Dcs

Year IV
Semester I
2016

SESSION
III

Intelligent Agents

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Year IV
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Contents will be covered

- Describe what an intelligent agent is?
- Agents and environments
- Rationality
- Environment types
- Design an Intelligent Agent
  - PEAS (Performance measure, Environment, Actuators, Sensors)
- Types of Agent programs

Intelligent Agent

- I want to build a robot that will
  - Clean my house
  - Information filtering agents
  - Fix my car (or take it to be fixed)
  - Wash my clothes
  - Handle my emails
  - Cut my hair
  - Take a note when I am in a meeting
  - Cook when I don't want to

  i.e. do the things that I don't feel like doing…

- AI is **the science of building machines** (agents) that act **rationally** with respect to a goal.

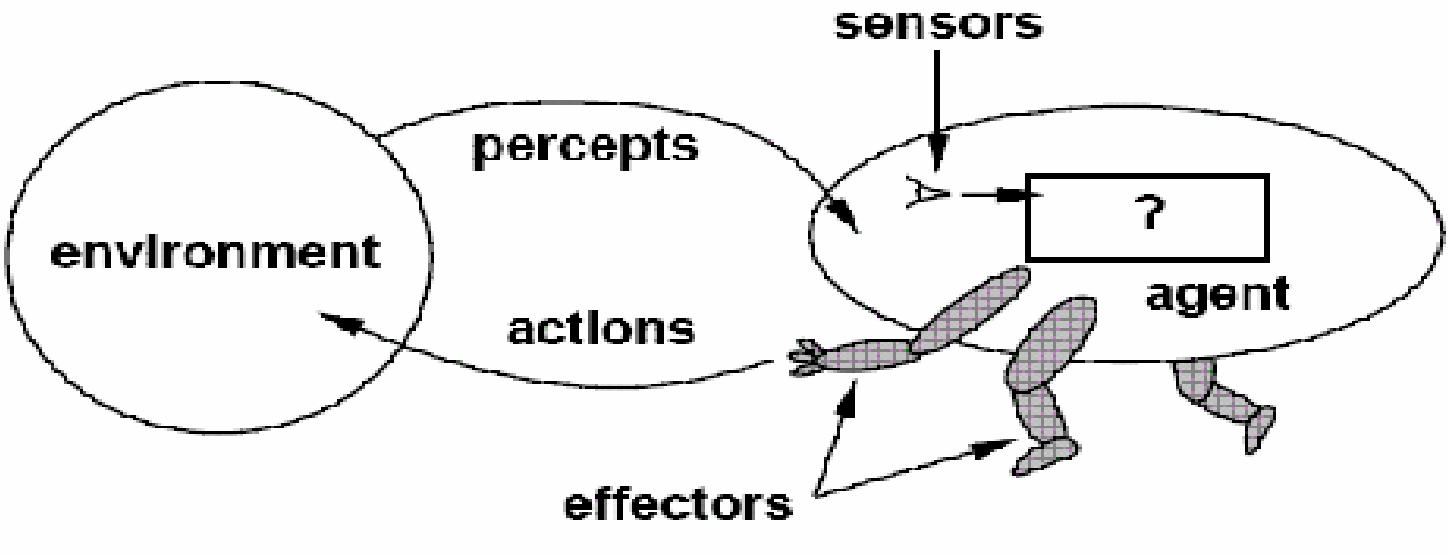
Agent

- **Agent** is anything that can be viewed as
  - **perceiving** its **environment** through **SENSORS** and
  - **acting** upon that environment through **EFFECTORS/ACTUATORS**.

- A **human agent** has ***sensory organs*** such as eyes, ears, nose, tongue and skin parallel to the **sensors,** and other organs such as hands, legs, mouth, ***for effectors***.
- A **robotic agent** replaces cameras and infrared range finders for the ***sensors***, and various motors and actuators for ***effectors***.
- A **software agent** has ***encoded bit strings*** as its programs and actions.

Agent…

- The agent is assumed to exist in an environment in which it perceives and acts
- An agent is rational since it ***does the right thing*** to achieve the specified goal.



Agent...

	Human beings	Robot
Sensors	Eyes(Vision), Ears(Hearing), Nose(Smell), Tongue(Gustation/test), Skin(Touch)	Cameras, Scanners, Mic, infrared range finders
Effectors	Hands, Legs, Mouth	Various Motors (artificial hand, artificial leg), Speakers, Radio

How Agents should act?

- A rational agent should strive to "**do the right thing**", based on what it can perceive and the actions it can perform.
  - What does right thing mean*? It is an action that will cause the agent to be most successful and is **expected to maximize goal achievement**, given the available information*
- A rational agent is not **omniscient**
  - An Omniscient agent **knows the actual outcome** of its actions, and can act accordingly, but **in reality omniscience is impossible.**
  - **Rational agents take action with expected success**, where as **omniscient agent take action with 100% sure of its success**
  - Are human beings Omniscient or Rational agent?

Example: Is the agent Rational?

- You are walking along the road to ***Arat-Kilo***; you see an old friend across the street. There is no traffic.
- So, being rational, you start to cross the street.
- On the other hand, a big banner falls off from above and before you finish crossing the road,

Were you irrational to cross the street?

- This points out that rationality is concerned with expected success, given what has been perceived.
  - Crossing the street was rational, **because most of the time, the crossing would be successful,** and **there was no way you could have foreseen the falling banner.**
  - The EXAMPLE shows that **we can not blame an agent** for failing to take into account something it could not perceive. Or for failing to take an action that it is incapable of taking.

Examples of agents in different types of applications

Agent type	Percepts	Actions	Goals	Environment
Medical diagnosis system	Symptoms, patient's answers	Questions, tests, treatments, diagnoses	Healthy patients, minimize costs	Patient, hospital
Interactive English tutor	Typed words, questions, suggestions	Write exercises, suggestions, corrections	Maximize student's score on exams	Set of students, materials
Softbot	webpages	ftp, mail, telnet	Collect information on a subject	Internet
Satellite image analysis system	Pixels intensity, color	Print a categorization of scene	Correct categorization	Images from orbiting satellite
Refinery controller	Temperature, pressure readings	Open, close valves; adjust temperature	Maximize purity, yield, safety	Refinery

Rational agent

- In summary what is **rational** **at any given point depends on four things.**

  I. Perception: -

  Everything that the agent has perceived so far concerning the current scenario in the environment (percept sequence till now)

  II. Prior Knowledge:

  What an agent already knows about the environment

  III. Action:

  The actions that *the agent can perform* back to the environment

  IV. Performance measure:

  The performance measure that **defines degrees of success of the agent**

- Therefore in designing an **intelligent agent**, one has to remember PEAS (Performance, Environment, Actuators, Sensors) framework/tasks.

Performance measure

- How do we decide whether an agent is successful or not?
  - **Establish a standard** of what it means to be successful in an environment and **use it** to measure the performance
  - A rational agent should do whatever action is **expected to maximize its performance measure, on the basis of the evidence provided by the percept sequence** and whatever built-in knowledge the agent has.
- What is the performance measure for "**Medical Diagnosis System**"?
- What about "**Chess Playing**"?

Examples of agent types and their PEAS description

Agent Type	Performance measure	Environment	Actuators	Sensors
Taxi driver	Safe: fast, legal, comfortable trip, maximize profits	Roads, other traffic, pedestrians, Customers, weather	Steering, accelerator, brake, signal, horn/alert, display	Cameras, speedometer, odometer, GPS, accelerometer, engine sensors, key board
Interactive English tutor	Maximize student's score on test	Set of students	Screen display(exercises, suggestions, corrections)	Keyboard
Medical Diagnosis System	?	?	?	?
Internet Shopping Agent	?	?	?	?

Reading Assignment (for next class)

- Consider the need to design **a "a player agent"** for the national team. It **may be** chess player, football player, tennis player, basketball player, handball player, etc…
  - Identify **sensors, effectors, goals, environment** and **performance measure** that should be integrated for the agent to be successful in its operation?
  - Identify what to perceive, actions to take, the environment it interacts with?

Designing an agent

- Identify **the goal** and **performance measure**
- Identify **the environment** and its characteristics
- Decide **what sensors are required** to sense both ***the environment*** and ***the performance measure.***
- Decide **what actions the agent must perform** and how they are to be made.

Designing an agent

- Agent structure has two parts: **architecture + agent program**
- **Architecture**
  - *Runs the programs*
  - *Makes the percept from the sensors available to the programs*
  - *Feeds the program's action choices to the effectors*
- **Agent Programs**
  - Accepts percept from an environment and **generates actions**
    - Before designing an agent program, we need to know **the possible percept and actions**
  - By enabling **a learning mechanism,** the agent could have a degree of autonomy, such that it **can reason and take decision**

Program Skeleton of Agent

function SKELETON-AGENT (*percept*) **returns** action
static: ***knowledge***, the agent's memory of the world

knowledge← UPDATE-KNOWLEDGE(*knowledge*, ***percept***)
action ← **SELECT-BEST-ACTION**(*knowledge*)
knowledge← UPDATE-KNOWLEDGE (*knowledge*, ***action*)**
return *action*

On each invocation, **the agent's knowledge base** is ***updated*** **to reflect the new percept**, the best action is chosen, and the **fact** that the action taken is also stored in the knowledge base. The knowledge base persists from one invocation to the next.

NOTE: Performance measure is not part of the agent

Classes of Environments

- **Actions** are done **by the agent** on the environment.
- **Environments** provide **percepts to an agent.**
- **Agent** ***perceives and acts in an environment***.
- Hence in order to design **a successful agent** , the designer of the agent has to ***understand the type of the environment*** it interacts with.

•Properties of Environments:

–Fully observable vs. partially observable

–Deterministic vs. stochastic

–Discrete vs. continuous

–Static vs. Dynamic

Fully observable vs. partially observable

- Does the agent's sensory see the complete state of the environment?
  - If an agent has access to **the complete state of the environment**, then the environment **is accessible or fully observable.**
- An environment is effectively accessible if the sensors detect all aspects that are relevant to the choice of action.
- Taxi driving is partially observable
  - Any example of fully observable?

Deterministic vs. stochastic

- Is there **a unique mapping** from one state to another state for a given action?
- The environment is **deterministic** if the next state of the environment is completely determined by
  - the ***current state of the environment*** and
  - the ***actions selected by the agents.***
- **Non deterministic =** the next state has some **uncertainty** associated with it.
- Taxi driving is non-deterministic (i.e. stochastic)

Discrete vs. Continuous

- Are the distinct percepts & actions limited or unlimited?
  - If there are **a limited/finite number of distinct**, **clearly defined** **percepts** and **actions**, we say the environment is **discrete.**
    - **time moves in fixed steps**, usually with one measurement per step
  - **Continuous**- signal constantly coming into sensors, actions continually changing
- Taxi driving is continuous
  - Any example of discrete?

Static vs. Dynamic

- Can the world change while the agent is thinking?
  - If the environment can change **while the agent is choosing an action,** the environment is **dynamic.**
  - otherwise it is static.
- Taxi driving is dynamic
  - Any example of static?

Cont…

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

Types of agent programs

- Simple reflex agents
- Model-Based Reflex Agent
- Goal based agents
- Utility based agents

I. Simple reflex agents

- works by **finding a rule** ***whose condition matches*** the **current situation** (as ***defined by the percept***) and then ***doing the action associated with that rule***.
- Choose actions based on **the current percept**, ignoring the rest of percept history
  - No memory
- Simple but limited intelligence.
- Will only work **if the environment is fully observable** otherwise infinite loops may occur.
  - **Fails if the environment is partially observable.**
- Implemented through **condition-action rules.**

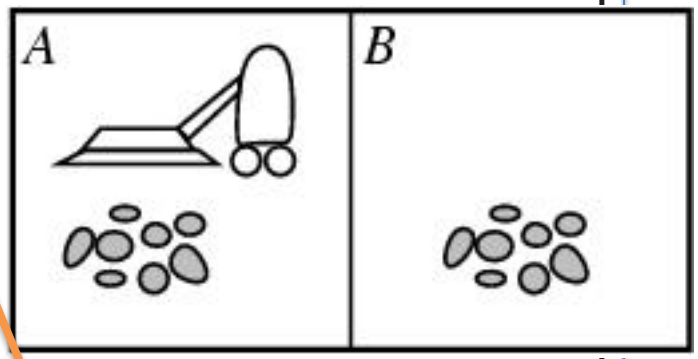
Structure of a simple reflex agent

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*



function SIMPLE-REFLEX-AGENT(*percept*) **returns** an action

static: *rules*, a set of condition-action rules

state ← **INTERPRET-INPUT** (*percept*)

rule ← RULE-MATCH (*state*, *rules*)

action ← RULE-ACTION [*rule*]

return *action*

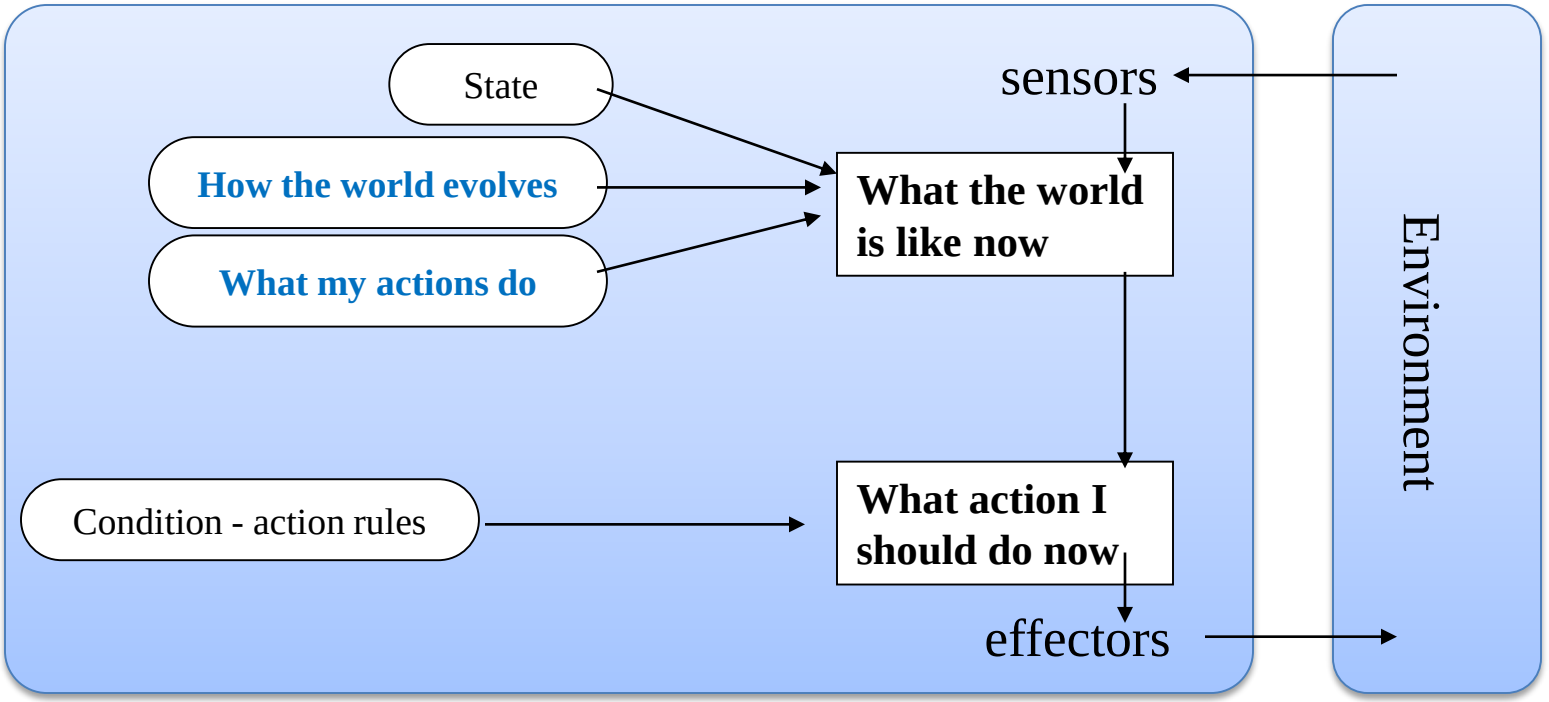
-Example vacuum cleaner agent

Disadvantage??????

II. Model-Based Reflex Agent

- Can handle **partial observable environment** **by use of a model** about the world.
- Agents have **internal state**, which is used to keep track **of past states of the world,** which can not see now.
- It works by **finding a rule** ***whose condition matches*** the current situation (as defined by **the percept** and **the stored internal state**)
- To **update the internal state information**, agent must know
  - ***How does the world evolves?***
  - ***How do actions affect the world?***

Structure of Model-Based Reflex agent



function REFLEX-AGENT-WITH-STATE (*percept*) **returns** action
static: ***state,*** a description of the current world state
rules, a set of condition-action rules

state ← **UPDATE-STATE** (***state, percept***)
rule ← RULE-MATCH (*state*, *rules*)
action ← RULE-ACTION [*rule*]
state ← **UPDATE-STATE** (***state, action***)
return *action*

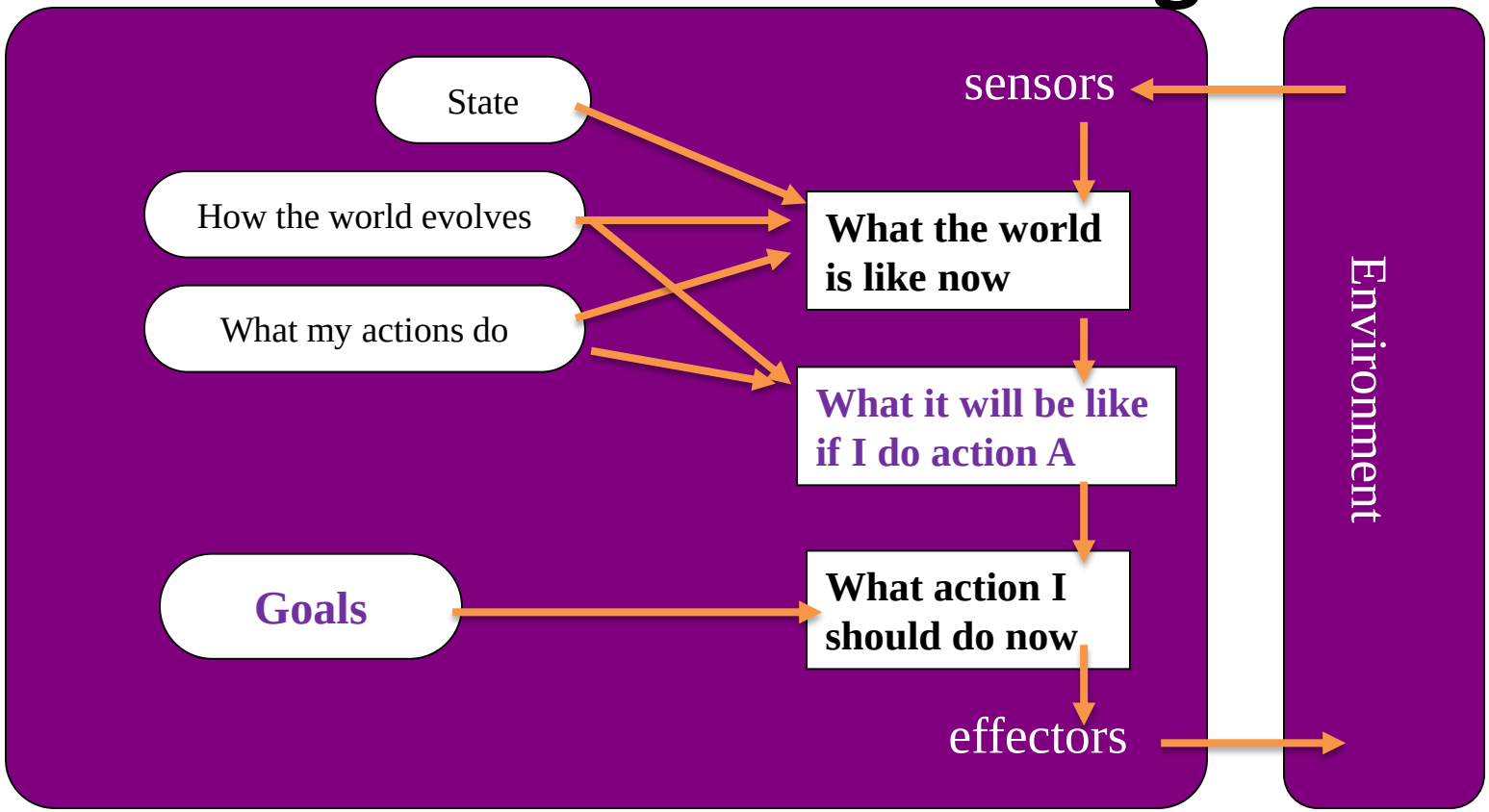
-Advantage Over Simple Reflex Agent???

-Disadvantage????

III. Goal based agents

- ***Knowing about the current state of the environment is not always enough to decide what to do.***
- Expand on the skills of the model based agents, by using ***goal information.***
- Choose actions that achieve the goal (***an agent with explicit goals***)
- Involves future influences when making current decision. "*What will happen if I do…?*"
- *Generally*
  - Agent continues to **receive percepts** and **maintain state**
  - **Have a goal- destination**
  - **Use k/ge about a goal to guide its actions like searching and planning**

Structure of a Goal-based agent



function GOAL_BASED_AGENT (*percept*) **returns** action
  state ← UPDATE-STATE (***state, percept***)
  action ← **SELECT-ACTION** [*state*, *goal*]
  state ← UPDATE-STATE (*state*, *action*)
 return *action*

IV. Utility based agents

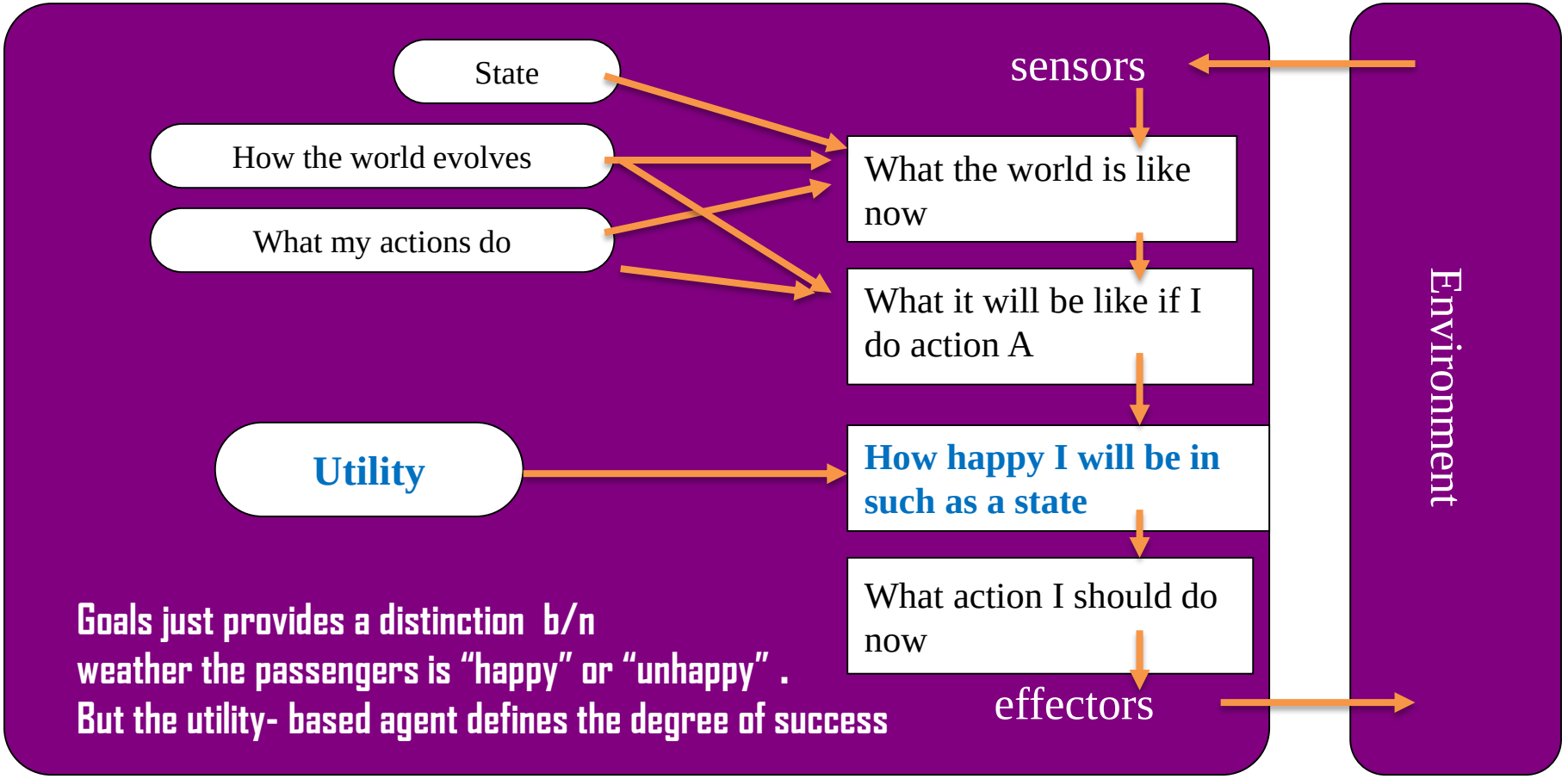
- Is similar to a goal-based agent, but in addition ***to attempting to achieve a set of goals,*** the utility-based agent is also **trying to maximize some utility value**.
    - Goals are ***not really enough*** **to generate high quality behavior** ***in most env't.***

For e.g., there are **many action sequences that will get the taxi to its destination**, thereby achieving the goal. Some are ***quicker, safer, more reliable, or cheaper than others***. We need to consider ***Speed and safety.***

- **Which goal should be selected if several can be achieved?**
- **What to do if there are conflicting goals?**

- Utility provides a way in which ***the likelihood of success can be weighed up against the importance of the goals***. An agent that possesses an explicit utility function can make rational decisions. **(Select appropriately between several goals based on likelihood of success)**

Structure of a Utility-Based Agent



function UTILITY_BASED_AGENT (*percept*) **returns** action

state ← UPDATE-STATE ***(state, percept)***
action ← **SELECT-OPTIMAL_ACTION** [*state*, *goal*]
state ← UPDATE-STATE (*state*, *action*)
return *action*

Assignment III (due: 10 days)

Review five or more articles & write publishable paper on one of the following topic. Share softcopy to all, with a copy to me

- Knowledge-based System **(5):** in various domain: legal; medical; agriculture
  - Case-based reasoning; Fuzzy reasoning; probabilistic reasoning; Ontology-based Knowledge System
- Optical Character Recognition (OCR) system : **(4)**
  - for Braille documents; printed historical documents; handwritten documents
  - Script identification
- Application of OCR: **(2)**
  - bank-check reader; passport reader, postal OCR, etc.
- Speech Analysis **(3)**
  - Speech Recognition; Speech synthesis, Speaker recognition
- Natural Language Processing **(1)**
  - machine translation; lexical analysis, lexical synthesis, part-of-speech tagging, stemming, parsing, Word sense disambiguation
- Security **(8)**
  - Face recognition; Signature recognition, Writer identification.
- Knowledge extraction: concept extraction from natural texts (i.e. legacy text; medical text) **(7)**
- information filtering agent, information extraction, etc. **(6)**

Test One
Oct 31, 2016
8:00 O'clock (Local Time)