# Intelligent Agents

# Intelligent Agents

- Agent Definition:
  - Any entity that perceives its environment through sensors and acts upon that environment through effectors
- Percept:
  - The agent's perceptual inputs at any given instant.
- Percept Sequence:
  - Complete history of everything that the agent has ever perceived.
- An agent's choice of action can depend on the entire percept sequence observed to date.
  - But not on anything it has not perceived.

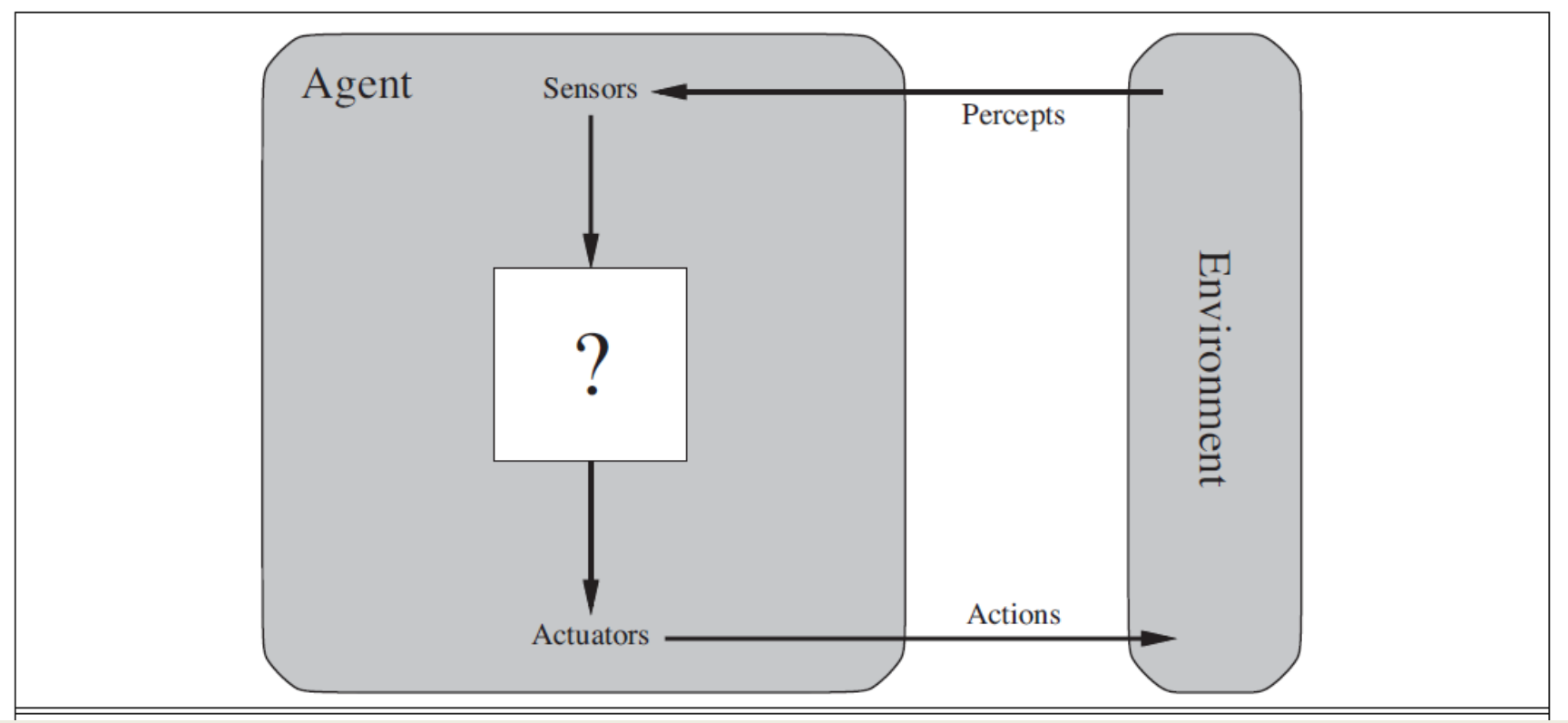
# Intelligent Agents

- An agent function maps any given percept sequence to an action.

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

- The agent function is internally implemented in an agent program.
- The agent program runs on the physical architecture to produce f.
- Job of AI is to design agent programs.

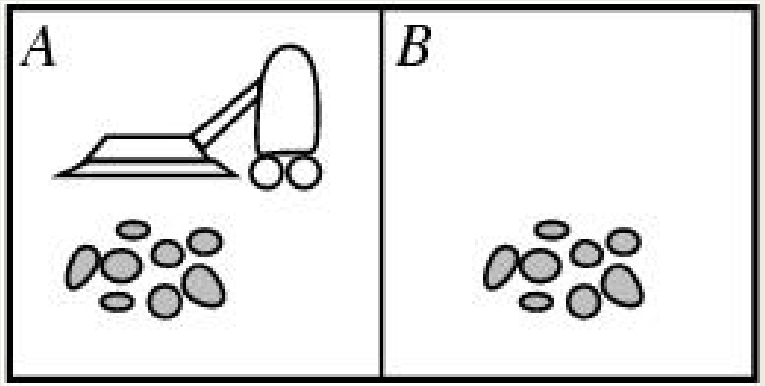
# Intelligent Agents



# Intelligent Agents

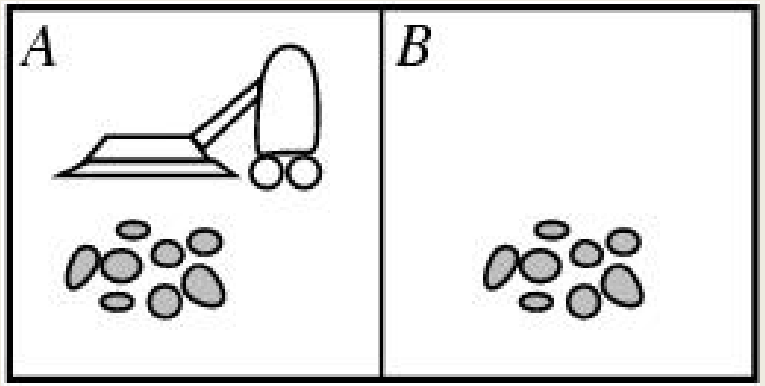
- Perception
  - Signal from environment
  - May exceed sensory capacity
- Sensors
  - Acquires percepts
  - Possible limitations
- Action
  - Attempts to affect environment
  - May exceed effector capacity
- Effectors
  - Transmits actions
  - Possible limitations

# The Vacuum-Cleaner World




- Environment: Squares A and B.
- Percepts: [Location, status], e.g., [A, dirty].
- Actions: left, right, suck, no-op.

# The Vacuum-Cleaner World




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

# Rationality

- Rationality depends on:
  - The performance measure that defines the criterion for success.
  - The agent's prior knowledge of the environment.
  - The actions that the agent can perform.
  - The agent's percept sequence to date.

# The 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.

# Rationality

- Rationality is NOT the same as omniscience.
- An omniscient agent knows the actual outcome of its actions.

- Rationality is also NOT the same as perfection.
- Rationality maximizes the expected performance.
- Perfection maximizes the actual performance.

# Rationality

- Rationality requires:
  - Information gathering
    - Doing actions to modify future percepts.
  - Learning from percepts
    - Extending prior knowledge.
  - Being autonomous
    - Compensate for partial prior knowledge, adapt.

# Specifying Task Environment

- To design a rational agent, we must specify its task environment.

- **PEAS** description of the task environment:
  - Performance
  - Environment
  - Actuators
  - Sensors

# PEAS Framework

- Performance Measure
  - Specified by outside observer or evaluator
  - Applied (consistently) to (one or more) agents in given environment
- Environment
  - Reachable states
  - “Things that can happen”
  - “Where the agent can go”
- Actuators
  - What can be performed
  - Limited by physical factors *and* self-knowledge
- Sensors
  - What can be observed
  - Subject to error: measurement, sampling, postprocessing

# Environment Types

- Categorize task environments according to properties.
- The properties may determine appropriate family of techniques for agent implementation.

| | Chess | Backgammon | Taxi driving |
|---|---|---|---|
| Observable?? | | | |
| Deterministic?? | | | |
| Static?? | | | |
| Discrete?? | | | |
| Single-agent?? | | | |

- **Fully observable** vs. **partially observable**: If an agent's sensors give it access to the complete state of the environment at each point in time, then we say that the task environment is fully observable.
- If the next state of the environment is completely determined by the current state and the action executed by the agent, then we say the environment is **deterministic**; otherwise, it is **stochastic**.

# Environment Types

- The simplest environment is:
  - Fully observable, deterministic, static, discrete, and single-agent.
- Most real situations are:
  - Partially observable, stochastic, dynamic, continuous, and multi-agent.

# Agent Types

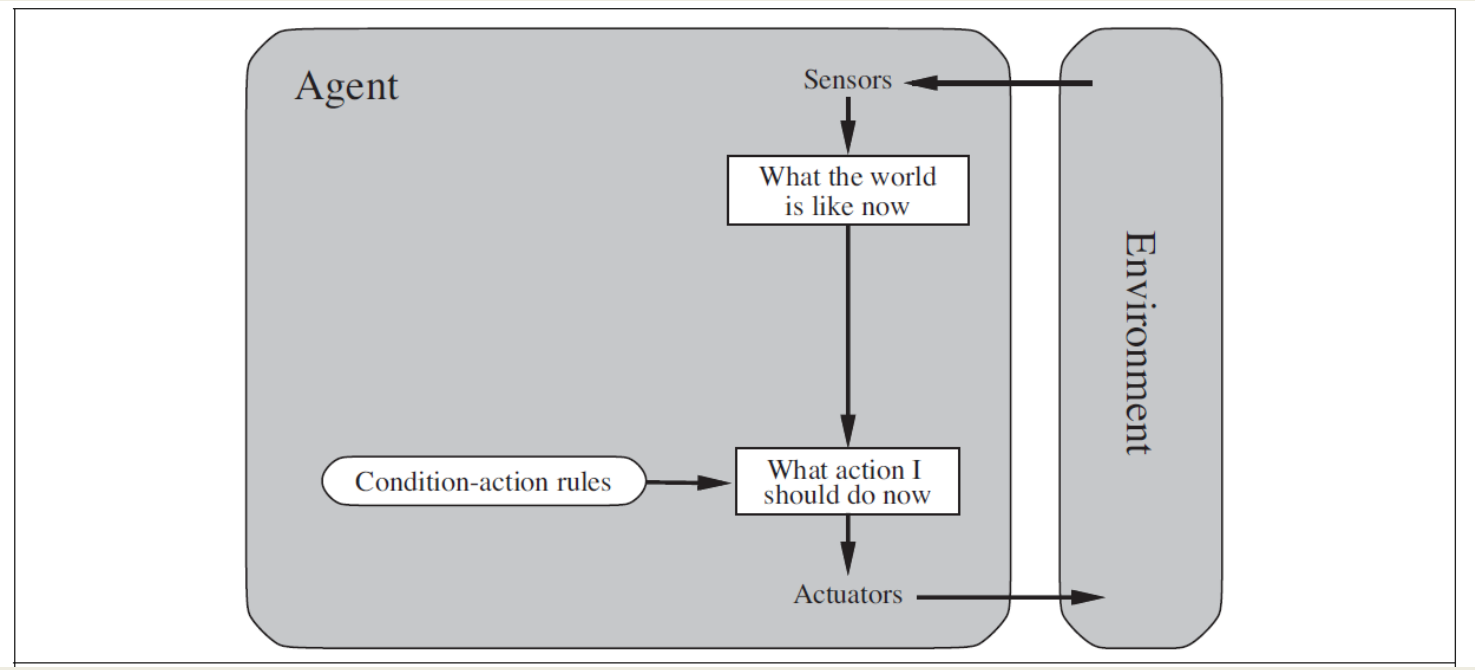
- The job of AI is to design agent programs
  - Agent = Architecture + Program
- Agent program implements agent function mapping percepts to actions
- All agent programs have the same skeleton:
  - Input = current percepts
  - Output = action
  - Program = manipulates input to produce output

# Agent Programs

- If the agent function uses a larger percept sequence, the agent program will have to remember it.
- What is a problem with keeping the entire percept history in a look-up table?
- Four basic types of agent programs:
  - Simple reflex agents
  - Model-based reflex agents
  - Goal-based agents
  - Utility-based agents

# Simple Reflex Agent

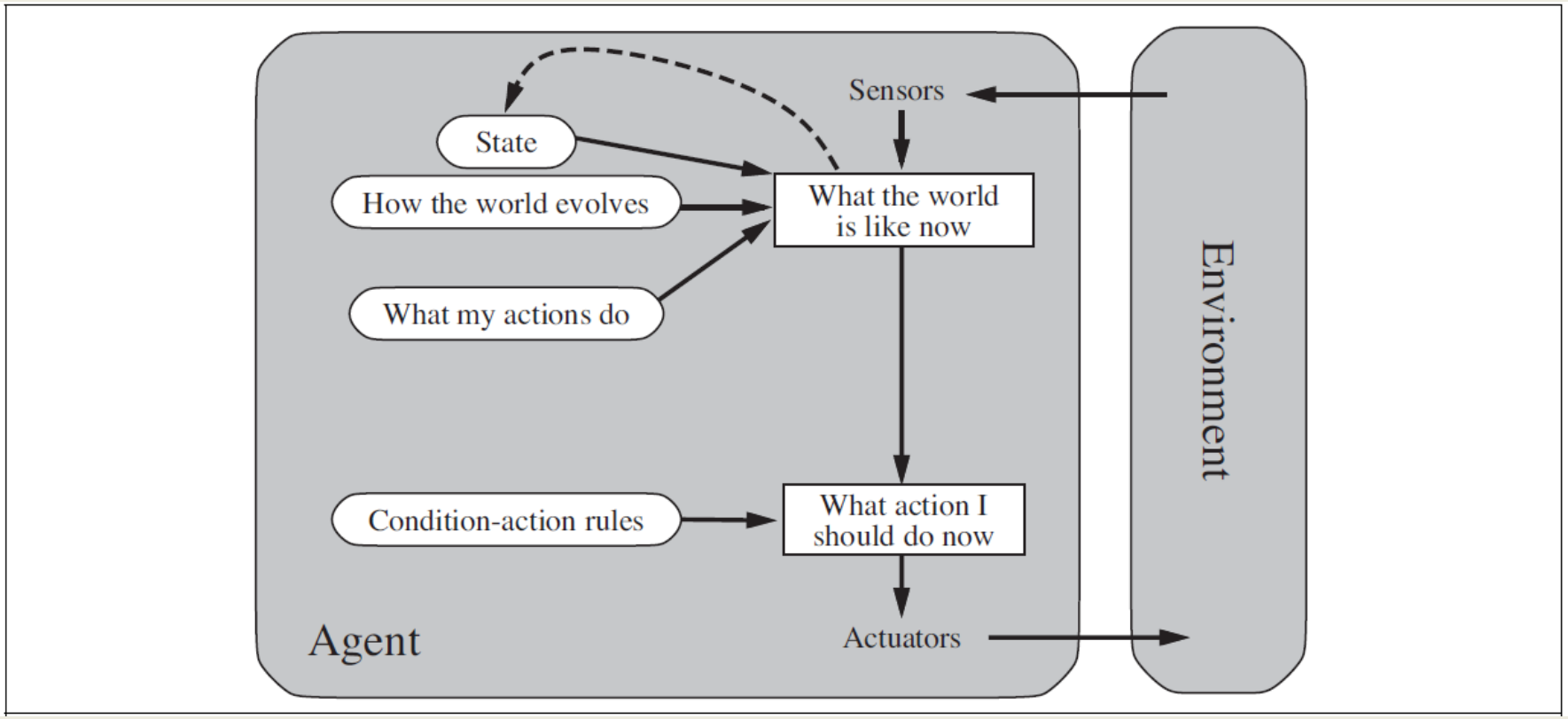
- Simple reflex agents select actions on the basis of current percept, ignoring rest of the percept history.



# Model-Based Reflex Agent

- To handle partial observability, the agent keeps track of the part of the world.
- The agent maintains an internal state that depends on the percept history.
- To update internal state, the agent requires a model of the world.
  - How does the world evolve independently of agent?
  - How the agent's actions affect the world?

# Model-Based Reflex Agent



# Goal-Based Agent

- The agent has some goal information that describes situations that are desirable.
- The agent may need to consider long sequences of actions to achieve the goal.
- **Search** and **planning** are subfields of AI to find such action sequences.

# Utility-Based Agents

- Goals alone do not guarantee high-quality behavior in most environments.
- A utility function is an internalization of the performance measure.
- The utility function allows the specification of an appropriate trade-off if needed.
- In reality, the expected utility is maximized.

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