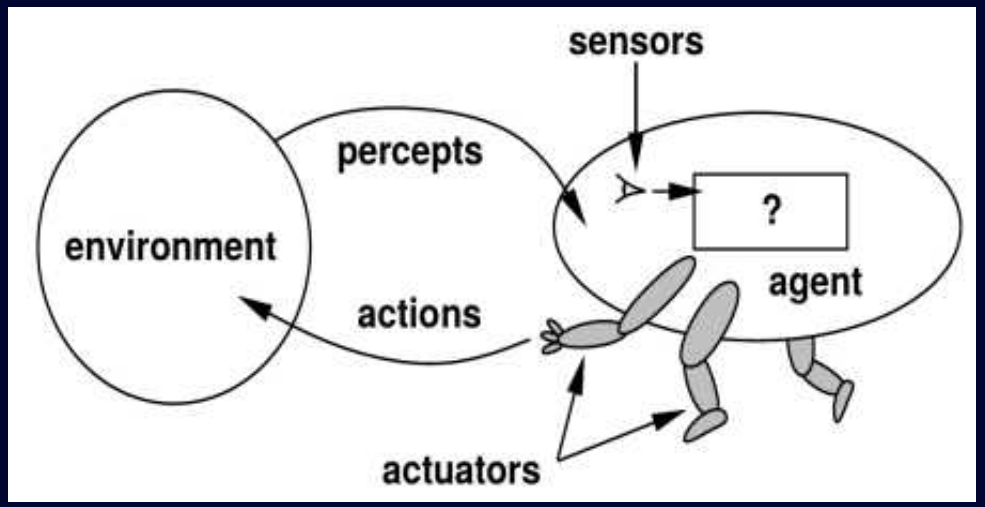
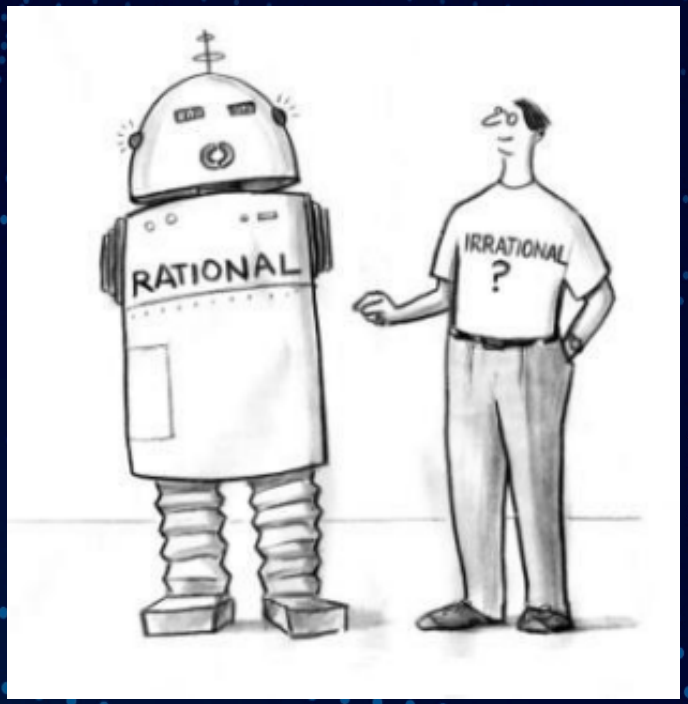


Intelligent Agents



Last modified on 2022/03/07 by f.maire@qut.edu.au

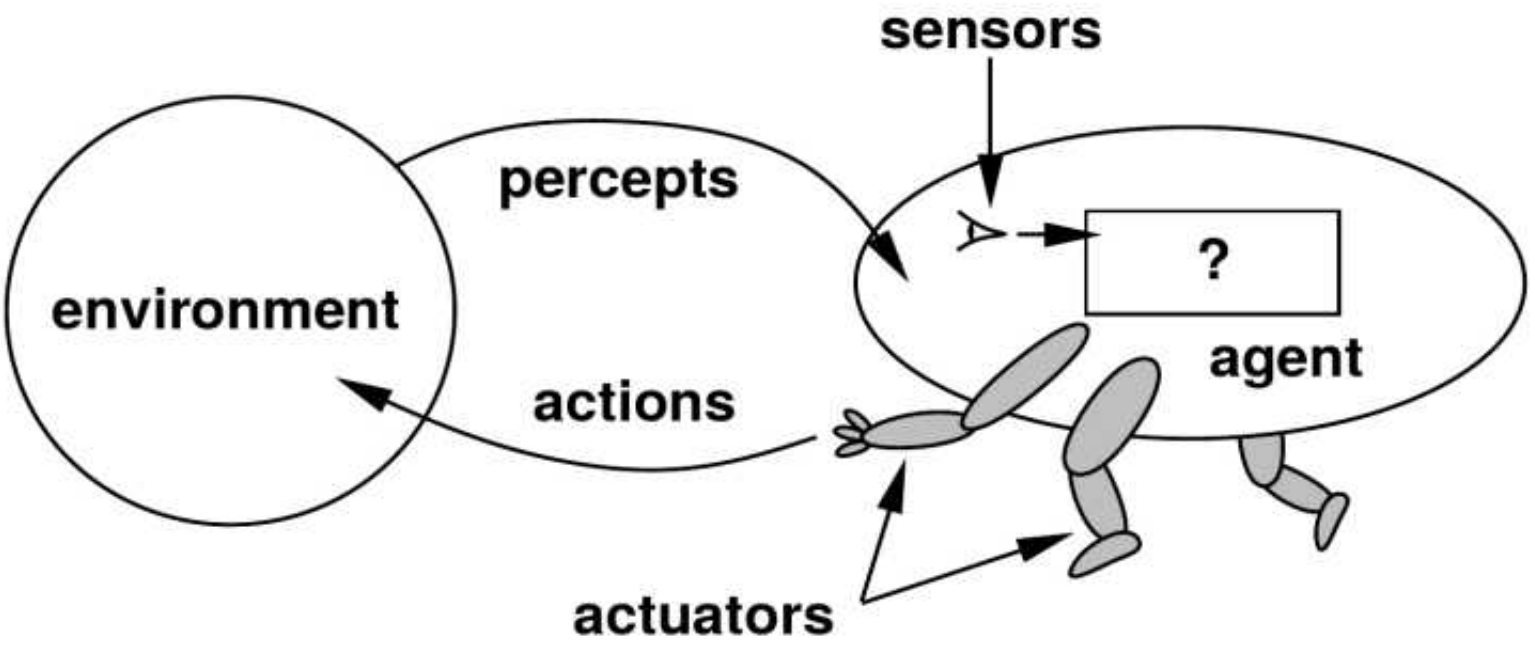
Reading for this lecture

- Chapter 02 of RN
  - Russell and Norvig Textbook:
    Artificial Intelligence, a modern approach
    4th edition

Outline

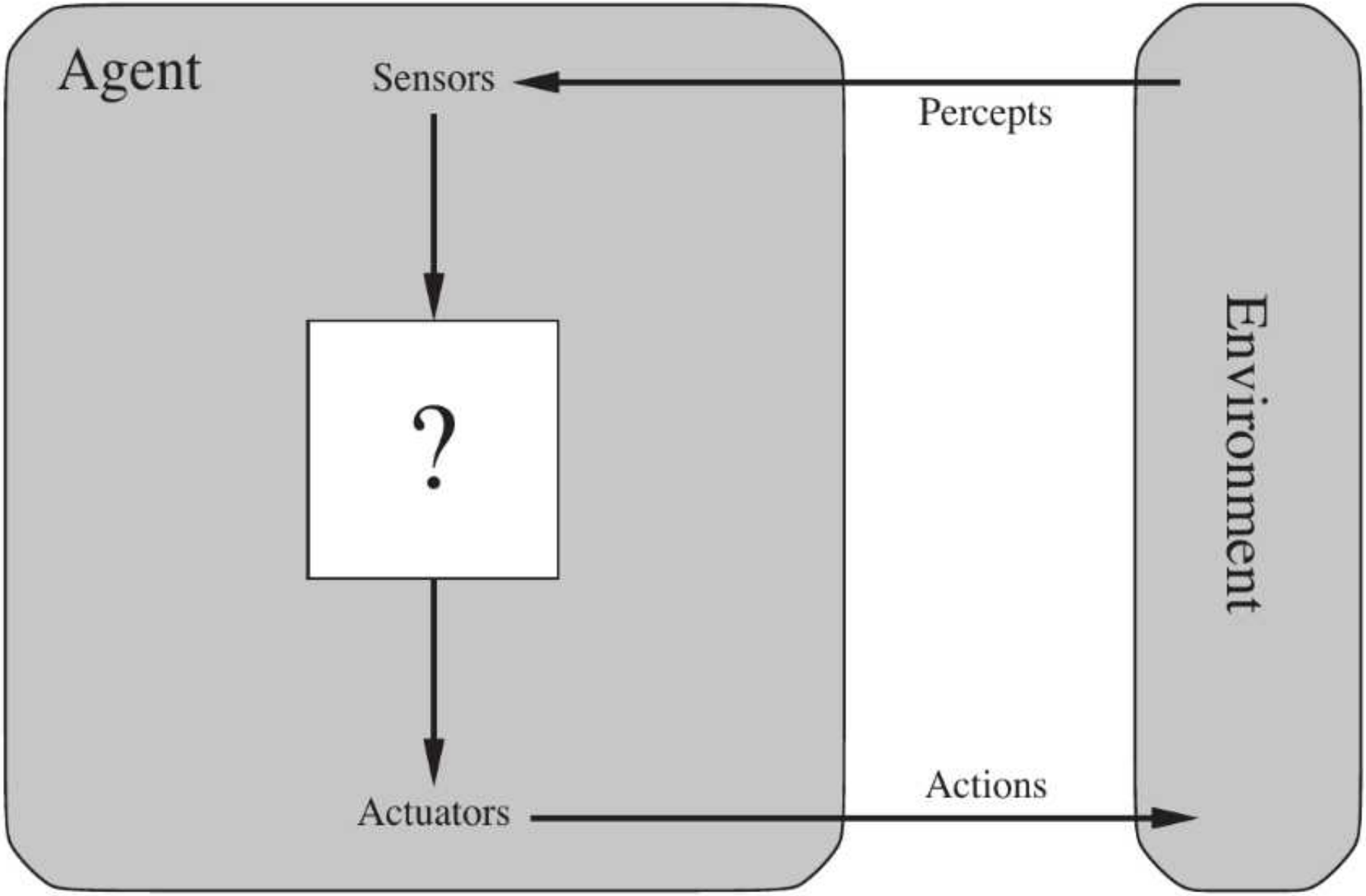
- Agents and environments
- Rationality
- PEAS (Performance measure, Environment, Actuators, Sensors)
- Environment types
- Agent types

Agents and environments

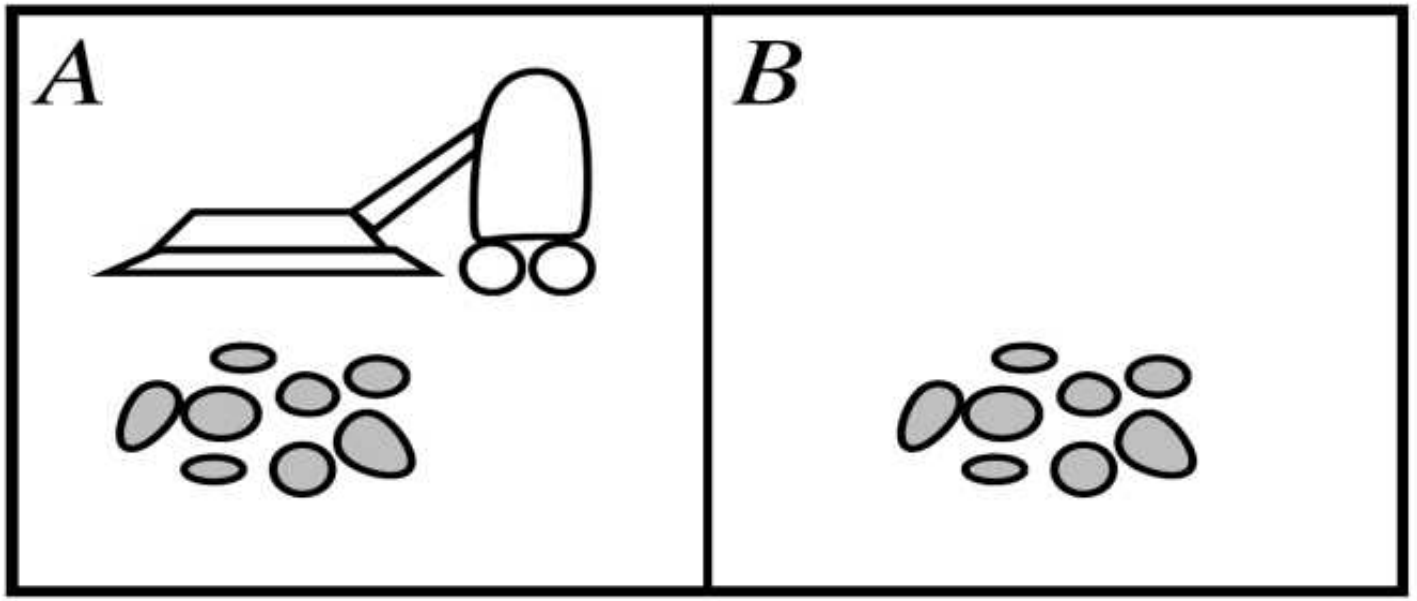


- Agents include humans, robots, softbots, thermostats, etc.
- The agent function maps from percept histories to actions

Agents interact with environments through sensors and actuators



Vacuum-cleaner world

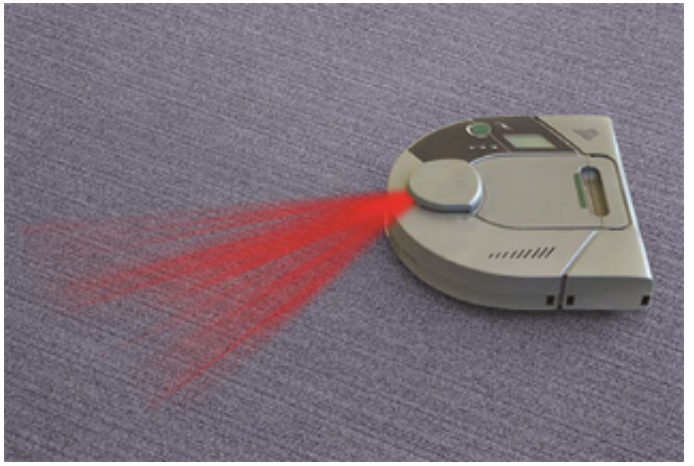


- Percepts: location and contents, e.g., [A, Dirty]
- Actions: Left, Right, Suck, NoOp

A vacuum-cleaner agent

```
function REFLEX-VACUUM-AGENT([location,status]) returns an action
    if status = Dirty then return Suck
    else if location = A then return Right
    else if location = B then return Left
```

- How do we know if this is a good agent function?
- What is the best function?
- Is there one?
- Who decides this?



Rationality

- A rational agent chooses any action that
  - maximises the expected value of the performance measure
  - given the percept sequence to date
- Rational != omniscient
  - percepts may not supply all relevant information
- Rational != perfect
  - Rationality maximises expected outcome while perfection maximises actual outcome

P.E.A.S.

- To design a rational agent, we must specify the *task environment*, which consists of the following four things:
  - Performance measure ?
  - Environment ?
  - Actuators ?
  - Sensors ?
- Examples of agents:
  - Automated taxi, part-picking robot
  - Internet shopping agent,
  - Boardgame artificial player

Automated taxi

The task environment for an automated taxi:

- Performance measure ?
  - Safety, destination, profits, legality, comfort, . . .
- Environment ?
  - Streets, traffic, pedestrians, weather, . . .

- Actuators ?
  - Steering, accelerator, brake, horn, speaker/display, . . .
- Sensors ?
  - Video, accelerometers, gauges, engine, keyboard, GPS, . . .

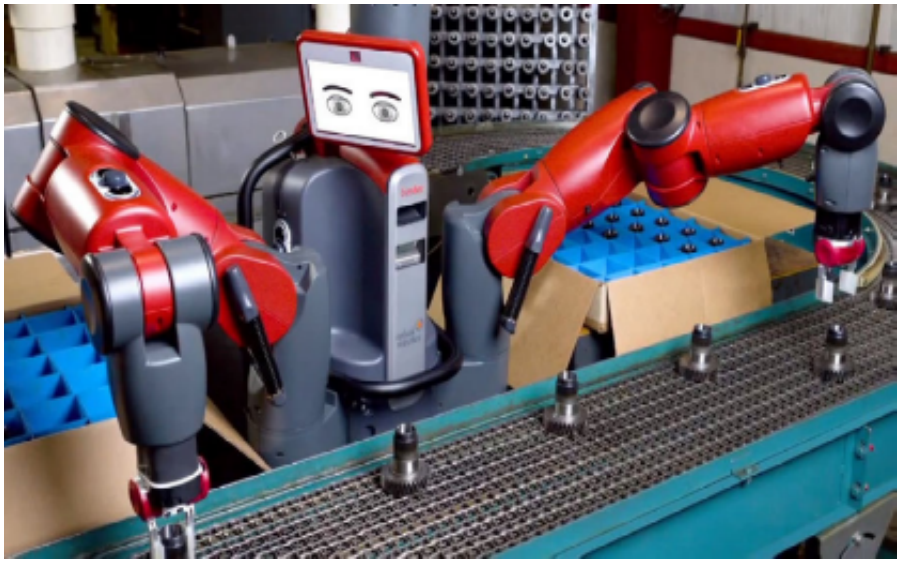
Internet shopping agent

The task environment for an internet shopping agent:

- Performance measure ?
  - Price, quality, appropriateness, efficiency
- Environment ?
  - Current and future WWW sites, vendors, shippers
- Actuators ?
  - Display to user, follow URL, fill in form
- Sensors ?
  - HTML pages (text, graphics, scripts)

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



Environment types

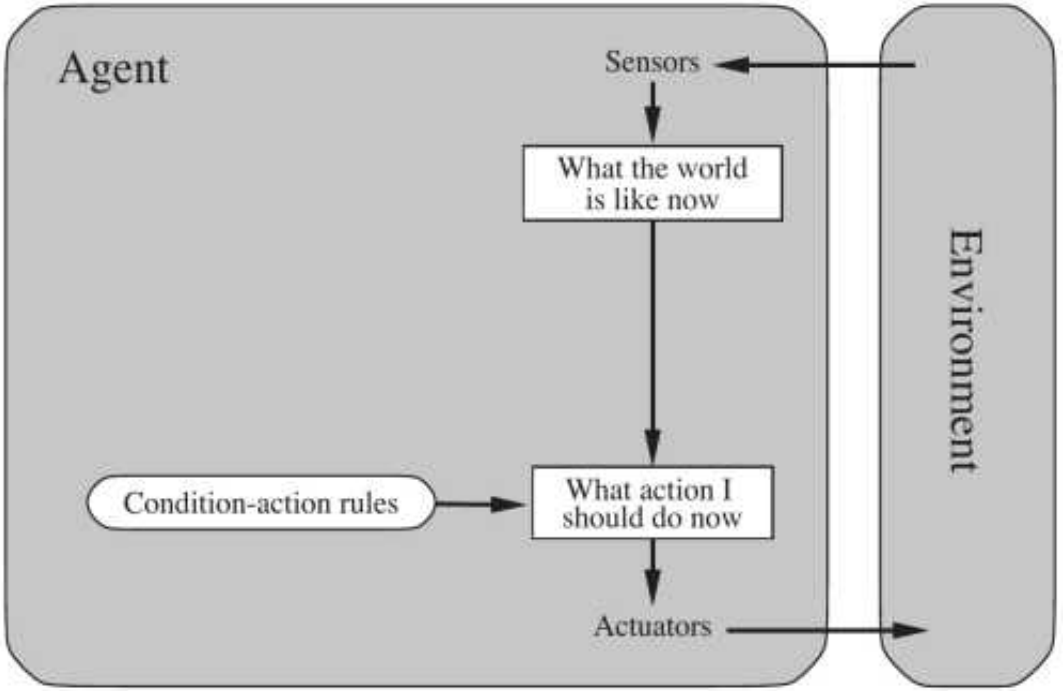
- **Deterministicness** (deterministic or stochastic): An environment is deterministic if the next state is perfectly predictable given knowledge of the previous state and the agent's action.
- **Staticness** (static or dynamic): Static environments do not change while the agent deliberates.
- **Observability** (full or partial): A fully observable environments is one in which the agent has access to all information in the environment relevant to its task.
- **Agency** (single or multiple): If there is at least one other agent in the environment, it is a multi-agent environment. Other agents might be apathetic, cooperative, or competitive.
- **Knowledge** (known or unknown): An environment is considered to be "known" if the agent understands the laws that govern the environment's behavior. For example, in chess, the agent would know that when a piece is "taken" it is removed from the game. On a street, the agent might know that when it rains, the streets get slippery.
- **Episodicness** (episodic or sequential): Sequential environments require memory of past actions to determine the next best action. Episodic environments are a series of one-shot actions. An AI that looks at radiology images to determine if there is a sickness is an example of an episodic environment. One image has nothing to do with the next.
- **Discreteness** (discrete or continuous): A discrete environment has fixed locations or time intervals. A continuous environment could be measured quantitatively to any level of precision.

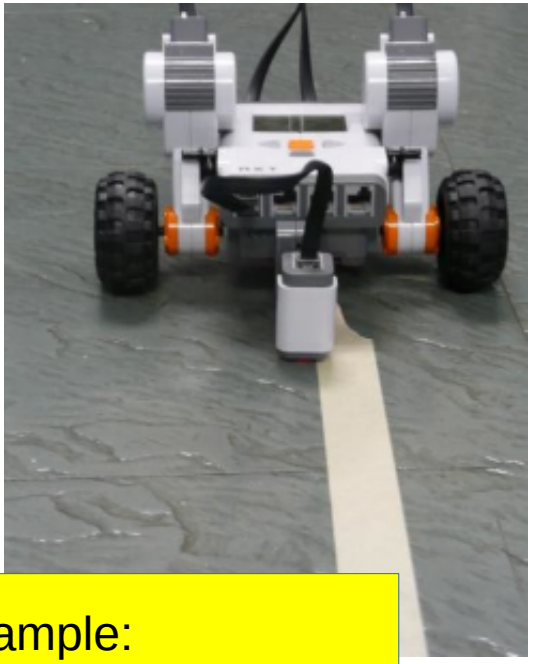
Agent types

- Four basic types in order of increasing generality:
  - Simple reflex agents
  - Reflex agents with state
  - Goal-based agents
  - Utility-based agents
  - All these can be turned into learning agents

Reflex Agents

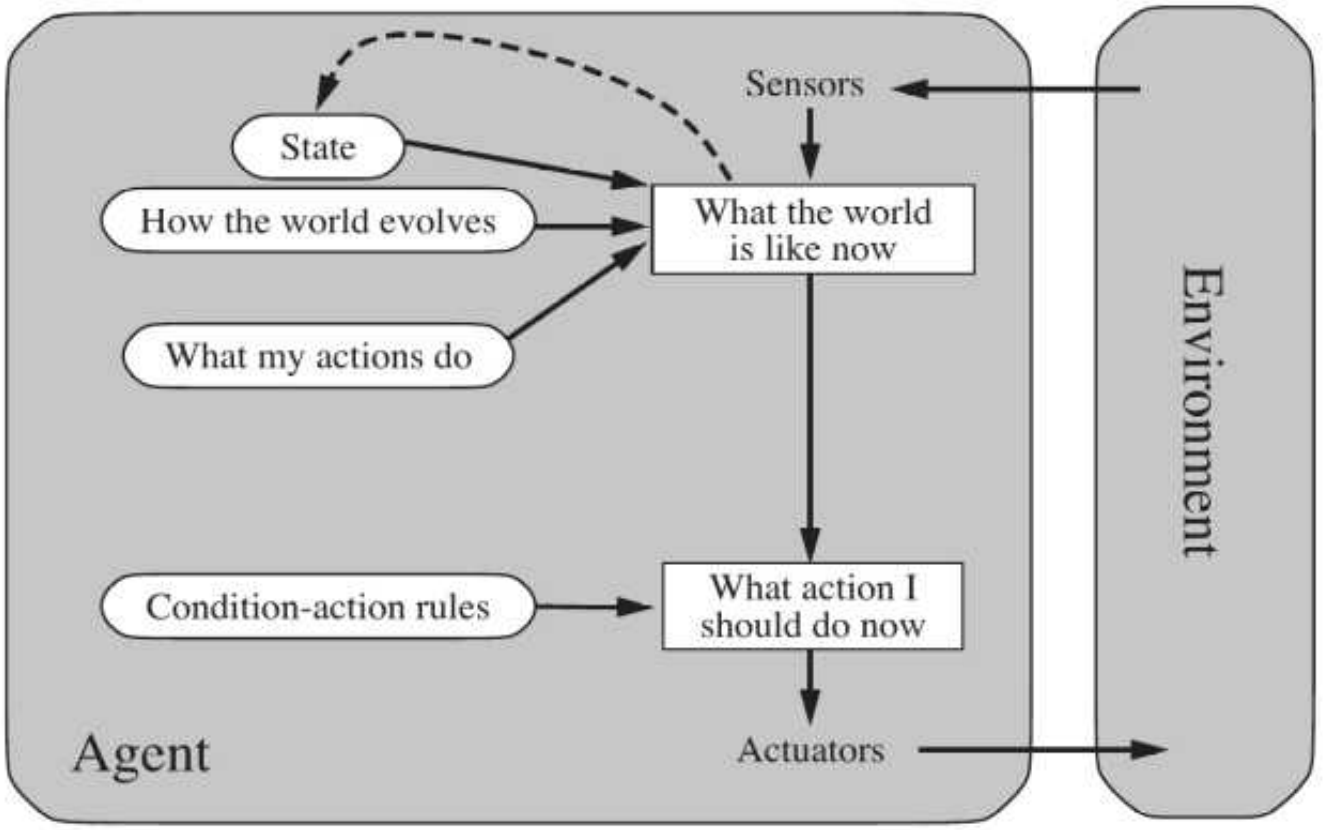
- Reflex agents:
  - Choose action based on current percept (and maybe memory)
  - May have memory or a model of the world's current state
  - Do not consider the future consequences of their actions





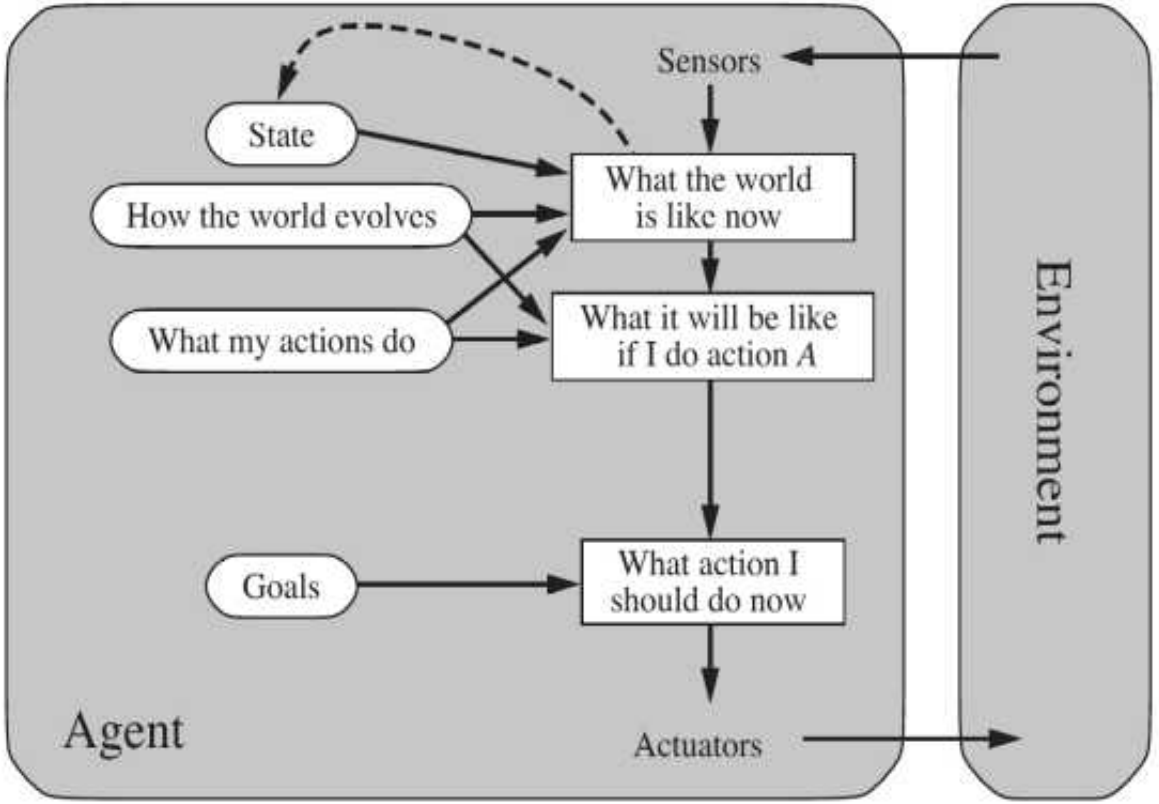
- Example:
  edge following robot

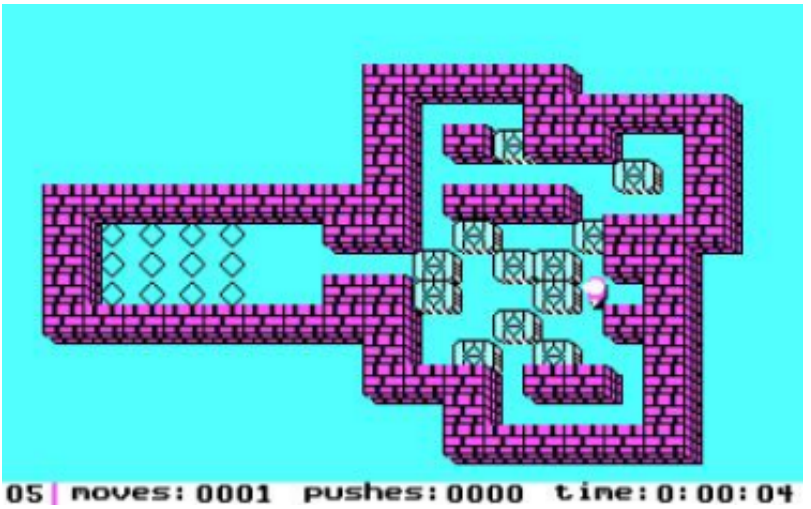
Model based reflex agent



- Can handle a partially observable environment
- Maintain some representation which describes the world that cannot be presently seen
- Example:
  Vacuum robot that counts the number of cells cleaned

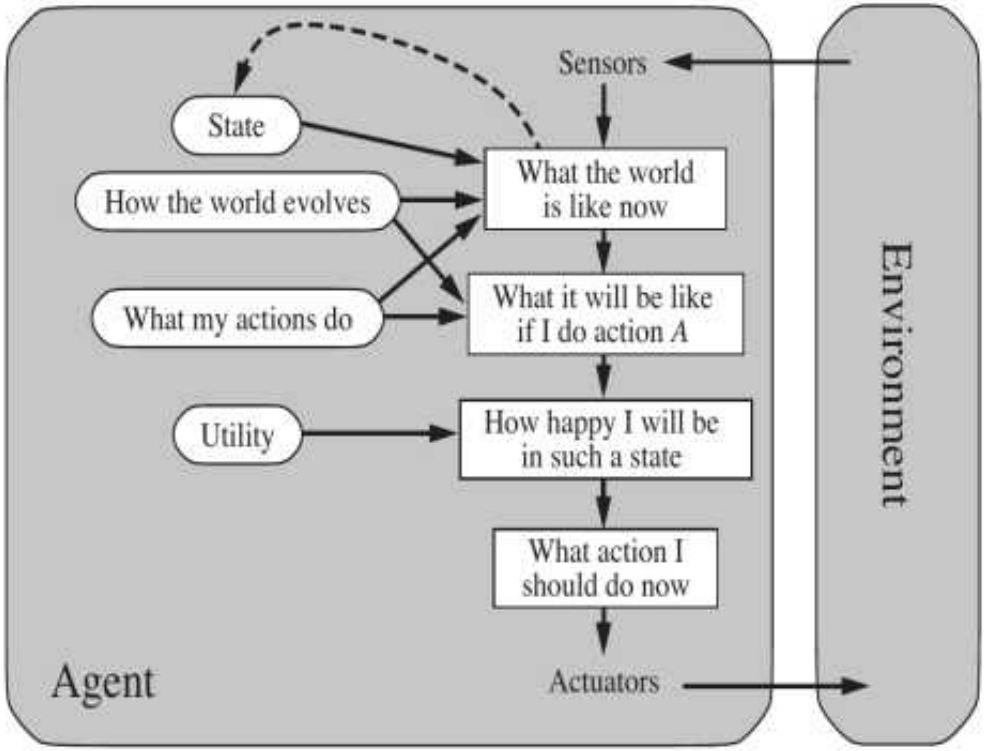
A model-based, goal-based agent

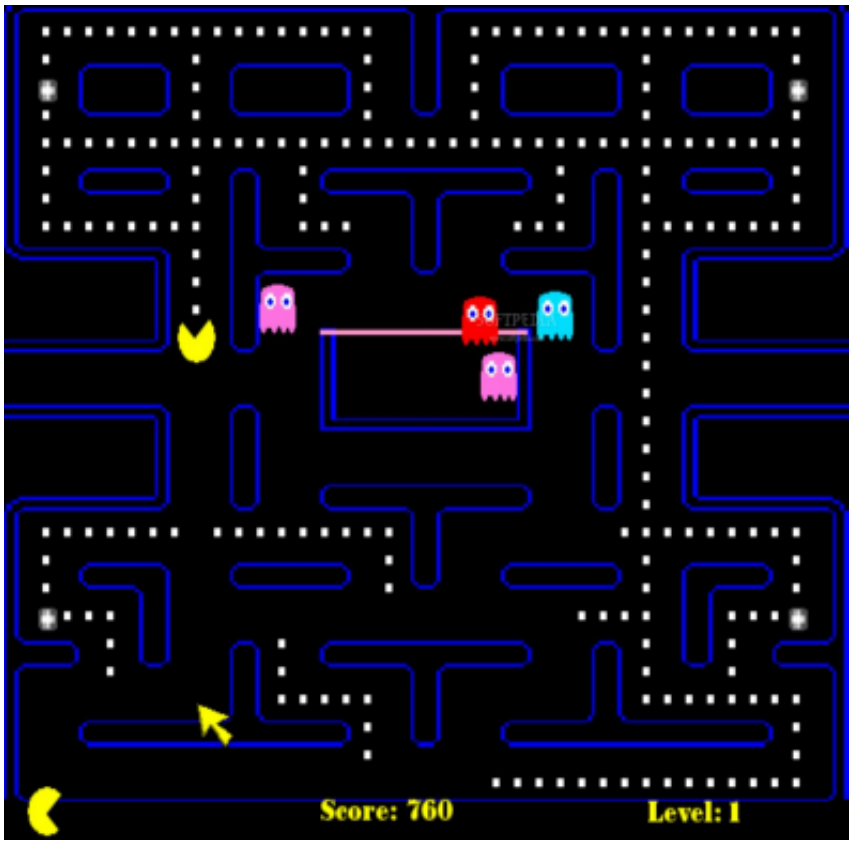




- Example: Sokoban agent

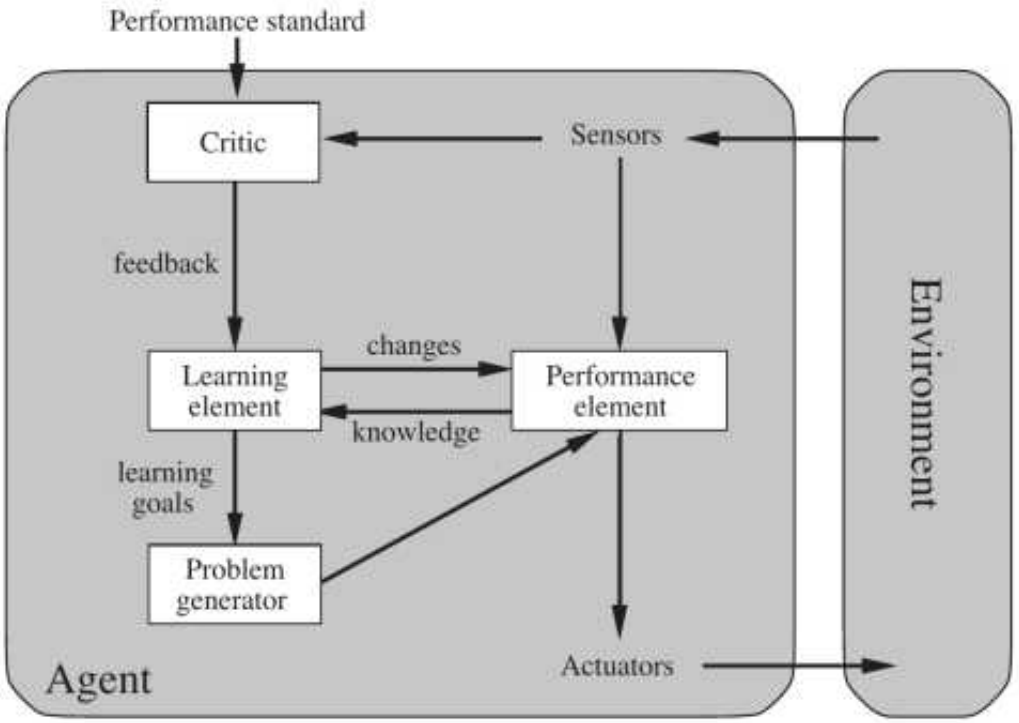
A model-based, utility-based agent

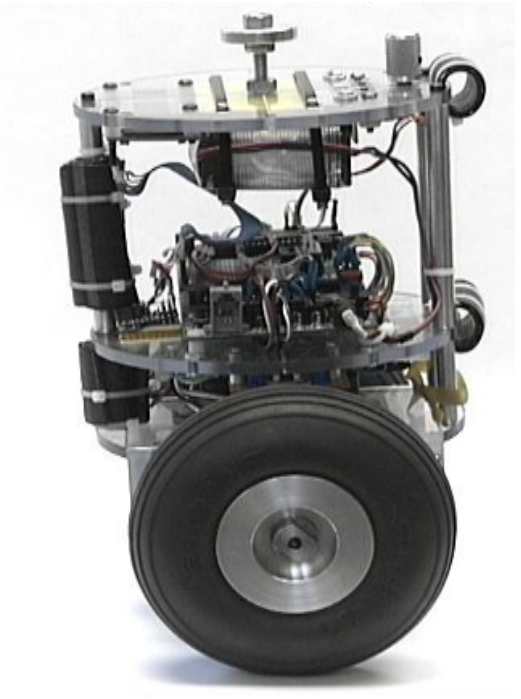




- Example: Pacman player

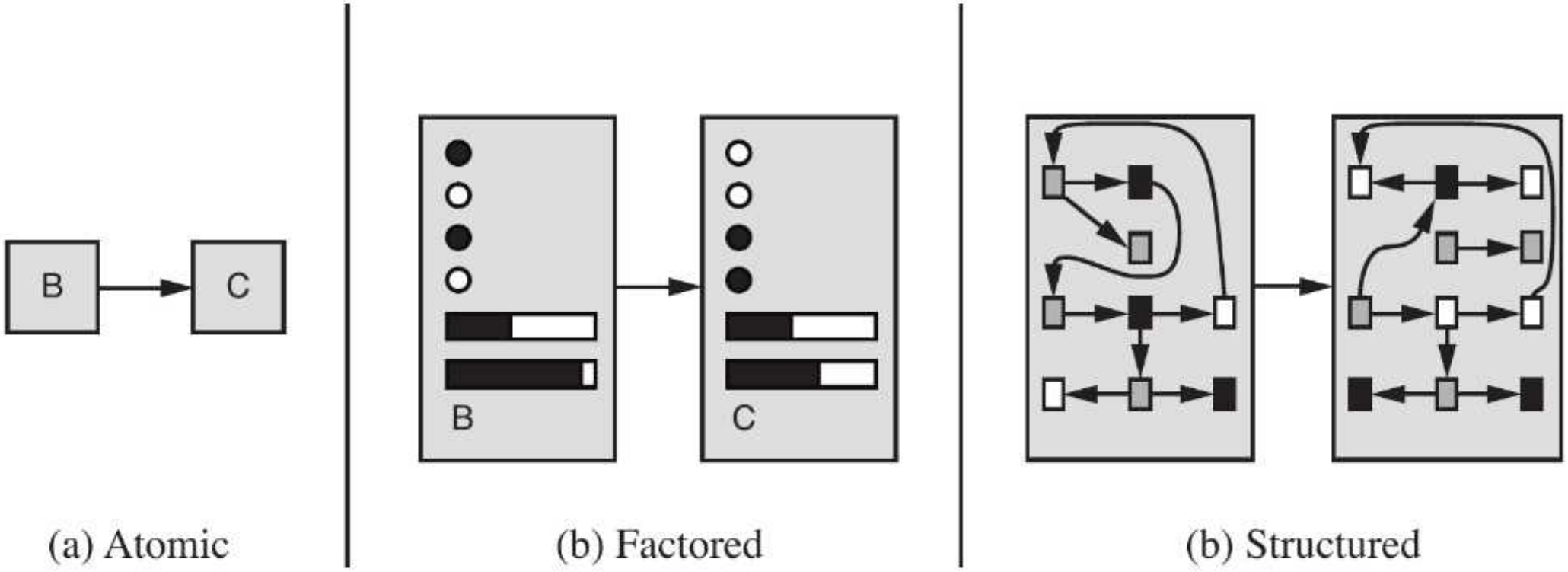
A general learning agent





- Example:
  Self balancing robot

State types



Summary

- Agents interact with environments through actuators and sensors
- The agent function describes what the agent does in all circumstances
- The performance measure evaluates the environment sequence
- A perfectly rational agent maximises expected performance
- Agent programs implement (some) agent functions
- PEAS descriptions define task environments
- Environments are categorised along several dimensions:
  - observable? deterministic? episodic? static? discrete? single-agent?
- Several basic agent architectures exist:
  - reflex, reflex with state, goal-based, utility-based