Introduction
Artificial Intelligence

Artificial Intelligent Agents

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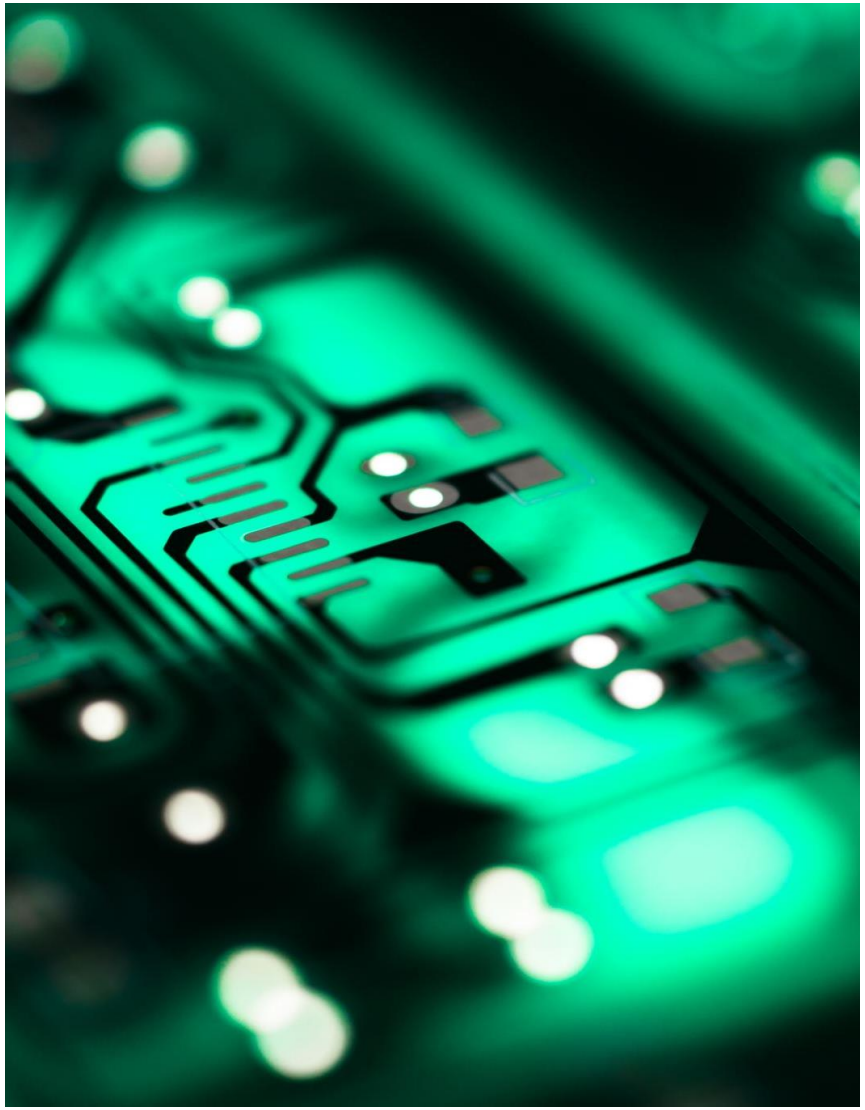
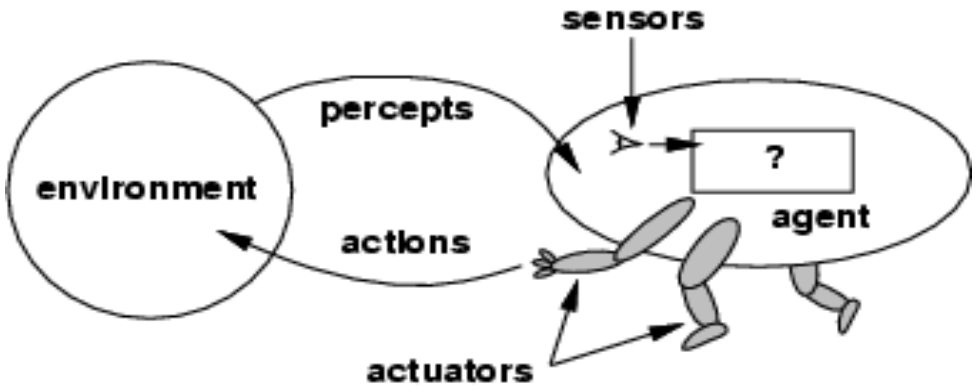


agents

- An agent is anything that can be viewed as
  - perceiving its environment through sensors and
  - acting upon that environment through actuators
- An agent is a computer system capable of flexible and autonomous action in some environment
  - Flexible: reactive, proactive and social
  - Autonomous: capable of acting independently, exhibiting control over their internal state



Agents

- 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
- Software agent
  - Keystrokes, file contents, received network packages as sensors
  - Displays on the screen, files, sent network packets as actuators

Agents and environment

- Agents perceive and act in an environment
  - Percept: perceptual inputs at any given instant
  - Percept sequence: complete history of percepts
    - An agent's choice of action at any given instant can depend on the entire percept sequence observed so far
  - Agent function: An agent's behaviour is described by the agent function, which maps percept sequence to actions

    $f: P^* \rightarrow A$
  - Agent program: The agent function is internally implemented as an agent program, which runs on an architecture
    - Aim of AI is to build agent programs
    - Agent = Architecture + Program

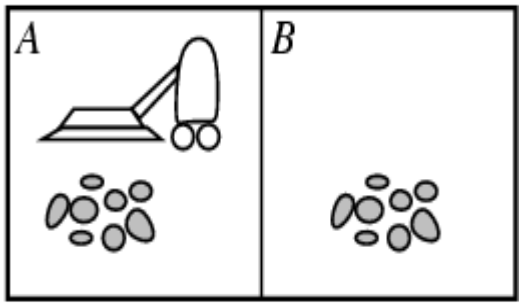
Agents and environment

Percepts and Percept Sequences

- A *percept* is a complete set of readings from all of the agent's sensors at an instant in time
- For the robot vacuum cleaner, this will consist of its location and whether the floor is clean or dirty
- Example percept: [A, dirty]
- A *percept sequence* is a complete ordered list of the percepts that the agent received since time began
- Example: [[A, dirty], [A, dirty], [A, clean], [B, dirty], …]

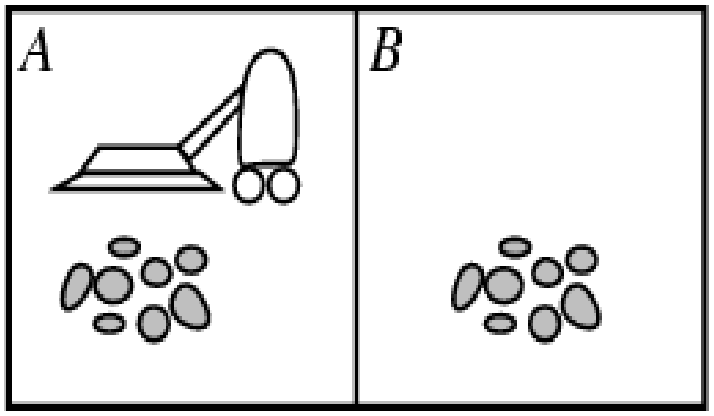
Agent: an example

- Vacuum-cleaner world
  - Percepts: Location (e.g. A or B) and content (e.g. Dirty or clean)
  - Actions: Move left, move right, suck, NoOp
  - Function: if the current square is dirty then suck, otherwise move to the other square or standby



Percept sequence	Actions
[A,Clean]	Right
[A, Dirty]	Suck
[B,Clean]	Left
[B,Dirty]	Suck
[A,Clean],[A,Clean]	Right
[A,Clean],[A,Dirty]	Suck
…	…

Agent: an example



An Agent Program

- An *agent program* is what we run on the architecture of the agent to implement the agent function:

```
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
```

Evaluating the agent: performance

- How can we evaluate an agent, such as our robotic vacuum cleaner?
- Look at its *performance* on the task in hand
- In other words, give it a score: how would you do this for the vacuum cleaner?
- The more intelligent the agent, the higher its score
- Simple agents can score well at simple tasks, but for complex tasks we need more sophisticated agents: rational agents which *reason* to achieve a high score

- Example: a Lego Mindstorms robot which can move around safely in a cluttered room:

Rational agents

- An agent should attempt 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

What is rationality at a given time

- Rationality at a given time depends on,
  - 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

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.

Rationality: discussion

- An agent is crossing the road and all of a sudden a heavy thing falls upon him from sky
  - Is the agent rational or not? Explain
- An agent is moving items from one place to another, but fails to move a rather heavy item
  - Is the agent rational or not? Explain
- An agent is designed to speed up mail-sorting task, but one day the agent consumed too much energy/electricity to perform the same task
  - Is the agent rational or not? Explain

Rational agents

- Rationality is distinct from perfection and omniscience
  - Rationality aims to maximize the expected output, while perfection aims to maximize the actual output
  - An omniscient agent knows the actual outcome of its action
  - 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
  - ability to learn and adapt

Rational agents

- The same agent can be irrational under different circumstances
  - once all dirt is cleaned up it will oscillate needlessly back and forth – such an agent could be penalised.
    - A better agent for this case would do nothing once it is sure that all the squares are clean
  - If the clean squares can become dirty again, the agent should occasionally check and clean them if needed.
  - If the geography of the environment is unknown, the agent will need to explore it rather than stick to squares A and B

Task environment

- To design a rational agent, first we must specify its task environment
- Task environment of an agent is often specified as four things: PEAS
  - **P**erformance
  - **E**nvironment
  - **A**ctuators
  - **S**ensors
- In designing an agent, the first step must always be to specify the task environment (PEAS) as fully as possible

PEAS for an auto-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, speedometer, GPS, engine sensors, keyboard

PEAS for medical diagnosis system

- Performance measure
  - Healthy patient, minimize costs, satisfaction
- Environment
  - Patient, hospital, staff
- Actuators
  - Screen display (questions, tests, diagnoses, treatments, referrals)
- Sensors
  - Keyboard (entry of symptoms, findings, patient‘s answers)

PEAS for a part-picking robot

- Performance measure
  - Percentage of parts in correct bins
- Environment
  - Conveyor belt with parts, bins
- Actuators
  - Jointed arm and hand
- Sensors
  - Camera, joint angle sensors

PEAS for an intelligent house

- Performance measure
  - Optimal room temperature, light on/off when occupants present/absent, optimal power consumption
- Environment
  - Occupants, house, outside world (including sunlight)
- Actuators
  - Jointed arm and hand to switch on/off buttons
- Sensors
  - Movement sensors, temperature sensors, clock, sound sensor

PEAS for an interactive tutor

- Performance measure
  - Maximize students' score on test, improve students' knowledge
- Environment
  - Set of students
- Actuators
  - Screen display (exercises, suggestions, corrections)
- Sensors
  - Keyboard

Environment types

- Fully observable vs. partially observable
- Deterministic vs. stochastic
- Episodic vs. sequential
- Static vs. dynamic
- Discrete vs. continuous
- Single agent vs. multi-agent