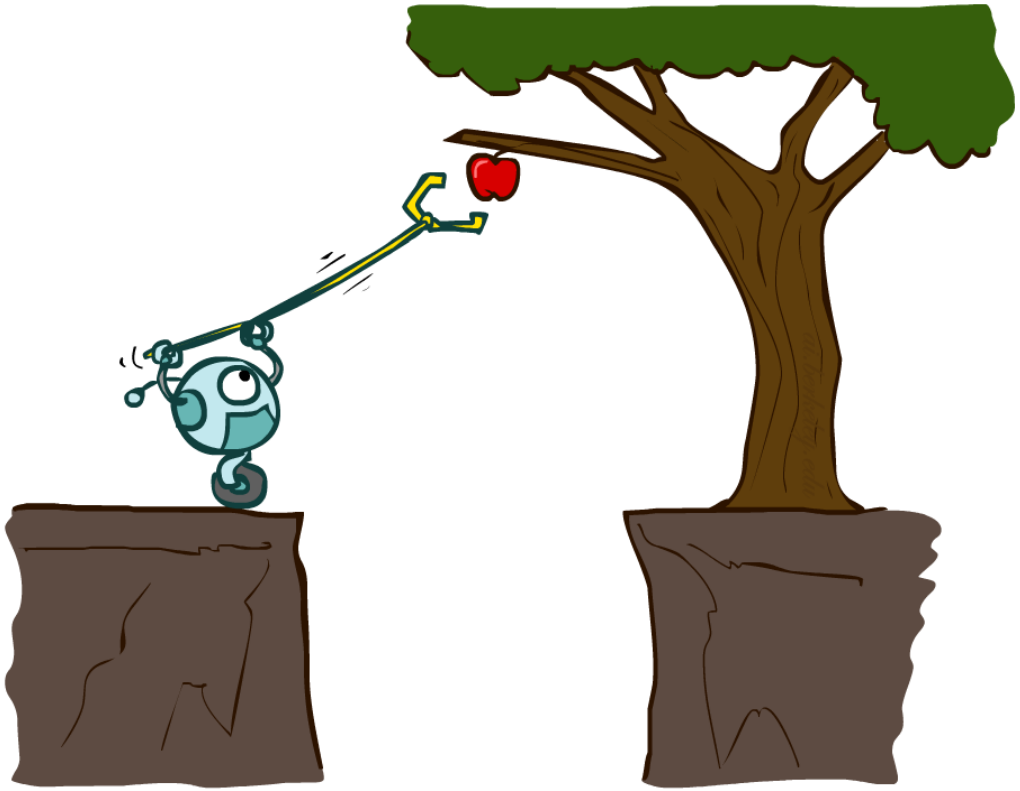
CSEP 573: Artificial Intelligence

Agents and environments

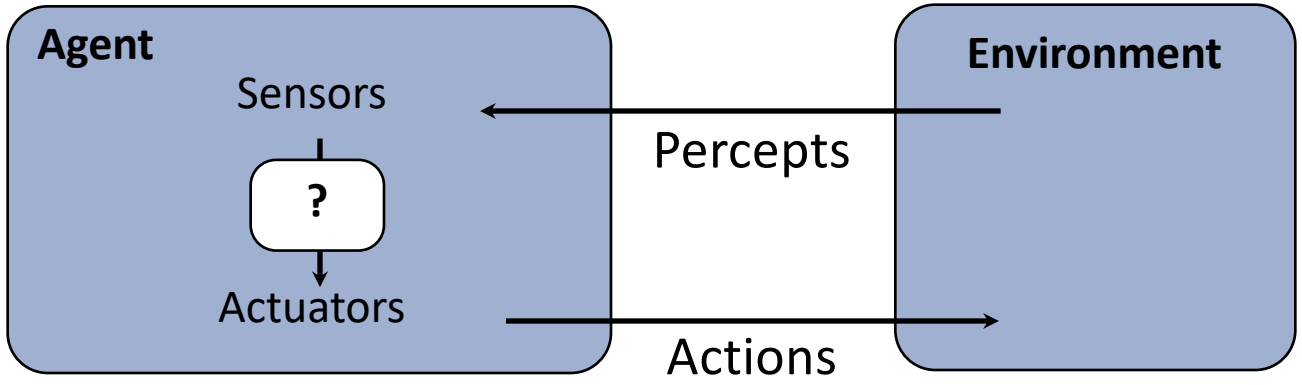


slides adapted from
Stuart Russel, Dan Klein, Pieter Abbeel from ai.berkeley.edu
And Hanna Hajishirzi, Jared Moore, Dan Weld

Outline

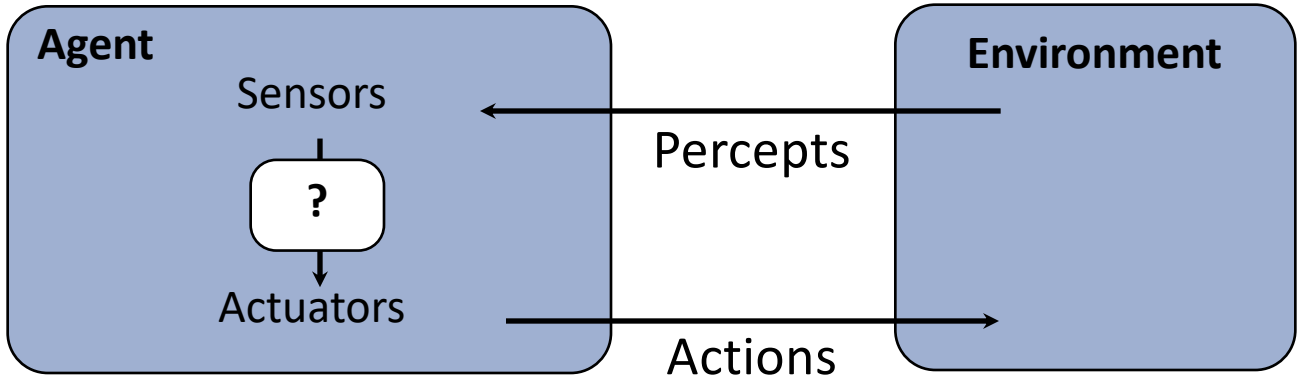
- Agents and environments
- Rationality
- PEAS (Performance measure, Environment, Actuators, Sensors)
- Environment types
- Agent types

Agents and environments



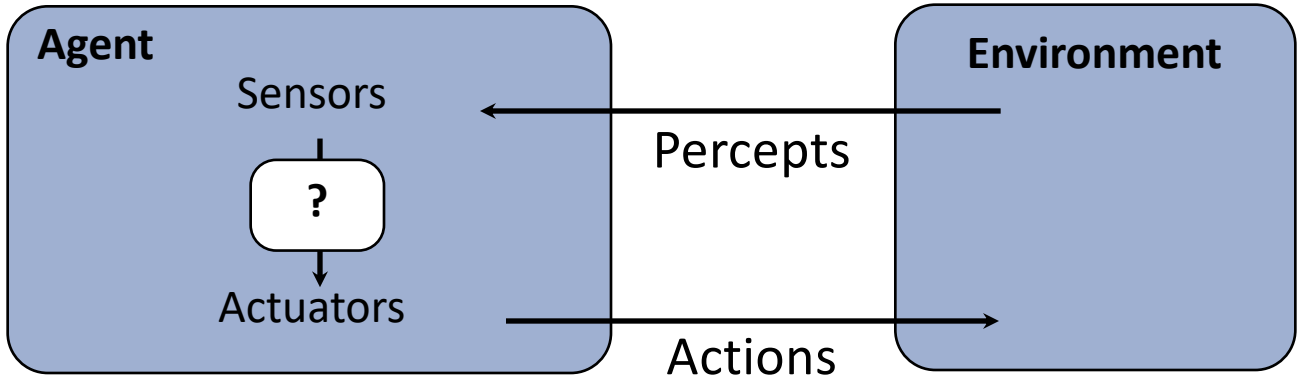
- An agent ***perceives*** its environment through ***sensors*** and ***acts*** upon it through ***actuators*** (or *effectors*, depending on whom you ask)

Agents and environments



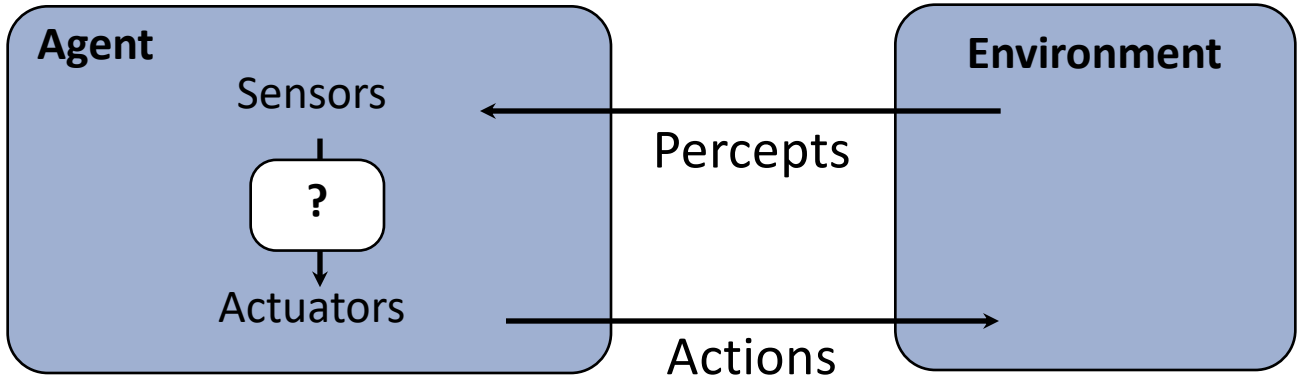
- Are humans agents?
- Yes!
  - Sensors = vision, audio, touch, smell, taste, proprioception
  - Actuators = muscles, secretions, changing brain state

Agents and environments



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

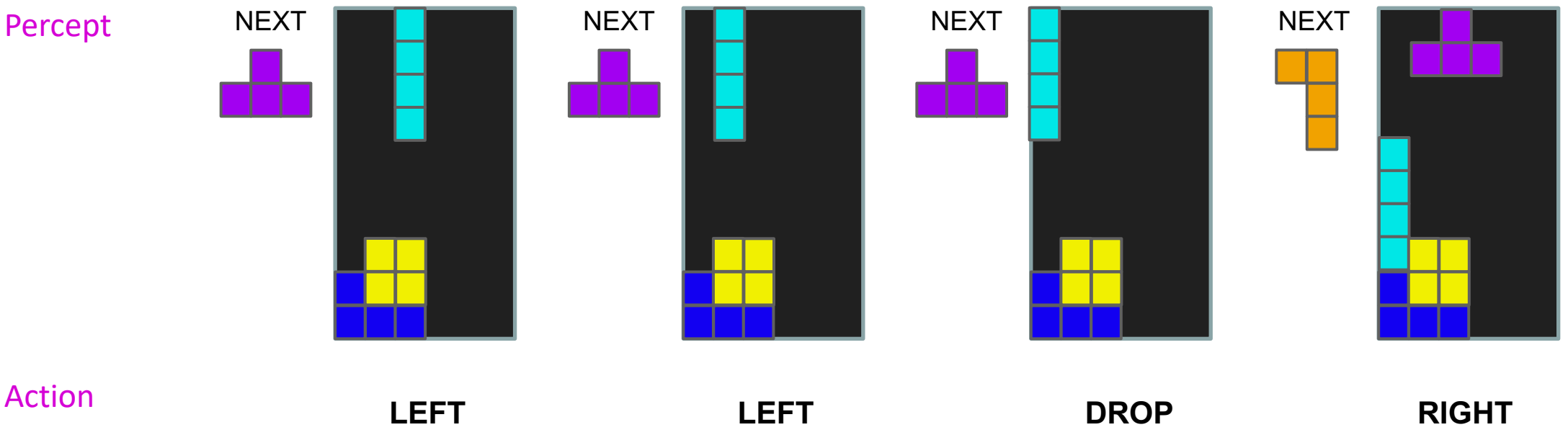
Agents and environments



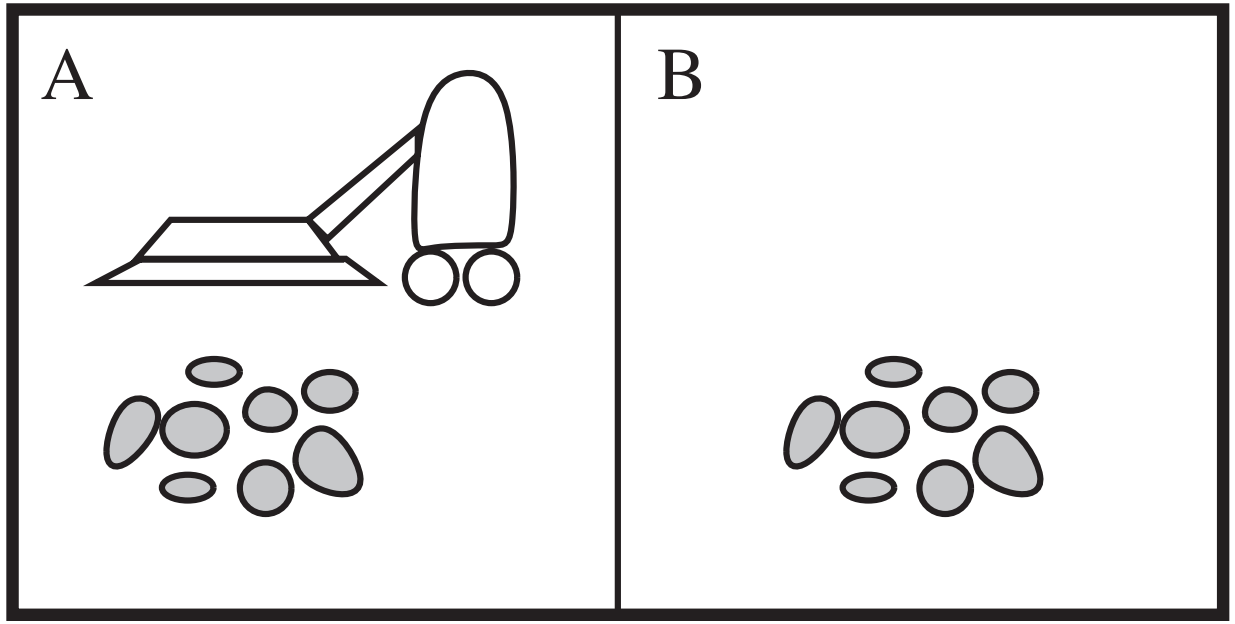
- AI is more interested in agents with large computational resources and environments that require nontrivial decision making

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

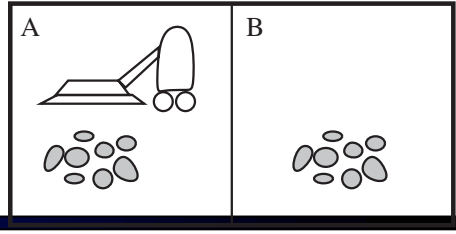


Example: Vacuum world



- 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?

Rationality

- A fixed ***performance measure*** evaluates the environment sequence
  - one point per square cleaned up?
    - Basically, but details matter: agent can dump dirt then clean, repeatedly
  - Add large penalty for dumping dirt? Add small penalty for moving?
- 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

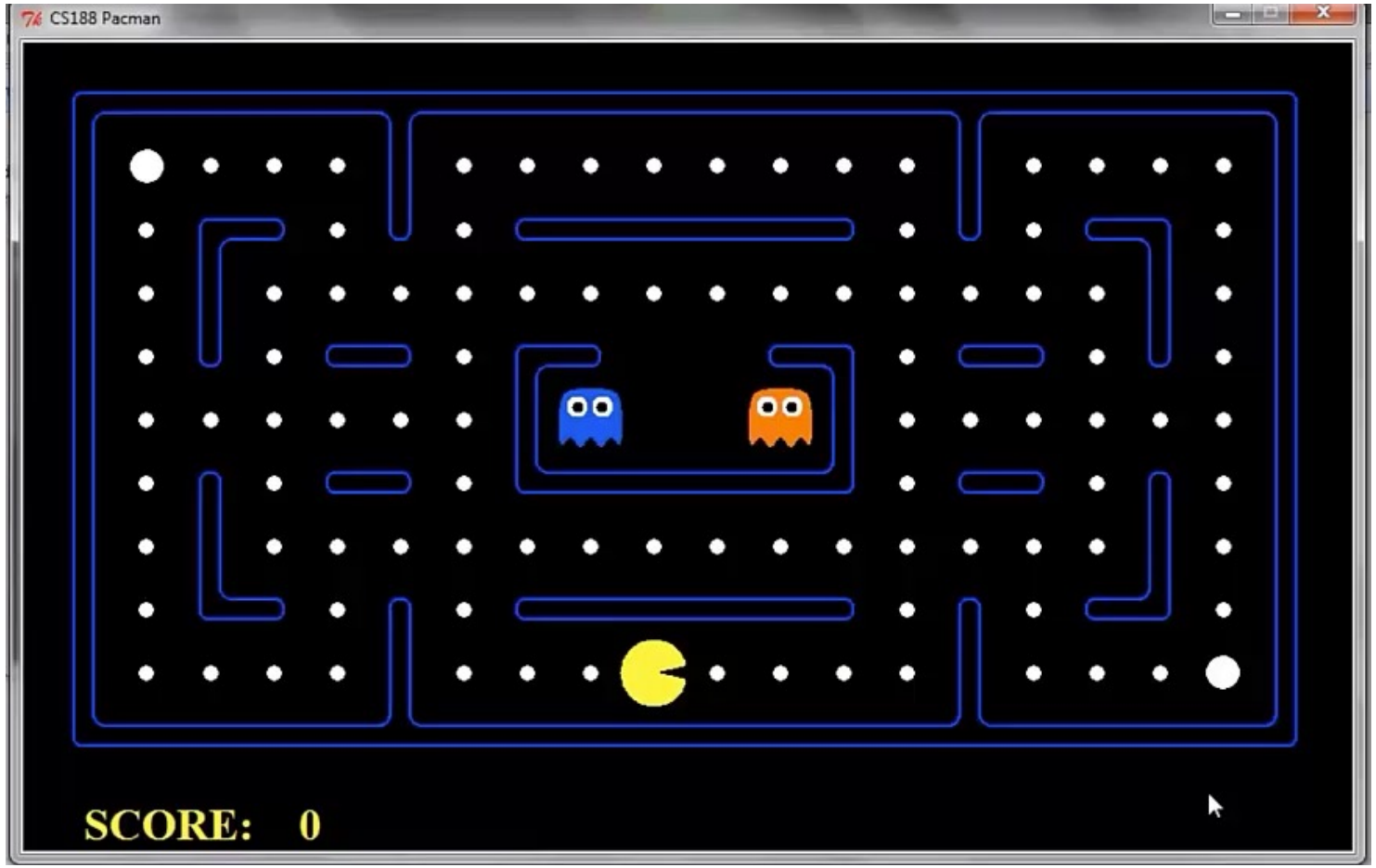
Does Reflex-Vacuum-Agent implement a rational agent function?

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

Rationality, contd.

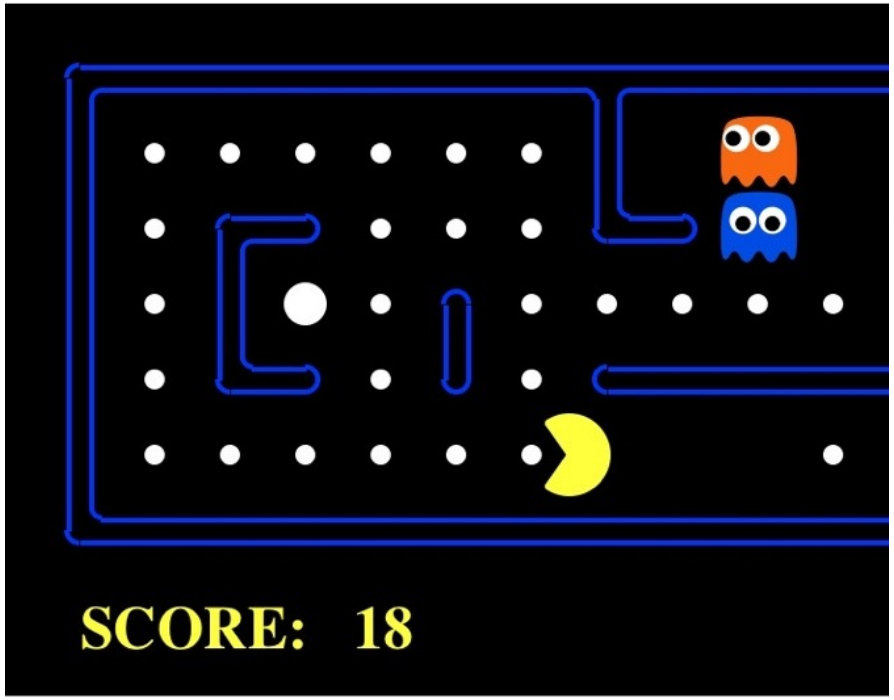
- Are rational agents ***omniscient***?
  - No – they are limited by the available percepts
- Are rational agents ***clairvoyant***?
  - No – they may lack knowledge of the environment dynamics
- Do rational agents ***explore*** and ***learn***?
  - Yes – in unknown environments these are essential
- Do rational agents ***make mistakes***?
  - No – but their actions may be unsuccessful / suboptimal
- Are rational agents ***autonomous*** (i.e., transcend initial program)?
  - Yes – as they learn, their behavior depends more on their own experience

A human agent in Pacman



The task environment - PEAS

- Performance measure
  - -1 per step; + 10 food; +500 win; -500 die; ghost
- Environment
  - Pacman dynamics (incl ghost behavior)
- Actuators
  - Left Right Up Down
- Sensors
  - Entire state is visible / observable (except power pellet duration)



Pacman agent contd.

- Can we (in principle) extend this reflex agent to behave well in all standard Pacman environments?
  - No – Pacman is not quite fully observable (power pellet duration)
  - Otherwise, yes – we can (*in principle*) make a lookup table…..

PEAS: Automated taxi

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

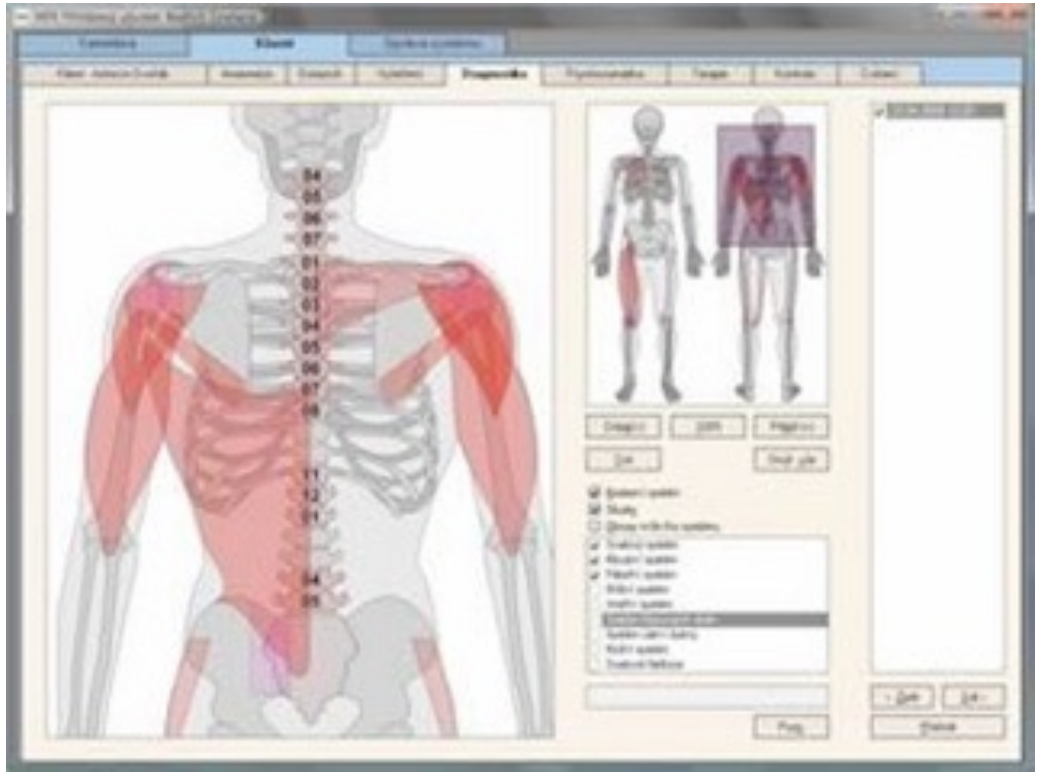
Image: http://nypost.com/2014/06/21/how-google-might-put-taxi-drivers-out-of-business/

PEAS: Backgammon

- Performance measure
  - Move all checkers home first
- Environment
  - Game board, other player?
- Actuators
  - Roll dice, decide how to move pieces
- Sensors
  - See the full board

PEAS: Medical diagnosis system

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



Environment types

	Pacman	Backgammon	Diagnosis	Taxi
Fully or partially observable	F*	F	P	P
Single-agent or multiagent	M	M	S	M
Deterministic or stochastic	D	S	D*	S
Static or dynamic	D	D	S	D
Discrete or continuous	D	D	C	C
Known physics?	Y	Y	N	Y
Known perf. measure?	Y	Y	N	Y*

Agent design

- **The environment type largely determines the agent design**
  - ***Partially observable*** => agent requires ***memory*** (internal state)
  - ***Stochastic*** => agent may have to prepare for ***contingencies***
  - ***Multi-agent*** => agent may need to behave ***randomly***
  - ***Static*** => agent has time to compute a rational decision
  - ***Continuous time*** => continuously operating ***controller***
  - ***Unknown physics*** => need for ***exploration***
  - ***Unknown perf. measure*** => observe/interact with ***human principal***

Summary

- An ***agent*** interacts with an ***environment*** through ***sensors*** and ***actuators***
- The ***agent function*** 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