Artificial Intelligence

Lecture 2:
Intelligent Agents

Tauseef Iftikhar

Punjab University College of Information Technology
Lahore.

Today's Agenda

- Intelligent Agents
  - Rational agent
  - Environment Types
  - Agent Types

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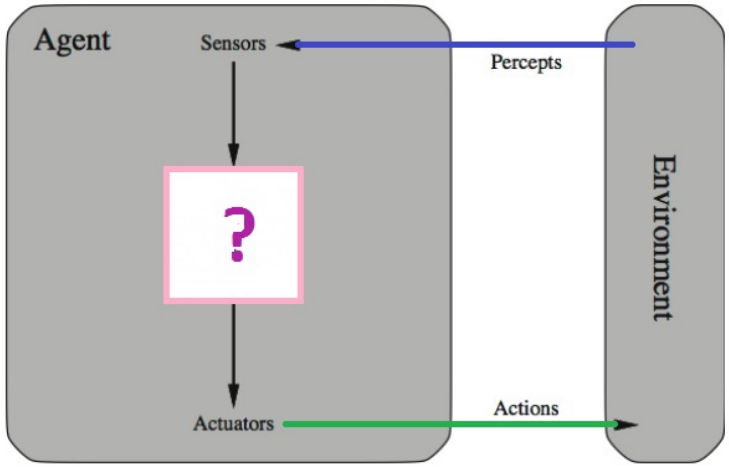
Agents

- The course is about **intelligent agents**
- An **agent** is any thing that can be viewed as:
  - *perceiving* its *environment* through **sensors** and
  - *acting* upon that **environment** through **actuators**
- **Percept** the agent's perceptual inputs at any given instant.
- **Percept sequence** is the complete history of everything the agent has ever perceived.

An agent's choice of action at any given instant can depend on the entire percept sequence observed to date, but not on anything it hasn't perceived.

Intelligent Agents

Agent function maps percepts to actions $f : P \rightarrow A$.



An agent program runs in cycles of: 1- perceive, 2- think, 3- act
Agent = Architecture + Program

Agents

Human agents

- Sensors: eyes, nose, ears and other organs
- Actuators: hands, legs, mouth and other organs

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Robotic agents

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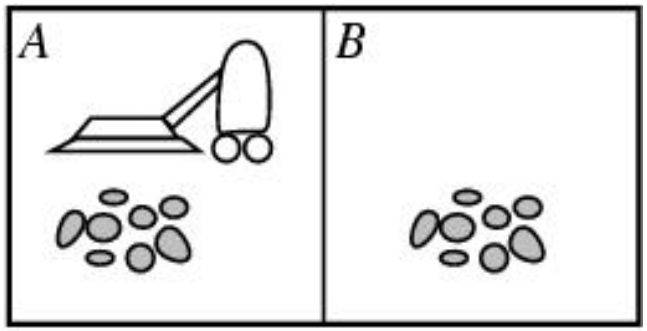
Agents are everywhere

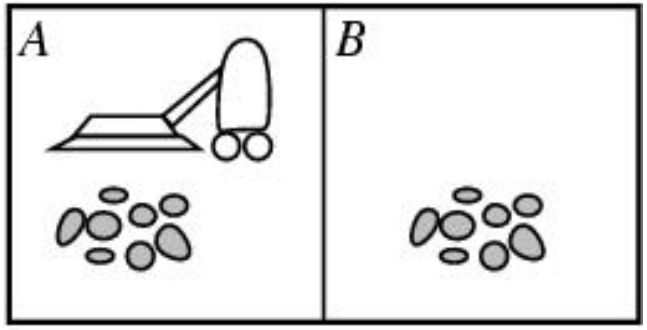
- Thermostat
- Cell phone
- Vacuum cleaner
- Robot
- Self-driving car
- Human
- etc

Vacuum cleaner



- **Percepts**: location and contents e.g., [A, Dirty]
- **Actions**: Left, Right, Suck, NoOp
- Agent function: mapping from percepts to actions.

Vacuum cleaner



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

Well-behaved agents

Rational Agents: is one that does the right thing.

[1] environment state vs agent state

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> *As a general rule, it is better to design performance measures according to what one actually wants in the environment, rather than according to how one thinks the agent should behave.*

1

[1] environment state vs agent state

Rationality

Rationality at any given time depends on four things

- The performance measure that defines the criterion of success.
- The agent prior knowledge of the environment.
- The possible actions that the agent can perform.
- The agent's percept sequence to date.

Now we define rational agent as:

> *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.*

PEAS

- When we define a rational agent, we group these properties under PEAS, the problem specification for the task environment.
- The rational agent we want to design for this task environment is the solution.
- PEAS stands for:
  - Performance
  - Environment
  - Actuators
  - Sensors

PEAS

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- Sensorss: Camera, sonar, GPS, Speedometer, odometer, accelerometer, engine sensors, keyboard.

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- Sensorss: camera, dirt detection sensor, cliff sensor, bump sensors, infrared wall sensors.

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- Episodic (vs. sequential): The agent's experience is divided into atomic "episodes" (each episode consists of the agent perceiving and then performing a single action), and the choice of action in each episode depends only on the episode itself.

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- Known (vs. Unknown): The designer of the agent may or may not have knowledge about the environment makeup. If the environment is unknown the agent will need to know how it works in order to decide.

Environment Types

Environment	Observable	Agents	Deterministic	Static	Discrete
8-puzzle	Fully	Single	Deterministic	Static	Discrete
Chess	Fully	Multi	Deterministic	(Semi)Static	Discrete
Pocker	Partially	Multi	Stochastic	Static	Discrete
Backgammon	Fully	Multi	Stochastic	Static	Discrete
Car	Partially	Multi	Stochastic	Dynamic	Continuous
Roomba	Partially	Single	Stochastic	Dynamic	Continuous

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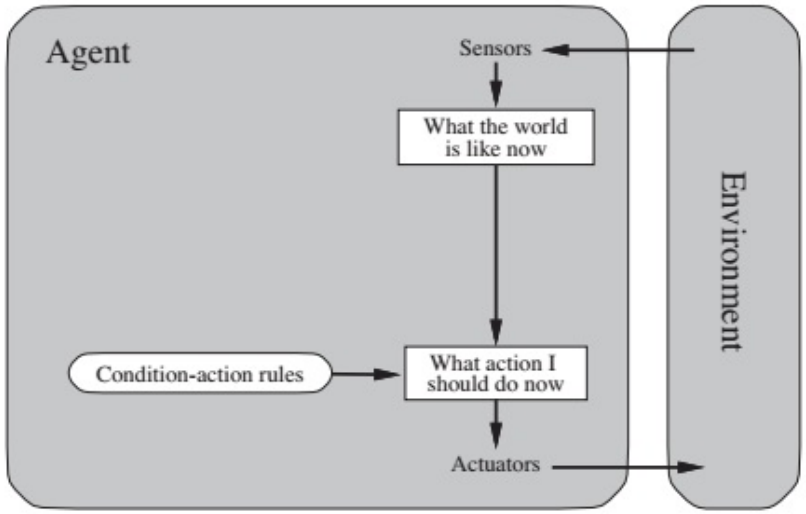
Agent Types

- Four basic types in order of increasing generality:
  - Simple reflex agents
  - Model-based reflex agents
  - Goal-based agents
  - Utility-based agents
- All of which can be generalized into learning agents that can improve their performance and generate better actions.

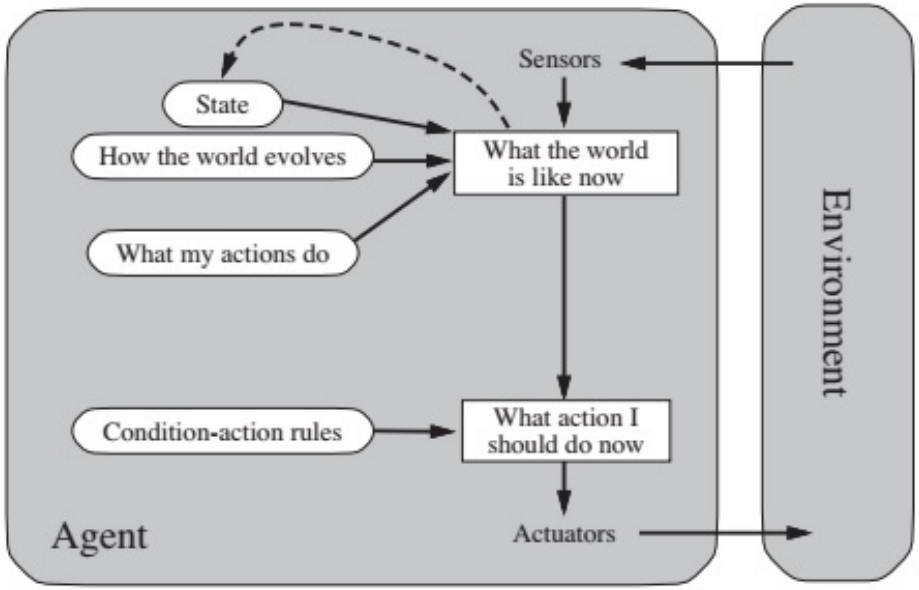
Simple reflex agents

- Actions are based on the current percept ignoring the percept history.
- Often required in complex environment
- Simple but limited.
- Can only work if the environment is fully observable, that is the correct action is based on the current percept only.



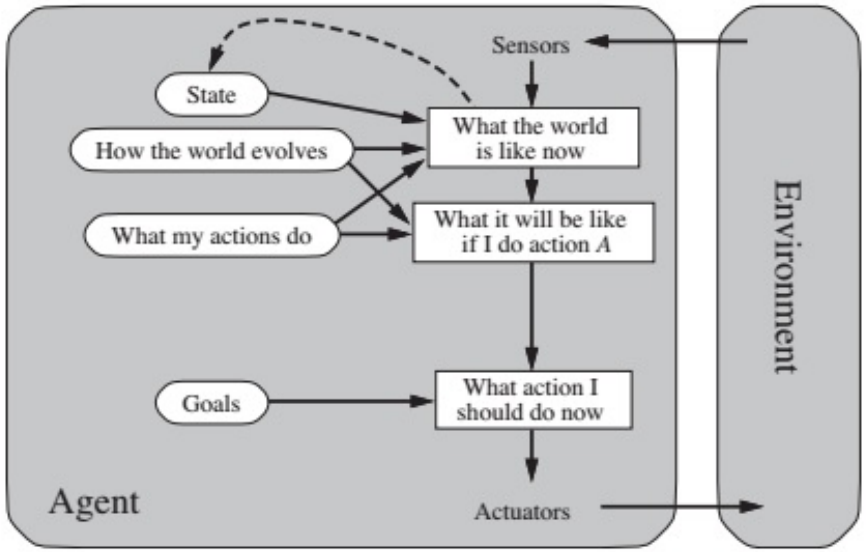
Model-based reflex agents

- Handle partial observability by keeping track of the part of the world it can't see now.
- Internal state depending on the percept history (best guess).
- Model of the world based on (1) how the world evolves independently from the agent, and (2) how the agent actions affects the world.



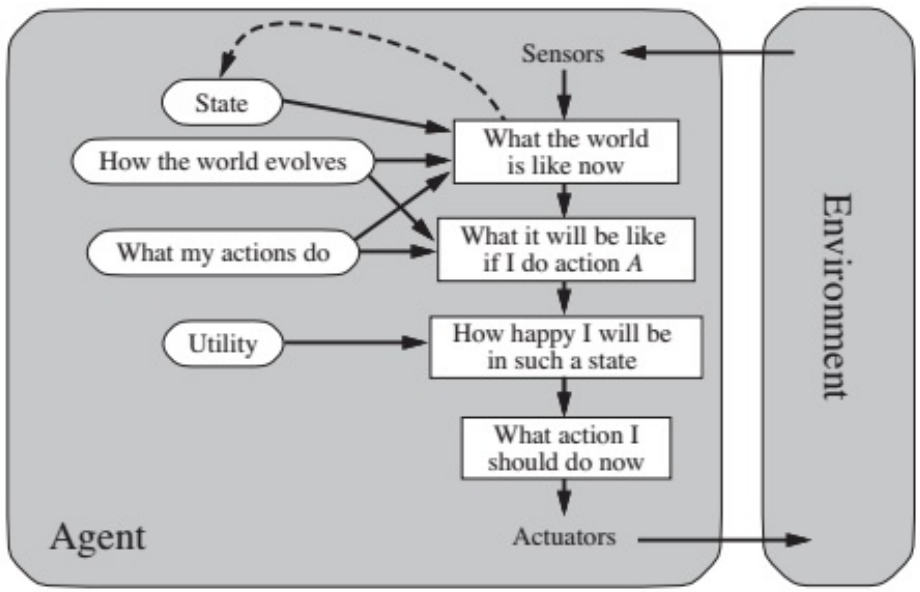
Goal-based agents

- Knowing the current state of the environment is not enough. The agent needs some goal information.
- Agent program combines the goal information with the environment model to choose the actions that achieve that goal.
- Consider the future with What will happen if I do A?"
- Flexible as knowledge supporting the decisions is explicitly represented and can be modified.



Utility-based agents

- Sometimes achieving the desired goal is not enough. We may look for quicker, safer, cheaper trip to reach a destination.
- Agent happiness should be taken into consideration. We call it utility.
- A utility function is the agent's performance measure
- Because of the uncertainty in the world, a utility agent choses the action that maximizes the expected utility.



Learning agents

- Programming agents by hand can be very tedious. "Some more expeditious method seem desirable" Alan Turing, 1950.
- Four conceptual components:
  - Learning element: responsible for making improvements
  - Performance element: responsible for selecting external actions. It is what we considered as agent so far.
  - Critic: How well is the agent is doing w.r.t. a fixed performance standard.
  - Problem generator: allows the agent to explore.