Robot grocery shopping in partially observable settings

Rodrigo Gomes, Xiaomin Wang, Dustin Tran

May 13, 2015

MIT, 6.834j Cognitive Robotics

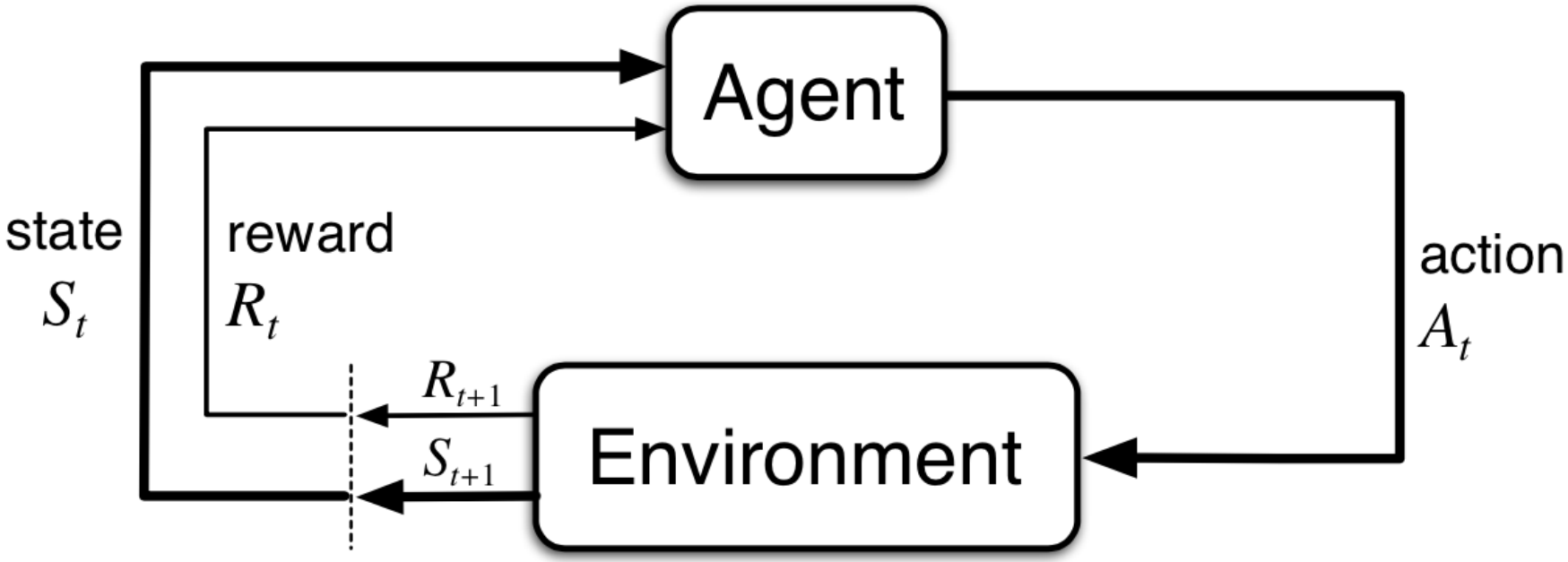
Outline

1. Background on POMDPs
2. Grocery shopping as planning in a POMDP
3. Demo!
4. What worked
5. What failed

A *partially observable Markov decision process* (POMDP) is a collection of objects (S, A, Ω, R, T, O)

- S: state space
- A: action space
- Ω: observation space
- $R : S \times A \to \mathbb{R}$ reward function
- T: transition operator. $T(s' \mid s, a)$ is probability of next state s' given state s and action a
- O: observable operator. $O(o \mid s)$ is probability of observing o given at state s

Background



Belief-state MDP

Implemented MDP solvers:

- Q-learning
- SARSA
- R-MAX
- Thompson sampling

There are a lot!

- Function approximations with adaptive basis functions
- BOSS
- Spectral methods
- Skill chaining
- . . .

Grocery shopping

the task in the POMDP framework

Grocery shopping

how the software works, etc.

demo

Our working solver

- Max Probability Value Iteration:
- Choose the most likely state from belief state to run value iteration

Our working solver

Value iteration:

$$
\begin{aligned}
v_{k+1}(s) &= \max_a \mathbb{E}[R_{t+1} + \gamma v_k(S_{t+1}) \mid S_t = s, A_t = a] \\
&= \max_a \sum_{s'} p(s' \mid s, a)[r(s, a, s') + \gamma v_k(s')]
\end{aligned}
$$

Failed tasks

- Value iteration as a belief-state MDP
- Thompson sampling
- ...

Play with it!

github.com/dustinvtran/bayesrl