Artificial Intelligence

Örebro University,

DT2016, DT2022,

First Exam

Date: January, 12th 2015

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Allowed Aids: Calculator and/or Swedish/English Dictionary

Grading:

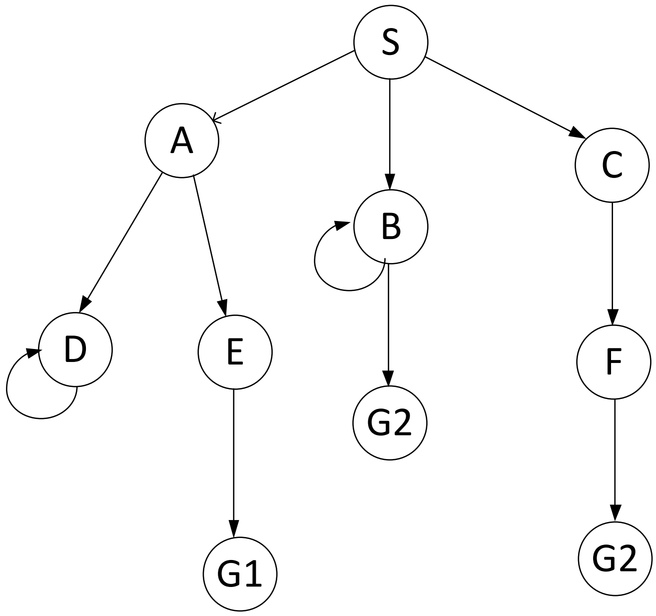
DT2016: 20 points are required for degree 3; 30 points for degree 4 and 35 points for degree 5.
DT2022: 20 points are required for degree G, 32.5 points required for degree VG.

Remarks:

- You may answer in Swedish or English.
- Use a new sheet for the solution of each task.
- Read the task descriptions carefully and do not forget to answer **all** questions.
- Motivate and justify all your answers in sufficient detail.
  Never answer with just one word, but argue and explain. This helps the examinator to understand your reasoning and evaluate your work.

Task 1: Search

In the following search graph (tree) there are three solutions G1, G2 and G3. Assume that the search terminates when the first goal state is reached.



a) **3 Points**

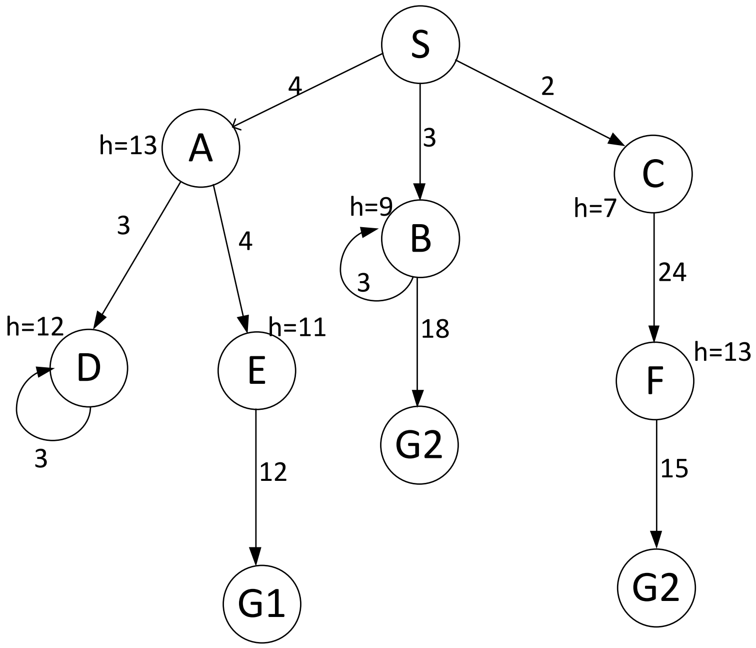
Search the tree starting from S using

- **Depth-First Search**
- **Iterative Deepening Search with Depth-Limited Depth First Search**

Precisely give the contents of the different lists involved in the search. The differences between Depth First Search and Iterative Deepening Search must be clearly shown. At which goal your search is ending?

b) 3 Points

Information about costs has been added to the search tree above: Numbers at links refer to costs from one node to the other; information at nodes ("h=…") are the values of the heuristic, that means the estimation of future costs between that node and the next goal.



Search this tree with information starting from S using

- **Best-First Search**
- **A***

Clearly describe what node you expand in which sequence and how the different involved lists are changing. The difference between Best First Search and A* must become clear. At which goal are the different search techniques ending?

c) **2 Points**

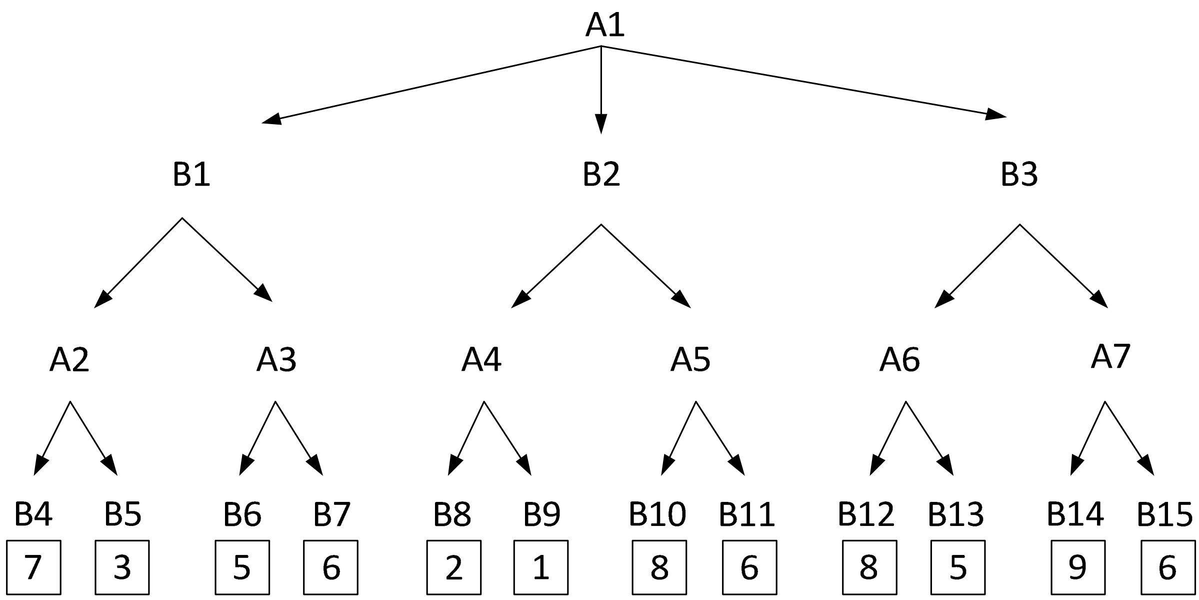
The standard Best First Search uses future costs as heuristic for guiding the search. Would it make sense to use the costs collected so far as heuristic to identify the next node to expand – e.g. by expanding the node with the lowest costs? Discuss this question.

d) **2 Points**

How an iterative deepening version of A* could look like? Under which circumstances such an iterative A* could make sense?

Task 2: Game Tree Search

Consider the following game tree for a 2-player game. All nodes starting with A are nodes in which the MAX-player needs to take a decision; all nodes starting with B belong to the MIN-player. The leafs of the tree represent evaluations of how the game develops for the MAX-player in the respective branch.



a) **3 points**
Which action the MAX-player shall take in the initial state A1? Use the MINIMAX algorithm for answering this question. Give all intermediate evaluation of game states.

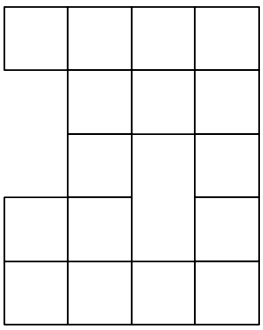
b) **3 points**
Use MINIMAX with alpha-beta-pruning on this tree. What branches do not need to be expanded? Explain why you did not consider these parts of the tree.

c) **1 points**
Would you say that alpha-beta pruning per se is a **heuristic** approach?

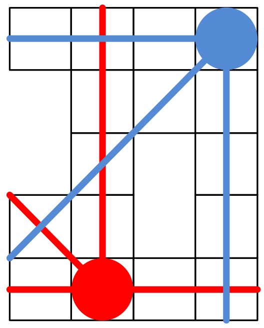
Task 3: Problem Modeling and Solving

5 points

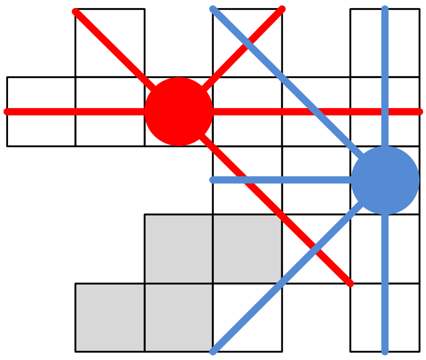
We have seen many mathematical puzzles as examples for AI problems and tried to solve them: Prominent examples that we had a (short) look at are Logical puzzles, N-queen problems, N-puzzles,...
A nice game that is available for smart phones is named “Octopus”: A number of octopuses needs to be placed on a (more or less complex) grid so that all cells are covered by the arms of the octopuses. Intersections are admissible. For example the following grid:



Can be solved by placing 2 octopuses:



For a grid like the following more than 2 octopuses would be necessary:



Which of the technique that are listed below would you use to determine the minimum number of octopuses and their placement for an arbitrary, given grid?

a) Uninformed State-Space Search (such as Depth-first, Breadth-first search)?
b) Heuristic Search (such as A* search)?
c) Local Search (such as Greedy/Hill-Climbing Search, Simulated Annealing or Genetic Algorithms)?
d) Constraint Satisfaction?
e) Automated Planning?

Select one of those techniques and argue why you would use it (and not the others). Also describe how you would model the problem in a way that this technique can be used.

Task 4: Knowledge Representation

a) **3 Points**
Consider the following natural language sentences and two candidates for potential translations into predicate logic.
Give **for each** translation, whether it is a correct translation, an erroneous translation or simply wrong syntax.

Line2 and Line3 both stop at Studentgatan.

$stopsAt(Line2 \wedge Line3, Studentgatan)$

$stopsAt\ (Line2, Studentgatan) \wedge stopsAt\ (Line3, Studentgatan)$

There is a time in which neither Line 2 nor Line 3 are scheduled

$\exists t\ time(t) \wedge \neg scheduled(Line2, t) \wedge \neg scheduled(Line3, t)$

$\exists t\ time(t) \Rightarrow (\neg scheduled(Line2, t) \wedge \neg scheduled(Line3, t))$

Two drivers who drive busses on the same line, cannot have lunch together

$\forall x,y\ (driver(x,Buss1) \wedge driver(y, Buss2) \wedge (line(Buss1)=line(\mathrm{Buss2}))) \Rightarrow \neg lunchTogether(x,y)$

$\forall x,y\ \neg\ driver(x, Buss1) \vee \neg\ driver(y, Buss2) \vee \neg\ (line(Buss1)=line(\mathrm{Buss2})) \vee \neg lunchTogether(x,y)$

b) Consider the following problem:
Victor has been murdered; Arthur, Bert and Carl are the only suspects – that means one of them is the murderer. They make the following statements:
Arthur says that Bert was the victim's friend, but Carl hated the victim
Bert says: He was out of town at the day of the murder and he did not even know Victor
Carl says: He saw Arthur and Bert with the victim just before the murder

We use the following predicates for formalizing those statements:
friend(x): x was a friend of Viktor
enemy(x): x was an enemy of Viktor
out(x): x was out of town during the murder
saw(x): x was seen just before the murder

We want to find out who is the murderer. You shall do that using Resolution. The statements of the three suspects can be easily translated to (predicate) logic:

Arthur states	Bert states	Carl states
friend(Bert) enemy(Carl)	out(Bert) $\neg$knows(Bert)	saw(Bert) saw(Arthur)

Yet, for doing reasoning, the knowledge base must be completed by adding the following commonsense statements:

$\forall$x: friend(x) $\Rightarrow$ knows(x)
(If x is a friend of the victim, then he knows the victim)

$\forall$x: enemy(x) $\Rightarrow$ knows(x)
(If x is a friend of the victim, then he knows the victim)

$\forall$x saw(x) $\Rightarrow$ [$\neg$out(x) $\wedge$ knows(x)]
If x has been seen with the victim just before the murderer, x was not out of town and x knows the victim

a) **3 points**
Translate the three common sense knowledge into CNF (Conjunctive Normal Form)

b) **5 points**
Use Resolution to find whether there is a contradiction when using all statements of each of the suspects for finding out who is a full liar. The statements of one produce the contradiction. This is the murderer. Who is the murderer?
Explain what you are doing in each step.

Task 4: Decision Trees

a.) **3 Points**

Sketch a decision tree for representing restaurants. Use attributes such as

- Open daily (boolean value)
- Size (large, medium, small)
- Sound (Noisy, Low-or-none)
- Service (high-level, unfriendly, self-service)
- Quality (Excellent, medium, low)

With a decision attribute representing a class of restaurants such as “First-class elite kitchen”, “neighbourhood restaurant”, “Fast-food restaurant”, etc.

b.) **2 Points**

Explain the basic idea of the ID3 Algorithm for learning Decision Trees

c.) **2 Points**

Describe the basic idea behind Case-based Reasoning and explain why it is different from using a decision tree when applied to similar problems.