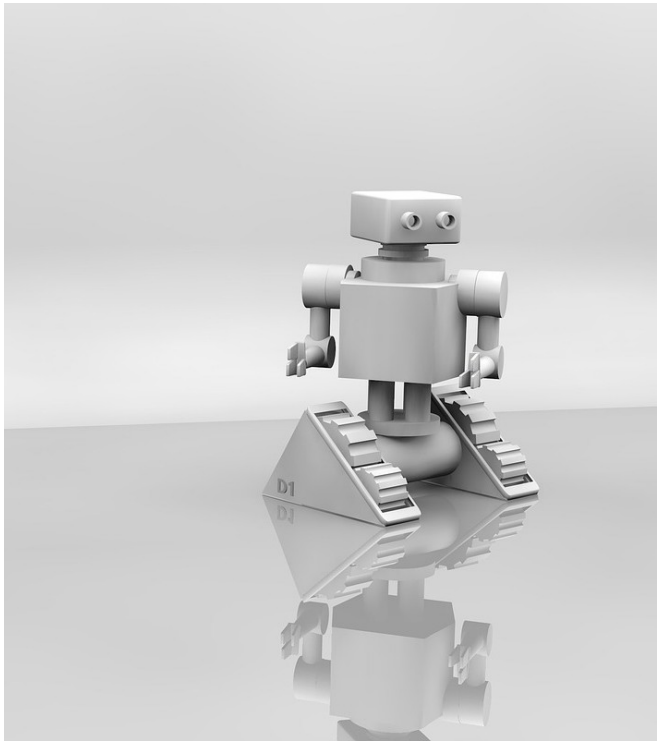

CPSC 481
Artificial Intelligence

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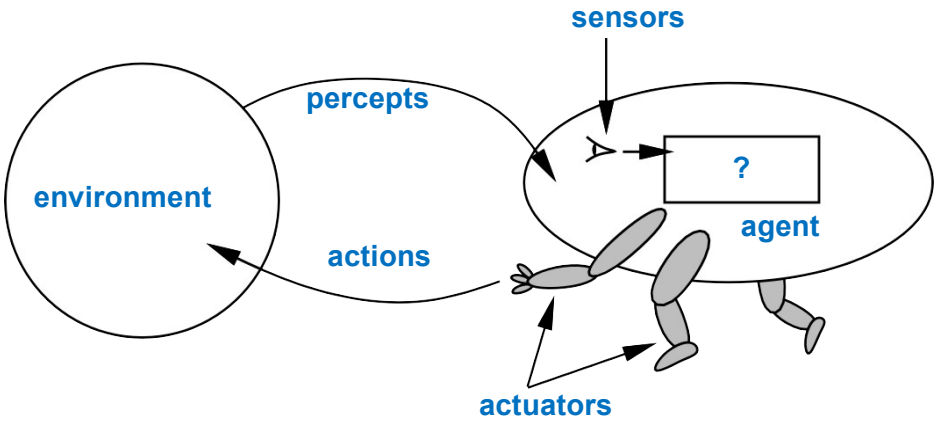
What we will cover today

- Intelligent Agents
  - Agents and environments

Textbook: Chapter 2.1-2.3

Agents and environment

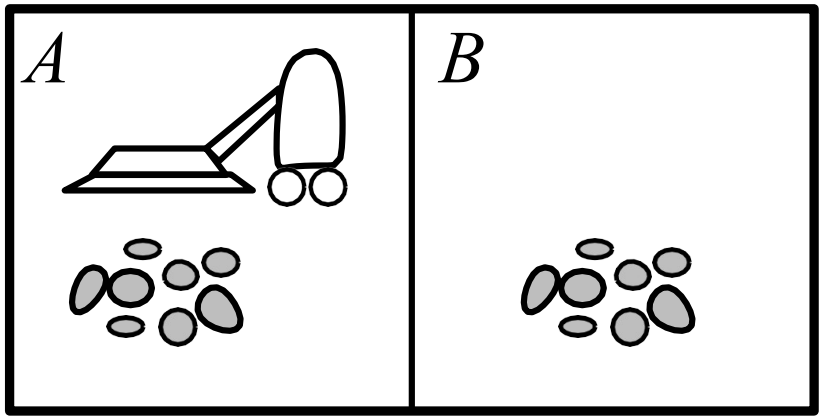


- Agents include humans, robots, thermostats, etc.
- An agent can be anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators
- The agent function maps from percept sequence to actions:

  $f : P* \rightarrow A$
- The agent program runs on the physical architecture to produce f

Vacuum-cleaner example

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



Vacuum-cleaner example

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

```
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
```

Rationality

- Fixed performance measure evaluates the environment sequence
  - one point per square cleaned up in time *T* ?
  - one point per clean square per time step, minus one per move?
  - penalize for > *k* dirty squares?

- As a general rule, it is better to design performance measure according to what one actually wants to be achieved in the environment, rather than according to how one thinks agent should behave

Rationality

- What is rational depends on four things
  - The performance measure that defines the criterion of success
  - The agent's prior knowledge of the environment
  - The actions that the agent can perform
  - The agent's percept sequence to date

Rationality – vacuum cleaner

- What is rational depends on four things
  - Performance measure: awards one point for each clean square at each time step
  - Prior knowledge: the geography of the environment is known but the dirt distribution and initial location of the agents are not
  - Available actions: Right, Left and Suck
  - Percept sequence: agent correctly perceives its location and whether the square is clean/dirty

Agent is rational

Omniscience, learning and autonomy

- Omniscience agent
  - Knows the actual outcome of its actions and can act accordingly
- Rational $\Rightarrow$ exploration, learning, autonomy

Task environments

- **PEAS** for an automated taxi driver
  - **P**erformance: safe, fast, legal, comfortable trip, maximize profits, minimize impact on other road users
  - **E**nvironment: roads, other traffic, police, pedestrians, customers, weather
  - **A**ctuators: steering, accelerator, brake, signal, horn, display, speech
  - **S**ensors: cameras, radar, speedometer, GPS, engine sensors, accelerometer, microphones, touchscreen

In-class exercise

- Design a rational agent for the following agent type
  - Internet shopping agent
  - Customer service chatbot
  - Inventory management in a retail store
  - Energy management in a smart home
  - Fraud detection in financial transactions
  - Supply chain optimization
  - Personalized healthcare assistance
  - Autonomous drone delivery
  - Social media content moderation
  - Personal financial management

Properties of task environments

Environment types

- Fully observable vs partially observable
  - Fully observable: agent has access to complete and accurate information about the state of the environment at any given time
  - Partially observable: agent does not have access to complete information about the state of the environment

Environment types

- Single agent vs multiagent
  - Single agent: operates autonomously and independently in an environment
  - Multiagent: involves multiple AI agents that interact and collaborate or compete with each other in a shared environment
    - Cooperative – Improves others' situation, helps your own
    - Competitive – Improves others' situation, worsens your own

Environment types

- Deterministic vs stochastic
  - Deterministic: the next state of the environment is completely determined by the current state and the action executed by the agent(s)
  - Stochastic: the future state is not uniquely determined by the current state and inputs. There exists uncertainty.

Environment types

- Episodic vs sequential
  - Episodic: agent's actions and decisions are independent of each other
  - Sequential: agent's actions and decisions are influenced by previous actions and events
- Static vs Dynamic
  - Does the environment change when you're deciding on a move?
  - Static: the state of the system do not change over time
  - Dynamic: the state/properties of the system can change due to various factors

Environment types

- Discrete vs Continuous
  - Discrete: variables or states can take on a finite or countable set of distinct values
  - Continuous: variables or states can take on an infinite number of values within a range or interval
- Known vs. unknown:
  - In a known environment, the outcomes for all actions are given, i.e., the rules of the game are known
  - If unknown, the agent will have to learn how it works.

Example) Playing soccer

- Fully or Partially observable
- Single of Multi-agent
- Deterministic or Stochastic
- Episodic or Sequential
- Static or Dynamic
- Discrete or Continuous
- Known or Unknown

Example) Playing soccer

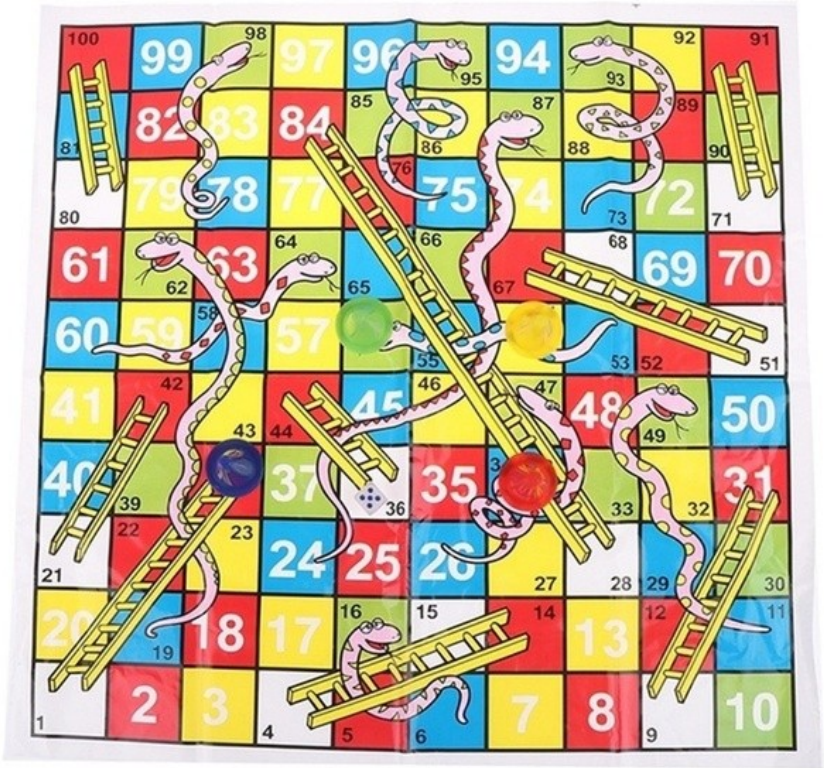
- **Partially observable** – Player cannot detect all the things on soccer field that can affect its action, for e.g. it cannot determine what other players are thinking.
- **Multi-agent** – There are many players in a soccer game.
- **Stochastic** – Given the current state and action executed by agent, the outcome cannot be exactly determined. E.g., if player kicks the ball, then the ball may or may not be stopped by other players, or the soccer field can change in many different ways depending on how players move.
- **Sequential** – The past history of actions in the game can affect the next action in the game.
- **Dynamic** – The environment can change while the agent is making decision, for e.g., position of other players changes when a player moves.
- **Continuous** – Positions of the ball and players are continuous. The speed or the direction (angle) at which the player kicks the ball is continuous.
- **Known** – Rules of the game are known

In-class exercise

- Determine which properties each example environments have
  - Fully or Partially observable
  - Single of Multi-agent
  - Deterministic or Stochastic
  - Episodic or Sequential
  - Static or Dynamic
  - Discrete or Continuous

Chutes and ladders

- Fully observable vs. partially observable?
- Deterministic vs. stochastic?
- Episodic vs. sequential?
- Static vs. dynamic?
- Discrete vs. continuous?
- Known vs. unknown?
- Single agent vs. multiple agents?



Passing a CAPTCHA

- Fully observable vs. partially observable?
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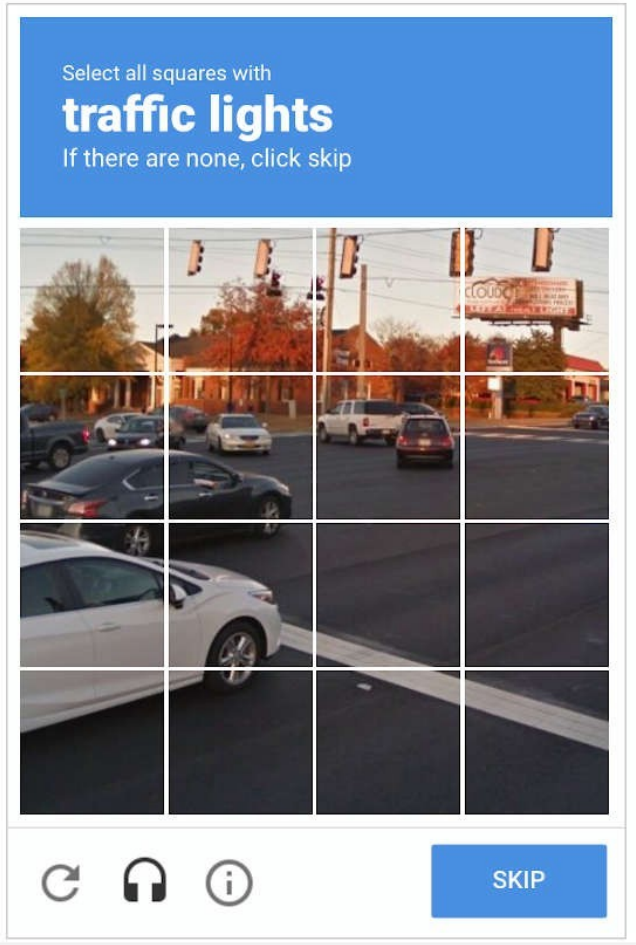

Chess

- Fully observable vs. partially observable?
- Deterministic vs. stochastic?
- Episodic vs. sequential?
- Static vs. dynamic?
- Discrete vs. continuous?
- Known vs. unknown?
- Single agent vs. multiple agents?

Driving a car

- Fully observable vs. partially observable?
- Deterministic vs. stochastic?
- Episodic vs. sequential?
- Static vs. dynamic?
- Discrete vs. continuous?
- Known vs. unknown?
- Single agent vs. multiple agents?

References

- Russel and Norvig, Artificial Intelligence: A Modern Approach, 4th edition, Prentice Hall, 2010.
- Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, 6th edition, **Chapter 1**, Addison Wesley, 2009.