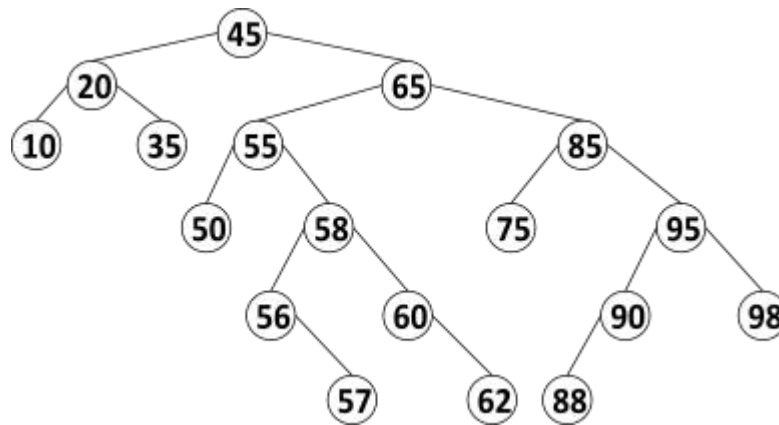


## Tree Traversal

Consider the following binary search tree:



Let's explore the following two types of traversals:

- Traversal 1:

Branch by Branch, from bottom to top and from Left to Right (BB-LR)

10, 20, 45, 35, 50, 55, 65, 57, 56, 58, 62, 60, 75, 85, 88, 90, 95, 98

- Traversal 2:

Leaf by Leaf, from Left to Right, then simulate as if the previous leaves have been absorbed (LL-LR)

10, 35, 50, 57, 62, 75, 88, 98, 20, 56, 60, 90, 58, 95, 55, 85, 65, 45

Similarly, we define traversals BB-RL (Traversal 3) and LL-RL (Traversal 4) by considering the direction from right to left.

To facilitate the algorithms, we introduce a "Visited" field at the node level indicating if the node has already been visited.

The correctness of traversals must be verified.

- One way to verify that traversals 1 and 3 are correct is to construct a list containing all the branches from bottom to top and eliminate duplicates.
- One way to verify that traversals 2 and 4 are correct is to remove visited leaves.

## "Khawarizm" Part

Express all necessary modules and then implement them in the Khawarizm environment using the following main algorithm:

For  $i := 1$  to  $m$

- Generate a binary search tree with  $n$  random data

- Verify that the tree is correctly constructed
  - Apply the different types of traversals and verify their correctness
- Endfor

Take  $m = 10$ ,  $n = 100$ .

### "C" Part

(a) Request automatic translation to C and test the resulting program.

(b) On the obtained C program, add modules to show (possibly animate) the considered traversal types.

- There is no need to attempt to present the results well with Khawarizm. It is not intended for this purpose.
- Include non-standard "Include" files in the C program.

### Grading

Khawarizm: 15 pts

C: 5 pts

### Transition to the C Language

*It is unlikely that during the translation, the obtained program will not run. In this case, the student must make an effort to search for and correct the error. Any error recognized as relevant and corrected by the student will be rewarded with a bonus. In this case, send us the Z code for which the translation does not work and the corrected C code indicating the changes. If a translation error cannot be corrected, please send us the Z code. The error will be corrected for you.*

### Software

- Standard C language :
- French version of Khawarizm: [https://zegour.esi.dz/Ftp/Khawarizm2\\_plus\\_64.7z](https://zegour.esi.dz/Ftp/Khawarizm2_plus_64.7z) or
- Multi-language Khawarizm: [https://zegour.esi.dz/Ftp/Khawarizm2\\_afe.7z](https://zegour.esi.dz/Ftp/Khawarizm2_afe.7z)

### Beware of plagiarism !!!

### Submission Deadline: Friday, May 31, 2024, before Midnight

- \* Assignments will be submitted according to a form that will be provided to you later.
- \* Any assignment not submitted according to the set deadline will result in a deduction of 2 points per day, with a total tolerance of 2 days.