UNIVERSITÄT ZU LÜBECK

Automated Planning and Acting – Introduction

Institute of Information Systems

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My Background

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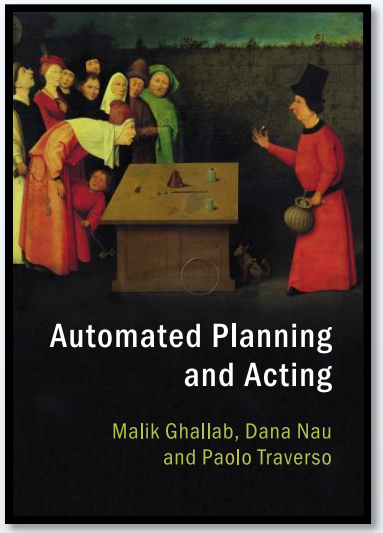
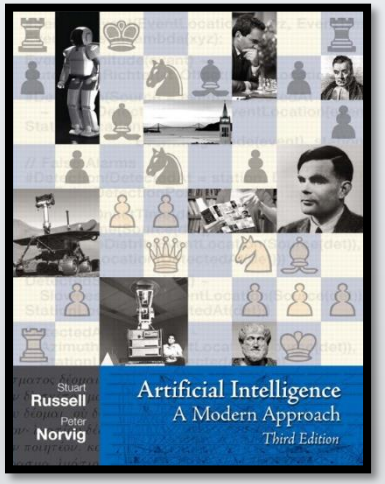
Literature

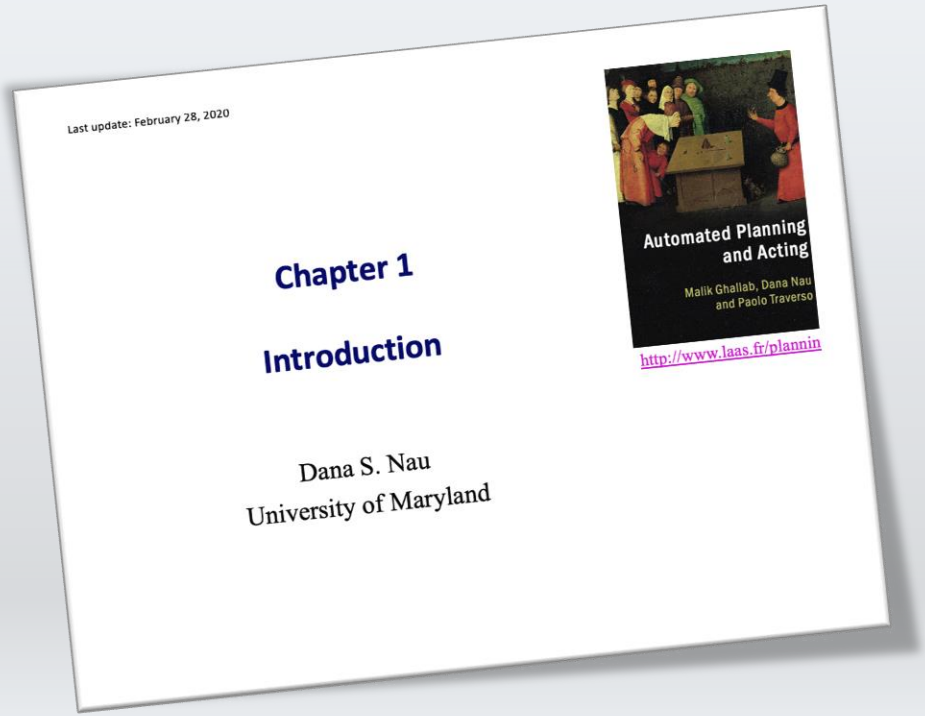
- Automated Planning and Acting
  - Malik Ghallab, Dana Nau, Paolo Traverso
  - Main source
- Artificial Intelligence: A Modern Approach (3rd ed.; abbreviation: AIMA)
  - Stuart Russell, Peter Norvig
  - Decision theory: Chs. 16 + 17
  - Reinforcement learning: Ch. 21
- Further research papers may be announced in lectures



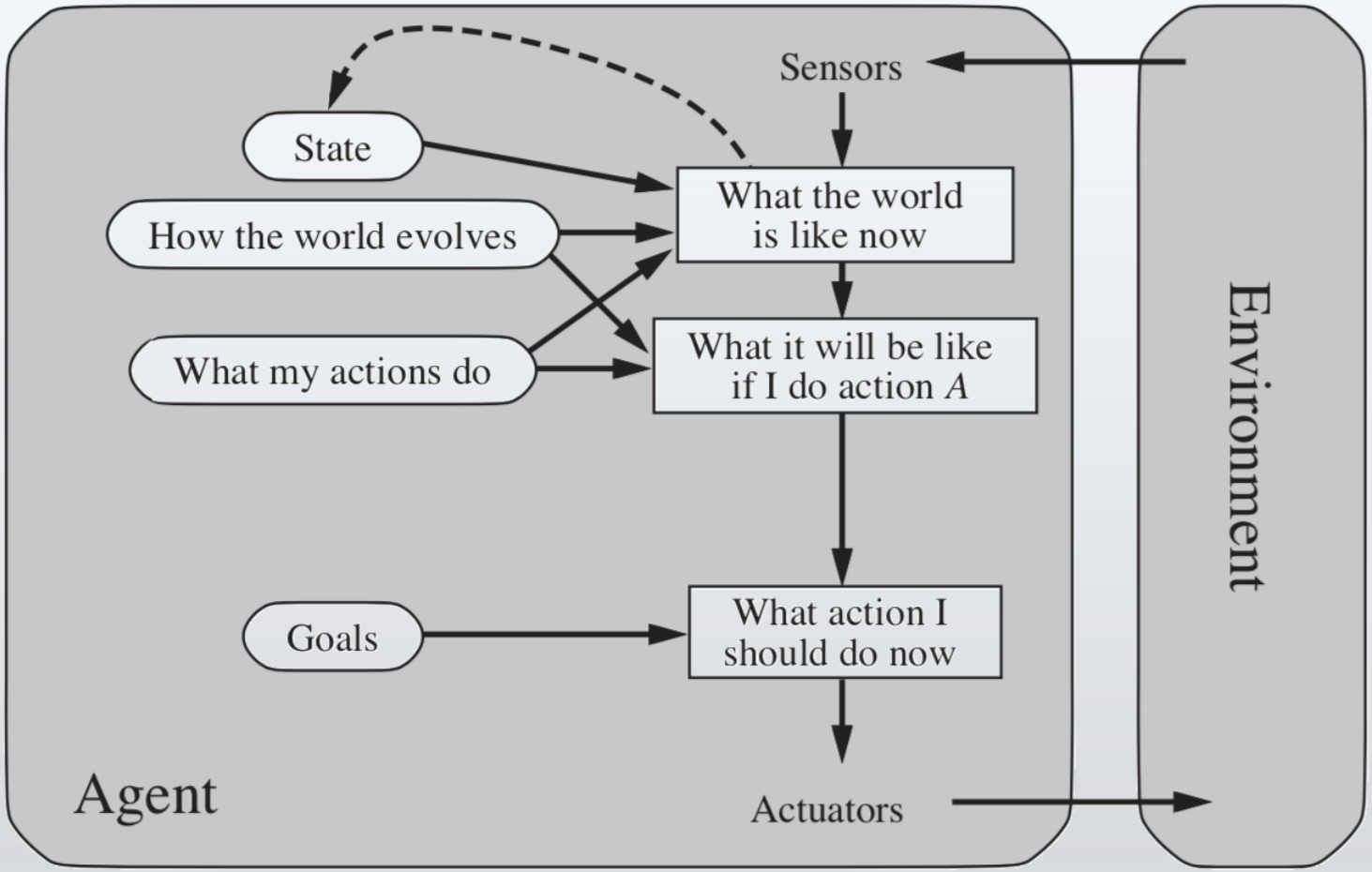


Acknowledgements

- Originally slides are designed by Dana Nau, University of Maryland
- I build upon the lecture by Tanya Braun, University of Münster



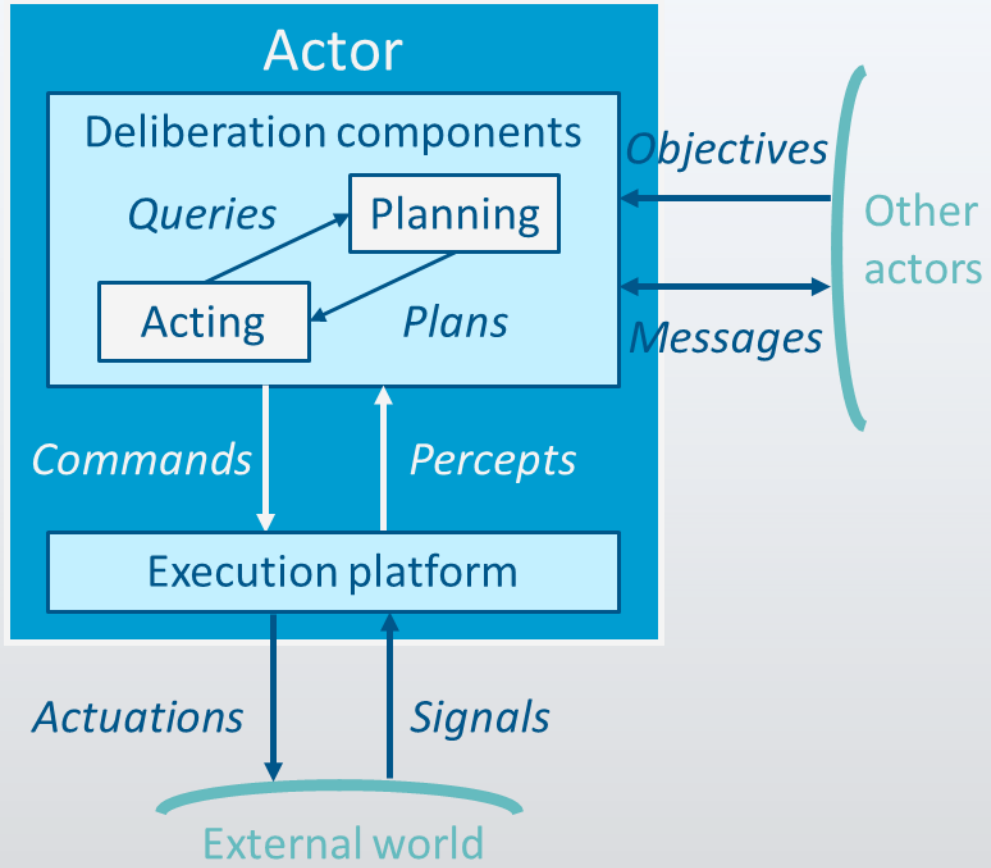
General Agent Setup



Source: AIMA, Russell/Norvig

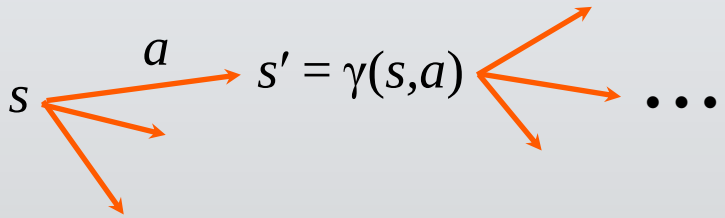
Setting Specific to Planning and Acting

- Actor: agent that performs actions
- Deliberation functions
  - Planning
    - What actions to perform
  - Acting
    - How to perform them
- Descriptive Models: Know What
- Operational Models: Know How



Planning

- Relies on prediction + search
- Uses descriptive models of the actions
  - Predict what the actions will do, but don't tell how to do them
- Search over predicted states and possible organizations of feasible actions

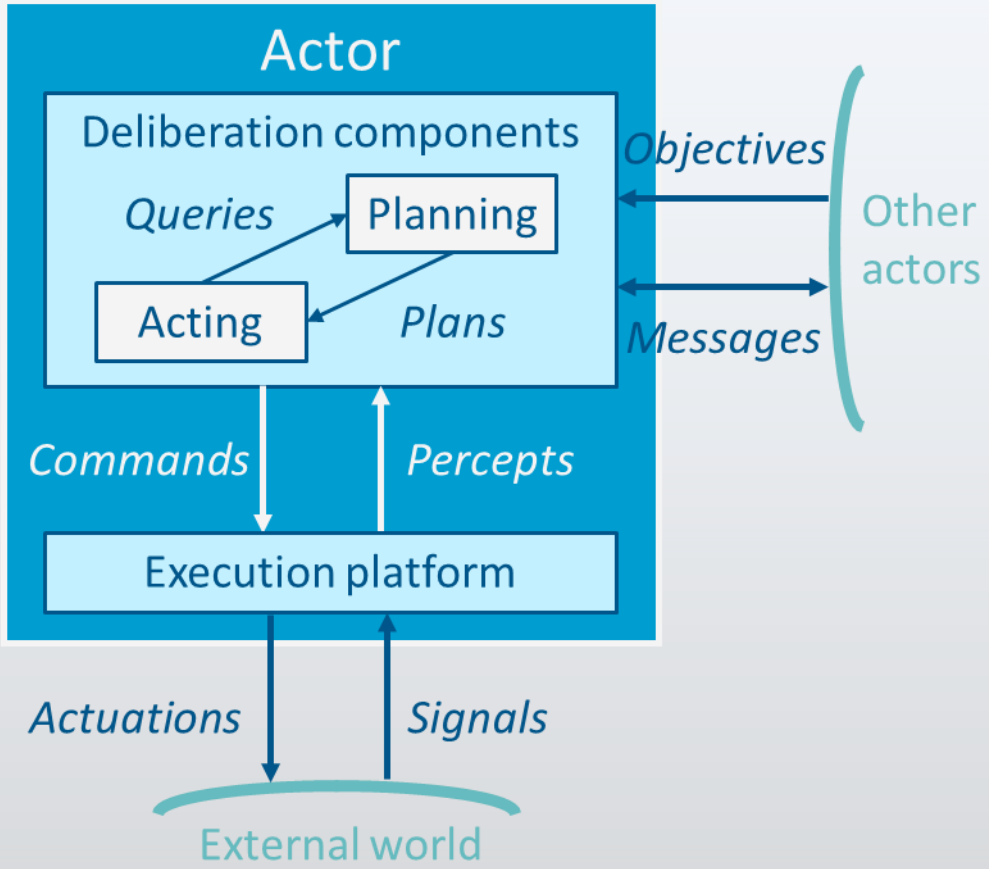


- Different types of actions
  - → Different predictive models
  - → Different planning problems and techniques
    - Motion and manipulation pl.
    - Perception planning
    - Navigation planning
    - Communication planning
    - **Task planning**

Most AI planning

Acting

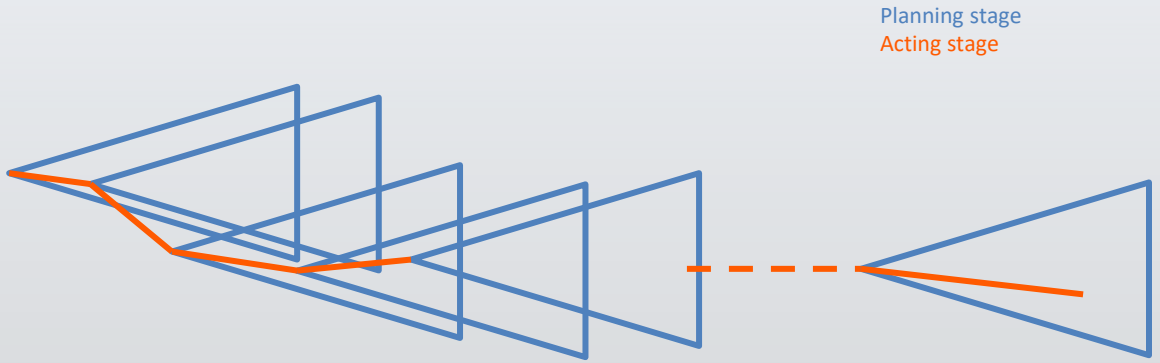
- Traditional "AI planning" view does not consider acting specially:
  - Carrying out an action is just execution
  - Doesn't require the actor to think about how
- Sometimes that's true
  - If the environment has been engineered to make it true
- Usually acting is more complicated



Acting as Execution

Deliberative Acting

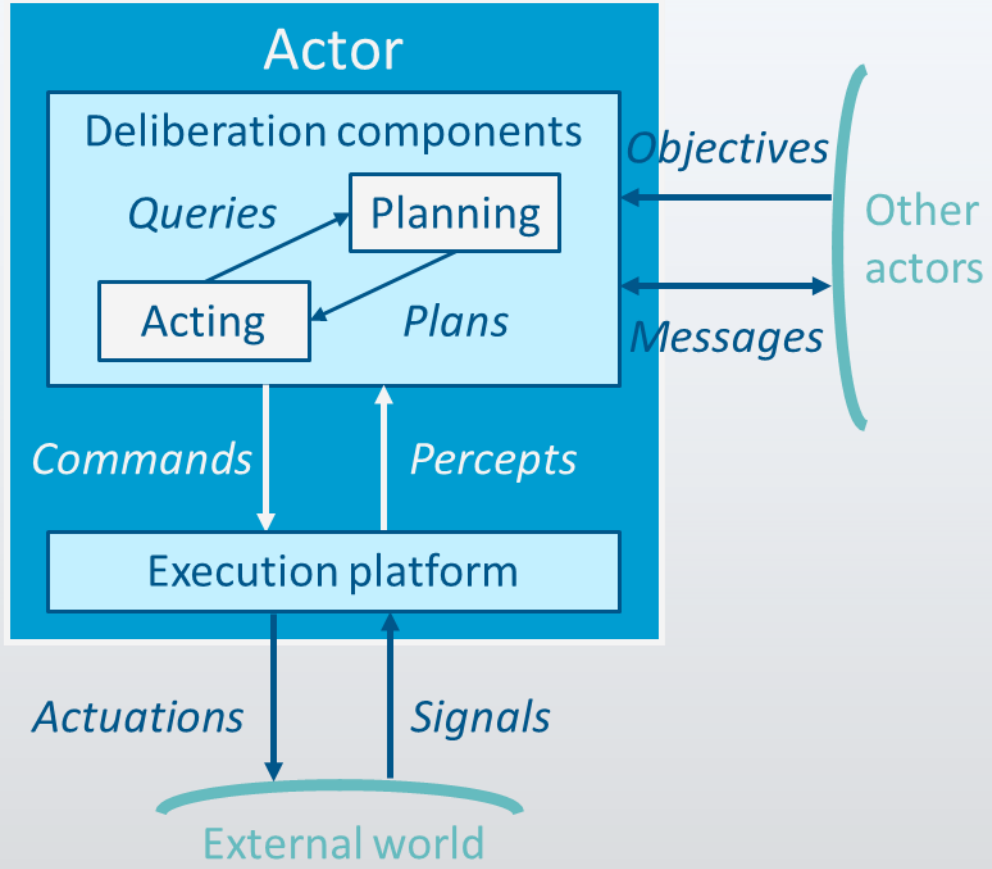
- Actor is situated in a dynamic unpredictable environment
  - Adapt actions to current context
  - React to events
- Relies on
  - Operational models telling how to perform the actions
  - Observations of current state



Deliberative Acting

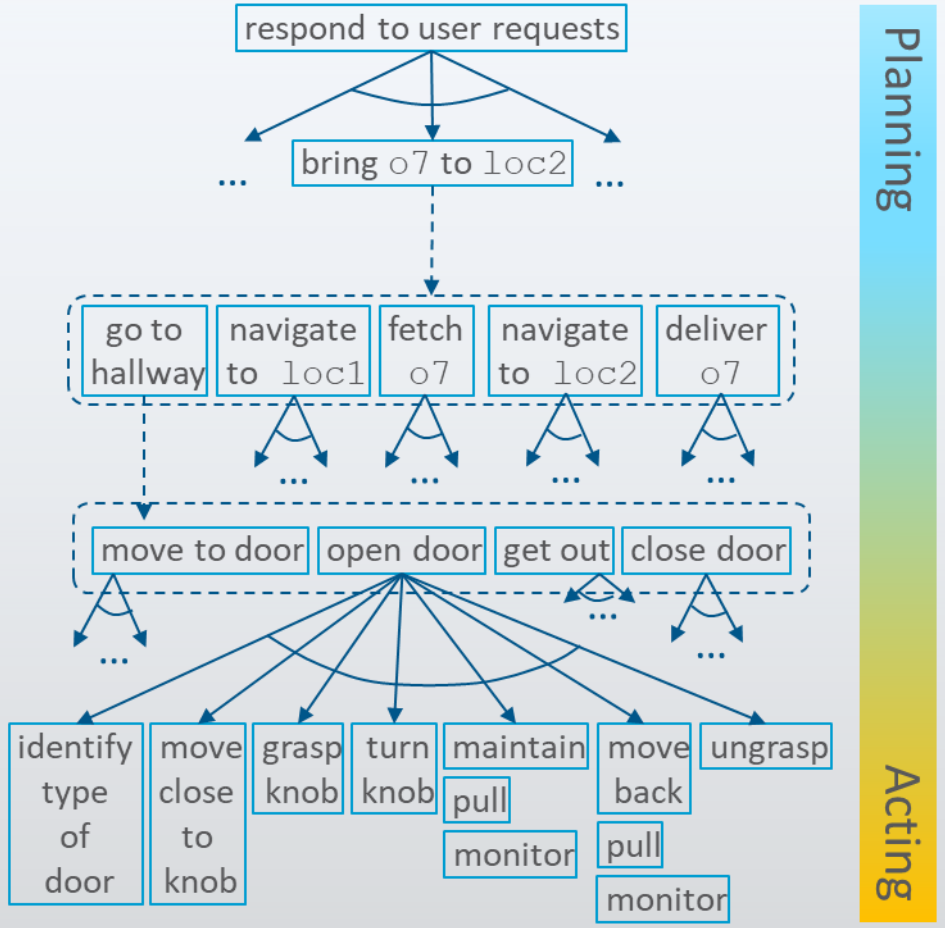
General Characteristics of Deliberation

- Hierarchically organized deliberation
  - Multiple levels of abstraction
    - Actors are organised into physical subsystems
  - Heterogeneous reasoning
    - Different techniques
      - At different levels
      - In different subsystems at same level
- Continual online deliberation
  - Can’t plan everything in advance
  - Plans are abstract and partial until more detail is needed



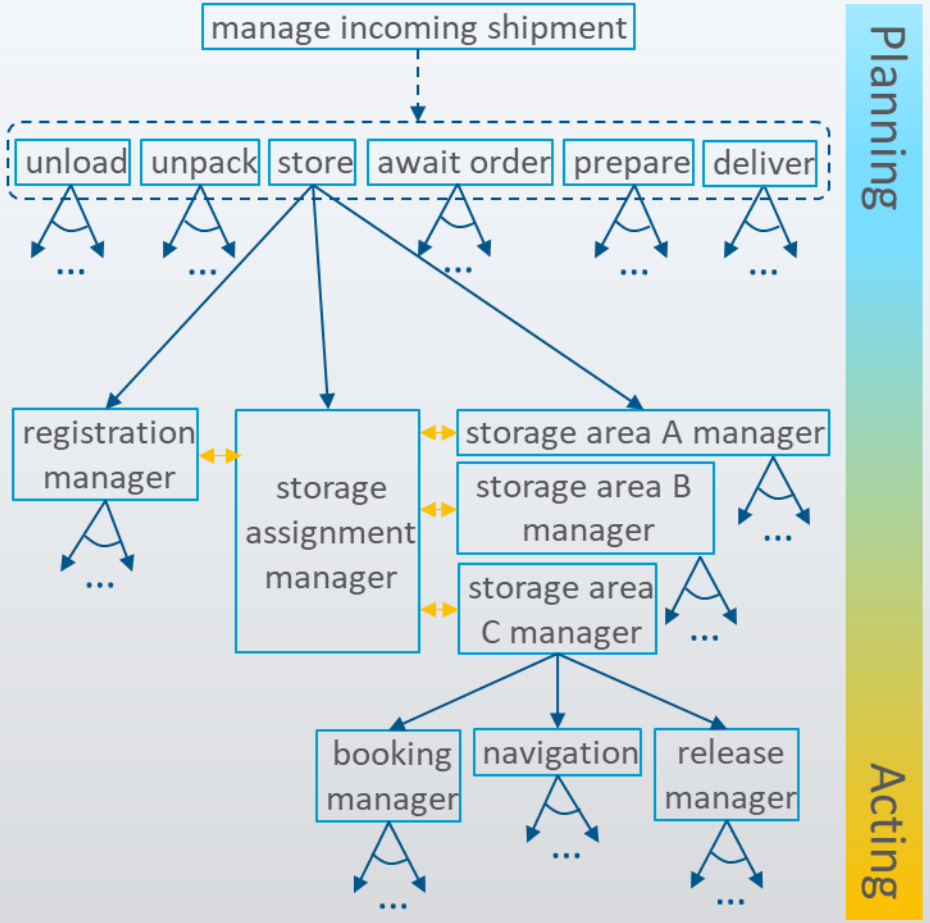
Example: Service Robot

- Multiple levels of abstraction
  - Higher levels: more planning
  - Lower levels: more acting
- Heterogeneous reasoning
  - bring o7 to room2: abstract steps
  - navigate to room1: path planning
  - open door: reactive
- Continual online planning
  - Is o7 really in room1?
  - What kind of door?
  - Close enough to the doorknob?



Example: Harbour Management

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



Quiz

When a servicing robot needs to perform exact motor control to pick up a perceived and classified item in what kind of model is the information about the exact motor control most likely stored?

a) Descriptive Model
b) Operational Model
c) Perception Model

Content

1. Planning and Acting with **Deterministic** Models
   Conventional AI planning
2. Planning and Acting with **Refinement** Methods
   Abstract activities → collections of less-abstract activities
3. Planning and Acting with **Temporal** Models
   Reasoning about time constraints
4. Planning and Acting with **Nondeterministic** Models
   Actions with multiple possible outcomes
5. **Standard** Decision Making
   Utility theory
   Markov decision process (MDP)
6. Planning and Acting with **Probabilistic** Models
   Actions with multiple possible outcomes, with probabilities
7. **Advanced** Decision Making
   Hidden goals
   Partially observable MDP (POMDP)
   Decentralised POMDP
8. **Human-aware** Planning
   Planning with a human in the loop
9. **Causal** Planning
   Causality & Intervention
   Implications for Causal Planning

Organisational Stuff

- Module: Formal Methods (small, 3 + 1)
- Topic: Automated Planning and Acting
- Language: English
- Schedule: Friday, 10:15-11:45
- Exam: Oral?!

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