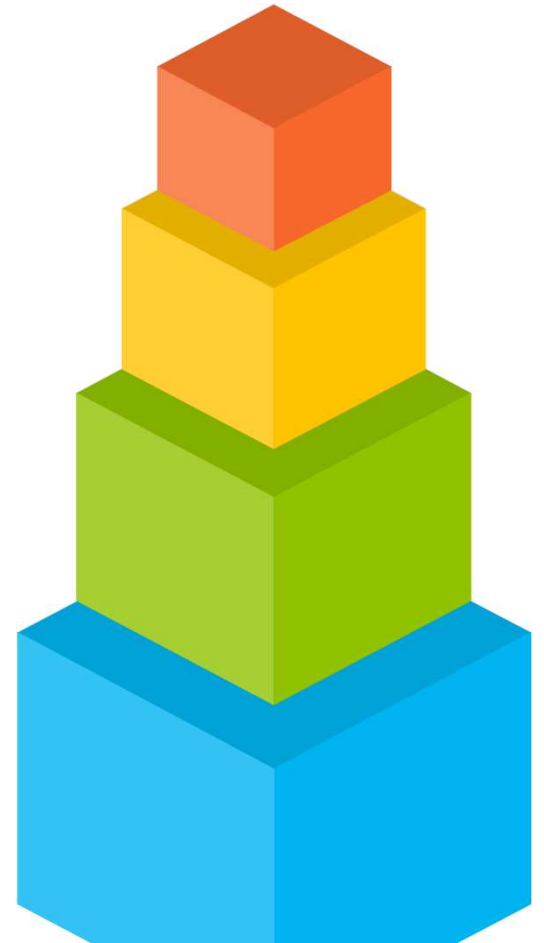


# Agents and Reasoning

Prof. Iván Axel Dounce Nava





# Overview

1. What is rationality?
2. Concrete architectures
3. Deductive vs Practical
4. Reactive vs Goal-oriented



# 1. What is rationality?

How can an agent be rational?



## What is rationality?

- The ability of the agent to perform actions towards a particular goal.
- The agent tries to maximize its performance.



# How to design a rational agent?

- Follow **PEAS**:

- Performance
- Environment
- Actuators
- Sensors



Example?

1. Rationality



- What are the PEAS of a taxi service.



## 2. Concrete architectures

Specifications from the abstract



# Abstract vs Concrete

## Abstract:

- Design requirements
- Agent and environment properties
- Action and perception
- Utility function
- Task Predicates

## Concrete:

- Systems design
- The “How” of implementation
- Decision Making
- Planning

## 2. Concrete Architectures







## Classification of reasoning



# Deductive vs Practical

Logic-  
based

Reactive

BDI

Layered  
/ Hybrid



# 3. Deductive vs Practical

How is the agent reasoning?



## Deductive Reasoning: Logic-based agent

- Classical AI: Symbolic
- It uses formal verification of theorems to reason
- Logical formulas about
  - Goal
  - Reactive rules
- From direct specifications of the environment, it acts directly over it.



## Logic-based agent: Beliefs and Theorem proving

- The database of the internal state about the environment
- Based on its Beliefs, how can the agent reason?
- How can the agent choose the ideal action?



## Logic-based agent: Example Vacuum World



## Logic-based agent

- Advantages:
  - Simple and effective
- Disadvantages:
  - Computationally expensive

### 3. Deductive vs Practical





## Practical Reasoning: BDI agents

- BDI: Beliefs-Desires-Intentions
- Why practical?
  - The agent deliberates
  - The agent plans over a goal (Means-Ends)



## Practical Reasoning: BDI agents

- What are Beliefs?
  - A representation of the world from the agent's perspective
- What are Desires?
  - The possible broader goals to pursue
- What are Intentions?
  - The commitment to a goal





## Practical Reasoning: BDI agents

- brf = Belief revision function
  - Gives new beliefs given new percepts (function “next”)
- Option generator function
  - Gives options (desires) from believes and intentions
- Filter function:
  - Deliberation process
- Action selection function:
  - Defines what action to take.



## BDI Agents: General Algorithm

```
1.  function action(p) returns an action
2.  begin
3.       $B := brf(B, p)$ 
4.       $D := options(B, I)$ 
5.       $I := filter(B, D, I)$ 
6.      return execute(I)
7.  end function action
```



## BDI Agents: Detailed Algorithm

```
1.  $B \leftarrow B_0$ ;      /*  $B_0$  are initial beliefs */
2.  $I \leftarrow I_0$ ;    /*  $I_0$  are initial intentions */
3. while true do
4.   get next percept  $\rho$  through see(...) function;
5.    $B \leftarrow brf(B, \rho)$ ;
6.    $D \leftarrow options(B, I)$ ;
7.    $I \leftarrow filter(B, D, I)$ ;
8.    $\pi \leftarrow plan(B, I, Ac)$ ;
9.   while not (empty( $\pi$ ) or succeeded( $I, B$ ) or impossible( $I, B$ )) do
10.     $\alpha \leftarrow hd(\pi)$ ;
11.    execute( $\alpha$ );
12.     $\pi \leftarrow tail(\pi)$ ;
    get next percept  $\rho$  through see(...) function;
14.     $B \leftarrow brf(B, \rho)$ ;
15.    if reconsider( $I, B$ ) then
16.       $D \leftarrow options(B, I)$ ;
17.       $I \leftarrow filter(B, D, I)$ ;
18.    end-if
19.    if not sound( $\pi, I, B$ ) then
20.       $\pi \leftarrow plan(B, I, Ac)$ ;
21.    end-if
22.  end-while
23. end-while
```



## BDI Agents:

- Advantages:
  - Intuitive
  - Design Informality
  - Subsystem decomposition
- Disadvantages:
  - Hard to implement with ease
  - Difficulty to determine how much commitment???

### 3. Deductive vs Practical





## Reactive agents

- There is no symbolic representation (“Modern” AI)
- Emergent Intelligence

### 3. Deductive vs Practical





## Reactive agents: Example: Subsumption Architecture

- Action selection process
- Simultaneous behavior



## Reactive agents

- Advantages
  - Economic
  - Simple
  - Fault tolerant
- Disadvantages
  - Not easy to prevent future actions
  - Non predictable

### 3. Deductive vs Practical





## Hybrid architectures

- How do humans reason?

### 3. Deductive vs Practical







## Hybrid architectures

- Vertical vs Horizontal architectures
- Non-reactive vs Reactive
- What about both?

### 3. Deductive vs Practical





## Hybrid architectures: Examples

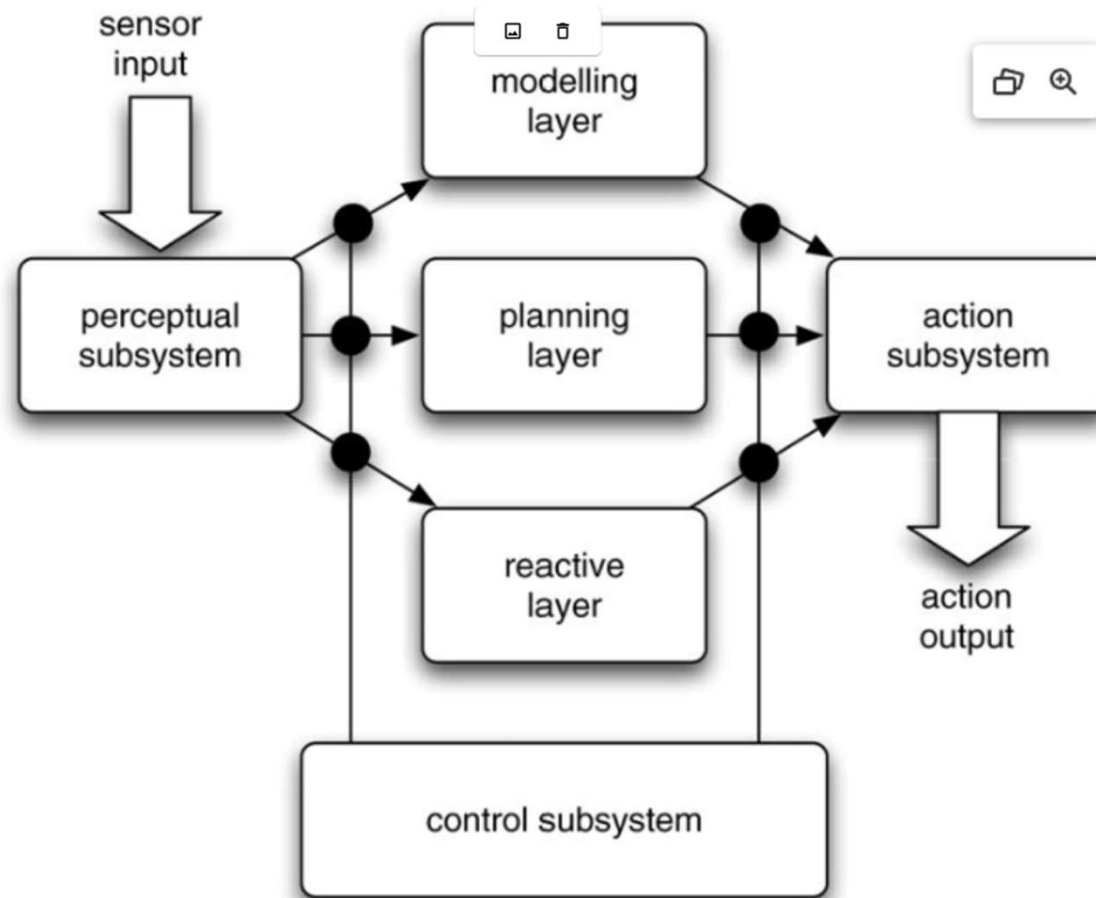
- TouringMachines
- InteRRap
- 3T

3. Deductive vs Practical



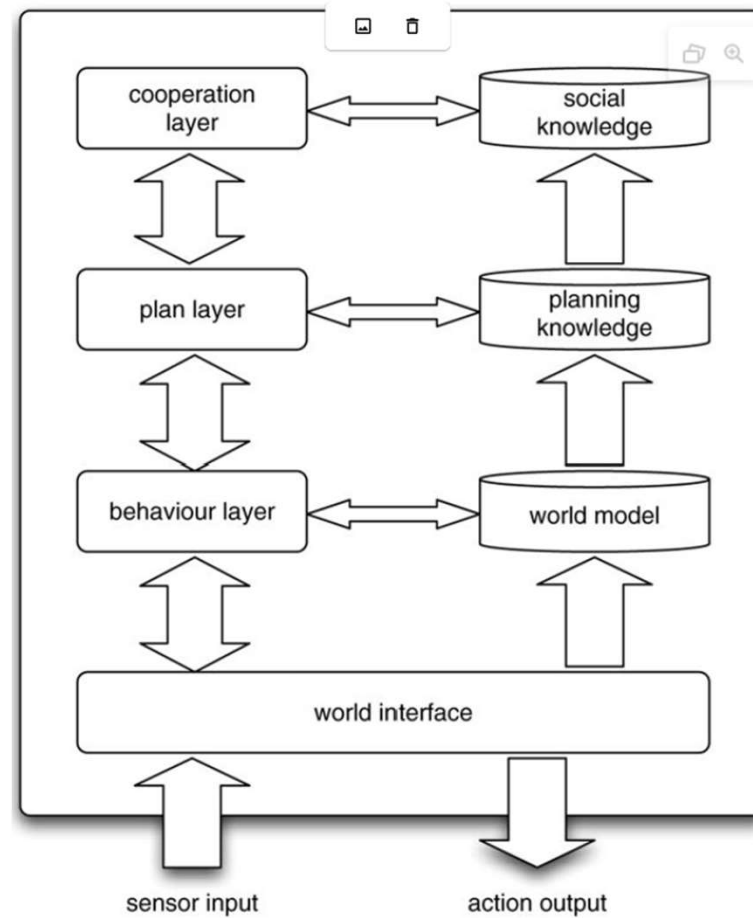


## Hybrid architectures: TouringMachine



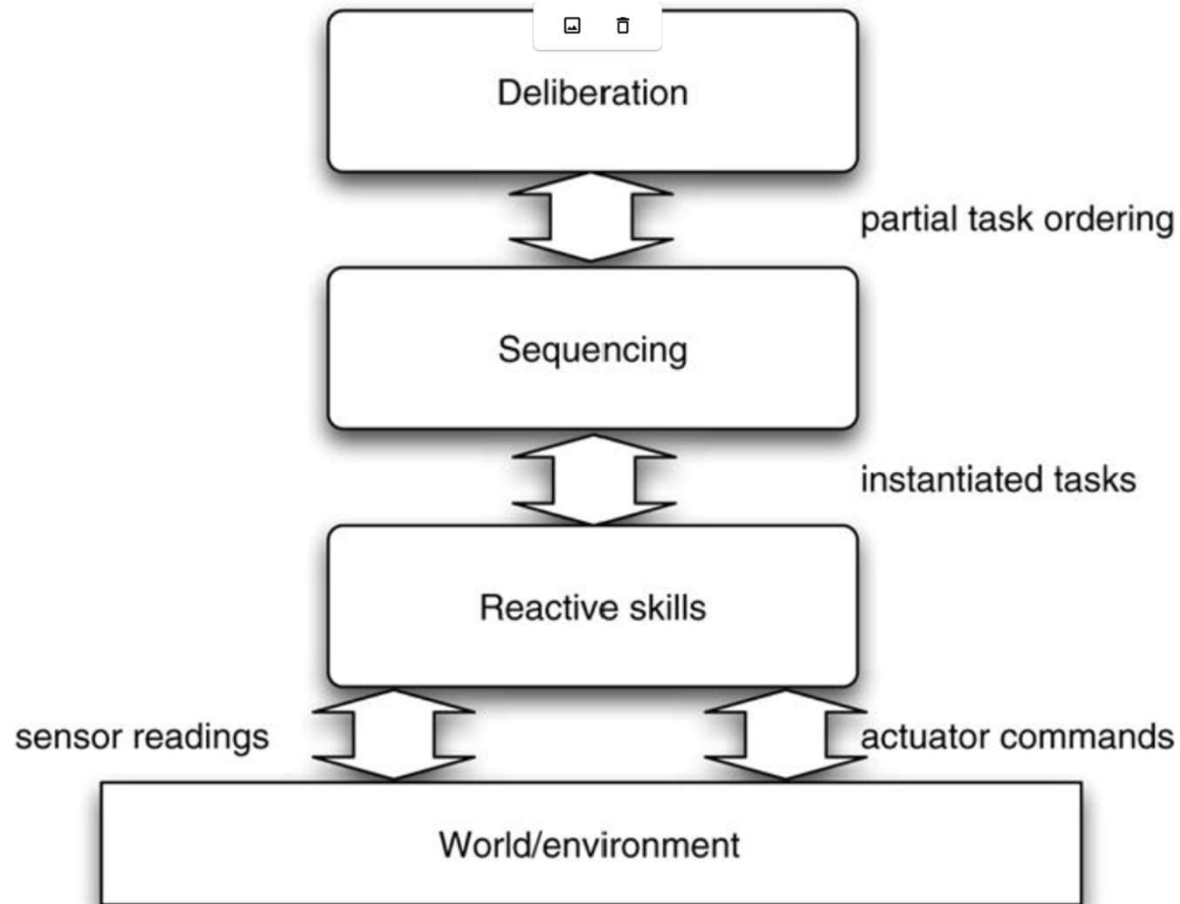


## Hybrid architectures: InteRRap





## Hybrid architectures: 3T





# 4. Reactive vs Goal-oriented

And how do we know that the agent is doing good?



## Other architecture classification

# Reactive vs Goal-oriented

Simple  
Reflex

Model-  
based  
Reflex

Goal-  
based

Utility-  
based



For this clasification...

- Simple Reflex Agent
- Model-based Reflex Agent
- Goal-based Agent
- Utility-based Agent

#### 4. Reactive vs Goal-oriented

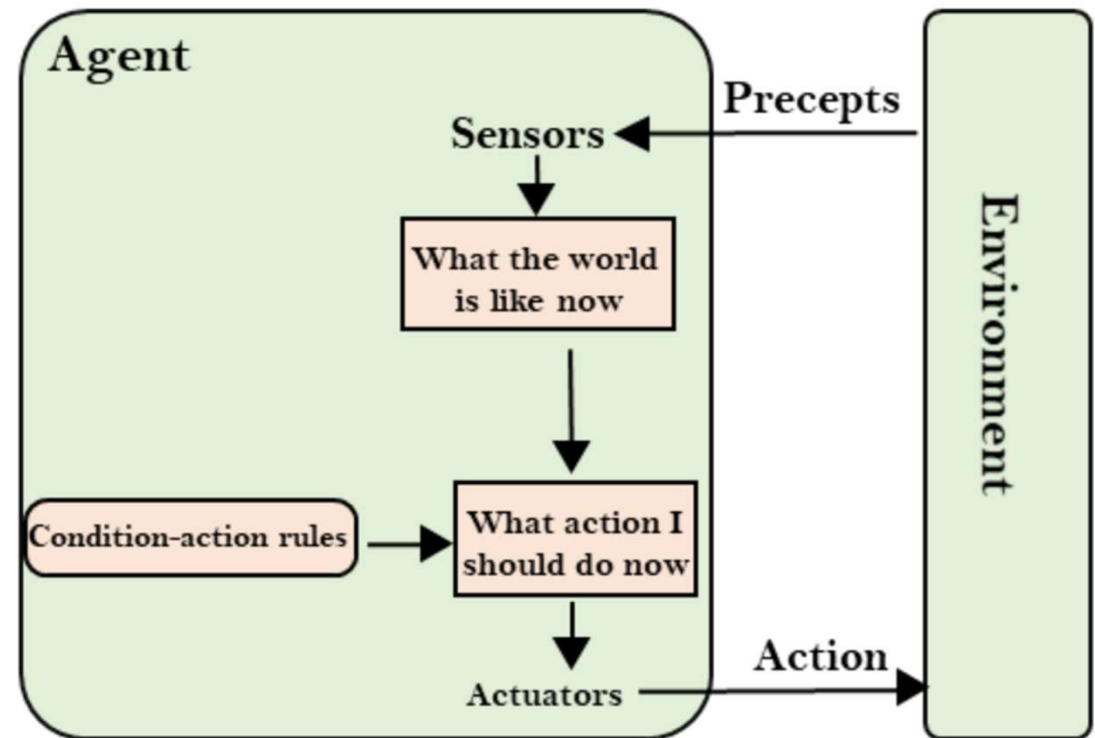






## Simple Reflex Agent

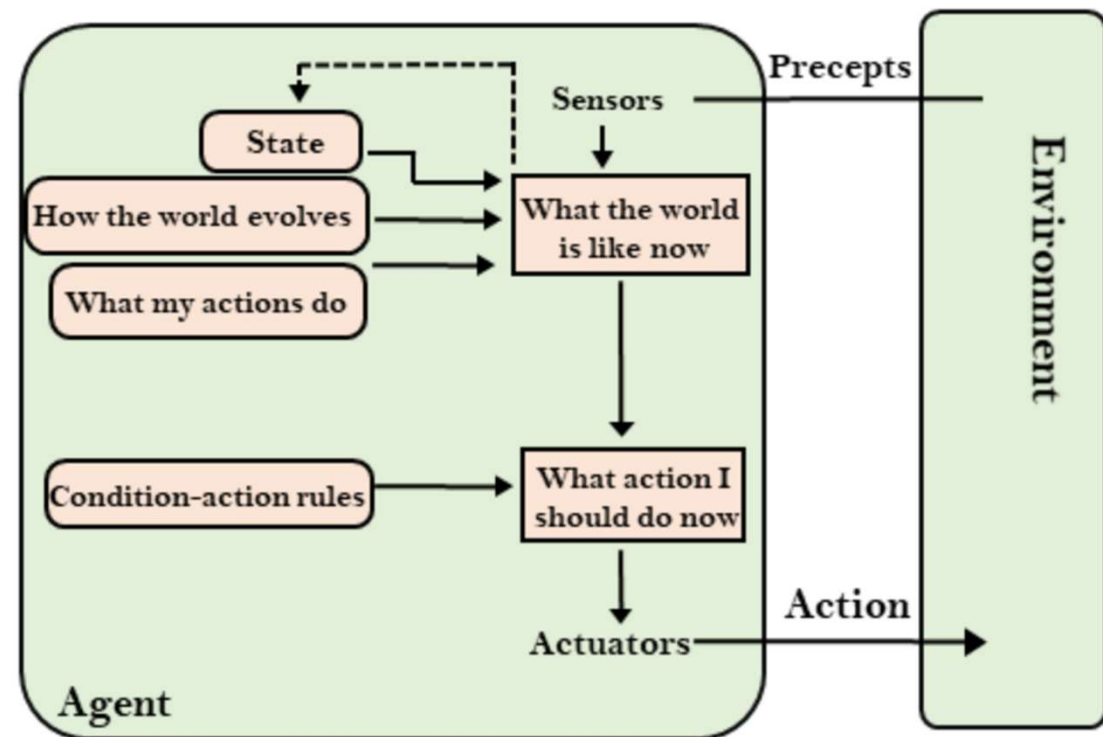
- Works for Accessible Environments
- Takes only the present state (No Memory)
- Rule-based





## Model-based Reflex Agent

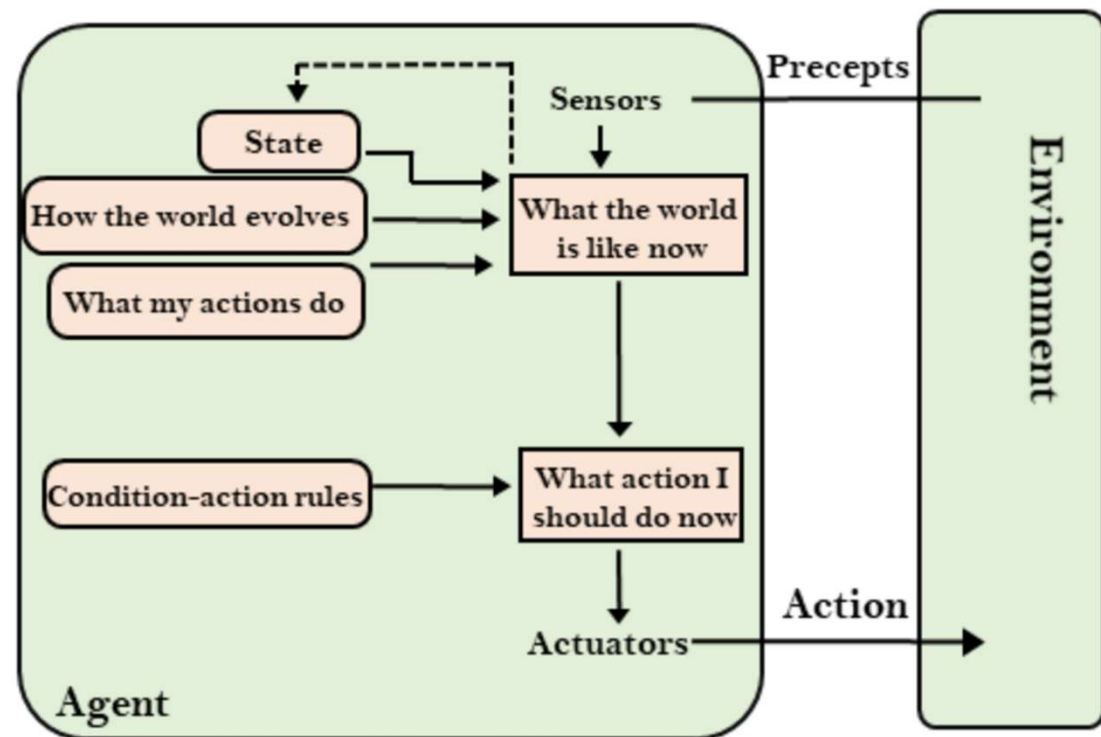
- Works good for Inaccessible Environments
- Takes a history of states (Yes Memory)
- Decisions based on runs + internal states





## Model-based Reflex Agent

- Works good for Inaccessible Environments
- Takes a history of states (Yes Memory)
- Decisions based on runs + internal states

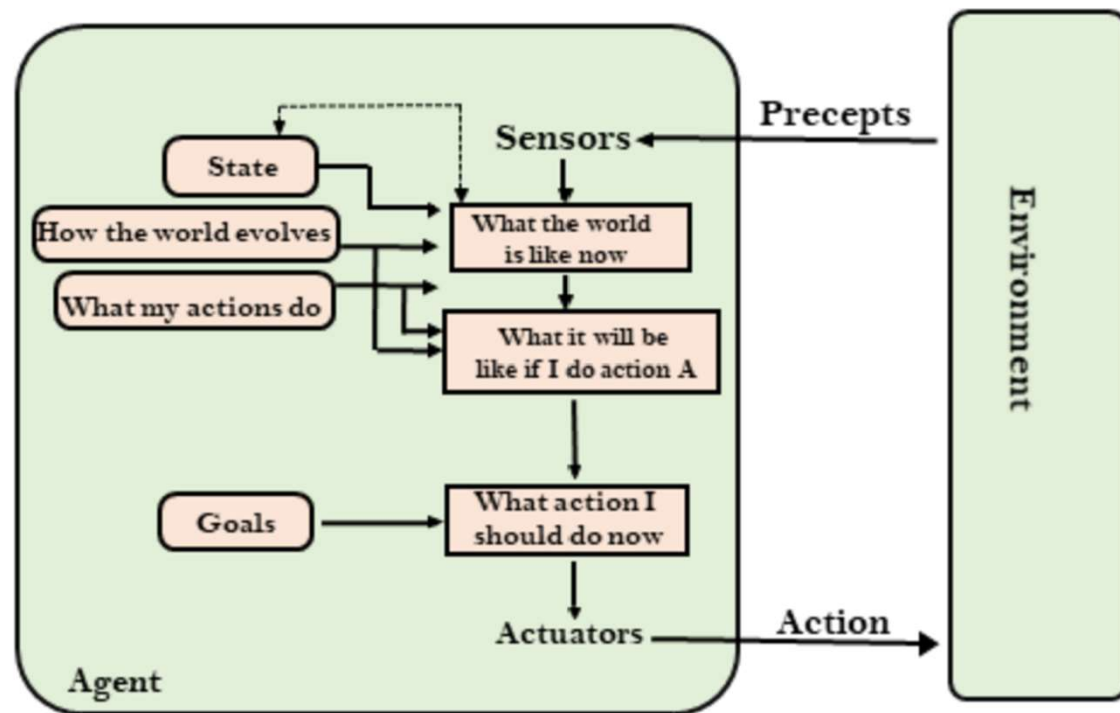




# Goal-based Agent

- When the env. state is not enough
- It creates plans and choose the best one
- Decisions based on the primal goal

## 4. Reactive vs Goal-oriented

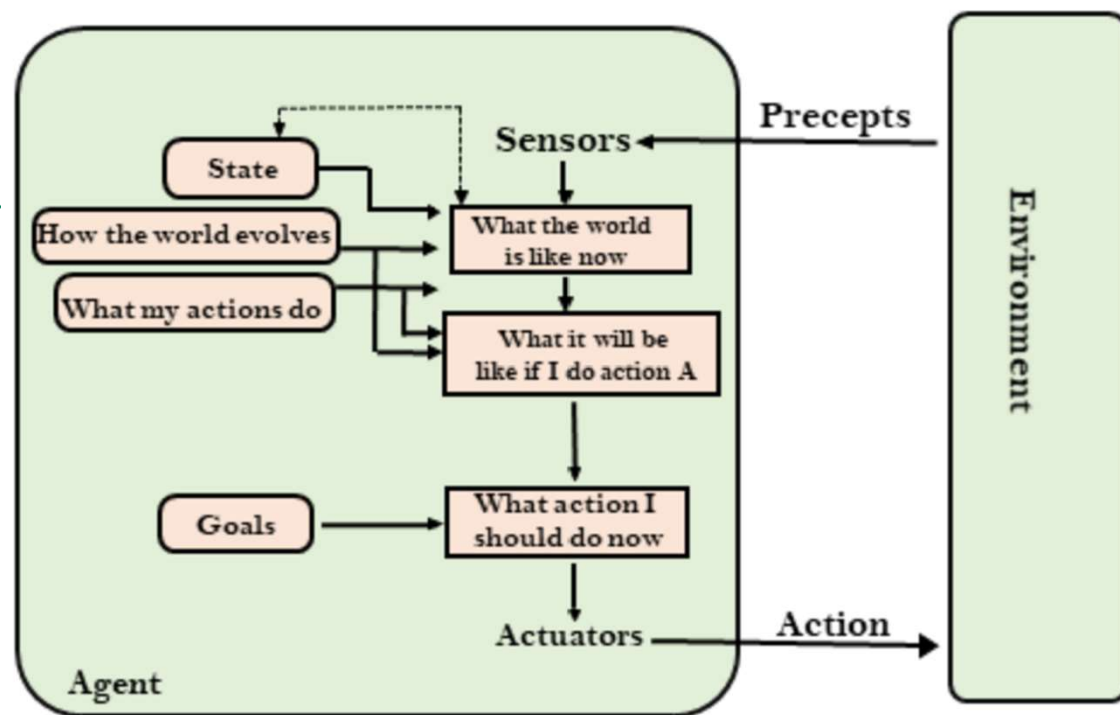




## Utility-based Agent

- Similar to a Goal-based agent
- It **creates plans** and choose the best one
- Decisions based on their **utility of their decisions**, additional to their primal goal
- Useful when there are **more than one possible action.**

### 4. Reactive vs Goal-oriented



Thank you for your attention

