CSE 604
Artificial Intelligence

Chapter 2: Intelligent Agents

Adapted from slides available in Russell & Norvig's textbook webpage

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Outline

- Agents and environments

- Rationality

- PEAS (Performance measure, Environment, Actuators, Sensors)

- Environment types

- Agent types

Agents

- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators

- **Human agent**: eyes, ears, and other organs for sensors; hands, legs, mouth, and other body parts for actuators

- **Robotic agent**: cameras and infrared range finders for sensors; various motors for actuators

- **Software agent**: receives keystrokes, file contents, network packets as sensory inputs; acts by displaying on screen, writing files etc.
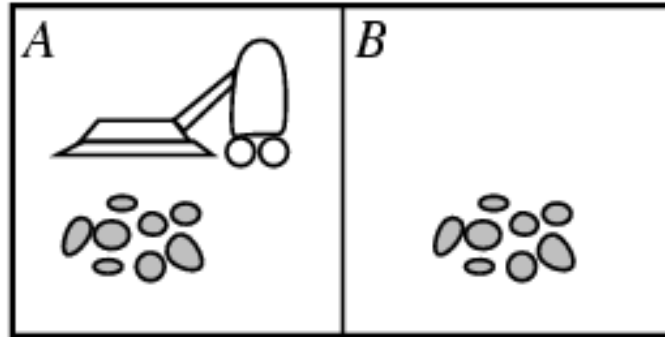
Agents and environments
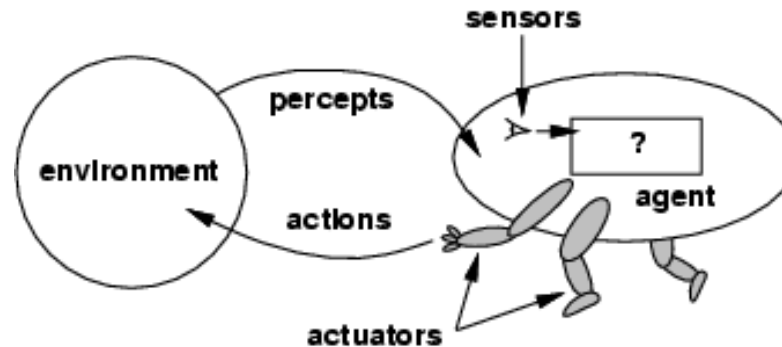
- The agent function maps from percept histories to actions:

$$[f: \mathcal{P}^\star \rightarrow \mathcal{A}]$$

- The agent program runs on the physical architecture to produce f

- agent = architecture + program

Vacuum-cleaner world

- **Percepts**: location and contents, e.g., [A, Dirty]

- **Actions**: *Left, Right, Suck, NoOp*

Rational Agent

- A rational agent chooses whichever action maximizes the expected value of the performance measure given the percept sequence to date

- Rational ≠ omniscient
  - percepts may not supply all relevant information

- Rational ≠ clairvoyant
  - action outcomes may not be as expected

- Hence, rational ≠ successful

- Rational ⇒ exploration, learning, autonomy

Rational agents

- An agent should strive to "do the right thing", based on what it can perceive and the actions it can perform.

- Performance measure: An objective criterion for success of an agent's behavior

- E.g., performance measure of a vacuum-cleaner agent could be :
  - amount of dirt cleaned up
  - amount of time taken
  - amount of electricity consumed

PEAS

- Specifying the task environment:

  – **P**erformance measure

  – **E**nvironment

  – **A**ctuators

  – **S**ensors

PEAS

- Agent: **Part-picking robot**

  – **Performance measure**: % of parts in correct bins

  – **Environment**: Conveyor belt, parts, bins

  – **Actuators**: Jointed arm and hand

  – **Sensors**: Camera, joint angle sensors

PEAS

- Agent: **Automated car**

  - **Performance measure**: Safe, fast, legal, comfortable trip

  - **Environment**: Roads, other traffic, pedestrians

  - **Actuators**: Steering wheel, accelerator, brake

  - **Sensors**: Camera, GPS, Speedometer, engine sensor

Environment types

- Fully observable   vs.   partially observable

- Single agent   vs.   multiagent

- Deterministic   vs.   stochastic

- Episodic   vs.   sequential

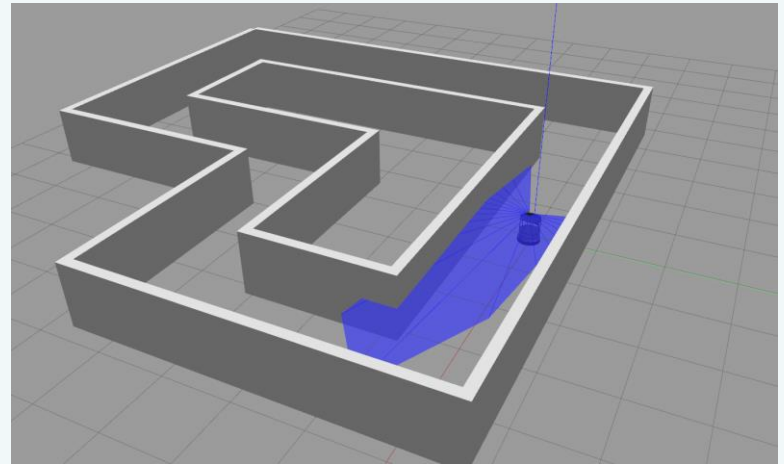- Static   vs   dynamic

- Discrete   vs   continuous

Fully Observable	**Partially Observable**
Agent can observe (see/hear/perceive) all relevant information from the environment	Agent can observe only partial information from the environment

Single Agent	**Multiagent**
Our agent is the only intelligent agent in the environment	There are multiple intelligent agents which can be either cooperative or competitive

Deterministic	**Stochastic**
Agent can fully determine the outcome of it's action (next step, not necessarily the full task)	Agent is uncertain of the outcome of it's action

| **Episodic**	**Sequential**
Agent's actions are completely independent of each other, not linked to past or future actions	Agent's actions are dependent on it's past/future actions. The actions form a sequence.

Static	Dynamic
While the agent is in the process of taking it's action, the environment doesn't change	The environment is constantly changing even when the agent is taking an action
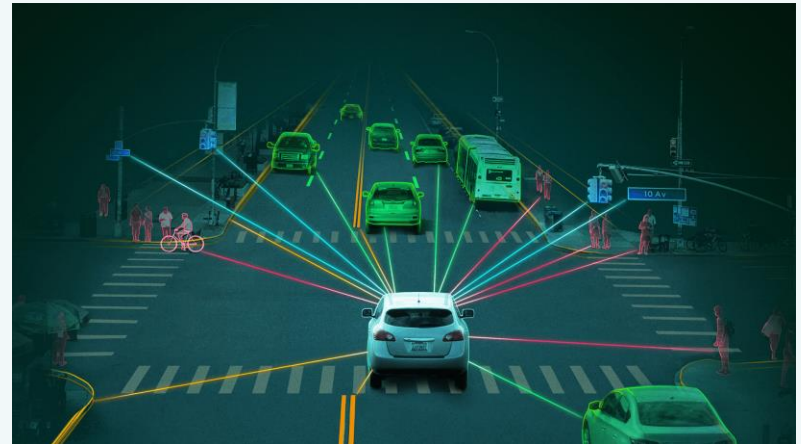
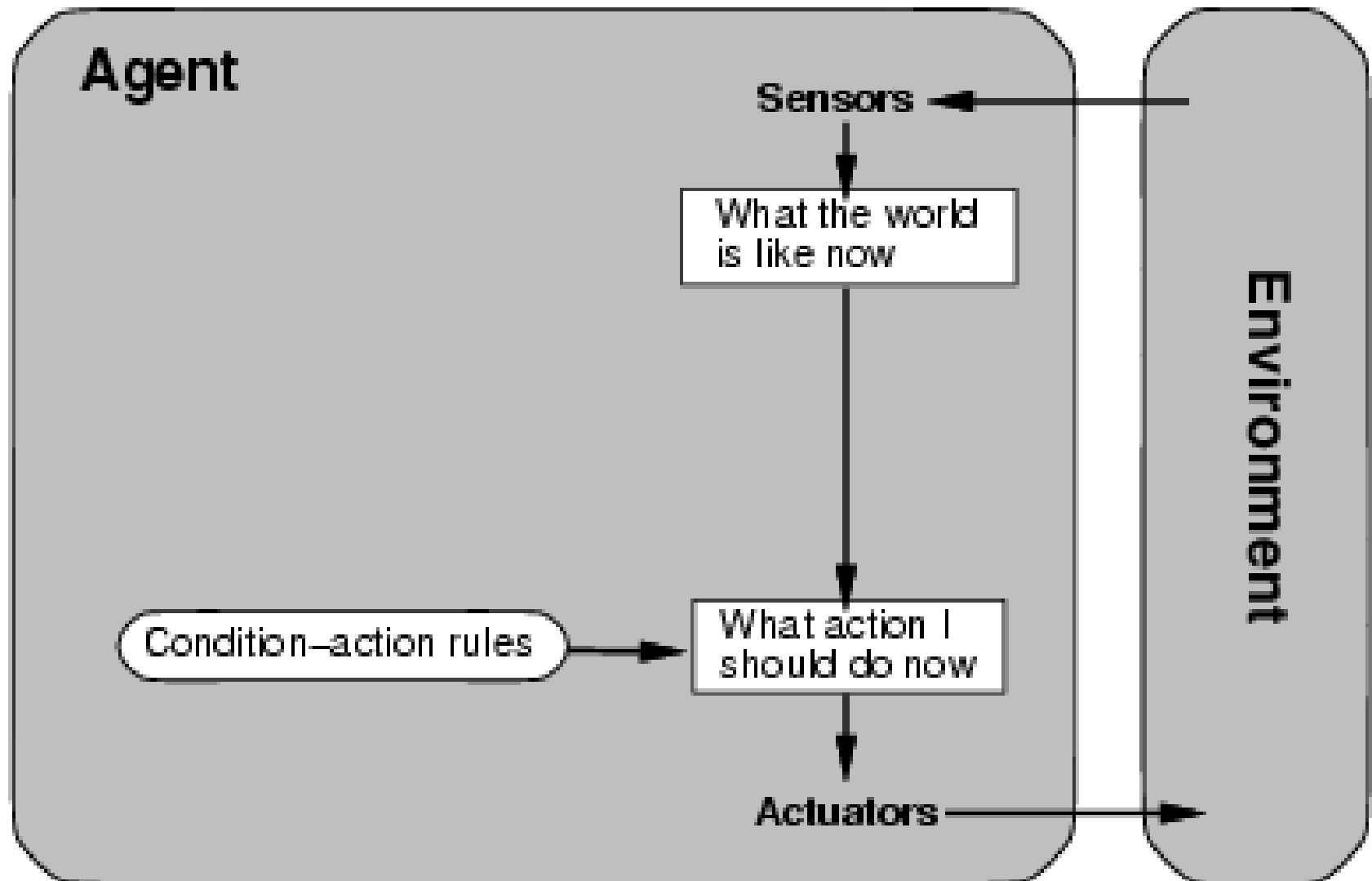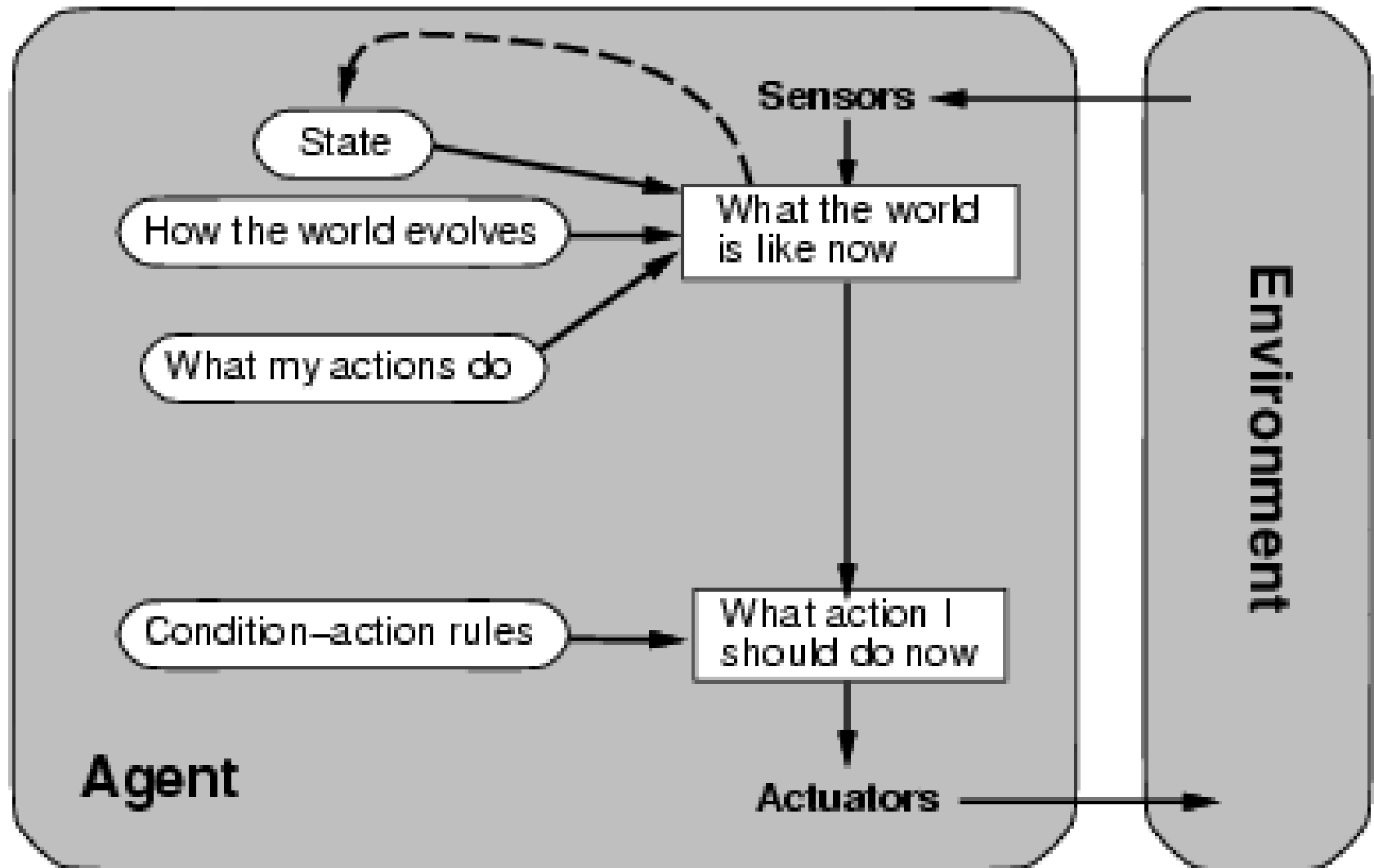| Discrete	Continuous
Agent's task can be broken down into discrete set of actions (you can make a list of agent's actions $A_1, A_2, ..., A_n$)	Actions are happening continuously and can not be listed, i.e., you cannot say where one action ends and the other begins

Agent types

- Four basic types in order of increasing generality:
    - Simple reflex agents
    - Model-based reflex agents
    - Goal-based agents
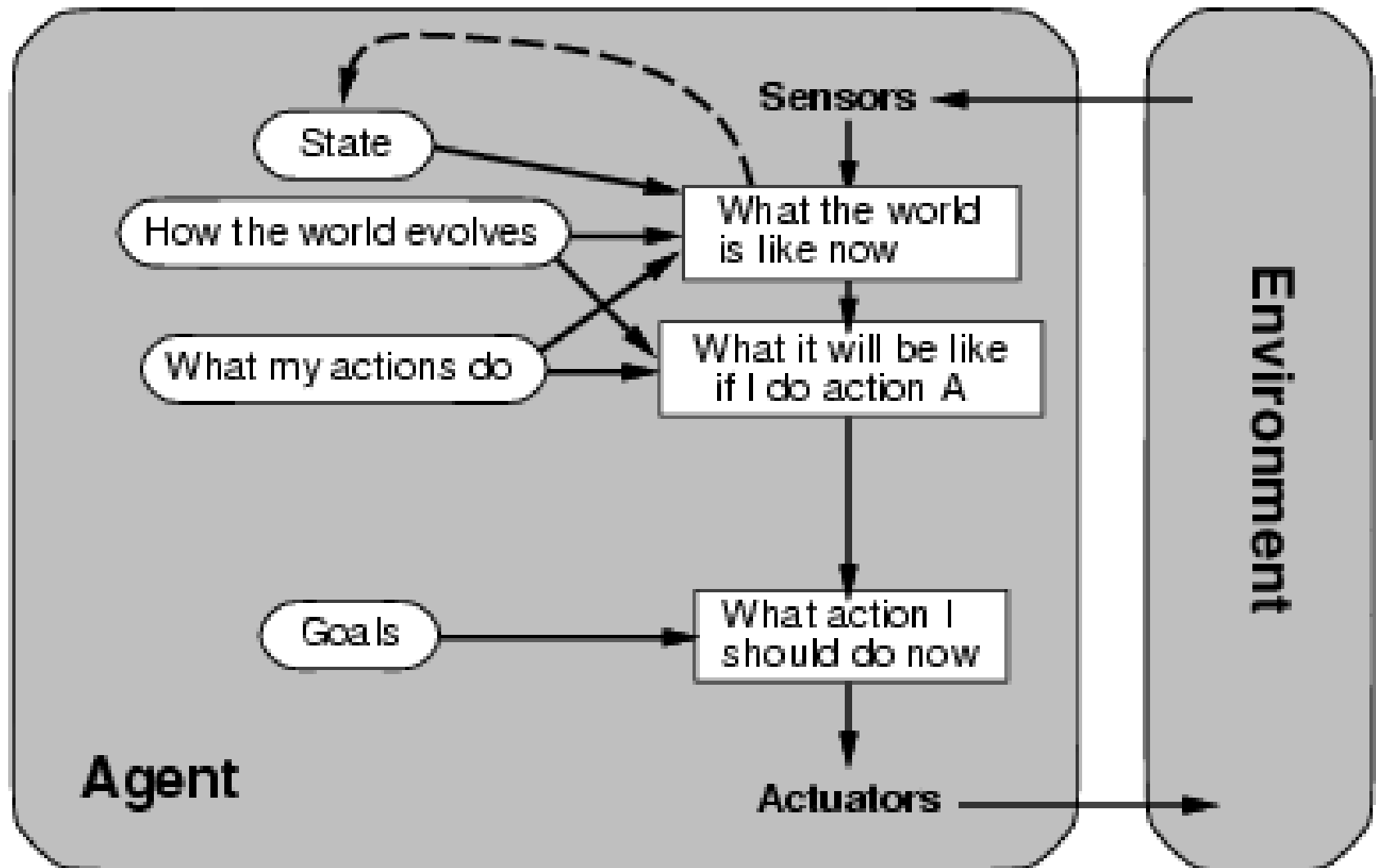   - Utility-based agents

Simple reflex agents

Model-based reflex agents

Goal-based agents

Utility-based agents