NTNU
Kunnskap for en bedre verden

KANDIDAT

10577

PRØVE

TDT4136 1 Introduksjon til kunstig intelligens

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Seksjon 1

Oppgave	Tittel	Oppgavetype
i	Cover page Fall-2019	Dokument
1	T/F Questions Fall2019	Flervalg
2	FOL fall 2019	Langsvar
3	A-star fall2019	Langsvar
4	CSP fall 2019	Langsvar
5	GT Question Fall2019	Langsvar
6	Adversarial-Search Question Fall2019	Langsvar
7	Short Questions Fall 2019	Tekstfelt

1 T/F Questions Fall2019

True/False Questions. Choose one of the alternative answers for each question below.
(20 Points, 2pts for each correct answer, -1 for each wrong answer. Total score will not be less than zero.)

1. Greedy best-first search algorithm is guaranteed to find an optimal path.
   Velg ett alternativ
   - (x) False
   - ( ) True
2. Uniform Cost algorithm is guaranteed to find an optimal solution.
   Velg ett alternativ
   - (x) True
   - ( ) False
3. Let *b* be the branching factor of a search, *d* the depth of the solution, and *m* the maximum depth of the search space. Then the space complexity of breadth-first search is b^m.
   Velg ett alternativ
   - ( ) True
   - (x) False
4. $(A \Leftrightarrow B) \models (\neg A \lor B)$

Velg ett alternativ

- (x) True
- ( ) False

5. Linear planning is incomplete.
Velg ett alternativ

- ( ) True
- (x) False

6. Simple "hill climbing" algorithm is perfect to solve constraint satisfaction problems.
Velg ett alternativ

- ( ) True
- (x) False

7. A sound logical reasoning process is not necessary in order to pass the Turing test.
Velg ett alternativ

- ( ) True
- (x) False

8. Depth-first tree search algorithm always expands at least as many nodes as an A* tree search algorithm with admissible heuristic does.
Velg ett alternativ

- (x) False
- ( ) True

9. The set consisting of "mammal" and non-mammal" categories is both a disjunctive and an exhaustive decomposition of the category "animal".
Velg ett alternativ

- ( ) False
- (x) True

10. Explainability is an ethical problem in AI which domain knowledge may help to solve.
Velg ett alternativ

- (x) True
- ( ) False

Knytte håndtegninger til denne oppgaven?
Bruk følgende kode:

3305992

2 FOL fall 2019

Predicate Logic (15pts. 7-3-5 points for the sub-questions)

The Knowledge base has the following sentences for which FOL representations are given below:

Everyone who loves all animals is loved by someone.
Anyone who kills an animal is loved by no one..
Sofie loves all animals.
Either Sofie or CarAccident killed the cat, who is named Kismet.

FOL representations:

1. $\forall x\ [\forall y\ [Animal(y) \Rightarrow Loves(x,y)]] \Rightarrow [\exists z\ Loves(z,x)]$
2. $\forall x\ [\exists y\ (Animal(y) \wedge Kills(x,y)] \Rightarrow \neg(\exists z\ Loves(z,x)$
3. $\forall x\ [Animal(x) \Rightarrow Loves(Sofie, x)]$
4. $Kills(Sofie,Kismet) \vee Kills(CarAccident,Kismet)$
5. $Cat(Kismet)$

Query: Did CarAccident kill the cat?

You are going to the answer the above query by using resolution by refutation.

1. First convert all FOL sentences into conjunctive normal form (CNF). Show every step in this process.
2. Write down any background knowledge that is needed to solve the problem.
3. Apply resolution by refutation and show how the query is answered. Show each and every unification.

Skriv ditt svar her

2. We need the background knowledge that a cat is an animal in other words that $cat(x) \Rightarrow animal(x)$.

Knytte håndtegninger til denne oppgaven?
Bruk følgende kode:

0 8 7 5 5 7 3

Question Code Oppgavekode	Date Dato	Subject code Emnekode	Candidate ID KandidatID	Question nr Oppgavenr	Page number Sidetall
0875573	6.12	TDT4136	10577	2	1

1. $\forall x \left[\forall y \left[Animal(y) \Rightarrow Loves(x,y)\right]\right] \Rightarrow \left[\exists z\ Loves(z,x)\right]$

$\forall x \left[\neg \forall y \left[\overline{Animal}(y) \lor \overline{Loves}(x,y)\right] \lor \left[\exists z\ Loves(z,x)\right]\right]$

$\forall x\ \exists y\ Animal(y) \land \overline{Loves}(x,y) \lor \exists z\ Loves(z,x)$

$Animal(f(x)) \land \overline{Loves}(x, f(x)) \lor Loves(g(x), x)$

$\left[Animal(f(x)) \lor Loves(g(x),x)\right] \land \left[\overline{Loves}(x, f(x)) \lor Loves(g(x),x)\right]$

2. $\forall x \left[\exists y \left(Animal(y) \land Kills(x,y)\right)\right] \Rightarrow \left[\neg \exists z\ Loves(z,x)\right]$

$\forall x\ \neg \left[\exists y \left(Animal(y) \land Kills(x,y)\right)\right] \lor \left[\neg \exists z\ loves(z,x)\right]$

$\forall x\ \forall y\ \forall z\ \overline{Animal}(y) \lor \overline{kills}(x,y) \lor \overline{Loves}(z,x)$

$\left(\overline{Animal}(l) \lor \overline{kills}(k,l) \lor \overline{Loves}(m,k)\right)$

3. $\forall x \left[Animal(x) \Rightarrow Loves(sofie, x)\right]$

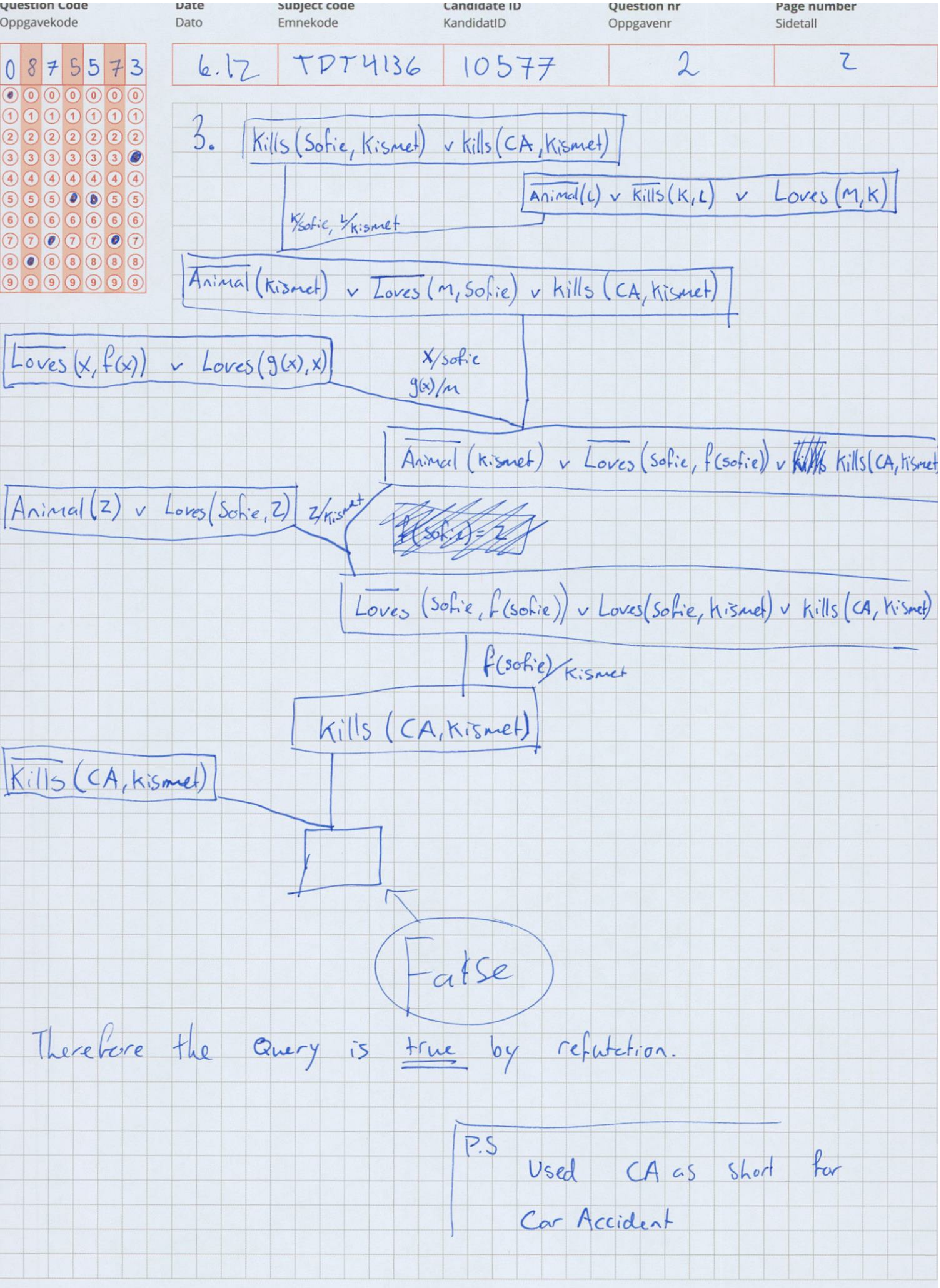
$\forall x\ \overline{Animal}(x) \lor Loves(sofie, x)$

$\overline{Animal}(Z) \lor Loves(sofie, Z)$

4. $\left(Kills(sofie, Kismet) \lor Kills(CarAccident, Kismet)\right)$

5. $Cat(Kismet)$

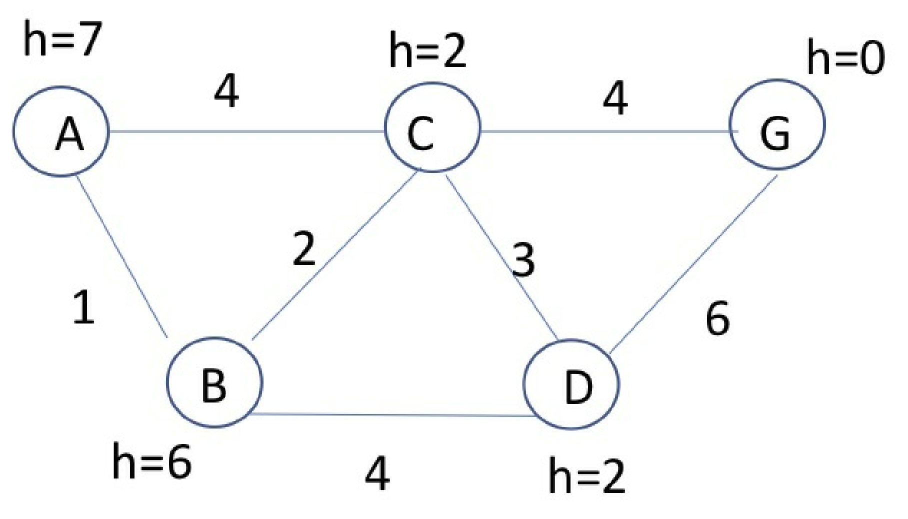
Håndtegning 2 av 2



3 A-star fall2019

A* search algorithm (13 pts, 1-4-4-4)

1. Apply the A* algorithm for graphs on the graph in the following figure. Write down the nodes in the order they are expanded. A is the start node, and G is the goal node.



2. What is the returned path? Is it optimal? explain your answer on an example from the given graph in the figure.
3. Modify the pseudocode (in the figure below) for the A* algorithm for graph search so that it guarantees to find the optimal solution with heuristic values given in the first figure (above). Write down the pseudocode in a separate paper starting from the sentence just before your modification starts, and ending with the sentence right after your last change. That is, you don't need to write the whole pseudocode, only the part you modified, plus a single/one original sentence before and one after your

```
Start.g = 0;
Start.h = heuristic(Start)
FRONTIER = {Start}
CLOSED = {empty set}
    WHILE FRONTIER is not empty
        N = FRONTIER.popLowestF()
        IF state of N= GOAL RETURN N
        add N to CLOSED
        FOR all children M of N not in CLOSED:
            M.parent = N
            M.g = N.g + cost(N,M)
            M.h = heuristic(M)
            add M to FRONTIER
        ENDFOR
    ENDWHILE
```

   modified sentences.
4. Assume that a search tree has heuristic values which enable the A* algorithm presented in the pseudocode to find an optimal path to the goal. Is the A∗ algorithm still guaranteed to find the minimal path to the goal if there are negative transition costs? This question is general, not about the graph shown in the first figure.

Skriv ditt svar her

1) A, C, G

2) ACG is returned and is not optimal. ABCG is better giving a cost of 7, hence ACG giving a cost of 8 is not optimal.

4) No, If there are edges of negative weight this will throw our algorithm in a continuous, never-ending loop. For optimality we also need consistency which negative transition costs inherently disallow.

Knytte håndtegninger til denne oppgaven?

Bruk følgende kode:

7 3 5 6 9 7 4

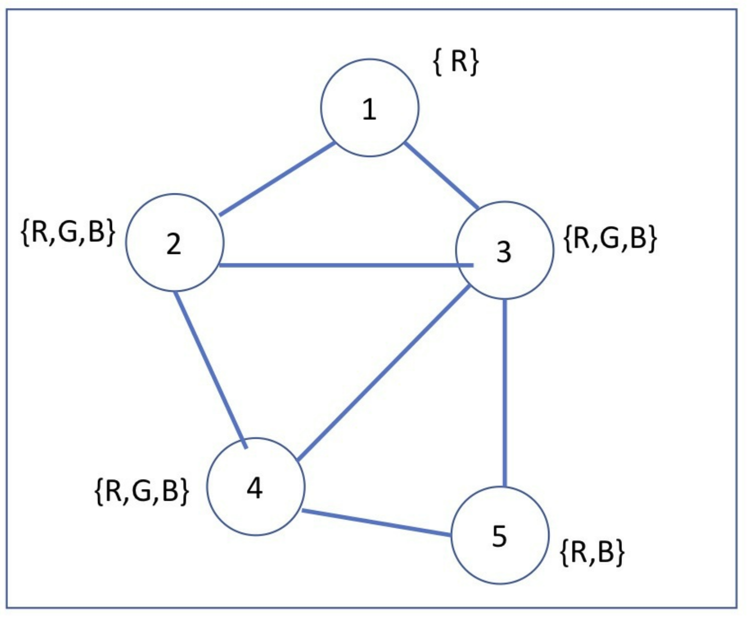
Question Code Oppgavekode	Date Dato	Subject code Emnekode	Candidate ID KandidatID	Question nr Oppgavenr	Page number Sidetall
7356974	6.12	TDT4136	10577	3	3

8. Add N to CLOSED
FOR all children M of N:
IF M in CLOSED or in FRONTIER:
IF M.g ≤ N.g + cost(N,M):
continue
else:
CLOSED. Remove(M) # if it exists in Closed it will be removed, else ~~will~~ nothing is removed.
11. M.parent = N

4 CSP fall 2019

Constraint Satisfaction Problem. (12 pts, 2-4-2-4)

Consider the following constraint graph (in the figure) for a graph coloring problem where the constraints mean that the connected nodes cannot have the same color. The variables are shown inside the nodes while the domains are shown next to each variable node.



1. What are the domains after a full constraint propagation using an arc consistency algorithm?
2. Show the sequence of variable assignments during a pure backtracking search (don't assume that propagation above has been done, i.e., start with the original domains shown in the figure). Assume that the variables are examined in numerical order and the values are assigned in the order shown next to each node. Show assignments by writing the variable number and the letter for the value, e.g, 5R, 2G.
3. Describe how forward checking works.
4. This time you'll apply backtracking search with forward checking - again use the original domains shown in the figure. Use the same ordering convention for variables and values as above. Show the sequence of variable assignments during backward search with forward checking. Again, show assignments by writing the number of variables followed by the letter for the value.

Skriv ditt svar her

1) domains are:

1 : {R}

2: {G, B}

3: {G, B}

4: {R, G, B}

5: {R, B}

2) 1R, 2G, 3B, 4R, 2B, 3G, 4R, 5B

3) Forward Checking looks forward and finds out if an assignment will cause a break in consistency in future assignments.

4)1R, 2B, 3G, 4R, 5B

Knytte håndtegninger til denne oppgaven?

Bruk følgende kode: **1 0 6 1 7 1 0**

5 GT Question Fall2019

Game Theory Question. (10 points, equal points for each sub-question)

Consider the game for which the payoff matrix is shown in the following figure.

		agent2 G	*agent2* NG
agent1	H	8, 0	3, 1
agent1	NH	4,4	2,3

1. Identify any *dominated* strategy. Explain your answer.
2. Find the *Nash equilibrium*. What are the equilibrium payoffs, i.e., values for each agent?
3. Are there any *pareto optimal* joint actions? If any exist, what are they?
4. Explain (in general, not for this particular problem) why a *social welfare maximizing* joint action profile is also pareto optimal.

Skriv ditt svar her

1. NH is the dominated strategy.

2. (H, NG) is the *Nash equilibrium*. The payoffs are (3,1) which means agent1 gets 3 and agent2 gets 1.

3. (H, G) is the pareto optimal joint actions

4. a social welfare maximizing joint action is the actions which maximizes spent utility, maximizes x + y when eval of some joint action = (x,y). Therefore we have that a social welfare maximizing joint action profile must also be pareto optimal.

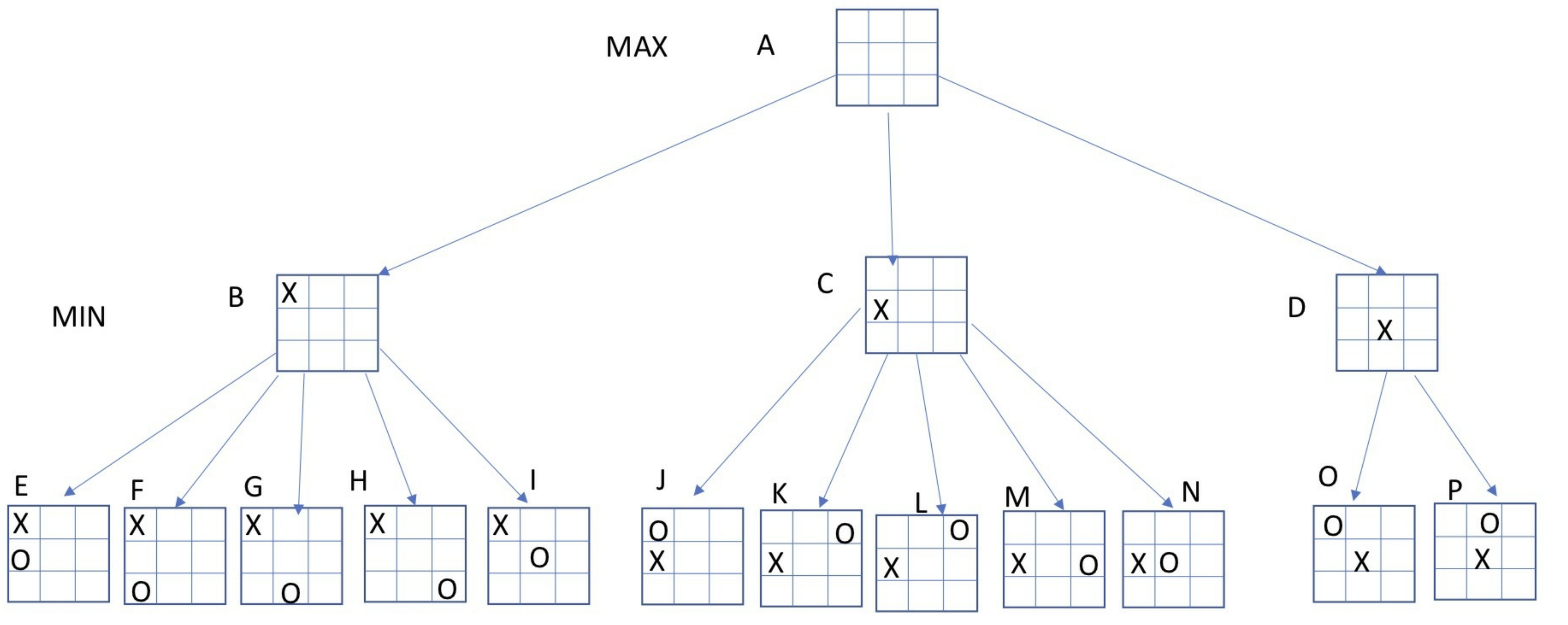
Knytte håndtegninger til denne oppgaven?

Bruk følgende kode: **1 2 7 0 7 5 8**

6 Adversarial-Search Question Fall2019

Adversarial Search Question (10 pts, 3-3-4 pts for sub-questions).

Consider a tic-tac-toe game on a 3x3 grid (see the figure below) where players MAX and MIN take turns marking the spaces in a 3×3 grid by placing their X's and O's, respectively. The player who succeeds in placing three of their marks in a horizontal, vertical, or diagonal row is the winner..

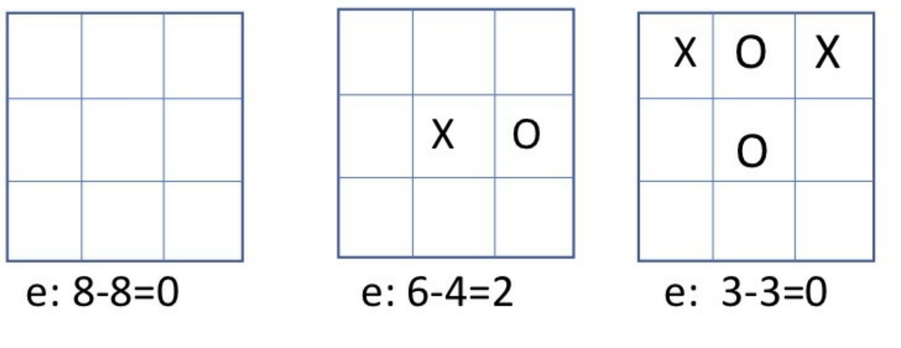


The values of the terminal nodes have not been provided. You will compute these values using an evaluation function *e*. Function *e* uses a heuristic that estimates the value of each terminal node according to the following formula:

e(node)= E1-E2 where

E1=sum of the number of rows, columns and diagonals that are possible winning situations for Max and,
E2= sum of the number of rows, columns and diagonals that are possible winning situations for Min.

The following figure shows examples for computing the values of some hypothetical nodes:



1. Compute and write down the values of each terminal node node, i.,e of E, ……, P.
2. Using the *Minimax* algorithm find and write down the values of the remaining nodes(A,…D) in the search tree. Which action will Max play in this game, the action whose outcome is B, C or D?

3. Is it possible to prune any nodes using the *Alpha-Beta pruning* algorithm? If there are, write down the pruneable node(s) - i.e., write the letter for the node.

Skriv ditt svar her

1.

E: 6 - 5 = 1

F: 0

G: 1

H: 0

I: -1

J: -1

K: -1

L: -1

M: 0

N: -2

O: 1

P: 2

2.

B = min(E,...,I) = -1

C = min(J,...,N) = -2

D = min(O,P) = 1

A = max(B,C,D) = 1

If max plays optimally based on this eval. function, he will place his piece in the middle, and barring any irrational moves by opposing player, he will achieve an eval of 1. This move is the move D.

3.

Yes, one can prune K, L, M, N as J <= -1.

Knytte håndtegninger til denne oppgaven?
Bruk følgende kode:

3 8 9 2 6 9 5

7 Short Questions Fall 2019

Short Questions (22 points, 2 points each question. The last question is a bonus question).

1. How is the goal information represented in simple reflex agents?

Fill in your answer here

Goal information is not represented in simple reflex agents.

2. Is the propositional logic sentence ((P⇒ Q) ∧ Q) ⇒ P valid, unsatisfiable or satisfiable? Justify your answer.
   Fill in your answer here

   Satisfiable, (P,Q) = (0,1) is False, however all three other binary combinations of (P,Q) is True. Therefore satisfiable.

3. Translate the following sentence into predicate logic: “Any person who has an umbrella is not wet”.
   Fill in your answer here

   Vx,y [Person(x) ^ Umbrella(y) ^ Has(x,y)] => ~(wet(x)) , where V is the universal quantifier.

4. Translate the following sentence into predicate logic: “John has at least two daughters.”
   Fill in your answer here

   E x,y,z (John(x) ^ DaughterOf(y,x) ^ DaughterOf(z,x)) , where E is the existensial quantifier.

5. Assume a Hill Climbing algorithm that aims to find the best state according to a heuristic cost function. Does it try to find the global minimum or the global maximum?
   Fill in your answer here

   global minimum

6. It has been suggested that the first phase of *GraphPlan* be used as a heuristic function for forward search in the following way: Given a state *s* and goal *g*, run the graph-construction phases of *GraphPlan* until all the components are represented and not mutex in the last layer. Let *n* be the number of action layers in the graph. We will let *n* be the heuristic value for s. Is this an admissible heuristic? Explain your answer.
   Fill in your answer here

   yes as it may not overestimate the number of actions needed, only underestimate.

7. If *GraphPlan* terminates with a successful, 3-action plan in the first iteration, what constraints are there on the order in which the actions must be executed?
   Fill in your answer here

   Must be in the order of discovery.

8. Does *Regression Planning* work in a forward or backward manner?
   Fill in your answer here

   Backward

9. You will represent the concept of ”student “ using a *frame-based* knowledge representation language. You want the age of a student to be computed on the basis of her birth year and the current year. How would you represent this in a slot of “student” frame ?
   Fill in your answer here

   As a Demon slot with (calculate-age)

10. Assume a version of the original vacuum cleaner agent in the text book. 5% of the time the SUCK action of this one does not clean the floor if it is dirty and even may deposit dirt on the dirt on the floor if the floor is clean. Classify this environment with respect to each of the following dimensions: Sequential/Episodic, deterministic/stochastic, and dynamic versus static.
    Fill in your answer here

    Sequential: If he were to deposit dirt this would affect future actions.

    Stochastic: There is uncertainty to the outcome of his actions

    Dynamic: The environment gets dirtier over time, meaning the agents environment is dynamic.

11. Bonus Question: Assume that *Simulated Annealing* search algorithm starts from a state S_0 in the middle of a large plateau. That is, the values of all states on the plateau are exactly the same. Assume also that in the first step the random neighbor we picked is S_1, which has the same value as S_0. Will Simulated annealing move to S_1? Explain your answer mathematically (i.e. using a formula). No points will be given otherwise.

Knytte håndtegninger til denne oppgaven?
Bruk følgende kode:

8 9 0 8 3 6 5