(Linear Temporal) Logic to robot control

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High-level Specification

Robot

Known Map

Correct-by-construction robot control
High-level Specification
Robot
Known Map

LTL Synthesis
Hybrid control

Correct-by-construction robot control
“LTL” – Part I
Explaining Unsynthesizable Specifications
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Types of Problems

• Specification Unsatisfiable: $\neg \varphi_s$

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

• Specification Unrealizable:

$\exists \text{Environment} \models \varphi_e \text{ s.t. } \neg \varphi_s$

“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
# Initial conditions
1. Env starts with false
2. Robot starts with false
3. Robot starts in porch

# Assumptions about the environment
4. If you were in porch then do not hazardous_item and do not person
5. 
6. Define robot safety including how to pick up
7. Do pick_up if and only if you are sensing hazardous_item and you are not activating carrying_item
8. If you did not activate carrying_item then always not porch
9. 
10. Define when and how to radio
11. Do radio if and only if you are sensing person
12. If you are activating radio or you were activating radio then stay there
13. 
14. Patrol goals
15. If you are not activating carrying_item and you are not activating radio then visit dining
16. Visit porch

**ERROR:** Specification was unrealizable.

**RESULT**
System highlighted goal(s) unrealizable
No automaton synthesized.
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
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)
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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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