

Gas Station Problem Documentation

Problem Statement

You are given n gas stations along a circular route, where the amount of gas at the i -th station is $gas[i]$. You have a car with an unlimited gas tank, but it costs $cost[i]$ of gas to travel from the i -th station to the next $(i + 1)$ -th station. You begin the journey with an empty tank at one of the gas stations.

Given two integer arrays `gas` and `cost`, your task is to return the starting gas station's index if you can travel around the circuit once in the clockwise direction. If it is not possible to complete the circuit, return `-1`. If there is a solution, it is guaranteed to be unique.

Example 1

Input:

`gas = [1, 2, 3, 4, 5]`

`cost = [3, 4, 5, 1, 2]`

Output: 3

Explanation:

- Start at station 3 (index 3) and fill up with 4 units of gas. Your tank = $0 + 4 = 4$.
- Travel to station 4. Your tank = $4 + 1 - 5 = 0$.
- Travel to station 0. Your tank = $0 + 2 - 3 = -1$.
- Travel to station 1. Your tank = $-1 + 3 - 4 = -2$.
- Travel to station 2. Your tank = $-2 + 4 - 5 = -3$.
- Travel to station 3. The cost is 5. Your gas is just enough to travel back to station 3.
- Therefore, return 3 as the starting index.

Example 2

Input:

gas = [2, 3, 4]

cost = [3, 4, 3]

Output: -1

Explanation:

- You can't start at station 0 or 1, as there is not enough gas to travel to the next station.
- Let's start at station 2 and fill up with 4 units of gas. Your tank = $0 + 4 = 4$.
- Travel to station 0. Your tank = $4 - 3 + 2 = 3$.
- Travel to station 1. Your tank = $3 - 4 + 3 = 2$.
- You cannot travel back to station 2, as it requires 4 units of gas but you only have 2.
- Therefore, you can't travel around the circuit once no matter where you start.

Constraints

- $n == \text{gas.length} == \text{cost.length}$
- $1 \leq n \leq 10^5$
- $0 \leq \text{gas}[i], \text{cost}[i] \leq 10^4$

Approach

The problem can be solved using a greedy approach. The idea is to:

1. Calculate the total gas and total cost for the entire trip. If the total gas is less than the total cost, it's impossible to complete the circuit.

2. If the total gas is sufficient, find the starting gas station:

- Initialize total_tank and current_tank to 0.
 - Iterate through each gas station and update the total_tank and current_tank by adding the difference between gas[i] and cost[i].
 - If at any point current_tank becomes negative, it means you cannot reach the next station from the current starting station. Update the starting station to the next station and reset current_tank to 0.
3. If after iterating through all stations, the total_tank is non-negative, the starting station is the valid starting point. Otherwise, return -1.

Solution Explanation

The provided solution implements the above approach. Here is a breakdown of the logic:

1. Initialize total_tank, current_tank, and start_station to 0.

2. Iterate through each station:

- Update total_tank and current_tank with the difference between gas[i] and cost[i].
- If current_tank becomes negative, update start_station to the next station and reset current_tank to 0.

3. After the loop, check if total_tank is non-negative:

- If true, return start_station as the starting point.
- If false, return -1 indicating that completing the circuit is impossible.