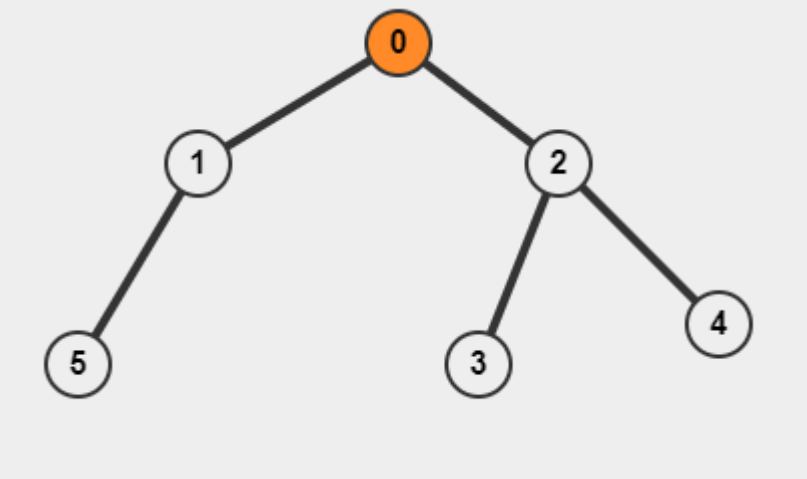
A thought before solving this problem

This problem involves a technique which might seems difficult at first, but once you get this, you will be easily able to solve similar problem.

Explanation

Let's first solve a simpler version of this problem.
Suppose we need to find the sum of distances for only root node.



Consider the tree above, with 0 as the root node.
The result for subtree with 2 as root will be 2 (we can easily count it) and for subtree 1 is 1.

This is the recurrence relation we can use to calculate the sum of distances for root.

```
res[0] = res[2] + number of nodes in subtree with root 2
        + res[1] + number of nodes in subtree with root 1

res[0] = 2 + 3 + 1 + 2 = 8
```

We are adding the number of nodes of subtree because every node in subtree will be 1 unit more far from the original root.

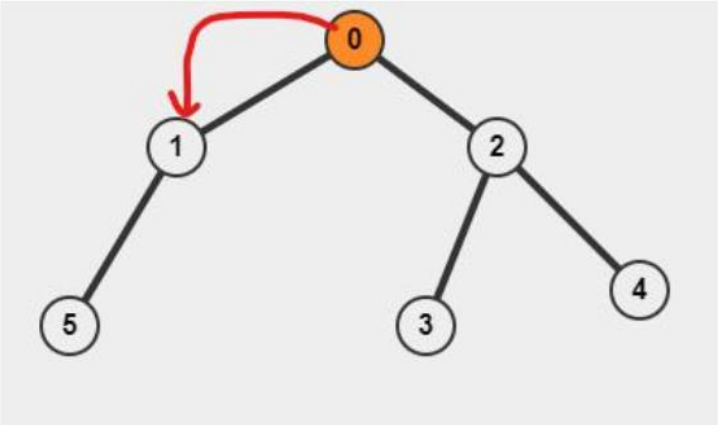
I need two arrays count and res. Count will store the number of nodes in each subtree and res will the store the answer as discussed above. Below is the code.

```
// intially count array was initialized to 0.
// count[parent] is the sum of count of its child + 1
// v is the Adjacency List
void dfs(int i, int p = -1) {
    for(auto u : v[i]) {
        if(u == p) continue;
        dfs(u, i);
        count[i] += count[u];
        res[i] += res[u] + count[u];
    }
    count[i] += 1;
}
```

The Original problem

We can run the dfs function above for every node and get the solution. This will result in **O(N * N)** time complexity. But we can do this in **O(N)** time using a technique popularly known as **re-rooting** techinque.

The idea is to derive the solution of every node by shifting the root.



Suppose we shift the root from root 0 to 1, what changes can we observe.
`count[1]` nodes got 1 unit closer to new root and `n - count[1]` nodes got 1 unit away from the new root.

So,
`res[1] = res[0] - count[1] + n - count[1]`
i.e
`res[new_root] = res[root] - count[new_root] + n - count[new_root]`

The way we are running dfs the new_root will be child and root will be parent.
Here, is the code for this part.

```
void dfs2(int i, int n, int p = -1) {
    for(auto u : v[i]) {
        if(u == p) continue;
        res[u] = res[i] - count[u] + n - count[u];
        dfs2(u, n, i);
    }
}
```

Complete Code

```
class Solution {
public:
    vector<vector<int>> v;
    vector<int> counter, res;

    void dfs(int i, int p = -1) {
        for(auto u : v[i]) {
            if(u == p) continue;
            dfs(u, i);
            counter[i] += counter[u];
            res[i] += res[u] + counter[u];
        }
        counter[i] += 1;
    }

    void dfs2(int i, int n, int p = -1) {
        for(auto u : v[i]) {
            if(u == p) continue;
            res[u] = res[i] - counter[u] + n - counter[u];
            dfs2(u, n, i);
        }
    }
```

```
    vector<int> sumOfDistancesInTree(int n, vector<vector<int>>& edges) {
        v.resize(n);
        for(int i = 0; i < n - 1; i++) {
            int a = edges[i][0];
            int b = edges[i][1];
            v[a].push_back(b);
            v[b].push_back(a);
        }
        res.resize(n);
        counter.resize(n);
        dfs(0);
        dfs2(0, n);
        return res;
    }
};
```