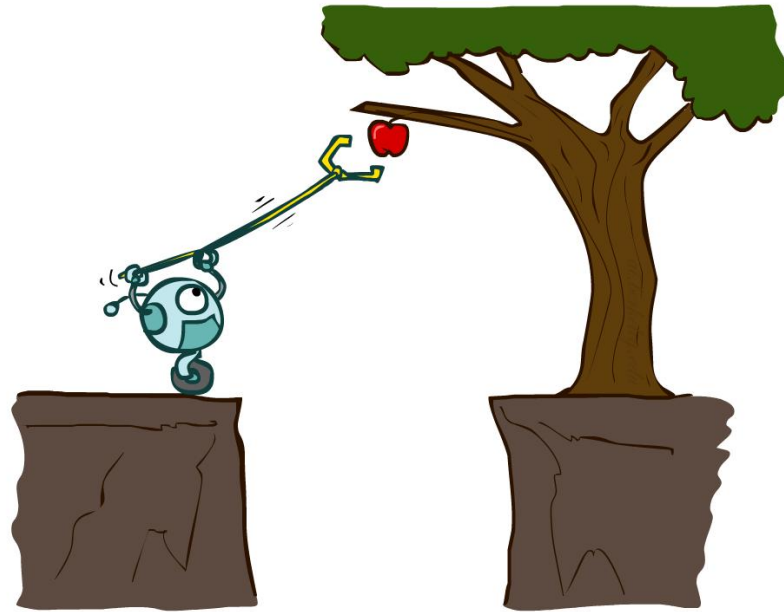


Artificial Intelligence

Agents and environments

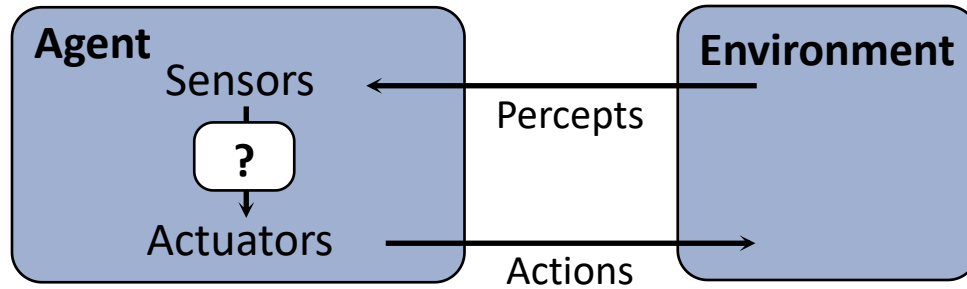


Instructors: Stuart Russell and Dawn Song ai.berkeley.edu

Outline

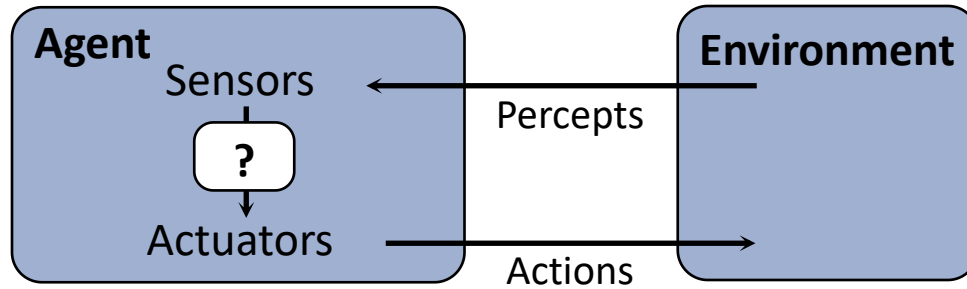
- Agents and environments
- Rationality
- PEAS (Performance measure, Environment, Actuators, Sensors)
- Environment types
- Agent types

Agents and environments



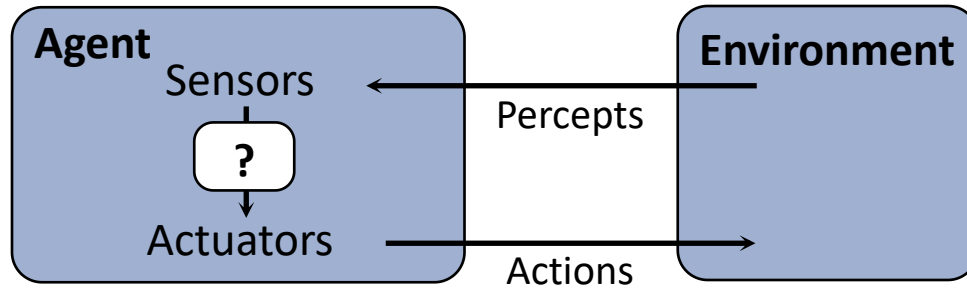
- An agent **perceives** its environment through **sensors** and **acts** upon it through **actuators** (or **effectors**, depending on whom you ask)

Agents and environments



- Are humans agents?
- Yes!
 - Sensors = vision, audio, touch, smell, taste, proprioception
 - Actuators = muscles, secretions, changing brain state

Agents and environments

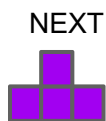


- Are pocket calculators agents?
- Yes!
 - Sensors = key state sensors
 - Actuators = digit display

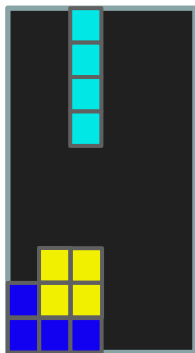
Agent functions

- The **agent function** maps from percept histories to actions:
 - $f: \mathcal{P}^* \rightarrow \mathcal{A}$
 - I.e., the agent's actual response to any sequence of percepts

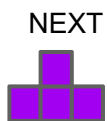
Percept



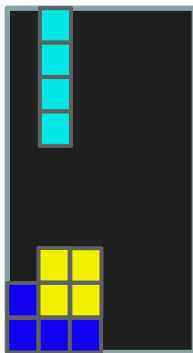
NEXT



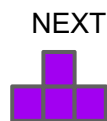
LEFT



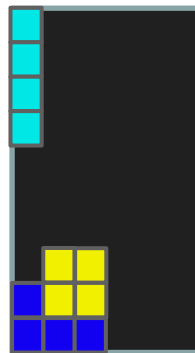
NEXT



LEFT



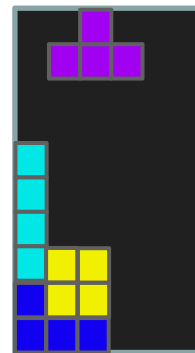
NEXT



DROP



NEXT



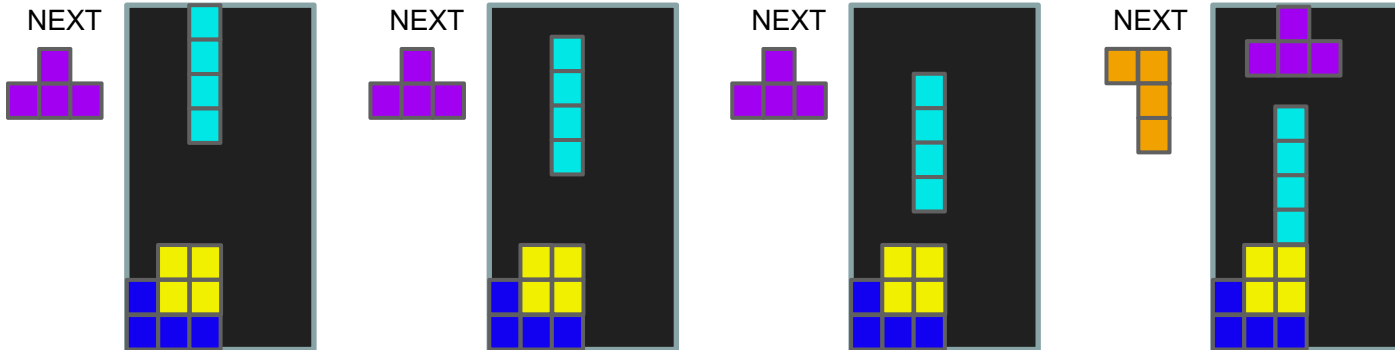
RIGHT

Action

Agent programs

- The **agent program** \mathcal{L} runs on some machine M to implement f :
 - $f = \text{Agent}(\mathcal{L}, M)$
 - Real machines have limited speed and memory, introducing delay, so agent function f depends on M as well as \mathcal{L}

Percept



Action

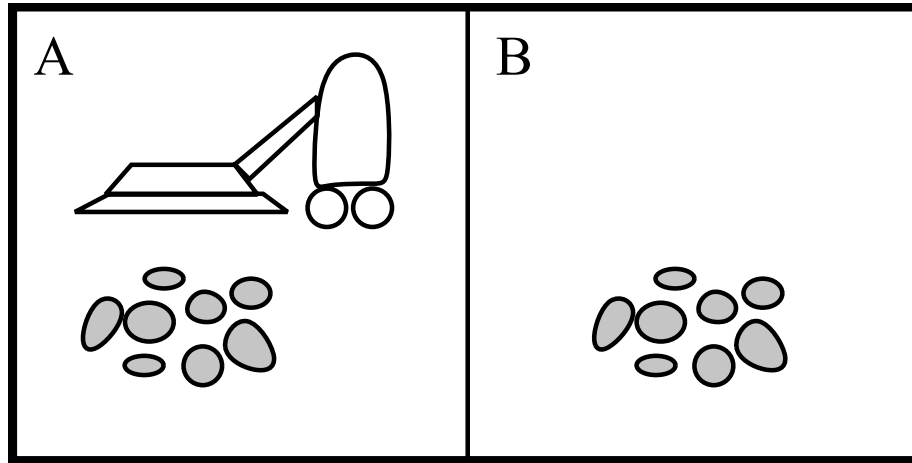
NOOP

NOOP

NOOP

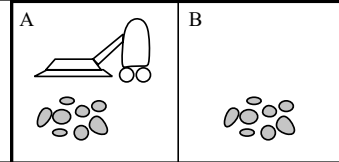
LEFT

Example: Vacuum world



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

Vacuum cleaner agent



Agent function

Percept sequence	Action
[A,Clean]	Right
[A,Dirty]	Suck
[B,Clean]	Left
[B,Dirty]	Suck
[A,Clean],[B,Clean]	Left
[A,Clean],[B,Dirty]	Suck
etc	etc

Agent program

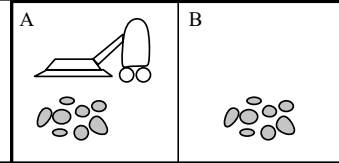
```
function Reflex-Vacuum-Agent([location,status])  
    returns an action  
if status = Dirty then return Suck  
else if location = A then return Right  
else if location = B then return Left
```

What is the *right* agent function?

Can it be implemented by a small agent program?

(Can we ask, “What is the right agent program?”)

Rationality



- Fixed **performance measure** evaluates the environment sequence
 - one point per square cleaned up?
 - NO! Rewards an agent who dumps dirt and cleans it up
 - one point per clean square per time step, for $t = 1, \dots, T$
- A **rational agent** chooses whichever action maximizes the **expected** value of the performance measure
 - given the percept sequence to date and prior knowledge of environment

Does Reflex-Vacuum-Agent implement a rational agent function?

Yes, if movement is free, or new dirt arrives frequently

A human agent in Pacman



The task environment - PEAS

- Performance measure

- -1 per step; + 10 food; +500 win; -500 die;
+200 hit scared ghost

- Environment

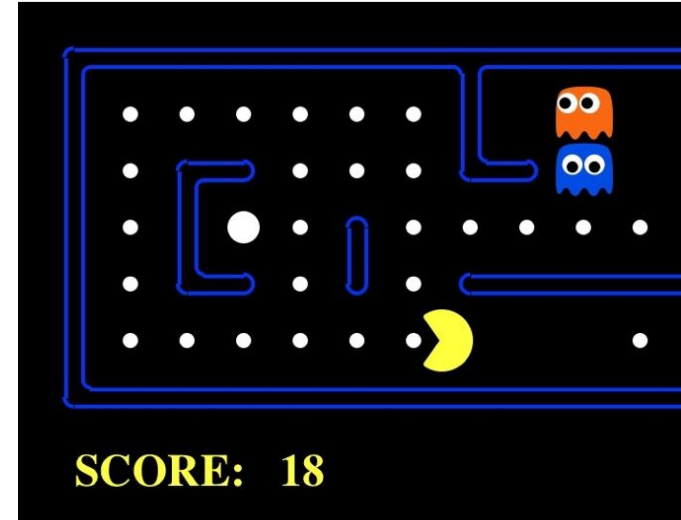
- Pacman dynamics

- Actuators

- Left Right Up Down

- Sensors

- Entire state is visible



PEAS: Automated taxi

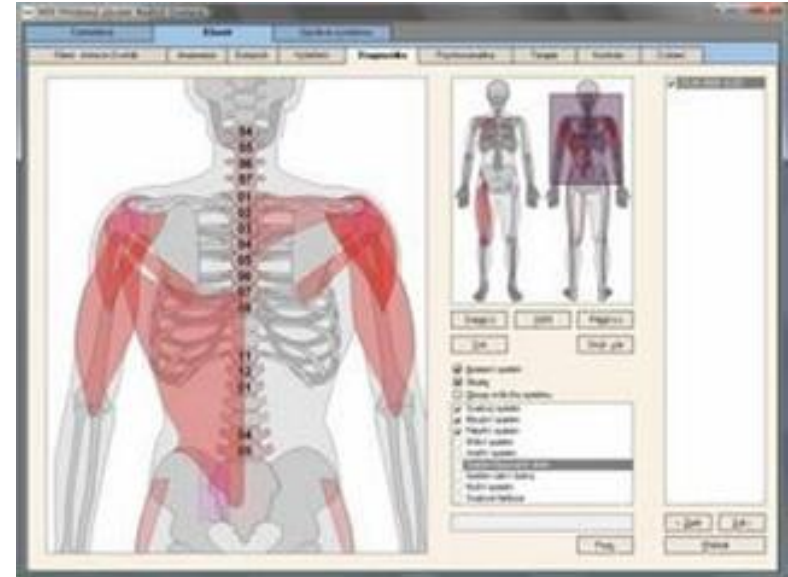
- Performance measure
 - Income, happy customer, vehicle costs, fines, insurance premiums
- Environment
 - streets, other drivers, customers, weather, police...
- Actuators
 - Steering, brake, gas, display/speaker
- Sensors
 - Camera, radar, accelerometer, engine sensors, microphone, GPS



Image: <http://nypost.com/2014/06/21/how-google-might-put-taxi-drivers-out-of-business/>

PEAS: Medical diagnosis system

- Performance measure
 - Patient health, cost, reputation
- Environment
 - Patients, medical staff, insurers, courts
- Actuators
 - Screen display, email
- Sensors
 - Keyboard/mouse



More Examples

Agent	Performance Measure	Environment	Actuator	Sensor
Hospital Management System	Patient's health, Admission process, Payment	Hospital, Doctors, Patients	Prescription, Diagnosis, Scan report	Symptoms, Patient's response
Automated Car Drive	Comfortable trip, Safety, Maximum Distance	Roads, Traffic, Vehicles	Steering wheel, Accelerator, Brake, Mirror	Camera, GPS, Odometer
Subject Tutoring	Maximize scores, Improvement is students	Classroom, Desk, Chair, Board, Staff, Students	Smart displays, Corrections	Eyes, Ears, Notebooks
Part -picking Robot	Percentage of parts in correct bins	Conveyor belt with parts, Bins	Jointed Arms, Hand	Camera, Joint angle, sensors

Summary

- An *agent* interacts with an *environment* through *sensors* and *actuators*
- The *agent function*, implemented by an *agent program* running on a *machine*, describes what the agent does in all circumstances
- Rational agents choose actions that maximize their expected utility
- PEAS descriptions define task environments; precise PEAS specifications are essential and strongly influence agent designs
- More difficult environments require more complex agent designs and more sophisticated representations