CS4054: Bioinformatics

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Assignment 5

Due Date: May 9, 2025
(10 points)

Code Challenge: Implement `UPGMA()`.

- **Input:** An integer *n* followed by a space separated *n* x *n* distance matrix.
- **Output:** An adjacency list for the ultrametric tree returned by `UPGMA()`. Edge weights should be accurate to three decimal places.

Note on formatting: The adjacency list must have consecutive integer node labels starting from 0. The *n* leaves must be labeled 0, 1, ..., *n* - 1 in order of their appearance in the distance matrix. Labels for internal nodes may be labeled in any order but must start from *n* and increase consecutively.

Sample Input:

```
4
0    20    17    11
20   0     20    13
17   20    0     10
11   13    10    0
```

Sample Output:

```
0->5:7.000
1->6:8.833
2->4:5.000
3->4:5.000
4->2:5.000
4->3:5.000
4->5:2.000
5->0:7.000
5->4:2.000
5->6:1.833
6->5:1.833
6->1:8.833
```