

# **Intelligent Agents**

Chapter 2



#### 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:

$$f:\mathcal{P}^*\to\mathcal{A}$$

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



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

Actions: Left, Right, Suck, NoOp

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
:	÷

What is the right function?

Can it be implemented in a small agent program?

```
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
```

- What is the right function?
- Can it be implemented in a small agent program?

Rationality

- Fixed performance measure evaluates the environment sequence
  - one point per square cleaned up in time T?
  - one point per clean square per time step, minus one per move?
  - penalize for > k dirty squares?
- *rational agent* chooses whichever action maximizes the *expected* value of the performance measure given the percept sequence to date
- Rational  $\neq$  omniscient
  Rational  $\neq$  clairvoyant
  Rational  $\neq$  successful
- Rational  $\implies$  exploration, learning, autonomy



- To design a rational agent, we must specify the task environment
- Consider, e.g., the task of designing an automated taxi:
  - Performance measure:
  - Environment:
  - Actuators:
  - Sensors:



- To design a rational agent, we must specify the task environment
- Consider, e.g., the task of designing an automated taxi:
  - Performance measure: safety, destination, profits, legality, comfort, ...
  - Environment: US streets/freeways, traffic, pedestrians, weather, ...
  - Actuators: steering, accelerator, brake, horn, speaker/display, ...
  - Sensors: video, accelerometers, gauges, engine sensors, keyboard, GPS, ...

### **Internet shopping agent**

- Performance measure:
- Environment:
- Actuators:
- Sensors:

			Internet	
	Solitaire	Backgammon	shopping	Taxi
Observable??				
Deterministic??				
Episodic??				
Static??				
Discrete??				
Single-agent??				

*Fully Observable*: access to the complete (relevant) state of the world *Partially Observable*: missing information

			Internet	
	Solitaire	Backgammon	shopping	Taxi
Observable??	yes (?)	yes	no	no
Deterministic??				
Episodic??				
Static??				
Discrete??				
Single-agent??				

*Deterministic*: the next state is completely determined by the current state and the action

Stochastic: Changes not known

Strategic: Deterministic except for the actions of the other agents

			Internet	
	Solitaire	Backgammon	shopping	Taxi
Observable??	yes (?)	yes	no	no
Deterministic??	yes	no	partly	no
Episodic??				
Static??				
Discrete??				
Single-agent??				

*Episodic*: task divided into atomic episodes

Sequential: Current decision may affect all future decisions

			Internet	
	Solitaire	Backgammon	shopping	Taxi
Observable??	yes (?)	yes	no	no
Deterministic??	yes	no	partly	no
Episodic??	no	no	no	no
Static??				
Discrete??				
Single-agent??				

Static: the world does not change while the agent is thinking *Dynamic*: changes *Semidynamic*: does not change but the performance is affected as time passes

			Internet	
	Solitaire	Backgammon	shopping	Taxi
Observable??	yes (?)	yes	no	no
Deterministic??	yes	no	partly	no
Episodic??	no	no	no	no
Static??	yes	semi	no	no
Discrete??				
Single-agent??				

*Discrete*: time, percepts, and actions are discrete *Continuous*: time, percepts, and actions are continuous over time

			Internet	
	Solitaire	Backgammon	shopping	Taxi
Observable??	yes (?)	yes	no	no
Deterministic??	yes	no	partly	no
Episodic??	no	no	no	no
Static??	yes	semi	no	no
Discrete??	yes	yes	yes	no
Single-agent??				

*Single-agent*: one agent *Multi-agent*: competitive or cooperating agents

			Internet	
	Solitaire	Backgammon	shopping	Taxi
Observable??	yes (?)	yes	no	no
Deterministic??	yes	no	partly	no
Episodic??	no	no	no	no
Static??	yes	semi	no	no
Discrete??	yes	yes	yes	no
Single-agent??	yes	no	yes (?)	no

The environment type largely determines the agent design

The real world is (of course) partially observable, stochastic, sequential,

dynamic, continuous, multi-agent



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

## Simple reflex agents



#### **Reflex agents with state**



#### **Goal-based** agents



#### **Utility-based agents**



### **Learning agents**

