

CS 6260 Automated Planning and Learning

Introduction

Department of Computer Science and Engineering
Indian Institute of Technology Madras (IITM), India



Intro and Logistics

Instructor: Pulkit Verma

- Preferred mode of contact:
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- PhD from **Arizona State University**
- Postdoc from **MIT CSAIL**
- Research Areas:
Automated Planning, Human-AI Collaboration, AI Safety and Assessment, Robotics, Lifelong Learning, ...



pulkitverma.net

Teaching Assistants



Sayak



Swapnil



Tushar

Lectures

- CS 15, CSB Ground Floor (of course!!)
- Tu: 11-11:50 AM; W: 10-10:50 AM; Th: 08-08:50 AM; F: 05-05:50 PM
 - Some classes will be cancelled due to official travel; watch out for announcements.
- Attendance is mandatory
- **Office Hours:** Starting Feb 1st week. Watch out for announcement.

Resources

- Course Website*: hails-group.github.io/courses/cs6260/jm26.html
 - Slides posted here
- Announcements: Moodle
- Course Email: cs6260.jm26@gmail.com
 - No URGENT email responses. Please **plan** ahead.
 - We will respond to each email within 48 hours.
 - Any course-related query should be posted on Moodle so that others can also benefit from the answer.



Exams

- 3 Exams:
 1. [Quiz 1] Feb 19: 08:00 AM – 08:50 AM
 2. [Quiz 2] Apr 02: 08:00 AM – 08:50 AM
 3. [End Sem] May 12: 08:00 AM – 08:50 AM
- More details closer to exams.

Grading Breakup*

- Exams: 70%
 1. Quiz 1 : 20%
 2. Quiz 2 : 20%
 3. End Sem: 30%
- Assignments: 25%
- In-class Tasks: 5%
- Relative Grading
- Hard Cut-offs: Despite grades being relative:
 - No Grade A below 80%
 - No Grade B below 60%
 - No Grade C below 50%

* Will revisit this in the second lecture

Assignments

- n ($n=4$ or 5) Assignments. Equal distribution, i.e., each assignment will be of $(25/n)\%$.
- Life Happens!!
 - Late submission (up to 2 days) allowed on any one. No questions asked. Just let us know!!
 - If facing any emergency, let us know; we can work something out. We are here to help.

Prerequisites

- Probability
- First Order Logic / Logic in CS
- Programming (Python)
- Analysis of Algorithms

- Sample Knowledge Check:
<https://forms.gle/PnMCm4qy2DuLxQaq7>

- Option to drop the course if you feel like its not for you



Academic Integrity

- Ask us if you ever need anything.
 - Office Hours, in addition to regular classes, if you are stuck.
 - Post on Moodle or Email us: No question is too silly or obvious.
 - Collaboration is okay. But final answers should be yours. Cite any collaborators.
 - Do not share your answers with anyone, and do not post any solutions online.
- No relief if any violation found!!
 - Will receive 0 on the assignment/quiz/exam.
 - U grade, if needed.
- Drop the course if you feel you don't know

We are here to Help

- Ask us if you ever need anything.
 - Office Hours, in addition to regular classes, if you are stuck.
 - Post on Moodle or Email us: No question is too silly or obvious.
- Wellness Center: <https://dost.iitm.ac.in/iitmdost/wellness-center>
- Student Wellness Resources: <https://dost.iitm.ac.in/iitmdost/student-wellness-resources-overview>

Planning

Human Planning and Acting

- acting without (explicit) planning:
 - when purpose is immediate
 - when performing well-trained behaviours
 - when course of action can be freely adapted
- acting after planning:
 - when addressing a new situation
 - when tasks are complex
 - when the environment imposes high risk/cost
 - when collaborating with others
- people plan only when strictly necessary

What is Automated Planning?

Automated planning and scheduling, sometimes denoted as simply **AI planning**,^[1] is a branch of **artificial intelligence** that concerns the realization of **strategies** or action sequences, typically for execution by **intelligent agents**, **autonomous robots** and **unmanned vehicles**. Unlike classical **control** and **classification** problems, the solutions are complex and must be discovered and optimized in multidimensional space. Planning is also related to **decision theory**.

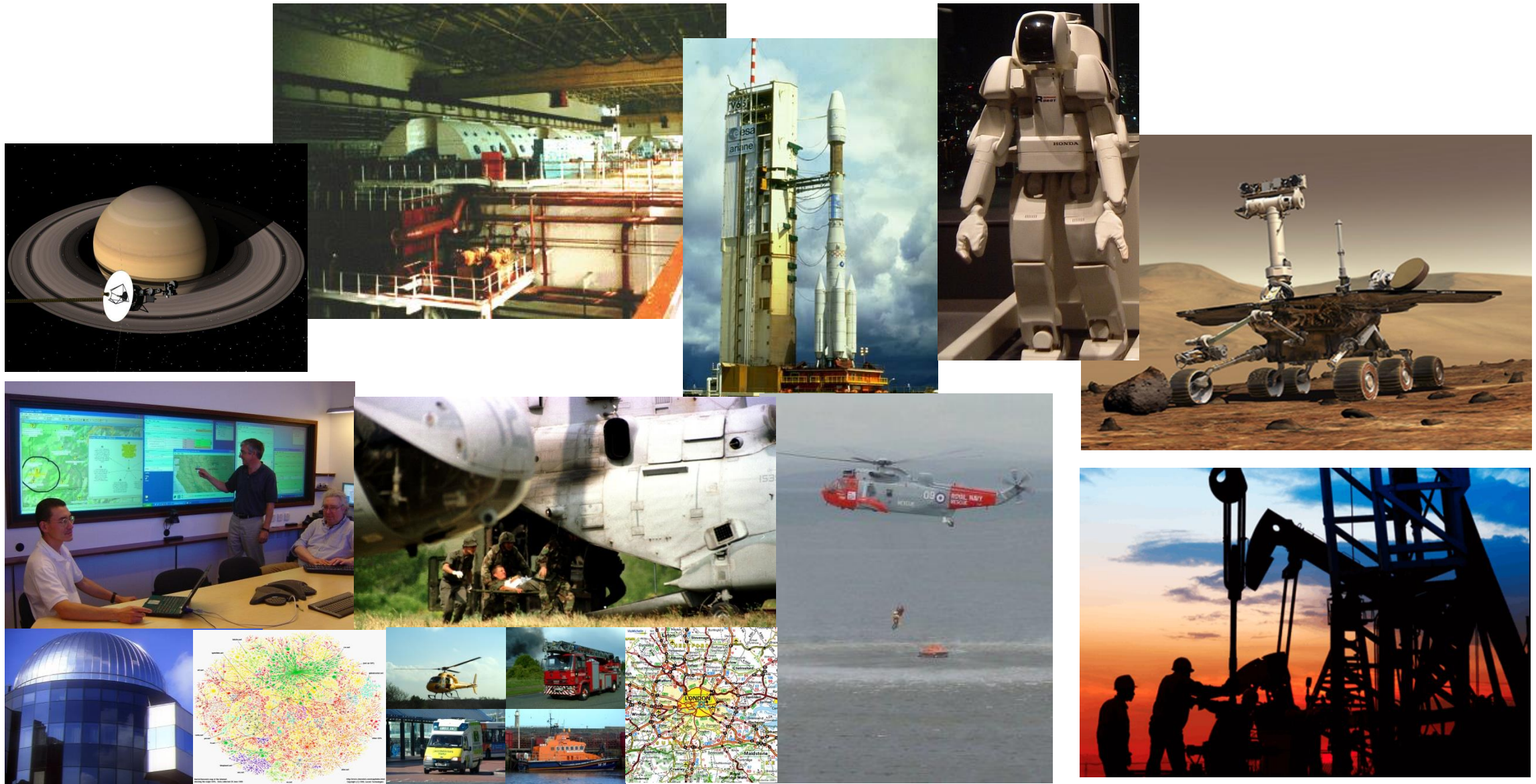


How would you go from your hostel to your parents' house?

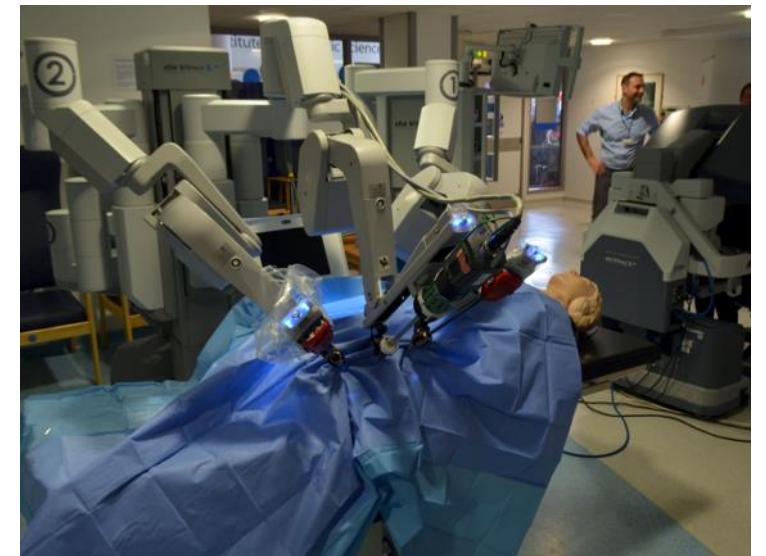
Automated Planning

- Planning:
 - explicit deliberation process that chooses and organizes actions by anticipating their outcomes
 - aims at achieving some pre-stated objectives
- Automated Planning:
 - computational study of this deliberation process

Why Planning?



Contemporary Robots



SHAKEY



Source: <https://www.sri.com/hoi/shakey-the-robot/>

sri



Source: <https://www.youtube.com/watch?v=GmU7SimFkpU>



Source: <https://sites.research.google/palm-saycan>

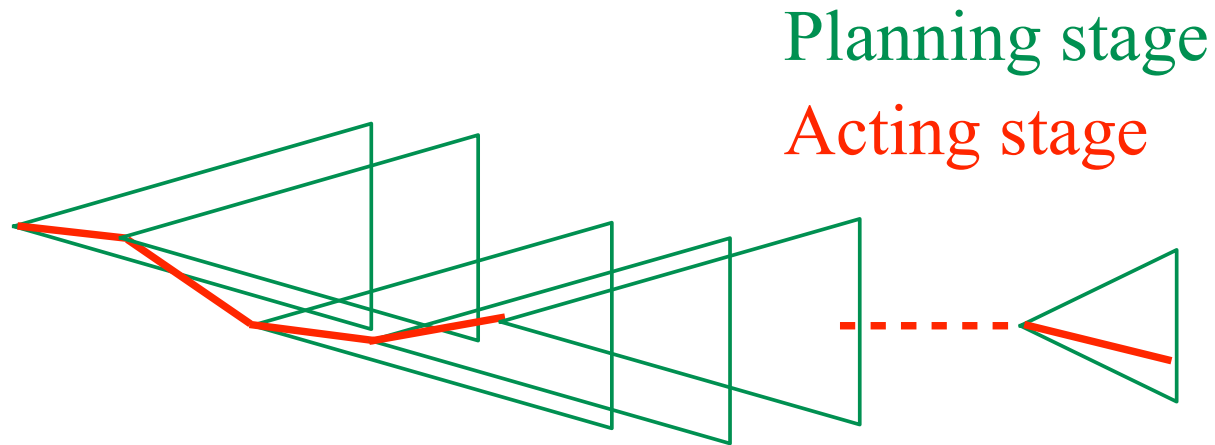
Agentic AI

- Break Complex Tasks into subtasks
- Create a plan to solve them
- Execute those tasks



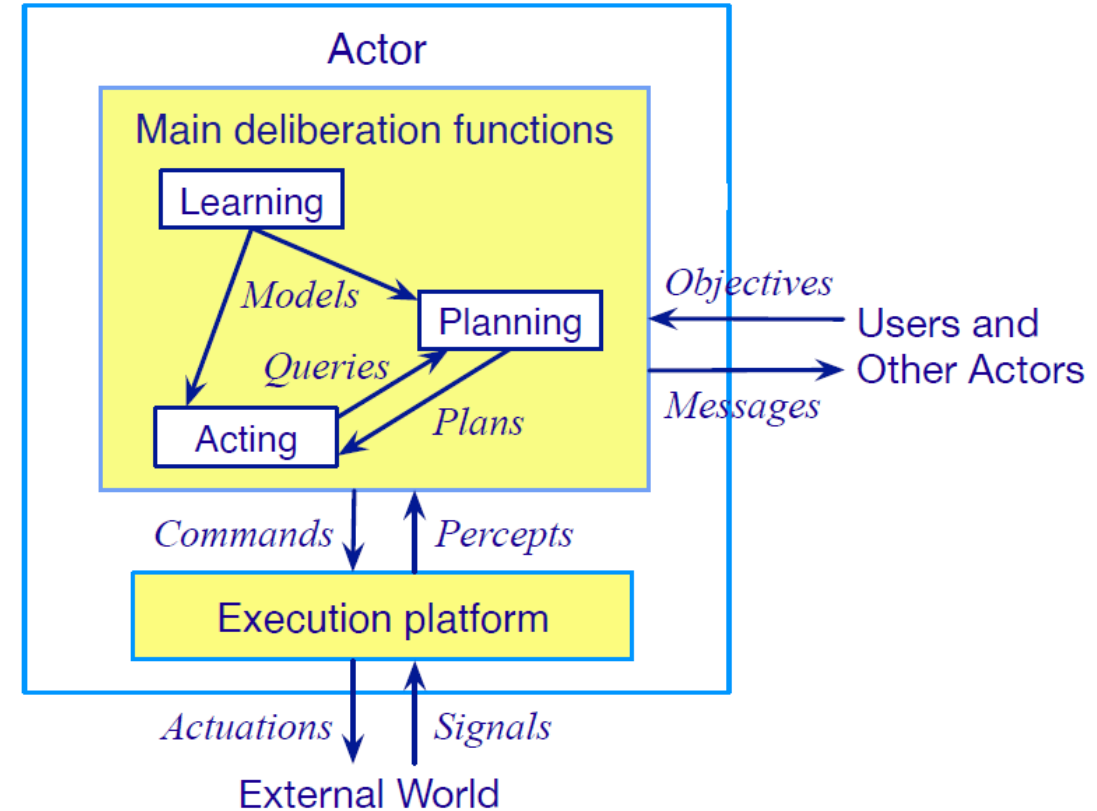
Interleaving Planning and Acting

- Actor is in a dynamic, unpredictable environment
 - Adapt actions to current context
 - React to events
- Relies on
 - Operational models telling how to perform the actions
 - Observations of the current state



Planning and Acting

- Multiple levels of abstraction
 - Actors are organized into physical subsystems
 - Deliberation reflects this
- Heterogeneous reasoning
 - Different techniques
 - at different levels
 - different subsystems at same level
- Continual online planning
 - Can't plan everything in advance
 - Plans are abstract and partial until more detail is needed

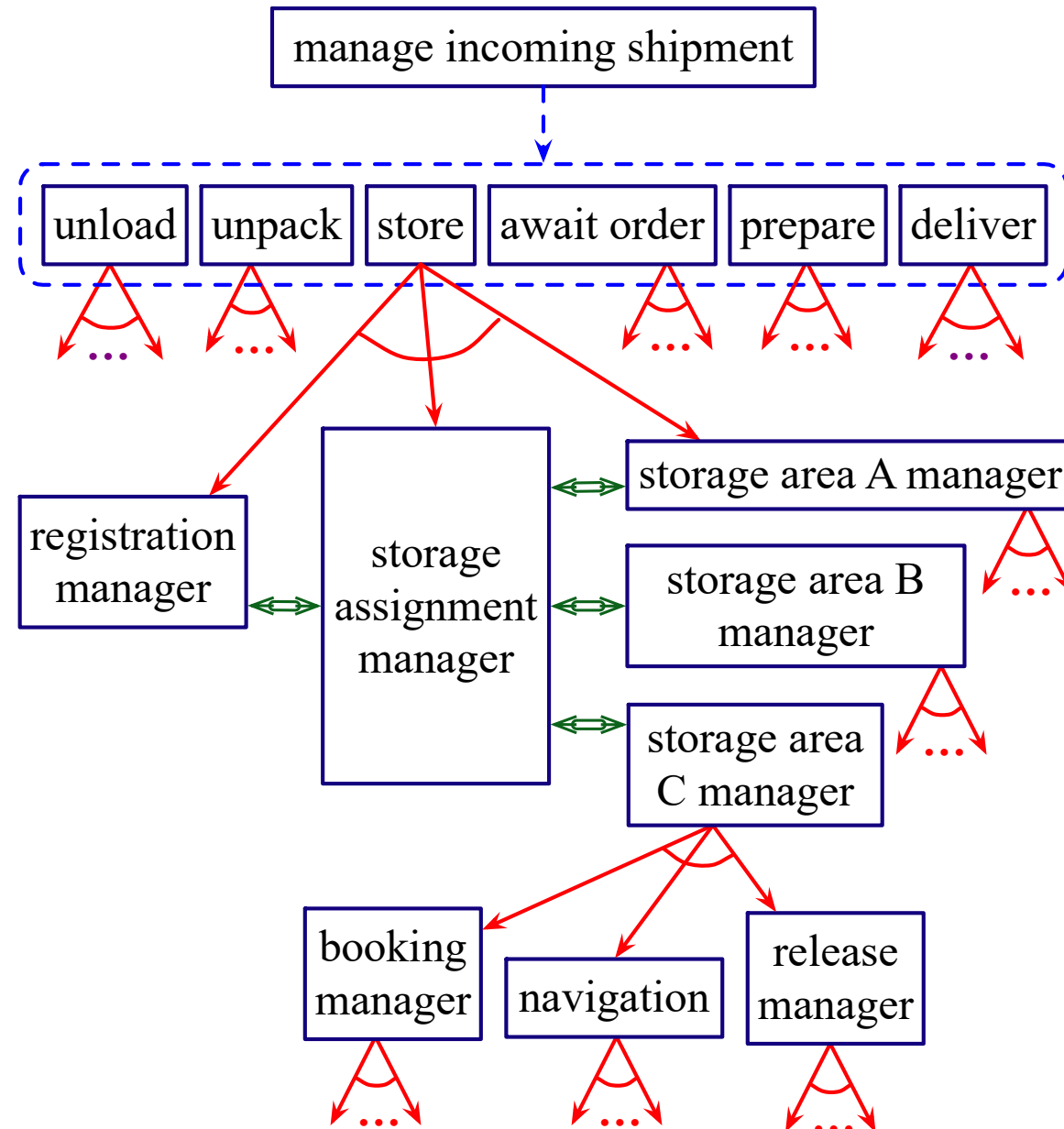


Bremen Harbor, Germany



Example: Harbor Management

- Importing/exporting cars
 - Based on Bremen Harbor
- Multiple levels of abstraction
 - Reflect physical organization of harbor
- Continual online planning
 - Top level can be planned offline
 - The rest is online, based on current conditions
- Heterogeneous reasoning
 - Different components work in different ways
 - Online synthesis of automata to control their interactions

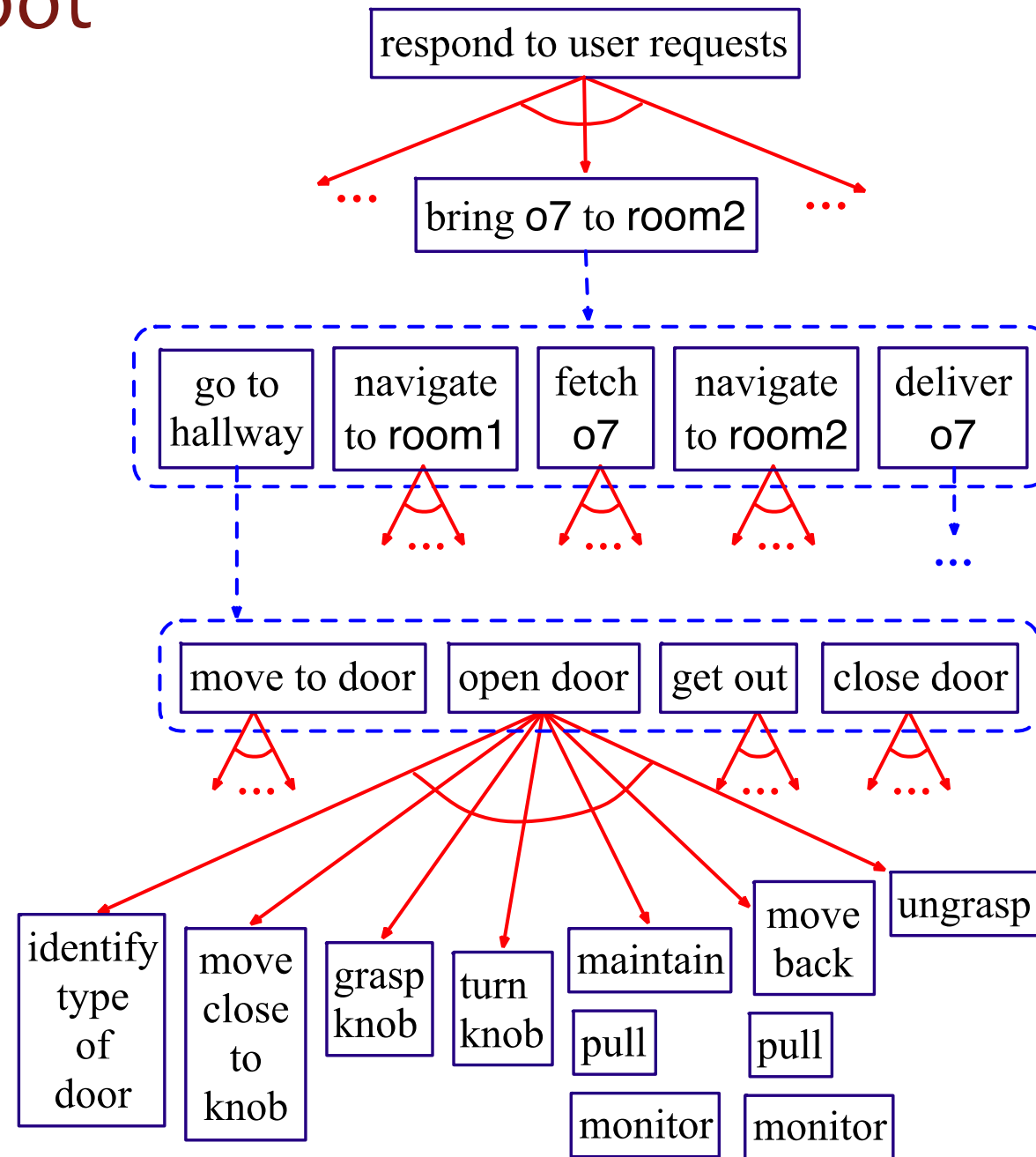


Planning

Acting

Example: Service Robot

- Multiple levels of abstraction
 - Higher levels: more planning
 - Lower levels: more acting
- Continual online planning
 - What room is o7 in?
 - What route?
 - What kind of door?
 - Close enough to door handle?
- Heterogeneous reasoning
 - planning abstract tasks
 - path planning
 - reactive (e.g., open door)



Planning

Acting