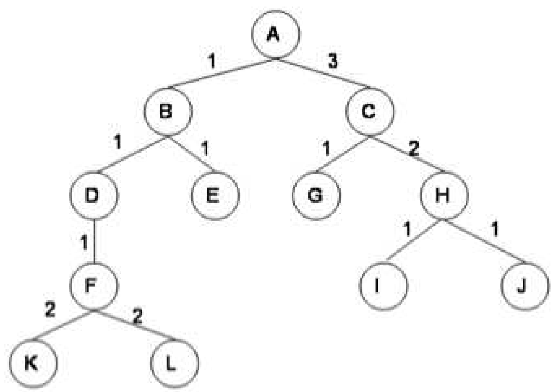
This mock exam is entirely voluntary. You *can* hand in solutions to your advisors if you're unsure and you are free to ask questions about them. Solutions will be provided in the following week.

These exercises are all representative of actual exam questions.

1 Search

Problem 1.1 Explain how BFS and DFS work and write down the sequences of nodes expanded for these algorithms. 8pt 4min



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Problem 1.2 (Admissibility limits)
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 $h(n) = h^*(n)$? 6pt 3min

Problem 1.3 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. 6pt 3min

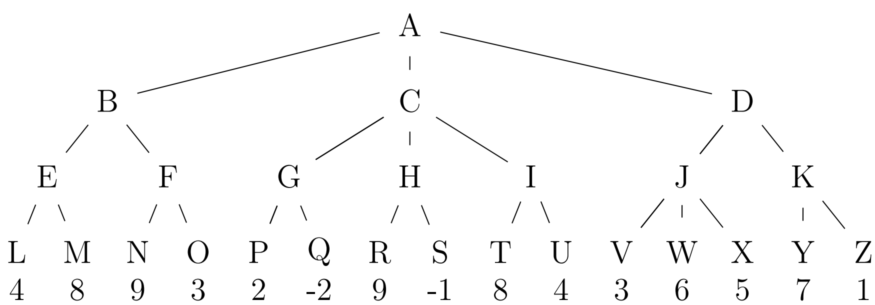
2 Adversarial Search

Problem 2.1 (Minimax Restrictions)

Name at least five criteria that a game has to satisfy in order for the minimax algorithm to be applicable. 10pt 5min

Problem 2.2 (Game Tree)

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. 10pt 5min



10 pt

1. Label each non-leaf node with its minimax value. See above 5 pt
2. Which move would be selected by Max? 10 pt
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. 5 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
   (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)

Explain backtracking search for CSPs and the minimum remaining values (MRV) heuristic, the degree heuristic and least constraining value heuristic (LCV). 14pt 7min

Problem 3.2 (Scheduling CS Classes)

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: 15pt 15min

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

The professors are:

- Professor A, who is available to teach Classes 3 and 4.
- Professor B, who is available to teach Classes 2, 3, 4, and 5.
- Professor C, who is available to teach Classes 1, 2, 3, 4, 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. 4 pt
2. Give the constraint graph associated with your CSP (e.g. by giving the edges). 2 pt
3. Show the domains of the variables after running arc-consistency on this initial graph (after having already enforced any unary constraints). 4 pt
4. Give one solution to this CSP. 1 pt
5. Your CSP should look nearly tree-structured. Briefly explain (one sentence or less) why we might prefer to solve tree-structures CSPs. 2 pt
6. Name (or briefly describe) a standard technique for turning these kinds of nearly tree-structured problems into tree-structured ones. 2 pt

4 Logic

Note: For ASCII submissions, use the symbols `&`, |, `~`, `->` instead of $\wedge, \vee, \neg, \Rightarrow$.

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Problem 4.1 (Calculus Properties)

Explain briefly what the following properties of calculi mean: 8pt 4min

- correctness
- completeness

Problem 4.2 (An incorrect calculus)

Why is this calculus $\mathcal{C}^2$ incorrect? 6pt 3min

- $\mathcal{C}^2$ 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)

Use the resolution calculus to prove the validity of the expression: 6pt 3min

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

Problem 4.4 Find three models for the following proposition: 6pt 3min

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