# Introduction to AI

## *Lecture 2: Intelligent Agents*

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## What is an (Intelligent) Agent?

- Anything that can be *viewed as* **perceiving** its **environment** through **sensors** and **acting** upon that environment through its **effectors** to maximize progress towards its **goals**.

## What is an (Intelligent) Agent?

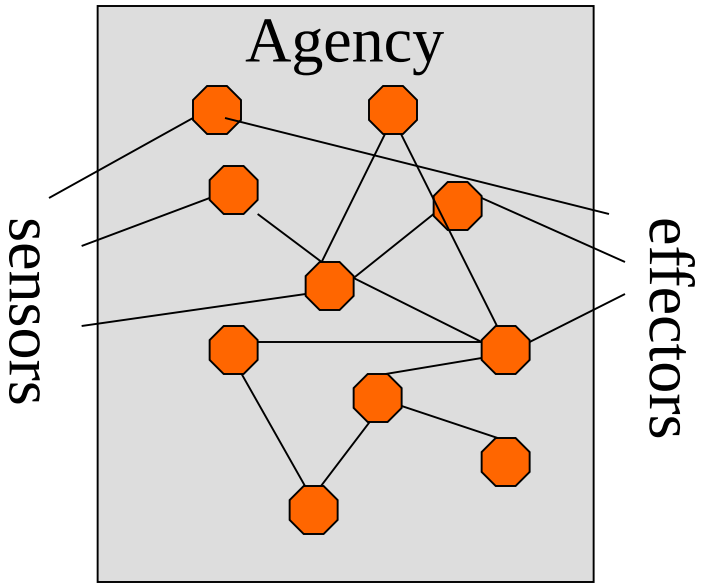
- **PAGE** (Percepts, Actions, Goals, Environment)
- Percept refers to the agent's perceptual inputs at a given time instant; an agent's perceptual sequence is the complete history of everything the agent has ever perceived.
- An "agent" is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.

# Intelligent Agents and Artificial Intelligence

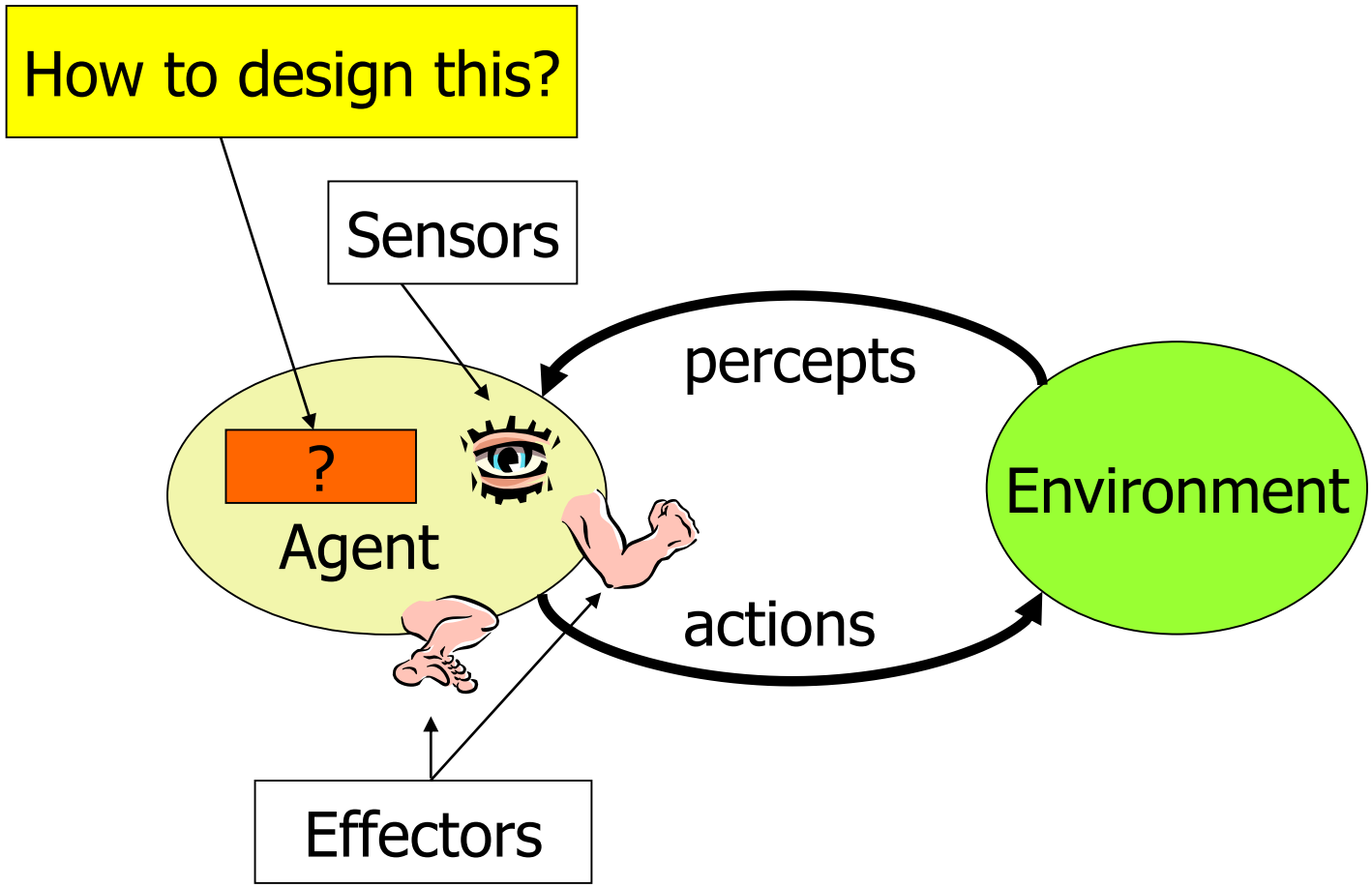
- **Example:** Human mind as network of thousands or millions of agents working in parallel. To produce real artificial intelligence, this school holds, we should build computer systems that also contain many agents and systems for arbitrating among the agents' competing results.

- Distributed decision-making and control

- Challenges:
  - Action selection: What next action to choose
  - Conflict resolution



# Rational Agents



## A Windshield Wiper Agent

How do we design a agent that can wipe the windshields when needed?

- Goals?
- Percepts?
- Sensors?
- Effectors?
- Actions?
- Environment?

# A Windshield Wiper Agent (Cont'd)

- Goals: Keep windshields clean & maintain visibility
- Percepts: Raining, Dirty
- Sensors: Camera (moist sensor)
- Effectors: Wipers (left, right, back)
- Actions: Off, Slow, Medium, Fast
- Environment: Inner city, freeways, highways, weather …

# Interacting Agents

Collision Avoidance Agent (CAA)

- Goals: Avoid running into obstacles
- Percepts ?
- Sensors?
- Effectors ?
- Actions ?
- Environment: Freeway

Lane Keeping Agent (LKA)

- Goals: Stay in current lane
- Percepts ?
- Sensors?
- Effectors ?
- Actions ?
- Environment: Freeway

# Interacting Agents

Collision Avoidance Agent (CAA)

- Goals: Avoid running into obstacles
- Percepts: Obstacle distance, velocity, trajectory
- Sensors: Vision, proximity sensing
- Effectors: Steering Wheel, Accelerator, Brakes, Horn, Headlights
- Actions: Steer, speed up, brake, blow horn, signal (headlights)
- Environment: Freeway

Lane Keeping Agent (LKA)

- Goals: Stay in current lane
- Percepts: Lane center, lane boundaries
- Sensors: Vision
- Effectors: Steering Wheel, Accelerator, Brakes
- Actions: Steer, speed up, brake
- Environment: Freeway

# Conflict Resolution by Action Selection Agents

- **Override:** CAA overrides LKA
- **Arbitrate:** if Obstacle is Close then CAA
  else LKA

## The Right Thing = The Rational Action

- **Rational Action:** The action that maximizes the expected value of the performance measure given the percept sequence to date
- **Performance measure:** a *subjective* measure to characterize how successful an agent is (e.g., speed, power usage, accuracy, money, etc.)

  - Rational = Best ?
  - Rational = Optimal ?
  - Rational = Omniscience ?
  - Rational = Clairvoyant ?
  - Rational = Successful ?

# The Right Thing = The Rational Action

- **Rational Action:** The action that maximizes the expected value of the performance measure given the percept sequence to date

  - Rational = Best — Yes, to the best of its knowledge
  - Rational = Optimal — Yes, to the best of its abilities (incl. its constraints)
  - Rational ≠ Omniscience
  - Rational ≠ Clairvoyant
  - Rational ≠ Successful

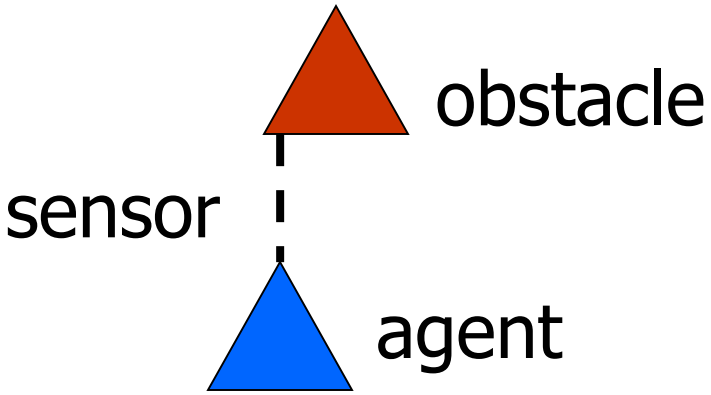
## Behavior and performance of IAs

- **Perception** (sequence) to **Action Mapping:** $f: \mathcal{P}^* \rightarrow \mathcal{A}$
  - **Ideal mapping:** specifies which actions an agent ought to take at any point in time
  - Look-Up-Table, Closed Form, etc.

- (degree of) **Autonomy:** to what extent is the agent able to make decisions and take actions on its own?

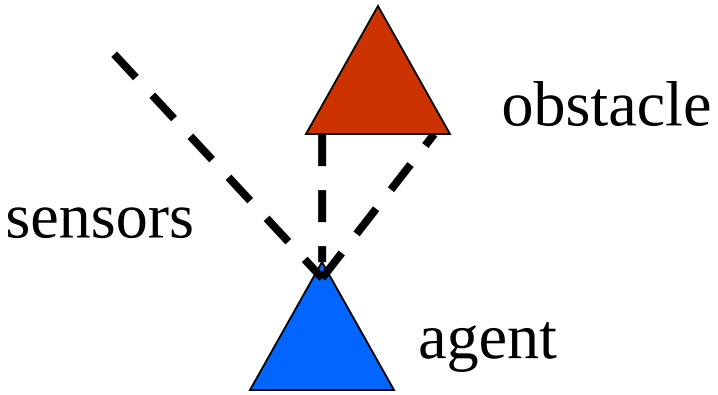
# Look up table

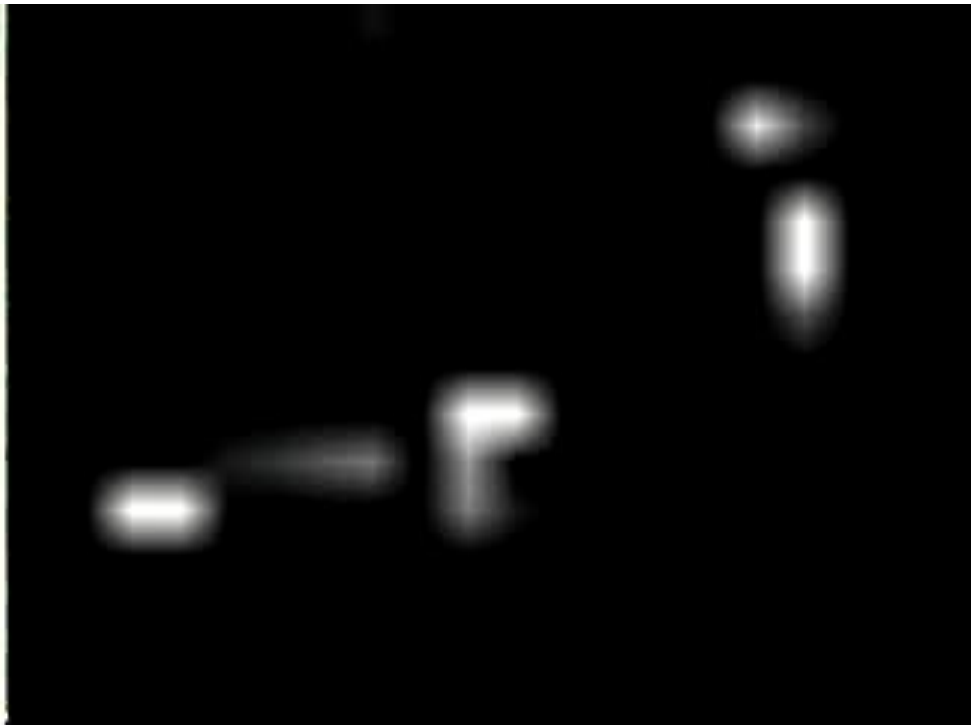
| Distance | Action |
|---|---|
| 10 | No action |
| 5 | Turn left 30 degrees |
| 2 | Stop |



# Using a look-up-table to encode $f : \mathcal{P}^* \rightarrow \mathcal{A}$

- **Example:** Collision Avoidance
  - Sensors: 3 proximity sensors
  - Effectors: Steering Wheel, Brakes
- How to generate?
- How large?
- How to select action?



# Using a look-up-table to encode $f : \mathcal{P}^* \rightarrow \mathcal{A}$

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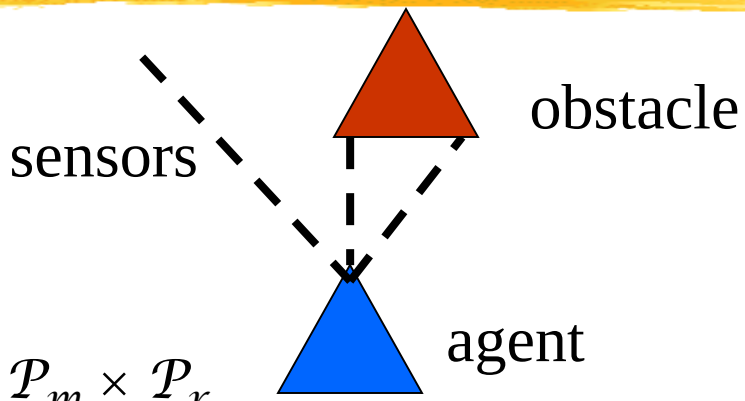


- How to generate: for each $p \in \mathcal{P}_l \times \mathcal{P}_m \times \mathcal{P}_r$ generate an appropriate action, $a \in S \times \mathcal{B}$

- How large: size of table = #possible percepts times # possible actions = $|\mathcal{P}_l|\ |\mathcal{P}_m|\ |\mathcal{P}_r|\ |S|\ |\mathcal{B}|$
  E.g., P = {close, medium, far}$^3$
  A = {left, straight, right} $\times$ {on, off}
  then size of table = 27*3*2 = 162

- How to select action? Search.

## Closed form

- Output (degree of rotation) = F(distance)