Problem 1

10 points total, 1 point each subtask. Answer each question with *True* or *False*.

(a) Artificial intelligence was born when Alan Turing formulated the Turing Test.

(b) Early advances in artificial intelligence were met with skepticism and doubt.

(c) The agent function maps percept sequences to action.

(d) The real world is fully observable.

(e) A taxi driving from A to B in traffic operates in a deterministic environment.

(f) A simple reflex agent has a small but limited short-term memory.

(g) Goal-based agents often rely on search and planning to find their goal.

(h) A utility-based agent is better suited in the real world than a learning agent, since it is able to estimate its own utility.

(i) Learning is necessary for complex agent behaviour to arise in a multi-agent setting.

(j) Learning helps in a stochastic and continuous environment.

Problem 2

10 points total, 1 point each subtask. Answer each question with *True* or *False*.

(a) Intelligent agents are supposed to optimize their performance measure.

(b) The vacuum world is not a toy problem.

(c) Redundant paths in a search tree are impossible to avoid.

(d) GRAPH-SEARCH is the same as TREE-SEARCH, only with history.

(e) Time complexity and space complexity are the two best ways to evaluate the performance of an algorithm.

(f) Blind search is also known as heuristic search.

(g) A graph with branching factor b and depth d can be solved in most cases by uninformed search.

(h) Bidirectional search reduces the time complexity with the square root.

(i) An heuristic estimates the cheapest cost from one node to the goal node, even if the path is impossible to execute.

(j) A* is the best known form of best-first search.

Problem 3

10 points in total, points indicated for each subtask. Express tasks a, b and e using first-order logic, otherwise follow the instructions.

(a) (1 point) All lectures are fun. (1 point) There exists a lecture that is not fun.

(b) (2 points) Siblinghood is a symmetric relationship (i.e. write how to express this relationship in first-order logic).

(c) (2 points) Express that "everyone dislikes vegetables" in two ways, using the "FOR ALL" quantifier in one sentence and "THERE EXISTS" quantifier in the other sentence, and the same predicate in both sentences.

(d) (4 points) Some siblings have different parents.

Problem 4

10 points in total, 2 points each subtask.

(a) What is another word for *unification*?

(b) What is the purpose of *Universal Instantiation*? *Existential Instantiation* is a special case of a more general process. What is the name of this general process?

(c) What is the best known programming language that builds on backward chaining?

(d) What is conjunctive normal form, and what is it used for?
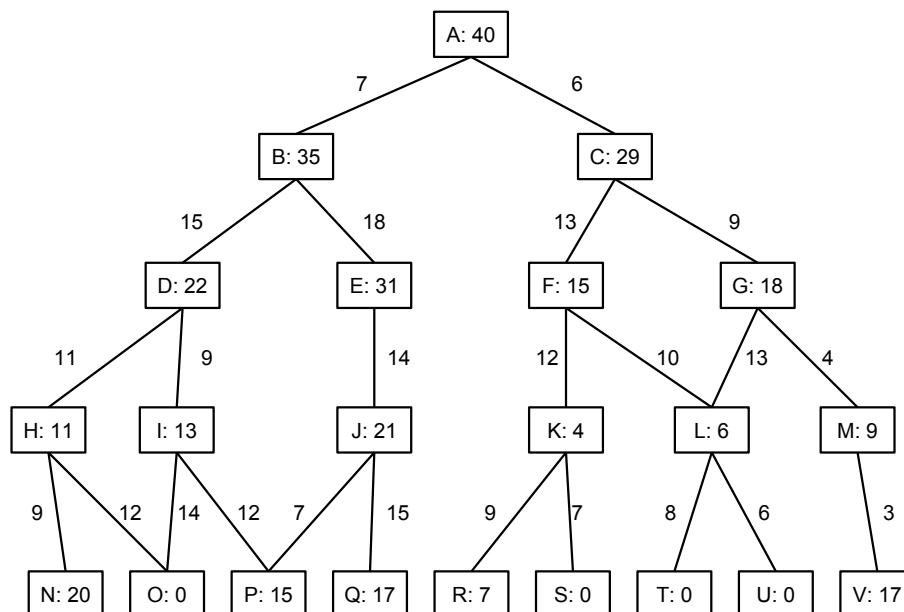
Problem 5

15 points. Points indicated in each subtask.

(a) (2 points) What is the name of the tree structure in the figure below? (2 points) What does it represent?

(b) (5 points) Write down the node values that are missing in a breadth-first manner.

(c) (6 points) Apply alpha-beta pruning and write down the leaf nodes that won't get expanded.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
3	4	7	2	3	5	4	5	6	4	3	1	4	3	7	2
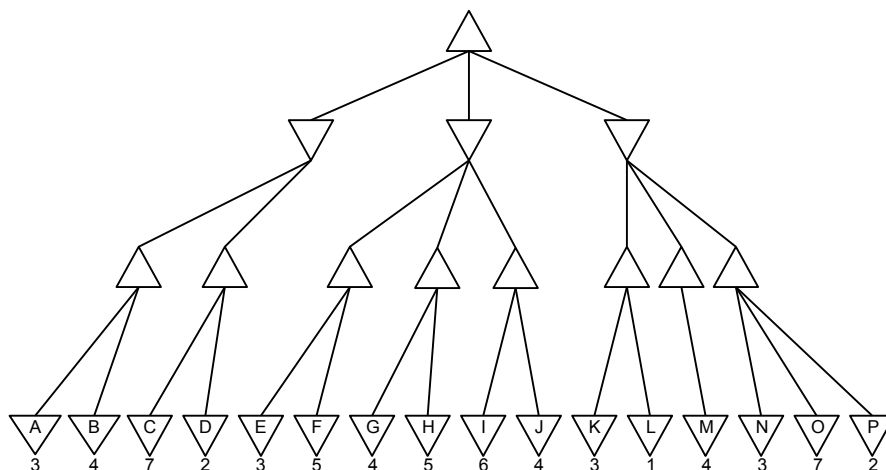
Problem 6

20 points. Points indicated in each subtask.

(a) (2 points) A* belongs to which class of search algorithms? (2 points) What is the worst-case time complexity of A*?

(b) (2 points) What does it mean to use an *admissible heuristic* in A* search?

(c) (9 points) In the figure below, each node is labeled with the heuristic function for that node, e.g. node A has heuristic function value 40. Apply A* search to the tree and write down $f(n) = g(n) + h(n)$ for each node the algorithm visits, e.g. the starting node would be written $A(40)$. Assume we visit child nodes from left to right.

(d) (2 points) List the nodes along the final path between the start state and the end state, using A* search.

(e) (3 points) What is the biggest drawback of the A* algorithm?

Problem 7

15 points. Points indicated in each subtask.

(a) (3 points) How are states and goals defined in STRIPS?

(b) (3 points) How are actions defined in STRIPS?

(c) (9 points) You are unhappy and poor, but you are also hardworking and lucky. You want to be happy and it is possible to buy happiness. Write down a representation of this domain in the STRIPS language, i.e. the intial state, goal state, and the actions required to achieve the goal state. Note: buying happiness will not make you poor, you stay rich.

Problem 8

10 points. Points indicated in each subtask.

(a) (2 points) What are the best known examples of information retrieval systems?

(b) (3 points) What are the three essential elements in information retrieval?

(c) (2 points) What separates information extraction from information retrieval?

(d) (3 points) What is the limiting factor in information extraction?