☑ Instructions

Uppsala University

Department of Information Technology

Artificial Intelligence

2023-02-03

Instructions: Read through the complete exam and note below any unclear directives before you start solving the questions. **If you find any unclear directives, then please note the question number and explain what you think is unclear.**

This is a **closed book** exam. You may use a standard English dictionary and a calculator. You are NOT allowed to use any other aids (e.g. course material, notes, mobile phones). The exam is **individual**: you are NOT allowed to get help from other people to answer the questions. Cheating will be reported in accordance with university regulations.

Please notify an exam invigilator if you have questions about the exam. They will contact the course teacher (Andreína Francisco) if necessary.

Grading scale. 0-49 pts. (U), 50-69 pts. (3), 70-84 pts. (4), 85-100 pts. (5)

There are 15 multiple-choice questions, each worth 2 points (30 points total). There are 7 problem-style questions, each worth 10 points (70 points total), some of which are divided into 2 parts.

Fill in your answer here

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1   MiniMax - 2023/10

What is the worst case time complexity of the Minimax algorithm?
Select one alternative:

○ O(b log d)
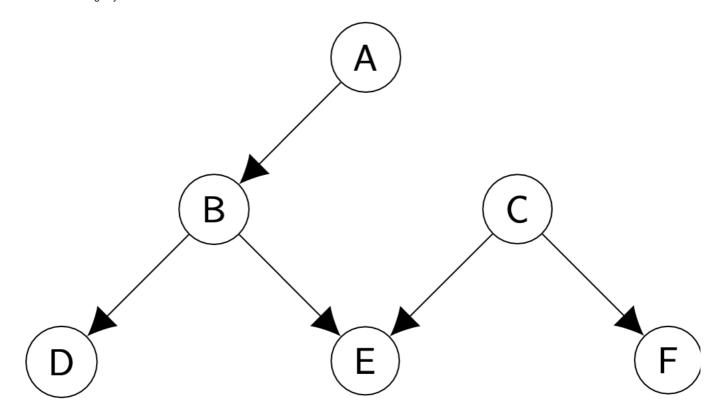
○ O(n^2)

○ O(bd)

○ O(b^d)

○ O(n log n)

Maximum marks: 2

2 MiniMax - 2023/10

Which of the following is **not** a characteristic of alpha-beta pruning?
Select one alternative:

○ It is a recursive algorithm

○ It is used in game theory

○ It is used in decision making

○ It can only be used in two-player games with perfect information

○ It is a greedy algorithm

Maximum marks: 2

3 MinMax - 2023/10

Which of the following is required to be able to use alpha beta pruning?
Select one alternative:

○ Deterministic

○ Two players

○ All of the other options

○ Turn-taking game

○ Zero-sum

Maximum marks: 2

4 Bayesian Networks - 2023/10

Which of the following statements is true about Bayesian networks?
Select one alternative:

○ A probability distribution is associated with each node, and this probability is conditional on the node's parents

○ It is always possible to tractably calculate the conditional distribution of a node given its Markov blanket.

○ The Bayesian Network representation of a joint distribution is unique

○ A Bayesian network is a type of linear regression model

○ Conditional independencies cannot be encoded in a Bayesian network

Maximum marks: 2

5 Bayesian Networks - 1DL340

Consider the following bayesian network:

Which probability distribution is associated with node B?
Select one alternative:

○ P(B)

○ P(B|A)

○ P(B|A,D,E)

○ P(A|B)

○ P(B|D,E)

Maximum marks: 2

6 Scheduling - 2023/10

Which of the following statements about scheduling is true?
Select one alternative:

○ The goal is to provide a sequence of tasks needed to achieve a goal

○ The minimum-slack algorithm is never optimal

○ It is not possible to obtain optimal solutions to scheduling problems

○ The minimum-slack algorithm is always optimal

○ Resource-free scheduling is a way to estimate a lower-bound of the end time of the tasks

Maximum marks: 2

7 **Markov Blanket - 2023/10**

What is a 'Markov Blanket' in a Bayesian Network?
Select one alternative:

○ The set of nodes around a given node

○ A method of error correction

○ A type of node

○ The node's parents, its children, and co-parents of its children

○ A mathematical formula used in the network to calculate a node's probability distribution

Maximum marks: 2

8 **Iterative Deepening - 2023/10**

What is Iterative Deepening?
Select one alternative:

○ A search strategy that combines the benefits of depth-first and breadth-first search

○ A search strategy that combines breadth-first search and uniform cost search

○ An incomplete but fast search strategy

○ A search strategy that combines depth-first search and heuristic search

○ A type of machine learning algorithm

Maximum marks: 2

9 **Statistical Learning - 2023/10**

Which of the following statements is true about statistical learning?
Select one alternative:

○ A distribution assigns probabilities to a random variable taking particular values

○ When variables are correlated, it means there is a causal relationship

○ P(A,B) and P(A|B) both represent the joint distribution of A and B

○ None of the other statements are true

○ Bayesian networks are a type of neural networks

Maximum marks: 2

10 **PDDL - 2023/10**

What is the main advantage of using PDDL?
Select one alternative:

○ It simplifies the process of data analysis

○ It simplifies the process of defining planning problems

○ It simplifies the process of solving and ensures that a solution is found

○ It simplifies the process of programming

○ It simplifies the process of machine learning

Maximum marks: 2

11 **Shortest Path Problems - 2023/10**

Which of the following statements is true about Shortest Path Problems?
Select one alternative:

○ Can only be solved using A*

○ Can only be solved if the graph is acyclic

○ Are only applied to graphs that have costs associated with the nodes

○ Can be used to find a route that minimises some cost

○ Can always be solved with BFS

Maximum marks: 2

12 **HMM - 2023/10**

Which of the following is **not** a component of a Hidden Markov Model?
Select one alternative:

○ Decision Tree

○ Emission probabilities

○ All of the other alternatives are part of a HMM

○ Initial state probabilities

○ State transition probabilities
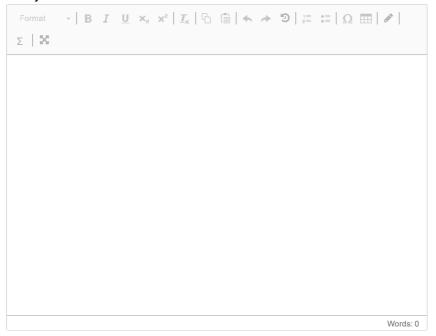
Maximum marks: 2

13 AlphaBeta - 2023/10

What does' pruning' mean in the context of the alpha-beta pruning algorithm?
Select one alternative:

○ Increasing the search space

○ Reducing the search space

○ Finding the maximum value

○ Finding the minimum value

○ Adding nodes to the tree

Maximum marks: 2

14 A* - 2023/10

What happens when the heuristic function in the A* algorithm overestimates the cost?
Select one alternative:

○ The algorithm becomes slower

○ Nothing happens as long as the heuristic is monotonic

○ The algorithm becomes faster

○ The algorithm becomes uninformed

○ The algorithm becomes non-optimal

Maximum marks: 2

15 DFS - 2023/10

Which of the following is **not** a characteristic of DFS? (which statement is false)
Select one alternative:

○ It has a complexity of O(V + E)

○ It always gives the shortest path in a graph

○ It cannot be used for cycle detection

○ It can be implemented using recursion

○ It traverses the depth of any particular path before exploring its breadth

Maximum marks: 2

16 Planning - 1DL340

What is PDDL? Explain all components of a PDDL problem. Be as precise as possible and give a small example. You do not have to worry about the exact syntax of PDDL expressions, but you should have all the components of PDDL expressions. In your small example explain what each syntactic element does. (10 points)

Fill in your answer here

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Σ | ⤢

Words: 0

Maximum marks: 10

17 Scheduling - 1DL340

Consider the actions in the table below:

Index	Action	Duration	Uses
0	Start	0	
1	Action 1	50	
2	Action 2	45	Plate
3	Action 3	40	Plate
4	Action 4	5	
5	Action 5	5	Cup
6	Action 6	25	Plate
7	Action 7	20	Plate, C
8	Finish	0	

Provide a complete unconstrained schedule (5 points)

Fill in your answer here
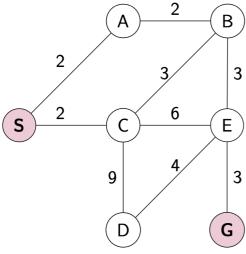
Provide a complete resource-constrained schedule (5 points)

Fill in your answer here

Maximum marks: 10

18 Heuristic Search - 1DL340 - 2024/02

Use A* to find a shortest path from the start node S to the goal node G in the graph below:

Provide an admissible heuristic (2 points)

Fill in your answer here

Show all your workings (all the steps in the algorithm to find the goal) (8 points)

Fill in your answer here

Maximum marks: 10

19 Guest lectures - 1DL340

How are the goals of AI in computer games different from the typical goals of more 'academic' AI? (5 points)
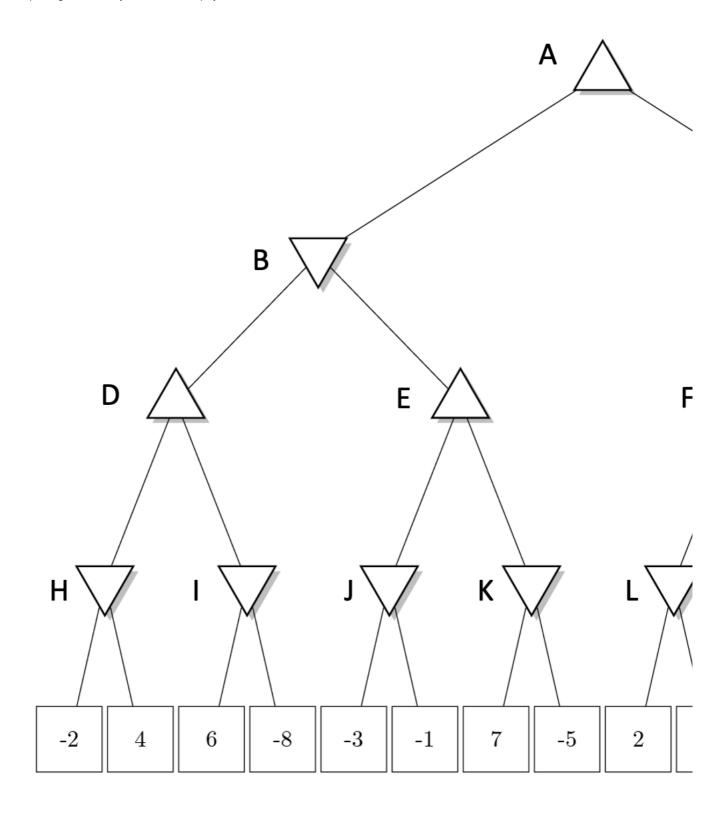
Fill in your answer here

Ant Colony Optimization is a natural computation method inspired by the behaviour of ants and termites. The core concept which is modelled here is called stigmergy. What is stigmergy? Explain the concept and why this way to solve problems is interesting to computer scientists. (5 points)

Fill in your answer here

Maximum marks: 10

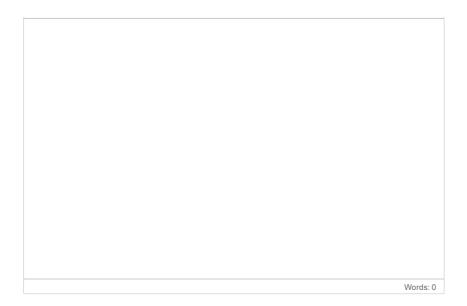## 20 MiniMax - 1DL340 - 2024/02

Consider the following tree representing a zero-sum game, where triangles pointing up are max nodes, triangles pointing down are min nodes, and squares are terminal nodes with the corresponding value of utility function for max player.

Apply the mini max algorithm for finding the best action for the max player at the root. Uppercase letters represent the name of a given node.

Fill in your answer here

Words: 0

Maximum marks: 10

21 Philosophy, ethics, and safety of AI

You have a job as an ethical adviser for a major company that runs a popular social media site. You are working with the team that is developing the AI to manage recommendations for users' newsfeeds.
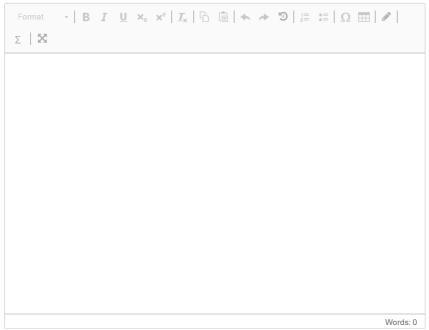
Discuss the following two core functions related to the design of the newsfeed AI:

- Identifying ethical issues of AI, and
- Ensuring the accountability of AI.

For both of these core functions, you should consider the Teleological perspective (that is, considers goods or harms to individuals or society).

Your answer should be of a minimum of about 150 words on each core function.
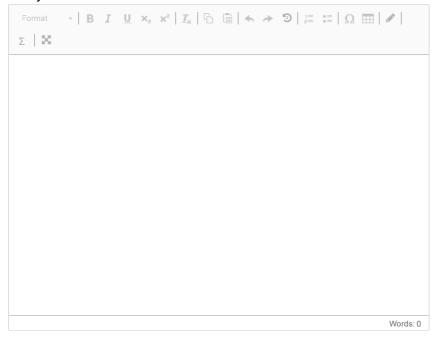
Fill in your answer here

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Σ | ⤢

Words: 0

Maximum marks: 10

22 ## 1DL340_Markov_Chains_2

Please read the PDF panel for the question text.

Fill in your answer here

| Format ▾ | B | I | U | x₂ | x² | I_x | ⎘ | 📋 | ↶ | ↷ | ⟲ | ≔ | ⋮≡ | Ω | ⊞ | ✎ |
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Words: 0

Maximum marks: 10

| Format ▾ | B | I | U | x₂ | x² | I_x | ⎘ | 📋 | ↶ | ↷ | ⟲ | ≔ | ⋮≡ | Ω | ⊞ | ✎ |
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The question has two parts. You are to answer both parts, and make it clear in your answer where each part starts.

Part A

Consider a Markov chain with two states S (Snow) I (Ice) with the following transition matrix.

$$\begin{pmatrix} P(S_{i+1} \mid S_i) = 0.9 & P(I_{i+1} \mid S_i) = 0.1 \\ P(S_{i+1} \mid I_i) = 0.5 & P(I_{i+1} \mid I_{i+1}) = 0.5 \end{pmatrix},$$

The initial probability are $P(S_0) = 0.5$ and $P(I_0) = 0.5$.

Derive an expression for the probability that it is snowing after 4 days $P(S_4)$. You need not give the actual numerical answer, but the sequence of multiplications that give that answer.

Part B

You are running a coffee shop. Because you work so hard you cannot see the weather outside. You just observe the number of customers that you have. You are too busy to count how many customers you have, so you have three estimates F (Few) , H (Half full), P , (Packed with many people). You are trying to estimate the probability that it is raining or sunny.

Your Hidden Markov Model has three observations (or emissions): F, H, and P, and two hidden states R (Rainy), S (Sunny). Given the initial probabilities of it being raining $P(R_0)$ or sunny $P(S_0)$. Derive an algebraic expression that is efficient to compute for the probability that it is raining given that you have observed the sequence F, H, P.