Artificial Intelligence

Intelligent Agents

Intelligent Agents

Outline

- Agents and environments
- Rationality
- Intelligence Agent
- 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

  - Operates in an environment
  - Perceive its environment through sensors
  - Acts upon its environment through actuators/ effectors
  - Has Goals

Agents and environments

- The agent function maps from percept histories to actions:

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

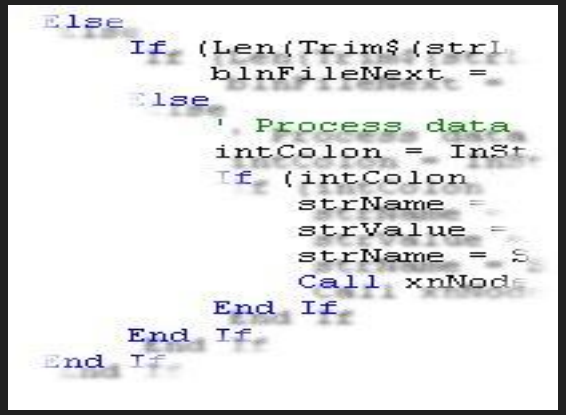
- The agent program runs on the physical architecture to produce *f*
- agent = architecture + program

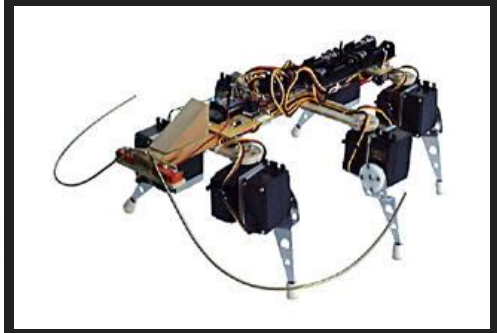
Sensor and Effectors

- An agent perceives its environment through sensors
  - The complete set of inputs at a given time is called a percept
  - The current percept or Sequence of percepts can influence the action of an agent

- It can change the environment through actuators/ effectors
  - An operation involving an actuator is called an action
  - Action can be grouped into action sequences

Examples of Agents





Humans	Programs	Robots
senses	keyboard, mouse, dataset	cameras, pads
body parts	monitor, speakers, files	motors, limbs

Examples of Agents (cont..)

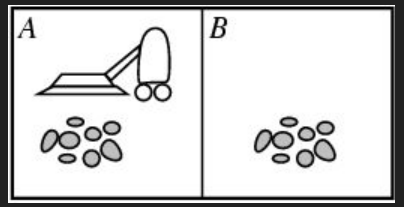
Ex:

- 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, wheels, and speakers for actuators

- A software agent: function (Input) as sensors
  - function as actuators (output-Screening)

Vacuum-Cleaner World



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

A vacuum-cleaner agent

Percept sequence	Action
$[A, Clean]$	$Right$
$[A, Dirty]$	$Suck$
$[B, Clean]$	$Left$
$[B, Dirty]$	$Suck$
$[A, Clean]$, $[A, Clean]$	$Right$
$[A, Clean]$, $[A, Dirty]$	$Suck$
⋮	⋮

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** $Left$

What is the **right** function?
Can it be implemented in a small agent program?

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?

A rational agent chooses whichever action maximizes the expected value of the performance measure given the percept sequence to date

Rational $\neq$ omniscient
- percepts may not supply all relevant information

Rational $\neq$ clairvoyant
- action outcomes may not be as expected

Hence, rational $\neq$ successful

Rational $\Rightarrow$ exploration, learning, autonomy

Rationality

What is rational at any given time 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.

Rational agents

- A **rational agent** is one that does the right thing.
- 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.
- An agent's **percept sequence** is the complete history of everything the agent has ever perceived

Rational agents (cont..)

- 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)

Autonomy in Agents

The **autonomy** of an agent is the extent to which its behaviour is determined by its own experience (with ability to learn and adapt)

- Extremes
  - No autonomy – ignores environment/data
  - Complete autonomy – must act randomly/no program
- Example: baby learning to crawl
- Ideal: design agents to have some autonomy
  - Possibly good to become more autonomous in time

Intelligence Agent

- Must sense
- Must act
- Must autonomous (to some extent)
- Must rational

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

- **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

PEAS

Agent: Medical diagnosis system

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

PEAS

Agent: 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

Agent: Interactive English tutor

- **Performance measure:** Maximize student's score on test
- **Environment:** Set of students
- **Actuators**: Screen display (exercises, suggestions, corrections)
- **Sensors**: Keyboard

Types of the Environment

Environments – *Accessible* vs. *inaccessible*

- An accessible environment is one in which the agent can obtain complete, accurate, up-to-date information about the environment's state
- Most moderately complex environments (for example, the everyday physical world and the Internet) are inaccessible
- The more accessible an environment is, the simpler it is to build agents to operate in it

Environments – *Deterministic* vs. *non-deterministic*

- A deterministic environment is one in which the next state of the environment is completely determined by the current state and the action executed by the agent.

- The physical world can to all intents and purposes be regarded as non-deterministic
- Non-deterministic environments present greater problems for the agent designer

Environments – *Episodic* vs. *non-episodic*

- In an episodic environment, the performance of an agent is dependent on a number of discrete episodes, with no link between the performance of an agent in different scenarios
- Episodic environments are simpler from the agent developer's perspective because the agent can decide what action to perform based only on the current episode — it need not reason about the interactions between this and future episodes

Environments – *Static* vs. *dynamic*

- A static environment is unchanged while an agent is reflecting.
- A dynamic environment is one that has other processes operating on it, and which hence changes in ways beyond the agent's control
- Other processes can interfere with the agent's actions (as in concurrent systems theory)
- The physical world is a highly dynamic environment

Environments – *Discrete* vs. *continuous*

- An environment is discrete if there are a fixed, finite number of actions and percepts in it
  - Ex: chess game
- Continuous environments have a certain level of mismatch with computer systems
  - Ex: taxi driving
- Discrete environments could *in principle* be handled by a kind of “lookup table”

Discussion

Review Question

- Define in your own words the following terms:
  - agent, agent function, agent program, rationality, autonomy,
- For each of the following agents, develop a PEAS description of the task environment
  - Part-picking robot, Taxi Driver
- Describe the following types of the environment
  - Static vs. Dynamic
  - Deterministic vs. non-deterministic
- List 4 most complex environments in which constructing agent is very difficult.
- What is Omniscience?