CK0031: Homework 01

Exercise 01.01 (part of 02.03 AIMA3). For each of the following assertions, say whether it is *true* or *false* and support your answer with examples or counterexamples where appropriate.

a) An agent that senses only partial information about the state cannot be perfectly rational [*Hint*: Use the working definition of rationality.];

b) There exist task environments in which no pure reflex agent can behave rationally [*Hint*: Think about the limitations of reflex agents.];

c) There exists a task environment in which every agent is rational [*Hint*: Think about the usual properties of the task environment.];

d) The input to an agent program is the same as the input to the agent function;

e) Every agent function is implementable by some program/machine combination;

f) Suppose an agent selects its action uniformly at random from the set of possible actions. There exists a deterministic task environment in which this agent is rational [*Hint*: Check question c).];

g) It is possible for a given agent to be perfectly rational in two distinct task environments;

h) Every agent is rational in an unobservable environment [*Hint*: Think about the function of the model.];

i) A perfectly rational poker-playing agent never loses.

Exercise 01.02 (part of 02.04 AIMA3). For each of the following activities, give a PEAS description of the task environment and characterise it in terms of the usual properties [i.e., i) Fully observable v partially observable; ii) Single agent v multi-agent; iii) deterministic v stochastic; iv) Episodic v sequential; v) Static v dynamic; vi) Discrete v continuous; and, vii) Known v unknown.]

a) Playing soccer;

b) Shopping for used AI books on the Internet;

c) Playing a tennis match;

d) Practicing tennis against a wall;

e) Performing a high jump;

f) Bidding on an item at an auction.

Exercise 01.03 (02.05 AIMA3). Define in your own words the following terms:

a) agent;

b) agent function;

c) agent program;

d) rationality;

e) autonomy;

f) reflex agent

g) model-based agent;

h) goal-based agent;

i) utility-based agent;

j) learning agent.

Exercise 01.04 (part of 02.06 AIMA3). This exercise explores the differences between agent functions and agent programs.

a) Can there be more than one agent program that implements a given agent function? Give an example, or show why one is not possible.

b) Given a fixed machine architecture, does each agent program implement exactly one agent function?

c) Suppose we keep the agent program fixed but speed up the machine by a factor of two. Does that change the agent function? [*Hint*: Consider whether the environment is static or dynamic.]

Exercise 01.05. An earthquake of magnitude 6.2 ± 0.016 hit Central Italy on August 24, 2016 at 03:36:32 CEST (01:36:32 UTC). Reports indicated severe damage in the town of Amatrice. You, as a trainee, have been called up to develop an intelligent agent to rescue humans from a region otherwise inaccessible. The agent operates a drone over a predefined rescuing area:

- **Environment**: The environment consists of a rectangular area consisting of 15×20 squares. Some squares are occupied by obstacles (e.g., walls and rocks), some are empty and some other are occupied by humans. Assume that each square has a 10% chance of being occupied by a human (i.e., 30 humans) and 33% chance of being occupied by an obstacle (i.e., 100 obstacles). During operations, the area is understood as surrounded by impenetrable walls.

- **Goals**: The goal is to rescue humans and leave the area. Specifically, the performance measure is $+100$ points for each rescued human and -1 point for each performed action.

- **Percepts**: The drone agent gets a three-element percept consisting of

  – A frontal 'proximity sensor': It returns 1 if the machine faces an obstacle (e.g., a wall) and 0 otherwise;

  – A 'presence sensor' under the drone: It returns 1 if there is human below the drone and 0 otherwise;

  – An 'infrared sensor': It returns 1 if the agent receive the external command to leave the area (i.e., fly back to the paramedics) and 0 otherwise.

- **Actions**: There are five actions available: `Go forward`, `Turn right by` 90°, `Turn left by` 90°, `Pick up human` and `Leave`.

- A `Go forward` action moves the agent forward by one square, unless the square is occupied by an obstacle, in which case the agent must turn right or left by 90 degrees;
- A `Turn` action rotates the agent, within the current square;
- A `Pick up human` action rescues a human, if present;
- A `Leave` action ends the simulation.

As a trainee developer of the agent, your tasks are:

1. Design and implement a model-based agent for the aforementioned situation and measure its performance. Assume that the duration of the mission is $T = 1500$ actions/steps and that the initial position of the drone in the grid is $(1, 1)$.
2. Explain why it would be impossible to have a reflex agent that is capable to return to the start position when it receives a `Leave` command.
3. Speculate on what the best possible reflex agent could do. What prevents a reflex agent from doing very well?

Please notice that you are expected to submit your code for us to evaluate it. The code can be submitted either in the form of an archive (i.e., package it together with your answer sheet and submit) or, and preferably, in the form of a link, within the answer sheet you submit, for us to download it (it is your responsibility to make sure the link you provide works also after deadline.)

[*Code*: You can use the code (Python and Java) available at `GitHub Lista 1`. If you have any enquiry regarding the implementation, do not hesitate to contact `J` (for Python) or `S` (for Java).]