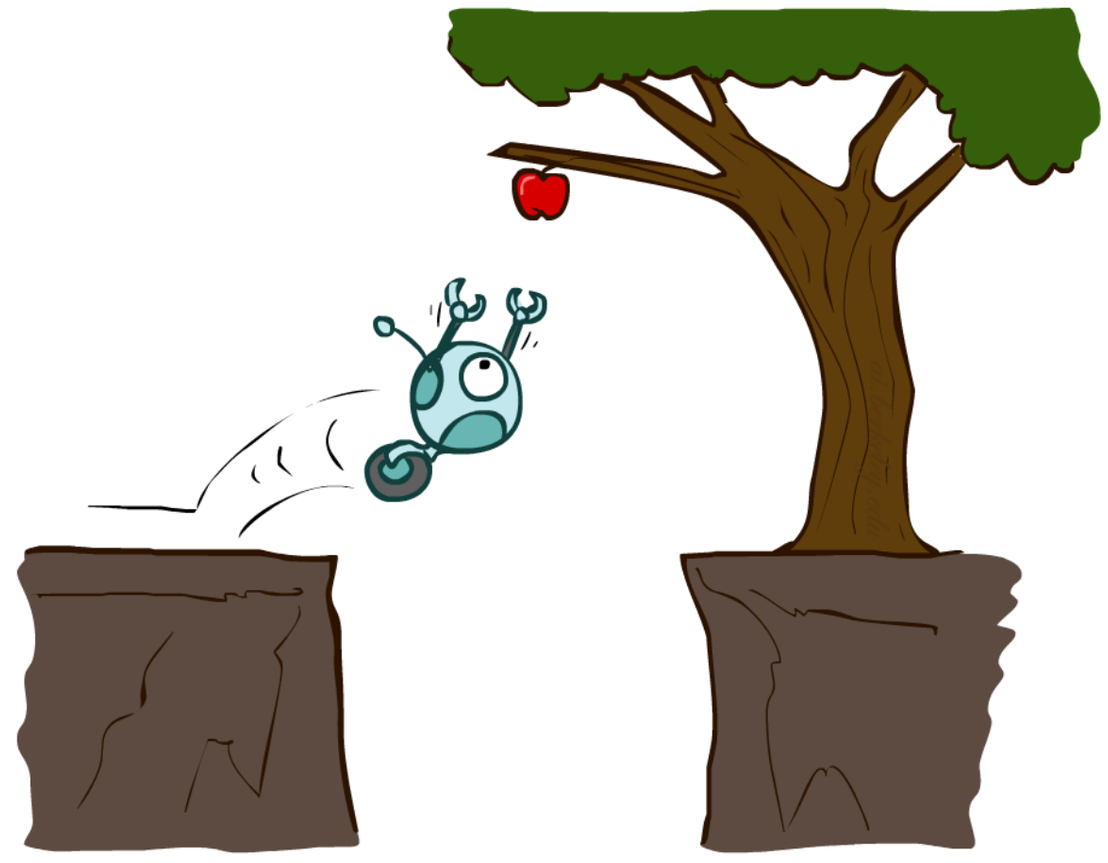
Announcements

- Please log on Canvas before class
- Project 0: Python Tutorial
  - Due next Monday
  - Don't wait for last moment!
- HW 1 will also be released on next Monday
- Project 1 will also be released on next Wednesday
- Survey for deciding OHs and Recitation times
  - Respond by the end of the week
  - OH and Recitation start next week
- Survey for flipped classroom

Ve492: Introduction to Artificial Intelligence

Agents and Environments



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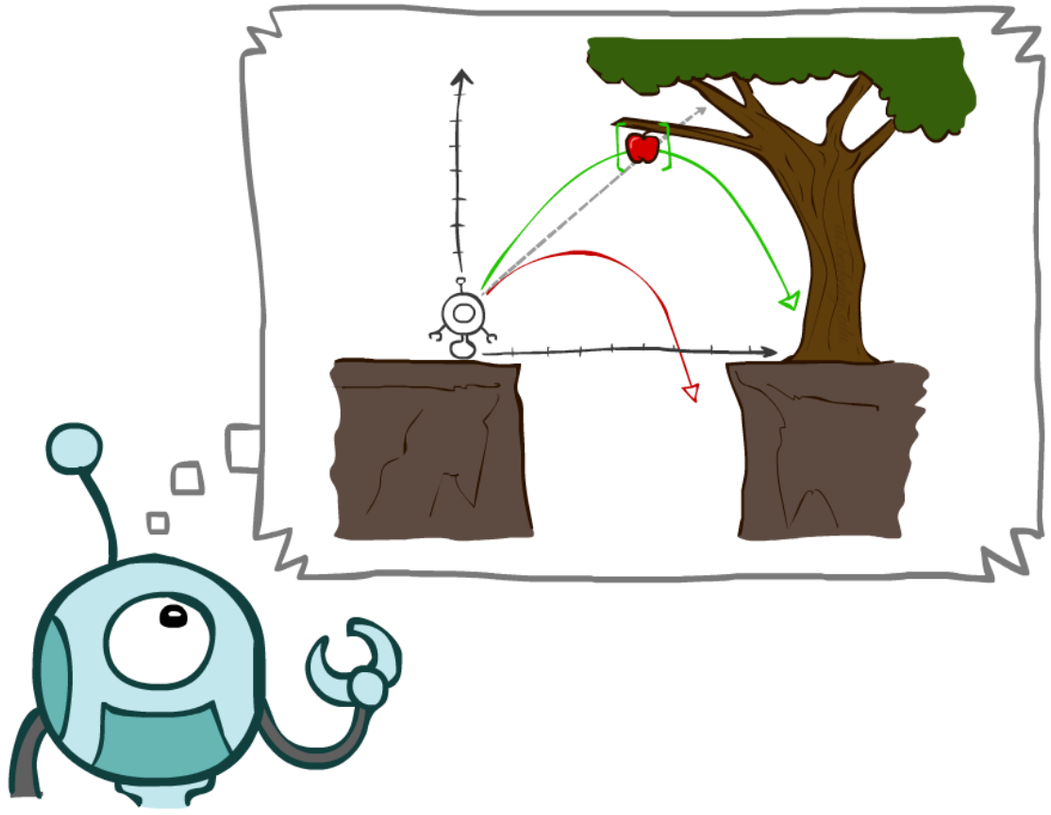
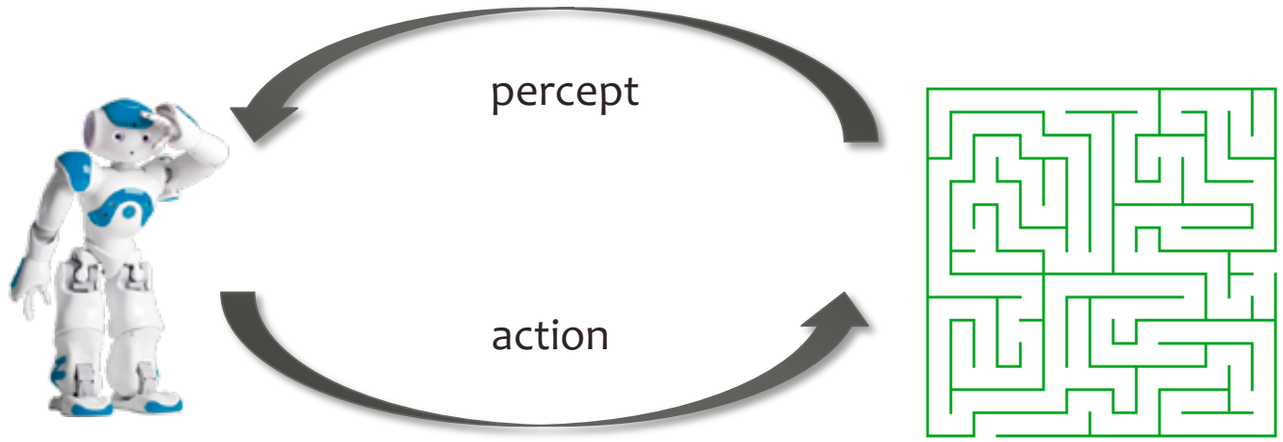
Slides adapted from http://ai.berkeley.edu, AIMA

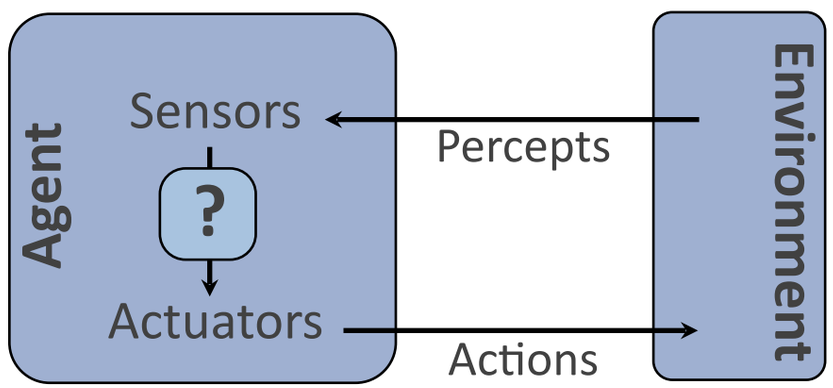
Outline

- Agents and Environments
- PEAS (Performance measure, environment, actuators, sensors)
- Environment types
- Agent types
- Complexity

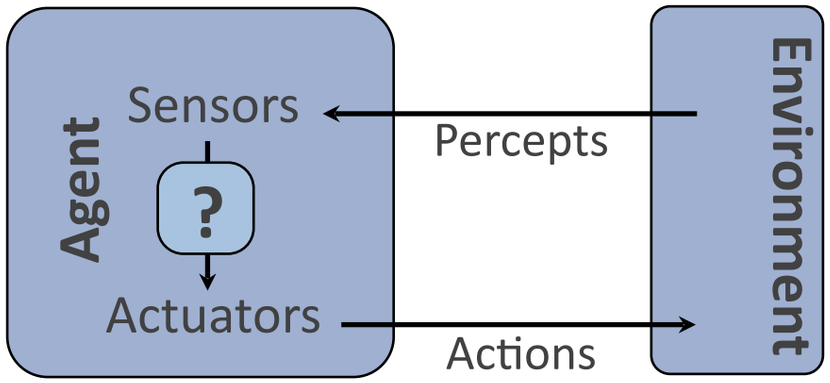


Agents and Environments





What is an Agent?

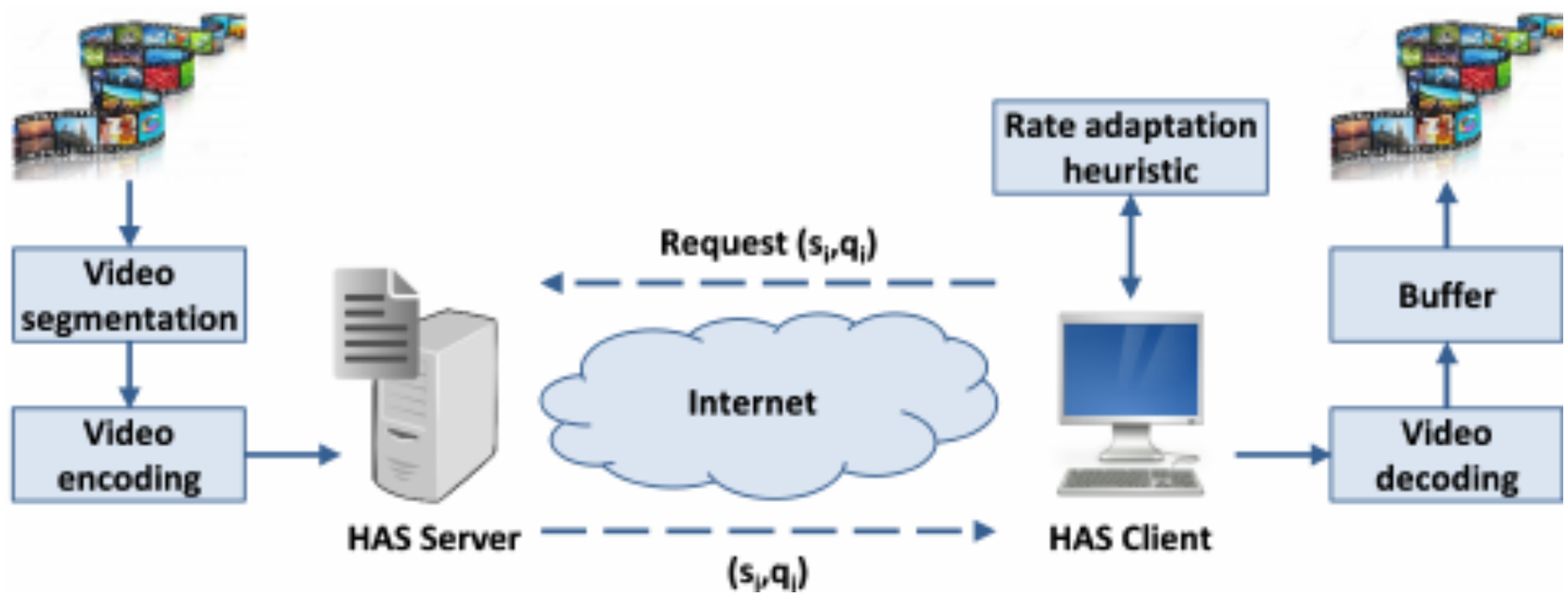


- Agents: humans, robots, software, cars…
- Mathematical view:
  - Function from percept or percept sequence to action
- CS view:
  - Program that takes a percept as an input and returns an action

Example: Vacuum Cleaner

- What are the percepts?
  - Readings from sensors
    - Location
    - Dirt detection
    - Obstacle detection
- What are the actions?
  - Move, brush, vacuum

Example: Adaptive Video Player



Huysegems et al. 2015

- What are the percepts?
  - Network conditions
- What are the actions
  - Request of the most suited quality version of the next video chunks

Example: Autonomous Trader

- What are the percepts?
  - Financial prices
  - Economic data
  - News
- What are the actions?
  - Buy/sell/hold stocks

Recommender Systems

- What are the percepts?
  - User's search query
  - User's previous interactions (clicks, page views, purchases…)
  - User's information
- What are the actions?
  - Product lists

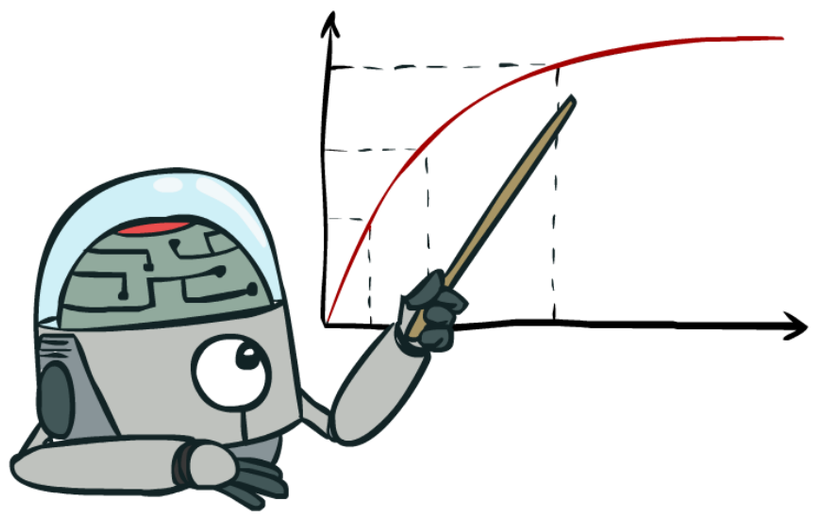
How to Select Actions?

- What is the right function from intercepts to actions?
  - Performance measure for environment sequence
    - 1pt per m^2 cleaned in time T
    - 1pt per m^2 cleaned / time step
    - -1pt per dirty m^2

- Can it be implemented as a small / efficient program?

Rationality

- Being rational = maximizing "expected utility"
- What is rational depends on:
  - Agent's prior knowledge of environment
  - Current percept sequence
  - Actions available to agent
  - Performance measure



Rational Agents

- Are rational agents omniscient?
  - No - they are limited by the available percepts and limited prior knowledge
- Are rational agents clairvoyant?
  - No - they may lack knowledge of the environment dynamics
- Do rational agents explore and learn?
  - Yes - in unknown environments these are essential
- So rational agents are not necessarily successful, but they are autonomous

PEAS

- To design a rational agent, we must specify the task environment
- Consider, e.g., the task of designing an automated taxi:
- Performance measure
  - Safety, destination, profits, legality, comfort, …
- Environment
  - Streets/highway, traffic, pedestrians, weather…
- Actuators
  - Steering, brake, accelerate, display/speaker…
- Sensors
  - Camera, radar, accelerometer, engine sensors, microphone…

Image: http://nypost.com/2014/06/21/how-google-might-put-taxi-drivers-out-of-business/

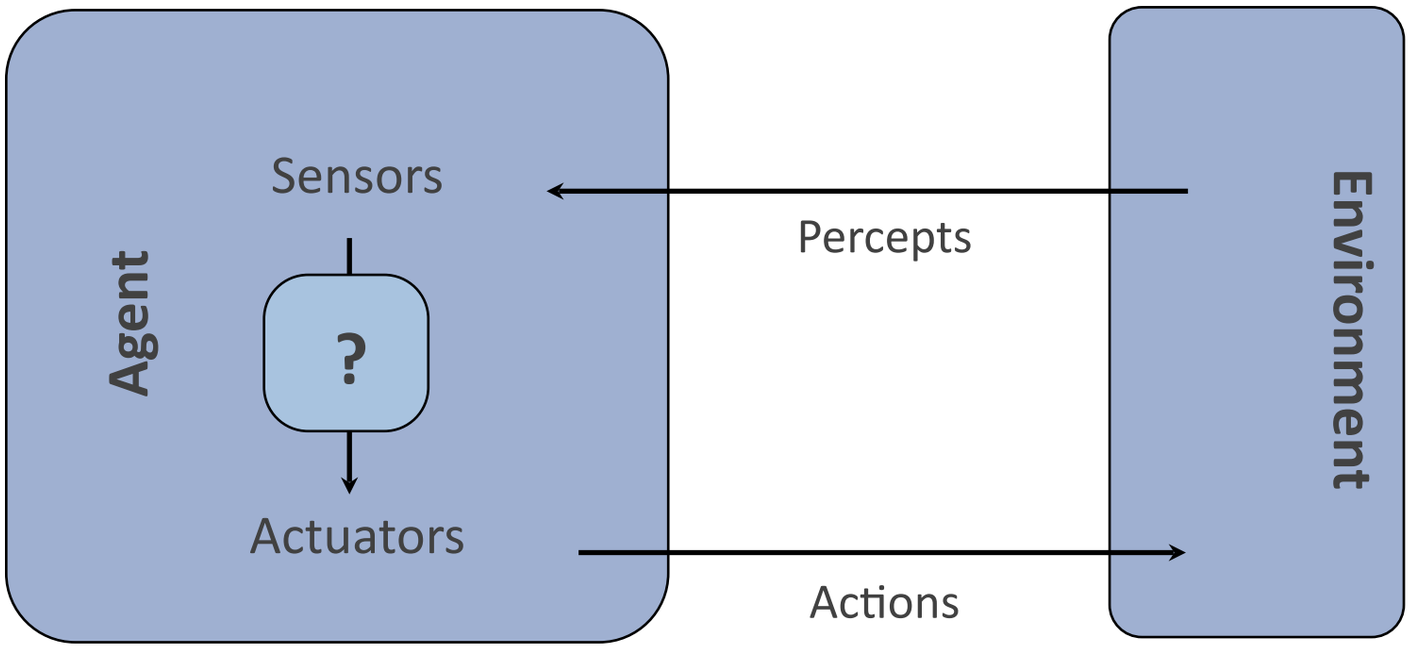
PEAS for Recommender System

- Performance measure
  - CTR (Click-Through-Rate), profits, happy customer…
- Environment
  - Users, products
- Actuators
  - Product lists
- Sensors
  - Database accesses, APIs

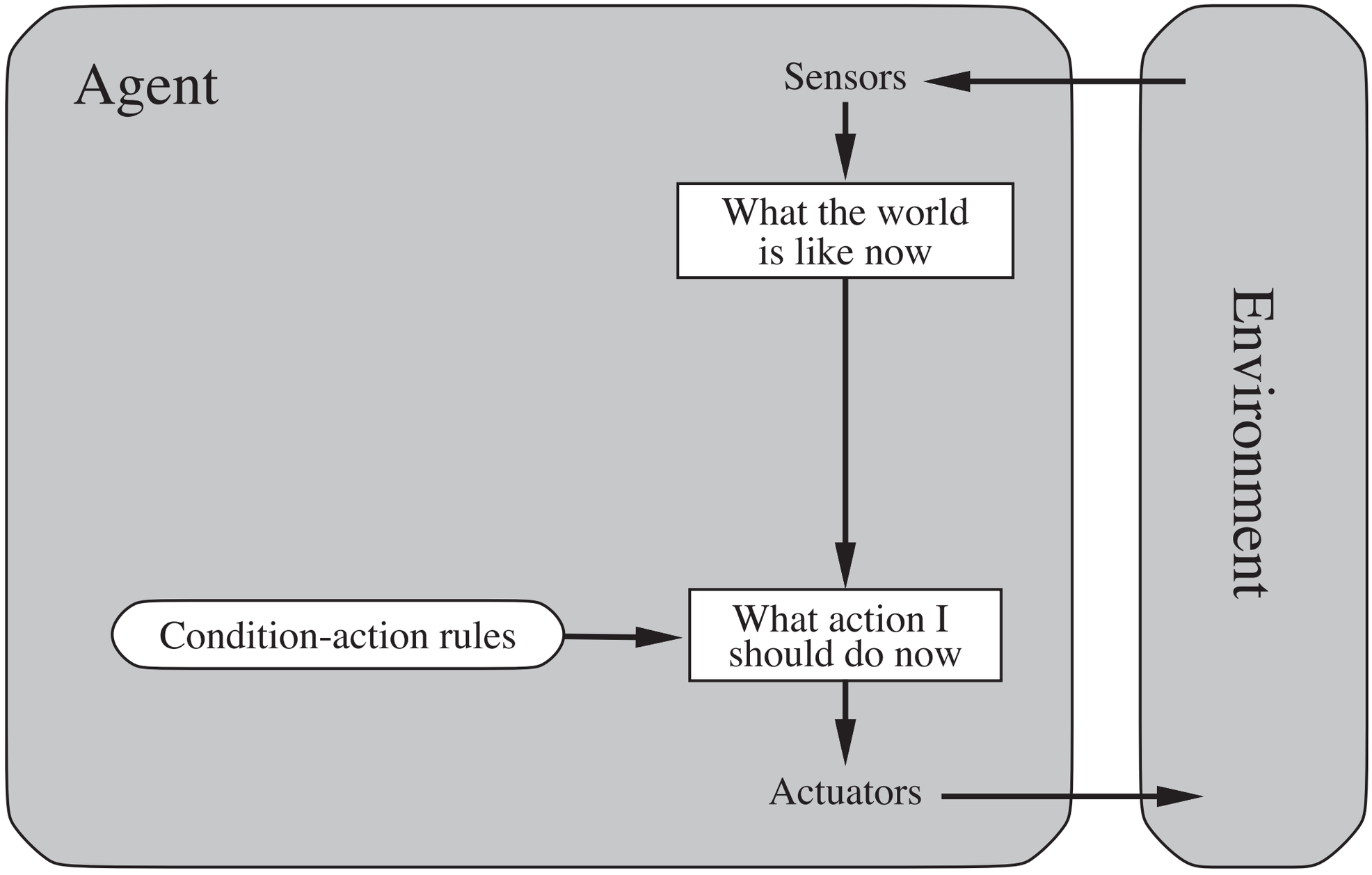
Environment Types

	Mahjong solitaire	Mahjong	Recommender system	Taxi	Real world
Fully or partially observable					
Single agent or multi-agent					
Deterministic or stochastic					
Static or dynamic					
Discrete or continuous					
Episodic or sequential					

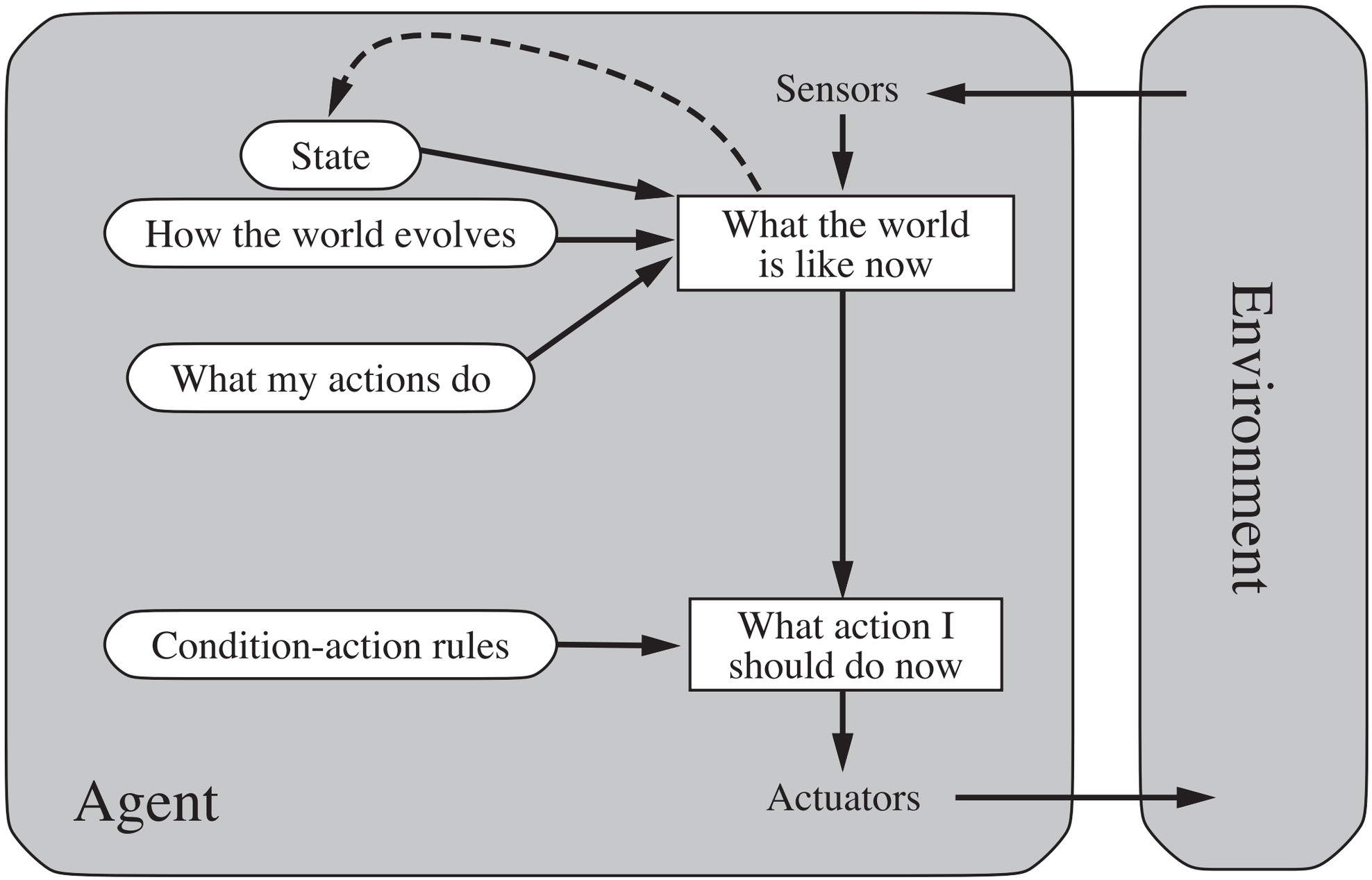
Different Types of Agents



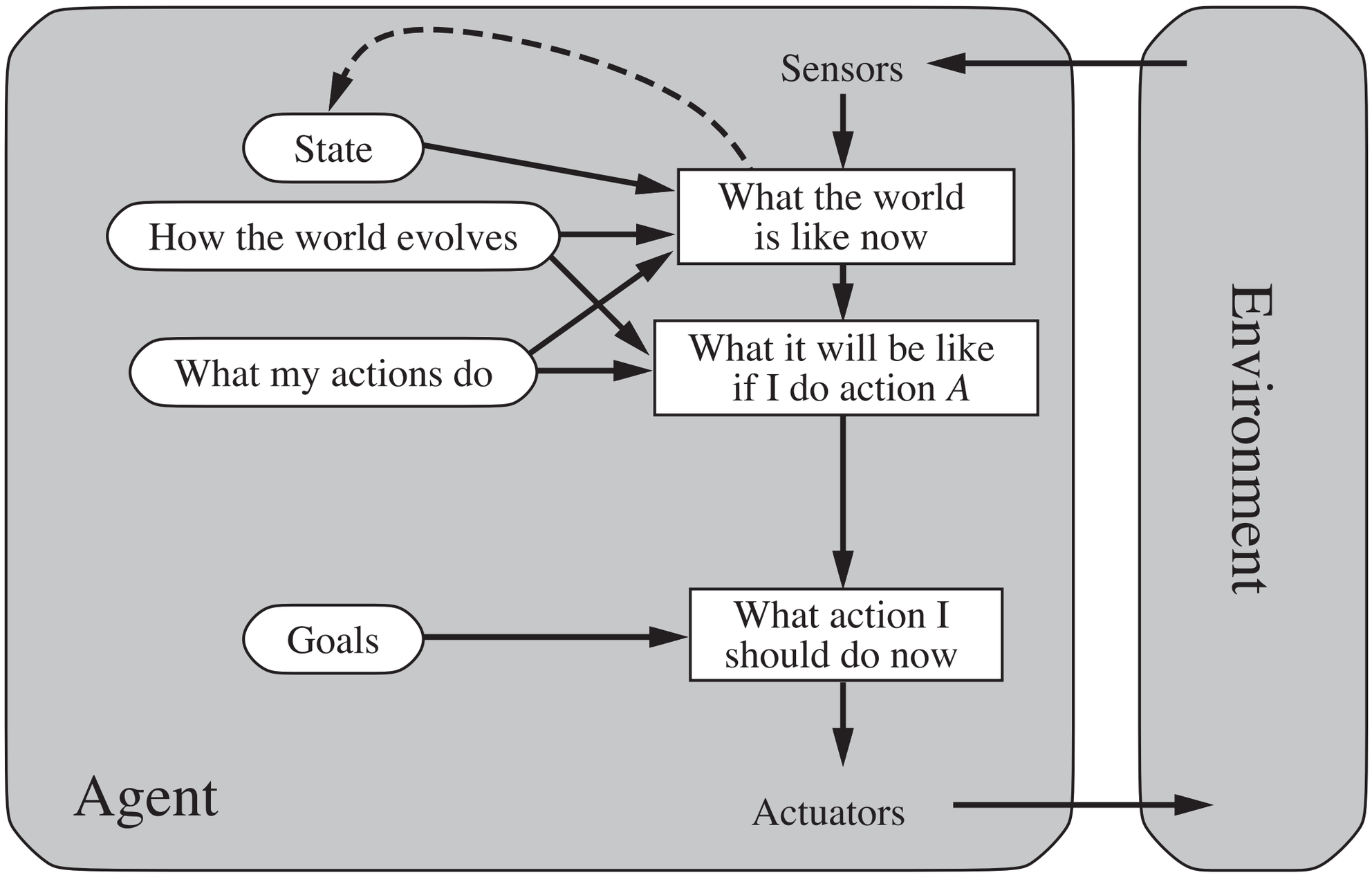
Simple Reflex Agents



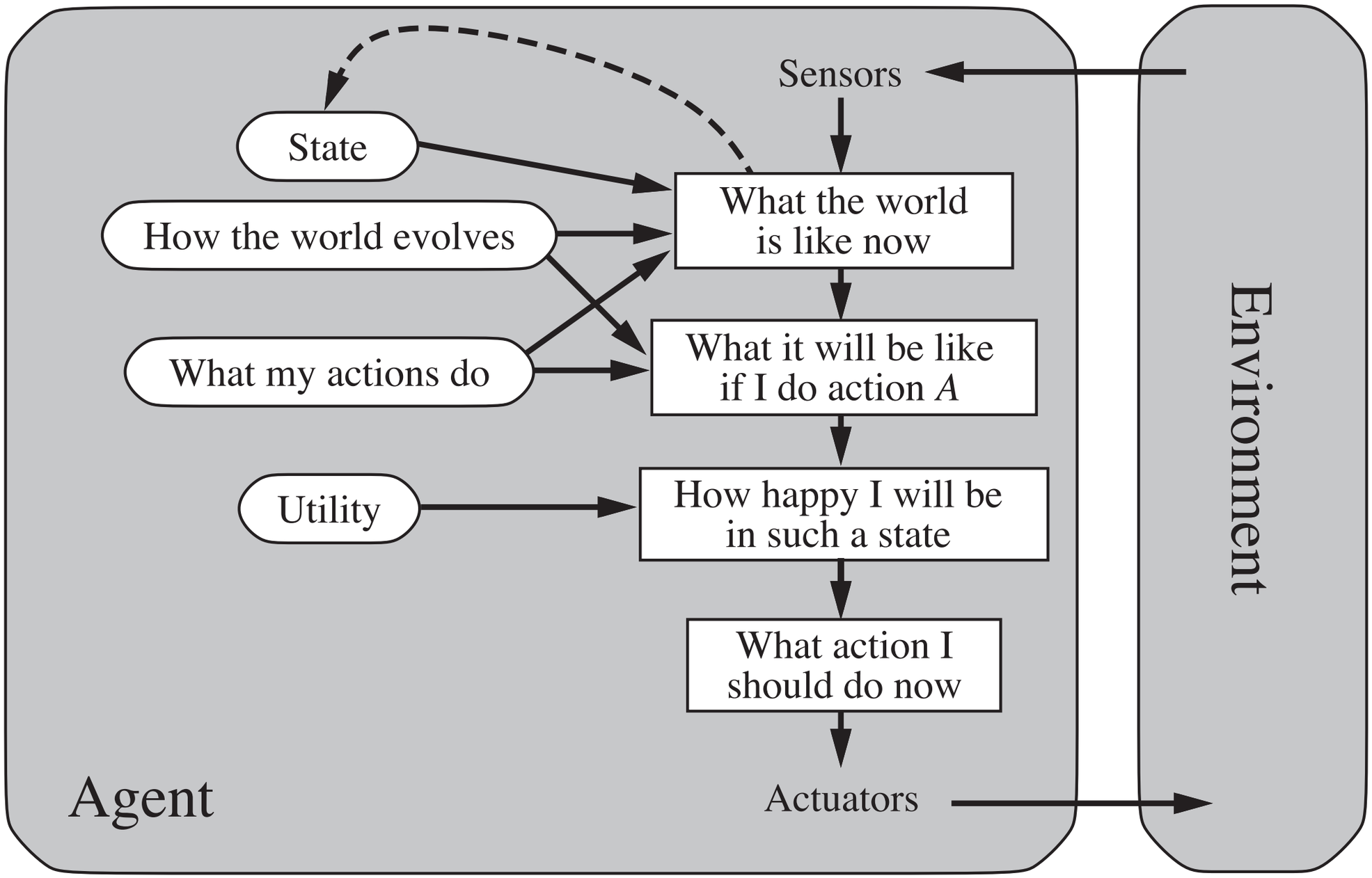
Model-based Reflex Agents



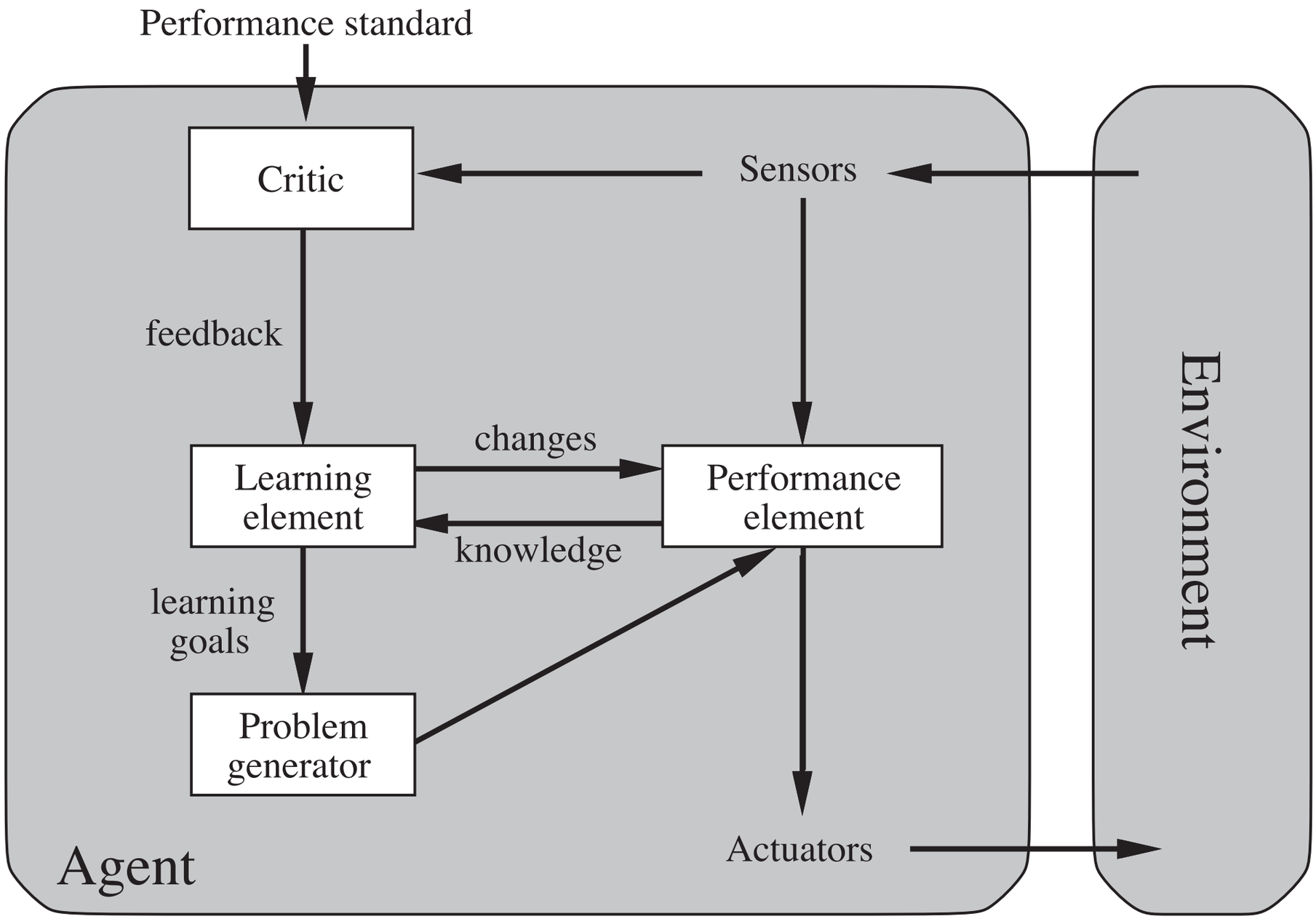
Goal-based Agents



Utility-based Agents

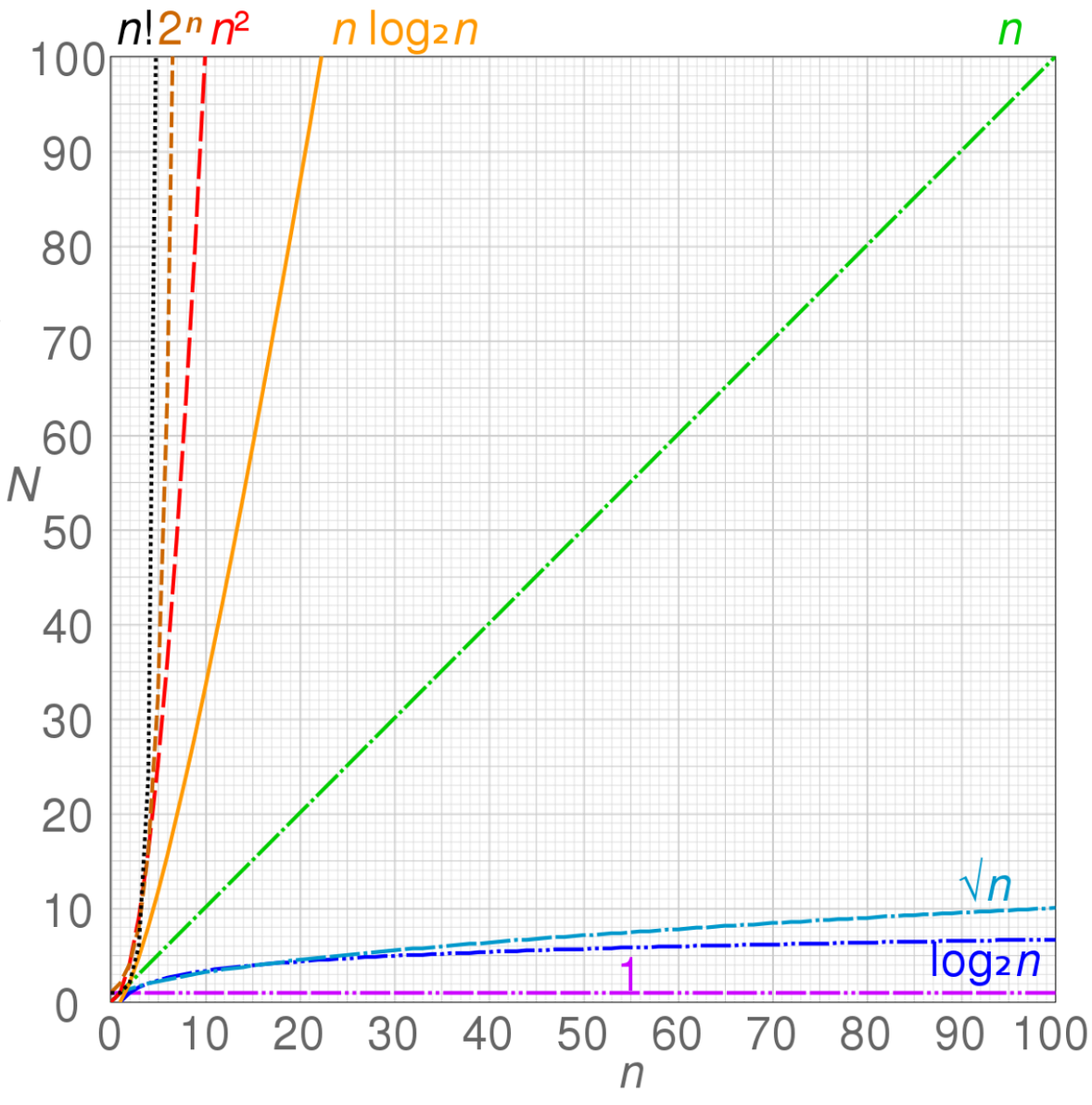


Learning Agents



Overview of Complexity Theory

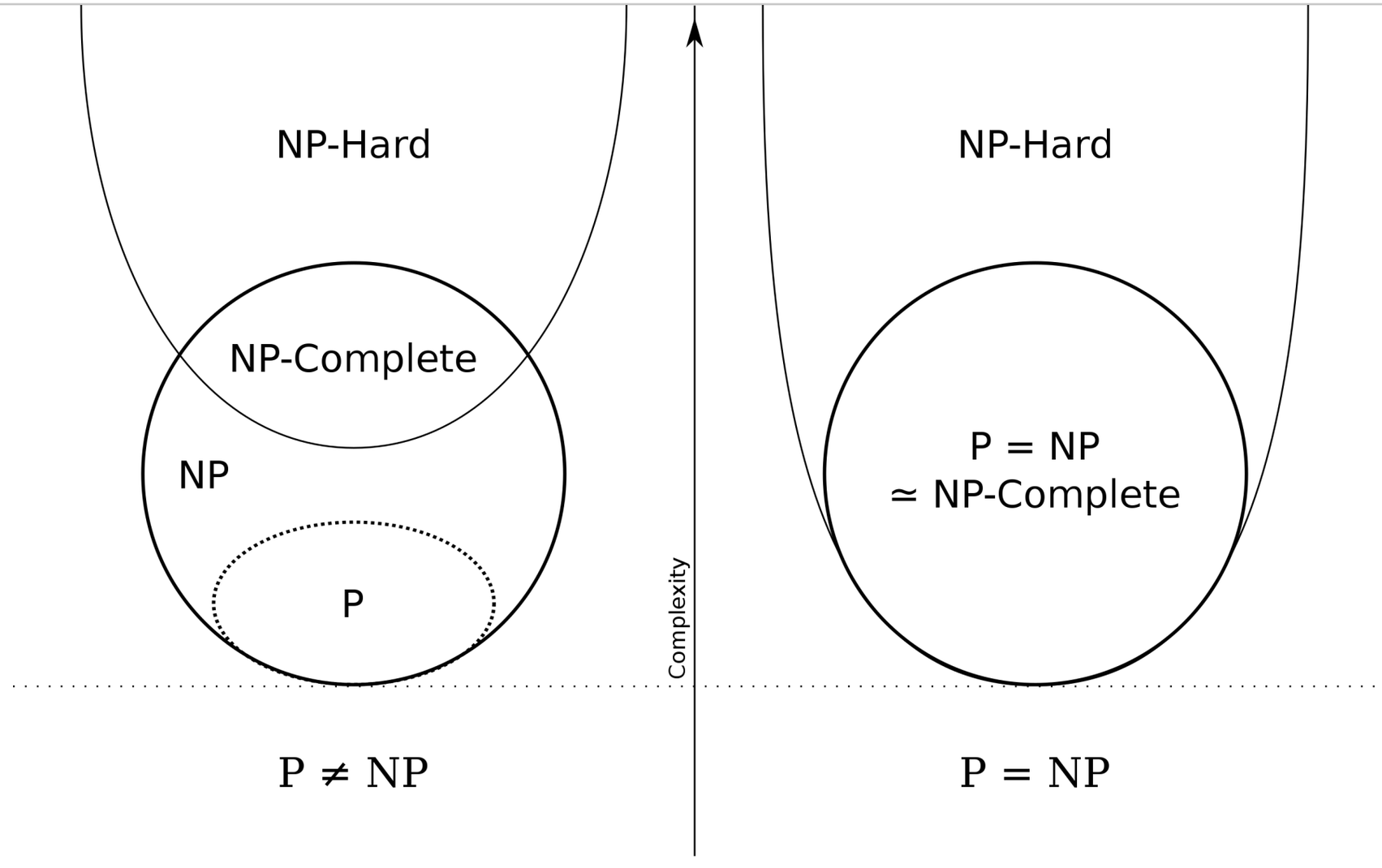
- Measure of difficulty wrt size of problem instance
- Problem vs algorithm complexity
- Space vs computational vs sample complexity
  - $O(1) \subset O(\log(n)) \subset O(\sqrt{n}) \subset O(n)$
  - $O(n\log(n)) \subset O(n^{1+\alpha}) \subset O(2^n) \subset O(n!)$
  - 2^{100} on machine 1e9 op/sec requires 4e13 years



Important Complexity Classes

- Class = set of problems; Problem = set of instance of problem
- P: problems that can be solved in polynomial time $O(n^k)$
  - Shortest path problem, linear programming, matching
- NP: problems where if solutions can be verified in polynomial time
  - Traveling salesman problem, Boolean satisfiability problem

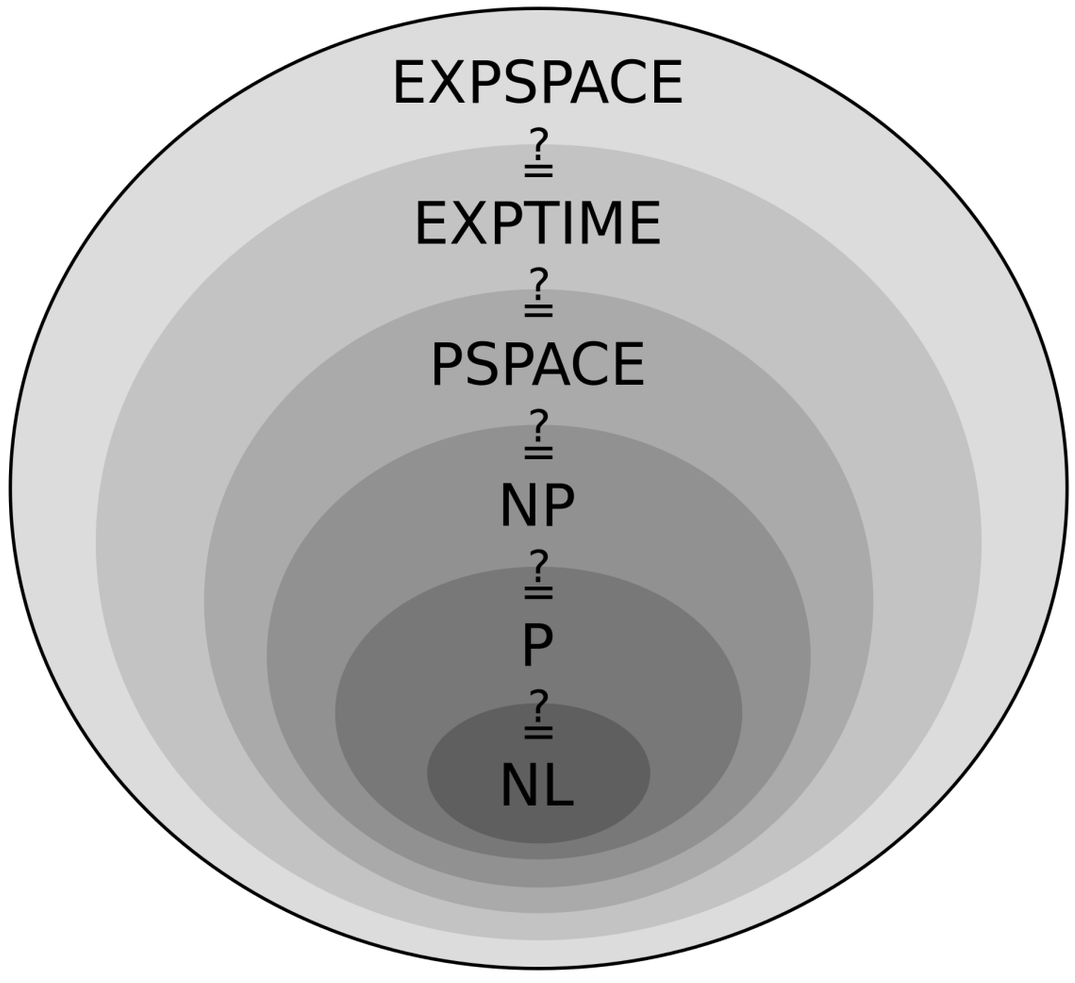
Million Dollar Question: P=NP?



- NP-hard = as hard as NP
- NP-complete = hardest problems in NP

Some Other Complexity Classes

- PSPACE: problems that can be solved using polynomial amount of space
- EXPTIME: problems that can be solved in exponential time $O(2^{p(n)})$



For More Information

- AIMA, Chapter 2 for Intelligent Agents
- AIMA, Chapter A.1 for Complexity