COMS W4701: Artificial Intelligence

Lecture 2: Agents, Environments, and Search Problems

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*Lecture materials derived from UC Berkeley's AI course at ai.berkeley.edu

Announcements

- Wait lists have not changed much…
- Auditors are welcome, please reach out to Tony

- HW0 submission for wait list students out next Tuesday

- Attend Pieter Abbeel's talk!

CS @CU DISTINGUISHED LECTURE SERIES 2018

Deep Learning to Learn

SEPT. 10, 2018 (MONDAY)
11:30AM–12:30PM
DAVIS AUDITORIUM
(412 CEPSR)

Pieter Abbeel (UC Berkeley)

Last Time

- Definitions of AI
- History of AI
- Modern applications
- What do you want to take away from this course?

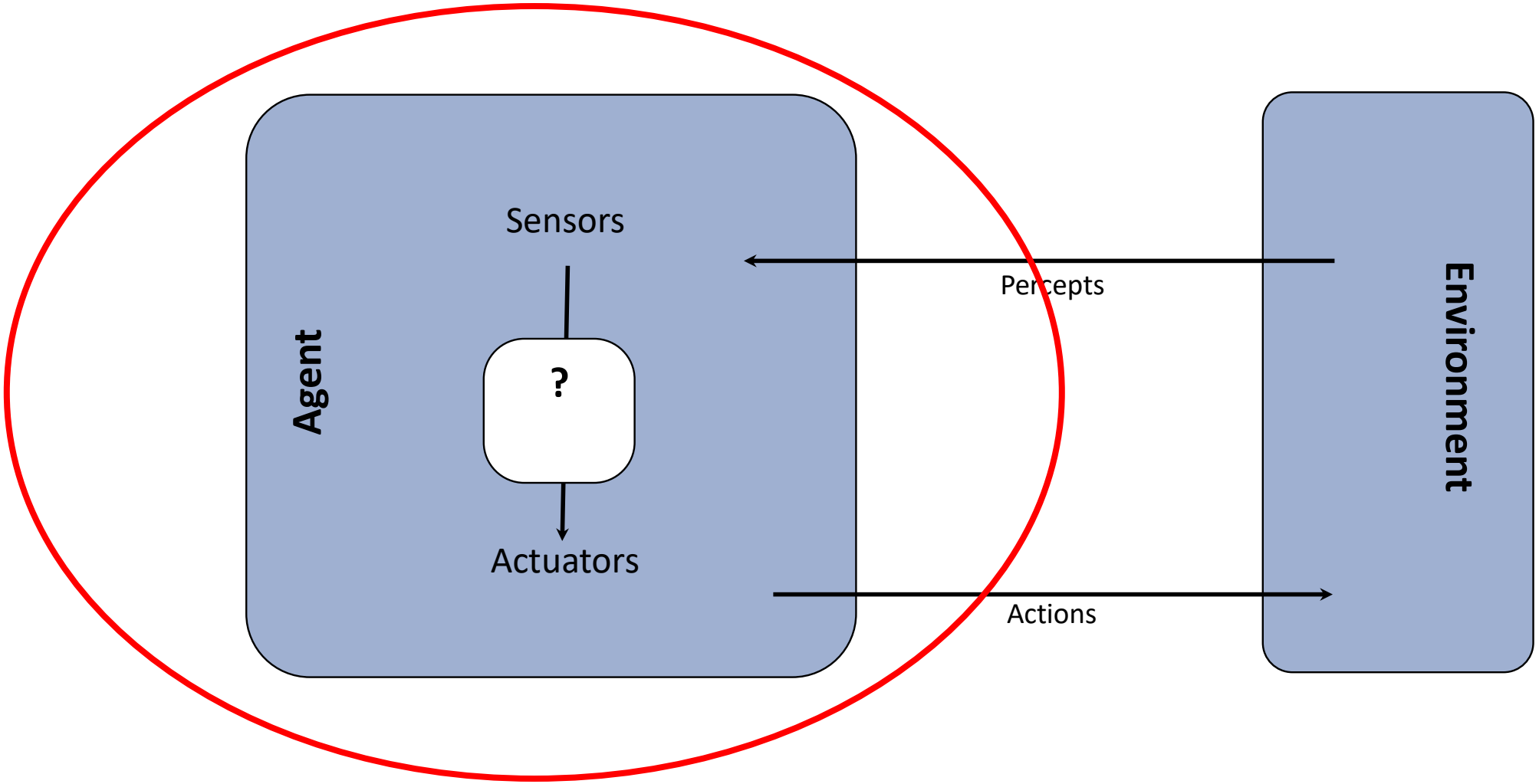
What do you want to take away from this course?

- Applications and modern technology, AI in the real world
- Fundamental theory and general methods
- Human-AI interactions
- Deep learning, reinforcement learning
- Outlook for the future

Today

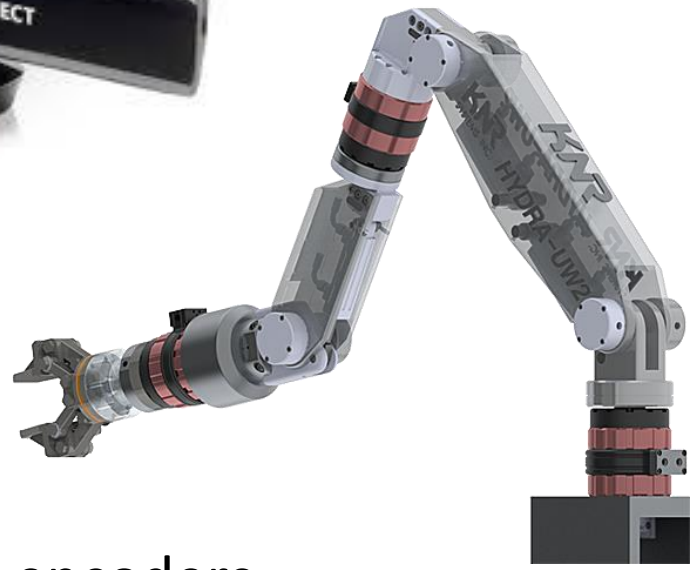
- Characteristics of agents
- Properties of environments
- Time permitting: Search problems

Agents



Sensors and Actuators

- Human agents
  - Sensors
    - Eyes, ears, nose, mouth, skin
  - Actuators
    - Mouth, arms, hands, legs, feet
- Robot agents
  - Sensors
    - Cameras (stereo, infrared, lidar, etc.), force sensors, encoders
  - Actuators
    - Motors, wheels, arms and grippers, legs

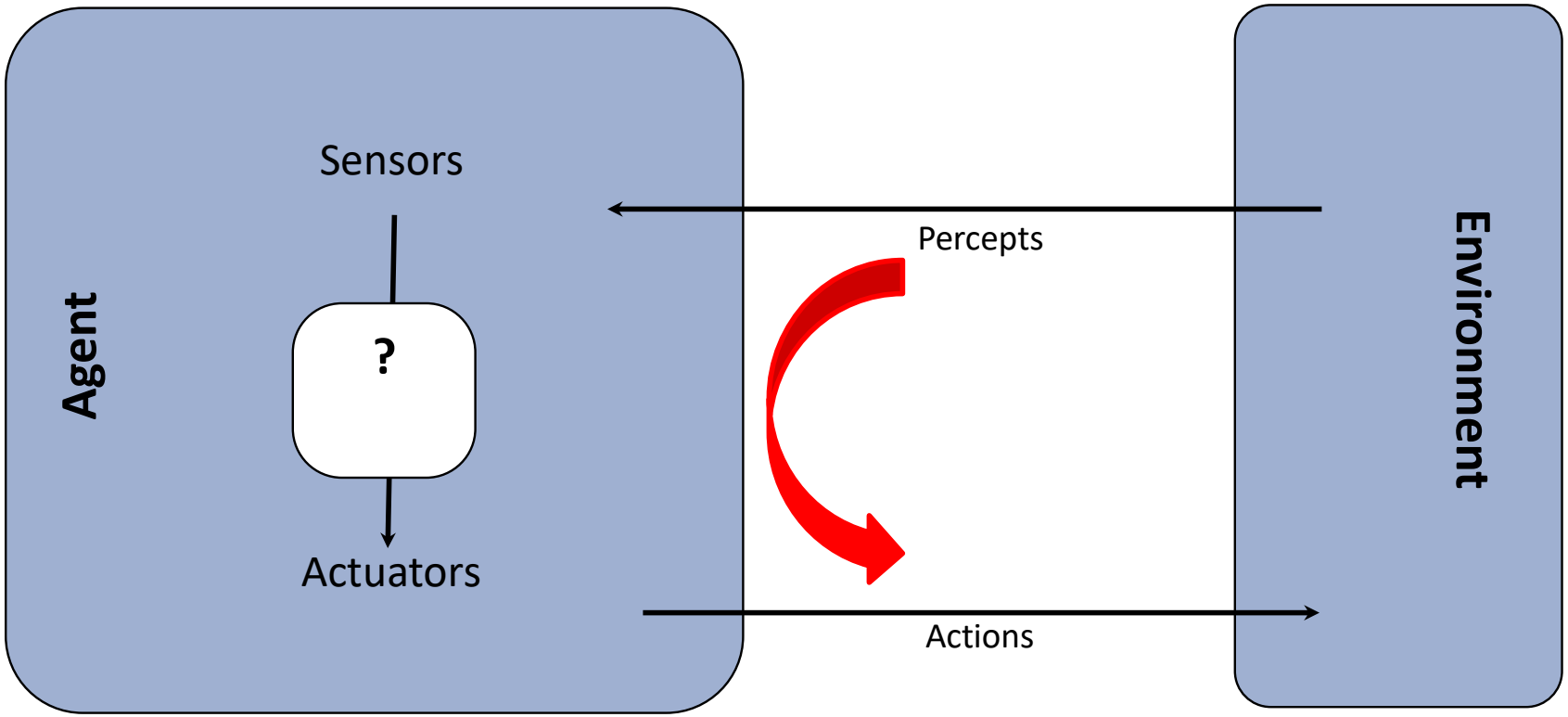


Failures of Robot Agents

Other Examples of Agents

- Self-driving cars
- Roombas
- Watson
- Spam filters
- Google Maps
- Siri

Agent Functions

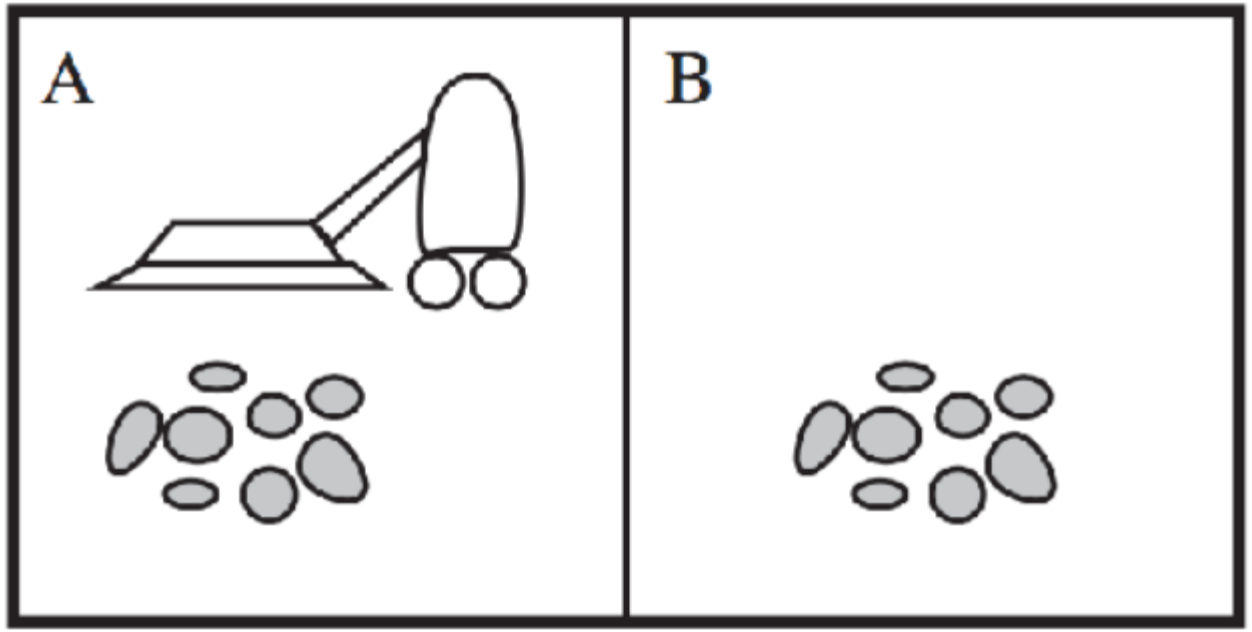


$$f: P^* \rightarrow A$$

Percept history Actions

Vacuum Cleaner World

- Agent: Vacuum cleaner
- Environment: Two discrete locations



Classify the following as either percepts or actions

Vacuum Cleaner World

- Percepts: Current Location, IsDirty?
- Actions: Move left, move right, clean, do nothing

[A, IsClean]	Move right
[A, IsDirty]	Clean
[B, IsClean]	Move left
[B, IsDirty]	Clean
[[A, IsDirty], [A, IsClean]]	Move right
[[B, IsDirty], [A, IsClean]]	Move right
[[B, IsClean], [A, IsClean]]	Do nothing
……	……

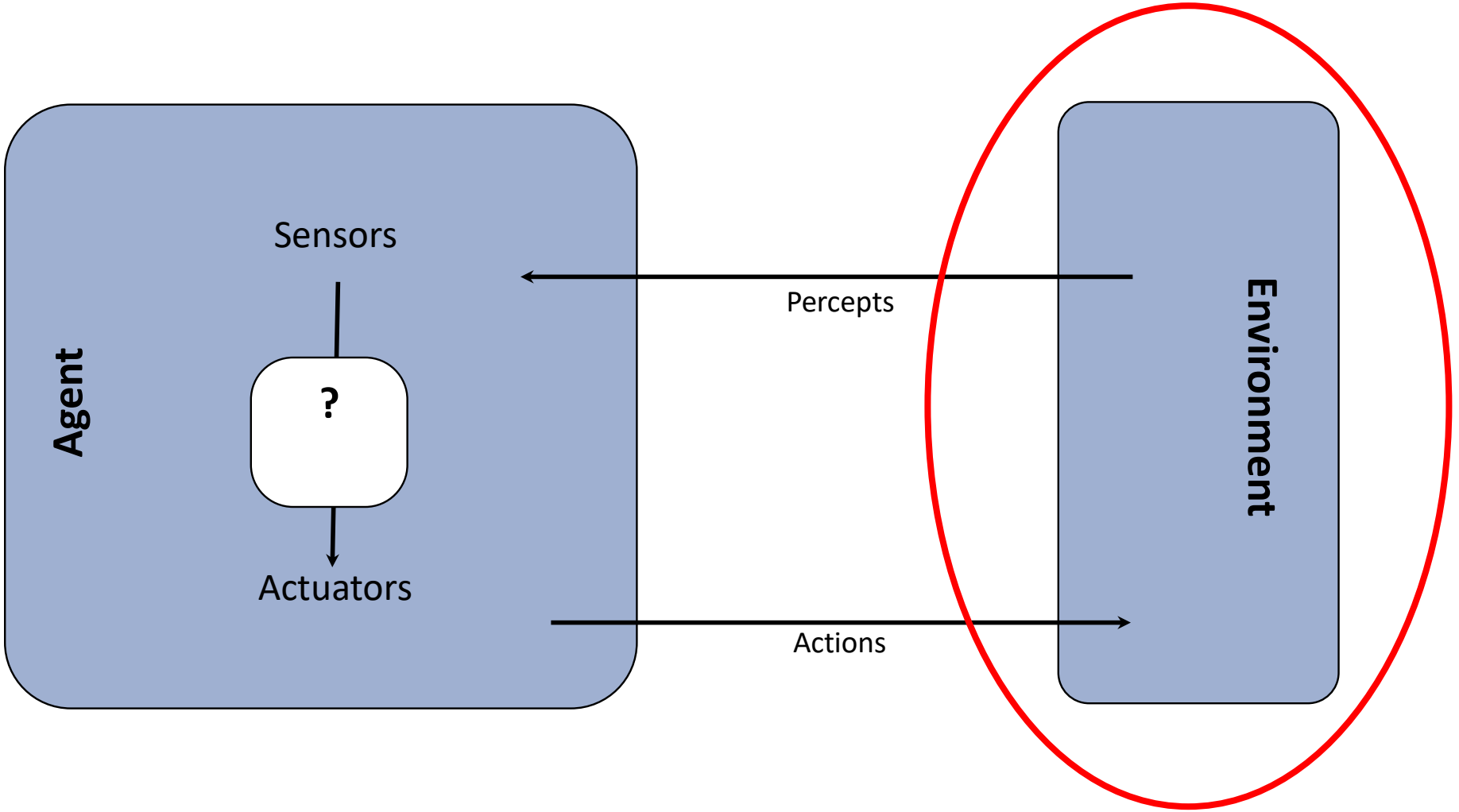
Rational Agents

- How do we define agent functions?

- "Rationality" depends on several factors
  - Agent's **knowledge** of the environment
  - Agent's **percept history**
  - Agent's available **actions**
  - A performance measure or **utility** that defines success

- What are some examples of utilities for the vacuum cleaner?

Environments



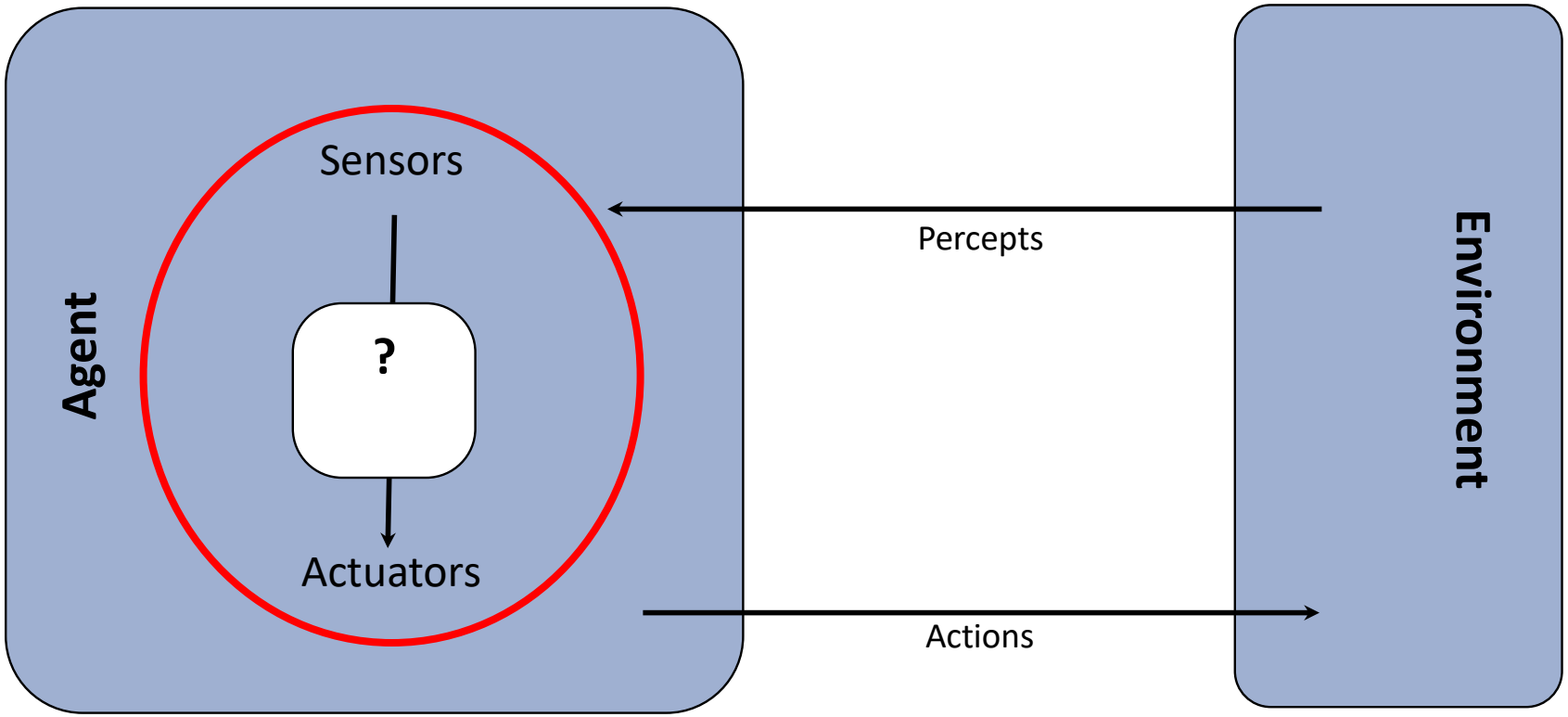
Environments

- Fully observable vs partially observable
- Deterministic vs stochastic
- Episodic vs sequential
- Static vs dynamic
- Discrete vs continuous
- Single-agent vs multi-agent

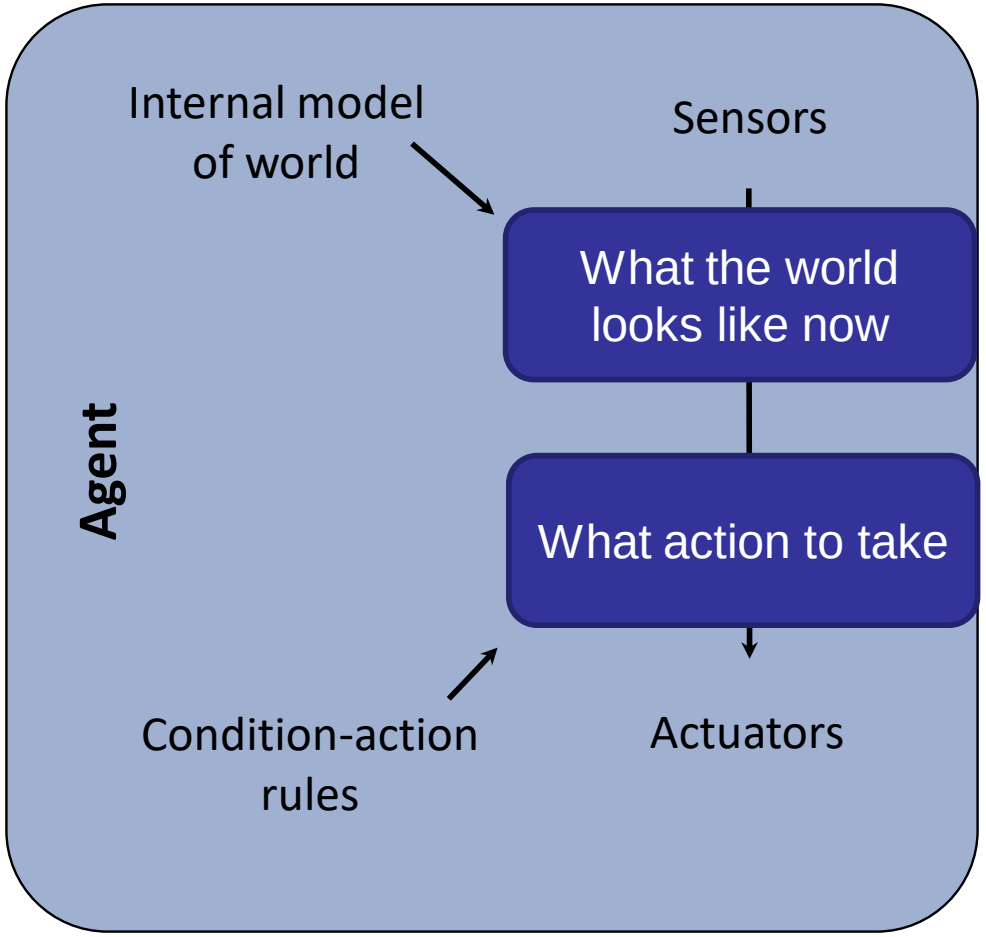
Examples of Environments

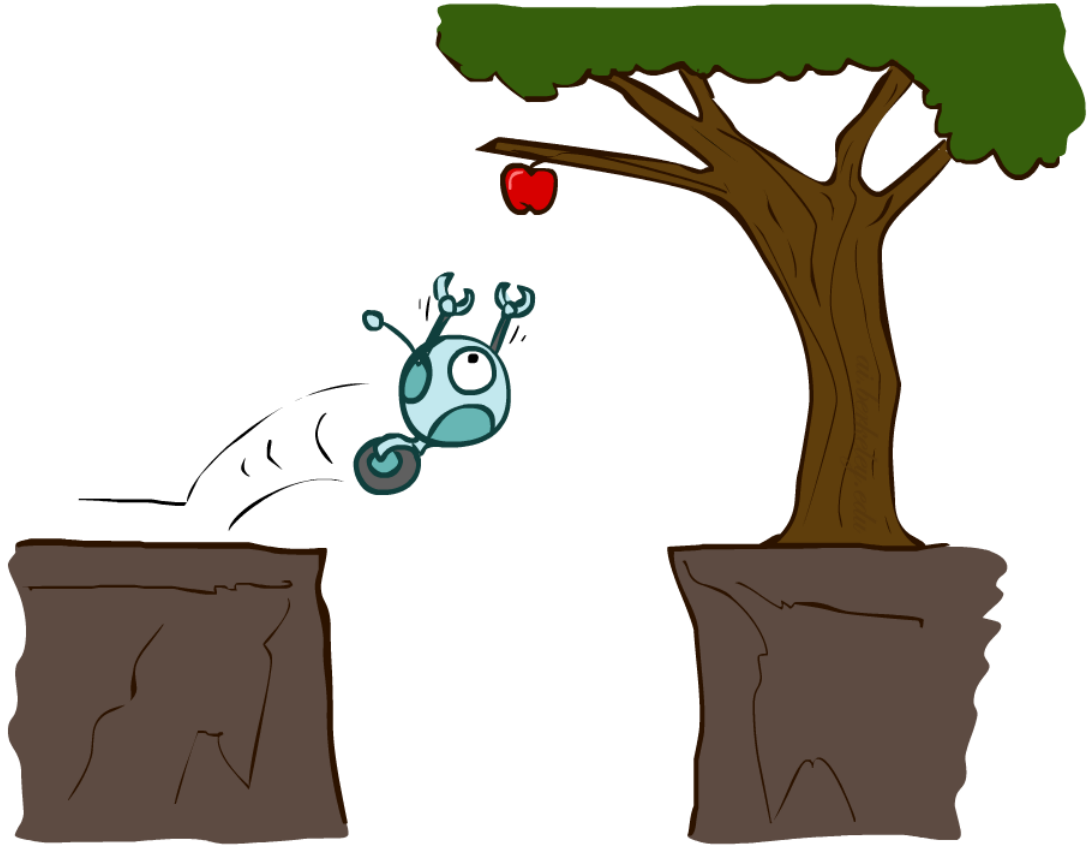
Environment	Partially / Fully Observable	Deterministic / Stochastic	Sequential / Episodic	Dynamic / Static	Continuous / Discrete	Single- / Multi-Agent
Vacuum cleaner world	P	D	S	S	d	s
Chess	F	D	S	S	d	
Self-driving car (real world)	P	S	S	D	c	
Image classification	F	D	E	s	d	s

Reflex vs Goal-Based Agents

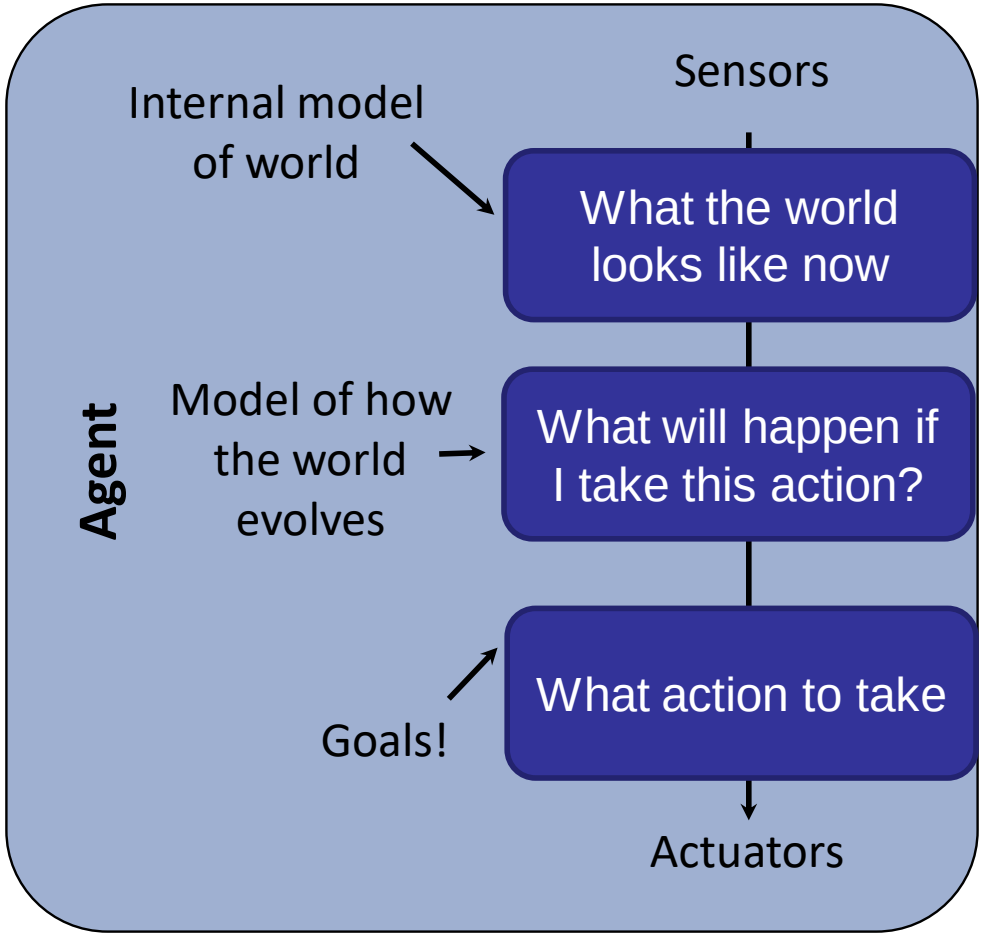


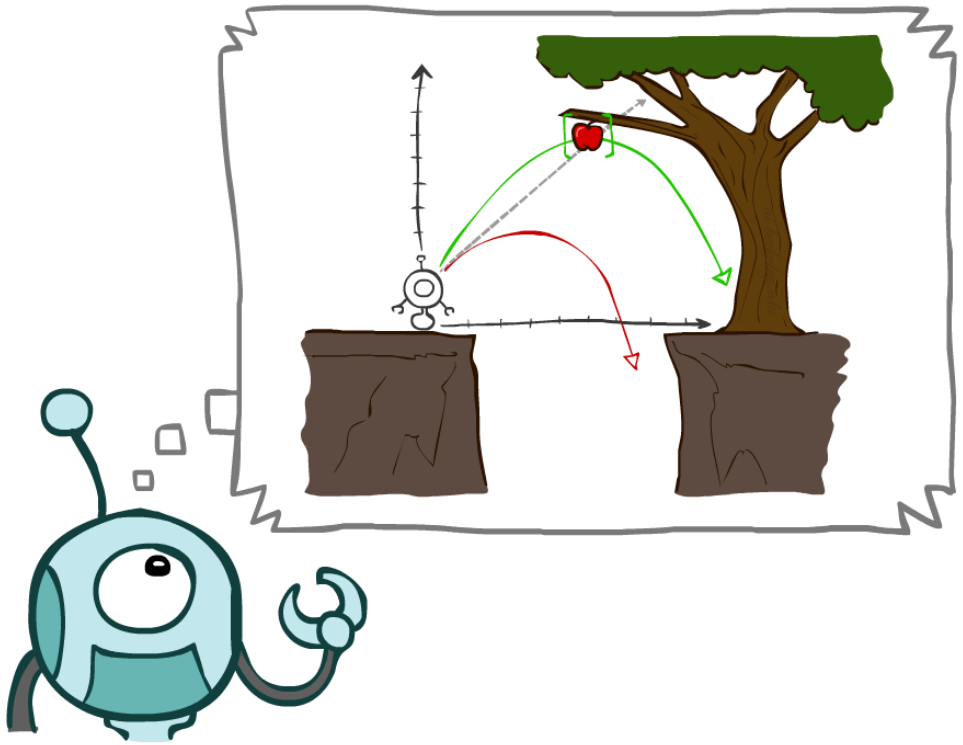
Reflex Agents





Goal-Based (Planning) Agents

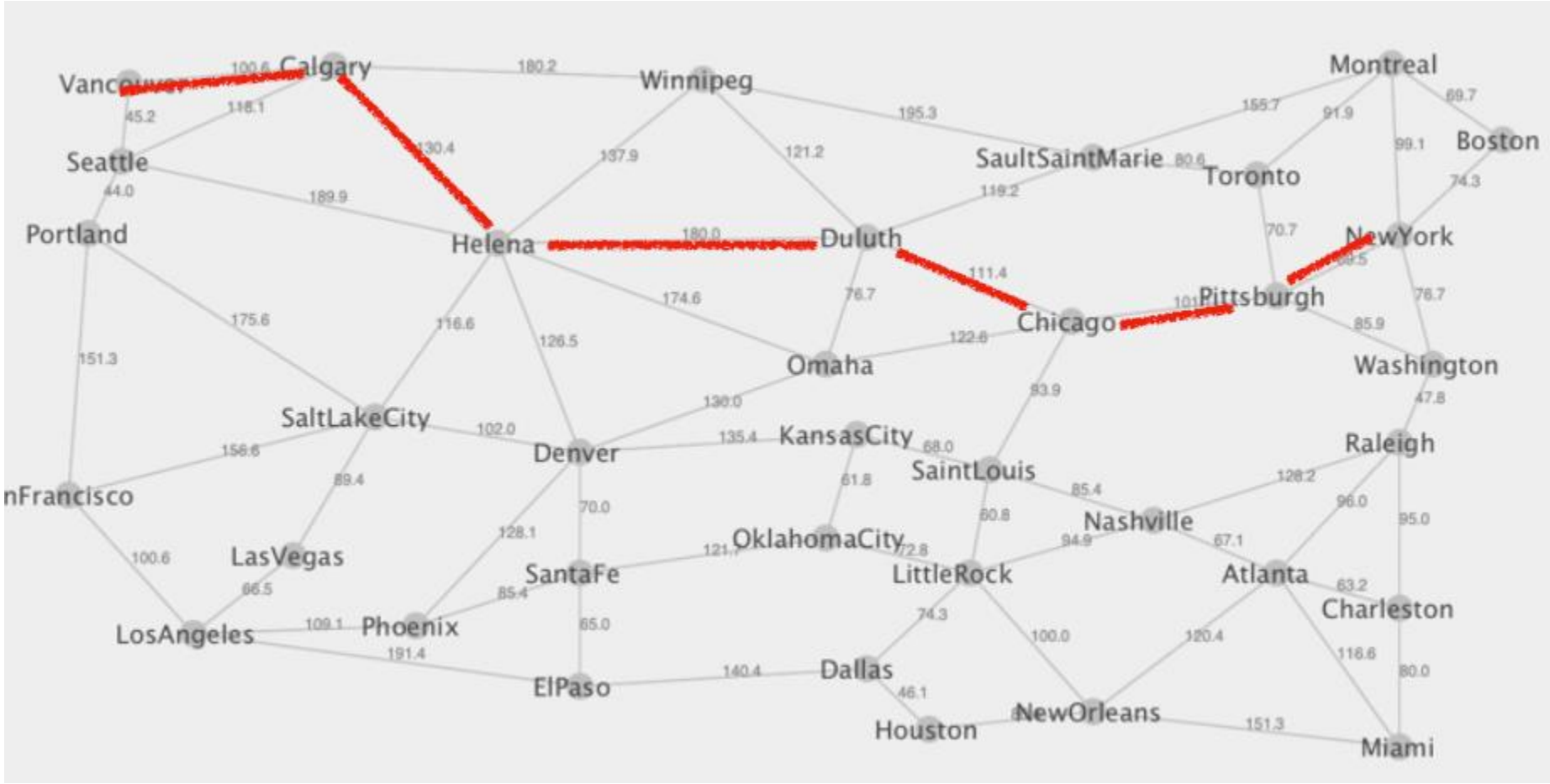




Search Problems

- State space: All possible descriptions of the agent in the world
- Action space: All possible actions an agent can take in its state
  - *Actions*(s), $s \in$ state space
- Transition model: Function mapping current state + action to a new state
  - *Results*: $(s_1, a) \rightarrow s_2,\ a \in$ *Actions*(s_1)
- Path costs
- Start state and goal test
- Solution: Sequence of actions going from start state to goal state

Example: Route Planning



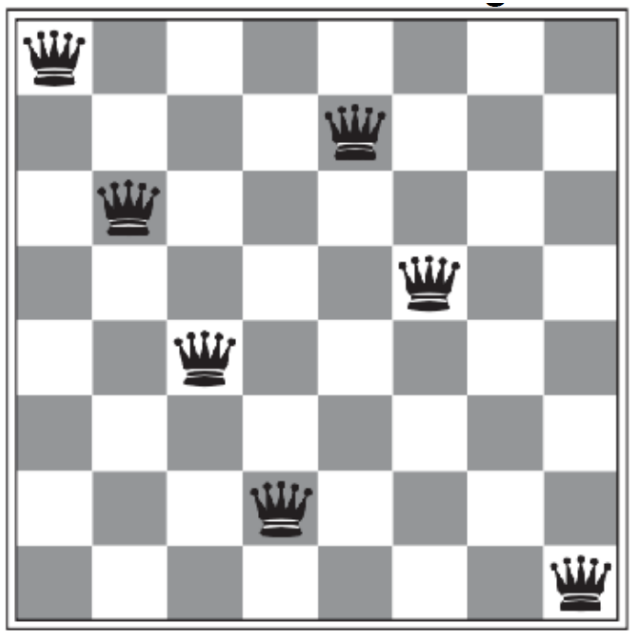
Example: Route Planning

- State space: S = {Vancouver, Seattle, Portland, Calgary, …}
- Action space: *Go* from current city to adjacent city
  - *Actions*(Vancouver) = {*Go*(Seattle), *Go*(Calgary)}
- Transition model: Trivial result of the action
  - *Results*(Vancouver, *Go*(Seattle)) = Seattle
- Start state: s_0 = Vancouver
- Goal test: *In*(New York)
- Solution: {Go(Calgary), Go(Helena),…}

Example: 8-Queen Problem

- Starting out with an empty chess board, we want to place 8 queen pieces such that no piece is in the same row, column, or diagonal as any other piece.

- Initial state
- Goal test
- State space
- Action space
- Transition model



Review

- Agent percepts (sensors) and actions (actuators)
- Agent functions and rational agents
- Properties of environments
- Reflex vs planning agents

Next Time

- Search!
- Trees vs graphs
- DFS, BFS, UCS