

CMPT 280

Topic 15: Hash Tables

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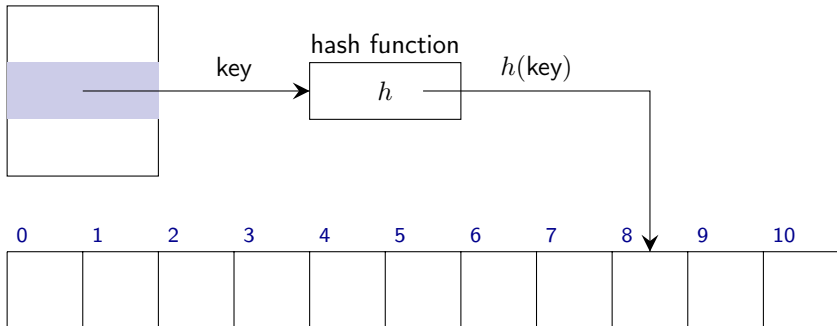
References

- Textbook, Chapter 15

Hash Tables

Basic idea:

keyed data item



Hashing Functions

- For integers: $h_{\text{int}}(k) = k \bmod N$
- For floats: $h_{\text{float}}(k) = h_{\text{int}}(\text{round}(k))$
- For strings: $h_{\text{string}}(k) = (\sum_i k[i]) \bmod N$

Exercise 1

Let $N = 12$. Using the appropriate hash functions on the previous slide,

- (a) Determine the hash values of the keys: 7, 9, 26, 48
- (b) Determine the hash values of the keys: 9.7, 13.7
- (c) Determine the hash values of the keys: "ABC", "123".
(the ASCII value of 'A' is 65; the ASCII value of '1' is 49)

Exercise 2

Using the appropriate hash function from the earlier slide, insert items with keys 42, 27, 69, 78, and 7 into the following hash table array:

0	1	2	3	4	5	6	7	8

(a) using linear probing for collision resolution; $p(j) = j$

(b) using quadratic probing for collision resolution;

$$p(j) = (-1)^{i-1} \left(\frac{i+1}{2} \right)^2$$

(c) using double hashing; $p(j) = h_2(k) \cdot j$,

$$h_2(k) = k \bmod 7 + 1$$

Exercise 3

0	1	2	3	4	5	6	7	8
27	7	11	12			42	69	78

How many probes are required to perform a search for each of the keys: 27, 78, 12, and 87 using linear probing?

Exercise 4

0	1	2	3	4	5	6	7	8
27		11	12	69		42	7	78

- What is the load factor of the hash table pictured above?
- How many probes are required to perform a search for each of the keys: 78, 11, and 87 using double hashing (again using $p(j) = h_2(k) \cdot j$, and $h_2(k) = k \bmod 7 + 1$).

Exercise 5

- Draw a diagram representing the structure of a hash table with separate chaining with $N = 10$ after the insertion of items 27, 11, 91, 77, 42, 202, and 7.
- What is the load factor of the hash table?

Exercise 6

In a hash table that uses separate chaining, what is the average number of items that will be examined when searching for a key if the load factor of the hash table is:

- (a) 2?
- (b) 5?
- (c) an integer n ?
- (d) What is the time complexity of searching this hash table in the average case?
- (e) What is the time complexity of searching this hash table in the worst case?
- (f) What is the time complexity of searching this hash table in the best case?

Exercise 7

For a hash table that uses separate chaining:

- (a) What is the time complexity for insertion in the worst case?
best case?
- (b) What is the time complexity for deletion in the average case?
worst case? best case?

Next Class

- Next class reading: Chapter 16: 2-3 trees.