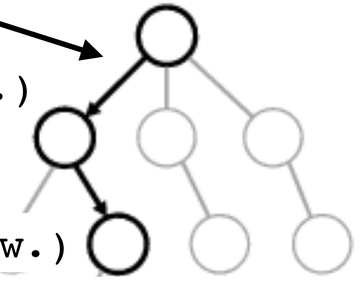
MCTS Planner

Activity Predicates

CLOSED(Dishw.)
IN(Cup, Dishw.)
IN(Glass, Dishw.)

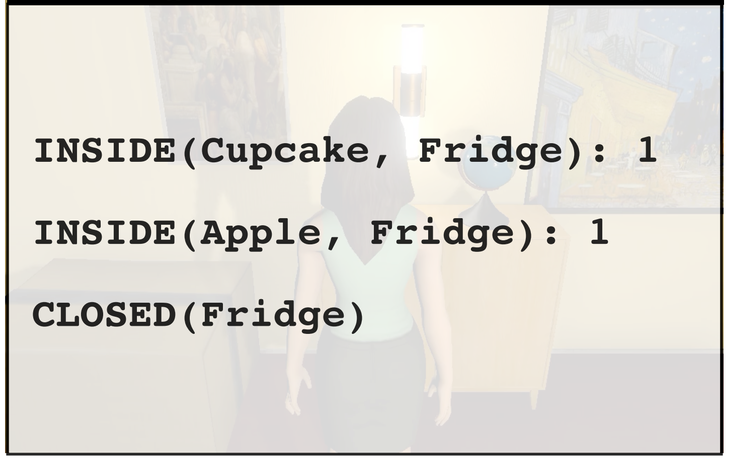
Put glass
1. walk glass
2. grab glass
3. walk dishwasher

IN(Glass, Dishw.)



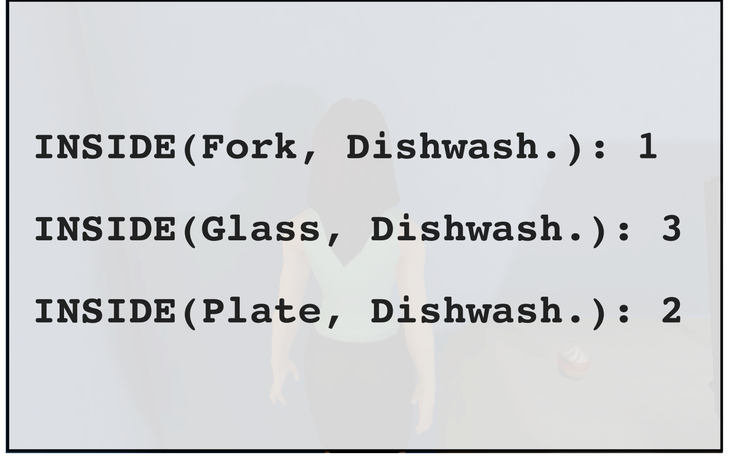
Activity Set

Put groceries in fridge



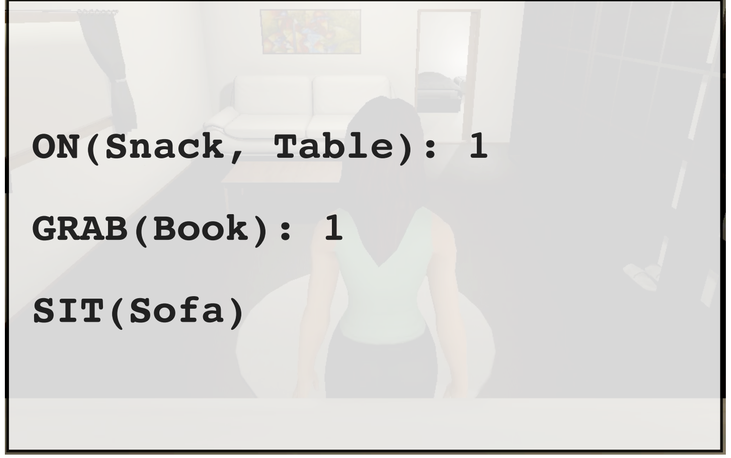
```
INSIDE(Cupcake, Fridge): 1
INSIDE(Apple, Fridge): 1
CLOSED(Fridge)
```

Put dishwasher



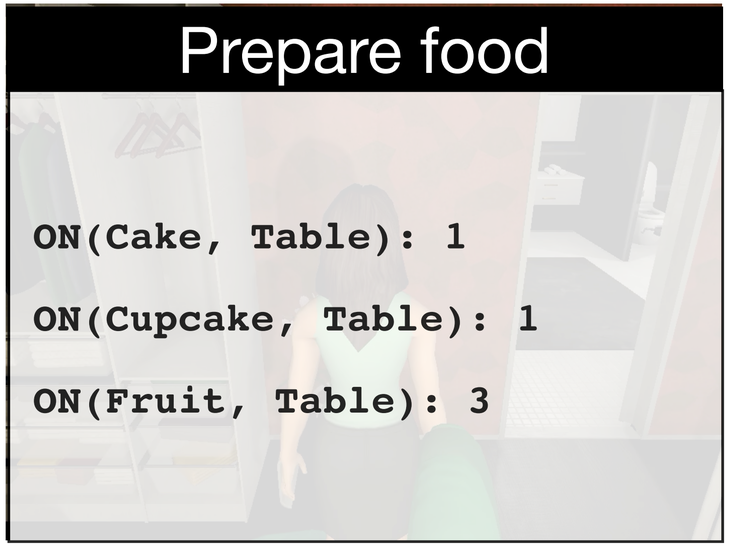
```
INSIDE(Fork, Dishwash.): 1
INSIDE(Glass, Dishwash.): 3
INSIDE(Plate, Dishwash.): 2
```

Read book



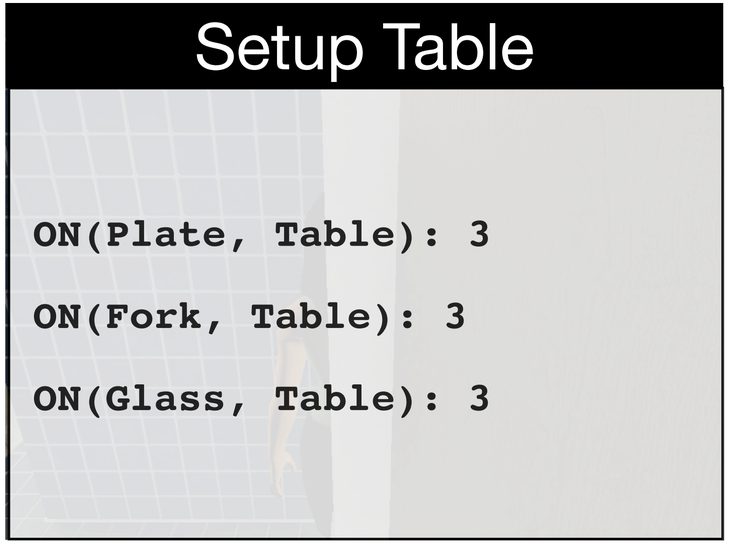
```
ON(Snack, Table): 1
GRAB(Book): 1
SIT(Sofa)
```

Prepare food



```
ON(Cake, Table): 1
ON(Cupcake, Table): 1
ON(Fruit, Table): 3
```

Setup Table



```
ON(Plate, Table): 3
ON(Fork, Table): 3
ON(Glass, Table): 3
```

Building a Helper Agent

Generate Demonstration

Sample task: Set Table

```
ON(plate, table)
ON(glass, table)
ON(fork, table)
```

Building a Helper Agent

Generate Demonstration

Watch Model

Predict Task

```
ON(plate, table)
ON(glass, table)
```

Sample task: Set Table

```
ON(plate, table)
ON(glass, table)
ON(fork, table)
```

Building a Helper Agent

Generate Demonstration

Sample task: Set Table

```
ON(plate, table)
ON(glass, table)
ON(fork, table)
```

Watch Model

Predict Task

```
ON(plate, table)
ON(glass, table)
```

Help Model

Help Environment

Action

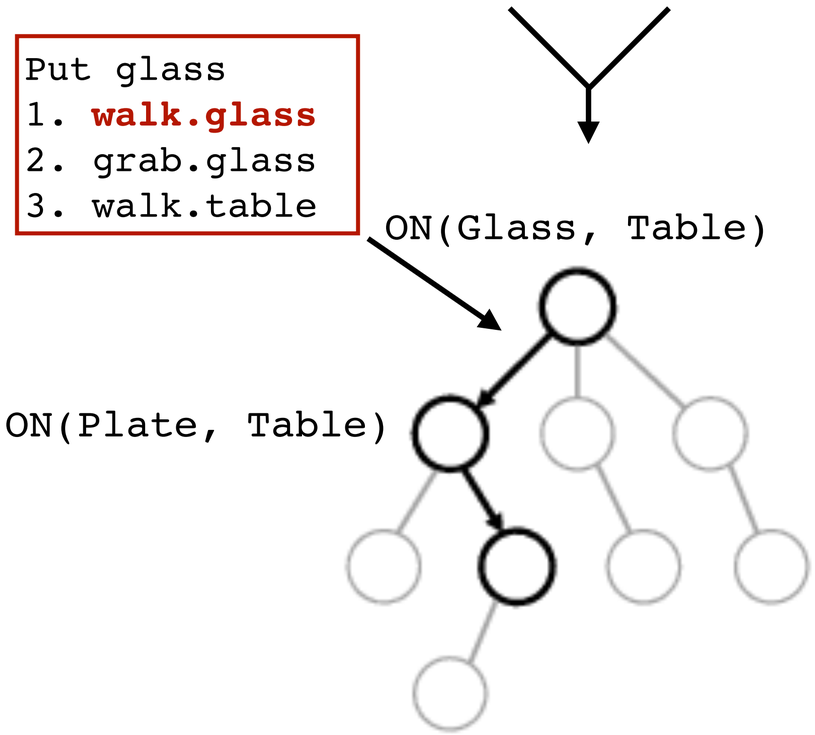
Action

Helping

Helping

Planning

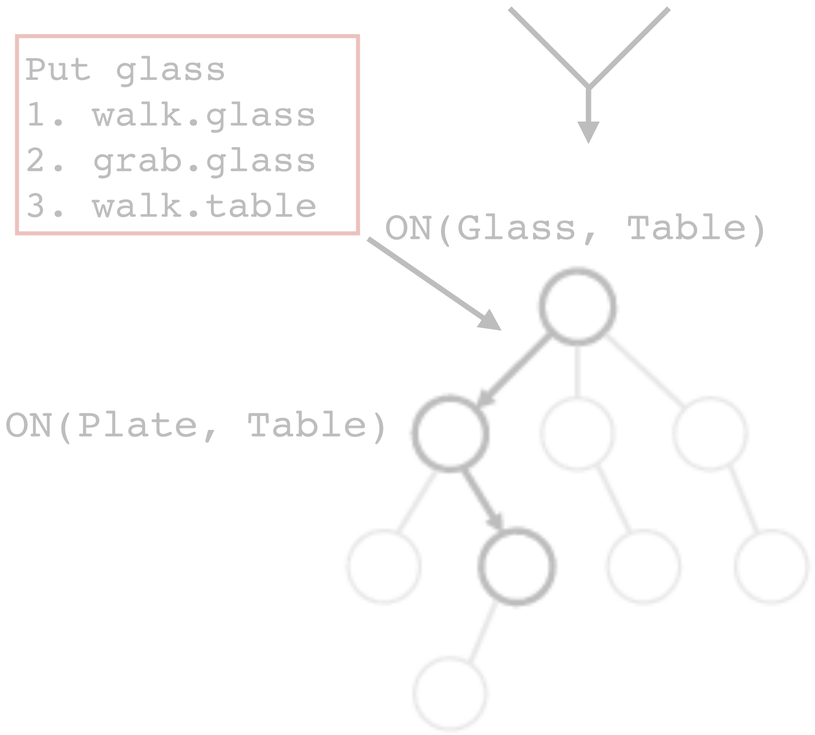
Observations **Predicates**



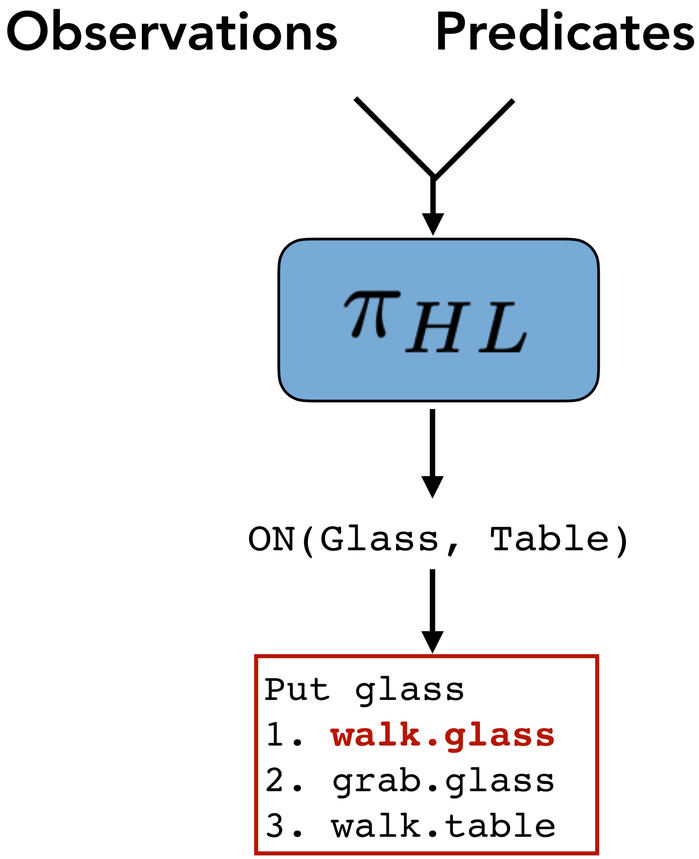
Helping

Planning

Observations Predicates



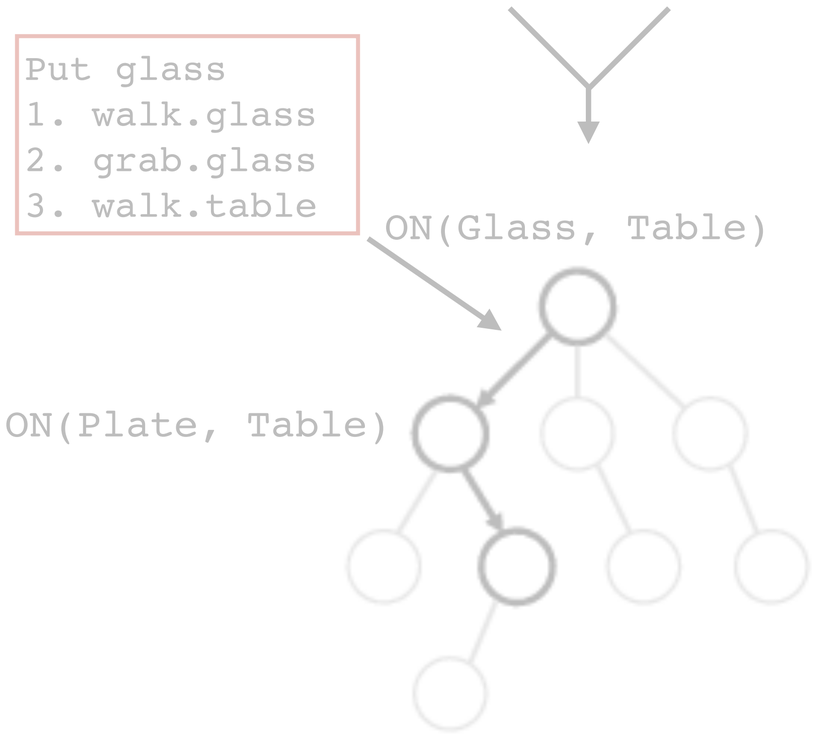
Hybrid RL



Helping

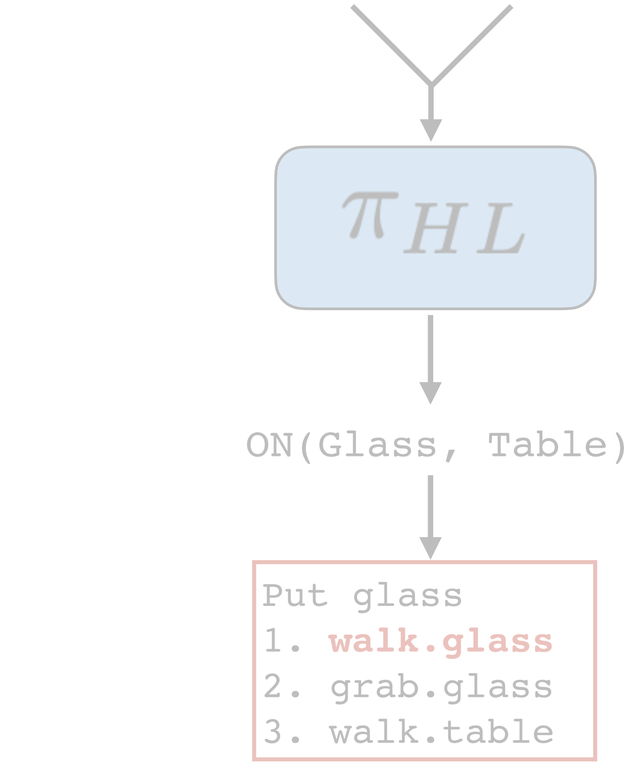
Planning

Observations Predicates

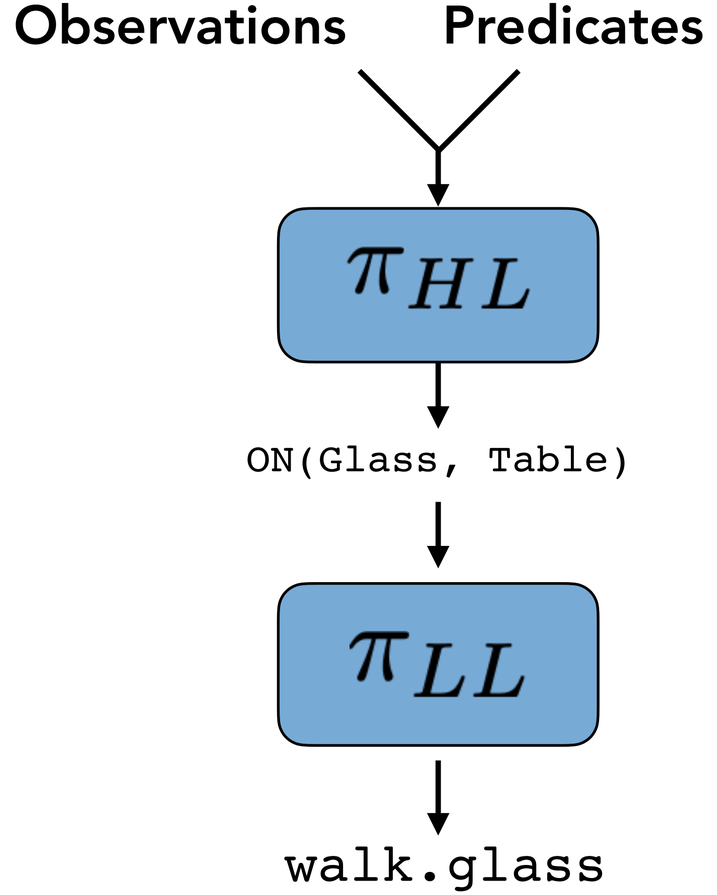


Hybrid RL

Observations Predicates



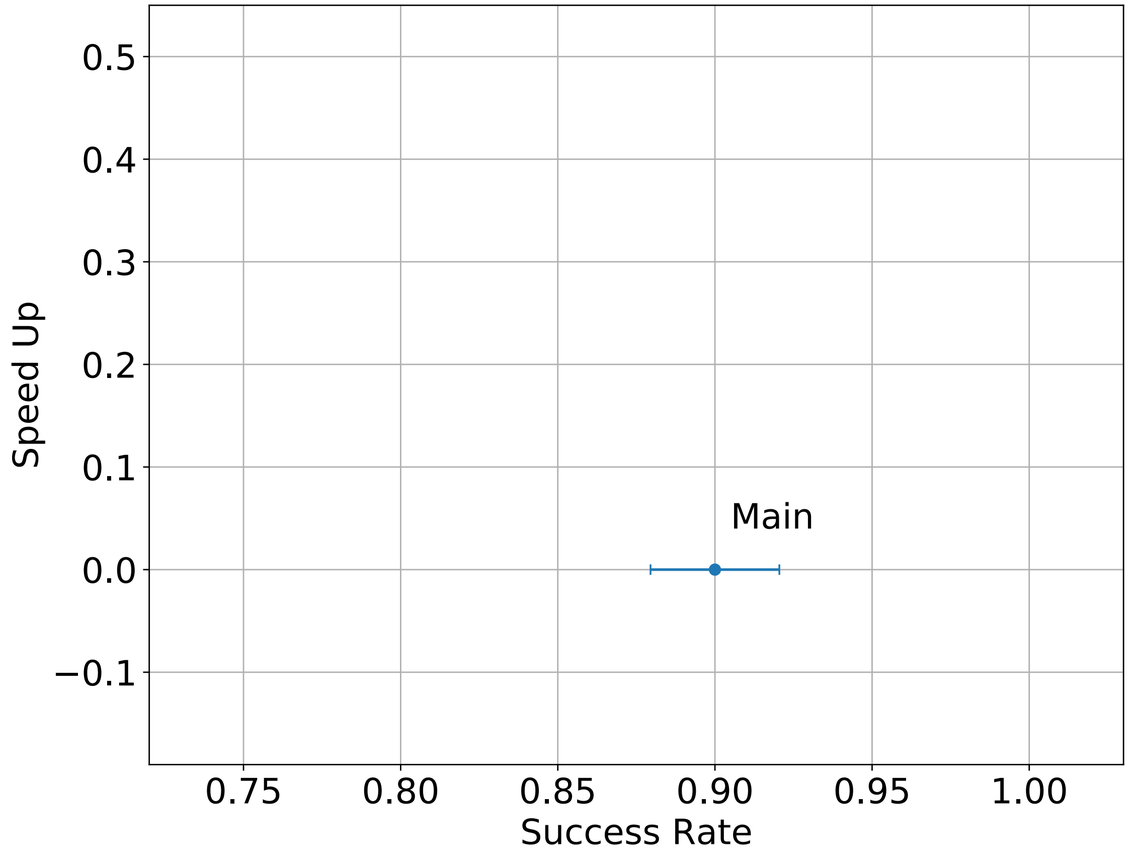
Hierarchical RL



Watch And Help Performance

Evaluate:

1. Success Rate
2. Collaboration Speed Up



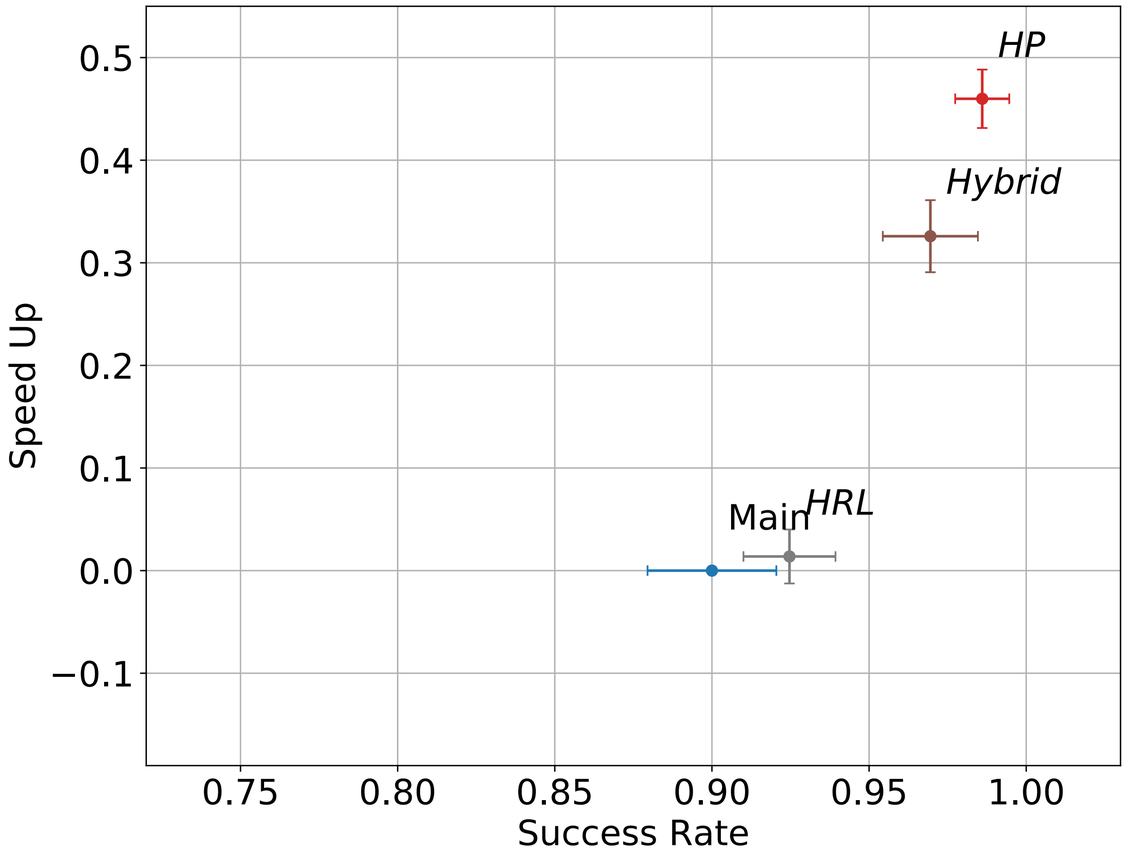
Watch And Help Performance

Evaluate:

1. Success Rate
2. Collaboration Speed Up

Helper Agents

1. Planning Based (HP)
2. Hybrid
3. Learning Based (HRL)



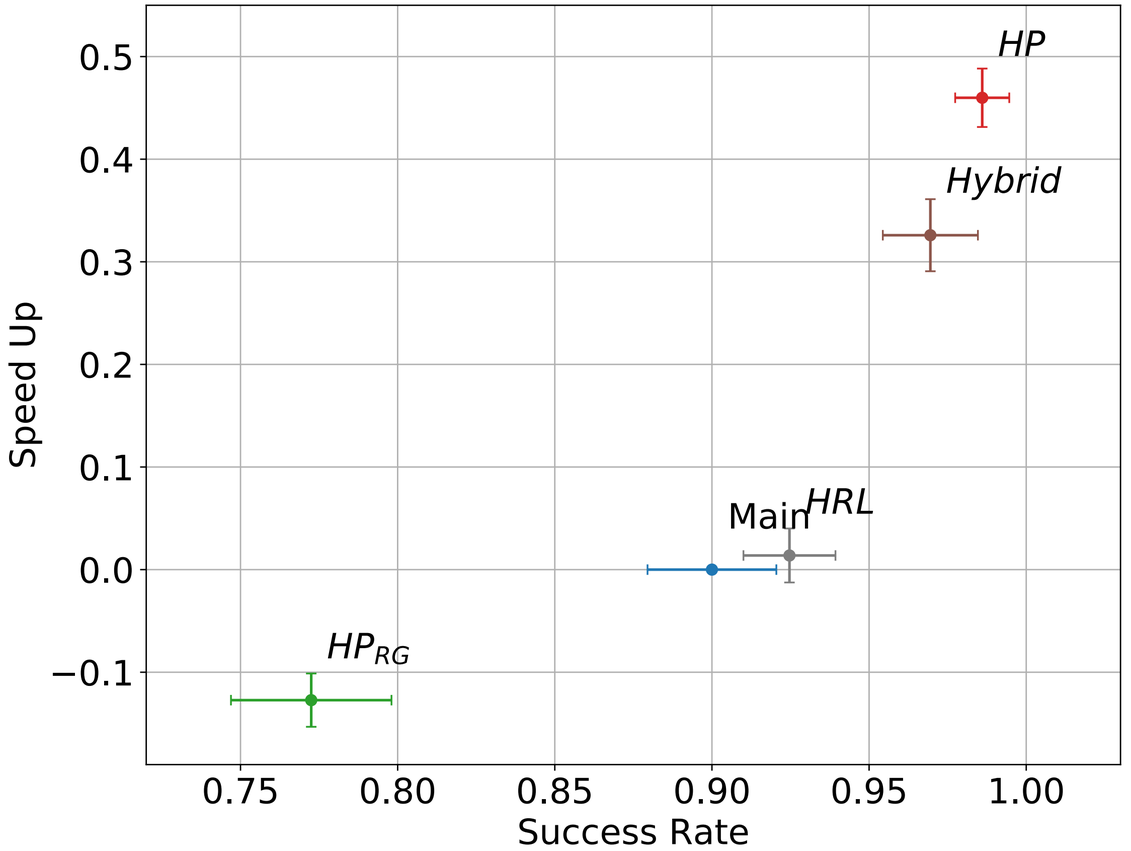
Watch And Help Performance

Evaluate:

1. Success Rate
2. Collaboration Speed Up

Helper Agents

1. Planning Based (HP)
2. Hybrid
3. Learning Based (HRL)
4. Planning with wrong goals



Watch And Help Performance

Conflicting goals

True Goal:

1 Glass on the table
2 Forks on the table

Random Goal:

1 Glass on the dishwasher

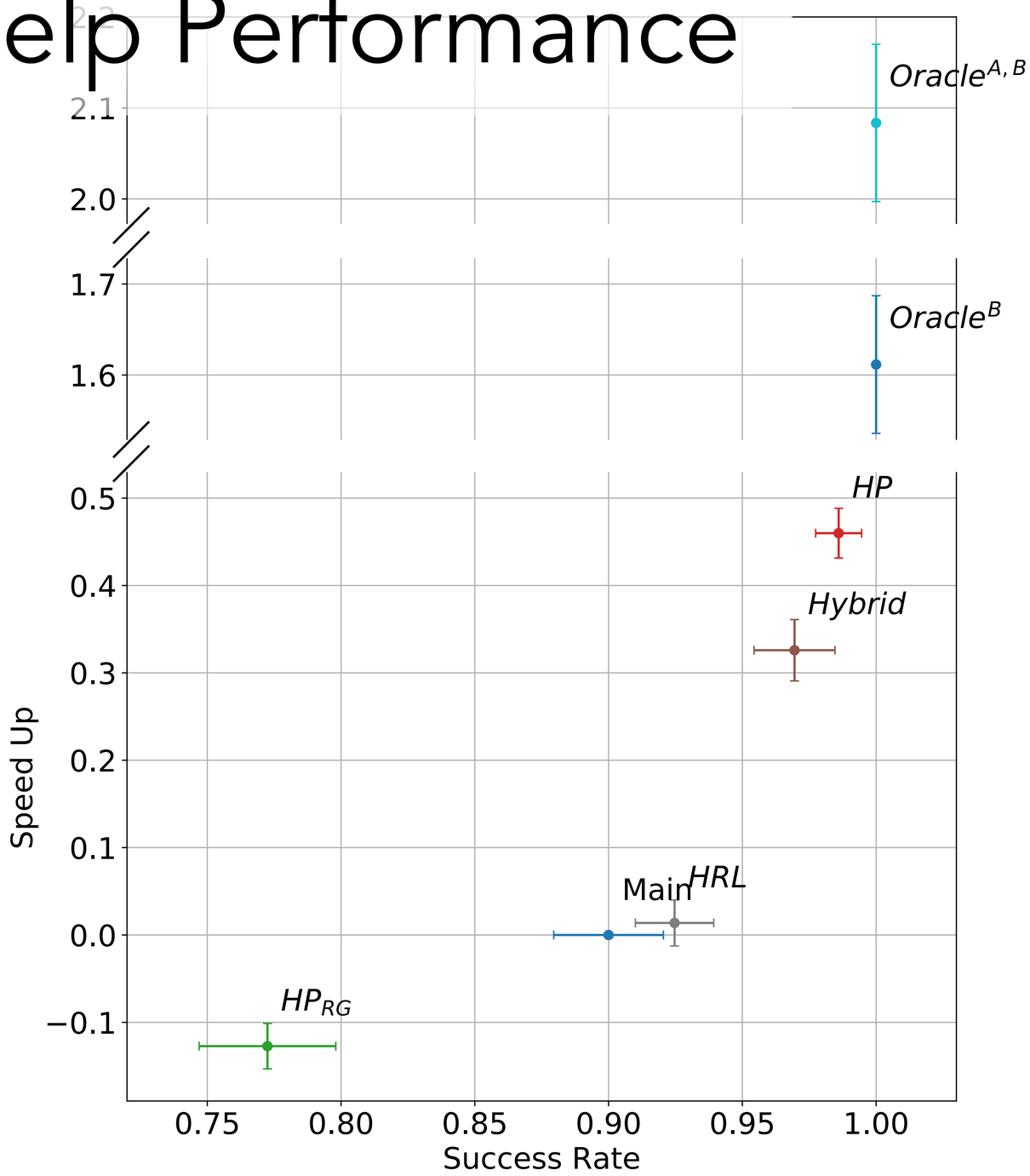
Watch And Help Performance

Evaluate:

1. Success Rate
2. Collaboration Speed Up

Helper Agents

1. Planning Based (HP)
2. Learning Based (HRL)
3. Hybrid
4. Planning with wrong goals
5. Fully observable oracles



Collaboration

Main Agent

Helper Agent

Goal

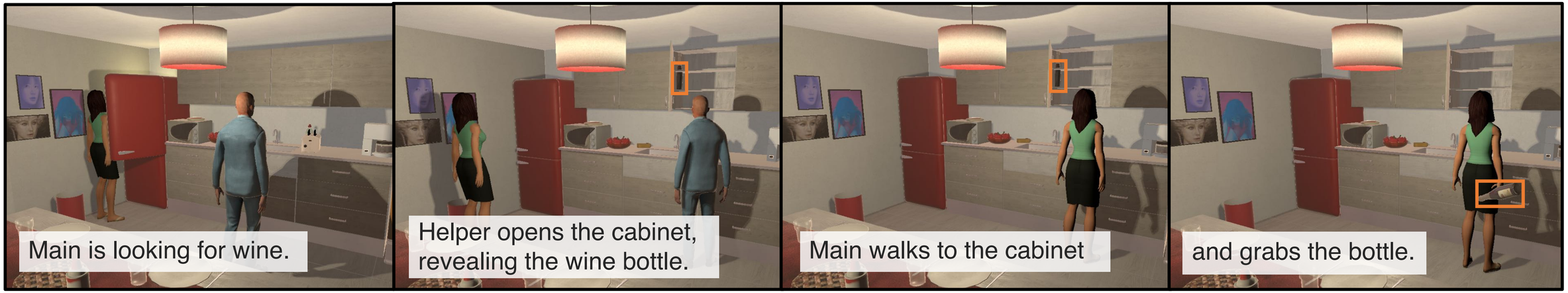
INSIDE(Cupcake, Fridge): 2

INSIDE(Wine, Fridge): 1

Modeling other agents minds

Improving beliefs

Help by showing where objects are.

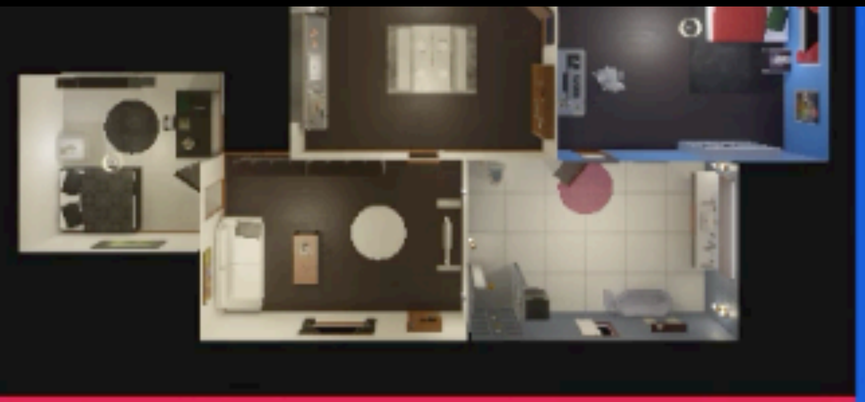


False Beliefs

Goal

`INSIDE(Apple, Fridge): 2`

`INSIDE(Cupcake, Fridge): 1`

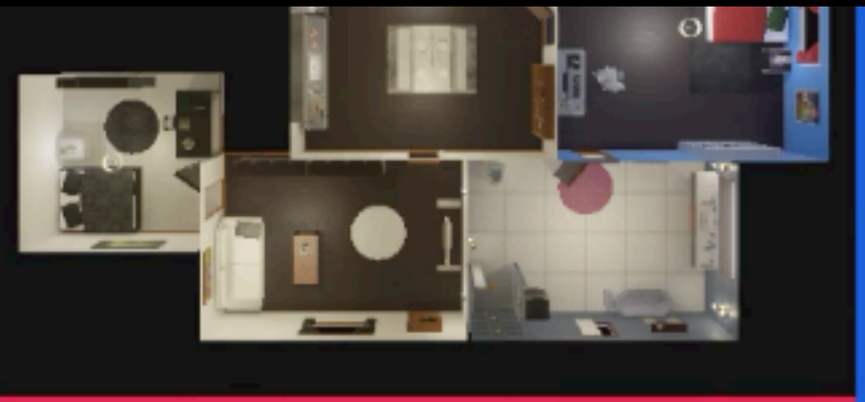


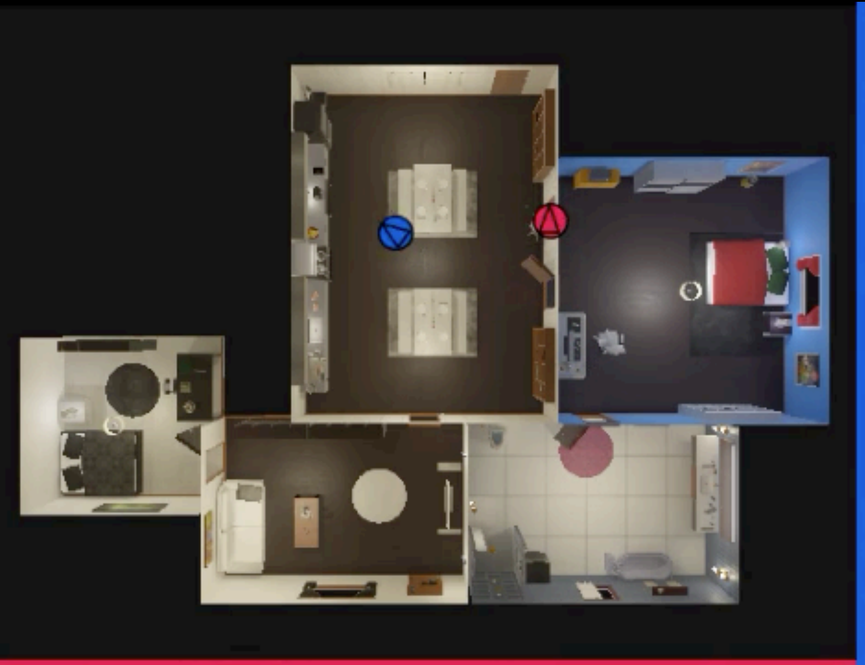
False Beliefs

Goal

`INSIDE(Apple, Fridge): 2`

`INSIDE(Cupcake, Fridge): 1`





How realistic are these agents?

Next Task | Refresh

Activity 1/2 #Steps 0/250

Activity name: read_book
Tasks:

- on cupcake coffeetable: 0/1
- on pudding coffeetable: 0/2
- hold book: 0/1

Tasks Completed: 0/4 false

Walk to

kitchen | bathroom | bedroom | livingroom

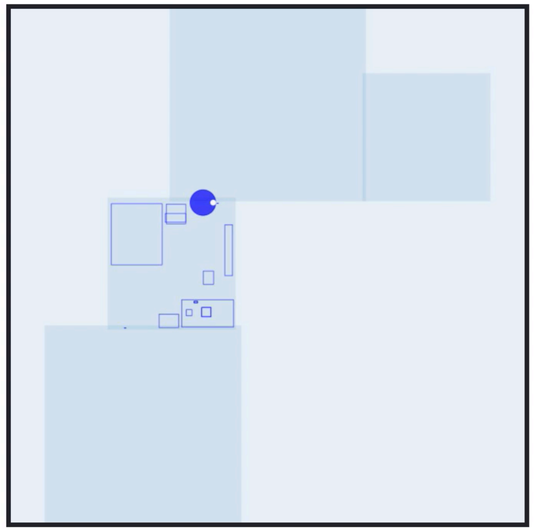
Visible Objects About

Other locations inside room

Containers/Surfaces

cabinet.1 | chair.5 | desk.1 | nightstand.3

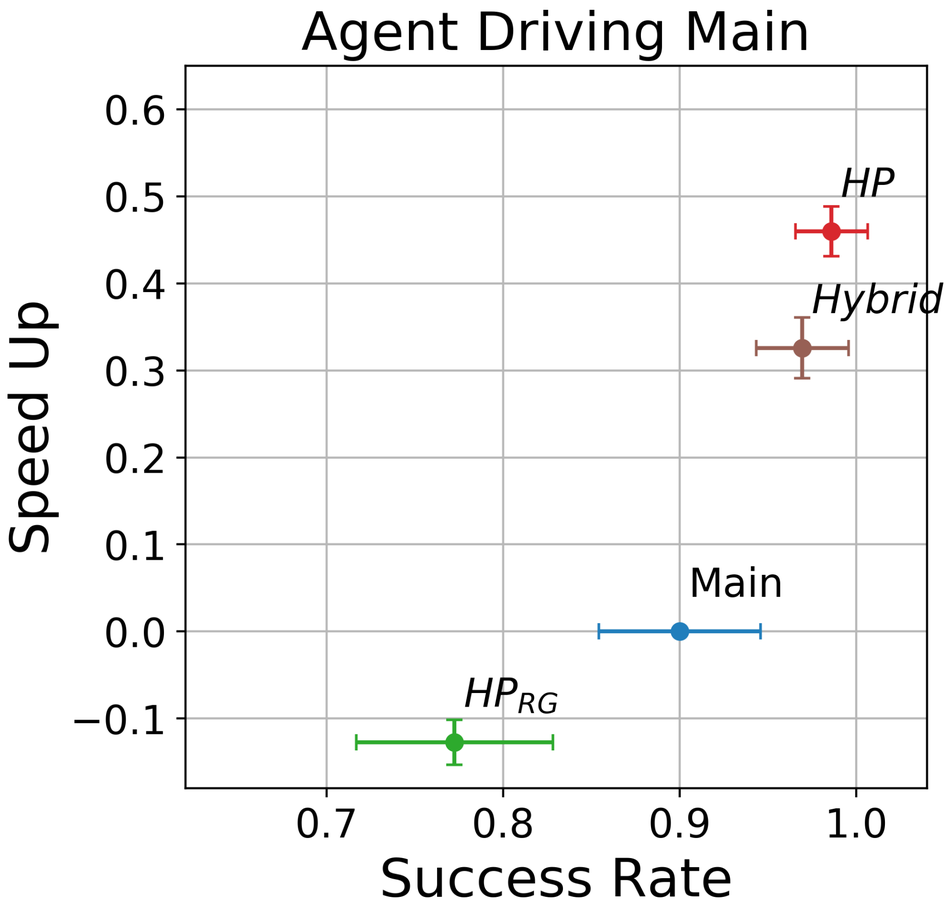
plate.7

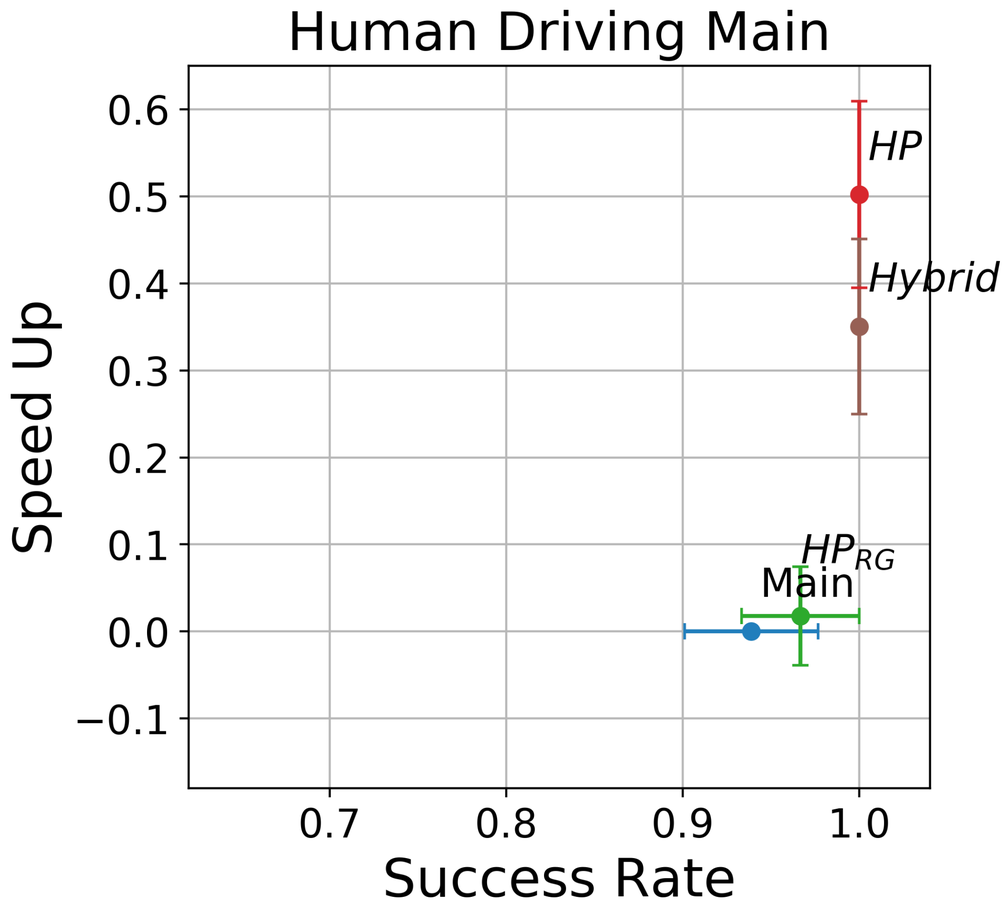


Agent

Location: bedroom
Grabbed Object: **Nothing**

How realistic are these agents?





Thank you!

Poster Id 2576

Poster Session 8

May 5th, 9am-11am PDT

Info and Datasets

virtual-home.org

Watch and Help Code

https://github.com/xavierpuigf/watch_and_help