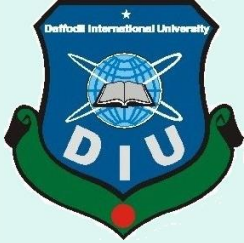
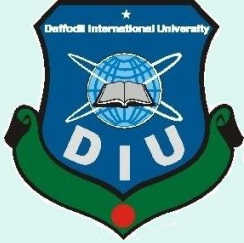


CSE 412: Artificial Intelligence

Topic - 2: Intelligent Agents

Department of CSE
Daffodil International University

Topic Contents

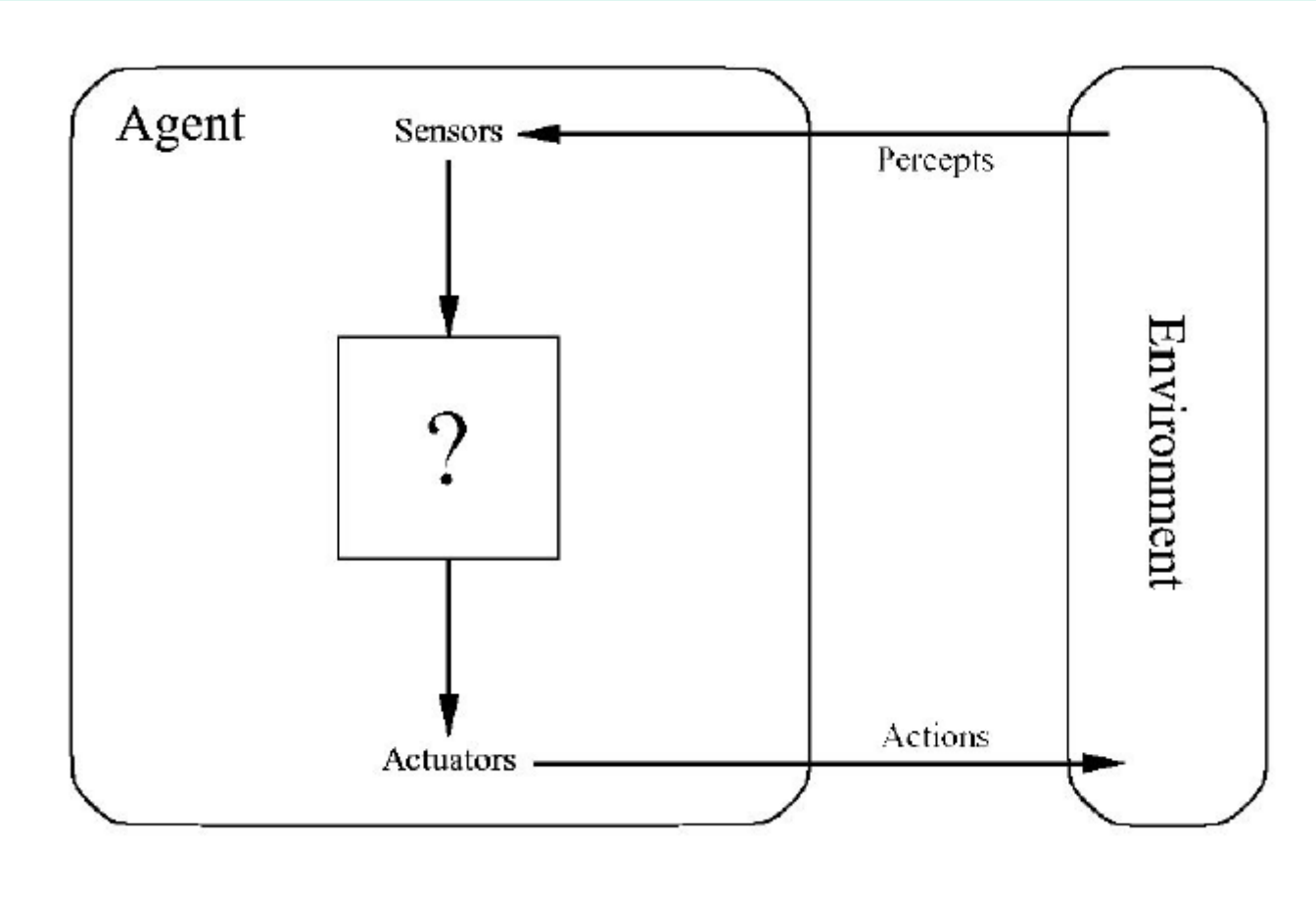


- Agents and Environments
- Good Behavior: The Concept of Rationality
- The Nature of Environments
- The Structure of Agents

Intelligent Agent

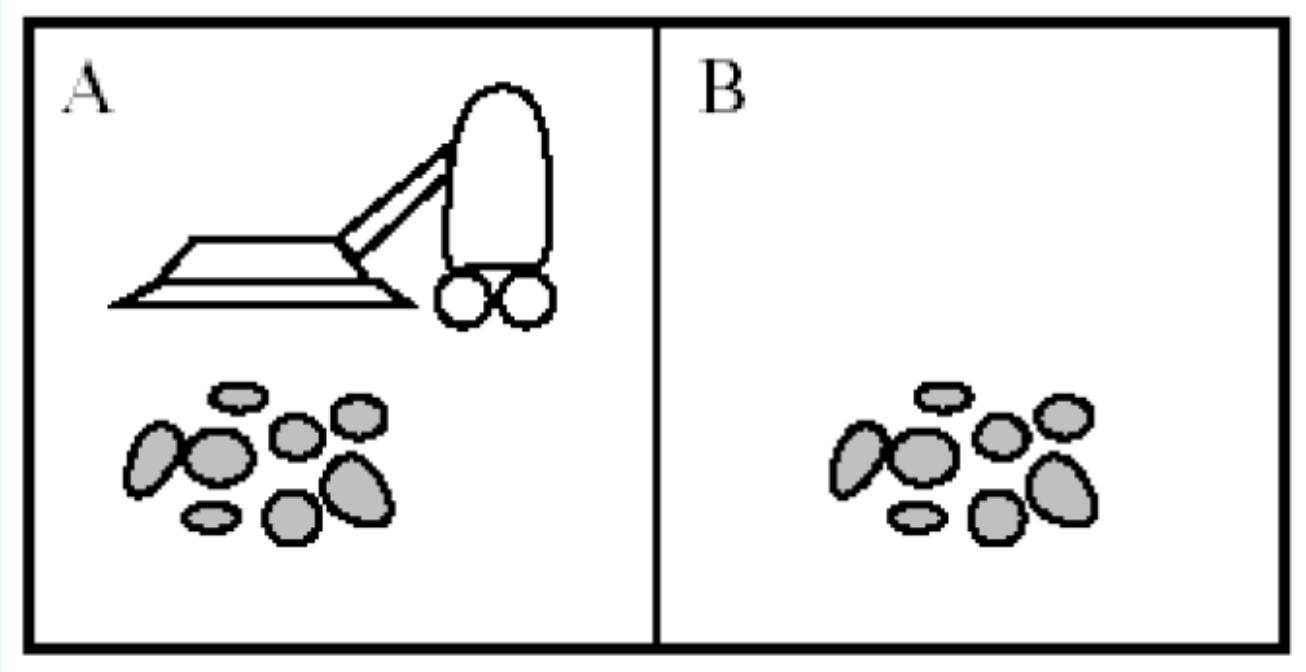
- An agent
  - **perceives its environment with sensors and**
  - **acts upon that environment with its actuators.**
- An agent gets percepts one at a time, and maps this percept sequence to actions.

An Agent



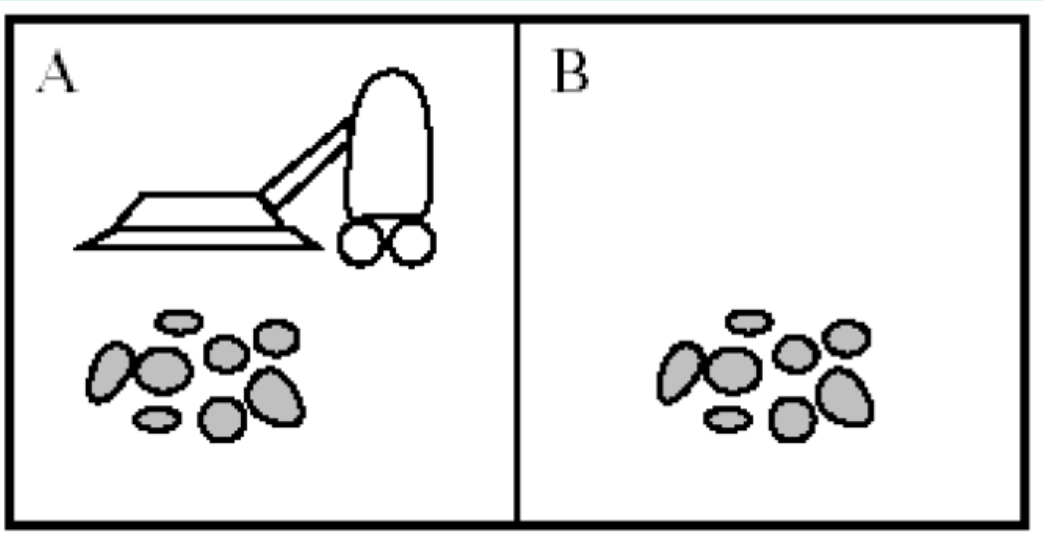
Example of an Agent

- Let us consider a vacuum-cleaner agent that is shown in the figure below.
- The vacuum-cleaner world has just two locations: squares ***A*** and ***B***.



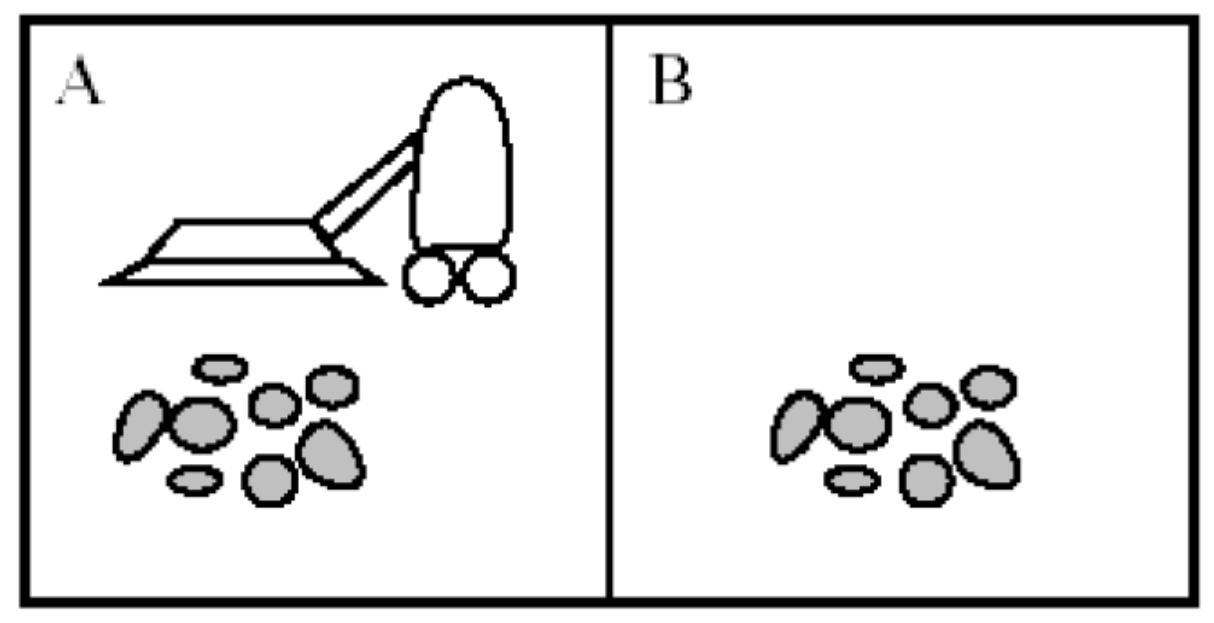
Example of an Agent

- The vacuum agent perceives which square it is in and whether there is dirt in the square.
- It can choose to move left, move right, suck up the dirt, or do nothing.
- One very simple agent function is the following: if the current square is dirty, then suck; otherwise, move to the other square.

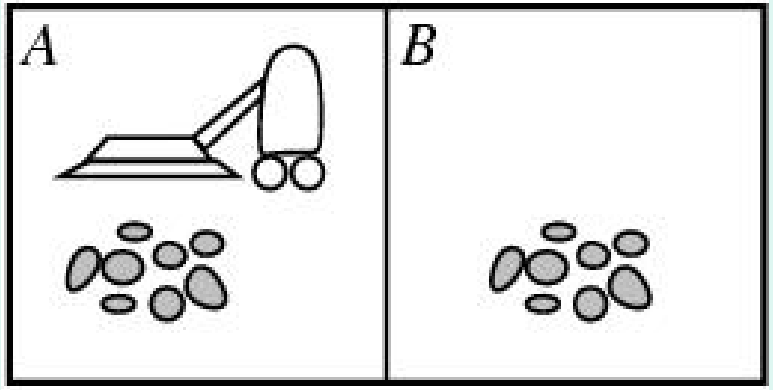


Example of an Agent

- Environment: squares *A* and *B*
- Percepts: [*location, status*], e.g. [*A, Dirty*]
- Actions: *left*, *right*, *suck*, and *no-op*



Example of an Agent



function REFLEX-VACUUM-AGENT ([*location, status*]) return an action

if *status* == *Dirty* then return *Suck*

else if *location* == *A* then return *Right*

else if *location* == *B* then return *Left*

Rational Agent

- For each possible percept sequence, a *rational agent* should select an action (using an *agent function*) that is expected to maximize its *performance measure*, given the evidence provided by the *percept sequence* and whatever built-in *prior knowledge* the agent has.

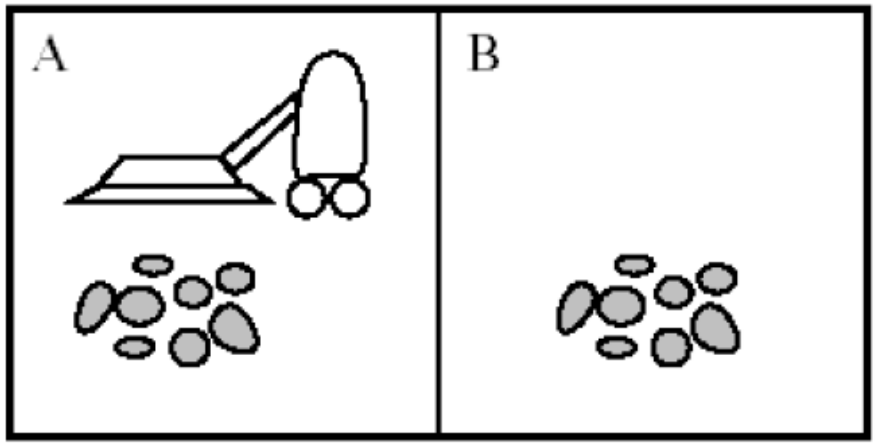
- A *percept sequence* is the complete history of anything the agent has ever perceived.
- A *performance measure* is a means of calculating how well the agent has performed based on the sequence of percepts that it has received.
- An agent's *prior knowledge* of the environment is the knowledge that the agent designer has given to the agent before its introduction to the environment.

Rational Agent

- An agent's behavior is described by the *agent function* that maps percept sequences to actions.

$$f : \text{seq}(P) \rightarrow A$$

- Agent function for vacuum cleaner example:



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

Task Environments

❑ **To design a rational agent we must specify its task environment:**

Performance Measures	used to evaluate how well an agent solves the task at hand
Environment	surroundings beyond the control of the agent
Actuators	used by the agent to perform actions
Sensors	provide information about the current state of the environment

Example

- **PEAS** description of the environment for an automated taxi:
  - **Performance**
    Safety, destination, profits, legality, comfort
  - **Environment**
    Streets/motorways, other traffic, pedestrians, weather
  - **Actuators**
    Steering, accelerator, brake, horn, speaker/display
  - **Sensors**
    Video, sonar, speedometer, engine sensors, keyboard, GPS

Example…

Agent	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	Healthy patient, minimize costs, lawsuits	Patient, hospital, staff	Display questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers
Satellite image analysis system	Correct image categorization	Downlink from orbiting satellite	Display categorization of scene	Color pixel arrays
Part-picking robot	Percentage of parts in correct bins	Conveyor belt with parts; bins	Jointed arm and hand	Camera, joint angle sensors
Refinery controller	Maximize purity, yield, safety	Refinery, operators	Valves, pumps, heaters, displays	Temperature, pressure, chemical sensors
Interactive English tutor	Maximize student's score on test	Set of students, testing agency	Display exercises, suggestions, corrections	Keyboard entry

Figure 2.5 Examples of agents and their PEAS descriptions.

Environment Types

- The environment for an agent may be
  - Fully or partially observable
  - Deterministic or stochastic
  - Episodic or sequential
  - Static or dynamic
  - Discrete or continuous
  - Single or multi-agent

Environment Types

Solitaire

Backgammom

Environment Types

	Solitaire	Backgammom	Internet shopping	Taxi
Observable??				
Deterministic??				
Episodic??				
Static??				
Discrete??				
Single-agent??				

Environment Types

Fully vs. partially observable: an environment is full observable when the sensors can detect all aspects that are relevant to the choice of action.

	Solitaire	Backgammom	Internet shopping	Taxi
Observable??				
Deterministic??				
Episodic??				
Static??				
Discrete??				
Single-agent??				

Environment Types

Fully vs. partially observable: an environment is full observable when the sensors can detect all aspects that are relevant to the choice of action.

	Solitaire	Backgammom	Internet shopping	Taxi
Observable??	FULL	FULL	PARTIAL	PARTIAL
Deterministic??				
Episodic??				
Static??				
Discrete??				
Single-agent??				

Environment Types

Deterministic vs. stochastic: if the next environment state is completely determined by the current state the executed action then the environment is deterministic.

	Solitaire	Backgammom	Internet shopping	Taxi
Observable??	FULL	FULL	PARTIAL	PARTIAL
Deterministic??				
Episodic??				
Static??				
Discrete??				
Single-agent??				

Environment Types

Deterministic vs. stochastic: if the next environment state is completely determined by the current state the executed action then the environment is deterministic.

	Solitaire	Backgammom	Internet shopping	Taxi
Observable??	FULL	FULL	PARTIAL	PARTIAL
Deterministic??	YES	NO	YES	NO
Episodic??				
Static??				
Discrete??				
Single-agent??				

Environment Types

Episodic vs. sequential: In an episodic environment the agent's experience can be divided into atomic steps where the agents perceives and then performs a single action. The choice of action depends only on the episode itself.

	Solitaire	Backgammom	Internet shopping	Taxi
Observable??	FULL	FULL	PARTIAL	PARTIAL
Deterministic??	YES	NO	YES	NO
Episodic??				
Static??				
Discrete??				
Single-agent??				

Environment Types

Episodic vs. sequential: In an episodic environment the agent's experience can be divided into atomic steps where the agents perceives and then performs a single action. The choice of action depends only on the episode itself

	Solitaire	Backgammom	Internet shopping	Taxi
Observable??	FULL	FULL	PARTIAL	PARTIAL
Deterministic??	YES	NO	YES	NO
Episodic??	NO	NO	NO	NO
Static??				
Discrete??				
Single-agent??				

Environment Types

Static vs. dynamic: If the environment can change while the agent is choosing an action, the environment is dynamic. Semi-dynamic if the agent's performance changes even when the environment remains the same.

	Solitaire	Backgammom	Internet shopping	Taxi
Observable??	FULL	FULL	PARTIAL	PARTIAL
Deterministic??	YES	NO	YES	NO
Episodic??	NO	NO	NO	NO
Static??				
Discrete??				
Single-agent??				

Environment Types

Static vs. dynamic: If the environment can change while the agent is choosing an action, the environment is dynamic. Semi-dynamic if the agent's performance changes even when the environment remains the same.

	Solitaire	Backgammom	Internet shopping	Taxi
Observable??	FULL	FULL	PARTIAL	PARTIAL
Deterministic??	YES	NO	YES	NO
Episodic??	NO	NO	NO	NO
Static??	YES	YES	SEMI	NO
Discrete??				
Single-agent??				

Environment Types

Discrete vs. continuous: This distinction can be applied to the state of the environment, the way time is handled and to the percepts/actions of the agent.

	Solitaire	Backgammom	Internet shopping	Taxi
Observable??	FULL	FULL	PARTIAL	PARTIAL
Deterministic??	YES	NO	YES	NO
Episodic??	NO	NO	NO	NO
Static??	YES	YES	SEMI	NO
Discrete??				
Single-agent??				

Environment Types

Discrete vs. continuous: This distinction can be applied to the state of the environment, the way time is handled and to the percepts/actions of the agent.

	Solitaire	Backgammom	Internet shopping	Taxi
Observable??	FULL	FULL	PARTIAL	PARTIAL
Deterministic??	YES	NO	YES	NO
Episodic??	NO	NO	NO	NO
Static??	YES	YES	SEMI	NO
Discrete??	YES	YES	YES	NO
Single-agent??				

Environment Types

Single vs. multi-agent: Does the environment contain other agents who are also maximizing some performance measure that depends on the current agent's actions?

	Solitaire	Backgammom	Internet shopping	Taxi
Observable??	FULL	FULL	PARTIAL	PARTIAL
Deterministic??	YES	NO	YES	NO
Episodic??	NO	NO	NO	NO
Static??	YES	YES	SEMI	NO
Discrete??	YES	YES	YES	NO
Single-agent??	YES	NO	NO	NO

Environment Types

- The simplest environment is
  - Fully observable, deterministic, episodic, static, discrete and single-agent.
- Most real situations are:
  - Partially observable, stochastic, sequential, dynamic, continuous and multi-agent.

Agent Types

- Four basic kinds of agent that embody the principles underlying almost all intelligent systems:
  - Simple reflex agents;
  - Model-based reflex agents;
  - Goal-based agents; and
  - Utility-based agents.

Agent Types: Simple Reflex

- Select action on the basis of *only the current* percept,

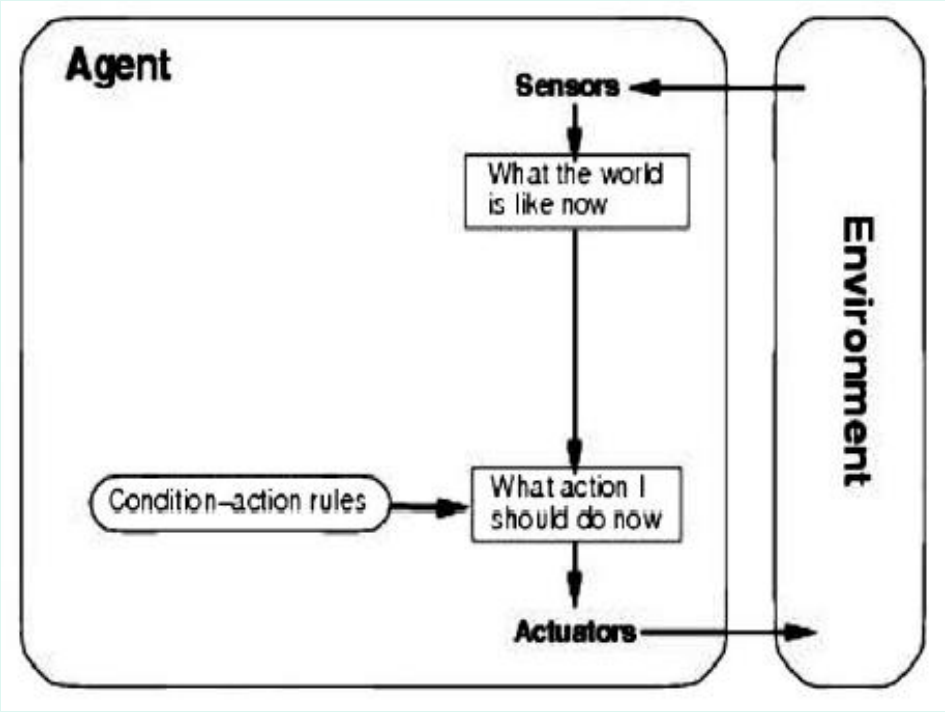
  e.g. the vacuum-agent

- Large reduction in possible percept/action situations
- Implemented through *condition-action rules*

  if dirty then suck

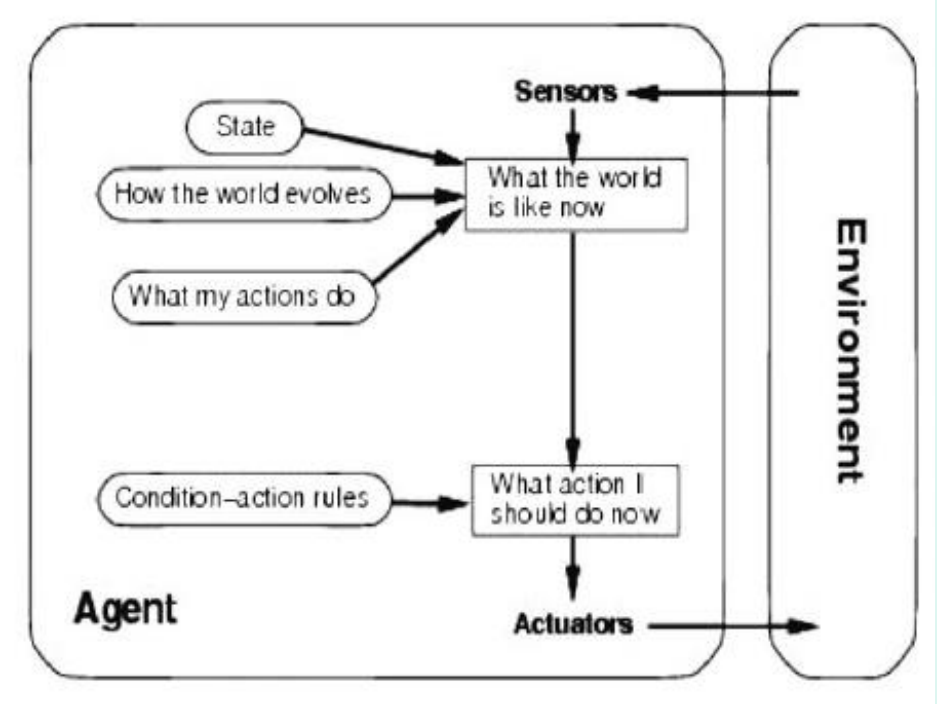
- Example:
  - Agent: Mail sorting robot
  - Environment: Conveyor belt of letters
  - Rule: e.g.

    city = Edin → put Scotland bag



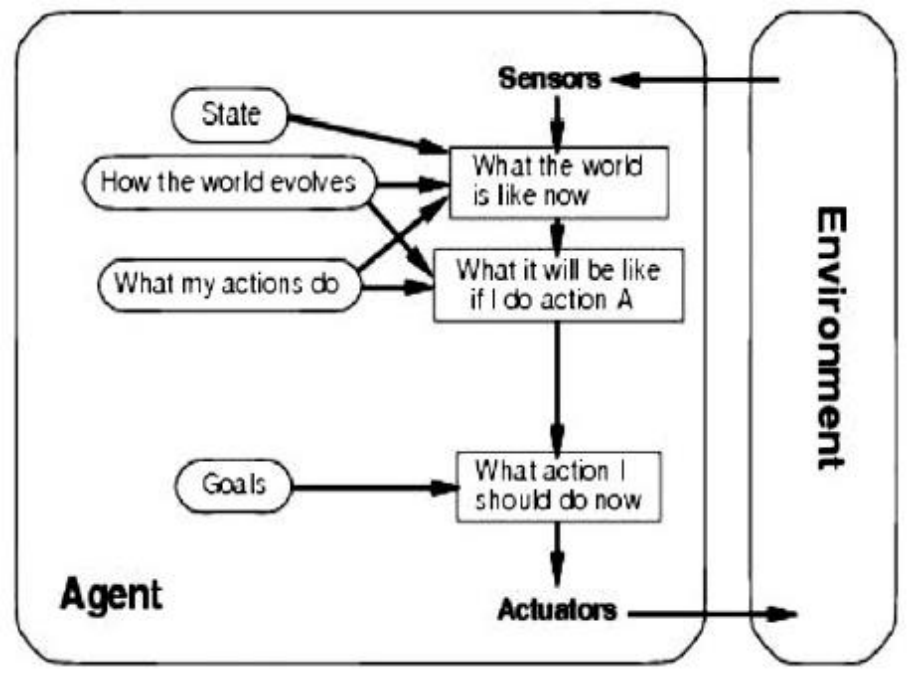
Agent Types: Model-Based

- To tackle *partially observable* environments
- Maintain internal state that depends on percept history
- Over time update state using world knowledge
- How does the world change independently
- How do actions affect the world
- Example:
  - Agent: Robot vacuum cleaner
  - Environment: Dirty room, furniture
  - Model: Map of room, which areas already cleaned



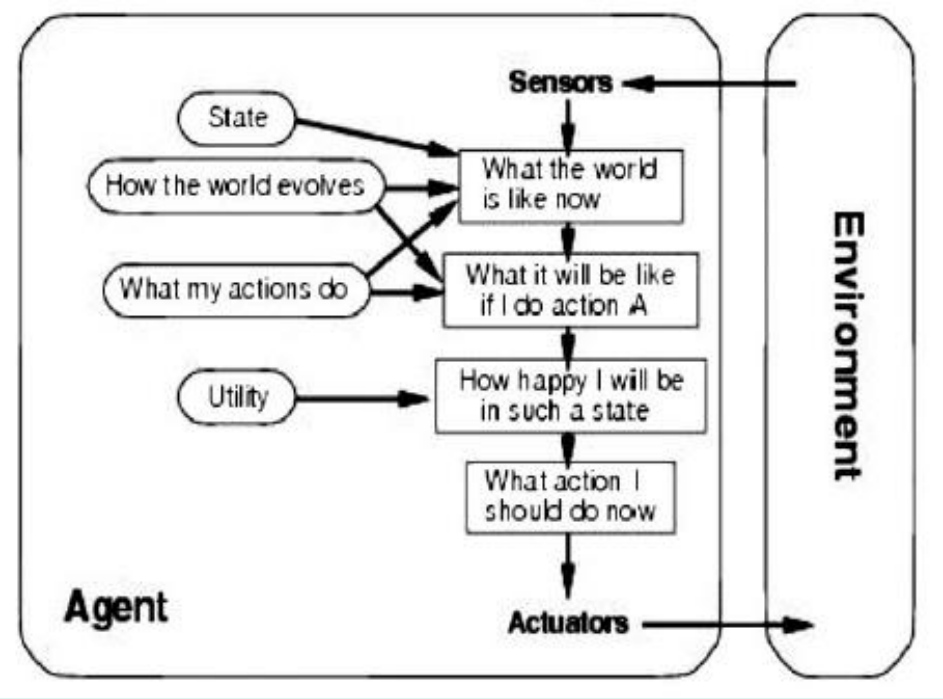
Agent Types: Goal-Based

- The agent needs a goal to know which situations are *desirable*
- Difficulties arise when long sequences of actions are required to find the goal
- Typically investigated in **search** and **planning** research
- Major difference: future is taken into account
- Example:
  - Agent: Robot maid
  - Environment: House and people
  - Goal: Clean clothes, tidy room, table laid, etc



Agent Types: Utility-Based

- Certain goals can be reached in different ways
- Some are better: have a higher **utility**
- Utility function maps a (sequence of) state(s) onto a real number
- Improves on goals:
  - Selecting between conflicting goals
  - Selecting between several goals based on likelihood of success and importance of goals
- Example:
  - Agent: Mars Lander
  - Environment: The surface of mars with obstacles
  - Utility: Shortest and obstacle-free path



THANKS...