

Agents



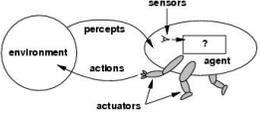

What's an agent?

- Russell and Norvig:
 - “An **agent** is anything that can be viewed as perceiving its **environment** through **sensors** and acting on that environment through **actuators**.” (p. 32)
- Examples:
 - The automatic driver
 - Internet shopper
 - Backgammon player
 - Chemical plant controller
 - Spam detector

The agent and the environment

An agent:

- Works in a particular environment
- Has goals
- Perceives the environment
- Performs actions to achieve its goals.



Example: the automated driver

- Performance measures?
- Environment:
 - Roads, other traffic, pedestrians, weather
- Actuators:
 - Steering, accelerator, brake, turn signal, horn
- Sensors:
 - Cameras, LIDAR, RADAR, GPS engine and motion sensors, microphone



Example: the automated driver

- Possible performance measures:
 - Safe, fast, legal, comfortable trip.
- Environment:
 - Roads, other traffic, pedestrians, weather
- Actuators:
 - Steering, accelerator, brake, turn signal, horn
- Sensors:
 - Cameras, LIDAR, RADAR, GPS engine and motion sensors, microphone



Environments

Fully vs. partially observable: can the sensors detect all aspects that are relevant to the choice of action.

	Crossword puzzle	Backgammon	Internet shopping	Automated driver
Observable	fully	fully	?	?
Deterministic				
Episodic				
Static				
Discrete				
Agents				

Environments



Deterministic vs. stochastic: is the next environment state completely determined by the current state?

	Crossword puzzle	Backgammon	Internet shopping	Automated driver
Observable	fully	fully	?	partially
Deterministic	deterministic	stochastic	?	?
Episodic				
Static				
Discrete				
Agents				

Environments



Episodic vs. sequential: can the agent's experience be divided into steps where the agent's action depends only on the current episode?

	Crossword puzzle	Backgammon	Internet shopping	Automated driver
Observable	fully	fully	?	partially
Deterministic	deterministic	stochastic	?	stochastic
Episodic	sequential	sequential	sequential	sequential
Static				
Discrete				
Agents				

Environments



Static vs. dynamic: can the environment change while the agent is choosing an action?

	Crossword puzzle	Backgammon	Internet shopping	Automated driver
Observable	fully	fully	?	partially
Deterministic	deterministic	stochastic	?	stochastic
Episodic	sequential	sequential	sequential	sequential
Static	static	static	?	?
Discrete				
Agents				

Environments



Discrete vs. continuous: This distinction can be applied to the state of the environment, the way time is handled and to the percepts/actions of the agent.

	Crossword puzzle	Backgammon	Internet shopping	Automated driver
Observable	fully	fully	?	partially
Deterministic	deterministic	stochastic	?	stochastic
Episodic	sequential	sequential	sequential	sequential
Static	static	static	dynamic	dynamic
Discrete	discrete	discrete	discrete	continuous
Agents				

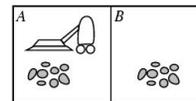
Environments



Single vs. multi-agent: Does the environment contain other agents who are also maximizing some performance measure that depends on the current agent's actions?

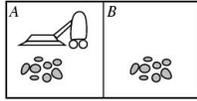
	Crossword puzzle	Backgammon	Internet shopping	Automated driver
Observable	fully	fully	?	partially
Deterministic	deterministic	stochastic	?	stochastic
Episodic	sequential	sequential	sequential	sequential
Static	static	static	dynamic	dynamic
Discrete	discrete	discrete	discrete	continuous
Agents	single	multi	multi	multi

The vacuum world



- Environment: squares A and B
- Percepts: [location and content] e.g. [A, Dirty]
- Actions: left, right, suck, no-op

A simple agent function



```
def REFLEX-VACUUM-AGENT (location, status) :
  if status == Dirty:
    return Suck
  elif location == A:
    return Right
  elif location == B:
    return Left
```

Is this the best agent for the job?

Rational agents

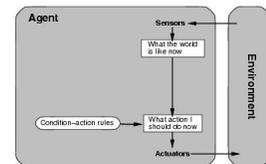
- An agent has a performance measure according to what is wanted in the environment (goal).
- Performance measures for the vacuum world?
- A rational agent chooses an action which maximizes the expected value of the performance measure given the percept sequence and its built-in knowledge

Agent structure

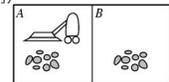
- Agent: architecture + program
- The **agent program**: maps percepts to actions
- The agent program receives as input the current percept and returns an action for the agent's actuators.

Simple reflex agent

- Selects action only on the basis of the current percept
- Large reduction in possible percept/action combinations

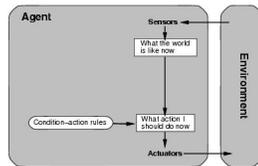


```
function REFLEX-VACUUM-AGENT ([location, status])
  if status == Dirty then return Suck
  else if location == A then return Right
  else if location == B then return Left
```



Simple reflex agent

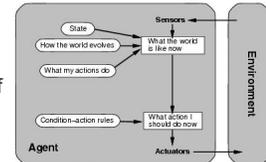
- Selects action only on the basis of the current percept
- Large reduction in possible percept/action combinations



Will our automated-driver agent work as a simple reflex agent?

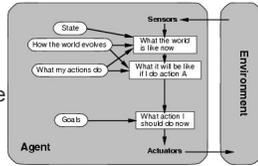
Model-based reflex agent

- Maintain an internal state
- Update the state using information on "how the world works" (the model of the world)
- Automated-driver agent: needs to keep track of cars in his blind spot



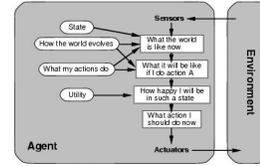
Goal-based agents

- Our automated-driver agent needs to get somewhere: it has a *goal*. Chooses actions to achieve goal.
- Search and planning** are subfields of AI devoted to finding a sequence of actions that achieve the agent's goals.



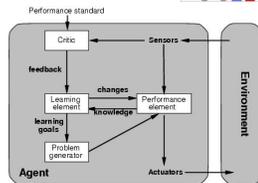
Utility-based agents

- Utility function maps a (sequence of) state(s) onto a real number.
- Certain goals can be reached in different ways.
 - Some are better, have a higher utility.
- Improves on goals:
 - Selecting between conflicting goals
 - Select appropriately between several goals that have varying probability of success.



Learning agents

- All previous agent-programs describe methods for selecting *actions*.
 - Yet it does not explain the origin of these programs.
 - Learning mechanisms can be used to perform this task.
 - Teach them instead of instructing them.
 - Advantage is the robustness of the program toward initially unknown environments.



Learning agents

- Performance element:** selects actions based on percepts.
 - Corresponds to the previous agent programs
- Learning element:** introduce improvements in performance element.
 - Critic provides feedback on agents performance based on fixed performance standard.

