today’s topics:
  • logic-based agents
Logic-Based Agents

• When we started talking about logic, it was as a means of representing knowledge.
• We wanted to represent knowledge in order to be able to build agents.
• We now know enough about logic to do that.
• We will now see how a logic-based agent can be designed to perform simple tasks.
• Assume each agent has a database, i.e., set of FOL-formulae.
  These represent information the agent has about environment.
• We’ll write $\Delta$ for this database.

• Also assume agent has set of rules. We’ll write $R$ for this set of rules.

• We write $\Delta \vdash_R \phi$ if the formula $\phi$ can be proved from the database $\Delta$ using only the rules $R$.

• How to program an agent:

  Write the agent’s rules $R$ so that it should do action $a$ whenever $\Delta \vdash_R Do(a)$.

  Here, $Do$ is a predicate.

• Also assume $A$ is set of actions agent can perform.
- The agent's operation:

1. for each $a$ in $A$ do
2.     if $\Delta \vdash_R Do(a)$ then
3.         return $a$
4.     end-if
5. end-for
6. for each $a$ in $A$ do
7.     if $\Delta \not\vdash_R \neg Do(a)$ then
8.         return $a$
9.     end-if
10. end-for
11. return $null$
• An example:

We have a small robot that will clean up a house. The robot has sensor to tell it whether it is over any dirt, and a vacuum that can be used to suck up dirt. Robot always has an orientation (one of n, s, e, or w). Robot can move forward one “step” or turn right 90°. The agent moves around a room, which is divided grid-like into a number of equally sized squares. Assume that the room is a $3 \times 3$ grid, and agent starts in square $(0, 0)$ facing north.
- Illustrated:
• Three *domain predicates* in this exercise:

\[ \begin{align*}
\text{In}(x, y) & \quad \text{agent is at } (x, y) \\
\text{Dirt}(x, y) & \quad \text{there is dirt at } (x, y) \\
\text{Facing}(d) & \quad \text{the agent is facing direction } d
\end{align*} \]

• For convenience, we write rules as:

\[ \phi(\ldots) \rightarrow \psi(\ldots) \]

• First rule deals with the basic cleaning action of the agent

\[ \text{In}(x, y) \land \text{Dirt}(x, y) \rightarrow \text{Do(suck)} \]  \hspace{1cm} (1)

• Hardwire the basic navigation algorithm, so that the robot will always move from (0, 0) to (0, 1) to (0, 2) then to (1, 2), (1, 1) and so on.
• Once agent reaches \((2, 2)\), it must head back to \((0, 0)\).

\[
\begin{align*}
  \text{In}(0,0) \land \text{Facing}(\text{north}) \land \neg \text{Dirt}(0,0) & \quad \rightarrow \quad \text{Do}(\text{forward}) \\
  \text{In}(0,1) \land \text{Facing}(\text{north}) \land \neg \text{Dirt}(0,1) & \quad \rightarrow \quad \text{Do}(\text{forward}) \\
  \text{In}(0,2) \land \text{Facing}(\text{north}) \land \neg \text{Dirt}(0,2) & \quad \rightarrow \quad \text{Do}(\text{turn}) \\
  \text{In}(0,2) \land \text{Facing}(\text{east}) & \quad \rightarrow \quad \text{Do}(\text{forward})
\end{align*}
\]

• Other considerations:
  - \textit{adding} new information after each move/action;
  - \textit{removing} old information.

• Suppose we scale up to \(10 \times 10\) grid?
Summary

• This lecture covered two logic-related topics.
  • First is covered mechanical theorem proving:
    – Pointed out some problems.
    – Suggested resolution as a solution.
  • Next we looked at how logic might be used to program an agent.
    – Assumes we have a theorem prover.