Identificação do aluno:

Nome: ____ #: ________

I

Review the following functions written in Python and explain what they do. You don't need to explain how they are implementated:

a)
```
def f(x):
   if x==[]:
      return 0
   if x[0]>0:
      return x[0] + f(x[1:])
   return f(x[1:])
```

b)
```
def g(x):
   if x==[]:
      return [[]]
   y = g(x[1:])
   return y + [ [x[0]]+z for z in y ]
```

2. In the context of generating all interpretations of a formula in propositional logic, it is necessary to generate all possible combinations of values of the propositional variables contained in the formula. Develop a function that, given a list of propositional variables, generates all possible combinations of values.
Example:
```
>>> interpretacoes(["a","b"])
[  [ ("a",True), ("b",True) ], [ ("a",True), ("b",False) ], [ ("a",False), ("b",True) ], [ ("a",False), ("b",False) ] ]
```

II

1. In this exercise, you have a set of multiple-choice questions. In each question, only one of the given options is correct, and you can only select one of them. Each wrong answer deducts 20% from the score of the question.

a) The sentence "All cartoon books have hardcover" can be represented in 1st order logic as follows:

- $\forall x\ (Book(x) \wedge Cartoon(x)) \Rightarrow \neg\ Hardcover(x)$ ☐
- $\forall x\ Cartoon(x) \Rightarrow \neg\ Cover(x,Hard)$ ☐
- $\forall x\ Book(x) \vee (\ Cartoon(x)) \Rightarrow \neg\ Cover(x,Hard)$ ☐
- $\forall x\ Book(x) \wedge (\ Cartoon(x)) \Rightarrow \neg\ Cover(x,Hard)$ ☐
- None of the previous answers ☐

b) The sentence "The best grade in Portuguese was Ana's" can be represented in 1st order logic as follows:

- $\forall x\ Grade(Ana,Portuguese) > Grade\ (x, Portuguese) \wedge Student(x)$ ☐
- $\forall x,y,z\ Grade\ (Ana, Portuguese,y) > Grade(x, Portuguese,z) \wedge y>z$ ☐
- $\forall x\ Grade(Ana, Portuguese) \geq Grade(x, Portuguese) \vee Student(x)$ ☐
- $\forall x\ Student(x) \Rightarrow (Grade(Ana, Portuguese) \geq Grade(x, Portuguese)\ )$ ☐
- None of the previous answers ☐

c) Iterative improvement search (or local search) is:

- A search technique for solving assignment problems ☐
- A technique for combining heuristics ☐
- A search technique for solution optimization ☐
- A particular case of simulated annealing in which the temperature evolution resembles a mountain landscape ☐
- None of the previous answers ☐

d) A logical conseguence of{ $A \vee B, \neg B \vee C \vee D, \neg A\ , \neg D$} is:

- $B \wedge A$ ☐
- C ☐
- A ☐
- $A \vee D$ ☐
- None of the previous answers ☐

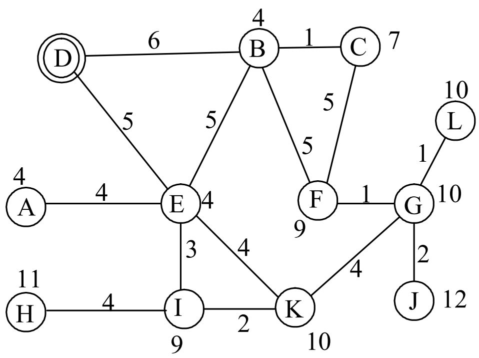
e) STRIPS operators are:

- An action representation format for reactive systems with internal state ☐
- A state transition representation format for local search ☐
- Solution modification mechanisms in simulated annealing search ☐
- Mechanisms for generating plans in the blocks world ☐
- None of the previous answers ☐

2. Identify similarities and differences between depth-first tree search and the hill-climbing search.

3. Houses have different types of rooms, for example, living rooms, dining rooms, bedrooms, kitchens and bathrooms. The rooms in the house have pieces of furniture, such as tables, chairs, beds, dressers and shelves. Gabriela's house is in Aveiro. This house has a room with a bed, in which Gabriela sleeps, and a dresser. Represent this knowledge through a semantic network.

4. The graph presented below represents a state space in a search problem, where D is the goal state (solution). Estimates of the cost of arriving at the solution from each state are noted next to them. The transition costs are noted next to the edges of the graph.



a) Check if the cost estimates annotated for each node constitute an admissible heuristic for A* search. If this is not the case, introduce (in the figure itself) amendments to make it admissible. Justify.

b) Taking state G as the initial state, present the search tree generated when performing an A* search with state repetition. Number the nodes in the order they are added to the tree and also note the value of the evaluation function at each node. In case of a tie in the values of the evaluation function in two or more nodes, use the alphabetical order of the respective states.

5. Consider an autonomous vehicle that moves in an environment structured in nodes and links, that is, structured as a graph. The links correspond to streets. Nodes represent confluences of 1 or more streets. Also, each node can have 0 or more car parks. Streets start and end at adjacent nodes in the graph. The vehicle is able to perform the following actions: crossing (going to another street of the node), parking in one of the parking lots of the same node, walking (going to the node at the other end of the current street), leaving the parking lot for a given street that starts or ends at the same node.

a) Identify and characterize a set of predicates in first-order logic that can be used to specify conditions about planning states in this domain. Identify the possible values of the arguments of these predicates. (Note: To answer this question, it is advisable to also see exercice b), where these predicates are used.)

b) Using the predicates you proposed, define a set of STRIPS operators to represent the actions that can be performed in this domain.

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INTELIGÊNCIA ARTIFICIAL Exame, xx/xx/xxxx (Tempo: 3h)