Norwegian University of Science and Technology

Assignment Title

Assignment 1
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Artificial Intelligence Fundamentals and Intelligent Agents

Course

TDT4136 Introduction to Artificial Intelligence

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Submitted by

Dusan Jakovic

NTNU
Kunnskap for en bedre verden

1: What is the Turing test, and how it is conducted?

A Turing test is used for determining if a computer is able to think like a human being, or not. The test is passed if the computer can mimic human responses under specific conditions.

The test consists of three terminals, where two are operated by humans and one by a computer. One of the humans are the questioner, and the second human and the computer are respondents. The questions are within a pre-specified theme, time ,and number of questions. After the questions, the questioner has to decide which of the two respondents that was a computer and which was a human.

This test is repeated multiple times, and if the questioner can't resolve if the respondent is a computer or human, then the machine passes and is verified as intelligent.

2. What is the relationship between thinking rationally and acting rationally? Is rational thinking an absolute condition for acting rationally?

Thinking rationally is to think logically, and acting rationally means to achieve one's goals, given one's beliefs. One can say that to act rationally, you have to reason logically. But there are often circumstances where there is not *one* correct thing to do, but still something has to be done. If one has to react to something unsuspected, as for example tripping on a rock, there is no room for anything else than "just to act". Hence, rational thinking is <u>not</u> an absolute condition for acting rationally.

3. What is Tarski's "theory of reference" about?

Def: It's a theory of reference that shows how to link the objects in a logic to objects in the real world.

It is a theory which, like a propositional semantic theory, pairs the expression of a language with certain values. A theory of reference pairs the expressions with the contribution those expressions make to the determination of the truth-values of sentences in which they occur.

To explain this more in depth, I will use the racing driver Michael Schumacher as an example:

- Michael Schumacher is a retired Formula One (F1) driver.
- Michael Schumacher is a retired Prime Minister of Norway.

The first statement is true, and the second one is false. The truth-value between these sentences is explained by the fact that "Michael Schumacher" is a former F1-driver, and not the Prime Minister of Norway.

“Is a former retired F1 driver” - the reference - is now the object for which that name stands. Given this, it is a short step to some conclusions to the reference of other sorts of expressions. Now, considering the following pair of sentences (below), we already have a function from the object to some truth-values

- Michael Schumacher raced for Ferrari
- Michael Schumacher raced for Red Bull

Once more, the first statement is true, whereas the second is false. The reference of “raced for Ferrari” is the function which return the truth-value (true) when given as the input object. Likewise, the second reference will return a false, since Schumacher never raced for Red Bull.

4. Describe rationality. How is it defined?

Def: It is a belief or action that that follows some logic or reason. It aims to achieve benefits that are most optimal for the decision maker, based on correct reasoning.

Rationality is the compliance with standards, rules, or laws of one’s beliefs with one’s reasons to believe, and of one’s actions with one’s reasons for action.

5. Consider a robot whose task it is to cross the road. Its action portfolio looks like this: look-back, look-forward, look-left-look-right, go-forward, go-back, go-left and go-right.

(a) While crossing the road, a helicopter falls down on the robot and smashes it. Is the robot rational?

Yes, because it is doing what it is supposed to do to achieve its goal, which is “go-forward” and maybe some other gestures. A helicopter falling down on it is something it can’t take in account because it is not rational to look up in the sky while walking over the street.

(b) While crossing the road on a green light, a passing car crashes into the robot, preventing it from crossing. Is the robot rational?

The robot could be rational if this happened in a moment where it was doing the right thing and didn’t have any other choice (an accident). On the other hand, if the robot has a green light and it sees the car approaching it, but is still continues to “go-forward” towards its goal to achieve it (because green light means that you can “walk anyway”), then it’s not rational. It should know that even if there is a green light, it should always be cautious and observant.

6. Consider the vacuum cleaner world described in Chapter 2.2.1 of the textbook. Let us modify this vacuum environment so that the agent is penalized 1 point for each movement.

(a) Can a simple reflex agent be rational for this environment? Explain your answer

No. It could do the work with moving left, right, and sucking up dirt, but the problems could occur when the robot is moving and encountering “obstacles”, e.g the edges of box A or B, which could potentially lead to an infinite loop. Although, this infinite loop can be escaped by the agent randomizing its actions.

(b) Can a reflex agent with state be rational in this environment? Explain your answer.

Yes. With help of keeping the internal state it will be able to react in unwanted circumstances, as a simple reflex agent couldn’t. E.g by having its previous state available, it can figure out that it has already “bounced” into the edge, and change its action in the next task.

(c) Assume now that the simple reflex agent (i.e., no internal state) can perceive the clean/dirty status of both locations at the same time. Can this agent be rational? Explain your answer. In case it can be rational, design the agent function.

With the agent being aware of both location, it will think rationally by moving to the location where the dirt being placed, instead of bouncing from one edge to the other and finding dirt occasionally and getting into unwanted circumstances.

```
def main_function():
        if perception = dirty_right:
                move(right)
                suck()
                perception = getPerception()
        elif perception = dirty_left:
                move(left)
                suck()
                perception = getPerception()
        else:   #clean
                do_nothing()
```

7. Consider the vacuum cleaner environment shown in Figure 2.3 in the textbook. Describe the environment using properties from Chapter 2.3.2, e.g. episodic/sequential, deterministic/stochastic etc. Explain selected values for properties in regards to the vacuum cleaner environment.

Partially observable

The environment is partially observable because the agent has not access to the complete state of the environment at each point of time. The vacuum-cleaner has only access to the local area it is in and not in the whole, hence it's not fully observable.

Single agent

It is a single-agent environment because the agent is cleaning by itself and only minding its "own business". It is not communicating or competing with any other agent by doing what it does. The vacuum-cleaner agent has none additional sensors as e.g. a collision sensor, so it's not cooperative either.

Stochastic

The environment is not deterministic because it is impossible for the agent to keep track of all the unobservable aspects. For example, the agent can't predict where the next dirt spot is at any given moment because the environment can change at any time.

Episodic

It's an episodic task environment because the agent receives and then performs a single action, all the time. E.g <receives>Dirt</receives> <perform>Suck</perform>, <receives>Clean</receives> <perform>Move Right</perform>, etc..

Dynamic

The environment is dynamic because it can change while an agent is deliberation. The agent has to keep looking for dirty all the time. Previously clean spots can be dirty next time the agent encounter the spot.

Deterministic

There is no uncertainty about the state that will result from the agent performing an action. If the agent sucks up the dirt, it sucks up the dirt and in the next state it is clean - counting on that the vacuum-cleaner is 100% efficient.

Known

It's a known environment because the agent know the to fields (A,B) it's supposed to clean, even though it doesn't know where the dirt is placed at any given time.

8. Discuss the advantages and limitations of these four basic kinds of agents:

(a) Simple reflex agents

+ It selects actions on the basis of the current percept, ignoring the percept history, which makes it effective on simple tasks. It doesn't use its time on making decisions that doesn't have anything with its job to do.

- It has some limitations when it comes the environment being partially observable. The agent will only work if the current percept is fully observable. The agent may make a decision in this case, but it might not be an optimal one. Infinite loops are often unavailable when operating in partially observable environments.

(b) Model-based reflex agents

+ It can maintain internal state to track aspects of the world that are not evident in the current percept. In this way we can say that the agent is more observable than an simple reflex agent.

- With a large number of agents, execution speed drops considerably. This model lacks the ability to have goals.

(c) Goal-based agents

+ Giving the agent a sort of goal, it can take “more” correct decision by taking actions that will get it closer to its goal. This gives the agent the ability of considering the future; “What will happen if I do this and that?” and “Will that decision make me happy?”.

- The goal based agent appears to be less efficient because its more flexible. Goals alone are not enough to generate high-quality behavior in most environments. Goals just provide a crude binary distinction between “happy” and “unhappy”.

(d) Utility-based agents

+ Utility-based allows a comparison of different world states according to exactly *how* happy they would make the agents. A utility-based agent has many advantages in terms of flexibility and learning, like the the goal-based agents.
Additionally, in two kinds of cases, goals are inadequate but a utility-based agent can still make rational decisions. First, when there are conflicting goals - the utility function specifies the appropriate tradeoff. Second, when there are several goals that the agent can aim for, none of which can be achieved with certainty, utility provides a way in which the likelihood of success can be weighed against the importance of the goals.

- Choosing the utility-maximizing course of action is a difficult task, requiring ingenious algorithms.