Announcement

- Some exercises and homeworks need to be submitted at the end of the semester
  → will be indicated on the slides

- Please consider to stick to a consistent folder structure; e.g.:

```
[student-ID]-AI-handin.zip
|-----> Lab 1 (folder)
---------|-----------> Exercises (folder containing .py files)
---------|-----------> Homework (folder containing .py files)
|-----> Lab 2
---------|-----------> Exercises
---------|-----------> Homework
etc…
```

Agents

Lab 1

Agenda

1. Running example: vacuum-cleaner world
2. Table-driven agent
3. Simple reflex agent
4. Reflex agent with state/memory
5. Homework

Vacuum-cleaner world

Percepts:

Location, status (e.g., [A, dirty])

Actions:

Left, Right, Suck, NoOperation

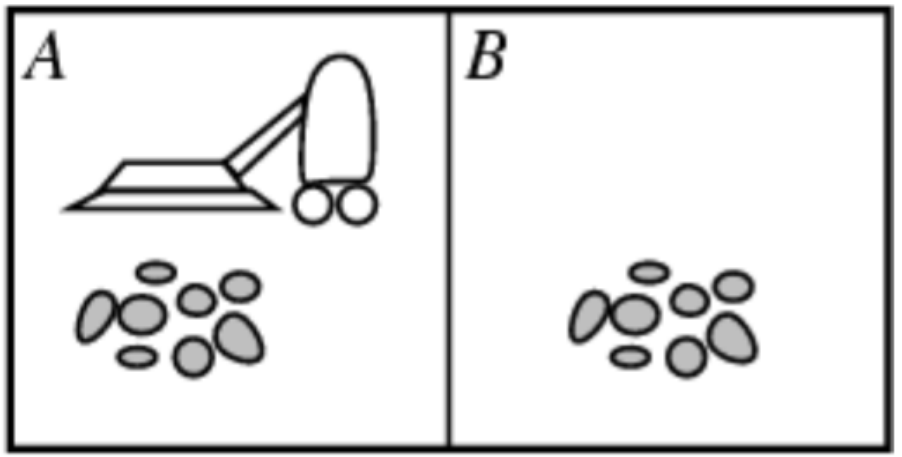


Table-driven agent

Table-driven agent

- Refer to table_driven_agent.png
- **Table** contains all possible *percepts* that can occur
- Each step appends current *percept* to list of *percepts*
- **LOOKUP** current *percepts* in *table*

Table-driven agent

function TABLE-DRIVEN-AGENT(*percept)* **returns** an action
static: *percepts,* a sequence, initially empty
table, a table of actions, indexed by percept sequences, initially fully specified

append *percept* to the end of *percepts*
action = LOOKUP*(percepts, table)*
return *action*

```
1  def TABLE_DRIVEN_AGENT(percept):
2      '''Determine action based on table and percepts'''
3      #Append percept
4      percepts.append(percept)
5      #Lookup appropriate action for percepts return action
6      action = LOOKUP(percepts, table)
7      return action
```

Exercise 1

1. Run the module (using run())
2. The percepts should now be: [(‘A’, ’Clean’), (‘A’, ’Dirty’), (‘´B’, ’Clean’)]
   - The table contains all possible percept sequences to match with the percept history
   - Enter:
     print(TABLE_DRIVEN_AGENT((B, 'Clean')), '\t', percepts)
   - Explain the results
3. How many table entries would be required if only the *current* percept was used to select and action rather than the percept history?
4. How many table entries are required for an agent lifetime of T steps?

Simple reflex agent

using condition-action rules and if statements

Simple reflex agent

- Refer to reflex_vacuum_agent.png
- Only responds to current percept (location and status) ignoring percept history
- Uses *condition-action* rules rather than a table
  - **if** *condition* **then return** *action*
  - **if** *status* = *Dirty* **then return** *Suck*
- **Sensors()** – Function to sense current location and status of environment (i.e., *location* of agent and *status* of square)
- **Actuators(action)** – Function to affect current environment location by some action (i.e., *Suck, Left, Right, NoOp*)

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*

```python
def REFLEX_VACUUM_AGENT((location, status)):
    # Determine action
    if status == 'Dirty': return 'Suck'
    elif location == A: return 'Right'
    elif location == B: return 'Left'
```

Exercise 2

1. Run the module
2. Enter *run(10)*
3. Should bogus actions be able to corrupt the environment? Change the REFLEX_VACUUM_AGENT to return bogus action, such as *Left* when it should go *Right* etc. Run the agent. Do the Actuators allow bogus actions?

Simple reflex agent

using condition-action rules and dictionaries

Simple reflex agent

- Refer to simple_reflex_agent.png
- **Condition-action rules**

  – **rules** = { (A,'Dirty'):1, (B,'Dirty'):1, (A,'Clean'):2, (B,'Clean'):3, (A, B, 'Clean'):4 }
  Defines *rule* for each *condition* such as: condition == (A,’Dirty’) uses rule 1

  – RULE_ACTION = { 1:'Suck', 2:'Right', 3:'Left', 4:'NoOp’ }
  Defines *action* for each *rule* such as: rule 1 produces action ‘Suck’

Simple reflex agent

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*

```
1  def SIMPLE_REFLEX_AGENT(percept):
2      # Determine action state = INTERPRET_INPUT(percept)
3      rule = RULE_MATCH(state,rules)
4      action = RULE_ACTION[rule]
5      return action
```

Exercise 3

1. Run the module
2. Enter *run(10)*
3. Change the SIMPLE_REFLEX_AGENT *condition-action* rules to return bogus actions, such as *Left* when should go *Right*, or *Crash*, etc. Rerun the agent. Do the Actuators allow bogus actions?

Reflex agent with state/memory

Reflex agent with state

- Reflex agent only responded to current percepts; no history or knowledge
- Model-based reflex agents:
  - Maintain internal state that depends upon percept history
  - Agent has a model of how the world works
  - The model requires two types of information to update:
    - How environment evolves independent of the agent (e.g., Clean square stays clean)
    - How agent’s action affect the environment (e.g., Suck cleans square)

Reflex agent with state

- Refer to reflex_agent_with_state.png
- Model – used to update history
  - History initially empty:
    model = {A: None, B: None}
  - Model only used to change state when A == B == ‘Clean’
    if model[A] == model[B] == ‘Clean’: state = (A, B, ‘Clean’)

Simple reflex agent

function REFLEX-AGENT-WITH-STATE(*percept*) **returns** an action
static: *state,* a description of the current world state
rules, a sequence, a set of condition-action rules
action, the most recent action, initially none
state = UPDATE-STATE(*state, action, percept*)
rule = RULE-MATCH(*state, rules*)
action = RULE-ACTION*[rule]*
return *action*

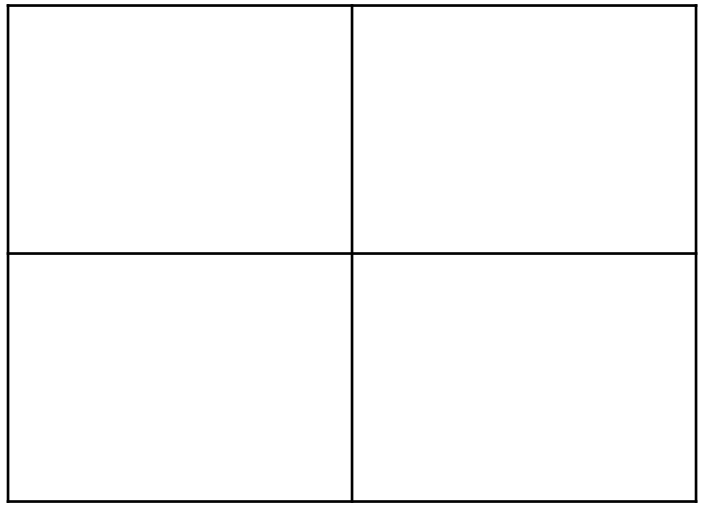
```
1  def REFLEX_AGENT_WITH_STATE(percept):
2      global state, action
3      state = UPDATE_STATE(state, action, percept)
4      rule = RULE_MATCH(state, rules)
5      action = RULE_ACTION[ rule ]
6      return action
```

Homework

Homework 1 – Simple Reflex Agent

Must be submitted

- Extend the REFLEX_VACUUM_AGENT (Exercise 2) program to have 4 locations (4 squares)
  - The agent should only sense and act on the square where it is located
  - Allow any starting square
  - Use run(20) to test and display results



Homework 2 – Reflex agent with state

Must be submitted

- Extend the REFLEX_AGENT_WITH_STATE program to have 4 locations
  - The agent should only sense and act on the square where it is located
  - Allow any starting square
  - Use run(20) to test and display results