Please consider the following rules; otherwise you may lose points:

- If you continue an answer on another page, please indicate the problem number on the new page and give a page reference on the old page.
- Always justify your statements (we would like to give poins for incorrect answers). Unless you are explicitly allowed to, do not just answer "yes", "no", or "42".
- If you write program code, give comments!

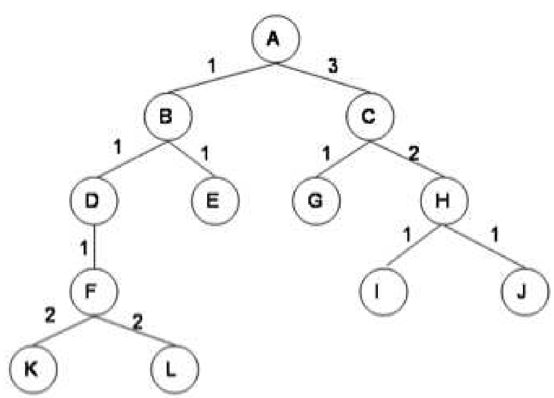
This mock exam is entirely voluntary. You *can* hand in solutions to your advisors if you're unsure and you are free to ask questions about them. Solutions will be provided in the following week.

These exercises are all representative of actual exam questions.

1 Search

Problem 1.1 — 8 pt, 4 min

Explain how BFS and DFS work and write down the sequences of nodes expanded for these algorithms.



Problem 1.2 (Admissibility limits) — 6 pt, 3 min

The condition for a heuristic $h(n)$ to be admissible is that for all nodes n holds that $(0 \leq h(n) \leq h^*(n))$, where $h^*(n)$ is the true cost from n to goal. What happens when for all nodes, $h(n) = 0$ and when $h(n) = h^*(n)$?

Problem 1.3 — 6 pt, 3 min

Does a finite state space always lead to a finite search tree? How about a finite space state that is a tree? Justify your answers.

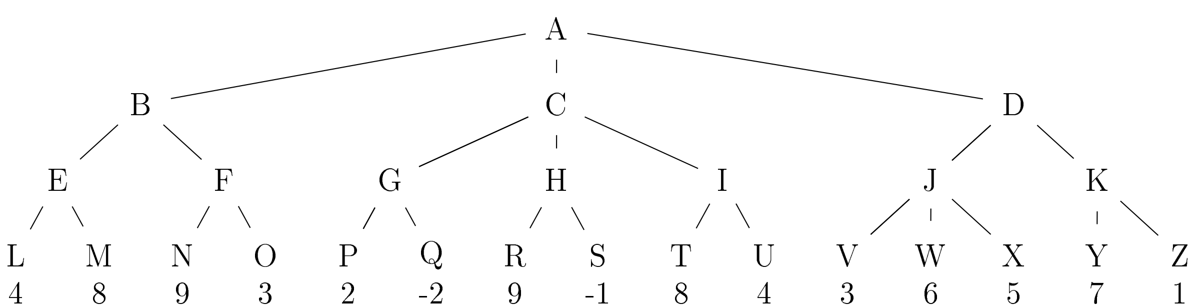
2 Adversarial Search

Problem 2.1 (Minimax Restrictions) 10 pt

Name at least five criteria that a game has to satisfy in order for the minimax algorithm to be applicable. 5 min

Problem 2.2 (Game Tree) 10 pt

Consider the following game tree. Assume it is the maximizing player's turn to move. The values at the leaves are the static evaluation function values of the states at each of those nodes. 5 min



20 pt

1. Label each non-leaf node with its minimax value. See above 5 pt
2. Which move would be selected by Max?
3. List the nodes that the alpha-beta algorithm would prune (i.e., not visit). Assume children of a node are visited left-to-right. 15 pt
4. In general (i.e., not just for the tree shown above), if we traverse a game tree by visiting children in right-to-left order instead of left-to-right, can this result in a change to 10 pt
   (a) the minimax value computed at the root?
   (b) The number of nodes pruned by the alpha-beta algorithm?

3 Constraint Satisfaction Problems & Inference

Problem 3.1 (CSP Heuristics) 14 pt

Explain backtracking search for CSPs and the minimum remaining values (MRV) heuristic, the degree heuristic and least constraining value heuristic (LCV). 7 min

Problem 3.2 (Scheduling CS Classes) 10 pt

You are in charge of scheduling for computer science classes that meet Mondays, Wednesdays and Fridays. There are 5 classes that meet on these days and 3 professors who will be teaching these classes. You are constrained by the fact that each professor can only teach one class at a time. The classes are: 15 min

- Class 1 - *Intro to Artificial Intelligence*: meets 8:30-9:30am,
- Class 2 - *Intro to Programming*: meets 8:00-9:00am,
- Class 3 - *Natural Language Processing*: meets 9:00-10:00am,
- Class 4 - *Machine Learning*: meets 9:30-10:30am,
- Class 5 - *Computer Vision*: meets 9:00-10:00am.

The professors are:

- Professor A, who is available to teach Classes 1, 2, 3, 4, 5.
- Professor B, who is available to teach Classes 3 and 4.
- Professor C, who is available to teach Classes 2, 3, 4, and 5.

1. Formulate this problem as a CSP problem in which there is one variable per class, stating the domains, and constraints. Constraints should be specified formally and precisely, but may be implicit rather than explicit. 3 pt
2. Give the constraint graph associated with your CSP. 2 pt
3. Show the domains of the variables after running arc-consistency on this initial graph (after having already enforced any unary constraints). 3 pt
4. List all optimal cutsets for the constraint graph associated with the CSP. 2 pt

4 Logic

Problem 4.1 (Calculus Properties) 8 pt

4 min

Explain briefly what the following properties of calculi mean:

- correctness
- completeness

Problem 4.2 (An incorrect calculus) 6 pt

3 min

Why is this calculus $\mathcal{C}^2$ incorrect?

- $\mathcal{C}^2$ Axiom: $\mathbf{A} \vee \neg\, \mathbf{A}$
- $\mathcal{C}^2$ Inference Rules: $\dfrac{\dfrac{[\mathbf{A}]^1}{\mathbf{B}}}{\mathbf{A} \Rightarrow \mathbf{B}} \Rightarrow I^1 \qquad \dfrac{\mathbf{A} \Rightarrow \mathbf{B} \quad \mathbf{B} \Rightarrow \mathbf{C}}{\mathbf{C}} \Rightarrow E$

Problem 4.3 (Resolution Calculus) 6 pt

3 min

Use the resolution calculus to prove the validity of the expression:

$$(X \wedge Y) \vee (X \wedge \neg\, Y) \Rightarrow X$$

Problem 4.4 6 pt

3 min

Find three models for the following proposition:

$$(P \vee (Q \wedge R)) \Rightarrow (P \vee Q) \wedge (\neg\, P \vee R)$$