Lecture 2
Machines as Intelligent Agents

M.Filippone

Artificial Intelligence 4 (AI4)
School of Computing Science
University of Glasgow (UK)

Lecture 2: Reference

This lecture corresponds to Chapter 2 of the following textbook:

Artificial Intelligence. A Modern Approach

Stuart Russell and Peter Norvig

`aima.cs.berkeley.edu/`

Outline

Definitions

Intelligence and "Rational Behavior"

The Task Environment

Agent Programs

Outline

Definitions
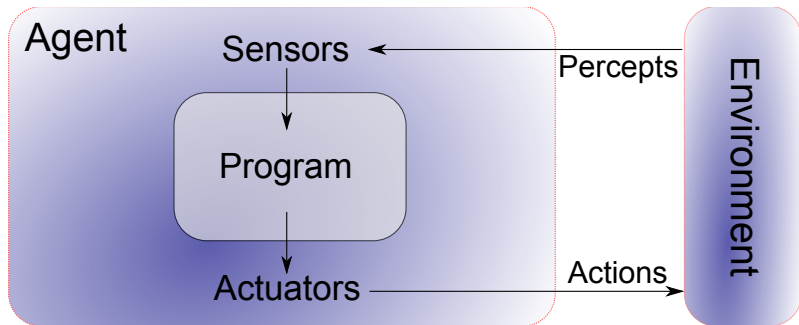
Intelligence and "Rational Behavior"

The Task Environment

Agent Programs

The Agents

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

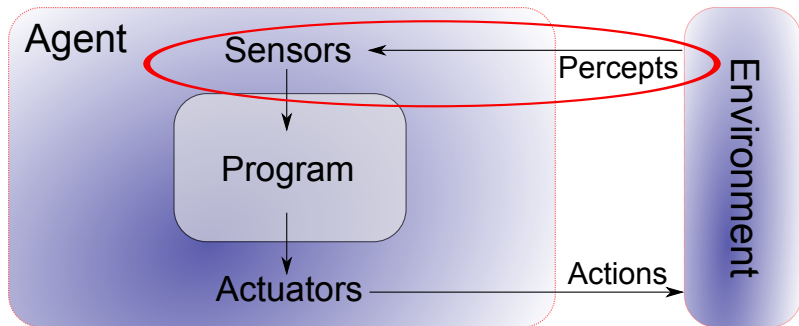S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)

The Agents

- ▶ A way of looking at systems, not a prescription on how to build systems

Sensors and Percepts

[The term percept refers] to the agent's perceptual inputs at any given instant. An agent's percept sequence is the complete history of everything the agent has ever perceived. In general, an agent's choice of action at any given instant can depend on the entire percept sequence observed to date.

S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)

The Percepts

> ▸ Sensors and percepts are both bridge and bottleneck between environment and agent

University of Glasgow

The Agent Function

If we can specify the agent's choice of action for every possible percept sequence, then we said more or less everything there is to say about the agent. Mathematically speaking, we say that an agent's behavior is described by the agent function that maps any given percept sequence to an action.

S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)
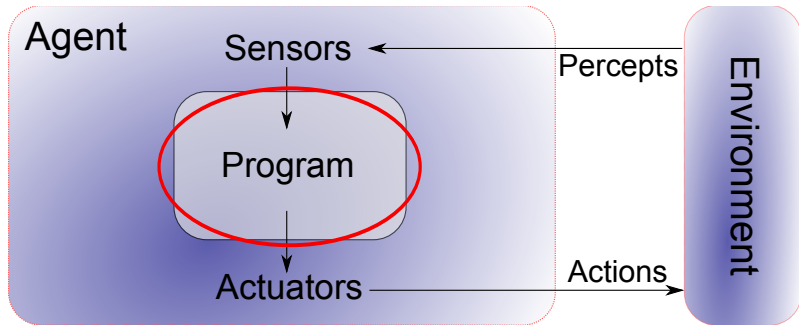
The Agent Function
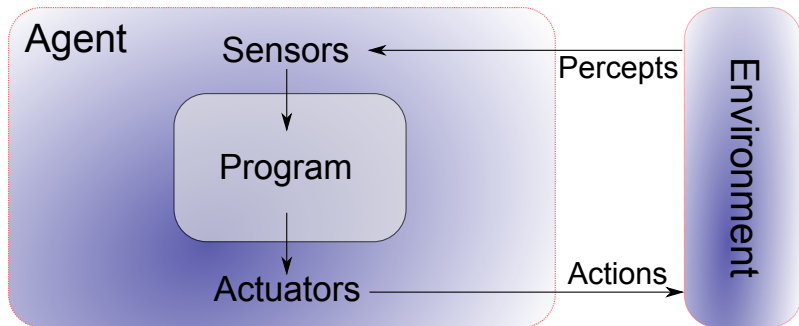
- The function is an external characterization of the agent

The Agent Program

The [function] is, of course, an external characterization of the agent. Internally, the agent function for an artificial agent will be implemented by an agent program.

S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)
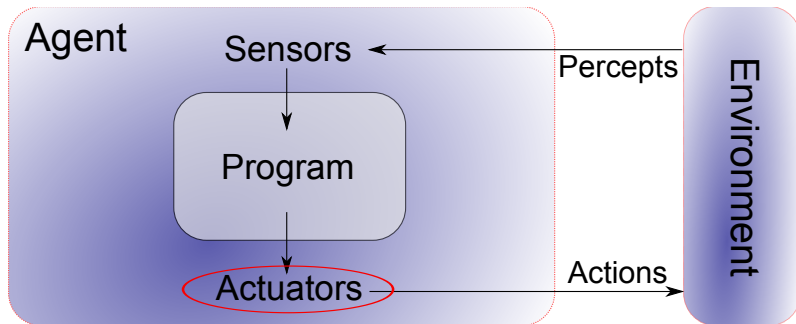
The Agent Program

- The program maps percepts into actions

The Actuators

A mechanical device for moving or controlling something
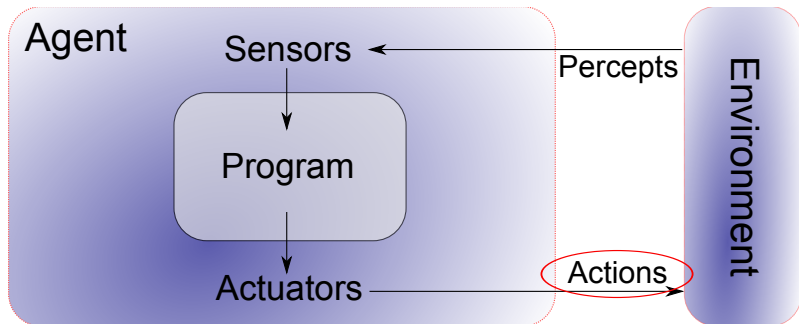
"Merriam Webster Dictionary"

The Actuators

▶ The actuators act on the environment

The Actions

The accomplishment of a thing usually over a period of time, in stages, or with the possibility of repetition.

"Merriam Webster Dictionary"

The Actions

- The actions are whatever an agent does in the environment

Outline

Definitions

Intelligence and "Rational Behavior"

The Task Environment

Agent Programs

Performance Measures

A performance measure embodies the criterion for success of an agent's behavior [...]. We will insist on an objective performance measure, typically imposed by the designer who is constructing the agent.

S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)

Rationality

Rationality results from four elements:

- The performance measure
- Prior knowledge of environment
- Actions that can be performed
- 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.

S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)

Outline

PEAS

An agent is defined in terms of four elements:

- ▶ Performance: defines the "good behavior"
- ▶ Environment: limits the circumstances the agent can deal with
- ▶ Actuators: limit what the agent can do
- ▶ Sensors: limit what the agent can know about the environment

Properties of Task Environments

- ▸ Fully observable vs Partially observable
- ▸ Deterministic vs Stochastic
- ▸ Episodic vs Sequential
- ▸ Static vs Dynamic
- ▸ Discrete vs Continuous
- ▸ Single Agent vs Multiagent environment

Outline

The Agent Program

The job of AI is to design the agent program that implements the agent function mapping percepts to actions. We assume this program will run on some sort of computing device with physical sensors and actuators - we call this architecture.

S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)

Table Driven Agent

- A binary 30×30 array contains 900 elements and can encode 2^{900} binary images

- The program of a table driven agent expected to recognize the images should then include 2^{900} entries

- The program of a table driven agent expected to recognize sequences of N images should include $2^{N \times 900}$ entries

Simplest Reflex Agents

The simplest kind of agent is the simple reflex agent. These agents select actions on the basis of the current percept, ignoring the rest of the percept history.

S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)

The Agent Program
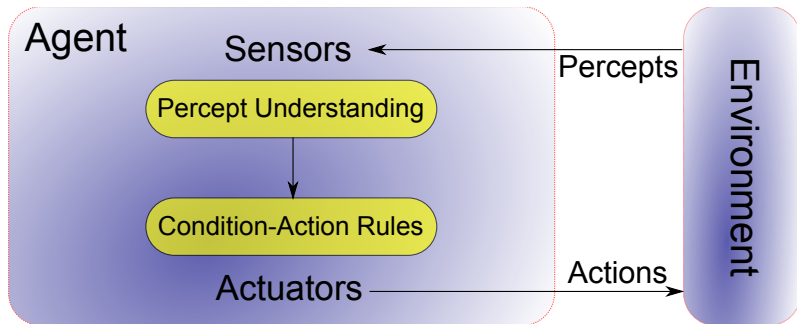
▶ The action depends on the current percept

Limitations

The agent [...] will work only if the correct decision can be made on the basis of only the current percept - that is, only if the environment is fully observable.

S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)

Model-Based Reflex Agents

[...] the agent [keeps] track of the part of the world it can't see now. That is, the agent should maintain some sort of internal state that depends on the percept history and thereby reflects at least some of the unobserved aspects [...]

S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)

The Agent Program
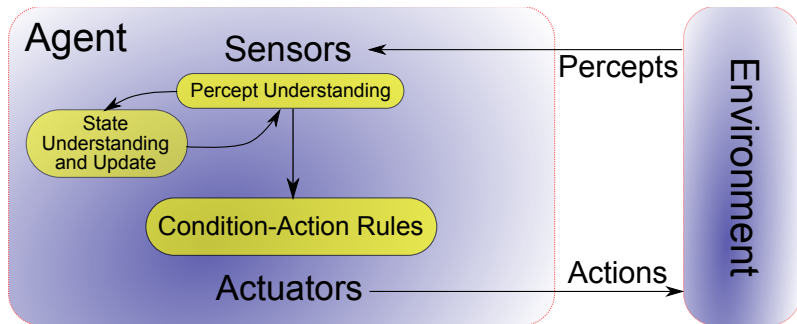
- Actions depend on current percept and state

Goal-Based Agents

[...] as well as a current state-description, the agent needs some sort of goal information that describes situations that are desirable [...] The agent can combine this with information about the results of possible actions [...].

S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)

The Agent Program
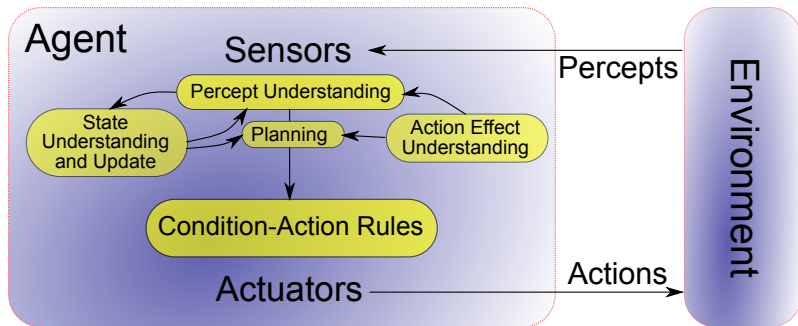
► Actions depend on current percept, state and goal

Utility-Based Agents

A utility function maps a state (or a sequence of states) onto a real number, which describes the associated degree of happiness. A complete specification of the utility function allows rational decisions [...]

S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)

The Agent Program
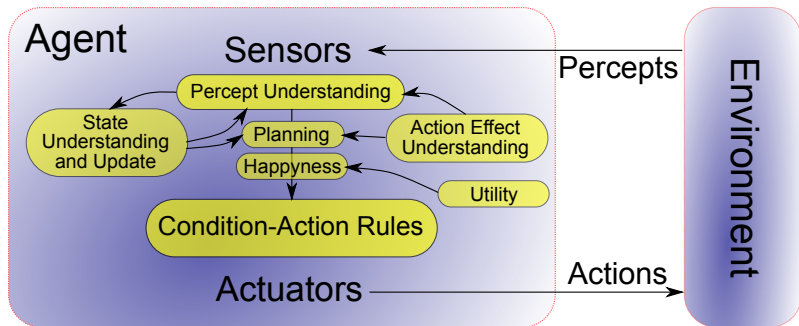
- Actions depend on current percept, state, goal and utility

Learning Agents

A learning agent can be divided into four conceptual components. The most important distinction is between the learning element [...] and the performance element [...] The learning element uses feedback from the critic on how the agent is doing [...].

S.Russell, P.Norvig, "Artificial Intelligence. A Modern Approach", Prentice Hall (2003)

End of the Lecture

University
of Glasgow