# Intelligent Agents

(Chapter 2)

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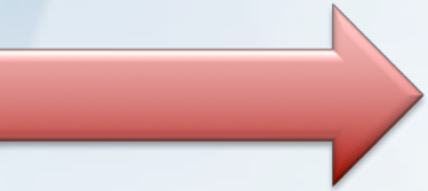
Acknowledgement:
This lecture is based on (but not limited to) chapter 2 in "S. Russell and P. Norvig: *Artificial Intelligence: A Modern Approach".*

# Intelligent Agents



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.

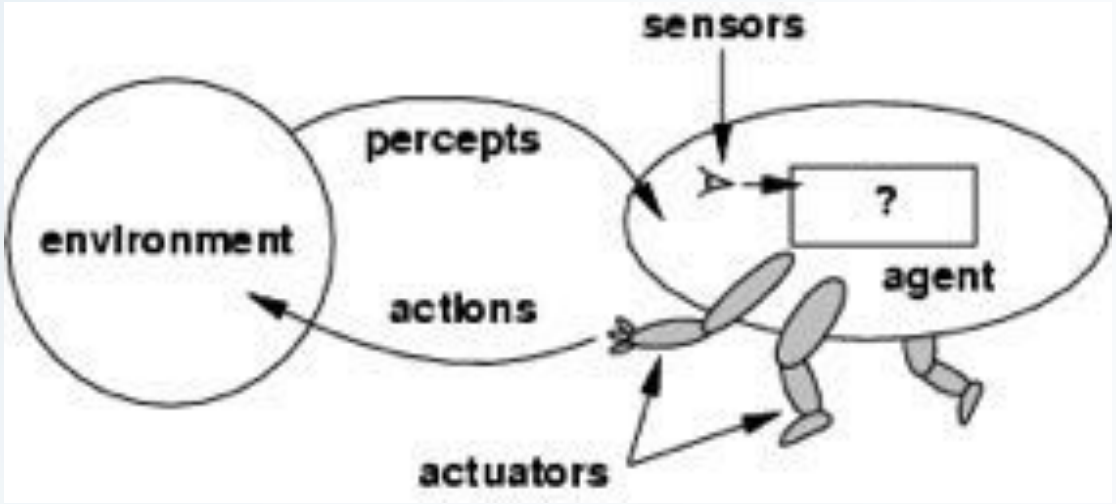
Human agent: eyes, ears, and other organs for sensors; hands, legs, mouth, and other body parts for actuators

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

An agent might be a software

Agent in Arabic means (عامل)

# Agents and Environments



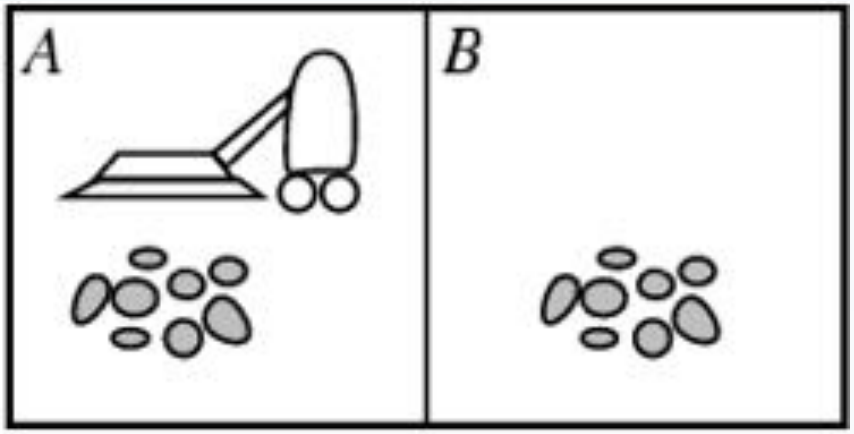

The agent function maps from percept histories to actions:

$$[f: \mathcal{P}^{\star} \rightarrow \mathcal{A}]$$ [2]

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

Agent = Architecture + Program

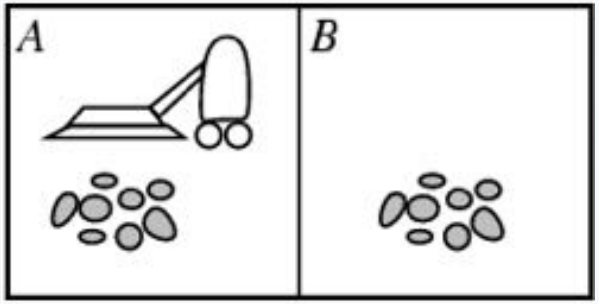
# Vacuum-cleaner world




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

Actions: *Left*, *Right*, *Suck*, *DoNothing*

# A vacuum-cleaner Agent




Tabulation of an agent function of the vacuum-cleaner

| Percept sequence | Action |
|---|---|
| [A, Clean] | Right |
| [A, Dirty] | Suck |
| [B, Clean] | Left |
| [B, Dirty] | Suck |
| [A, Clean], [A, Clean] | Right |
| [A, Clean], [A, Dirty] | Suck |
| ⋮ | ⋮ |
| [A, Clean], [A, Clean], [A, Clean] | Right |
| [A, Clean], [A, Clean], [A, Dirty] | Suck |
| ⋮ | ⋮ |

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# Rational Agents

An agent should strive to "do the right thing", based on what it can perceive and the actions it can perform. The right action is the one that will cause the agent to be most successful.

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, amount of noise generated, etc.

# Rational Agents

Rational Agent: For each possible percept sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and whatever built-in knowledge the agent has.

# Rational Agents

Rationality (عقلانية) is distinct from omniscience (all-knowing with infinite knowledge معرفة غير محدودة ).

Agents can perform actions in order to modify future percepts so as to obtain useful information (information gathering, exploration, learn).

An agent is autonomous if its behavior is determined by its own experience (with ability to learn and adapt).

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# PEAS

When designing a rational/intelligent agent, we keep in mind PEAS (محدات اداء العاملات).

PEAS: **P**erformance measure, **E**nvironment, **A**ctuators, **S**ensors

Consider, e.g., the task of designing an automated taxi driver:

- Performance measure
- Environment
- Actuators
- Sensors

# PEAS

## Agent: automated taxi driver

- Performance measure: *Safe, fast, legal, comfortable trip, maximize profits*
- Environment: *Roads, other traffic, people and objects in/around the street*
- Actuators: *Steering wheel, accelerator, brake, signal, horn*
- Sensors: *Cameras, sonar, speedometer, GPS, odometer, engine sensors, keyboard*

# Agent: Medical diagnosis system

- Performance measure: Healthy patient, minimize costs, lawsuits
- Environment: Patient, hospital, staff
- Actuators: Screen display (questions, tests, diagnoses, treatments, referrals)
- Sensors: Keyboard (entry of symptoms, findings, patient's answers)

# Agent: Part-picking robot

- Performance measure: Percentage of parts in correct bins
- Environment: Conveyor belt with parts, bins
- Actuators: Jointed arm and hand
- Sensors: Camera, joint angle sensors

# Agent: Interactive English tutor

- Performance measure: Maximize student's score on test
- Environment: Set of students
- Actuators: Screen display (exercises, suggestions, corrections)
- Sensors: Keyboard

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# Environment Types

❖ Fully observable (vs. partially observable): An agent's sensors can measure all relevant aspects of the environment at each point in time.

❖ Deterministic (vs. stochastic): The next state of the environment is completely determined by the current state and the action executed by the agent. Vacuum is deterministic? Taxi driver is stochastic?

(If the environment is deterministic except for the actions of other agents, then the environment is strategic).

❖ Episodic (vs. sequential): The agent's experience is divided into atomic "episodes" (each episode consists of the agent perceiving and then performing a single action), and the choice of action in each episode depends only on the episode itself.

Taxi driver is sequential because the current action affect the next action.

# Environment Types

❖ Static (vs. dynamic): The environment is unchanged while an agent is deliberating. (The environment is semidynamic if the environment itself does not change with the passage of time but the agent's performance score does). Taxi driver is dynamic, chess is static, chess with clock I semidynamic.

❖ Discrete (vs. continuous): A limited number of distinct, clearly defined percepts and actions. Chess has a finite number of distinct states, thus it is discrete; however the Taxi-driving is not.

❖ Single agent (vs. multiagent): An agent operating by itself in an environment. Crossword is Single, while Chess is a two-player environment.

# Environment Types

| | Chess with a clock | Chess without a clock | Taxi driving |
|---|---|---|---|
| Fully observable | Yes | Yes | No |
| Deterministic | Strategic | Strategic | No |
| Episodic | No | No | No |
| Static | Semi | Yes | No |
| Discrete | Yes | Yes | No |
| Single agent | No | No | No |

The environment type largely determines the agent design

The real world is (of course) partially observable, stochastic, sequential, dynamic, continuous, multi-agent

# Agent Functions & Programs

An agent is completely specified by the agent function mapping percept sequences to actions.

Aim: find a way to implement the rational agent function concisely.

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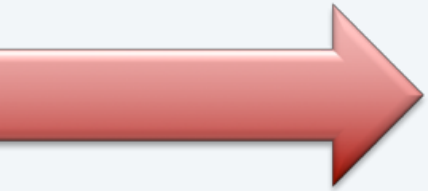

# Lecture Outline

- Agents and environments
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# Agent Types

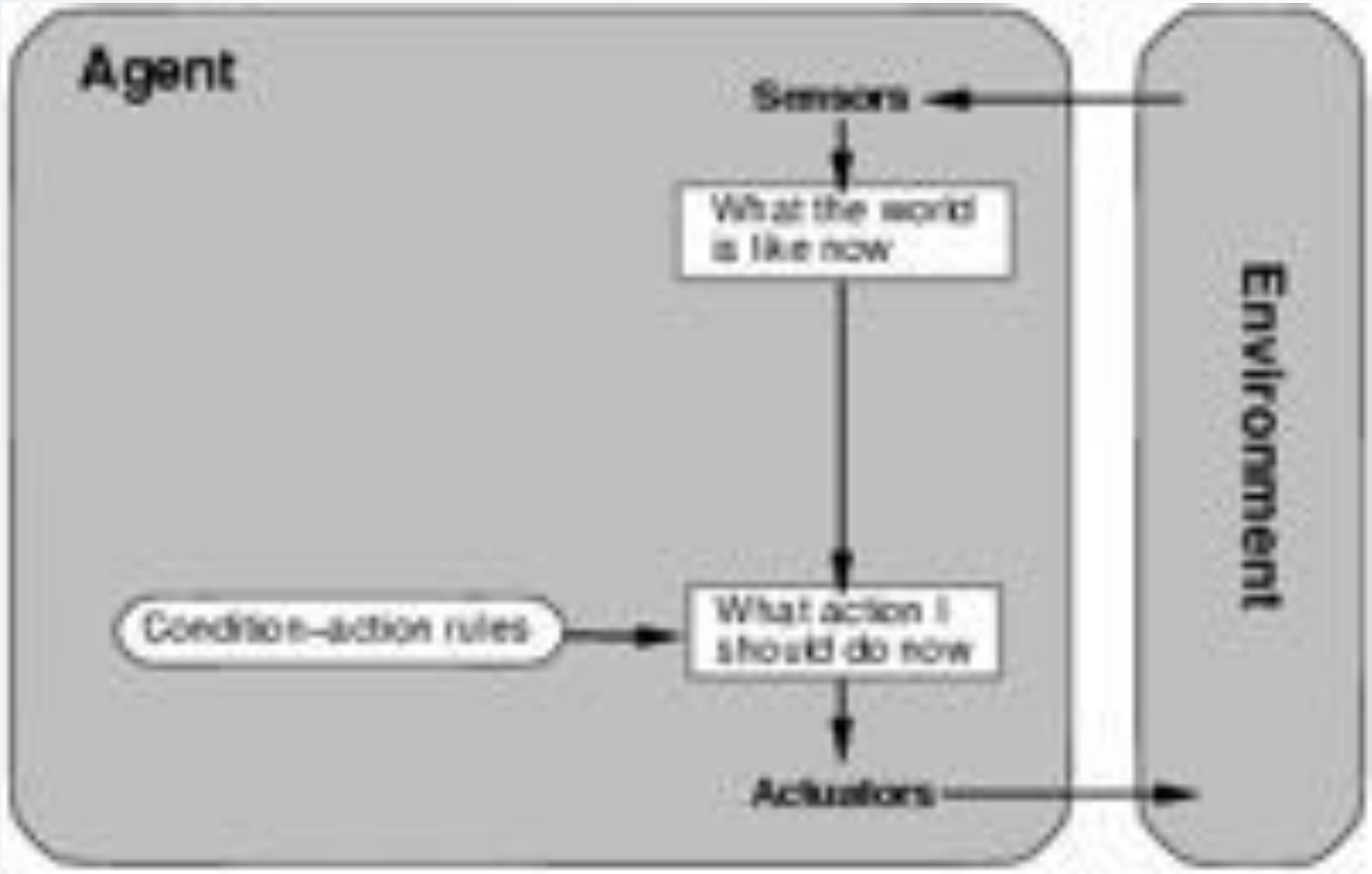
Four basic types in order of increasing generality:

- Simple reflex agents
- Model-based reflex agents
- Goal-based agents
- Utility-based agents

# Simple Reflex Agents

The agent selects an action(s) based on the current precept, ignoring the rest of the precept history.

e.g., alarm clock



# Model-based Reflex Agents

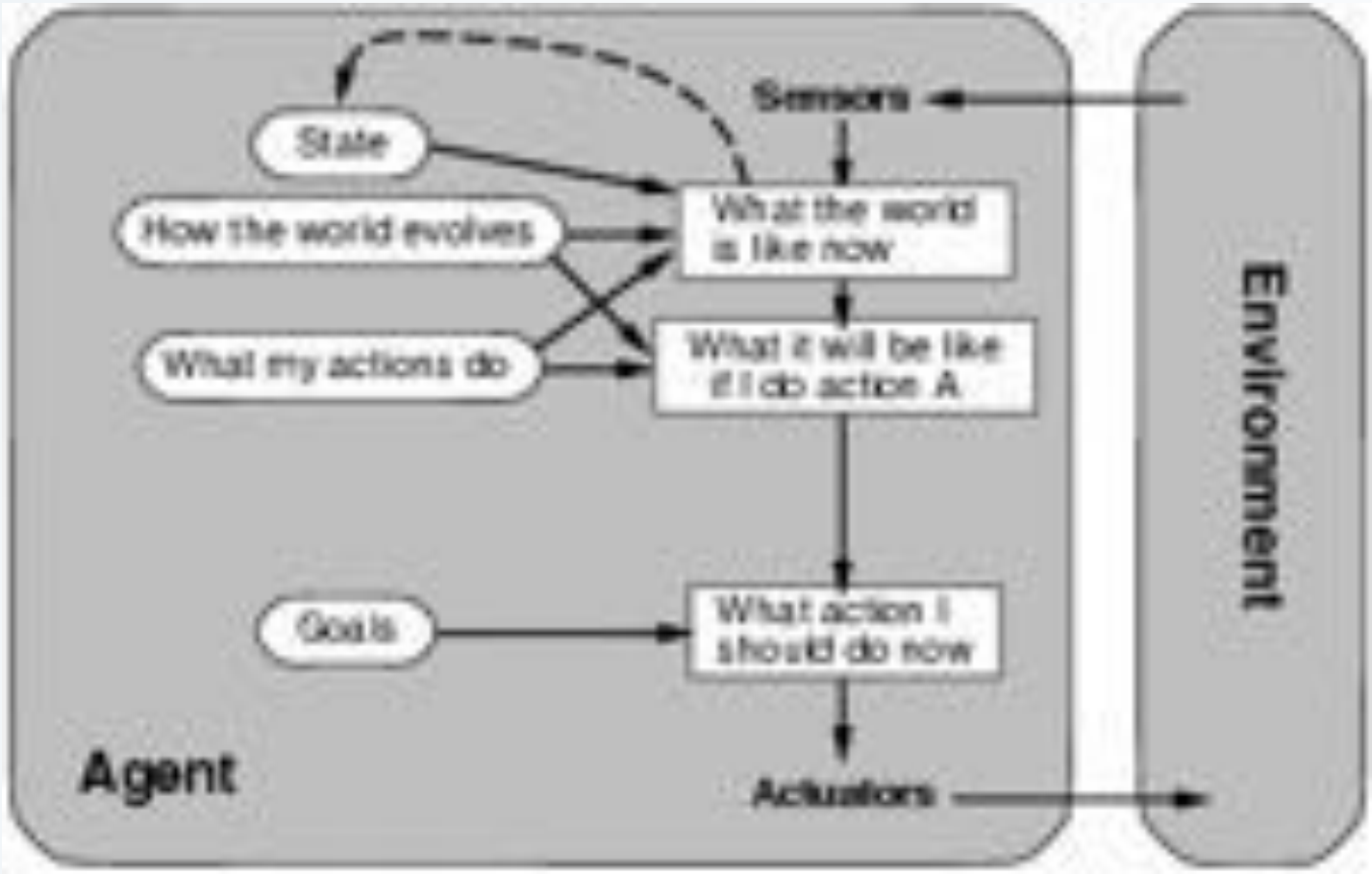
The agent decides its action(s) based on a predefined set of condition-action rules.

e.g., a telephone operator/answering machine.

# Goal-based Agents

The agent decides its action(s) based on a known goal.

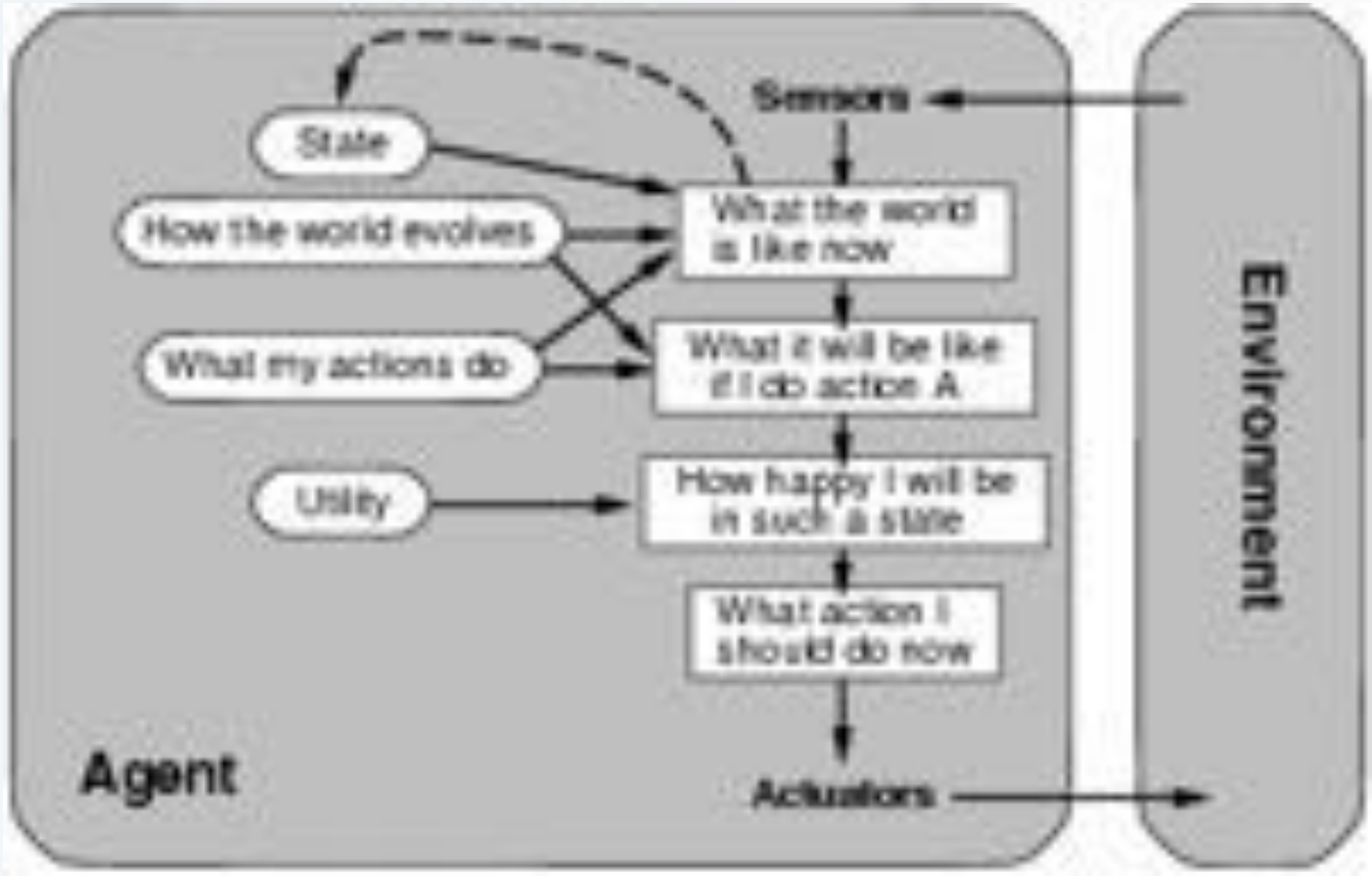
e.g., a GPS system finding a path to certain destination.



# Utility-based Agents

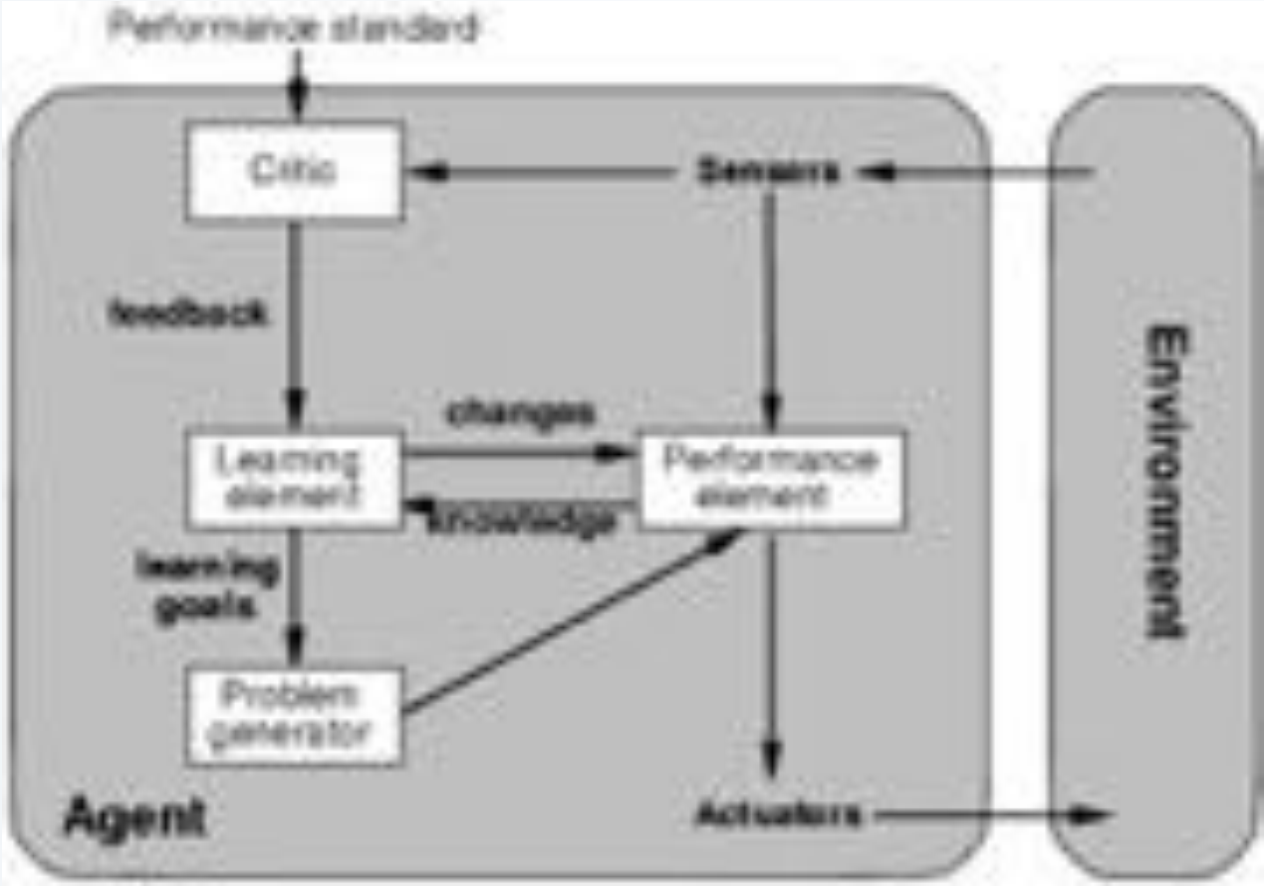
The agent decides its action(s) based on utilities/ preferences.

a GPS system finding a shortest/fastest/safer path to certain destination.



# Learning Agents

The agent adapts its action(s) based on feedback (not only sensors).



# References

[1] S. Russell and P. Norvig: Artificial Intelligence: A Modern Approach Prentice Hall, 2010, Third Edition

[2] Paula Matuszek: Lecture Notes on Artificial Intelligence
http://www.csc.villanova.edu/~matuszek/fall2008/IntelligentAgents.ppt