

Approaching Qualitative Spatial Reasoning About Distances and Directions in Robotics

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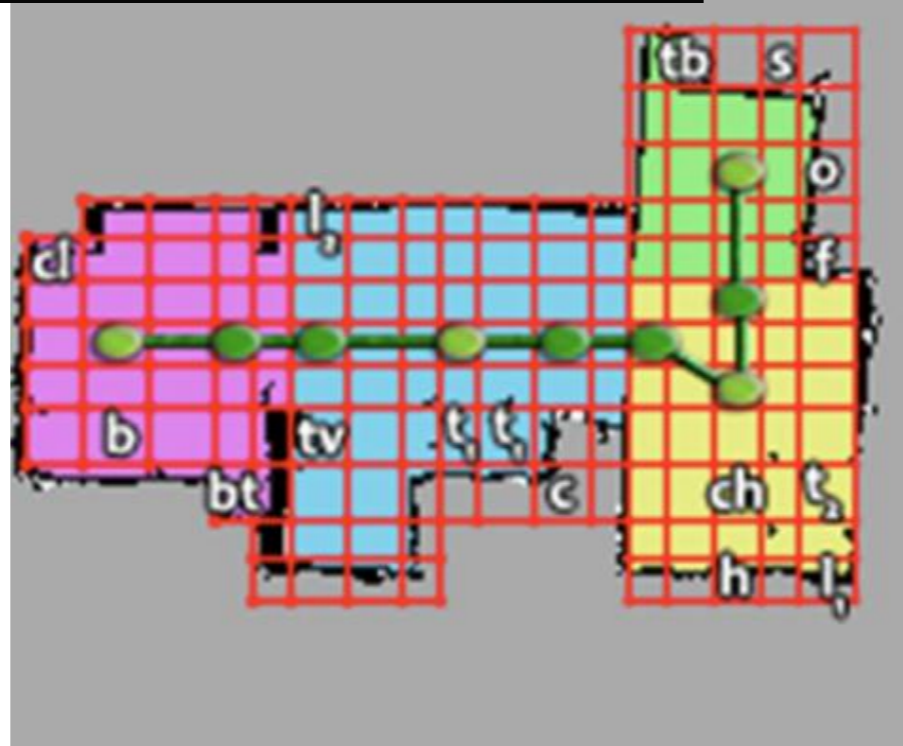
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Interacting With Robots

Multiple works have considered robots able to take vocal commands from humans



Our Robot



- kitchen
- dining-room
- living-room
- bed room

- b = bed
- bt = bedside table
- c = couch
- ch = chair
- cl = closet
- f = fridge
- h = heater

- l = lamp
- o = oven
- s = sink
- t = table
- tb = trash bin
- tv = tv-set

Semantic Map acquired during the First Örebro Winter School on "Artificial Intelligence and Robotics"

Considered Problem

- Tasks given to mobile robots often consist of reaching certain positions
- These locations are often described by an object nearby (e.g., go to the fridge to get a coke, or go to someone's desk to deliver an object).
- What if you tell the robot to go in front of an object and the robot knows multiple instances of such an object?

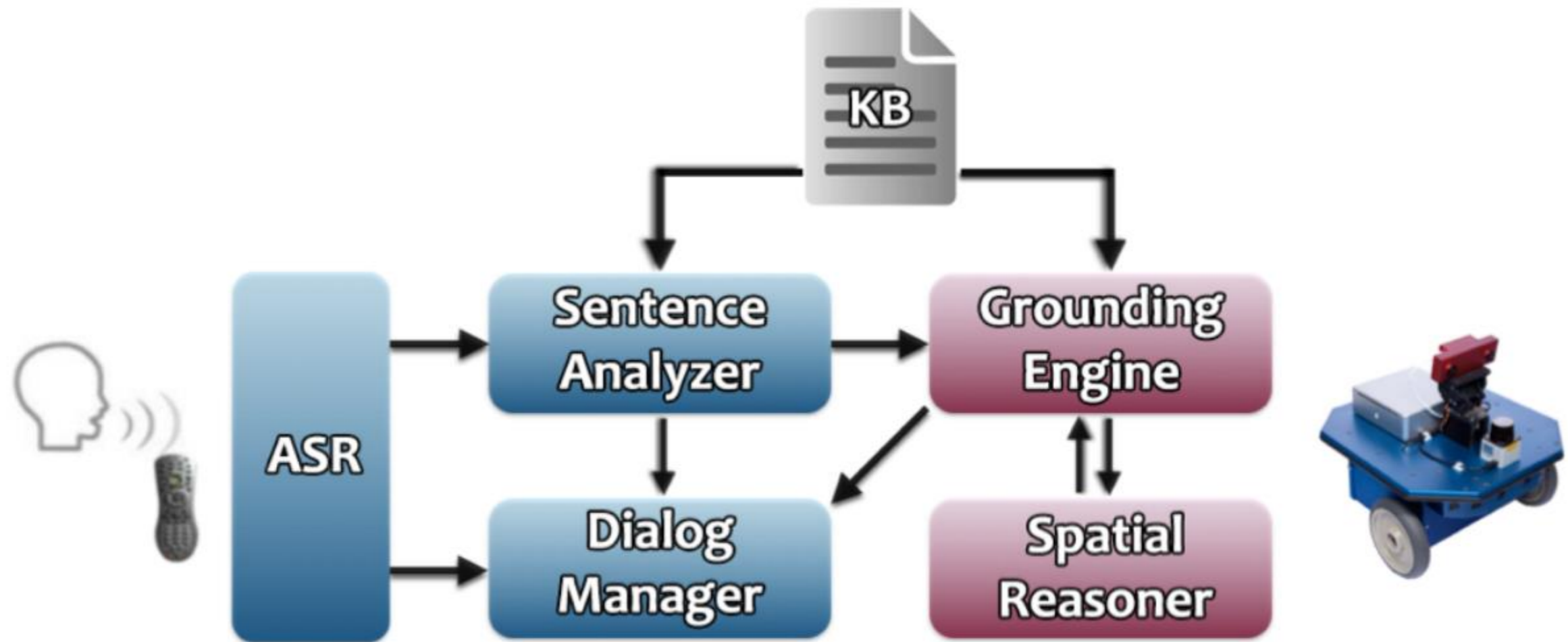
Example

- Assume we need to tell a robot to go in front of a plug in order to charge it
- Assume that we have a particular plug in mind since the robot should not be in the way while charging
- How could we distinguish the plugs?



We propose to use objects' spatial properties

Grounding Commands



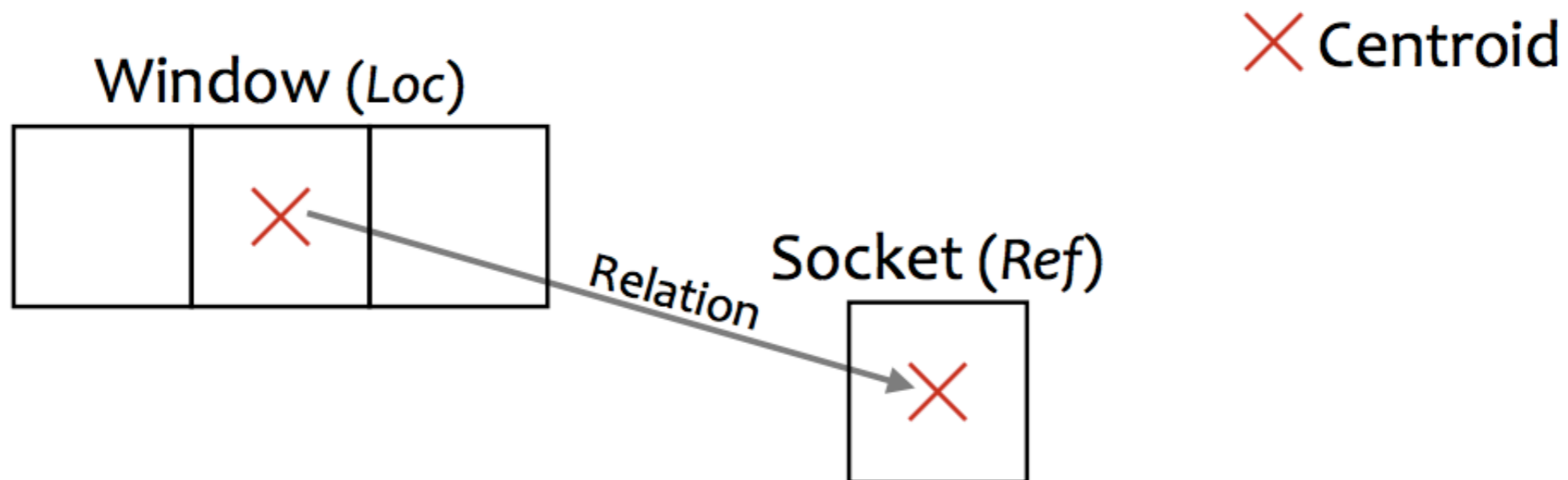
- Vocal commands are grounded in the robot KB
- The grounding step might fail
- We allow the user to specify objects based on their spatial relations with another object (e.g., “go to the socket on the right of the closet”)

Spatial Reasoner

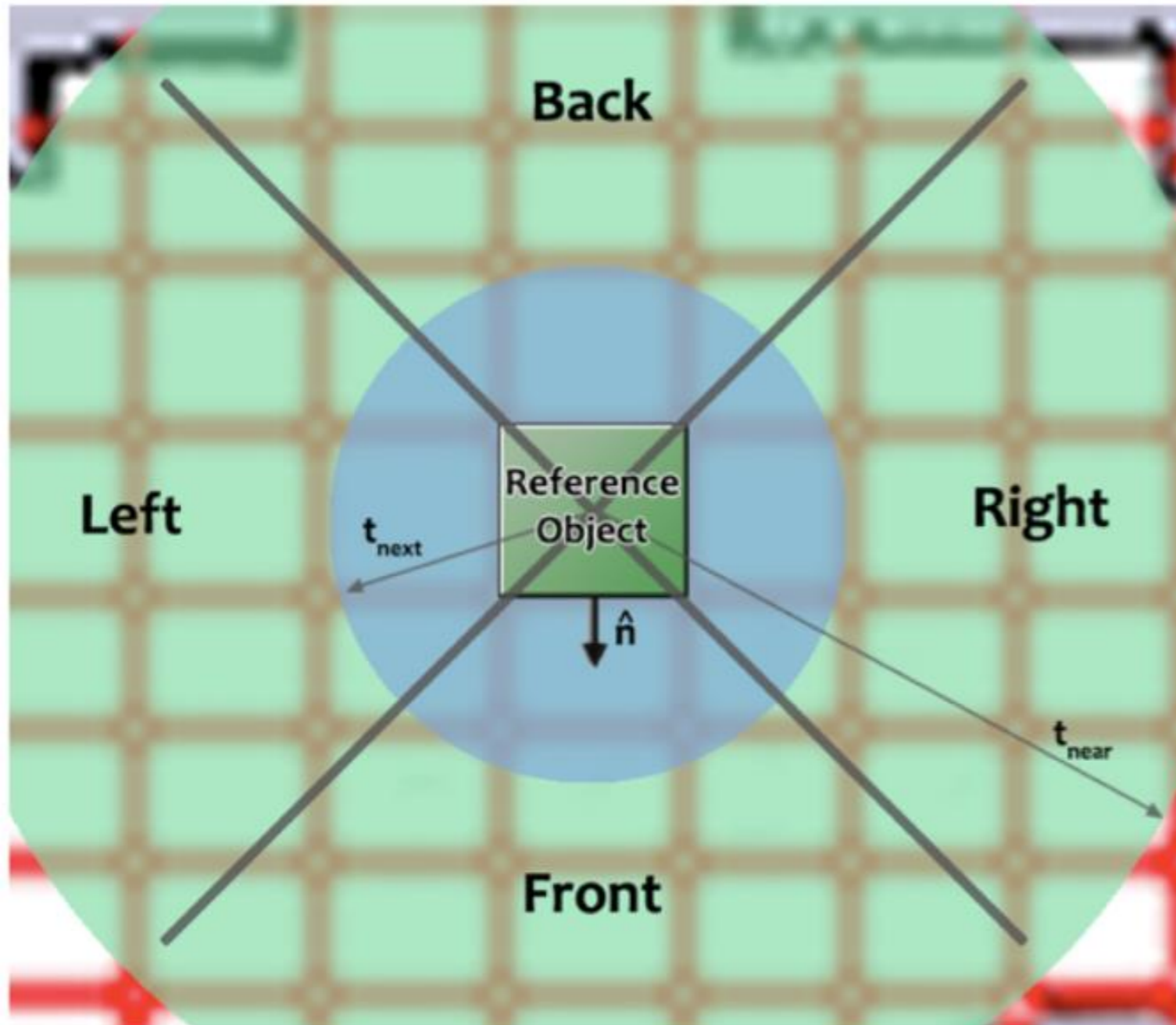
Defined ten qualitative spatial relations using our representation:

- Three vicinity relations (near, next to, nearest)
- Their three negative relations (far, not next to, farthest)
- Four orientations (behind, in front, on the right, on the left)

Objects represented as points located in the centroid of their rectangles



Cone-Based Reasoner



Loc has a vicinity relation with Ref:
 $d(\text{centroid}(C_{Loc}), \text{centroid}(C_{Ref})) < t$

Loc and Ref to be related by R:

$$\text{centroid}(C_{Loc}) \in A_R^{Ref}$$

- Experiments show that our approach allows the robot to effectively ground previously ambiguous commands
- We can now disambiguate using 2D spatial relations. For the future, what about 3D?