SAARLAND UNIVERSITY
Prof.Dr. Jana Koehler

ARTIFICIAL INTELLIGENCE

Theoretical Exercise Sheet 0

Solutions due Sunday, April 19, 23:59

This sheet will not be graded for the lecture and points do NOT count!

Total points of the sheet: 20

Exercise 1: Definition

Define in your own words the following terms:

1. Agent

   Solution:

   (a) Has the ability to perceive the environment?
   (b) These perceptions are used to make decisions.
   (c) The decisions will result in actions.

   1 points

2. Rationality

   Solution: *Decisions must be rational (i.e. decisions must lead to the best possible action the agent can take)*

   1 points

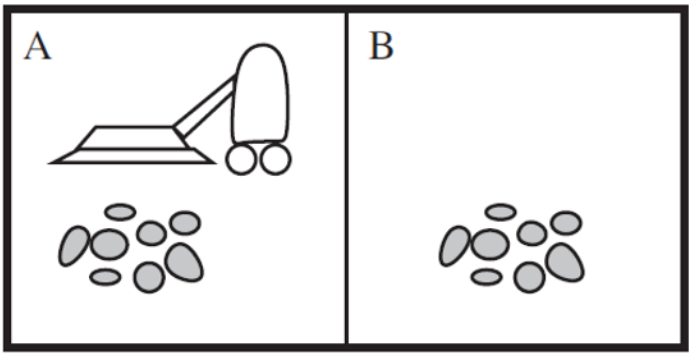
Total points: 2

Exercise 2: Rational agent

We are looking at the vacuum cleaner world as defined in the lecture, see the slides in the Intelligent Agents slide deck with the whiteboard description of the vacuum cleaner world state space. Is the following simple vacuum cleaner function rational if we are given the following additional assumptions:

- The "geography" is known a priori, but not the distribution of dirt and the location of the agent.

- Clean squares stay clean, sucking removes dirt.
- Left and right moves move the agent to the other location unless they would take the agent outside the room. In this latter situation, it stays where it is.
- The only available actions are LEFT, RIGHT, SUCK.
- The agent correctly perceives its location and whether there is dirt.
- The performance measure awards 1 point for each clean square at each time step.




```
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
```

Please justify your answer. If the function is rational, you should do so by showing that its expected performance is at least as high as any other agent's performance (by analysing the state space). If the function is not rational, you should give an example of a situation, where the agent's action is not rational, it i.e. does not maximise its performance measure. In this case, you should further give a different agent function, which is rational for the given state space and assumptions.

Solution:
It is rational.

1 points

It suffices to show that for all possible actual states (i.e., all dirt distributions and initial locations), this agent cleans the squares at least as fast as any other agent. This is trivially true when there is no dirt. When there is dirt in the initial location and none in the other location, the world is clean after one step; no agent can do better. When there is no dirt in the initial location but dirt in the other, the world is clean after two steps;

no agent can do better. When there is dirt in both locations, the world is clean after three steps; no agent can do better. (Note: In general, the condition stated in the first sentence of this paragraph is much stricter than necessary for an agent to be rational.)

2 point

Total points: 3

Exercise 3: PEAS description

Given is a standard toaster. You can set the time and intensity of the toasting process. We are considering the toaster as an agent. Give a PEAS description of this agent and give at least one example for each of P, E, A and S. Please justify your answers in 1 or 2 sentences.

Solution:

Performance Measure: *For example: How even the toasting is, number of slices of bread toasted per hour, ...*

1 points *for* ***1*** *valid performance measure*

Environment: *For example: Kitchen, User input, ...*

1 points *for* ***1*** *valid environment*

Actuators: *For example: Heating element, ejector of the toasted slices, acoustic signal (?), flashing light (?), ...*

1 points *for* ***1*** *valid actuators*

Sensors: *For example: Times, Toasting intensity setting sensor, ...*

1 points *for* ***1*** *valid sensors*

Total points: 4

Exercise 4: Specification of Task environments

You are given the following four domains:

1. A group of people playing poker.
2. A person driving a car.
3. A machine detecting chocolate bars weighing less than 50g.
4. A doctor performing a medical diagnosis.

Classify each of the domains above along domain the properties that we discussed in the lecture by entering yes/no in the cells of the following table:

	Accessible	Deterministic	Episodic	Static	Discrete	Single agent
Poker						
Car						
Machine						
Doctor						

Solution:

	Accessible	Deterministic	Episodic	Static	Discrete	Single agent
Poker	*no*	*no*	*no*	*yes*	*yes*	*no*
Car	*no*	*no*	*no*	*no*	*no*	*no*
Machine	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Doctor	*no*	*no*	*no*	*no*	*no*	*yes*

1 points for each row if at least 5 out of the 6 properties are correct

Total points: 4

Exercise 5: True/False

For each of the following assertions, say whether it is true or false and give a short explanation in 1 or 2 sentences for each of your answers.

1. An agent that senses only partial information about the state cannot be perfectly rational.

   Solution: *False. Perfect rationality refers to the ability to make good decisions given the sensor information received.*

   1 points

2. There exist task environments in which no pure reflex agent can behave rationally.

   Solution: *True. A pure reflex agent ignores previous percepts, so cannot obtain an optimal state estimate in a partially observable environment. For example, correspondence chess is played by sending moves; if the other player's move is the current percept, a reflex agent could not keep track of the board state and would have to respond to, say, "a4" in the same way regardless of the position in which it was played.*

   1 points

3. There exists a task environment in which every agent is rational.

   Solution: *True. For example, in an environment with a single state, such that all actions have the same reward, it doesn't matter which action is taken. More generally, any environment that is reward-invariant under permutation of the actions will satisfy this property.*

   1 points

4. The input to an agent program is the same as the input to the agent function.

   Solution: *False. The agent function, notionally speaking, takes as input the entire percept sequence up to that point, whereas the agent program takes the current percept only.*

   1 points

5. Is it possible for a given agent to be perfectly rational in two distinct task environments.

   Solution: *True. For example, we can arbitrarily modify the parts of the environment that are unreachable by any optimally acting agent as long as they stay unreachable.*

   1 points

6. Every agent is rational in an unobservable environment.

   Solution: *False. Some actions are stupid—and the agent may know this if it has a model of the environment—even if one cannot perceive the environment state.*

   1 points

7. A perfectly rational poker-playing agent never loses.

   Solution: *False. Unless it draws the perfect hand, the agent can always lose if an opponent has better cards. This can happen for game after game. The correct statement is that the agent's expected winnings are non-negative.*

   1 points

Total points: 7

Submission Instructions (Optional)

If you like feedback on your solutions, please upload them in the CMS until April 19, 23:59. Remember that points **do not count** towards examen admission.

Solutions need to be packaged into a `.zip` file and uploaded in the AI CMS. The `.zip` file has to contain a single folder with name:
`AI2020_TE0_mat1_mat2_mat3` where `mat1, mat2, mat3` are the matriculation numbers of the students who submit together. This folder must contain the following files:

- `authors.txt` listing the names and matriculation numbers of all students who submit together. Use one line per student and no spaces: Name;Matriculation number.
- The `.pdf` file containing your solutions.

Do not add any other folder or sub folder, this means place all files directly into `AI2020_TE0_mat1_mat2_mat3`. Do not place any file outside of `AI2020_TE0_mat1_mat2_mat3`.

Remember that you can submit sheets alone or in groups of up to three people. For later sheets, your group partners must be assigned to the same tutorial as you. As the tutorials have not been assigned yet, this restriction does not apply for this sheet (and you can submit later sheets in a different group). Only one student of each group needs to do the submission! If you are looking for submission partners, it is recommended to ask in the forum of the CMS in the category "Student Room".