Artificial Intelligence Fundamentals and Intelligent Agents Solutions

Theoretical Questions

1. **What is Turing test, how it is conducted?**
2. **What is the relationship between thinking rationally and acting rationally? Is rational thinking an absolute condition for actig rationally?**

   Answer: No, a reflex agent (which does not "think"/deliberate) can be rational if given the percept it behaves according to the performance measure that underlies its design.
3. **What is Tarski's "theory of reference" about?**

   Answer: Shows how to relate the objects in a logic to objects in the real world semantics of formal languages.
4. **Describe rationality. How is it defined?**

   Answer: Here the important point is "given the percept sequence", if it does not have possibility (e.g., sensors) to perceive more that it already did, it cannot be said it was irrational.
5. **Consider a robot of which task 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?**
   Answer: Probably yes, because the helicopter does not have the action (e.g., look-up) that enables it to perceive the helicopter closing to it.
   (b) **While crossing the road on a green light, a passing car crashes into the robot preventing it from crossing. Is the robot rational?**
   Answer: The agent is not rational. It could and must execute a look-right (or left whatever direction the car was coming from) action before crossing the road.
6. **Consider the vacuum cleaner world described on page 38 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.**
   Answer: No, it will continue moving back and forth even after all dirt is cleaned.
   (b) **Can a reflex agent with state be rational in this environment? Explain your answer.**
   Answer: Yes, it can have an internal state to remember where it has been earlier. Also, the agent should have NOOP as a possible action in its action set.
   (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.**
   Answer: Yes, it can be designed as a table with 8 entries indexed by the percepts (i.e., a percept now have info about both locations, e.g., [A, dirt] [B, clean]), and the corresponding actions.

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.**

   Answer: Episodic (because the agent does not have internal state to remember what it did before). There is such entry in the table [A, clean][A, dirty] which mean that a clean location can be dirty later meaning that there are other factors then the actions of the agent which changes the environment. So there are some stochastic elements there. Regarding the dynamic aspect, it can be interpreted in different ways; We don't know whether dirt appears continuously or at discrete steps. That is, it is not sure that the location becomes "clean" when the agent executes "SUCK". If the dirt appears longer than the time one SUCK" action is executed, then here may still be dirt in the location after SUCK is stopped.

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

   (a) **Simple reflex agents**

   Answer:

   Advantages:

   - The major advantage of the simple reflex agent is its simplicity. Basically the implementation of such an agent can be represented as a table that maps every possible situation in the environment to an action.
   - The complexity of a simple reflex agent's architecture is relative low so it's much easier to understand and analyze it. It leads to the possibility to fine tune the parameters of the agent to maximize the performance.
   - Execution of such an agent requires less computer resources (CPU, memory) then the agents with the internal state.
   - The development cost is lower.

   Disadvantages:

   - No planning capabilities. Obviously an agent without the internal state can't carry out the plan. In some environments and domains it is the crucial ability.
   - Inability to adapt and learn from its experience, so the performance of the partially representational agents in theory can always be equal or better than purely reactive agent.

   (b) **Model-based reflex agents**

   Answer:

   Advantages:

   - Handles partially observable environment.
   - Use of states is an intuitive approach that provides flexibility and some structure.
   - Possibility to use history information. The decision of an agent with the states can take into consideration several states from the past.
   - By using its internal memory an agent with state can accommodate some mechanisms for machine learning and improve its performance over time.

   Disadvantages:

   - Require more memory to store model.
   - More complex than of purely reactive agent.

   (c) **Goal-based agents**

   Answer:

   Advantages:

   - Possibility to follow long-term strategy.
   - Much more flexible in regards to environment changes.

- Explicit representation of knowledge that can be modified.

Disadvantages:

- Complexity.
- May require considerable computations.
- Over commitment problems.

(d) **Utility-based agents**

Answer:

Advantages:

- The utility provides the possibility to tell the agent what to do without telling how to do it.
- The utility function provides control over behavior of an agent without modifying its hard-coded general logic.
- Utility function makes it easier to state several goals for the agent.

Disadvantages:

- For relative static environments it can be easier to hardcode the successful behavior of a reflex agent then to find an appropriate utility function.
- In general, tuning parameters of utility function can be a time consuming process that requires a lot of test runs.
- Utility function requires kind of outcome prediction for possible actions that is not always obvious in stochastic environments.