

# Agents

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CS 4480

August 27, 2010



# AI prehistory

- Philosophy Logic, methods of reasoning, mind as physical system foundations of learning, language, rationality
- Mathematics Formal representation and proof algorithms, computation, (un)decidability, (in)tractability, probability
- Economics utility, decision theory
- Neuroscience physical substrate for mental activity
- Psychology phenomena of perception and motor control, experimental techniques
- Computer engineering building fast computers
- Control theory design systems that maximize an objective function over time
- Linguistics knowledge representation, grammar



# Bits of History

- **1956:** The name “Artificial Intelligence” is coined
- **60's:** Search and games, formal logic and theorem proving
- **70's:** Robotics, perception, knowledge representation, expert systems
- **80's:** More expert systems, AI becomes an industry
- **90's:** Rational agents, probabilistic reasoning, machine learning
- **00's:** Systems integrating many AI methods, machine learning, reasoning under uncertainty, robotics again

# State of the art

- Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997
- Proved a mathematical conjecture (Robbins conjecture) unsolved for decades
- No hands across America (driving autonomously 98% of the time from Pittsburgh to San Diego)
- During the 1991 Gulf War, US forces deployed an AI logistics planning and scheduling program that involved up to 50,000 vehicles, cargo, and people
- NASA's on-board autonomous planning program controlled the scheduling of operations for a spacecraft
- `Proverb` solves crossword puzzles better than most humans



# Outline for Chapter 2

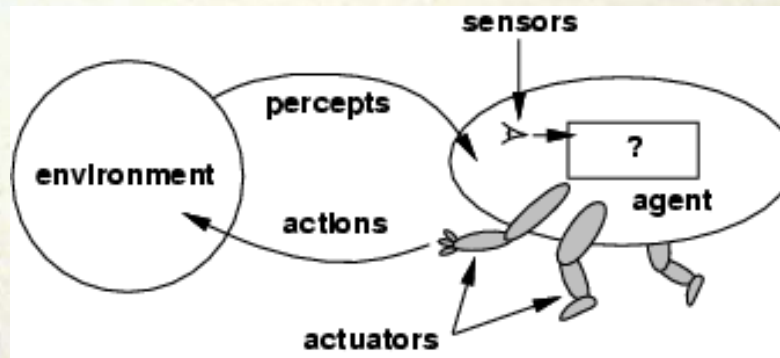
- Agents and environments
- Rationality
- PEAS (Performance measure, Environment, Actuators, Sensors)
- Environment types
- Agent types

# Agents

- An **agent** is anything that can be viewed as **perceiving** its **environment** through **sensors** and **acting** upon that environment through **actuators**
- Human agent: eyes, ears, and other organs for sensors; hands, legs, mouth, and other body parts for actuators
- Robotic agent: cameras and infrared range finders for sensors;
- various motors for actuators



# Agents and environments

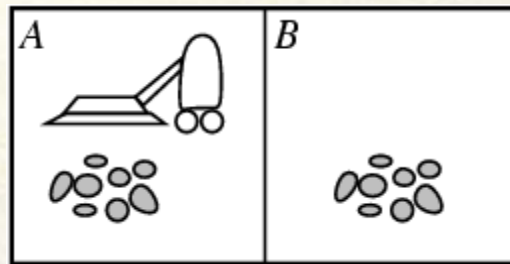


- The **agent function** maps from percept histories to actions:

$$[f: \mathcal{P}^* \rightarrow \mathcal{A}]$$

- The **agent program** runs on the physical **architecture** to produce  $f$
- agent = architecture + program

# Vacuum-cleaner world



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



## A vacuum-cleaner agent

Percept sequence	Action
<i>[A, Clean]</i>	<i>Right</i>
<i>[A, Dirty]</i>	<i>Suck</i>
<i>[B, Clean]</i>	<i>Left</i>
<i>[B, Dirty]</i>	<i>Suck</i>
<i>[A, Clean], [A, Clean]</i>	<i>Right</i>
<i>[A, Clean], [A, Dirty]</i>	<i>Suck</i>
<i>⋮</i>	<i>⋮</i>

**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*

# Rational agents

- An agent should strive to "do the right thing", based on what it can perceive and the actions it can perform. The right action is the one that will cause the agent to be most successful
- **Performance measure:** An objective criterion for success of an agent's behavior
- E.g., performance measure of a vacuum-cleaner agent could be amount of dirt cleaned up, amount of time taken, amount of electricity consumed, amount of noise generated, etc.



# Rational agents

- **Rational Agent:** For each possible percept sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and whatever built-in knowledge the agent has.

# Rational agents

- Rationality is distinct from omniscience (all-knowing with infinite knowledge)
- Agents can perform actions in order to modify future percepts so as to obtain useful information (information gathering, exploration)
- An agent is **autonomous** if its behavior is determined by its own experience (with ability to learn and adapt)



# PEAS

- PEAS: Performance measure, Environment, Actuators, Sensors
- Must first specify the setting for intelligent agent design
- Consider, e.g., the task of designing an automated taxi driver:
  - Performance measure
  - Environment
  - Actuators
  - Sensors

# PEAS

- Must first specify the setting for intelligent agent design
- Consider, e.g., the task of designing an automated **taxi driver**:
  - Performance measure: Safe, fast, legal, comfortable trip, maximize profits
  - Environment: Roads, other traffic, pedestrians, customers
  - Actuators: Steering wheel, accelerator, brake, signal, horn
  - Sensors: Cameras, sonar, speedometer, GPS, odometer, engine sensors, keyboard