

School of Informatics

## WRITTEN EXAMINATION

Course IT776A Artificial Intelligence A1N

Examination

Course code IT776A

Credits for written examination 4.5

Date 2023-10-26

Examination time 8:15-11:30

Examination responsible Joe Steinhauer

Teachers concerned Joe Steinhauer

Aid at the exam/appendices

Other

Instructions

- ☐ Take a new sheet of paper for each teacher.
- ☒ Take a new sheet of paper when starting a new question.
- ☒ Write only on one side of the paper.
- ☒ Write your name and personal ID No. on all pages you hand in.
- ☒ Use page numbering.
- ☒ Don't use a red pen.
- ☒ Mark answered questions with a cross on the cover sheet.

Grade points 40

**Examination results should be made public within 18 working days**

*Good luck!*

Total number of pages

# Artificial Intelligence, IT776A

Exam, autumn term, 2023

October 26<sup>th</sup>, 2023

## Rules

- All questions are to be answered within the context of artificial intelligence and the contents of lectures, slides and assignments.
- You are expected to answer in a thorough, yet concise manner. That is, elaborate on your answers without dwelling on aspects which are not strongly related to the question at hand.
- Write in an intelligible manner. If your writing needs to be decoded, no points will be awarded.
- Use a clear handwriting, if your text is not readable, no points will be awarded.
- The exam has 4 parts à 10 points. To pass this exam you have to pass each of the 4 parts by reaching no less than 5 points. If you successfully pass all parts your final grade will be determined by the sum of all points and the following grading scheme:

Sum of Points	Final Grade
36 – 40	A
32 – 35	B
28 – 31	C
24 – 27	D
20 – 23	E
< 20	F

Table 1: Exam grading scheme.

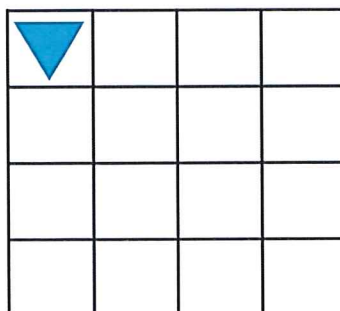
*Good luck!*

## 1. Artificial Intelligence

- 1.1. Provide the definition of AI as formulated by Marvin Minsky. (2 points)
- 1.2. Russel & Norvig define intelligent behavior as rational behavior, provide their definition of rational behavior. (2 points)
- 1.3. Provide the definition of machine learning, that we discussed during the course. Describe and explain what three elements are included in the definition. (2 points)
- 1.4. How are the areas of data science and artificial intelligence related to each other? (2 points)
- 1.5. How will knowledge in AI support you in your work as data scientist? (2 points)

## 2. Agents

- 2.1. List the four different agent types that we have discussed in the lectures and describe their differences using the two most important characteristics of these agent types. (3 point)
- 2.2. The picture below shows a room represented as a grid with an autonomous vacuum cleaner represented as a triangle. The agent (vacuum cleaner, can move left, right, up or down). What type of agent is the simplest type of agent that is capable of cleaning the whole floor in the picture below? Motivate your answer. (2 points)
- 2.3. Write the pseudo code for vacuum cleaner that will allow the agent to clean the whole floor. Keep the program as simple as possible. Include what input the agent needs and what output it produces. (3 Points)
- 2.4. Describe what kind of environment this autonomous vacuum cleaner is working in. Motivate your answer. (2 points)



## Search

Consider the sliding puzzle problem below. To the left you see the initial state and to the right you see the goal state that we want to achieve using a search strategy.

3	1
	2

Initial state

1	2
3	

Goal state

### 2.5. Uninformed Search

2.5.1. How deep would a complete search tree for this problem be? Motivate your answer (1 point)

2.5.2. What is the branching factor for the search tree? (1 Point)

2.5.3. How many paths are there in the complete search tree that lead to a goal state? Motivate your answer. (1 point)

2.5.4. Which uninformed search algorithms will provide a path to a goal state in a finite amount of time? Name the algorithms, explain how they work in general, and show, using a search tree, how each of algorithms will find the goal state. (Make sure you clearly indicate the order of nodes in that each algorithm will traverse the tree.) (3 points)

### 2.6. Heuristic Search

As a heuristic for this problem we use the number of tiles that are out of place.  
As the actual costs we say that each move has a cost of 1

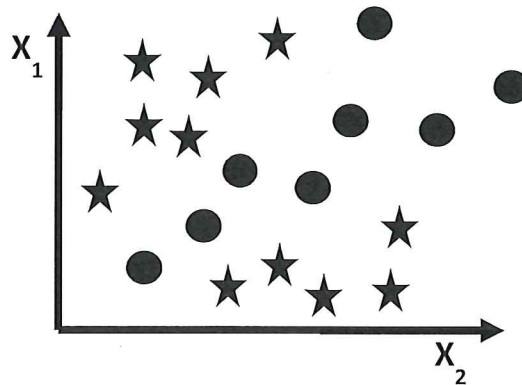
2.6.1. Explain how the A\* algorithm works in general (2 points)

2.6.2. Draw the search tree for the A\* algorithm (only the nodes that the A\* algorithm will explore) and provide the complete evaluation function for each node, provide the order in which the nodes are explored and indicate the goal state. (2 points)

### 3. Machine Learning

In the picture below, we need to use supervised machine learning to separate the stars from the circles based on the two input variables  $x_1$  and  $x_2$

- 3.1. What is this type of machine learning task called? (1 point)
- 3.2. During the lectures we discussed two different strategies to solve such a task, which one do you chose here? Motivate your answer. (1 point)
- 3.3. Draw the neural network, that can fulfill the task of separating the two groups of objects (stars and circles). The output from the network should be 1 if the object is a star and 0 if the object is a circle.  
You do not need to provide the first set of weights (from input nodes to first hidden layer) but you must provide the weights for all other connections in your network. Make sure to explain what each hidden node and each output node is calculating and how. (4 points)
- 3.4. What type of neural network did you use? (1 point)



- 3.5. When training a neural network, a cost function is used. Describe the purpose of a cost function and how the cost function is used to improve leaning. (3 points)