

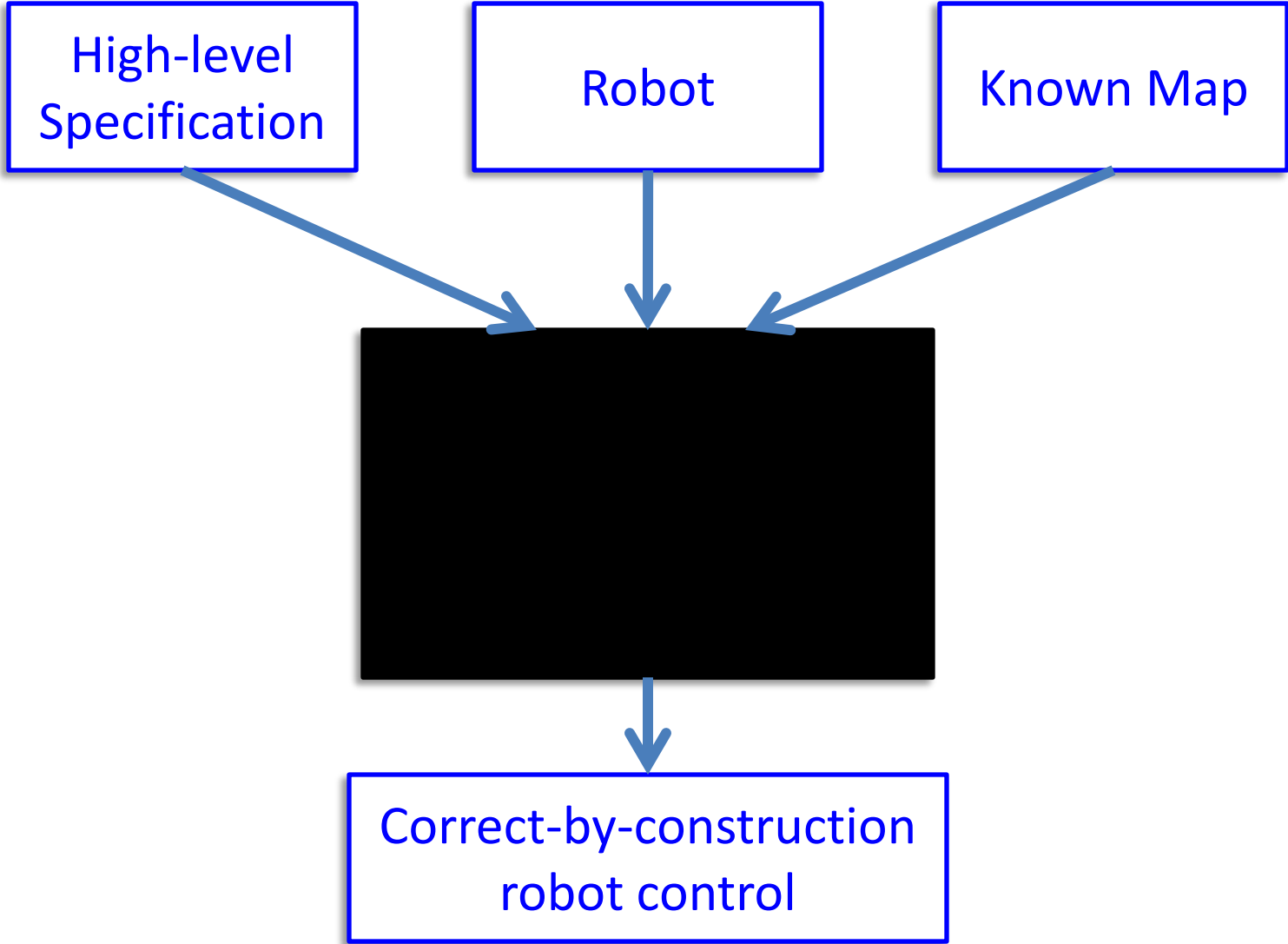
# (Linear Temporal) Logic to robot control

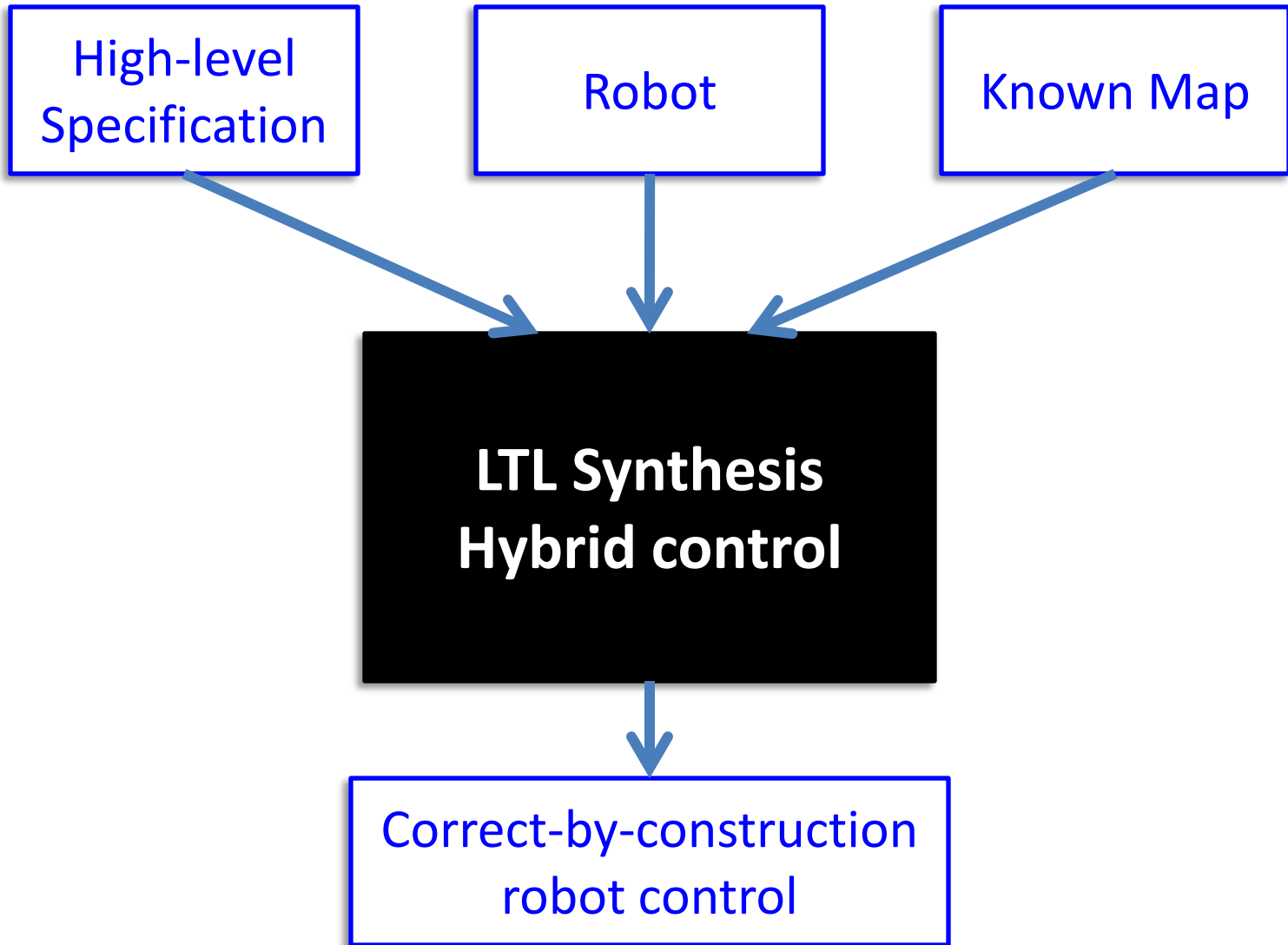
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**“LTL” – Part I**  
**Explaining Unsynthesizable**  
**Specifications**

?

High-level Specification

Robot

Known Map

LTL Synthesis  
Hybrid control

~~Correct-by-construction  
robot control~~

# Types of Problems

- Specification Unsatisfiable:

$$\text{Robot} \not\models \varphi_s$$

“Start in Deck. Always stay there. go to kitchen.”

- Specification Unrealizable:

$$\exists \text{Environment} \models \varphi_e \text{ s.t. } \text{Robot} \not\models \varphi_s$$

“Start in Deck. If you see a person stay there. go to kitchen.”

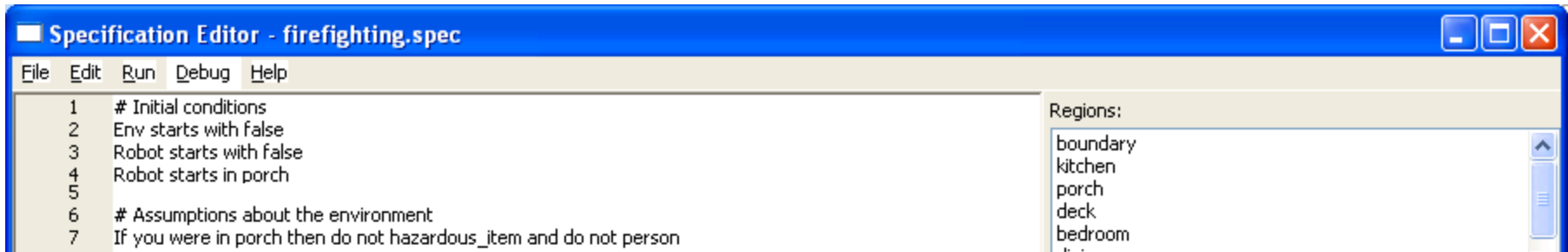
- Trivial solution:

$$\forall \text{Robot} \models \varphi_s$$

“Always person and not person.”

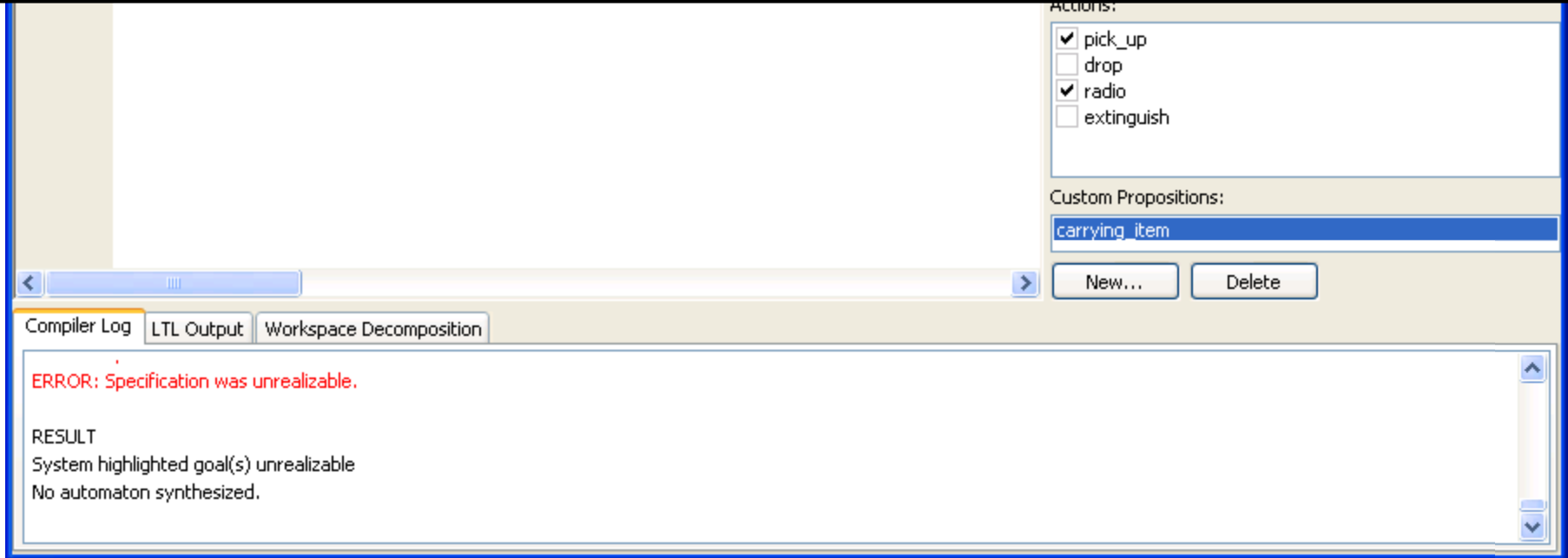
# Explaining the problems

- Distinguish between unsatisfiable, unrealizable and trivial
- Highlight subset of sentences

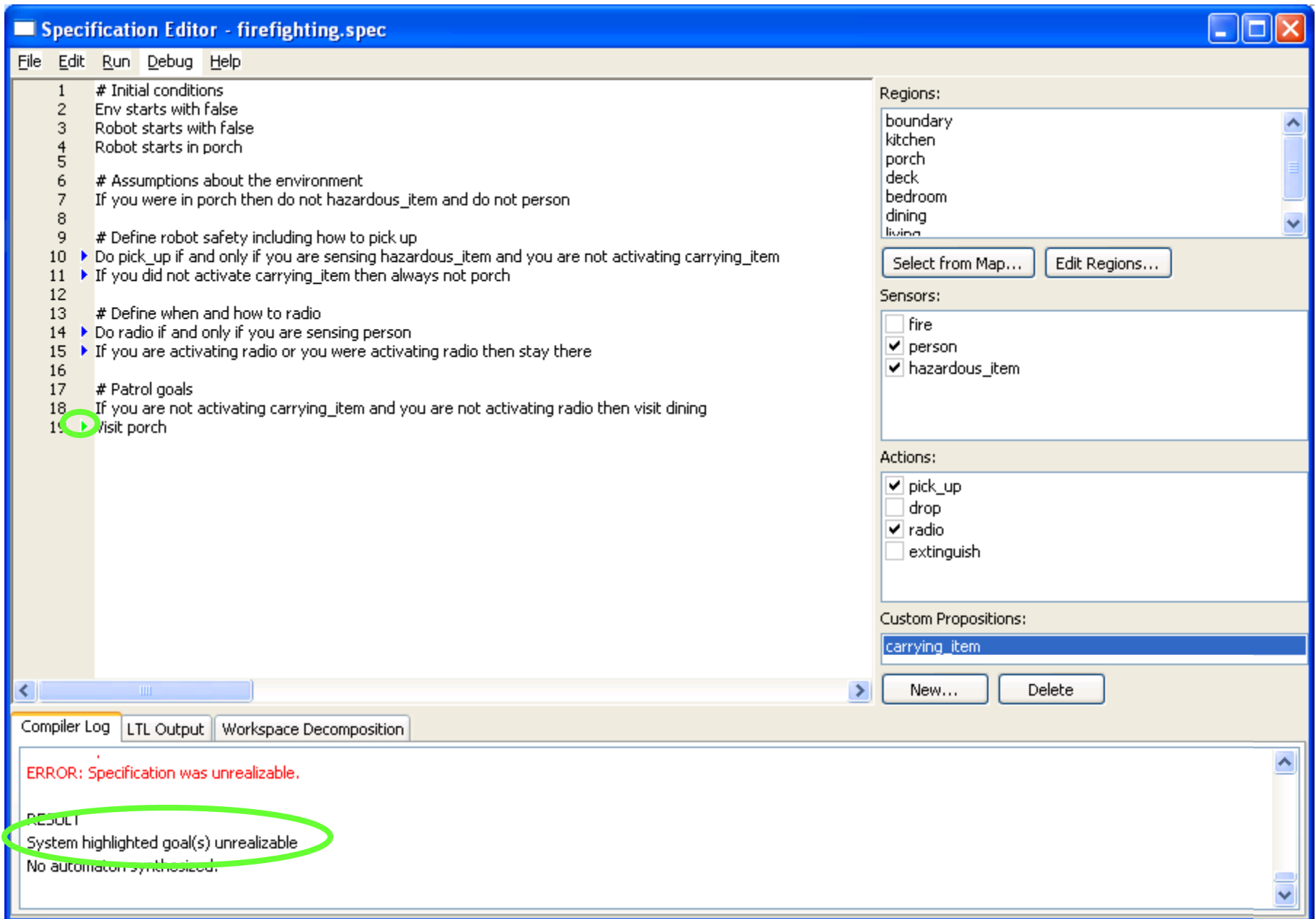


**#Define robot safety including how to pick\_up**  
Do **radio** if and only if you are sensing **person**  
If you are activating **radio** or you were activating **radio** then stay there

**#Patrol Goals**  
Visit **porch**







# Explaining the problems

- Distinguish between unsatisfiable, unrealizable and trivial
- Highlight subset of sentences
- Unrealizable spec: Playing a game with the user; we are the environment, the user is the robot

Counter-Strategy Visualizer

	fire	person	Region	radio
1	False	False	p7 (deck)	False

Current environment state:

fire person

Please choose your response:

Move to region p8 (bedroom)

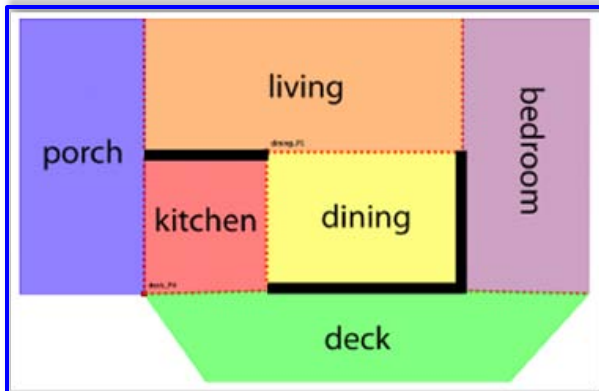
Actuator states:

radio

Internal propositions:

Execute Move >>

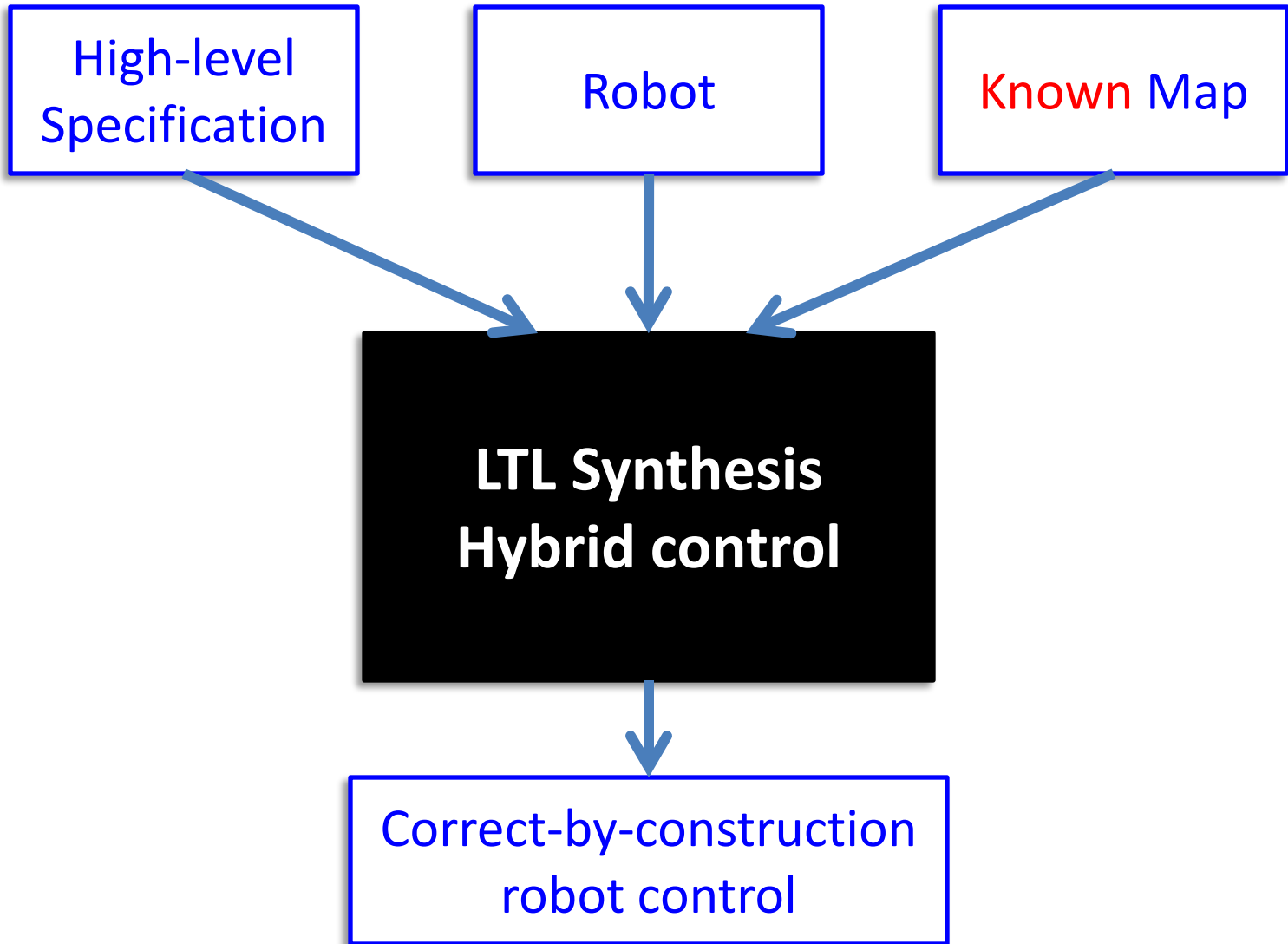
Currently in step #2



Robot starts with false  
 Robot starts in **deck**  
 Visit **porch**  
 If you are sensing **person** then do not **kitchen**  
 If you are sensing **fire** then do not **living**  
 Always do not (**fire** and **person**)  
 Always do not **radio**

## **“LTL” – Part II**

**High-level tasks in partially known  
maps (initial steps)**

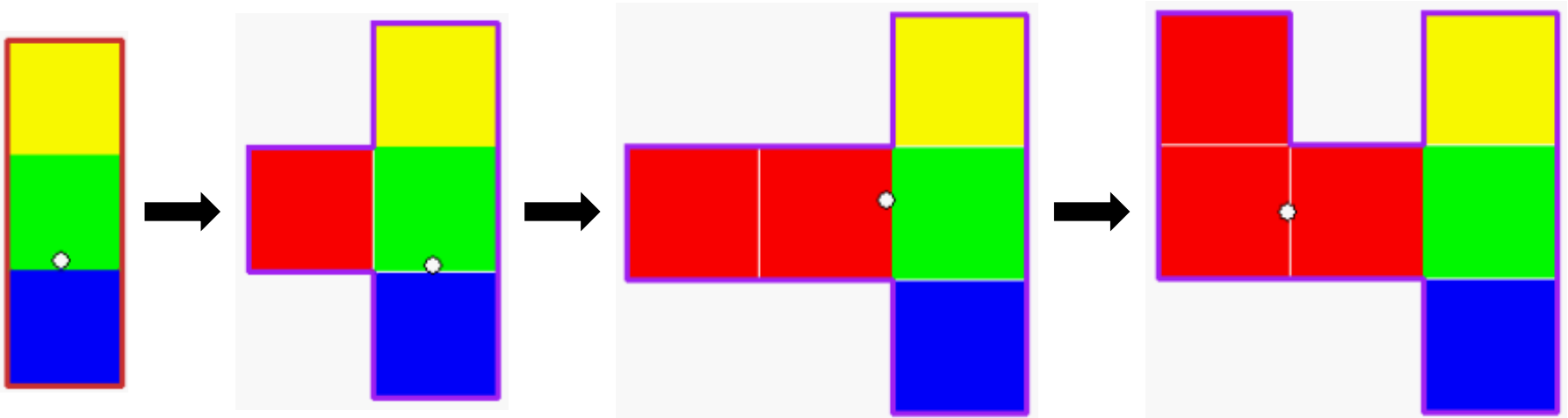
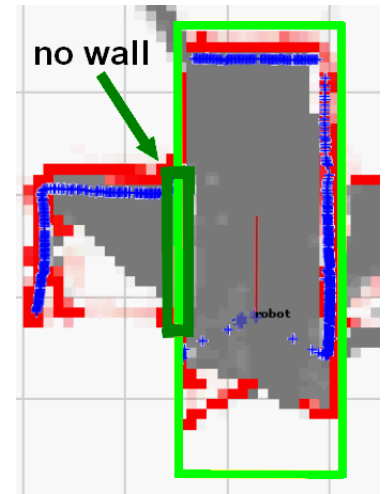


# Challenges

- When to resynthesize
- What to resynthesize

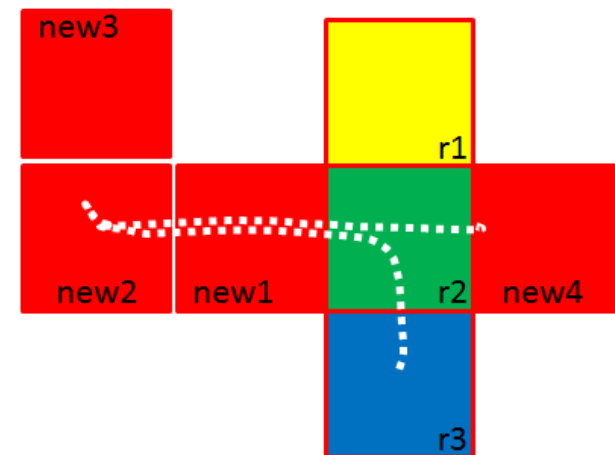
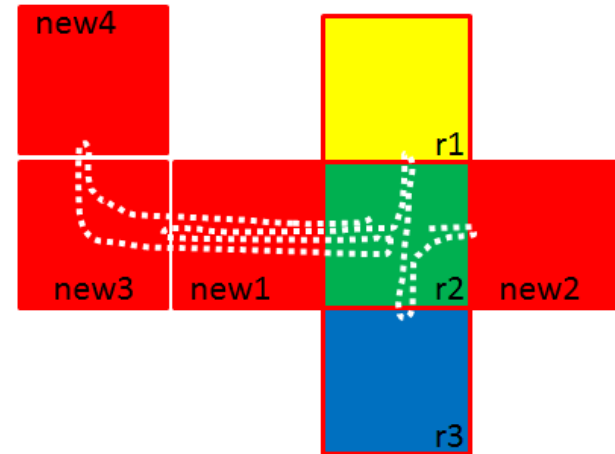
# Progress

- When to resynthesize
  - When discrete abstraction changes
  - Sensor based (Current work)

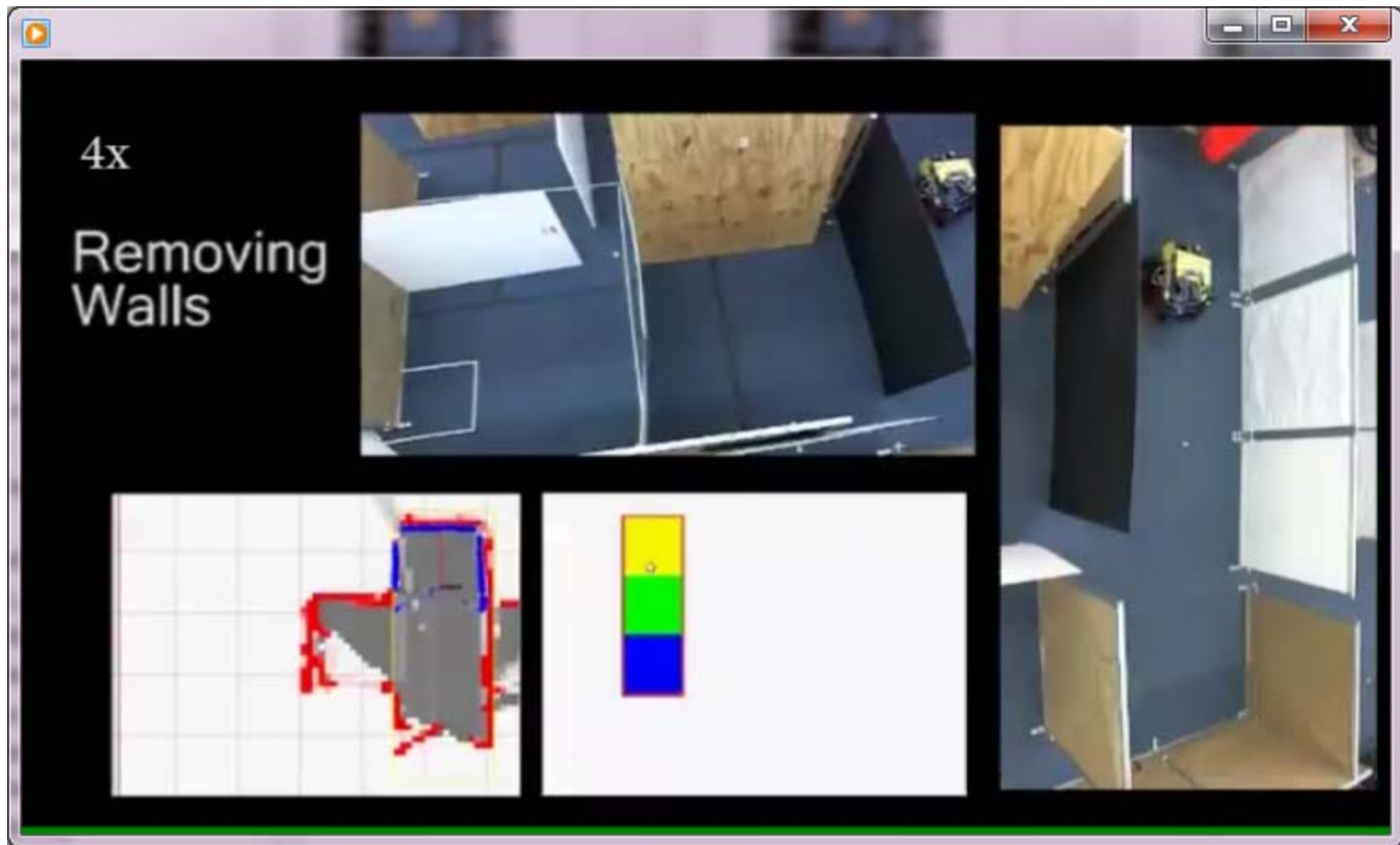


# Progress

- What to resynthesize
  - “remember” current state  
New initial state
  - Add safety and liveness  
Quantifiers over regions, add LTL formulas
  - Reorder goals  
Breadth/Depth first







*Patrol the rooms continuously  
If you see a cone stop and raise the flag*

?

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