2nd Examination Intelligent Systems

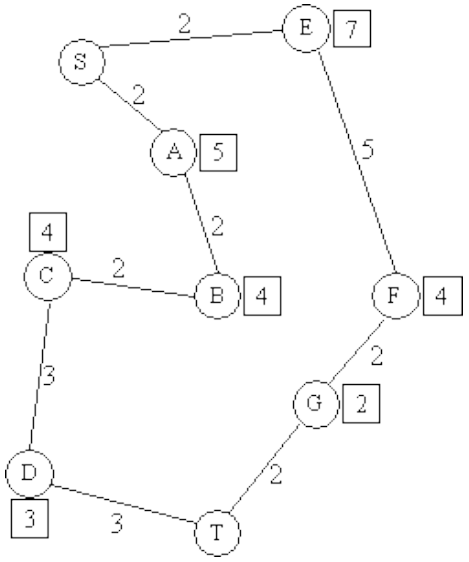
April 2nd 2014. 18.30-21.15

- 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:

E1	E2	E3	E4	E5	E6	E7	E8	Total
15	15	10	10	10	10	10	10	90 (+10 bonus)

- You may answer in English or Dutch
- This exam has **4 pages and 8 exercises**. Do not lose too much time with one exercise!

Exercise 1: Search algorithms (15 Points)



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

a) Draw the search tree that we get when using the above information to search for the shortest path between S and T (in a forward manner) using A*. Please:

- Number the nodes in the tree according to the order in which they are searched through by the A* algorithm.
- Give the heuristic values for each of the nodes in the tree.
- Provide the final path that is found by the A* algorithm to get from S to T.

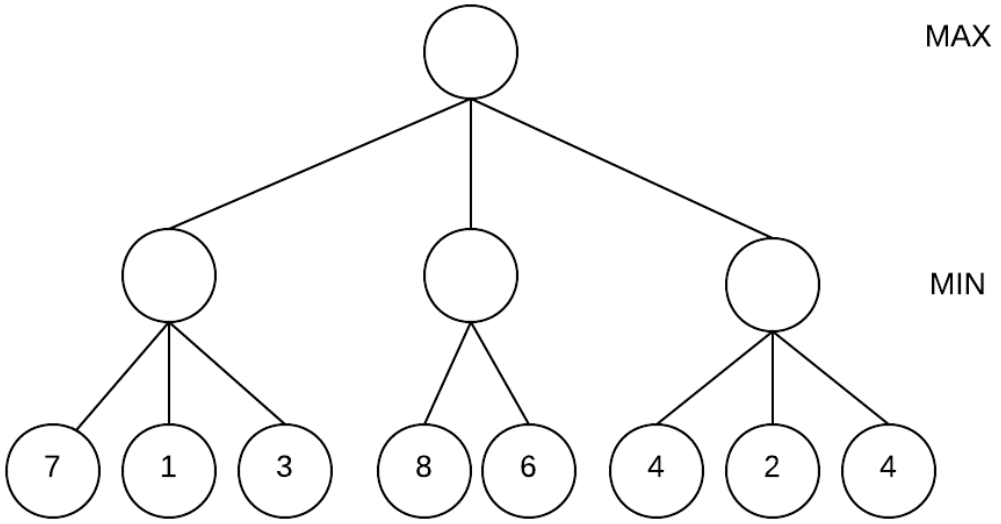
b) Give an example of a (small) search tree that is not admissible, and would therefore apply algorithm A instead of A*.

c) Please provide answers to the following sub-questions:

- What is the relation between beam-search and best-first search?
- Which algorithm corresponds to beam-search with a beam of 1 (no motivation needed)?

Exercise 2: Gaming (15 Points)

Consider the following Minimax-tree. Possible values in this tree are 1-8.



a) Use the Minimax-algorithm to compute who is the winning player when both players play optimally. MIN wins the game with values 1,2,3 and 4 and MAX wins the game with values 5,6,7 and 8. Explain your answer.

b) Use Alpha-Bèta pruning to reduce the search space. The algorithm searches from the left to the right side and MIN aims at reaching one of its winning values 1,2,3 or 4 whereas MAX aims at reaching one of its winning values 5,6,7 or 8. If there are, how many nodes can be cut-off by the algorithm? Do not write down only a number, but give also a drawing of the nodes that can be cut-off.

Exercise 3: Constraint Satisfaction Problem (10 Points)

Answer the following questions about the use of heuristics in CSP solving. Of course explain your answer.

a) Is it a good heuristic to choose the *variable* that is *most* constrained?

b) Is it a good heuristic to choose the *value* of a variable that is *most* constraining in a CSP search?

Exercise 4: Logical agents (resolution proof) (10 Points)

Given is the conversation between two students:

Student 1 tells: "If I am going to Portugal (P), then it is summer (S). When it is summer, I do not have any lecture (L). Moreover, when I do not have any lecture and it is summer, then it is not March (M). Unfortunately, it is March now."
Student 2 concludes: "Too bad, you are not going to Portugal now…"

Use a resolution proof – with all necessary steps (!) – by using the information given above to determine whether student's 2 conclusion is entailed by the information of student 1 or not. Please use the abbreviations given in brackets.

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 (10 Points)

Briefly explain the Decision Tree Learning algorithm in Machine Learning. Use at least the following terms in your explanation: *(un)supervised learning, decision tree, information gain, entropy.* Your explanation must show that you both use the terms correctly and understand the meaning of each term.

Exercise 7: Neural Networks (10 Points)

Given a classification problem of two concepts A and B.
We use a simple perceptron learning algorithm for learning the two concepts.
Decision region for concept A: $w0 + w1.x1 + w2.x2 < 0$
Decision region for concept B: $w0 + w1.x1 + w2.x2 > 0$

We start with all weights of 0.5.
The learning parameter is 0.3.
The desired value of concept A is -1, and the desired value of concept B is 1.

a) Given the above decision regions for concept A and concept B. We have a new training example (3,2) which is a concept A. Please adapt the weights based on this additional example (3,2).

b) Give an advantage and a disadvantage of a high learning rate parameter?

Exercise 8: Evolutionary Methods (10 Points)

a) Consider the following two bit-strings: 010110 and 101111. Apply respectively crossover after the second bit (read from right to left) and mutation of the last bit (again from right to left) and conclude your answer with the generated offspring.

b) Give two advantages and two disadvantages of evolutionary algorithms.

End of Exam