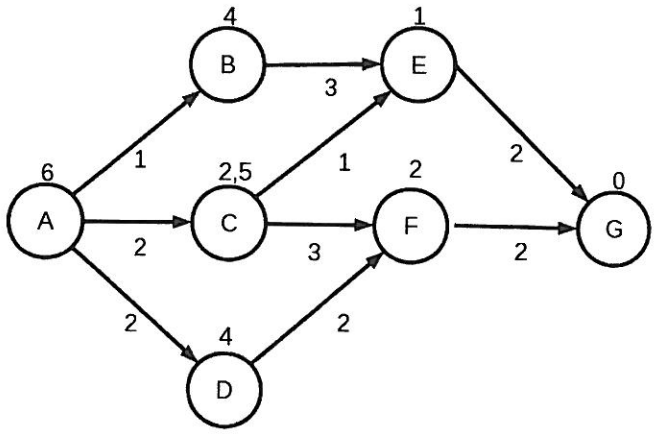
Task 1.

Apply A* - search procedure to a problem with the state transitions shown in the figure.



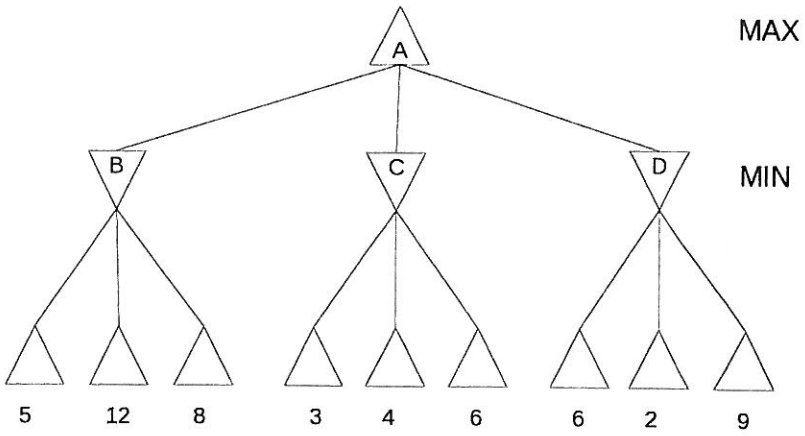
The aim is to find a path from state A to state G , when the values of function h are as shown in the figure on top of the states and the state transition costs are presented in connection to the arrows representing the transitions in the figure.

(a) Present the progression of the search using the fringe (i.e. frontier) so that in connection to the nodes in the fringe the estimate of the total cost is shown (3 p)

(b) What would happen if instead of the estimate $h(C) = 2.5$ an estimate $h(C) = 7$ were given to us? What is wrong with this estimate? What is required of estimates?

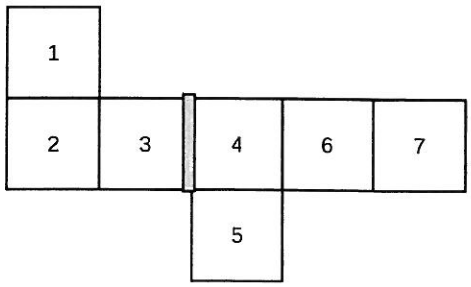
Task 2.

How does the minimax-algorithm with $\alpha-\beta$-pruning progress in the game shown in the figure , how do the values of minimal and maximal attainable value for nodes A,B,C ja D change and which branches are expanded during the search?



Task 3.

Agent, who can not make observations, has to find a plan that gets it to goal state, one in which the agent is in room nro 7., using a technique based on belief-states. The agent does not know its starting position, action U takes it up, D down, R to right and L to left. If there is now room in the direction agent is moving it holds it position but notices nothing. Agent knows the map of the appartment. There is a door between rooms 3 and 4 that opens when the agent is in either of these rooms by action O. The action O has no effect in other rooms. Agent knows additionally that in the initial state the door is closed.



Form the relevant belief-states and state transitions between them. Present a plan as a list of actions that is sure to take the agent to goal state with the

least number of actions.

Task 4.

Let us inspect the following statements:

- A minister faces High Court if he is disqualified in granting a funding and decides on this funding.
- A minister is a person that heads a ministry.
- A person is disqualified in granting a funding if the person works in an organization that receives that funding.
- Koplanen heads Ministry of Traffic.
- Ministry of Traffic is a ministry.
- Koplanen works in TieOy.
- TieOy receives investment funding.
- Investment funding is funding
- Koplanen does not face High Court.

(a) Express the statements in predicate logic (1-order logic). (2 p) Take care that the expressions are representationally sufficient, meaning that the inference steps required below are possible. Add if needed new clauses to make implicit knowledge explicit.

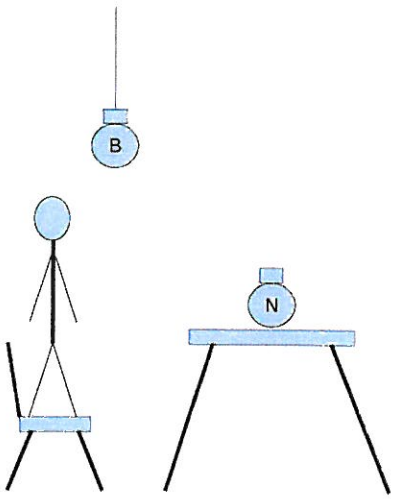
(b) Transform the expressions in part (a) to clausal format. (2 p)

(c) Use resolution to proof that Koplanen did not decide on investment funding (2 p)

Task 5.

The goal is to replace a broken lamp bulb (B) to a new bulb (N) that is on the table. One can step on a chair (u), decend from the chair (d) , grab a bulb (g(L)), release a bulb (e(L)) , as well as screwing a bulb into the lamp (r(L)) and screw it off the lamp (l). The fluents represent standing on the chair (c) (then screwings are possible) , a lamp on a table (t(L)) , a lamp in possession of the agent (h(L)), as well as a bulb being in a lamp (s(L)) and

the fact that there is some bulb in the lamp (s). The initial state is shown in the figure.



d
prec: c
eff: ¬ c

u
prec: ¬ c
eff: c

g(L)
prec: ¬ c, t(L)
eff: h(L)

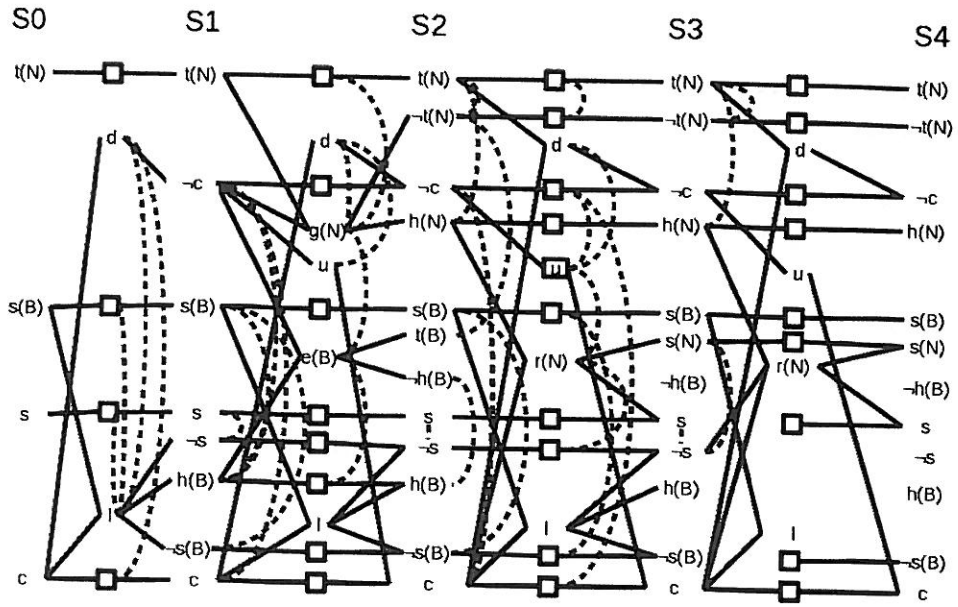
e(L)
prec: ¬ c, h(L)
eff: t(L)

l
prec: s(L),c
eff: h(L),¬ s(L), ¬ s

r(L)
prec: h(L),¬ s,c
eff: s(L) , s

So, initially the broken bulb is in the lamp and the new on is on the table. The goal state is charactericed by the fact that the new bulb in the lamp (s(N)).

The Graphplan-algorithm has expanded the planning graph to level 4 (levels $A_0 \ldots A_3$ are located in between the S_i levels) forming the following graph (some of the information is left out of the figure):



(a) Why on level A_0 d and the persistence action maintaining c are in mutex-relation (1 p)

(b) Why A_1 has $g(N)$ and $e(B)$ in mutex (1 p)

(c) On S_2 are $h(N)$ and $t(B)$ in mutex (make a marking to your use of this if they are) (1 p)

(d) Does Graphplan, starting from S_4 backwards, find a solution to the problem? If it does, draw the partial graph that is a solution. If a solution is not found present two different candidate solutions (partial graphs), that the search forms, that include the mutexes that the search meets. (1 p)

Write a short essay-answer:

(e) List the types of mutex-relations describing how they emerge on fluent and action levels between the nodes. (2p)