Searching: Intro

CPSC 322 – Search 1

Textbook §3.0 – 3.3
Lecture Overview

1. Agent Design
2. Example Problems
3. State Spaces
Agents and Representations

- Recall that an agent is something that acts in an environment.
- The agent also receives observations about the environment:
  - this could be observations from sensors such as cameras, laser rangefinders, etc.
  - can also include “observations” of the agent’s own past actions.
- In a deterministic environment, the agent can perfectly predict the outcome of an action:
  - doesn’t need sensors: just needs to remember its own past actions.
The Table-Lookup Agent

- An agent can be thought of as a mapping from observations to the new action that the agent will take.
- How should agents be constructed? One choice:
  - agent takes in the sequence of observations
  - agent looks up the correct action for this sequence of observations based on an internal representation (e.g., a table)
- Such an agent could indeed behave rationally. What’s the problem?
An agent can be thought of as a **mapping** from observations to the new action that the agent will take.

How should agents be constructed? One choice:
- agent takes in the sequence of observations
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Such an agent could indeed behave rationally. What’s the problem?
- too many sequences of observations are possible!
- e.g., 10 possible observations, 10 timesteps $\rightarrow 10^{10}$ different entries in the table
- compare this to e.g., the number of different move sequences that are possible in chess
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Example Problems

To make things more concrete, let’s think about some example problems:

- solving a Sudoku
- solving an 8-puzzle
- the delivery robot planning the route it will take
What’s an 8-Puzzle?

Start State

Goal State
To make things more concrete, let’s think about some example problems:
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All of these problems are deterministic; thus, there’s no need for any observations from sensors.

Are these single or sequential decision problems?
Example Problems

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Are these single or sequential decision problems?

- as discussed before, the distinction isn’t really useful here; problems can be seen both ways
- CSPs: settings where there’s nothing meaningfully sequential about the decision
- Planning: decisions are always sequential
- Now: we’re going to define the underlying tools that allow us to solve both
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State Spaces

- **Idea**: sometimes it doesn’t matter what sequence of observations brought the world to a particular configuration; it just matters how the world is arranged now.
  - called the Markov assumption
- **Represent the different configurations in which the world can be arranged as different states**
  - which numbers are written in cells of the Sudoku and which are blank?
  - which numbers appear in which slots of the 8-puzzle?
  - where is the delivery robot?
- **States are assignments of values to one or more variables**
  - a single variable called “state”
  - $x$ and $y$ coordinates; etc...
- **From each state, one or more actions may be available, which would move the world into a new state**
  - write a new number in a blank cell of the Sudoku
  - slide a tile in the 8-puzzle
  - move the delivery robot to an adjacent location
Agent Design

- An agent can be thought of as a mapping from the given state to the new action that the agent will take.
- However, there’s a problem... often, we don’t understand the domain well enough to build the mapping.
  - we’d need to be able to tell the agent how it should behave in every state.
  - that’s why we want intelligent agents: they should decide how to act for themselves.
  - in order for them to do so, we need to give them goals.
State Spaces

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- States are assignments of values to one or more variables
- From each state, one or more actions may be available, which would move the world into a new state
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- Some states are goal states
  - A Sudoku state in which all numbers are different in each box, row and column
  - The single 8-puzzle state pictured earlier
  - The state in which the delivery robot is located in room 123