Solution: Two City Scheduling

Let's solve the Two City Scheduling problem using the Greedy pattern.

We'll cover the following

Statement

A recruiter plans to hire n people and conducts their interviews at two different locations of the company. He evaluates the cost of inviting candidates to both these locations. The plan is to invite 50% at one location, and the rest at the other location, keeping costs to a minimum.

We are given an array, `costs`, where $costs[i] = [aCost_i, bCost_i]$, the cost of inviting the i^{th} person to City A is $aCost_i$, and the cost of inviting the same person to City B is $bCost_i$.

You need to determine the minimum cost to invite all the candidates for the interview such that exactly $n/2$ people are invited in each city.

Constraints:

- $2 \leq$ `costs.length` ≤ 100
- `costs.length` is even
- $1 \leq aCost_i, bCost_i \leq 1000$

Solution

Let's take an example to understand the solution to this problem. Given the `costs` array $[[100, 10], [1000, 10], [500, 50], [100, 1]]$, we want to invite half the people to City A and the other half to City B. We can see that inviting the first person and the fourth person to City A and the second and the third person to City B minimizes the cost to $100 + 100 + 50 + 10 = 260$.

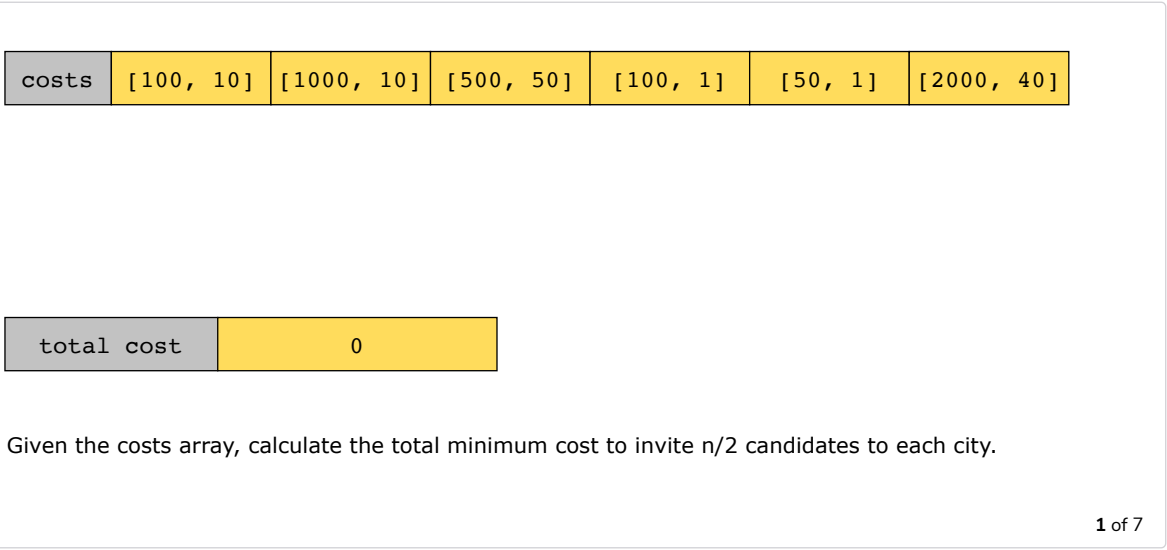
Let's take the difference of all city pairs ($aCost_i - bCost_i$) $[90, 990, 450, 99]$. If we sort our cost array based on these differences ([90, 99, 450, 990]), then the cost array will be $[[100, 10], [100, 1], [500, 50], [1000, 10]]$. Now, if we invite the first half of the array to City A and the next half to City B, then the cost is minimized to $100 + 100 + 50 + 10 = 260$.

This algorithm uses a greedy approach that chooses the minimum cost for inviting a person to a city based on the difference between the cost of inviting them to City A and City B. The idea behind this is that if the cost difference is large, inviting a person to a city with a lower cost is optimal, because the difference is large. After sorting the array based on difference, the costs with large differences will be in the second half of the array. When the difference is large, it means the second value will be much less than the first value in the `costs` array. Therefore, we are inviting the second half to City B for optimization.

The steps of the solution according to the above-mentioned methodology are given below:

1. Declare a variable, `total_cost`, initialized to `0`.
2. Sort the `costs` array in ascending order based on the difference between the cost of sending a person to City A versus sending the same person to City B.
3. Iterate over the sorted `costs` array to calculate the minimum costs required to send $n/2$ people to each city. We will perform the following steps:
    - For the first $n/2$ elements in the `costs` array, add aCosti to the total cost for inviting candidates to City A.
    - For the remaining $n/2$ elements in the `costs` array, add bCosti to the total cost for inviting candidates to City B.
4. Return the total minimum cost after traversing the `costs` array.

Let's look at the following illustration to get a better understanding of the solution:

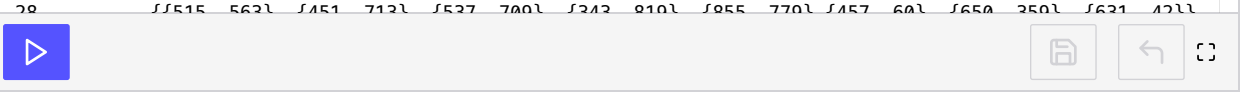


Let's look at the code for this solution:

Java

```java
import java.util.*;

class TwoCityScheduling {
    public static int twoCityScheduling(int[][] costs) {
        // Initialize the total cost to 0
        int totalCost = 0;

        // Sort the costs array in ascending order based on the difference
        // between the costs of sending someone to city A vs city B
        Arrays.sort(costs, (a, b) -> (a[0] - a[1]) - (b[0] - b[1]));

        // Get the length of the costs array
        int costLength = costs.length;

        // For each pair of cities, add the cost of sending one person to city A
        // and the other person to city B to the total cost
        for (int i = 0; i < costLength / 2; i++) {
            totalCost += costs[i][0] + costs[costLength - i - 1][1];
        }

        return totalCost;
    }

    public static void main(String[] args){
        int[][][] inputCosts = {{{10, 20}, {30, 200}, {400, 50}, {30,20}},
```

```
27          {{259,770}, {448,54}, {926,667}, {184,139}, {840,118}, {577,469}},
28          {{515,563}, {451,713}, {537,709}, {343,819}, {855,779}, {457,60}, {650,359}, {631,42}}
```



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Time complexity

We only traverse the array once but since we use sorting, the time complexity of the solution becomes $O(n \log n)$.

Space complexity

In Java, the sorting algorithm takes $O(n)$ space to sort the `costs` array. Therefore, the space complexity of the above solution is $O(n)$.

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