Welcome to the Robot Programming User Study

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Robot Programming User Study

- We are **not** trying to evaluate your performance
- Evaluate and improve **our** robot programming system
- Comments & difficulties you're facing during the experiment are important!

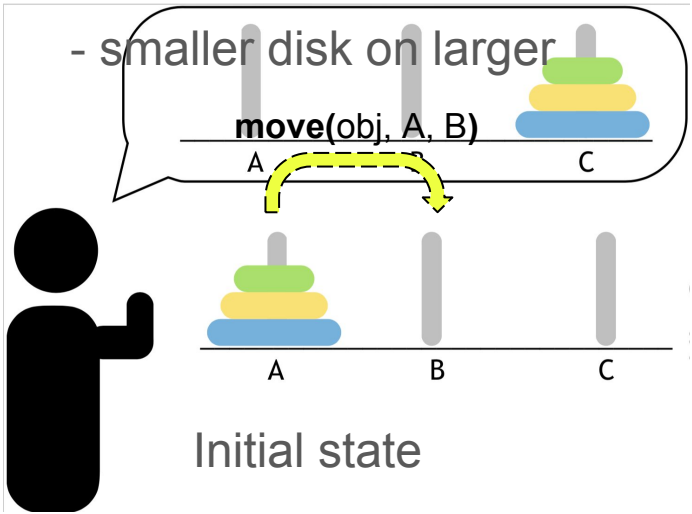
Overview

1. Introduction to Robot Programming
2. How to program Baxter
3. User tasks
4. Post-study questionnaire

How do we teach humans?

2. Problems with conditions:

- one disk at a time
- smaller disk on larger

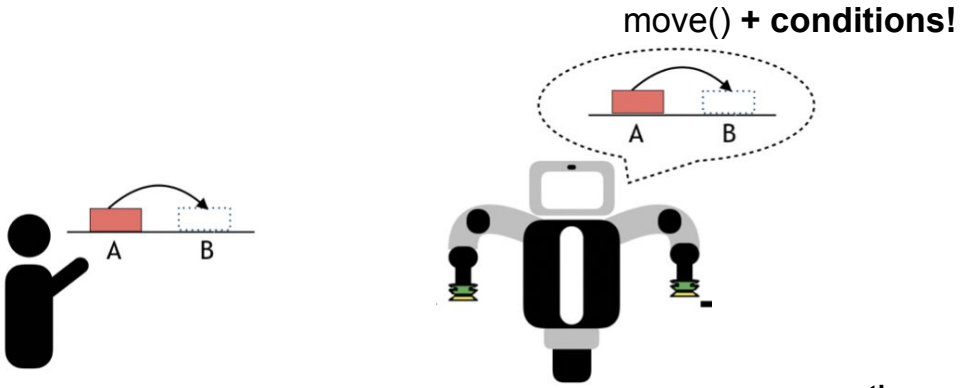


Initial state

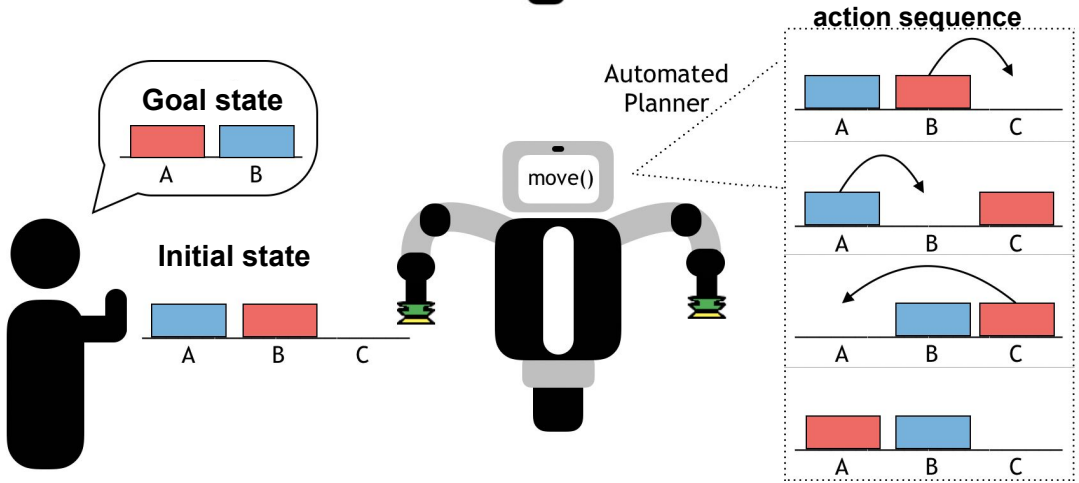
Goal state

How do we teach robots?

1. Actions

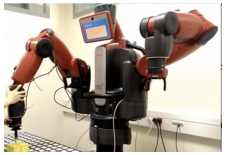


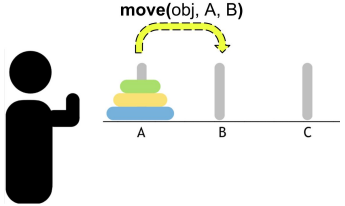
2. Problem



Humans

Robots

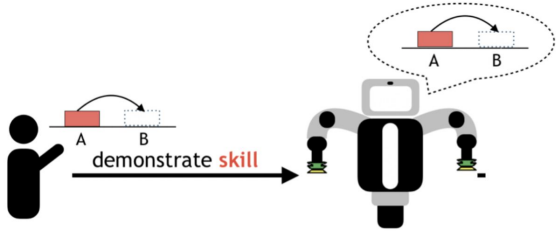


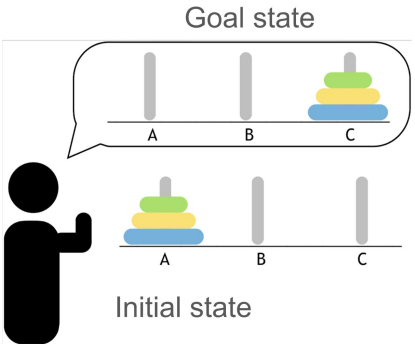


1. Learn Actions

\+ Conditions

move() **+ conditions!**

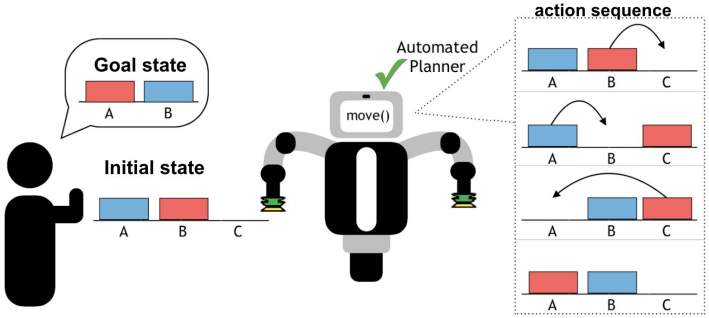




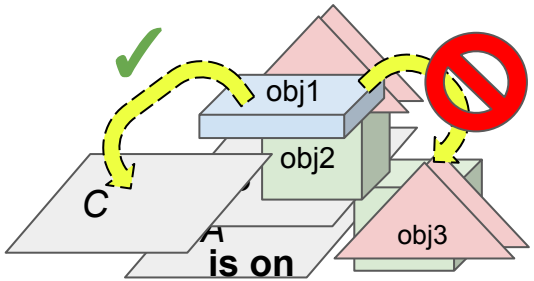
2. Solve Problems

\+ Initial state

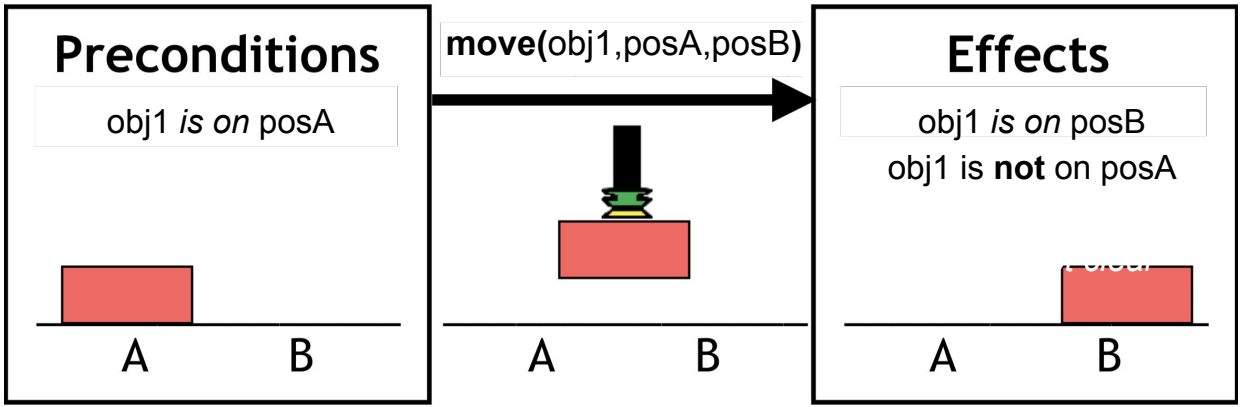
\+ Goal state



Predicates



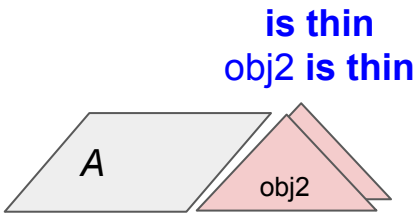
obj2 **is clear**
obj1 **is stackable on** posC
obj1 **is not stackable on** obj3



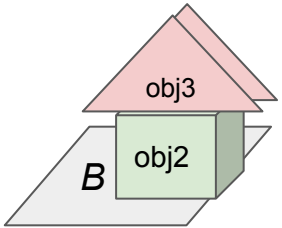
must be true to execute the action

changed the world state after the execution

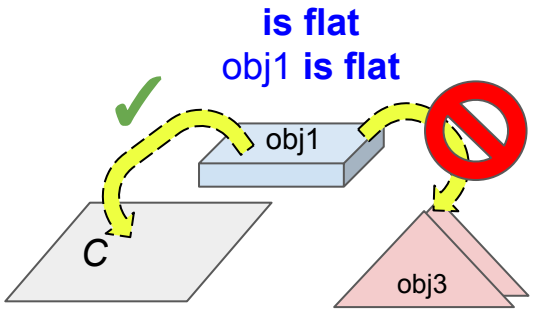
Predicates



is clear
posA **is clear**
obj2 **is clear**

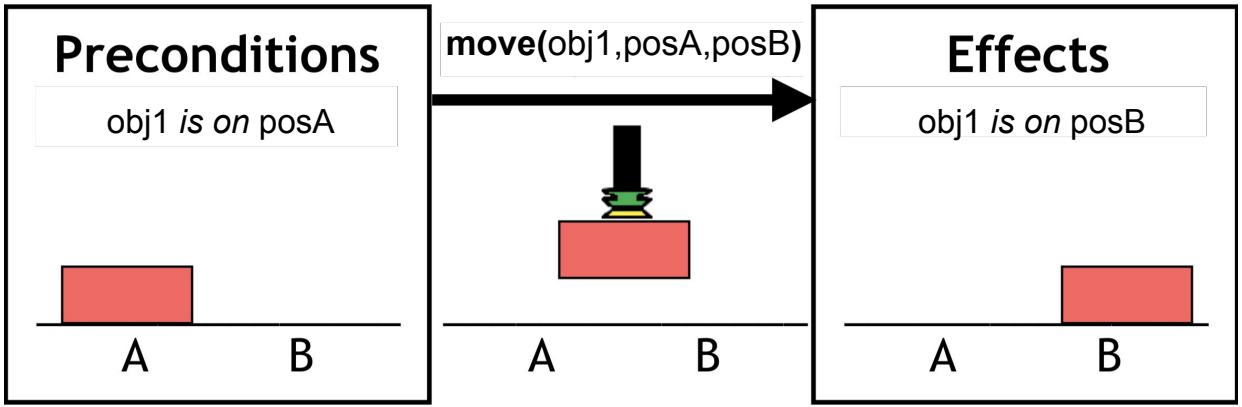


is on
obj2 **is on** posB
obj3 **is on** obj2



is stackable (= can be placed on)
obj1 **is stackable on** posC
obj1 **is not stackable on** obj3

move(CUBE, POSITION, POSITION)



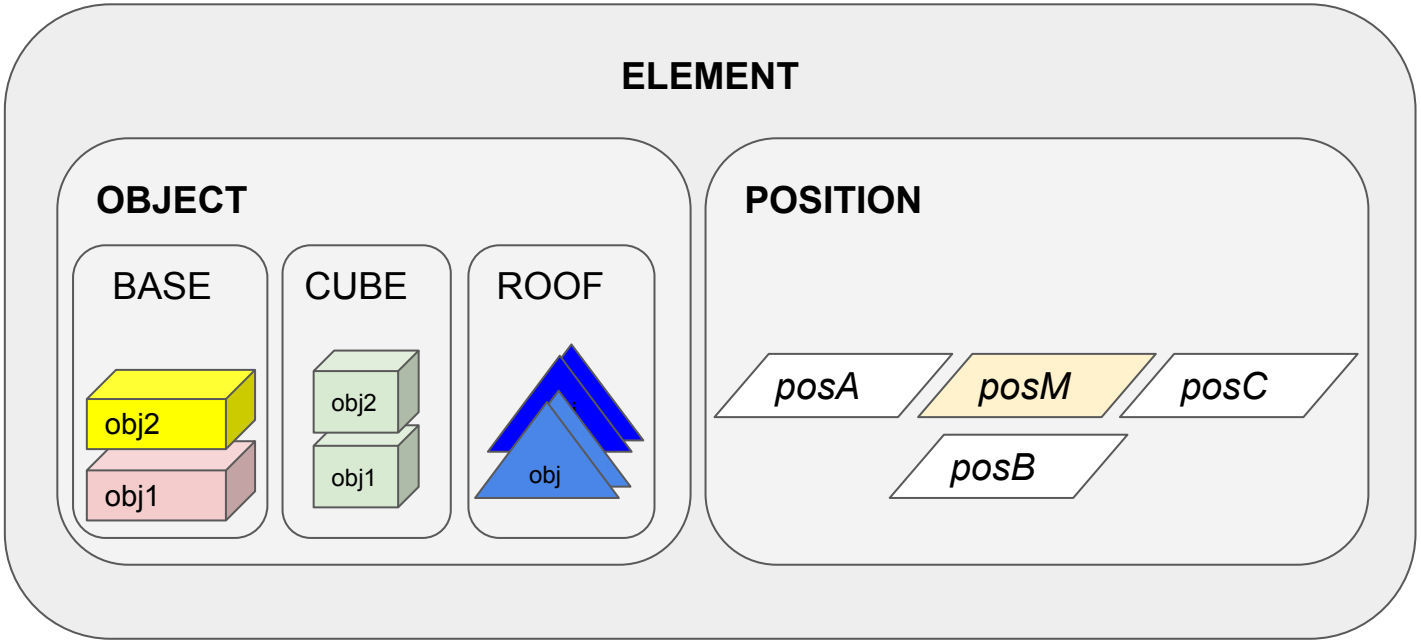
must be true to execute the action

changed the world state after the execution

Types

action(ELEMENT, ELEMENT, ...)

move(BASE, POSITION, POSITION)

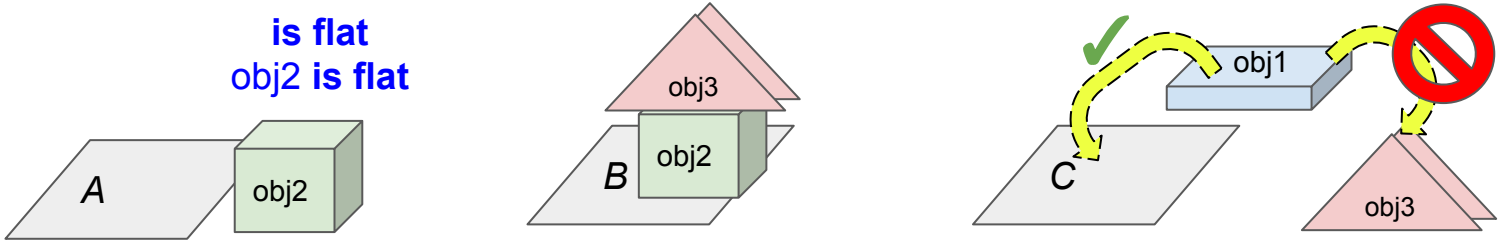


Questions?

https://goo.gl/forms/or7WoGqZeMI1KVT92

is thin
obj3 **is thin**

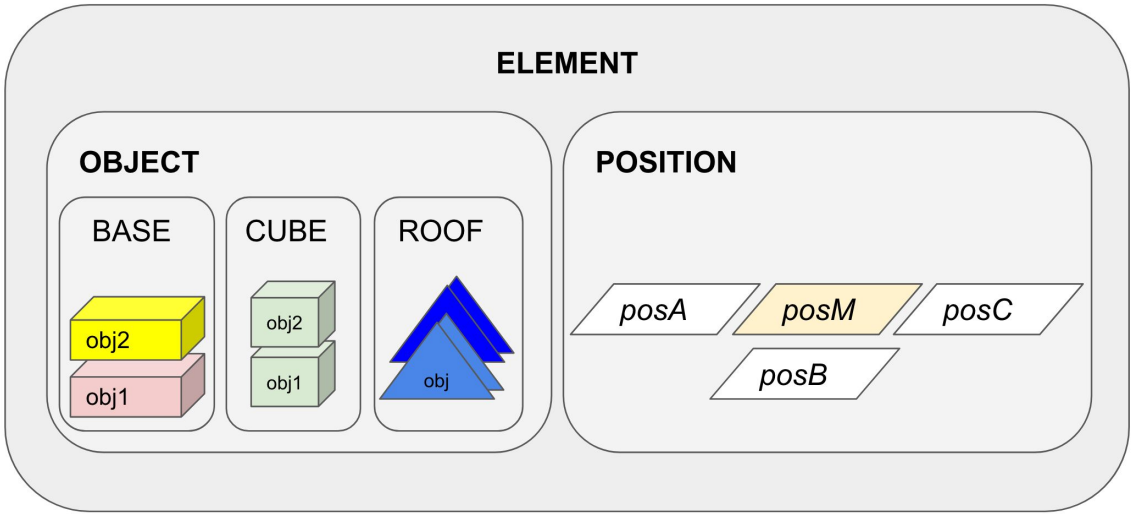
is flat
obj2 **is flat**



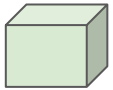
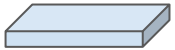
is clear
posA **is clear**
obj2 **is clear**

is on
obj2 **is on** posB
obj3 **is on** obj2

is stackable
obj1 **is stackable on** posC
obj1 **is not stackable on** obj3



Experimental Context

- Production line (positions A,B,C,M)
- Object types  Roof  Cube  Base

- Baxter does not know how to pick up objects
- Baxter grippers Electric  Vacuum 

- Press  start  stop

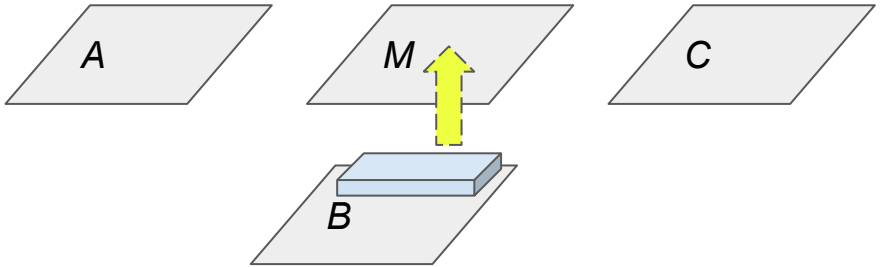
Manipulating Baxter

https://youtu.be/oD9DE0HjMM4?t=28

Note start time: _____

Move a BASE object

Program Baxter to move the BASE from position B to position M

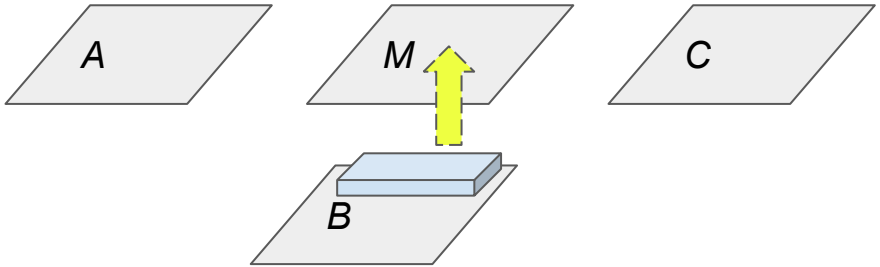


1. Create **Action**
2. **Perception** step
   a. Click on DETECT
   b. Verify all detected objects and their types
3. **Demonstration** step
   a. REPLAY action at least once
4. **Conditions** step
   a. Detect effects
   b. Save conditions
5. Rename action “**move-base**” & Save

Note start time: _____

Move a BASE object

Program Baxter to move the BASE from position B to position M



1. Create **Action**
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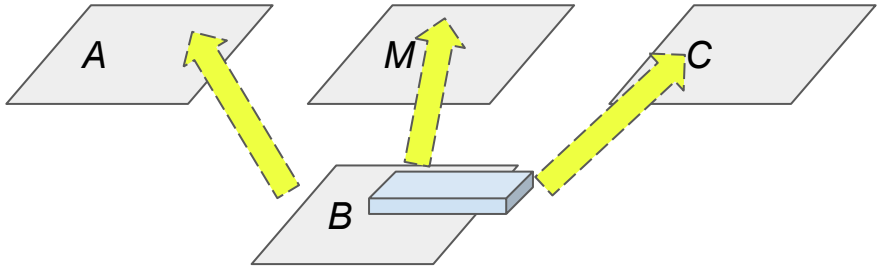
3. **Demonstration** step
   a. REPLAY action at least once
4. **Conditions** step
   a. Detect effects
   b. Save conditions
5. Rename action "**move-base**" & Save

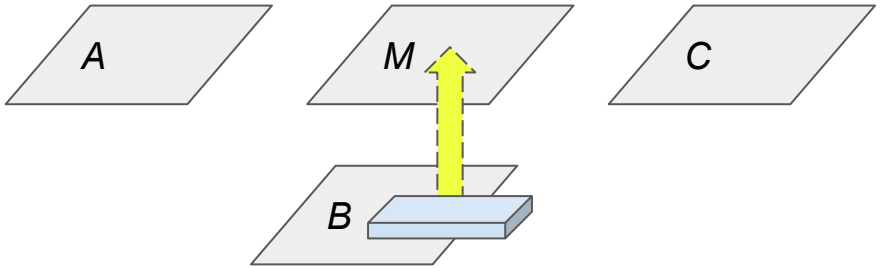
What if we want to move to any position?



1. Create **Problem**
2. **Initial states** step
   a. Click on DETECT
   b. Verify object types and initial states
3. **Goal states** step
   a. Add goal states
4. **Generated Plan** step
   a. Verify action sequence
   b. EXECUTE plan
5. Rename problem "**rearrange**" & Save

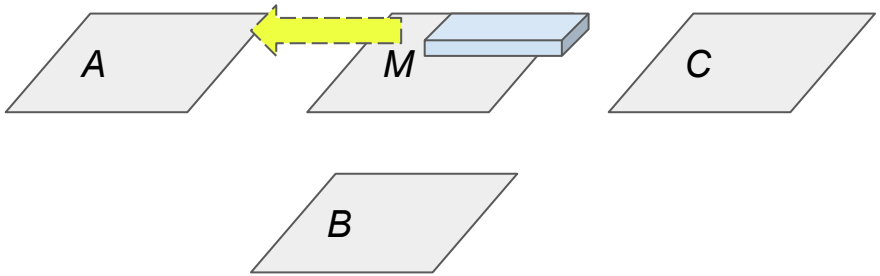
Experiment tasks

Teach Baxter an Action to move a BASE object

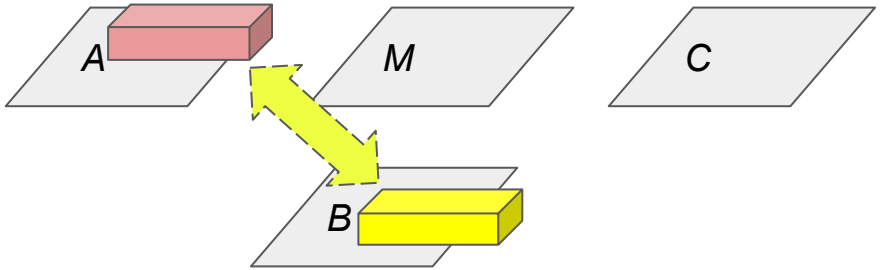


move-vacuum

Move BASE object to any position (e.g. A)



Generate a plan to swap positions of two BASE objects

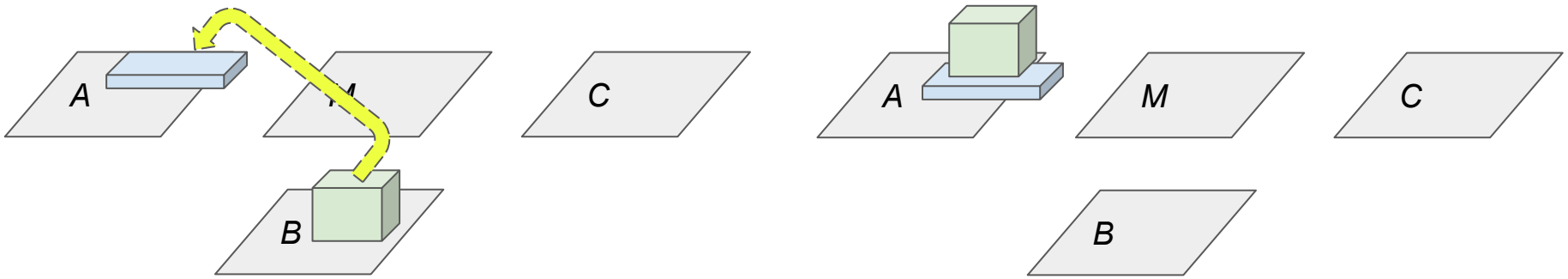


Define the goal states and let Baxter figure out the action steps

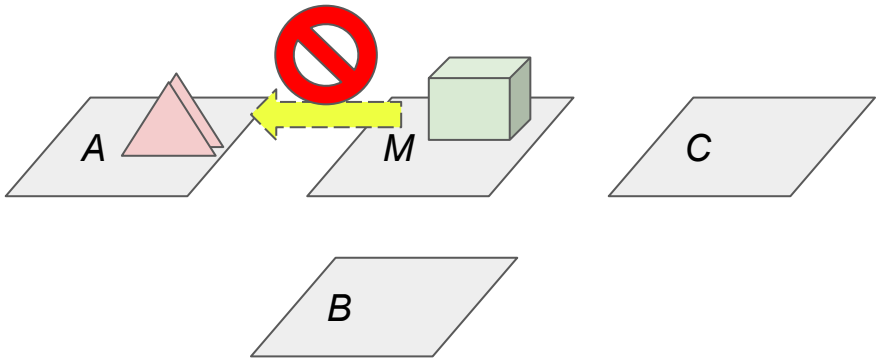
Hint: How can Baxter come up with the right steps?

(NO EXECUTION)

Stack CUBE object on BASE



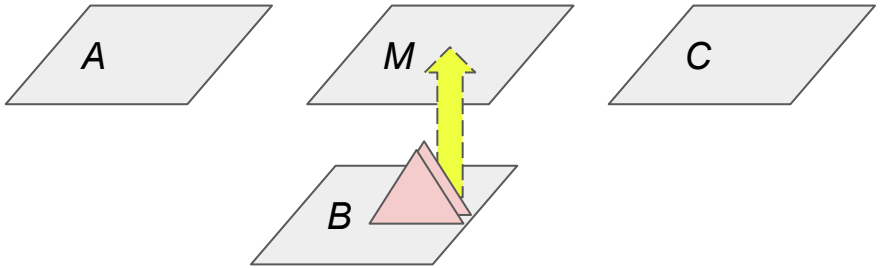
Modify the existing move action



Modify the existing move action so that Baxter would not stack the CUBE object if it is a ROOF

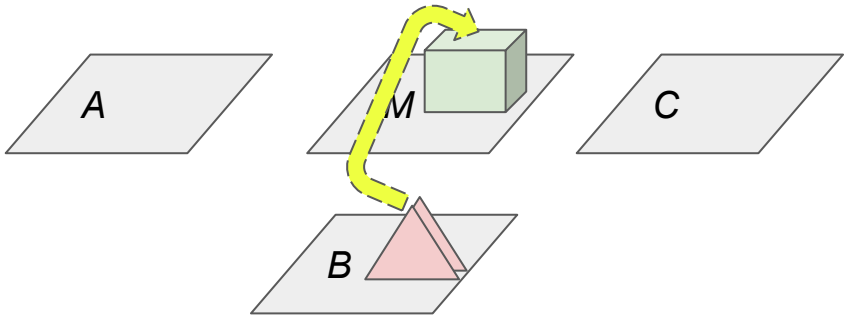
(NO EXECUTION)

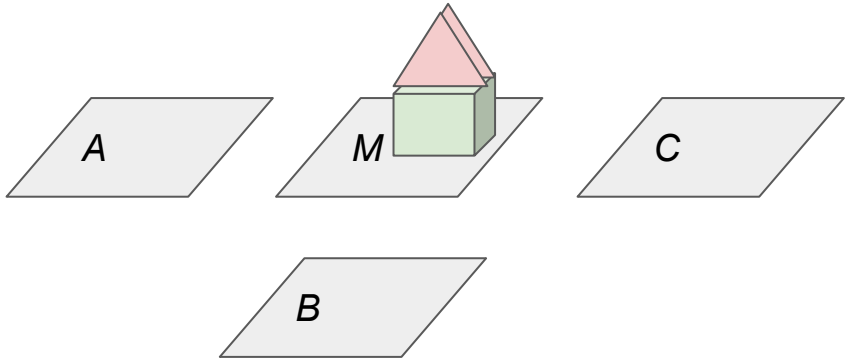
Move ROOF object to position M



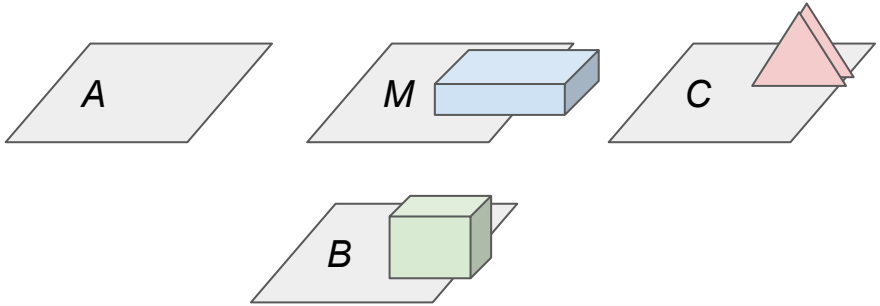
move-grip

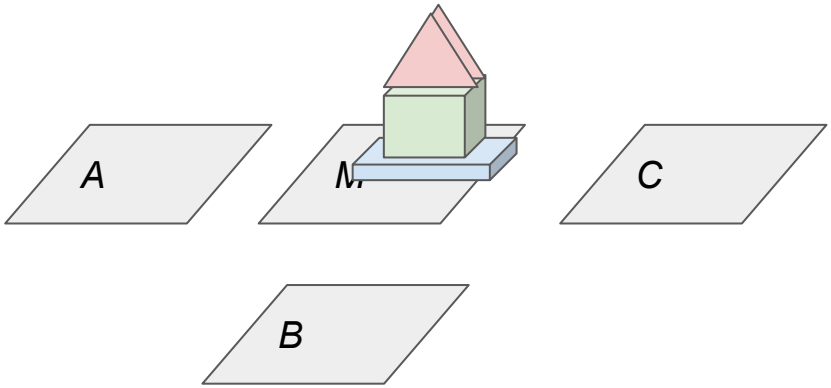
Stack ROOF object on CUBE



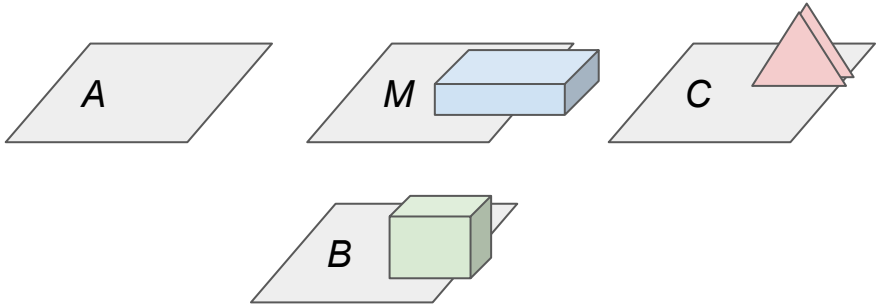


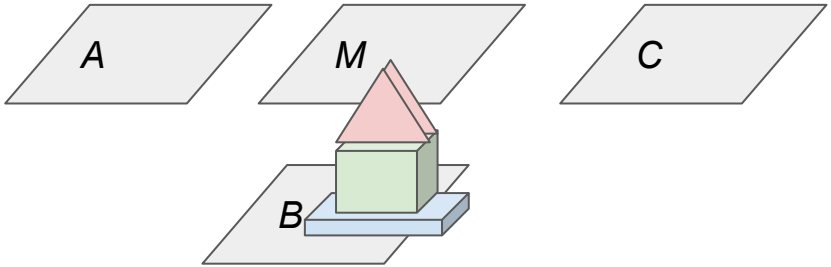
Final task: Build a house from all objects





Final task: Build a house from all objects - part 2





Bonus task: Have BASE and ROOF on position M