Rationality

- A rational agent does the right thing (what is this?)
- A fixed performance measure evaluates the sequence of observed action effects on the environment

Rational Agent

What is rational at any given time depends on four things:

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

This leads to a **definition of a 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.*

PEAS

- Use PEAS to describe task environment
  - Performance measure
  - Environment
  - Actuators
  - Sensors
- Example: Taxi driver
  - Performance measure: safe, fast, comfortable (maximize profits)
  - Environment: roads, other traffic, pedestrians, customers
  - Actuators: steering, accelerator, brake, signal, horn
  - Sensors: cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors

Environment Properties

- Fully observable vs. partially observable
- Deterministic vs. stochastic / strategic
- Episodic vs. sequential
- Static vs. dynamic
- Discrete vs. continuous
- Single agent vs. multiagent

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. A task environment is effectively fully observable if the sensors detect all aspects that are *relevant* to the choice of action; relevance, in turn, depends on the performance measure. Fully observable environments are convenient because the agent need not maintain any internal state to keep track of the world. An environment might be partially observable because of noisy and inaccurate sensors or because parts of the state are simply missing from the sensor data—for example, a vacuum agent with only a local dirt sensor cannot tell whether there is dirt in other squares, and an automated taxi cannot see what other drivers are thinking.

Deterministic vs. **stochastic**. 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.

Episodic vs. **sequential**: In an episodic task environment, the agent's experience is divided into atomic episodes. In each episode the agent receives a percept and then performs a single action. Crucially, the next episode does not depend on the actions taken in previous episodes.

Environment Examples

Environment	Observable	Deterministic	Episodic	Static	Discrete	Agents
Chess						

Fully observable vs. partially observable
Deterministic vs. stochastic / strategic
Episodic vs. sequential
Static vs. dynamic
Discrete vs. continuous
Single agent vs. multiagent

Environment Examples

Environment	Observable	Deterministic	Episodic	Static	Discrete	Agents
Chess	Fully	Strategic	Sequential	Static	Discrete	Multi

Fully observable vs. partially observable
Deterministic vs. stochastic / strategic
Episodic vs. sequential
Static vs. dynamic
Discrete vs. continuous
Single agent vs. multiagent

Environment Examples

Environment	Observable	Deterministic	Episodic	Static	Discrete	Agents
Poker						

Fully observable vs. partially observable
Deterministic vs. stochastic / strategic
Episodic vs. sequential
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Single agent vs. multiagent

Environment Examples

Environment	Observable	Deterministic	Episodic	Static	Discrete	Agents
Poker	Partial	Strategic	Sequential	Static	Discrete	Multi

Fully observable vs. partially observable
Deterministic vs. stochastic / strategic
Episodic vs. sequential
Static vs. dynamic
Discrete vs. continuous
Single agent vs. multiagent

Environment Examples

Environment	Observable	Deterministic	Episodic	Static	Discrete	Agents
Taxi driving						

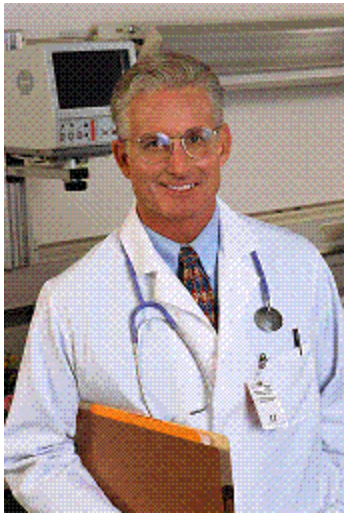
Fully observable vs. partially observable
Deterministic vs. stochastic / strategic
Episodic vs. sequential
Static vs. dynamic
Discrete vs. continuous
Single agent vs. multiagent

Environment Examples

Environment	Observable	Deterministic	Episodic	Static	Discrete	Agents
Taxi driving	Partial	Stochastic	Sequential	Dynamic	Continuous	Multi

Fully observable vs. partially observable
Deterministic vs. stochastic / strategic
Episodic vs. sequential
Static vs. dynamic
Discrete vs. continuous
Single agent vs. multiagent

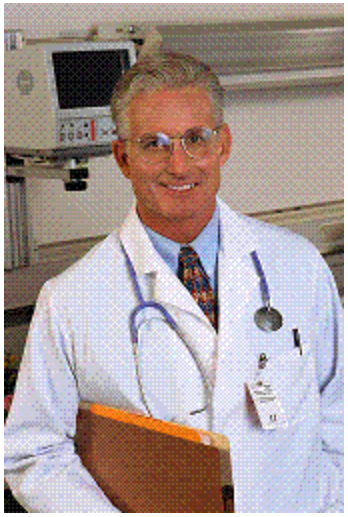
Environment Examples



Environment	Observable	Deterministic	Episodic	Static	Discrete	Agents
Medical diagnosis						

Fully observable vs. partially observable
Deterministic vs. stochastic / strategic
Episodic vs. sequential
Static vs. dynamic
Discrete vs. continuous
Single agent vs. multiagent

Environment Examples



Environment	Observable	Deterministic	Episodic	Static	Discrete	Agents
Medical diagnosis	Partial	Stochastic	Episodic	Static	Continuous	Single

Fully observable vs. partially observable
Deterministic vs. stochastic / strategic
Episodic vs. sequential
Static vs. dynamic
Discrete vs. continuous
Single agent vs. multiagent

Environment Examples

Environment	Observable	Deterministic	Episodic	Static	Discrete	Agents
Image analysis						

Fully observable vs. partially observable
Deterministic vs. stochastic / strategic
Episodic vs. sequential
Static vs. dynamic
Discrete vs. continuous
Single agent vs. multiagent

Environment Examples

Environment	Observable	Deterministic	Episodic	Static	Discrete	Agents
Image analysis	Fully	Deterministic	Episodic	Static	Discrete	Single

Fully observable vs. partially observable

Deterministic vs. stochastic / strategic

Episodic vs. sequential
Static vs. dynamic

Discrete vs. continuous

Single agent vs. multiagent

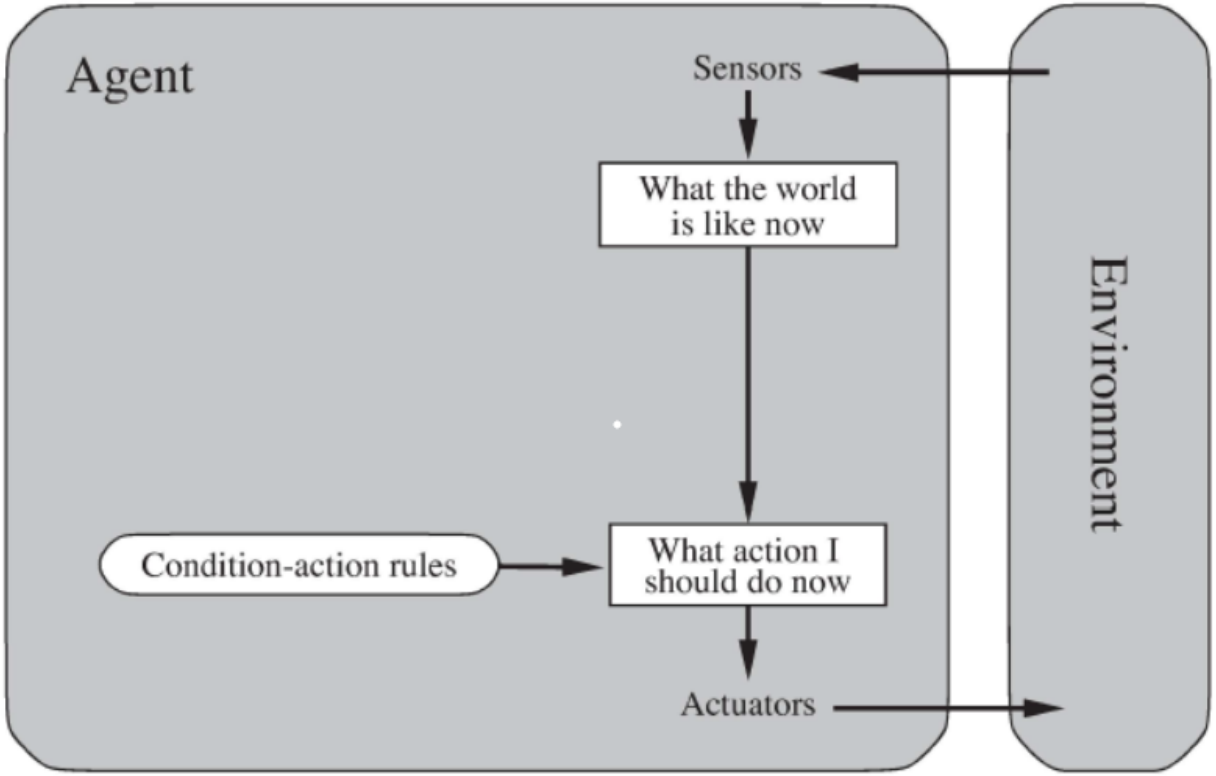
Agent Types

- Types of agents (increasing in generality and ability to handle complex environments)
  - Simple reflex agents
  - Reflex agents with state
  - Goal-based agents
  - Utility-based agents
  - Learning agent

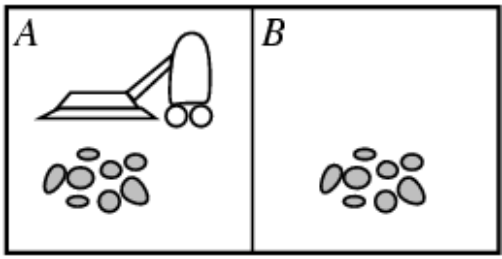
Simple Reflex Agent

- Use simple “if then” rules
- Can be short sighted

```
SimpleReflexAgent(percept)
  state  = InterpretInput(percept)
  rule   = RuleMatch(state, rules)
  action = RuleAction(rule)
  Return action
```



Reflex Vacuum Agent



- If status=Dirty then return Suck

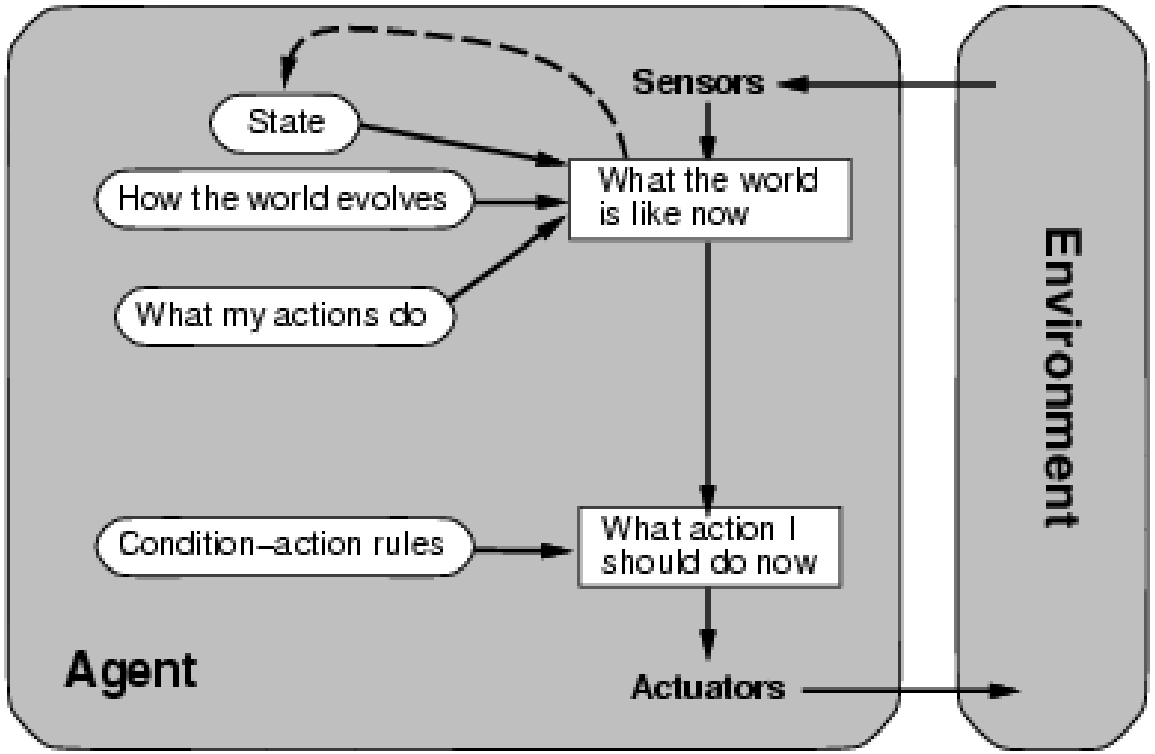
  else if location=A then return Right

  else if location=B then right Left

Reflex Agent With State

- Store previously-observed information
- Can reason about unobserved aspects of current state

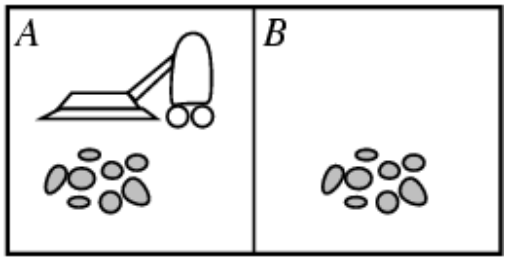
```
ReflexAgentWithState(percept)
  state  = UpdateDate(state,action,percept)
  rule   = RuleMatch(state, rules)
  action = RuleAction(rule)
  Return action
```



Reflex Vacuum Agent With State

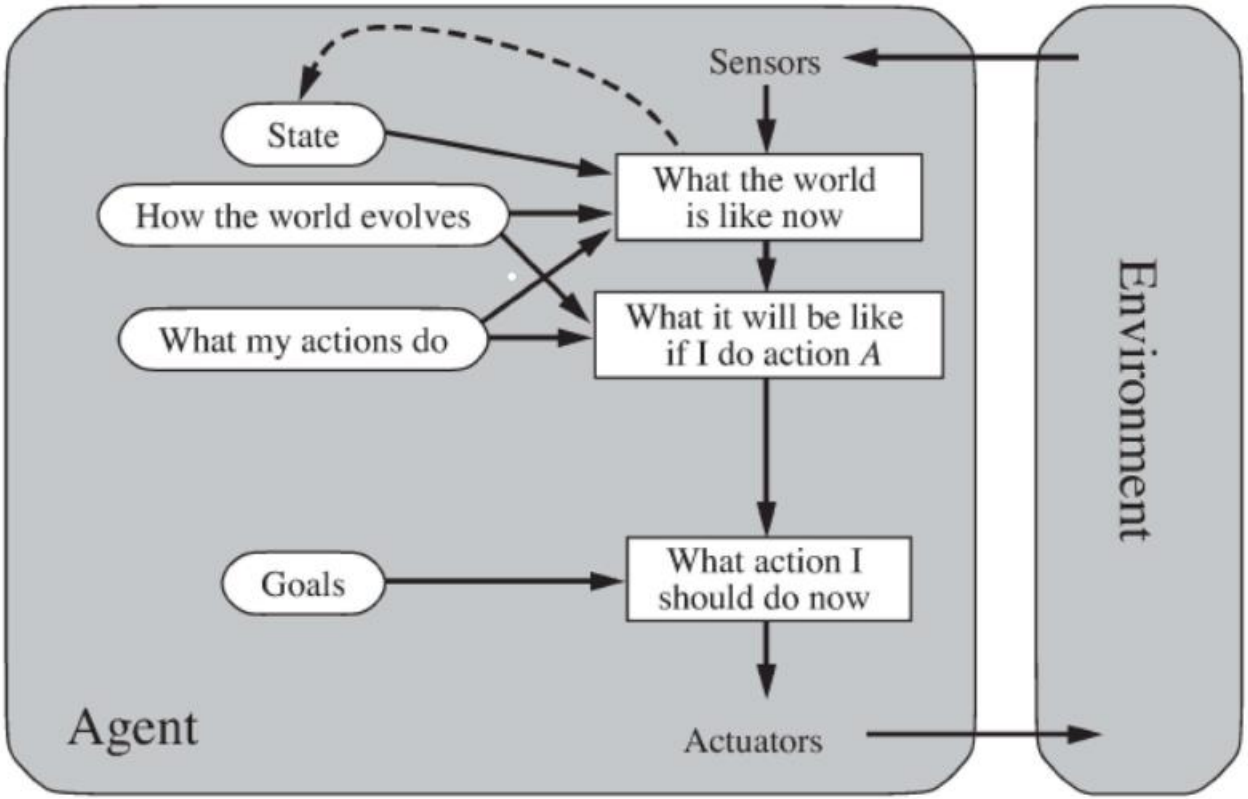
- If status=Dirty then Suck

  else if have not visited other square in >3 time units, go there



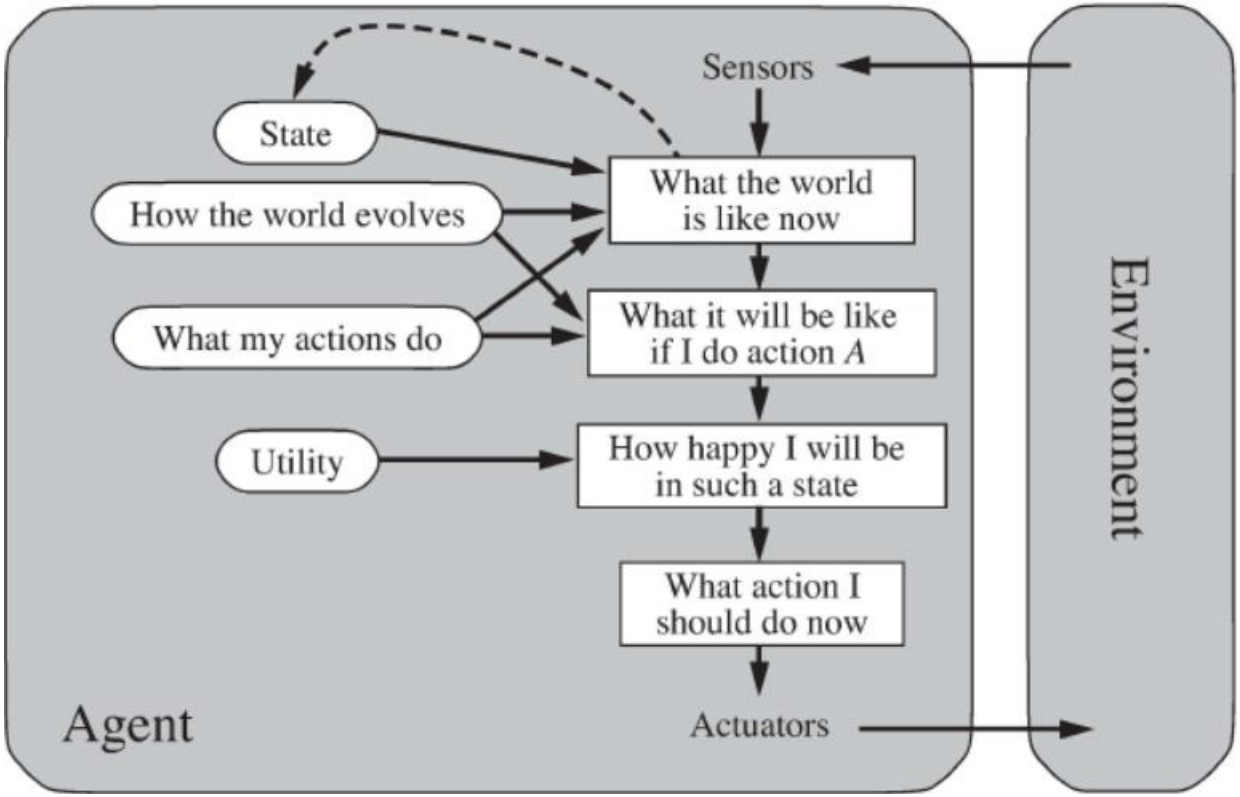
Goal-Based Agents

- Goal reflects desires of agents
- May project actions to see if consistent with goals
- Takes time, world may change during reasoning



Utility-Based Agents

- Utility function is internalization of performance measure
- Chooses the action that maximizes the expected utility of action outcome



Learning Agents