Algorithms

Binary Search Homework 1

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Problem #1: LeetCode 34. Find First and Last Position of Element in Sorted Array

Although the basic idea of binary search is comparatively straightforward, the details can be surprisingly tricky — **Donald Knuth**

- Given an array of integers **sorted** in ascending order:
  - Find the starting and ending position of a given target value.
  - If target is not found in the array, return [-1, -1].
- vector<int> searchRange(vector<int> &v, int target)
  - Return 2 values in the vector
  - First, Implement this using your own binary search
  - Another solution should be based on C++ STL

Examples

Example 1:

```
Input: nums = [5,7,7,8,8,10], target = 8
Output: [3,4]
```

Example 2:

```
Input: nums = [5,7,7,8,8,10], target = 6
Output: [-1,-1]
```

Example 3:

```
Input: nums = [], target = 0
Output: [-1,-1]
```

Problem #2: LeetCode 436 - Find Right Interval

You are given an array of `intervals`, where `intervals[i] = [start_i, end_i]` and each `start_i` is **unique**.

The **right interval** for an interval `i` is an interval `j` such that `start_j >= end_i` and `start_j` is **minimized**.

Return *an array of **right interval** indices for each interval* `i`. If no **right interval** exists for interval `i`, then put `-1` at index `i`.

- vector<int> findRightInterval(vector<vector<int>>& intervals)
  - Intervals.length >= 1
  - intervals[i].length == 2 (that is each element is 2 values in a vector)
  - starti <= endi. Values can be negative
  - The start point of each interval is **unique**.
- Develop
  - Develop solution based on your own binary search
  - Develop solution based on STL binary search
  - Optional: Develop solution based on STL **map** lower_bound

Example 1:

```
Input: intervals = [[1,2]]
Output: [-1]
Explanation: There is only one interval in the collection, so it outputs -1.
```

Example 2:

```
Input: intervals = [[3,4],[2,3],[1,2]]
Output: [-1,0,1]
Explanation: There is no right interval for [3,4].
The right interval for [2,3] is [3,4] since start0 = 3 is the smallest start that is >= end1 = 3.
The right interval for [1,2] is [2,3] since start1 = 2 is the smallest start that is >= end2 = 2.
```

Example 3:

```
Input: intervals = [[1,4],[2,3],[3,4]]
Output: [-1,2,-1]
Explanation: There is no right interval for [1,4] and [3,4].
The right interval for [2,3] is [3,4] since start2 = 3 is the smallest start that is >= end1 = 3.
```

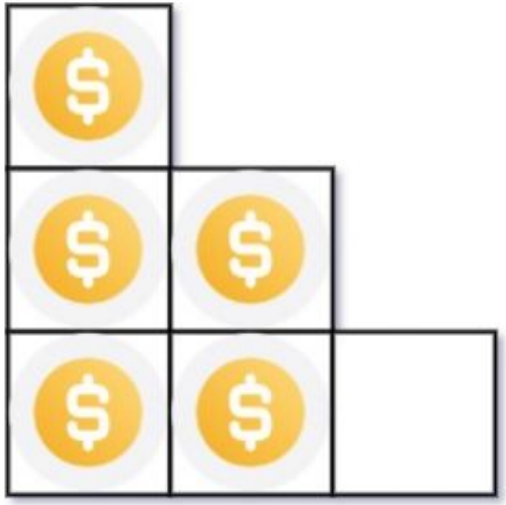
Problem #3: LeetCode 611 - Valid Triangle Number

- Given an integer array, return the number of **triplets** that can make triangles if we take them as side lengths of a triangle.
- Recall: Given 3 sides of a triangle (a, b, c), the triangle is valid IFF the **sum of any two sides** should always be **greater than the third side**
  - a+b > c and a+c > b, and b+c > a
- Input ⇒ Output
  - [2,2,3,4] ⇒ 3 (2,3,4), (2,3,4), (2,2,3)
  - [4,2,3,4] ⇒ 4
- int triangleNumber(vector<int> &nums)
  - Develop solution based on your own binary search
  - Develop solution based on STL binary search
  - Optional: Can you optimize your code by removing the binary search?

Problem #4: LeetCode 441 - Arranging Coins

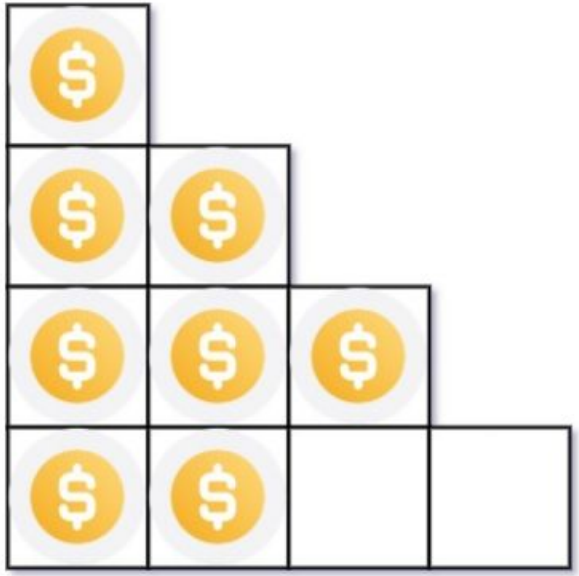
- You have n coins and you want to build a staircase with these coins.
  - The staircase consists of k rows where the ith row has exactly i coins.
  - The last row of the staircase may be **incomplete**.
  - Given the integer n, return the **number of complete rows** of the staircase you will build.
- int arrangeCoins(int n)
  - $1 <= n <= 2^{31} - 1$
- Note:
  - In this simple problem, try to **generalize** the binary search algorithm
  - In the next lecture, we will explain this problem

Example 1:



Input: n = 5
Output: 2
Explanation: Because the 3rd row is incomplete, we return 2.

Example 2:



Input: n = 8
Output: 3
Explanation: Because the 4th row is incomplete, we return 3.

"Acquire knowledge and impart it to the people."

"Seek knowledge from the Cradle to the Grave."