SWE210- Data Structures and Algorithms - Fall 2025
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Data Structures

Lab# 10

Hash Table

Example 9-2 from reference:

Suppose there are six students a_1, a_2, a_3, a_4, a_5, a_6 in the Data Structures class and their IDs are a_1: 197354863; a_2: 933185952; a_3: 132489973; a_4: 134152056; a_5: 216500306; and a_6: 106500306.

Let $k_1 = 197354863$, $k_2 = 933185952$, $k_3 = 132489973$, $k_4 = 134152056$, $k_5 = 216500306$, and $k_6 = 106500306$.

Suppose that HT denotes the hash table and HT is of size 13 indexed 0, 1, 2, ..., 12.

Define the function h: $\{k_1, k_2, k_3, k_4, k_5, k_6\} \rightarrow \{0, 1, 2, \ldots, 12\}$ by $h(k_i) = k_i \% 13$. (Note that % denotes the mod operator.)

Now

$h(k_1) = h(197354863) = 197354863 \% 13 = 4$	$h(k_4) = h(134152056) = 134152056 \% 13 = 12$
$h(k_2) = h(933185952) = 933185952 \% 13 = 10$	$h(k_5) = h(216500306) = 216500306 \% 13 = 9$
$h(k_3) = h(132489973) = 132489973 \% 13 = 5$	$h(k_6) = h(106500306) = 106500306 \% 13 = 3$

Suppose $HT[b] \leftarrow a$ means "store the data of the student with ID a into $HT[b]$." Then

$HT[4] \leftarrow 197354863$	$HT[5] \leftarrow 132489973$	$HT[9] \leftarrow 216500306$
$HT[10] \leftarrow 933185952$	$HT[12] \leftarrow 134152056$	$HT[3] \leftarrow 106500306$

Practice Questions:

1. Assume a hash table with 7 locations and the hashing function h(i) = i % 7. Show the hash table that results when the integers are inserted in the order given.
    a. 5, 11, 18, 23, 28, 13, 25, with collisions resolved **using linear probing**.
    b. 5, 11, 18, 23, 28, 13, 25, with collisions resolved **using quadratic probing**.
    c. 5, 11, 18, 23, 28, 13, 25 with collisions resolved **using chaining**.

2. Using a hash table with eleven locations and the hashing function h(i) = i % 11, show the hash table that results when the following integers are inserted in the order given: 26, 42, 5, 44, 92, 59, 40, 36, 12, 60, 80.
   Assume that collisions are resolved using linear probing.

3. Repeat Question 2, but assume that collisions are resolved using quadratic probing.

4. Repeat Question 2, but use double hashing to resolve collisions with the following secondary hash function:

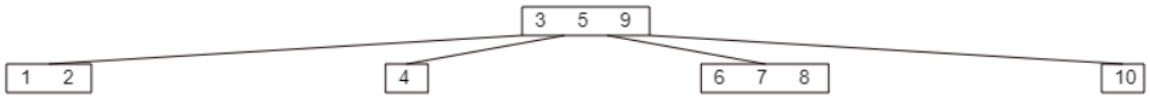
   h2(x) = 2x % 11 "if this is nonzero"
   = 1 "otherwise"

5. Repeat Question 2, but assume that collisions are resolved using chaining.

2-3-4 Tree:

Example: Insert the following nodes in a 2-3-4 Tree: 3, 1, 5, 4, 2, 9, 10, 8, 7, 6.

2-3-4 Tree:



1. Draw the 2-3-4 Tree that results when the values are inserted in the order given:
    a. 99, 88, 77, 66, 55, 44, 33, 22, 1
    b. 55, 66, 77, 88, 99, 11, 22, 33, 44