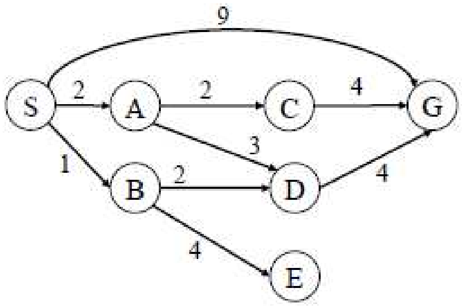
Open book exam. Duration: 2h30m. Exame da Época de Recurso

Note: Answer each question (1, 2, 3 and 4) in separate exam sheets (1, 2, 3 e 4).

1. **[4 points]** The state space of a given search problem is shown in the figure. We want to obtain a path from node S to node G. Each connections has the cost indicated in the figure. The heuristic function represented in the table has been defined.



   a) Identify the solution found by the **breadth-first search** strategy.

   b) Identify the first 4 nodes expanded by the **uniform cost** search strategy. Justify, presenting their respective costs.

   c) Show the search tree obtained by the **A*** search strategy, using the heuristic function presented. Next to each node in the tree, indicate the value of the cost function components (f=g+h). Identify the solution found.

S	A	B	C	D	E	G
6	0	6	4	1	10	0

   d) Is the heuristic function admissible and consistent? Why?

2. **[4 points]** In a real-estate market study, a knowledge-based system has been used to determine the renting probability of apartments. The following rules have been designed:

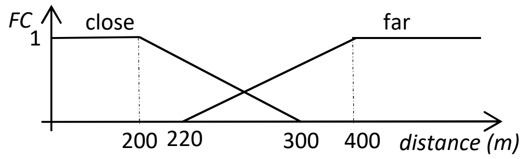
   R1: If city center Then good location (FC=0,9)

   R2: If metro nearby And hospital in the premises Then good location (FC=0,7)

   R3: If good location And floor > 3 Then high renting probability (FC=0,8)

   R4: If floor ≤ 3 Or no guard Then low renting probability (FC=0,6)

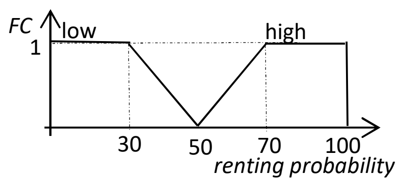
   The fuzzy concept "close" is represented by the membership function shown in the figure.



   Apartment ***Ap*** is in the 4th floor of a building in the city center (FC=0,8). It is at a 220m distance of a metro station. There is a hospital in the premises. The building does not have a guard (FC=0,7).

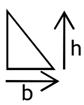
   a) From this rule set, which are the certainty factors associated with the low/high probabilities of apartment ***Ap*** being rented? Show your calculations.

   b) The figure shows the membership function of the fuzze concept "renting probability". Which is the renting probability of apartment ***Ap***? Show your calculations.

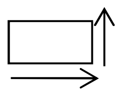


   c) We know that the implemented system uses rule inference through backward chaining. Explain what this inference mechanism is about.

Centroid (Xc,Yc) of a geometric figure:



Xc = 1/3 *b
Yc = h/3



Xc = c/2
Yc = a/2

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3. [**4 points**] We want to solve the travelling salesman problem using **simulated annealing** and considering as initial state the path ***A-B-C-D-A***. The traveling salesman departs from city A and wants to visit cities B, C and D, then returning to city A. Distances between cities are shown in the table, and we want to find the shortest path.

	A	B	C	D
A	0	30	40	35
B	30	0	35	25
C	40	35	0	20
D	35	25	20	0

a) Propose an evaluation function and a neighboring function for the problem (textual description). Calculate the value given by the evaluation function to the initial state.

b) Consider that the temperature parameter (T) starts at 50, and is decremented in 10 units each iteration. Show the list of the 4 first generated states and the corresponding decision. When and if you need to generate random numbers to decide on accepting the generated states, use the following values: 0,82; 0,6; 0,4; 0,75). Explain your reasoning.

c) Why is randomness included in simulated annealing? Describe the functioning of the algorithm when randomness is null or extremely high (infinite).

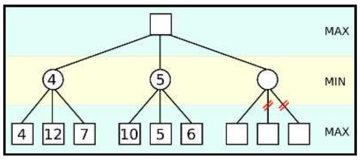
4. [**8 points**] Answer **six (6)** of the following seven (7) questions (each in 5-10 lines).

a) Explain two advantages of using "Monte Carlo Tree Search" instead of Minimax.

b) In optimization algorithms, the adoption of a neighboring state can be deterministic or probabilistic. Comment on this statement.

c) In the algorithm C4.5, explain what *split information* is for.

d) For the figure, indicate which value ranges the blank nodes can have when the only alpha-beta cuts are the ones illustrated.



e) In artificial neural networks, distinguish *activation function* from *transfer function*.

f) Explain the concept of supervised machine learning.

g) Suppose a KBS in which we introduce data according to incoming evidence (E1="clean sky", E2="dry", E3="clouds coming", E4="satellite photo") and that handles uncertain knowledge using the **Dempster-Shafer** model. Calculate the interval of belief in "it's not going to rain" (round it to 2 decimal cases), knowing that:

- E1 → "it's not going to rain" (0.7)
- E2 → "it's not going to rain" (0.6)
- E3 → "it is going to rain" (0.3)
- E4 → "it is going to rain" (0.2)