Artificial Intelligence Fundamentals and Intelligent Agents

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1 Define artificial intelligence (AI)

"AI [...] is concerned with intelligent behavior in artifacts" - (Nilsson, 1998)

"The study of the computations that make it possible to perceive, reason, and act." - (Winston, 1992)

"The study of how to make computers do things at which, at the moment, people are better" - (Rich and Knight, 1991)

"To proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it." - (McCarthy, Minsky, Rochester and Shannon, 1955)

2 What is the Turing test, and how it is conducted?

The **Turing Test** is a test of the intelligence of a machine. The test lays out a demand for the machine to be indistinguishable from an intelligent being such as a human. The test is conducted through a series of questions posed by the human to the machine, of which the machine will answer.The test is passed if the human questioner cannot for certain say of the respondent is a human or a machine.

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

A system thinks rationally if it follows sound logic rules to its deduction. A system acts rationally if it does the right thing.

By our definition, rational thinking can be the basis of rational action. A system which thinks rationally is more prepared to act rationally. However, rational thinking is not an absolute condition of a rational action. As we have defined rational action by its "correctness" and not its intention we can say that a robot which choses its action randomly may stumble upon a rational action without any sound rationality behind it.

4 What is Tarski's "theory of reference" about?

Tarski's theory of reference shows how to relate the object in a logic to objects in a real world

5 Describe rationality. How is it defined?

Rationality is an ideal concept of intelligence. We say that a system is rational if it does the right thing. Rationality of a system is defined by the outcome of its action

6 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.

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

Yes, as it has no way of perceiving the helicopter. It can neither hear nor look up. The robot acts correctly based on its perceptions. BEcause of this we can say it acts rationally despite its fate.

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

No, the correct action would be to look-left-look-right, and perceive the car and then acting on this by waiting for the car to pass.

7 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.

7.1 Can a simple reflex agent be rational for this environment? Explain your answer.

No, as it will see the movement as a negative and therefore only clean the tile it is on. It will not be the better model as it does not understand the investment of moving and losing a point and therefore being able to get points from keeping the other tile clean aswell.

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

As it has no memory it will never be certain that the other tile is clean, so it will enter a infinite loop of uncertainty. Here it will bounce back and forth not knowing whether the other is clean. Therefore it is not rational.

7.3 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.

Yes, it can be rational. This solves the one problem we found with the state-reflex agent.it can now perceive if the other tile is clean and whether it is necessary to move, limiting the number of penalizations.

function STATE-REFLEX-AGENT (perceptThis, perceptOther) **returns** an action

persistent: rules { [clean, clean, wait(1)], [dirty, clean, suck()], [clean, dirty, move()], [dirty, dirty, suck()]}

stateThis: INTERPRET-INPUT(perceptThis)
stateOther: INTERPRET-INPUT(perceptOther)
rule: RULE-MATCH(stateThis, stateOther, rules[:1])
action = rule[2]
return *rule*.ACTION

move() :
if thisSquare = A: left(); else: right();

8 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 cleaner can only perceive parts of the environment (the part it is on).
Single agent: The vacuum cleaner is the only system of its kind and goals.
Deterministic: The actions of the cleaner has a guaranteed effect. Suck cleans, left moves it left, right moves it right. All these effects are guaranteed barring any system failure.
Episodic: as it has no memory, its actions are episodic.
Semidynamic: The environment itself does not change without vacuum interference. However, its score increases each time passage depending on how many tiles are cleaned.
Discrete: There are a finite set of possible percepts
Known: The laws of the system are known by the vacuum as it is implemented in its rules.

9 Discuss the advantages and limitations of these four basic kinds of agents

9.1 Simple reflex agents

Advantages

+ Significantly reduces number of possibilities by ignoring percept and action history.

+ Very simple. Action based on fully-observable environment.

Limitations

- Infinite loops are often unavoidable when operating in partially observable environments.

- Will only work if the correct decision can be made on the basis of only the current percept.

9.2 Model-based reflex agents

Advantages

+ Works in a dynamic environment.

+ Most efficient for a partially observable universe.

+ Able to refelct over past states.

Limitations

- Limited in applicability.

- Cannot work towards a goal.

9.3 Goal-based agents

Advantages

+ Can work towards a goal, and reason how to get there.

+ Can do automated reasoning based on its states.

Limitations

- Not as efficient.

- No way to express utility and preference.

9.4 Utility-based agents

Advantages

+ Can work towards a goal, but finds the most utilizable solution.

+ Tracks state of world.

Limitations

- Complex.

- Limited range of applicability.