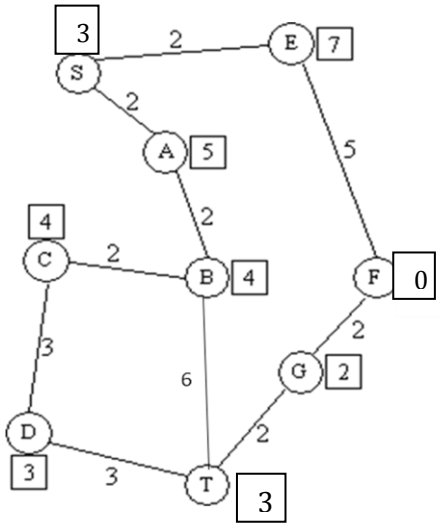
2nd Examination Intelligent Systems
April 1st 2015. 18.30-21.15

- Use of a normal (not graphical) calculator is allowed
- Always show how you got to your answers
- Write READABLE. If we cannot read your answer, you will get no points. You can get 100 points in total: distributed as follows:

Exercise 1	Exercise 2	Exercise 3	Exercise 4	Exercise 5	Exercise 6	Total
15	20	15	20	10	20	100

- You may answer in English or Dutch

Exercise 1: Search algorithms (15 Points)



Consider the following graph (→). The goal is to find the shortest path from a position B (Begin) to the final position F (Final). With each location the number in the square contains the estimated distance from the location to the end location F. Each edge is labelled with the true distance of the connection (which we obviously only know after we travelled the distance).

a) (3 points) Draw the search tree that we get when using the above information to search for the shortest path between B and F in a forward manner using Hill-Climbing? Please:

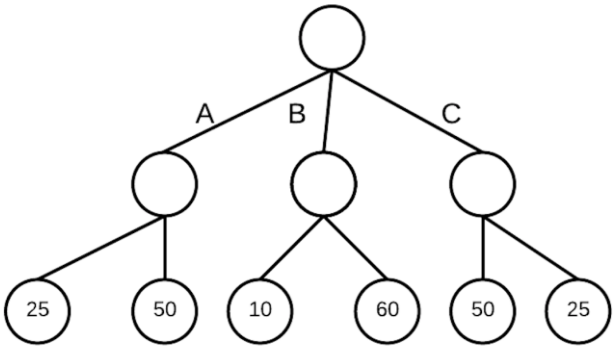
- Number the nodes in the tree according to the order in which they are searched through.
- In case there is a solution, provide the final path found by Hill-Climbing to get from B to F.

b) (12 points) Draw the search tree that we get when using the above information to search for the shortest path between B and F (in a forward manner) using A or A*? Please:

- Number the nodes in the tree according to the order in which they are searched through by the A or A* algorithm.
- Give the heuristic values for each of the nodes in the tree.
- Provide the final path that is found by the A or A* algorithm to get from B to F.
- Is it an A or A* algorithm you applied? Explain your answer.

Exercise 2: Gaming (20 Points)

a) (5 points) Given a choice between moves A, B and C in the following tree, which would MinMax choose (assuming Min is on the move at the root)?



Please briefly explain your answer by drawing the entire tree and calculating all the nodes that are still unknown.

b) (4 points) Are the following statements true or false? Briefly explain your answers for all separate statements A-D.

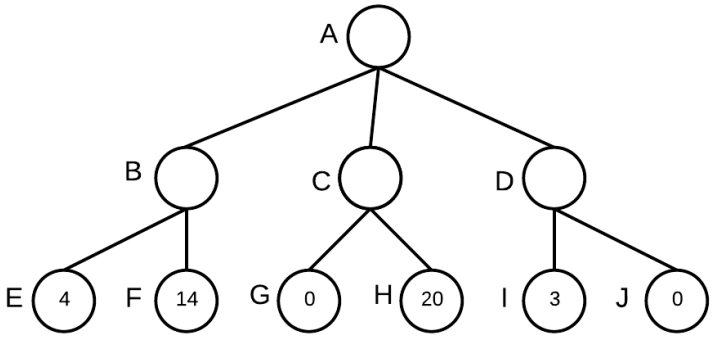
A) Alpha-beta pruning can be applied to trees of any (finite) depth.

B) With alpha-beta pruning it is possible to prune entire subtrees rather than just leaves.

C) The algorithm alpha-beta pruning is complete, while the MinMax algorithm is not.

D) Alpha is the value of the best choice we have found so far at any choice point along the path for MAX.

c) (6 points) Consider the following MinMax tree. Possible values in this tree are 0-20.



If Min is the first to play, is there a winning strategy for either Min or Max, when Min wins with 0-10 and Max with 11-20? Why (not)?

d) (5 points) Use alpha-beta pruning to reduce the search space from the search tree in the previous question. The algorithm searches from the left to the right side. Min aims at reaching the lowest possible value whereas Max aims at reaching the highest possible value. If there are, which leaf nodes can be pruned by the algorithm? Briefly explain your answer.

Exercise 3: Constraint Satisfaction Problem (15 Points)

a) (5 points) Which of the following statements is true? A CSP is consistent if, and only if,

A) an assignment of variables does not violate any of the constraints.
B) an assignment assigns values to all the variables.
C) an assignment of variables does not violate all the constraints.
D) all the constraints are satisfied by at least one variable assignment.

Briefly explain your choice, both why your chosen answer is correct, and why the other answers are incorrect.

b) (5 points) Consider a CSP with V={X,Y}, D_x={1,3,5} and D_y={3,6} and a single constraint 2* X = Y. Show how to find a solution (or not) using simple search with backtracking.

c) (5 points) For the same CSP what happens if you apply the arc consistency algorithm until your algorithm reaches saturation?

Exercise 4: Logical agents (resolution proof) (20 Points)

a) (8 points) Which of the following statements is or are true about Logical Reasoning?

A) In all worlds where the sentence $a \Rightarrow b$ is valid, $a \wedge \neg b$ is unsatisfiable.
B) When two separate clauses $a \vee \neg b$ and $\neg a \vee b$ are resolved, an empty clause {} is the result.
C) The formula $(q \wedge r) \vee (\neg r \wedge s)$ is represented in conjunctive normal form.
D) When an empty clause can be found by a resolution proof, a contradiction has been found, so the *original* claim is *not* true.

Briefly explain for each answer why it is true or false.

b) (12 points) Consider the game of Minesweeper ('Mijnenveger'). The game screen consists of a $n \times n$ field of squares, each of which might or might not contain a mine. Each square can be uncovered by clicking on it. If a square containing a mine is clicked upon, the game is lost. If the square did not contain a mine, two things can happen. Either a number k appears inside the square, meaning that among all 8 neighbours of the square precisely k contain a mine, or no number appears, meaning that none of the neighbours contain a mine. The game is won when all squares not containing a mine are uncovered.

Use a resolution to show that the *2x2* screen pictured below is inconsistent. Remember to represent all necessary steps of a proper resolution proof, and explain your answer where needed. (Hint: use the notation Ma1 to state that the lower left corner of the screen contains a mine, Mb2 for the upper right corner, etc.)

1	
	2

Exercise 5: Probabilistic knowledge (Bayes) (10 Points)

Consider two medical tests, A and B, for a virus. Test A is 95% effective at recognizing the virus when it is present, but has a 10% false positive rate (indicating that the virus is present, when it is not). Test B is 90% effective at recognizing the virus, but has a 5% false positive rate. The two tests use independent methods of identifying the virus. The virus is carried by 1% of all people. Say that a person is tested for the virus using only one of the tests, and that test comes back positive for carrying the virus. Which test returning positive is more indicative of someone really carrying the virus? Justify your answer mathematically.

Exercise 6: Machine Learning (20 Points)

Suppose there are 5 documents about two courses “Intelligent Systems (IS)“ and “Distributed Systems (DS)”:

- D1: Logics and intelligent systems are very important in the course
- D2: Intelligent algorithms are critical to solve problems in distributed environments
- D3: Intelligent algorithms and logic are crucial
- D4: Distributed systems are Intelligent
- D5: Distributed systems need good algorithms

D1, D3 and D4 are about the Intelligent Systems class, D2 and D5 about Distributed Systems. Use the features Logic, Intelligent, Systems, Distributed and Algorithms to predict whether the document D6 “Distributed algorithms can help reasoning in logic” is about the IS class, or DS?

a) (12 points) First, show this by using a Naïve Bayesian Classification algorithm. Apply Laplace smoothing (value 0.01) when necessary.

b) (8 points) Second, explain how you would apply a Decision Tree learning algorithm to the same problem. It is not necessary to build the entire tree, but your answer must show that you understand the learning algorithm clearly

End of Exam