

Task 1 A* (5p)

Luger defines monotonicity as:

A heuristic function h is monotone if

1. For all states n_i and n_j , where n_j is a descendant of n_i ,
 $h(n_i) - h(n_j) \leq \text{cost}(n_i, n_j)$,

where $\text{cost}(n_i, n_j)$ is the actual cost (in number of moves) of going from state n_i to n_j .

2. The heuristic evaluation of the goal state is zero, or $h(\text{Goal}) = 0$.

When we have looked on monotonicity I have instead used the formulation

$$|h(n_i) - h(n_j)| \leq |\text{cost}(n_i, n_j)|$$

- a. Under what condition do they differ?

If the cost of going from n_i to n_j differs from the cost of going from n_j to n_i .

- b. Discuss the formulation "(in number of moves)".

It should be taken away.

Task 2 Natural language (5p)

Luger mentions seven levels of analysis for natural language. Which are they and what do they do?

See book! Page 622-623 (6th ed.)

Task 3 Uncertainty (4p)

- a. Write down and explain the formula used in Bayes' theorem

See book! Page 183 (6th ed.)

- b. Apply it to the following problem:

Suppose you are going through some old papers and you find a photograph with a view from a city you vaguely recognize. In the street you see a green Honda Civic. You know you have been in Brussels three times, in Vienna four times, in Berlin twice, and in Rome only once. Every time you visit a city you take a photograph out of the window from your hotel room. As you are a freak on car brands you know that in Brussels 2.5 percent of the cars are Honda Civic, and in Vienna, Berlin and Rome the percentages are 1.5, 2.0 and 1.0, respectively.

What is the probability that the photograph was taken in Rome?

$$\frac{0.1 * 0.1}{0.25 * 0.3 + 0.15 * 0.4 + 0.2 * 0.2 + 0.1 * 0.1} = \frac{0.01}{0.185} \approx 0.054$$

Task 4 Expert Systems (5p)

Under which conditions is an expert system a feasible and applicable solution?

Under what circumstances is an expert system *not* applicable? Give *concrete* examples.

(I want a concise answer - no more than 30 lines.)

See book! Page 183 (6th ed.)

Applicable:

The cost is justified (where to find oil?)

A human expert is not always available (medical expertise in remote areas)

The problem has proper size and scope, is well structured and can be solved with symbolical reasoning

Not applicable:

The problem requires common-sense reasoning

There is a known algorithm to solve the problem (sorting a list)

No expert to provide the knowledge to build the system (problems that have no known solution)

Task 5 Candidate Elimination (6p)

You try to learn by candidate elimination what I consider a successful vacation.

The domain of vacations has the following properties and values.

weather = {sunny, clouded, rain}

temperature = {hot, warm, cool}

travel = {train, car, airplane}

month = {May, July, August}

destination = {Skåne, Thailand, Germany}

a. Show the successive values of G and S at each step, given the following examples

Positive: (s w t J S)

Negative: (s h a J T)

Positive: (s c t M S)

Negative: (r c t M S)

Negative: (s h t A G)

(4p)

example	S	G
+ (s w t J S)	(s w t J S)	(* * * * *)
- (s h a J T)	(s w t J S)	(* w * * *) (* * t * *) (* * * * S)
+ (s c t M S)	(s * t * S)	(* * t * *) (* * * * S)
- (r c t M S)	(s * t * S)	(s * t * *) (s * * * S)
- (s h t A G)	(s * t * S)	(s * * * S)

b. Explain *in words* the conclusion that is reached so far. In order to remove the remaining uncertainty, what final example you would ask me about? (2p)

On a successful vacation, I am in a sunny Skåne. Maybe it is only successful if I travel by train. So you must ask me about a vacation in sunny Skåne by car. For instance (s w c J S) - the w and J could be anything.

Task 6 AI Concepts (5p)

Describe the following concepts, each with a few sentences.

a. Decision tree (2p)

A decision tree is used to classify cases, or to make decisions for cases.

An internal node in the tree contains a question about the case, and has a child for each possible answer.

A leaf gives the answer (the class the case belongs to, the decision that has to be made).

The tool Match essentially uses decision trees.

b. Reinforcement learning (2p)

In this form of learning, the environment provides rewards (or punishments = negative rewards)

based on the action (or a sequence of actions) from an agent. The agent must learn to take actions that give good rewards. See slide 5 of “learning by nature” for a picture.

c. Turing test (1p)

The goal of the Turing test is to define general intelligence. If an interrogator cannot tell (from typed communication only) the difference between a human and an AI, then the AI is intelligent.

Task 7 Lisp (5p)

Define a lisp function, bind, which has two equally long lists as arguments and returns a list where the elements from the lists have been paired together as in the example below.

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(bind '(x y z) '(a (b c) (d (e f)))) = ((x a) (y (b c)) (z (d (e f))))
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(defun bind (x y)
  (cond ((null x) nil)
        (t (cons (list (car x) (car y))
                   (bind (cdr x) (cdr y))))))
```

Task 8 Logic (5p)

(omitted)