Agents and Environments

Lecture 2, CMSC 170

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Previously on CMSC 170

- *Artificial Intelligence*: machines that **act rationally**
- Brief History of AI
- Applications

Today's Topics

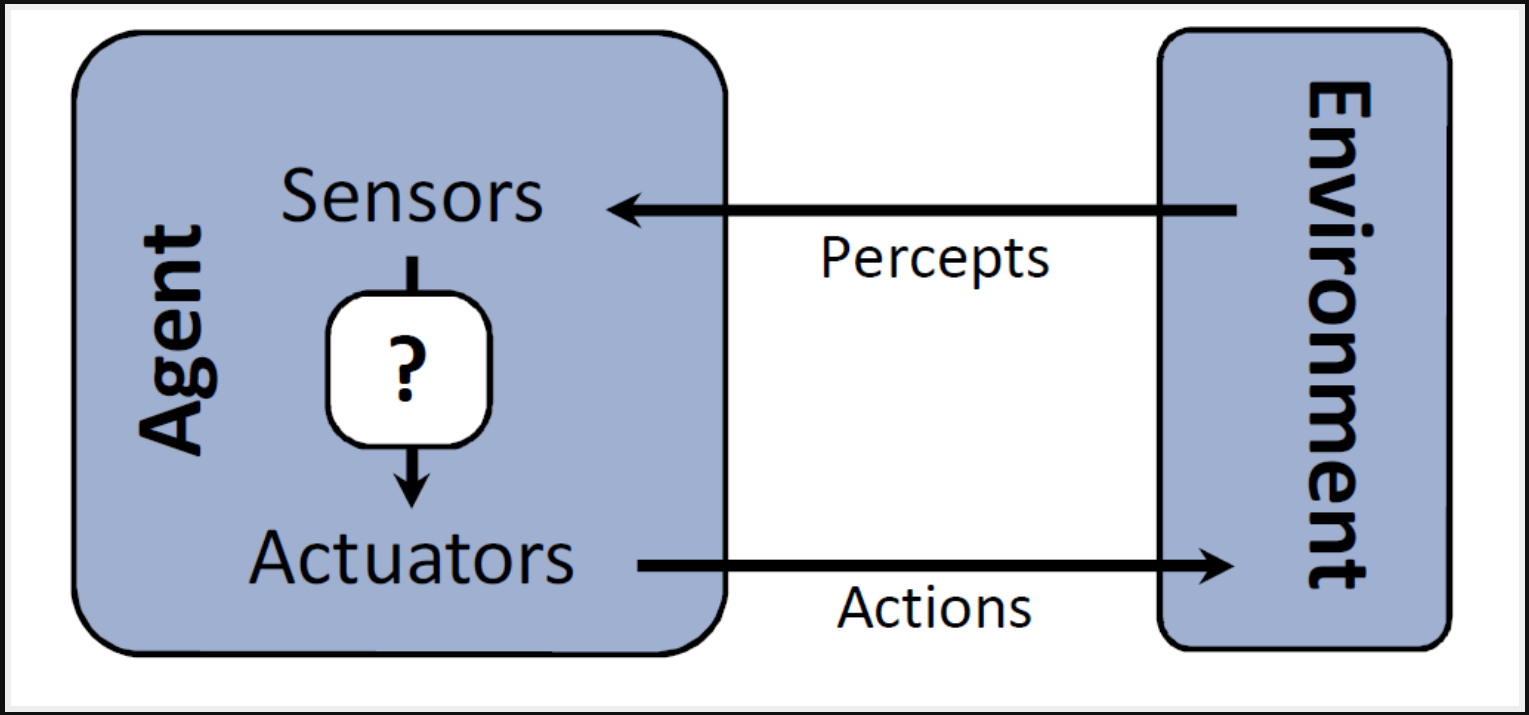
- Rational Agents
- Types of Agents
- Types of Environments

Agent

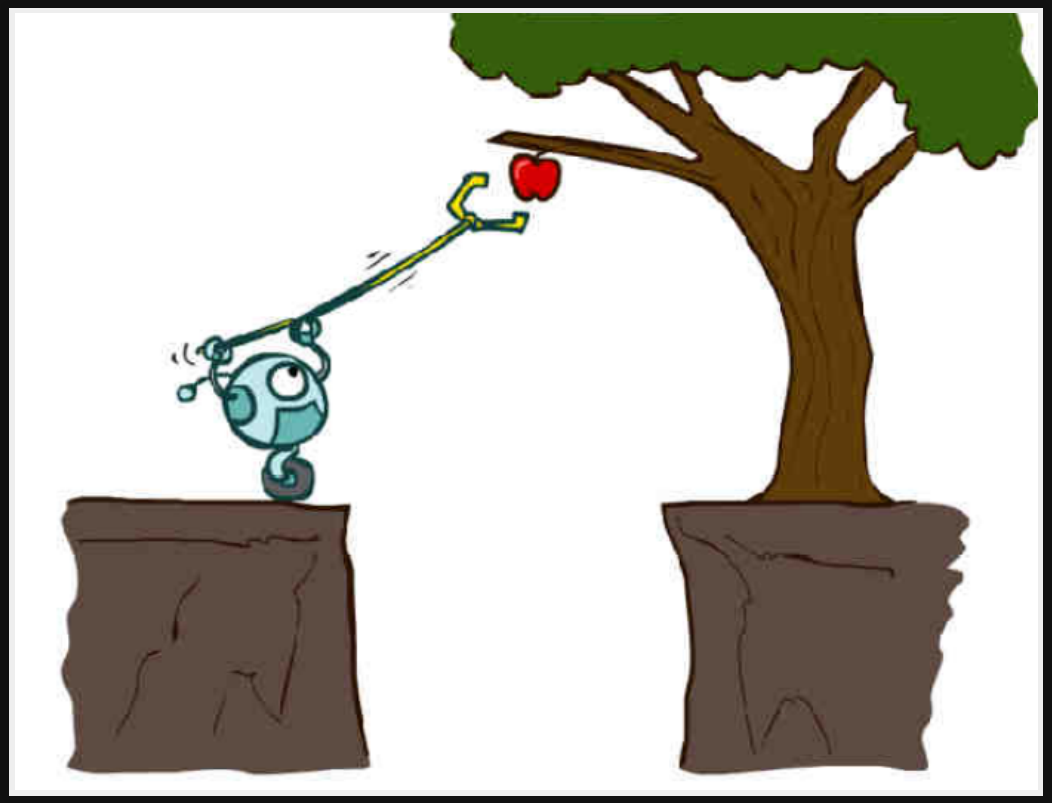
Agents in Sci-Fi

Agent

Entity that **perceives** its *environment* using **sensors**, and **acts** to achieve its **goals**



Agent



Example: Self-Driving Car

- **Percepts**: camera, GPS signal, speedometer
- **Actions**: steer, accelerate, brake
- **Goals**: safe, fast, legal trip
- **Environment**: streets, vehicles, pedestrians, traffic lights/signs

Example: Spam filter

- **Percepts**: emails, user info
- **Actions**: mark as spam, delete
- **Goals**: correctly mark spam messages
- **Environment**: user's email account

Rational Agents

- Machines that **act** *rationally*
- **Rational agent**: selects *actions* that **maximize** its **expected utility**

Maximize Expected Utility

- **Maximize**: optimal / best results
- **Utility**: numerical value for goal
- **Expected**: probability of success; relative to circumstances
- *Example*: taking exam

How to make good decisions?

Brain's keys to **decision-making**:

- Simulation → Planning
- Memory → Learning

Making Good Decisions

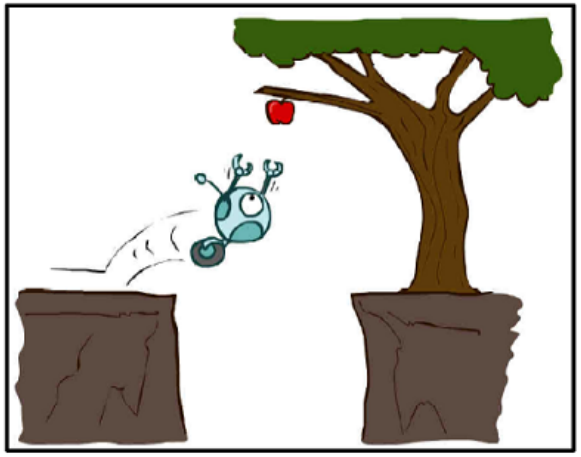
Inference

- **planning** ahead
- aware of consequences of actions

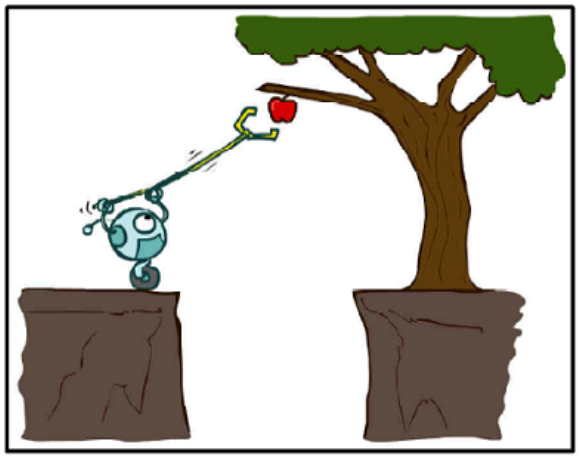
Machine Learning

- **remembering** past experiences

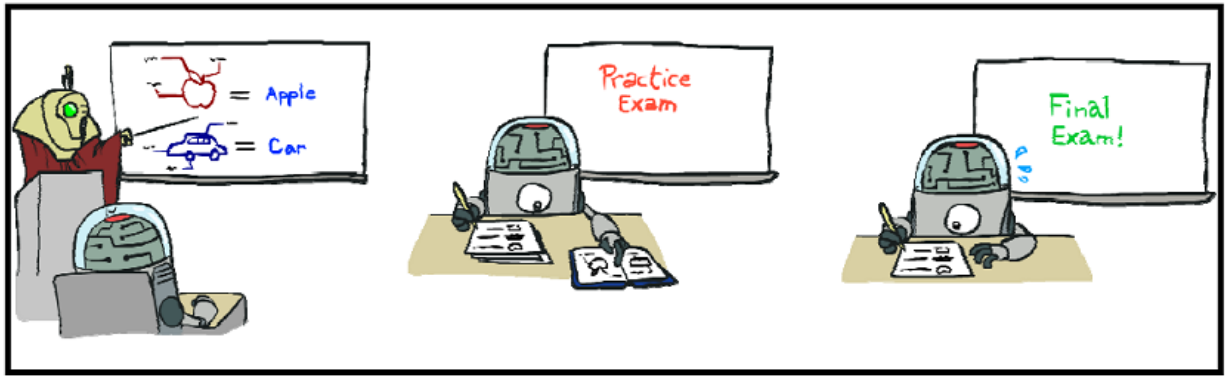
Types of Agents



Reflex Agent

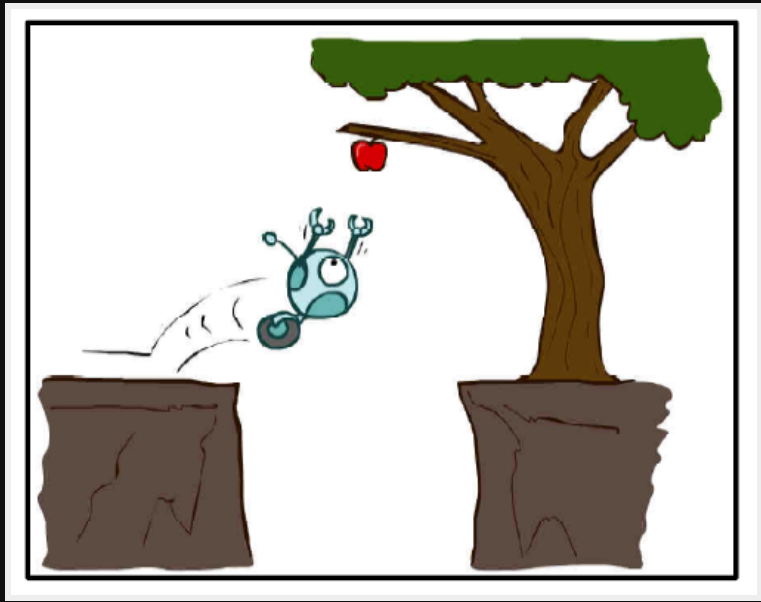


Planning Agent



Learning Agent

Reflex Agent



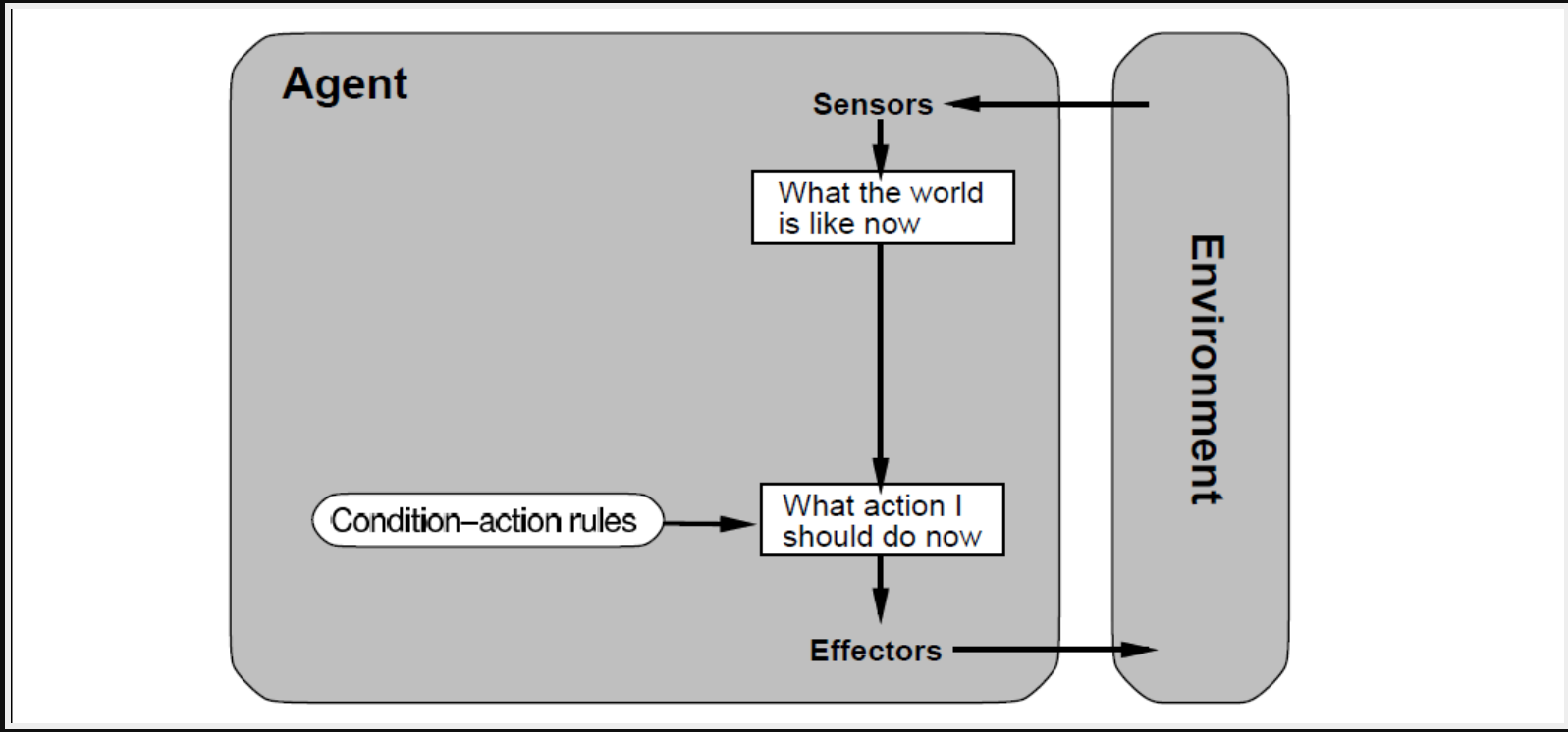
Reflex Agent

- Considers only how the world is **right now**
- Doesn't consider **future consequences** of actions
- *Example*: impulsive buying, partying hard, bringing umbrella

Simple Reflex Agent

- Actions are based only on **immediate percepts**
- Uses **condition-action rules**
- *Example*: if currently raining, then bring umbrella; otherwise, don't

Simple Reflex Agent



Disadvantages

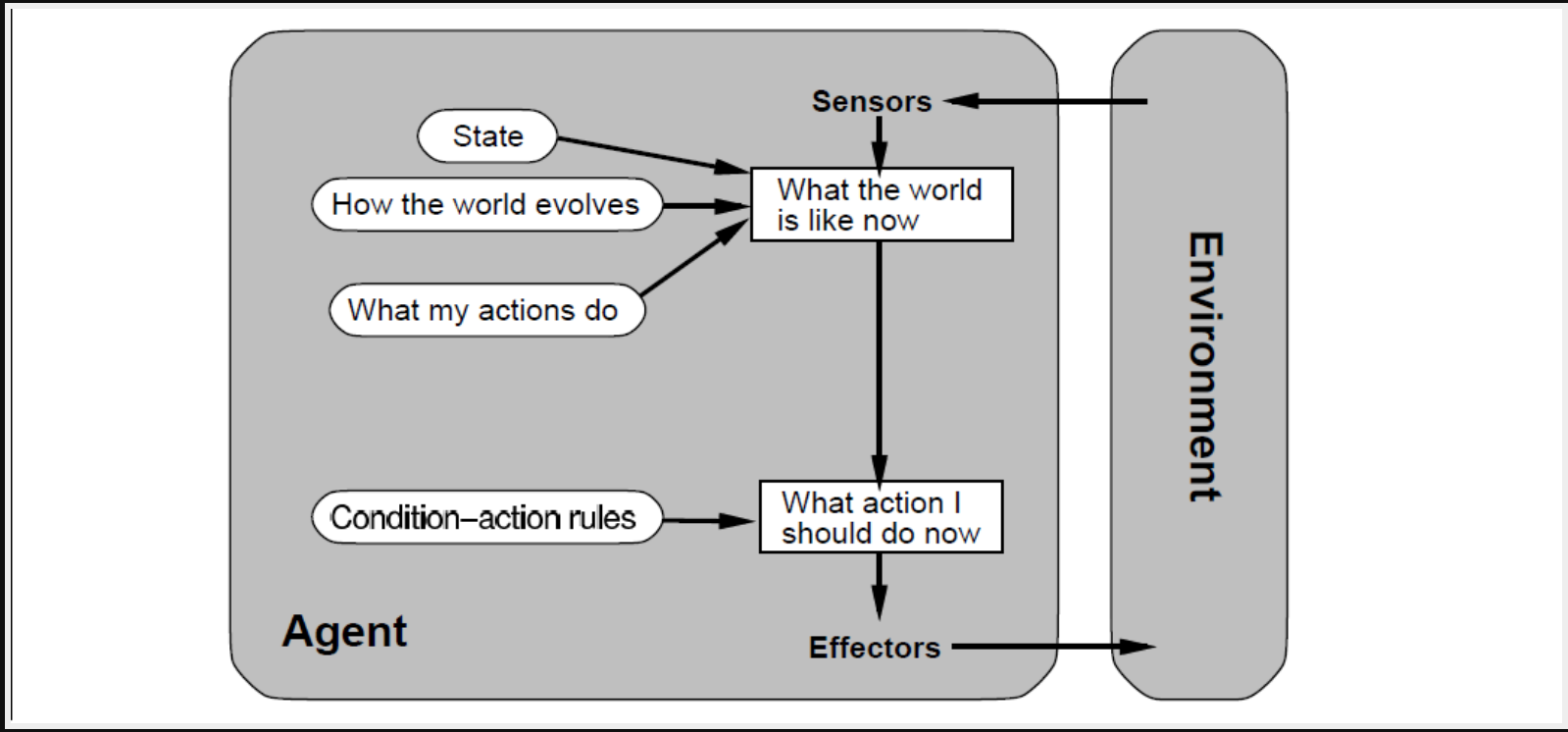
Simple Reflex Agent:

- Fast, but **too simple**
- No memory

Model-Based Reflex Agent

- Action may depend on history or unperceived aspects of the world
- Need to maintain **internal world model** (*memory*)
- *Example*: Not raining now but cloudy → about to rain → bring umbrella

Model-Based Reflex Agent



Reflex vs Rational

Can a reflex agent be rational? **Yes**

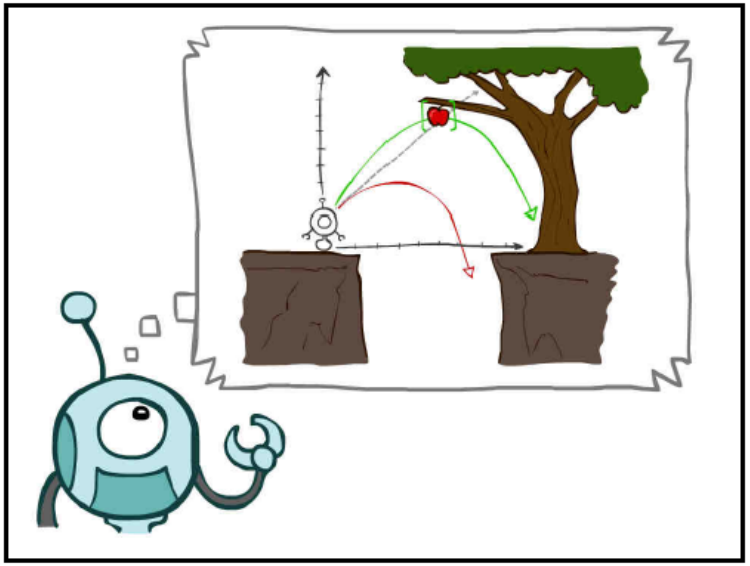
Reflex

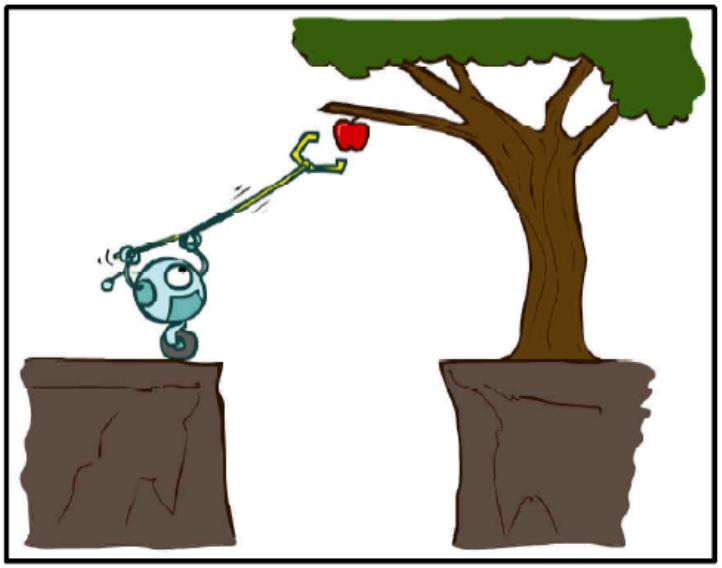
- not considering *future consequences*
- a comment on the **thought process**, not the *actions*

Reflex vs Rational

- *Rationality* is a function of **actions** taken, not *computation*
- Complex condition-action rules / world model could lead to good actions
- *Rational reflex* agent can be very *complex*

Planning Agent





Planning Agent

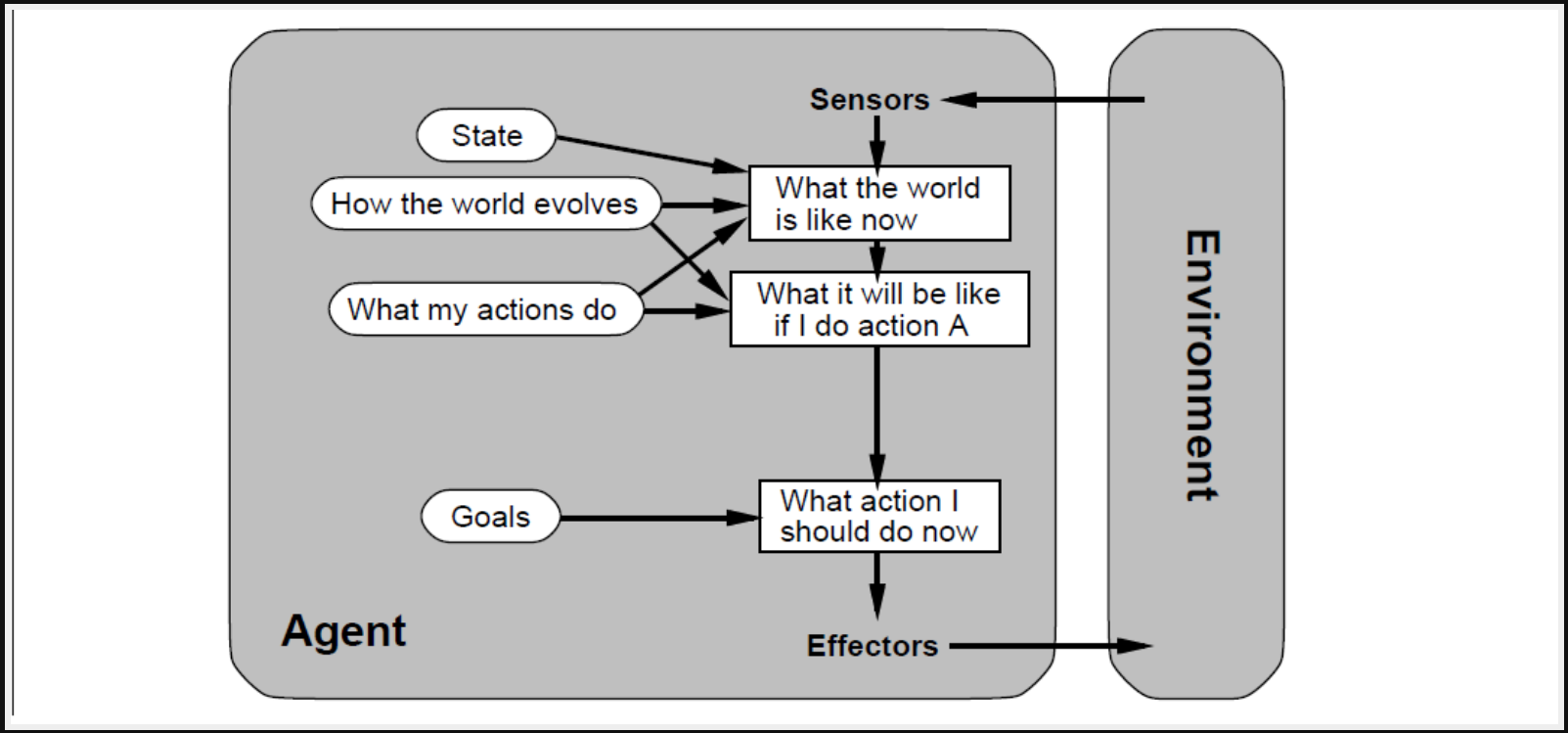
- Asks "what if?"
- Decisions are based on **consequences** of actions
- Finds out consequence **not by doing**, but by **simulation**

Planning Agent

- Has **internal world model** to enable *simulations*
- World model → how world *evolves* in response to *actions*

Goal-Based Planning Agent

Find **a solution** that satisfies the goals



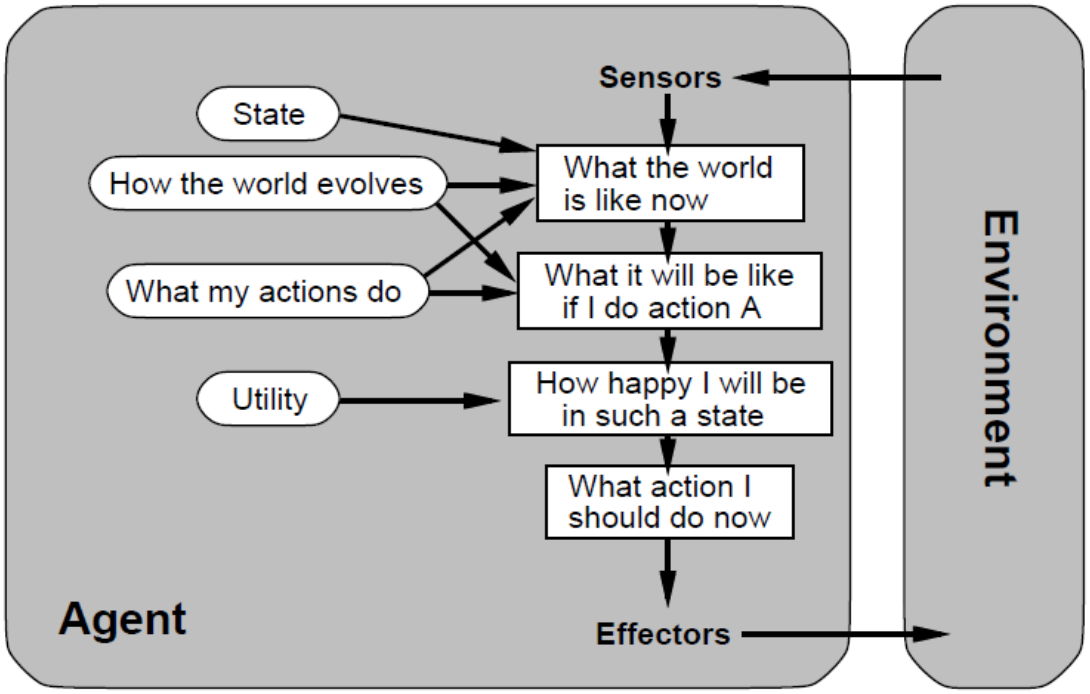
Goals and Solutions

- Some solutions are **better** than others
- If goals are **conflicting**, can't satisfy all

Utility-Based Planning Agent

- Find **best possible solution**
- **Optimize utility** over range of goals
- *Example*: course timetabling, online trading, gambling

Utility-Based Planning Agent



Planning vs Replanning

Planning Agent

- comes up with **entire plan**, executes it

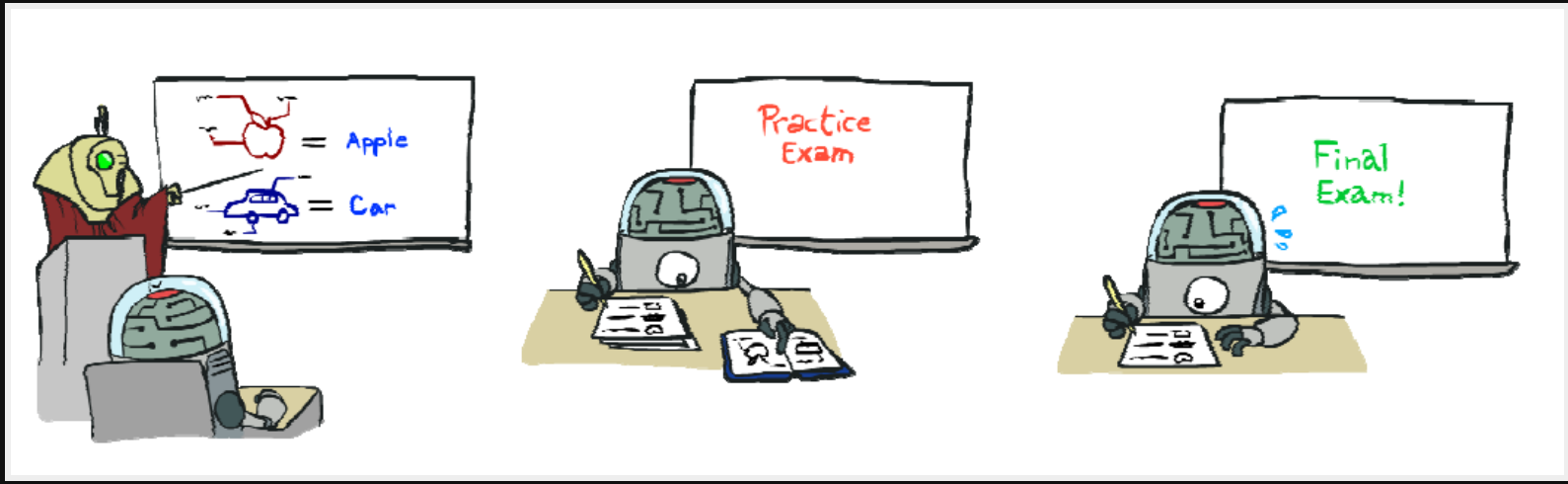
Replanning Agent

- comes up with **many plans**, one after the other

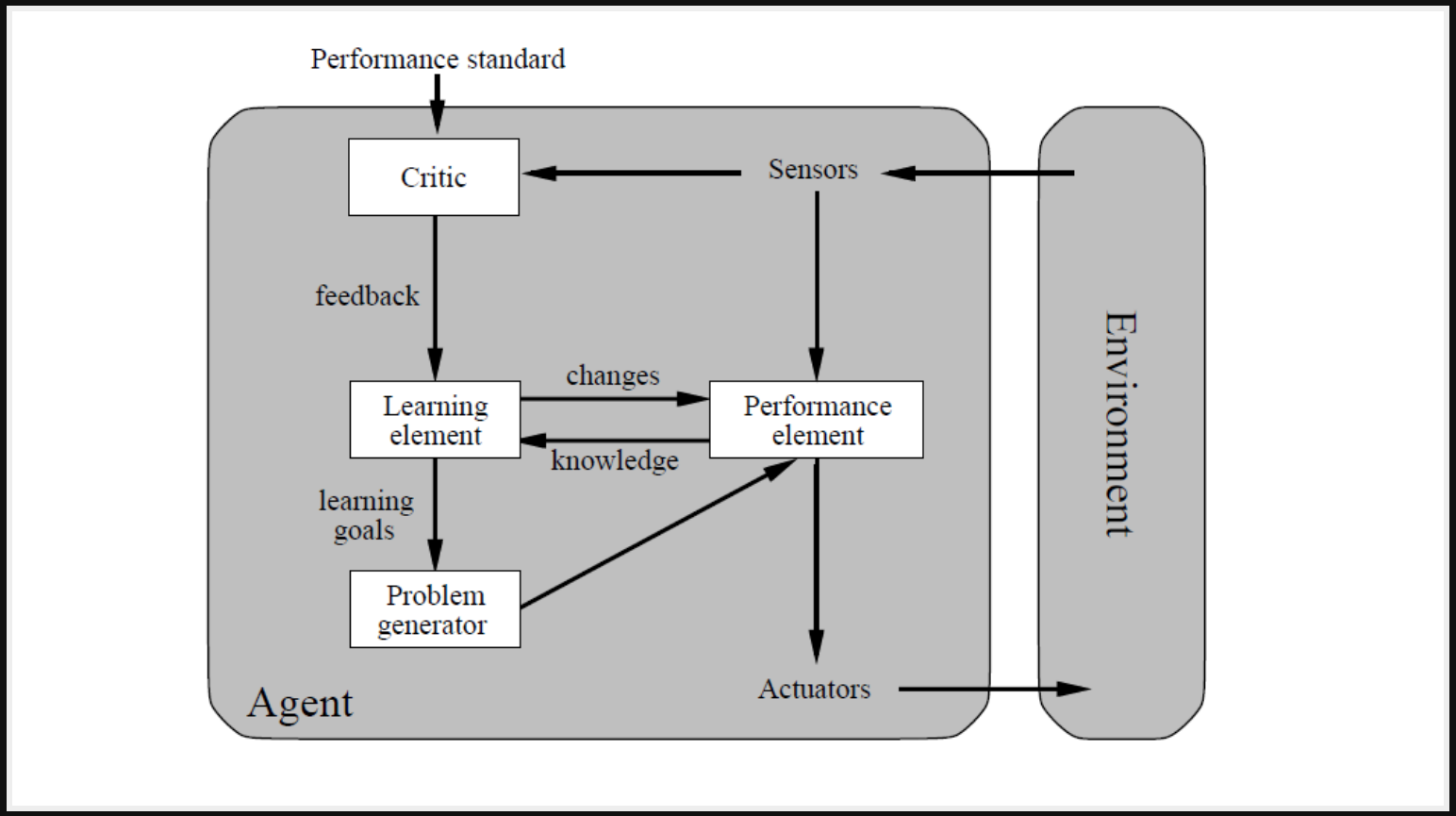
Question

"Are you a reflex agent or a planning agent?"

Learning Agent



Learning Agent



Learning Agent

Offline vs Online

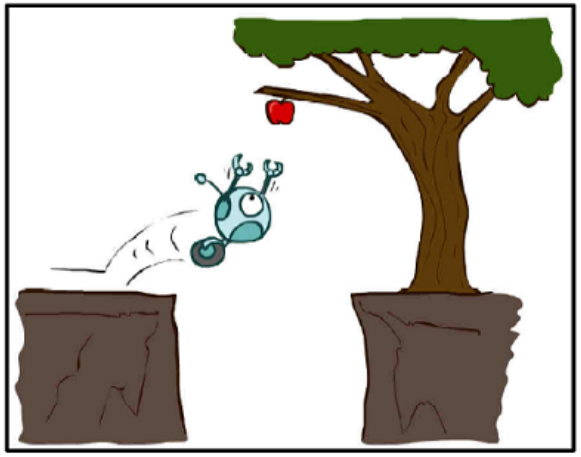
- **Offline**: static dataset
- **Online**: learning as data comes in

Learning Agent

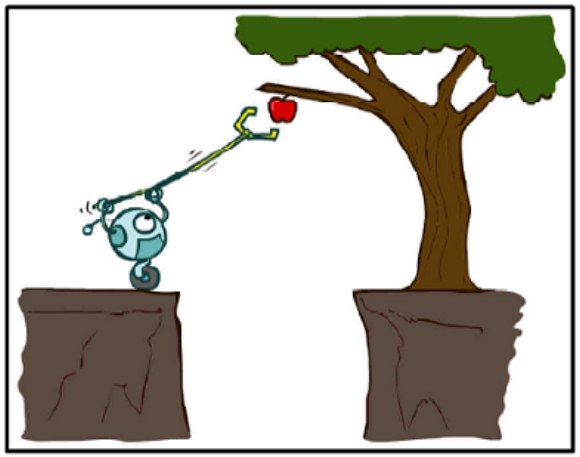
Supervised vs Unsupervised

- **Supervised**: labeled data
- **Unsupervised**: unlabeled data

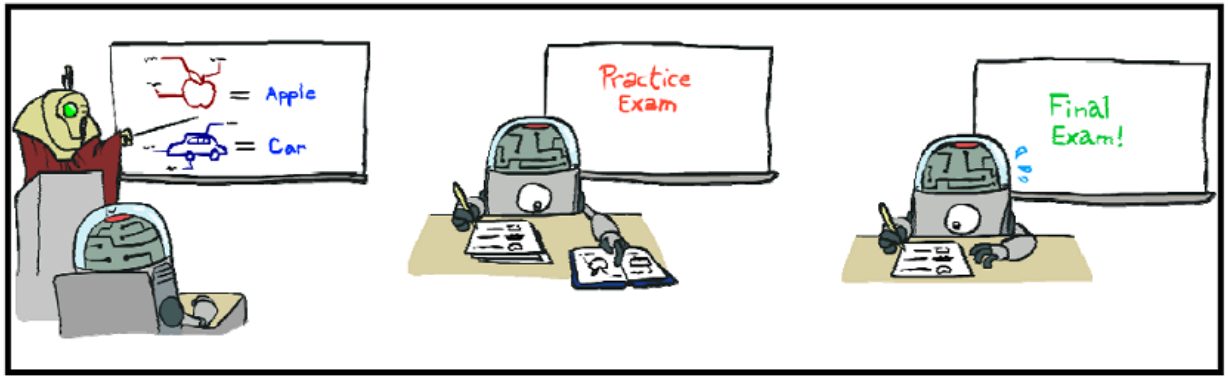
Types of Agents



Reflex Agent



Planning Agent



Learning Agent

Types of Environment

Fully vs Partially Observable

Fully Observable

- agent's sensors describe environment fully

Partially Observable

- some parts of environment **not visible**
- noisy sensors

- *Example*: chess vs taxi driver

Deterministic vs Stochastic

Deterministic

- next state fully determined by current state and agent's actions

Stochastic

- element of **randomness**
- can't be predicted exactly

- *Example*: chess vs snakes & ladders

Discrete vs Continuous

- **Discrete**: percepts and actions are finite
- **Continuous**: variables are floats
- *Example*: chess vs robot car (speed, angle)

Single vs Multi-Agent

- **Multi-agent**: actions / goals / strategies of **other agents** have to be taken into account
- *Example*: crossword vs auction bidding

Benign vs Adversarial

- **Adversarial**: other agents are working **against** you
- *Example*: chess vs group work

Episodic vs Sequential

- **Sequential**: if next action depends on previous action
- *Example*: spam filter vs crossword puzzle

Static vs Dynamic

- **Static**: environment unchanged while agent deliberates / think about next move
- *Example*: crossword vs taxi driver

Summary

- **Rational agent**: maximize expected utility
- Reflex vs Planning Agent
- **Reflex**: Simple vs Model-Based
- **Planning**: Goal-Based vs Utility-Based

Summary

Environment Types:

- Fully vs Partially Observable
- Deterministic vs Stochastic
- Discrete vs Continuous
- Single vs Multi-Agent
- Benign vs Adversarial
- Sequential vs Episodic
- Static vs Dynamic

CMSC 170

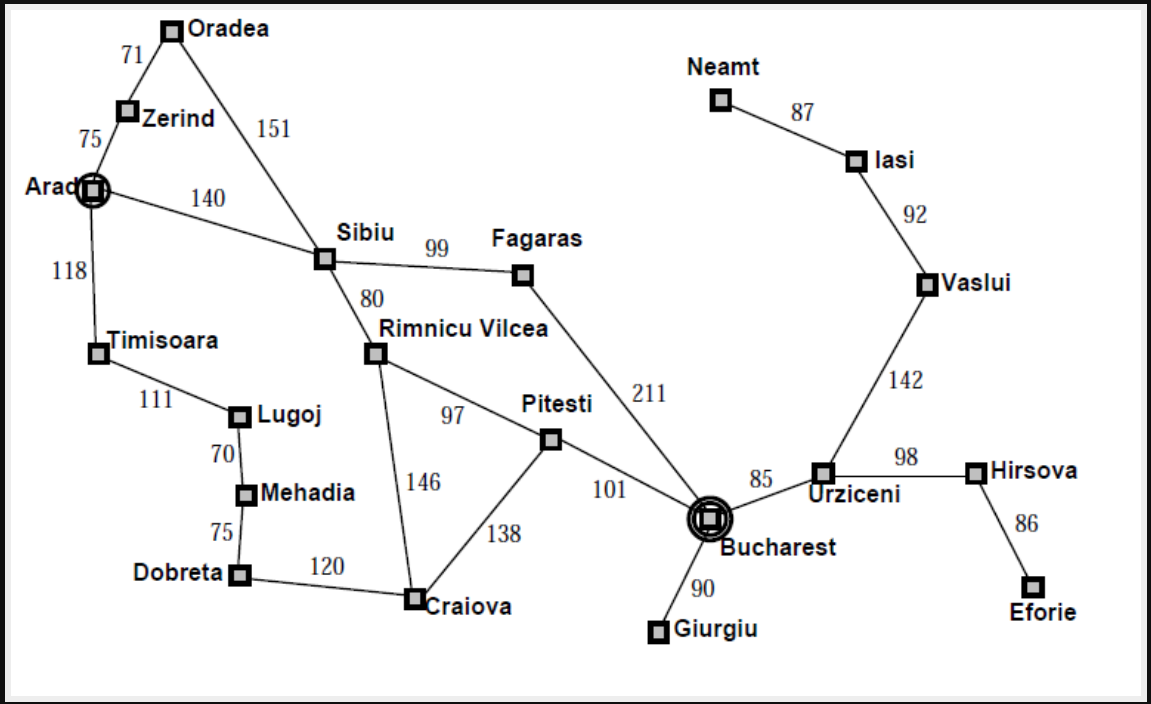
Intro	TITLE	SESSIONS	
1	Introduction to AI	1	
2	Agents and Environments	1	
3	Search	1	Planning Agents
4	Informed Search	1	
5	Constraint Satisfaction Problems	2	Goal-Based Planning Agents
6	Local Search	1	Utility-Based Planning Agents
7	Population-Based Search	1	
8	Machine Learning	1	Learning Agents
9	Classifiers	2	
10	Neural Networks	1	
11	Clustering	1	
12	Adversarial Search	1.5	Adversarial Environment
13	Search in Uncertainty	1.5	Stochastic Environment
BONUS	Reinforcement Learning	0	
MP			
1	Pacman Search	15%	
2	CSP and Optimization	20%	
3	Machine Learning	20%	
4	Multi-agent Pacman	15%	

Next Meeting

- Search Problems
- Uninformed Search
- Depth-First Search
- Breadth-First Search
- Uniform-Cost Search

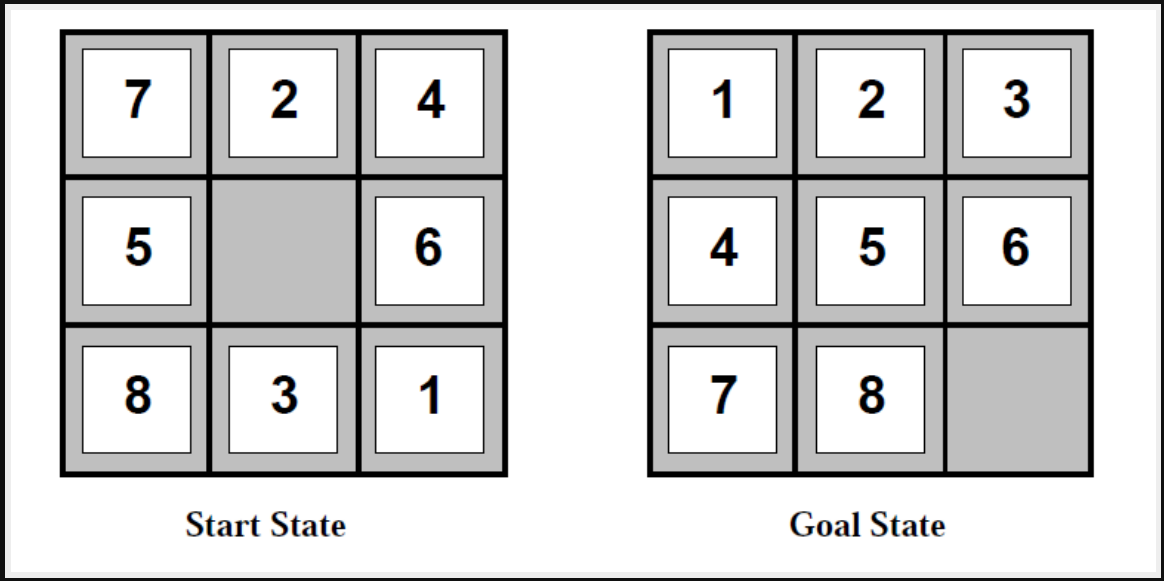
Planning and Search

Route Finding



Planning and Search

8-Puzzle



Quiz: By Pair

1. 10 pts - Agents & PAGE
2. 30 pts - Environment Types

Quiz Solution

	Solitaire	Poker	Checkers	Self-Driving Car	Digit Recognizer
Fully observable?	No	No	Yes	No	Yes
Deterministic?	Yes	No	Yes	No	Yes
Discrete?	Yes	Yes	Yes	No	Yes
Single agent?	Yes	No	No	No	Yes
Sequential?	Yes	Yes	Yes	Yes	No
Static?	Yes	Yes	Yes	No	Yes

References

- *Artificial Intelligence: A Modern Approach, 3rd Edition*, S. Russell and P. Norvig, 2010
- CS 188 Lec 2 slides, Dan Klein, UC Berkeley

Questions?