Data Structures 2

Assignment 2

Implementing Perfect Hashing

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Time & Space Complexity Analysis:

1. 0(N) Space Solution

Time Complexity:

- Best Case: **O(1)**

  No collisions in the first-level hash table.

- Average Case: **O(1)**

  Some collisions in the first-level hash table but they are evenly distributed across the bins.

- Worst Case: **O(n)**

  when there are many collisions in the first-level hash table, resulting in a large number of elements needing to be rehashed in the secondlevel hash tables.

Advantages:

- Low Collision Probability: By using universal hashing at the first level and rehashing with Method 1 at the second level, the probability of collisions is reduced, leading to better performance.

- Flexibility: The scheme allows for the use of different hash functions at both levels, providing flexibility in designing the hashing strategy.

Disadvantages:

The worst-case time complexity of O(N) can be a significant drawback if the hash function at the first level produces poor distribution of elements, leading to many collisions.

2. 0(N^2) Space Solution

Time Complexity:

- Best Case: **O(n)**

  when the first randomly chosen hash function results in no collisions.

- Average Case: **O(n)**

  when the first randomly chosen hash function results in some collisions, but a new hash function chosen randomly from the universal hash function family results in minimal collisions.

- Worst Case: **O(n^2)**

  when every randomly chosen hash function results in a significant number of collisions, requiring many attempts to find a suitable hash function.

Advantages:

- Adaptability: The method is flexible and can adapt to different sizes of dictionaries by adjusting the size of the hash table based on the square of the dictionary size.
- Space efficiency: This method allows for the creation of a hash table with a size that is quadratic in the size of the dictionary.

Disadvantages:

- The worst-case time complexity of O(N^2) can be a significant drawback, especially for large dictionaries. In the worst-case scenario, a large number of hash functions may need to be tried before finding one with minimal collisions.

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- Comparison between the 2 perfect hashing techniques w.r.t

1. **Mean Batch Insertion Time:**

No. of elements	$O(N^2)$	O(N)
10	3 ms	1 ms
100	3 ms	3 ms
1000	9 ms	13 ms
10000	67 ms	95 ms
100000	595 ms	590 ms
1000000	60 sec	57 sec 794 ms

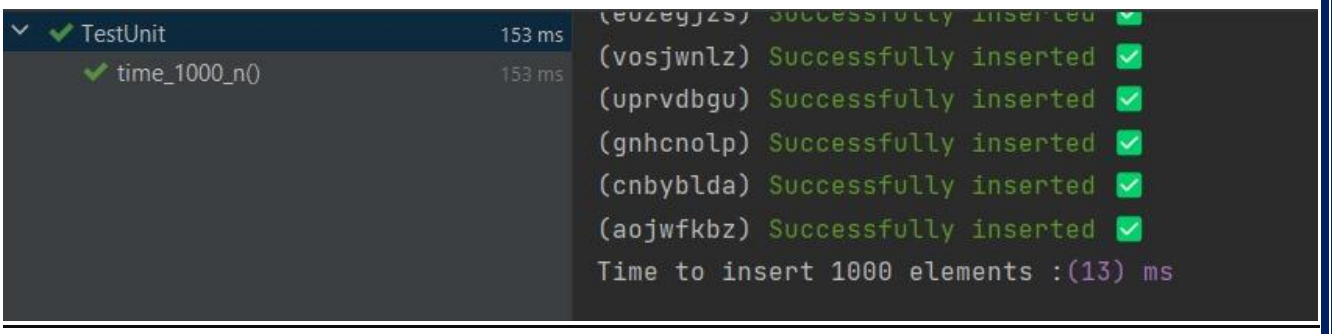
2. **Rehash Time:**

No. of elements	$O(N^2)$	O(N)
10	0 ms	0 ms
100	1 ms	0 ms
1000	83 ms	50 ms
10000	101 ms	88 ms
100000	196 ms	150 ms
1000000	254 ms	212 ms

3. **Mean Element Insert Time:**

No. of elements	$O(N^2)$	O(N)
10	1 ms	0 ms
100	6 ms	4 ms
1000	131 ms	101 ms
10000	230 ms	185 ms
100000	590 ms	502 ms
1000000	2 sec	1 sec 394 ms

JUnit test:


TestUnit 153 ms
time_1000_n() 153 ms
(vosjwnlz) Successfully inserted
(uprvdbgu) Successfully inserted
(gnhcnolp) Successfully inserted
(cnbyblda) Successfully inserted
(aojwfkbz) Successfully inserted
Time to insert 1000 elements :(13) ms