NTNU
Kunnskap for en bedre verden

KANDIDAT

10390

PRØVE

# TDT4136 1 Introduksjon til kunstig intelligens

| | |
|---|---|
| Emnekode | TDT4136 |
| Vurderingsform | Hjemmeeksamen |
| Starttid | 16.12.2021 09:00 |
| Sluttid | 16.12.2021 13:00 |
| Sensurfrist | 16.01.2022 23:59 |
| PDF opprettet | 22.07.2022 19:19 |

**Seksjon 1**

| Oppgave | Tittel | Oppgavetype |
|---|---|---|
| ℹ | Cover/Introduction page | Informasjon eller ressurser |
| 1 | Logic Question-Fall2021 | Filopplasting |
| 2 | Search-Fall2021 | Langsvar |
| 3 | CSP-Fall2021 | Filopplasting |
| 4 | Planning- Fall2021 | Filopplasting |
| 5 | AdversarialSearch-Fall2021 | Langsvar |
| 6 | ShortQuestions-Fall2021 | Langsvar |

# 1 Logic Question-Fall2021

Din fil ble lastet opp og lagret i besvarelsen din.

Last ned ✖ Fjern Erstatt

| | |
|---|---|
| Filnavn: | ai 1.pdf |
| Filtype: | application/pdf |
| Filstørrelse: | 1.27 MB |
| Opplastingstidspunkt: | 16.12.2021 13:15 |
| **Status:** | **Lagret** |

**LOGIC (25 pts). File uploading. (5 pts to each sub-question)**

1. Show, using a truth table, that $\neg a \implies (b \implies c)$ and $b \implies (a \vee c)$ are logically equivalent. Is $\neg a \implies (b \implies c)$ valid or satisfiable?

2. Prove that $A \Leftrightarrow B$ is logically equivalent to $A \vee B \Rightarrow A \wedge B$. Use standard logical equivalence rules here, not the truth table method.

3. Translate the following English sentences into logical representations.
    1. A niece is a sibling's daughter.
    2. Anette has at most two umbrellas.
    3. At least one professor teaches both "Experts in Team" course and an AI course.
4. Convert the following sentence into Conjunctive normal form (CNF). Show every step of the process and write the name of the operation used in the step, e.g., "eliminate existential quantification».
   $\forall x\ (R(x) \implies (\forall y(R(y) \implies R(f(x,y)))) \wedge \neg\forall y\ (S(x,y) \implies P(y)))$
5. Given the following sentences:
    1. $\forall x,y$ ( Father (x,y) $\implies$ ¬Woman(x))
    2. $\forall x,y$ ( Mother (x,y) $\implies$ Woman(x))
    3. Mother(Sophie, April)

Find out if Sophie is not the father of Edgar, using proof by contradiction (resolution refutation). That is, the question is: Is. ¬Father(Sophie, Edgar) true?

The first resolution shall be done on the first and second sentences above. Any other solution that does not start with resolving 1 and 2 will not be given any points. Show every operation you have done on/with the sentences, skolemization, standardizing apart, substitution/unification, and the like you may need to do.

# 2 Search-Fall2021

**Search(25 points). Write you answer in Inspera. (points: 5,5,5,10)**

A search problem is represented in the figure where A is the start and B is the goal node. Costs are shown on the edges while heuristic values for the nodes are shown in the box to the right. In this question solve ties by using left to right ordering, e.g., if there is a tie between R and F in the graph in the figure, then choose R.

1. Write down the expanded nodes in the order they are expanded when Breadth First search algorithm for graph search is applied. Write down the nodes in the frontier at each step. What is the returned solution? Is the solution optimal? Is that expected? Very briefly explain your answer.
2. Write down the expanded nodes in the order they are expanded when Depth First search algorithm for graph search is applied. Write down the nodes in the frontier at each step. What is the returned solution? Is it optimal? Is this expected? Very briefly explain your answer.
3. Write down the expanded nodes in the order they are expanded when uniform cost search algorithm for graph search is applied. Write down the nodes in the frontier at each step. What is the returned solution? Is it optimal? Is this expected? Explain very briefly your answer.
4. A* graph search algorithm:
    1. Is h(n) for all nodes n in the graph admissible? If not, write which are not.
    2. What would the A* algorithm for graph search return as solution? Write down the nodes in the frontier at each step. Write down the expanded nodes in the order they are expanded. Is the soluton cost-optimal? Briefly explain your answer.
    3. What would the same A* algorithm return for h(R)= 227 instead of 193? Is h(R) admissible now? What is the returned solution? Is it cost-optimal?
    4. Is your answer in 4.3 inconsistent/contradicts with your answer in 4.1? Elaborate on your answer and provide a description of the relationship between admissibility and cost-optimality for A* search algorithm that covers and explains the situation above.

Using the 3rd edition of the book.

2

frontier: ASRPB

expanded: ASRP

Returned solution: ASRPB

The returned solution is optimal.

It is not expected to be optimal, but we got lucky.

3

frontier: ASZRFOB

expanded: AZSORFP

Returned solution: ASRPB

Returned solution is optimal.

It is expected to be optimal since it considers cost, and will use the lowest cost path whenever two paths conjunct.

4

1.

h(n) for all nodes in the graph is admissible because it does not overestimate the remaining path, meaning h(n) < actual remaining path for all nodes.

2.

frontier: ASZRFPB

expanded: ASRFP

It is optimal, for the same reason as with uniform cost search. It is also skipped the AZOS branch since the h cost was too high.

3.

The returned solution is the same regardless.

H(R) is still admissible since 227 > 193.

The returned solution is: AZOSRPB

4.

A solution can still be found to be cost optimal even though the heuristic is not consistent. This is because of a tolerance depending on the graph, meaning that it could still be close enough. Regardless, one should not trust the result of an A* algorithm with inconsistent heuristics, since it could end up skipping a shorter path, resulting in a less optimal path.

# 3 CSP-Fall2021

**CSP(10 pts) File uploading. (points:2,4,4)**

Your task is to compare two given graphs and decide whether one contains a copy of the other. Two graphs G1(where nodes are named using integer numbers) and G2 (where nodes are referred to in terms of the letters of the alphabet), shown in the figure, are given. You will solve this as a constraint satisfaction problem (CSP) and find out if there is a copy of graph G1 in graph G2. «Copy» here means that the same number of nodes with the same connections between them. In other words, you will match these two graphs.

You can use the node-names of G1 (shown in the figure as 1,2,3,4) in the variable names, i.e., x1,….x4. Regarding the constraints, there is one global "all different", i.e., AllDiff, constraint expressing that all the variables will have a different value, and four local constraints, each representing the constraints on an edge(arc) in G1, e.g., between node 1 and node 2.

1. Write down the variables (i.e., X={x1,x2,x3,x4} and the domain of each variable (e.g., D(x1)={….})

2. Write down the constraints required for the mapping between the two graphs. Represent the constraints as explicit lists of allowed values for edges in the form of {(xi-v, xj-v'),…….} where (xi-v, xj-v') means that (xi,xj) is an edge in G1, and there is an edge (v,v') in G2. That is, it is legal that variable xi in G1 has value v (from G2) when variable xj in G1 has label v' (From G2) whenever (xi,xj) is an edge in G1 and (v,v') is an edge in G2.

3. Use backtracking search with forward checking to solve this CSP problem. Draw the search tree. The order of variable assignment is in numerical order, i.e., 1,2,3,4 while the assignment of values is in opposite/reverse alphabetical order. That is, you start with the assignment x1=the last letter in alphabetical order in the domain of x1.

Din fil ble lastet opp og lagret i besvarelsen din.

Last ned Fjern Erstatt

| | |
|---|---|
| Filnavn: | ai 3.pdf |
| Filtype: | application/pdf |
| Filstørrelse: | 1.03 MB |
| Opplastingstidspunkt: | 16.12.2021 13:16 |
| **Status:** | **Lagret** |

# 4 Planning- Fall2021

**Planning (10 its). File uploading (points: 2,8)**

1. In what way are Partial Order Planning (PoP) process and the resulting plans different from the ones in the progressive and regressive planning? In what situations is it suitable and attractive to use PoP?
2. Assume you are going to a Christmas party tonight and you want to put on some jewellery, more specifically a gold ring on each of your pointing finger. It is cold outside and you need to put on gloves as well. Naturally, you need to put on the rings before you put on gloves. You will use a partial order planner to make a plan. You have these action: RightGlove (means put on a glove on your right hand), LeftGlove, RightRing (put on a ring on your right hand), and LeftRing. You will use partial order planning to generate a plan.
    a. Write the required action schemas in the PDDL language.
    b. Draw the partial plan with the dependencies between the actions.
    c. Write down the plan. Use this notation: Action1; (Action2, Action3)… which means that Action1 is followed by either Action2 or Action3 in the plan.

Din fil ble lastet opp og lagret i besvarelsen din.

Last ned ✖ Fjern Erstatt

| | |
|---|---|
| Filnavn: | ai 4.pdf |
| Filtype: | application/pdf |
| Filstørrelse: | 1.37 MB |
| Opplastingstidspunkt: | 16.12.2021 13:16 |
| **Status:** | **Lagret** |

# 5 AdversarialSearch-Fall2021

**Adversarial Search (10 pts). Write your answer in Inspera. (points: 3,7)**

1. Apply minimax algorithm on the tree in the given figure and find the values of all the nodes above the leaf nodes. Write down the values of nodes A-J. What is the value of the solution for the agent *max*?

1. Apply alpha-beta pruning algorithm to find the nodes can be pruned. Write down the names of the nodes (i.e., the letters in the squares and ellipses), either leaves or the nodes of which all children are pruned. For example if *L3* and *L4* are both pruned then it is sufficient to write node *F* only. Give the reason why each pruned node is pruned, by referring to alpha and beta values

**Fill in your answer here**

1.

A-J: 3,3,0,2,3,5,0,3,2,7

2.

Pruned: L4, L7, L11

If we knew that leaves could not have values < 0, then h and j could also be pruned.

# 6 ShortQuestions-Fall2021

**Short Questions (30 pts). Write your answer in Inspera. (points: 10,10,5,5)**

1. Game theory: Does the payoff matrix in the given figure represent an instance of the Prisoner Dilemma game? Explain your answer - why does it, or why does it not.
2. Knowledge Representation
    a. What are the three ways to represent states and transitions between them? Describe each of them very briefly and describe what kinds of tasks (e.g., planning, or classical search task) we used each of them in this course.
    b. What are semantic networks capable of representing? What kind of reasoning mechanism/methods do they rely on?
3. AI-Ethics: What kind of connection can you make between P of PEAS (in Chapter 2) and ethical issues in AI? This is an open question which needs you to support your answer with arguments. In other words, explain your answer – concisely.
4. Environment type: Assume a human agent is collecting beautiful, rare orchids in the rain forest. They suddenly notice that some birds are following them and pick the orchids just when the agent reaches to the orchids. Is this a deterministic, stochastic or strategic environment? Explain your answer.

**Fill in your answer here**

1.

Yes, this does describe the Prisoner's dilemma. This is because of the described outcomes:

If both cooperate (give out information), then the penalty (sentence) will be reduced, but not by much since they both did. While if only one cooperates, they will get a much higher reward (less time in jail), while the other that did not would get sentenced fully (higher penalty). If both defect (stay silent), then the reward will be low, but not too bad. In this example, the best choice would be to always defect if both are intelligent agents, since this would result in no chance of the -1 outcome.

2.

a.

- frame based representation (factored and structural)

This allows for nodes to be used as states, and edges to be used as transformations. A common use case is with search graphs, were the nodes are used as geographical locations, and edges are used as the path between them.

- semantic network

Graphs that can be used to describe relationships between nodes.

- description logic

Can be used to determine things like wether or not

b.

Semantic networks

A method within knowledge representation that can represent semantic relationships (directed/undirected edges) between different concepts (vertices).

3.

Performance measure is the unit to define the success of an agent.Performance varies with agents based on their different percept.

A classical example is with self driving vehicles. In this system, one must occasionally decide on what to do in a given decision. This is not always trivial, as it can come down to wether or not to kill pedestrians, where one would have to decide between children, men, women etc, or even the driver himself. This becomes a problem where the driver would not want a car that kills himself in a decision, meanwhile others would want the opposite. These choices are ethically hard to make, and need to be addressed. This problem is described as the 'Trolley Problem'.

4.

Strategic environment since the birds are reacting to our intelligent behavior. This means that the birds sees the reaching, knows that the agent will pick up the flower, and then it needs to pick it up now in order to get the flower. If not, it will end up not getting the flower.