AE2ADS Lab 4

Reading

M. T. Goodrich, R. Tamassia and M. H. Goldwasser, *Data Structures and Algorithms in Java*, 6th Edition, 2014.

- Chapter 7. List Abstractions
- Chapter 8. Tree Structures

Exercise 1

- Implement the list ADT using an array with a fixed capacity.
- Implement the list ADT using a dynamic array and applying **incremental strategy** and **doubling strategy**.

Exercise 2

Implement the positional list ADT using a doubly-linked list.

Exercise 3

Implement the binary tree ADT using a concrete data structure and analyze the *complexity* of implemented methods.

Exercise 4

- Fibonacci numbers are defined recursively:
    - $F_0 = 0$
    - $F_1 = 1$
    - $F_i = F_{i-1} + F_{i-2}$ for $i > 1$
- Design an algorithm for calculating Fibonacci numbers, and analyze its complexity

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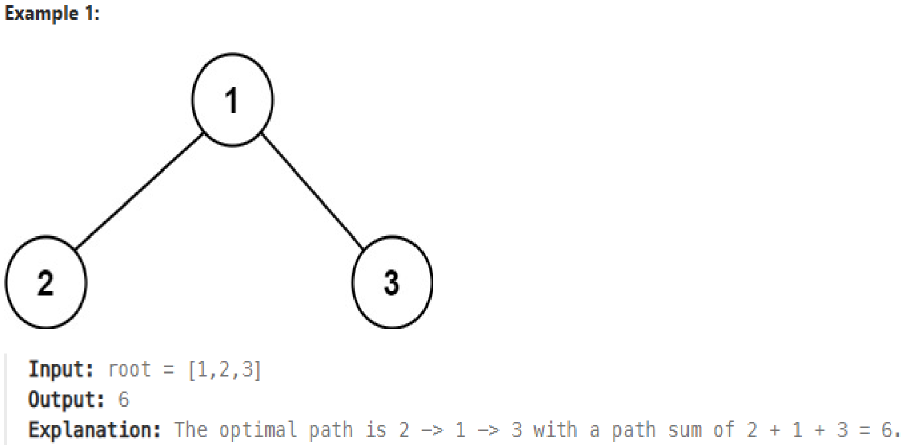
Algorithm BinaryFib($k$):
    Input: A nonnegative integer $k$
    Output: The $k$th Fibonacci number $F_k$
```

How to visualize the process of calculation of Fibonacci Numbers?

Exercise 5

- A path in a binary tree is a sequence of nodes where each pair of adjacent nodes in the sequence has an edge connecting them. A node can only appear in the sequence at most once. Note that the path does not need to pass through the root.
- The path sum of a path is the sum of the node's values in the path.
- Given the root of a binary tree, return the maximum path sum of any non-empty path.



Example 1:

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Input: root = [1,2,3]
Output: 6
Explanation: The optimal path is 2 -> 1 -> 3 with a path sum of 2 + 1 + 3 = 6.
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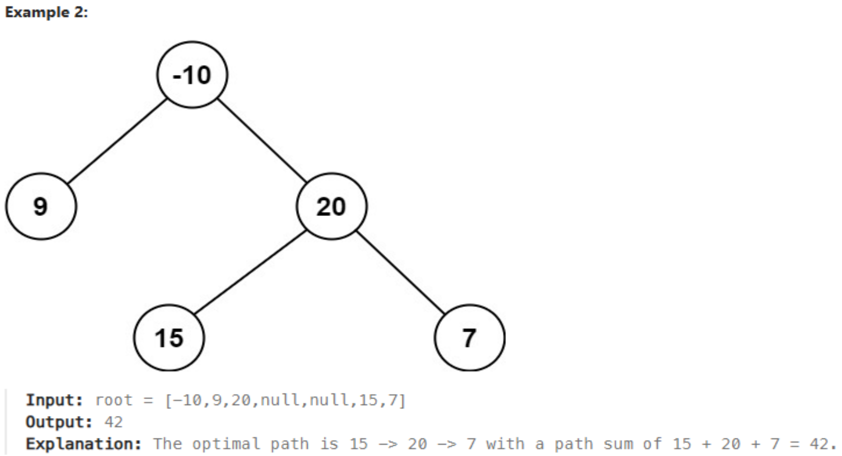

Example 2:

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Input: root = [-10,9,20,null,null,15,7]
Output: 42
Explanation: The optimal path is 15 -> 20 -> 7 with a path sum of 15 + 20 + 7 = 42.
```

Exercise 6

You are given a rooted tree consisting of n vertices. Vertices are numbered from 1 to n . Any vertex can be the root of a tree.

A tree is a connected undirected graph without cycles. A rooted tree is a tree with a selected vertex, which is called the root.

The tree is specified by an array of parents p containing n numbers: p_i is a parent of the vertex with the index i. The parent of a vertex u is a vertex that is the next vertex on the shortest path from u to the root. For example, on the simple path from 5 to 3 (the root), the next vertex would be 1 , so the parent of 5 is 1 .

The root has no parent, so for it, the value of p_i is i (the root is the only vertex for which $p_i = i$).

Find such a set of paths that:

- each vertex belongs to exactly one path, each path can contain one or more vertices;
- in each path each next vertex — is a son of the current vertex (that is, paths always lead down — from parent to son);
- number of paths is minimal.

https://www.luogu.com.cn/problem/CF1675D

Exercise 7

Vlad and Nastya live in a city consisting of n houses and $n-1$ road. From each house, you can get to the other by moving only along the roads. That is, the city is a tree.

Vlad lives in a house with index x , and Nastya lives in a house with index y . Vlad decided to visit Nastya. However, he remembered that he had postponed for later k things that he has to do before coming to Nastya. To do the i -th thing, he needs to come to the a_i -th house, things can be done in any order. In 1 minute, he can walk from one house to another if they are connected by a road.

Vlad does not really like walking, so he is interested what is the minimum number of minutes he has to spend on the road to do all things and then come to Nastya. Houses $a_1, a_2, \dots, a_k$ he can visit in any order. He can visit any house multiple times (if he wants).

https://www.luogu.com.cn/problem/CF1675F