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Interview Questions

Leetcode – 164. Maximum Gap

Posted on Jun 4 by Deepanshu Jain

Given an integer array nums, return the maximum difference between two successive elements in their sorted form. If the array contains less than two elements, return 0.

You must write an algorithm that runs in linear time and you can linear extra space.

Example 1:

```
Input: nums = [3,6,9,1]
Output: 3
Explanation: The sorted form of the array is
[1,3,6,9], either (3,6) or (6,9) has the maximum
difference 3.
```

Example 2:

```
Input: nums = [10]
Output: 0
Explanation: The array contains less than 2 elements,
therefore return 0.
```

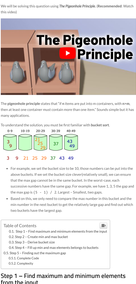
Constraints:

- 1 <= nums.length <= 10^5
- 0 <= nums[i] <= 10^9

Solution:

The main problem is we can't sort the array as it will take n log(n) complexity, but as asked we can't do that.

We will be solving this using the **The Pigeonhole Principle**. **Discovered**by Walsh this called



> For example, we are left the bucket size is size 10, these numbers can be put into the above buckets. If we set the bucket size (heretofore) smaller, we can ensure that the max gap, must be found in the same bucket. In the worst case, each successive numbers have the same gap. For example, we have 1, 3, 5 the gap and the max gap is (5 - 1) / 2 = 2 apart . Smallest, first gaps.
>
> Based on this, we only need to compare the max number in this bucket and the min number in the next bucket to get the relatively large gap and find out which two buckets have the largest gap.

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Step 1 – Find maximum and minimum elements from the input

```
Java
int min = nums[0];
int max = nums[0];
for(int num:nums){
    min = Math.min(num, min);
    max = Math.max(num, max);
}
```

Step 2 – Create min and max bucket

```
Java
int[] minBucket = new int[n];
int[] maxBucket = new int[n];

Arrays.fill(minBucket, Integer.MIN_VALUE);
Arrays.fill(maxBucket, Integer.MIN_VALUE);
```

Step 3 – Derive bucket size

```
Java
int bucketSize = (int)Math.ceil((double)(max-min)/(n - 1));
```

Step 4 – Fill up min and max elements belongs to buckets

As we can't have the maximum gap lies in the same bucket (because of maximum gap we can have is bucketSize-1), so we will be maintaining only min and max elements in the respective buckets.

```
Java
for(int num:nums){
    int bucketIndex = (num-min) / bucketSize;
    minBucket[bucketIndex] = Math.min(num,minBucket[bucketIndex]);
    maxBucket[bucketIndex] = Math.max(num,maxBucket[bucketIndex]);
}
```

Step 5 – Finding out the maximum gap

```
Java
int maxGap = 0;
int previous = minBucket[0];

for(int i=1;i<n;i++){
    if(maxBucket[i] == Integer.MIN_VALUE)
        continue;
    maxGap = Math.max(maxGap, minBucket[i] - previous);
    previous = maxBucket[i];
}
```

Complete Code

```
Java
class Solution {
    public int maximumGap(int[] nums) {
        int n = nums.length;

        if(n < 2)
            return 0;
        int min = nums[0];
        int max = nums[0];

        for(int num:nums){
            min = Math.min(num, min);
            max = Math.max(num, max);
        }

        if(max == min)
            return 0;

        int[] minBucket = new int[n];
        int[] maxBucket = new int[n];

        Arrays.fill(minBucket, Integer.MIN_VALUE);
        Arrays.fill(maxBucket, Integer.MIN_VALUE);

        int bucketSize = (int)Math.ceil((double)(max-min)/(n - 1));

        for(int num:nums){
            int bucketIndex = (num-min) / bucketSize;
            minBucket[bucketIndex] = Math.min(num,minBucket[bucketIndex]);
            maxBucket[bucketIndex] = Math.max(num,maxBucket[bucketIndex]);
        }

        int maxGap = 0;
        int previous = minBucket[0];

        for(int i=1;i<n;i++){
            if(maxBucket[i] == Integer.MIN_VALUE)
                continue;
            maxGap = Math.max(maxGap, minBucket[i] - previous);
            previous = maxBucket[i];
        }

        return maxGap;
    }
}
```

Complexity

Time complexity: O(n)

Space complexity: O(n)

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