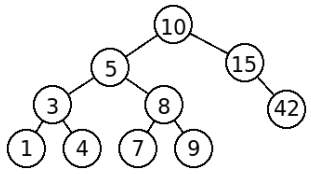
Model Questions (1st 1/3) - Advanced Topics in Algorithms 2021/2022 (CC4020)

DCC/FCUP

1 - *Balanced Binary Search Trees.*



a) Suppose you **remove number 42** from the **AVL tree** shown in the right figure. Indicate what would be the resulting tree, justifying your answer.

b) Indicate an **advantage** and a **disadvantage** of **AVL trees** when compared to **red black trees**, justifying why they would be better or worse in each situation.

2 - *Self-Adjusting Data Structures.* Consider you are using a *splay tree*.

a) What does it mean to say that each basic operation (ex: *find, insert, remove*) has an **amortized** complexity of $\mathcal{O}(\log n)$? Can any of these operations have a linear cost? Why?

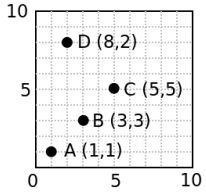
b) What is the purpose of the **splay operation**? Give a brief description of how it works (naming its basic operations) and why it has a fundamental role in the splay trees algorithmic efficiency.

3 - *Probabilistic Data Structures.*

a) Describe an algorithm to **search** for an item in a **skip list** with n items. Can you give an intuitive explanation of why its expected temporal complexity is **logarithmic**?

b) Why doe we say that a **bloom filter** may give **false positives**? Can it give **false negatives**? Why?

4 - *Spatial Data-Structures.*



a) Draw a **point-region (PR) quadtree** storing the 4 points of the right figure. (draw both the tree and the 2D plane representation)

b) Describe a set of points would give origin to a **very unbalanced PR quadtree**? Why? Explain how you could create a **balanced point quadtree** representing the same set of points.