Chapter 1

Introduction

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Motivation

- **Actor**: agent that performs actions

- Deliberation functions
  - Planning 
    - *What* actions to perform
  - Acting 
    - *How* to perform them
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
  \[ s \xrightarrow{a} s' = \gamma(s,a) \ldots \]

- Different types of actions ⇒
  - Different predictive models
  - Different planning problems and techniques

- Motion and manipulation planning
- Perception planning
- Navigation planning
- Communication planning
- Task planning

Most AI planning
Acting

- Traditional “AI planning” view:
  - Carrying out an action is just execution
  - Doesn’t require the actor to think about how to do it

- Sometimes that’s true
  - If the environment has been engineered to make it true
  - I’ll show you an example

- Usually acting is more complicated
  - Example of that later
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

- **Multiple levels of abstraction**
  - Actors are organized into physical subsystems
  - Deliberation reflects this

- **Heterogeneous reasoning**
  - Different techniques
    - at different levels
    - in different subsystems at same level

- **Continual online planning**
  - 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

- **Continual online planning**
  - Is o7 really in room1?
  - What kind of door?
  - Close enough to the doorknob?

- **Heterogeneous reasoning**
  - bring o7 to room2: abstract steps
  - navigate to room1: path planning
  - open door: reactive

Diagram:
- **Planning**
- **Acting**

 respond to user requests

 bring o7 to room2

 go to hallway
 navigate to room1
 fetch o7
 navigate to room2
 deliver o7

 move to door
 open door
 get out
 close door

 identify type of door
 move close to knob
 grasp knob
 turn knob
 maintain
 move back
 ungrasp

 pull
 monitor

 move

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 Multiple levels of abstraction

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 Lower levels: more acting

 Continual online planning

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 What kind of door?
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 Heterogeneous reasoning

 bring o7 to room2: abstract steps
 navigate to room1: path planning
 open door: reactive

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

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Outline of Book

1: *Introduction* (this lecture)
2: *Deterministic models*
   - Conventional (*classical*) AI planning
   - Integrating it with acting
3: *Refinement methods*
   - Abstract activities → collections of less-abstract activities
   - Reactive execution, lookahead planning, combining them
4: *Temporal models*
   - Reasoning about time constraints during planning and acting
5: *Nondeterministic models*
   - Actions with multiple possible outcomes
6: *Probabilistic models*
   - Multiple possible outcomes, with probabilities
7: *Other*: perceiving, monitoring, goal reasoning, learning, hybrid models, ontologies
Any questions?

Cover image: *The Conjuror*. Hieronymus Bosch (c.1450–1516)