



1st Theoretical Assignment in
Artificial Intelligence (SS 2005)
Solutions

Exercise 1.1

(10 P)

1. Define the concept *machine*.

(5 P)

Solution:

A machine is any device that transmits or modifies energy to perform or assist in the performance of tasks. Normally, it requires an input as trigger, transmits the modified energy to an output that performs the desired task. Additionally, a machine works according to physico-chemical laws and shows predictable and reproducible behavior.

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2. Use this definition to discuss whether human beings are can be considered as machines.
(5 P)

Solution:

In some sense humans are machines. The brain works as reasoning device, we get triggering effects from the environment that represent the input to activate our reasoning process, then, our brain tries to find a solution to the given problem and executes the particular action as output. But what about emotions, desires and so on? Humans do not always act predictable. This might change the situation, i.e, human beings are more than just machines.

Exercise 1.2

(20 P)

1. Do you think that a pile of stones and toilet paper can think?

(4 P)

Solution:

In principle, a pile of stones and toilet paper cannot think.

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2. Briefly discuss whether computers can think.

(8 P)

Solution:

What does thinking mean in this case. If we assume that solving particular problems by planning and executing some action then computers can think. But from my point of

view, thinking is just more than solving problems. Indeed, modern software can simulate the reasoning process of humans, but in general, they are made for given problems and cannot easily self-adapt on other problems.

3. Weizenbaum (*Computer Power and Human Reason*, Chapter 2, 1976) has shown how to build a computer from stones and toilet paper. Does this change your answers to 1 and 2? Discuss your answer. (8 P)
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Solution:

This kind of computer is not a computer in some conventional sense. Indeed, this computer might solve small problems, but is this fact a sign for being intelligence?

Exercise 1.3

(10 P)

Briefly discuss the four different forms of agents illustrated in the lecture. For each type, specify **one** example from the animal kingdom. Name the abilities of the particular type and the problems it can/cannot solve. Can you imagine other forms of agents? Show advantages of this *new* form of agent.

Solution:

- *Simple reflex agent: for each input from the environment, there is a precisely defined output specifying how to react.*
Example: fly which flies against the window, but does not recognise the window. This process is repeated and repeated.
 - *State-based agent: simple reflex agent with internal states in order to choose an action.*
Example: ants which store the path where they got food.
 - *Goal-based agent: agent has some sort of goal information describing states which are desirable.*
Example: dogs which are trying to catch a piece of wood an human being has thrown. At this moment, this is the only goal of the dog.
 - *Utility-based agent: provided with some function that evaluates the utility of particular goals.*
Example: cats would always like to be fondled, but if an human being will provide some food, the cat will always prefer to eat.
 - *New form of agents: social acting agents that try to maximize the utility of the group instead of maximizing the own utility. This newform of agents could provide solutions to social dilemmas (e.g. prisoners dilemma).*
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Exercise 1.4

(10 P)

Consider the following rows of numbers.

$$R_1 : 1$$

$R_2 : 11$

$R_3 : 21$

$R_4 : 1211$

$R_5 : 111221$

Specify in natural language a single rule that allows to get from R_i to R_{i+1} . How does R_6 look like? (Hint: You do not need to apply complex mathematical operations)

Solution:

$R_6 : 312211$, tuple = $\langle (\text{occurrences of number}), \text{number} \rangle$

- $R_2 =$ in R_1 there is “one 1” $\rightarrow (11)$
- $R_3 =$ in R_2 there are “two 1” $\rightarrow (21)$
- $R_4 =$ in R_3 there is “one 2 one 1” $\rightarrow (1211)$
- ...

Exercise 1.5

(20 P)

1. What is a *Turing test*? (5 P)
2. Give five questions you would ask in a Turing test. Discuss why you pick these questions. (10 P)
3. Discuss whether the Turing test is appropriate to decide if computers can think. (5 P)

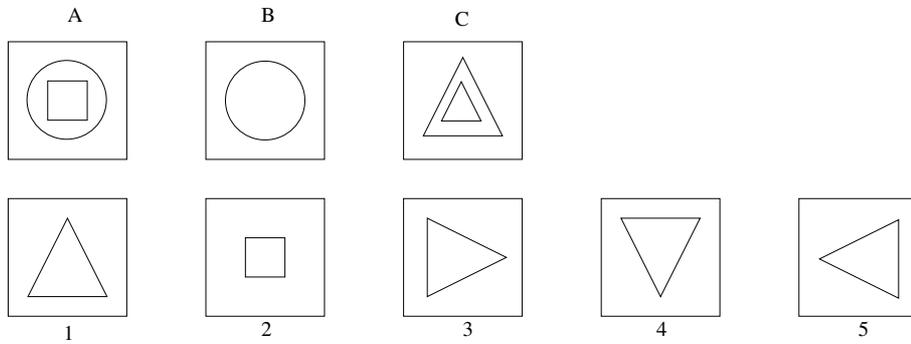
Solution:

1. An imitation game, where a human can ask questions to find out if its interlocutor is a person or a computer. (5 P)
2. Again much freedom. Good strategies are:
 - Asking questions difficult for persons to see how quickly the answer comes (e.g., what is 123×456 ?).
 - Asking questions about feelings and emotions (e.g., How did you sleep tonight? What do you feel when you listen to Bach?).
 - Asking questions about behavior typical for humans (e.g., When did you go to the dentist last?)
 - Asking a conundrum (*Scherzfrage*) (Can't think of one right now.).(10 P)
3. Important is to discuss the pros and cons.

Exercise 1.6

(30 P)

Consider the following analogy test:



1. Give a symbolic representation for each of the figures A-C, 1-5. (10 P)

What kind of problems do you encounter when applying the technique presented in the lecture

(a) to specify the single objects? (5 P)

(b) to specify the relations? (5 P)

2. Give a symbolic specifications for each of the following transformations

$A \rightarrow B, C \rightarrow 1, \dots, C \rightarrow 5.$ (5 P)

3. Generalise the symbolic specifications for each pair of transformation rules

$(A \rightarrow B, C \rightarrow 1), \dots, (A \rightarrow B, C \rightarrow 5)$

Which figure do you obtain using the schema described in the lecture? Which figure would you have chosen? (5 P)

Solution:

Part 1

We assume that the symbols representing a quadrat, circle and triangle are contained in the database.

A (FIG-A (PARTS P1 P2)
 (RELATION (INSIDE P2 P1))
 (SIM P1 CIRCLE (TRANS K 1 0 K))
 (SIM P2 QUADRAT (TRANS K 0.5 0 K)))

B (FIG-B (PARTS P3)
 (SIM P3 CIRCLE (TRANS K 1 0 K))

C (FIG-C (PARTS P4 P5)
 (RELATION (INSIDE P5 P4))
 (SIM P4 TRIANGLE (TRANS K 1 0 K))
 (SIM P5 TRIANGLE (TRANS K 0.5 0 K)))

1 (FIG-1 (PARTS P6)
 (SIM P6 TRIANGLE (TRANS K 1 0 K))

2 (FIG-2 (PARTS P7)
 (SIM P7 QUADRAT (TRANS K 0.5 0 K))

- 3 (FIG-3 (PARTS P8)
 (SIM P8 TRIANGLE (TRANS K 1 $\pi/2$ K))
- 4 (FIG-4 (PARTS P9)
 (SIM P9 TRIANGLE (TRANS K 1 π K))
- 5 (FIG-5 (PARTS P10)
 (SIM P10 TRIANGLE (TRANS K 1 $-\pi/2$ K))

- *After assuming that the objects are already contained in the knowledge base, the main problem is to identify the translation. Do we need to rotate the circle?*

Part 2

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(TRANSFORMATION A-->B (REMOVE X2 ((INSIDE X2 X1)
                               (SIM X2 QUADRAT (TRANS K 0.5 0 K))))
 (MATCH X1 FROM ((INSIDE X2 X1)
                 (SIM X1 CIRCLE (TRANS K 1 0 K)))
 TO ((SIM X1 CIRCLE (TRANS K 1 0 K))
 WITH (TRANS K 1 0 K)))

(TRANSFORMATION-C-->1 (REMOVE X2 ((INSIDE X2 X1)
                               (SIM X2 TRIANGLE (TRANS K 0.5 0 K))))
 (MATCH X1 FROM ((INSIDE X2 X1)
                 (SIM X1 TRIANGLE (TRANS K 1 0 K)))
 TO ((SIM X1 TRIANGLE (TRANS K 1 0 K))
 WITH (TRANS K 1 0 K)))

(TRANSFORMATION-C-->2 (REMOVE X2 ((INSIDE X2 X1)
                               (SIM X2 TRIANGLE (TRANS K 0.5 0 K))))
 (REMOVE X1 ((INSIDE X2 X1)
            (SIM X1 TRIANGLE (TRANS K 1 0 K))))
 (ADD X3 ((SIM X3 QUADRAT (TRANS K 0.5 0 K))))

(TRANSFORMATION-C-->3 (REMOVE X2 ((INSIDE X2 X1)
                               (SIM X2 TRIANGLE (TRANS K 0.5 0 K))))
 (MATCH X1 FROM ((INSIDE X2 X1)
                 (SIM X1 TRIANGLE (TRANS K 1 0 K)))
 TO ((SIM X1 TRIANGLE (TRANS K 1  $\pi/2$  K))
 WITH (TRANS K 1  $\pi/2$  K)))

(TRANSFORMATION-C-->4 (REMOVE X2 ((INSIDE X2 X1)
                               (SIM X2 TRIANGLE (TRANS K 0.5 0 K))))
 (MATCH X1 FROM ((INSIDE X2 X1)
                 (SIM X1 TRIANGLE (TRANS K 1 0 K)))
 TO ((SIM X1 TRIANGLE (TRANS K 1  $\pi$  K))
 WITH (TRANS K 1  $\pi$  K)))

(TRANSFORMATION-C-->5 (REMOVE X2 ((INSIDE X2 X1)
                               (SIM X2 TRIANGLE (TRANS K 0.5 0 K))))
 (MATCH X1 FROM ((INSIDE X2 X1)
                 (SIM X1 TRIANGLE (TRANS K 1 0 K)))
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TO ((SIM X1 TRIANGLE (TRANS K 1 -pi/2 K)))
WITH (TRANS K 1 -pi/2 K))

Part 3

(GEN-A->B+C->1 (REMOVE X2 ((INSIDE X2 X1)
 (SIM X2 Q (TRANS K 0.5 0 K))))
 (MATCH X1 FROM ((INSIDE X2 X1)
 (SIM X1 R (TRANS K 1 0 K)))
 TO ((SIM X1 R (TRANS K 1 0 K)))
 WITH (TRANS K 1 0 K)))

(GEN-A->B+C->2 (REMOVE X2 ((INSIDE X2 X1)
 (SIM X2 Q (TRANS K 0.5 0 K))))))

(GEN-A->B+C->3 (REMOVE X2 ((INSIDE X2 X1)
 (SIM X2 Q (TRANS K 0.5 0 K))))))

(GEN-A->B+C->4 (REMOVE X2 ((INSIDE X2 X1)
 (SIM X2 Q (TRANS K 0.5 0 K))))))

(GEN-A->B+C->5 (REMOVE X2 ((INSIDE X2 X1)
 (SIM X2 Q (TRANS K 0.5 0 K))))))

The first generalisation consists of the most concordances. Therefore, the algorithm would select the first figure as solution. We would also choose the first figure as solution.
