Class-3 Agenda

- Binary Search:
    - Search in a sorted and rotated array
    - Allocate the minimum number of pages

Hashing

- Characteristics of a problem where hashing has to be used:
    - Search, Insert, Delete = O(1) avg.
    - Any subset of these operations
    - No other data structure with this much low time complexity
- Hashing in java/C++:
    - Java
        - HashMap
        - HashSet
    - C++
        - Unordered_map
        - Unordered_set
- Self Balancing BSTs
    - Java
        - TreeMap
        - TreeSet
    - C++
        - Set
        - map
- Hashing theory:
    - ID from 0 to n-1, use an array to create the hashmap
    - But what if n is too large?
    - Take input ‘key’ and convert it into an integer value
    - hash-function(key) → integer
    - General hash-function:
        - HashFunction(key) = key % prime_no;
        - Example:
          70,17,12,7,15…
          HF(key) = key%7
          Collision 7 & 70

Problems (Arrays + Hashing):

Subarray with 0 sum

- Brute
- Hashing

Subarrays with equal 1s and 0s

- Hashing

Search in a sorted and rotated array

Given a sorted and rotated array A of N distinct elements which is rotated at some point, and given an element key. The task is to find the index of the given element key in the array A.

Example 1:

```
Input:
N = 9
A[] = {5, 6, 7, 8, 9, 10, 1, 2, 3}
key = 10
Output:
5
Explanation: 10 is found at index 5.
```

Example 2:

```
Input:
N = 4
A[] = {3, 5, 1, 2}
key = 6
Output:
-1
```

Allocate minimum number of pages
You are given **N** number of books. Every ith book has **Ai** number of pages.

You have to allocate contiguous books to **M** number of students. There can be many ways or permutations to do so. In each permutation, one of the **M** students will be allocated the maximum number of pages. Out of all these permutations, the task is to find that particular permutation in which the maximum number of pages allocated to a student is **minimum** of those in all the other permutations and print this minimum value.

Each book will be allocated to exactly one student. Each student has to be allocated at least one book.

```
Input:
N = 4
A[] = {12,34,67,90}
M = 2
Output:
113
Explanation:
Allocation can be done in following ways:
{12} and {34, 67, 90} Maximum Pages = 191
{12, 34} and {67, 90} Maximum Pages = 157
{12, 34, 67} and {90}  Maximum Pages =113
Therefore, the minimum of these cases is
113, which is selected as the output.
```

Input: [10, 20, 10, 30], M = 2
Output: 40

Subarray With Zero Sum

Given an array of positive and negative numbers. Find if there is a **subarray** (of size at-least one) with **0 sum**.

Example 1:

```
Input:
5
4 2 -3 1 6

Output:
Yes

Explanation:
2, -3, 1 is the subarray
with sum 0.
```

Example 2:

```
Input:
5
4 2 0 1 6

Output:
Yes

Explanation:
0 is one of the element
in the array so there exist a
subarray with sum 0.
```

Subarrays With Equal 1s and 0s

Given an array containing 0s and 1s. Find the number of subarrays having equal number of 0s and 1s.

Example 1:

```
Input:
n = 7
A[] = {1,0,0,1,0,1,1}
Output: 8
Explanation: The index range for the 8
sub-arrays are: (0, 1), (2, 3), (0, 3), (3, 4),
(4, 5) ,(2, 5), (0, 5), (1, 6)
```

Example 2:

```
Input:
n = 5
A[] = {1,1,1,1,0}
Output: 1
Explanation: The index range for the
subarray is (3,4).
```