CMPT 280

Topic 15: Hash Tables

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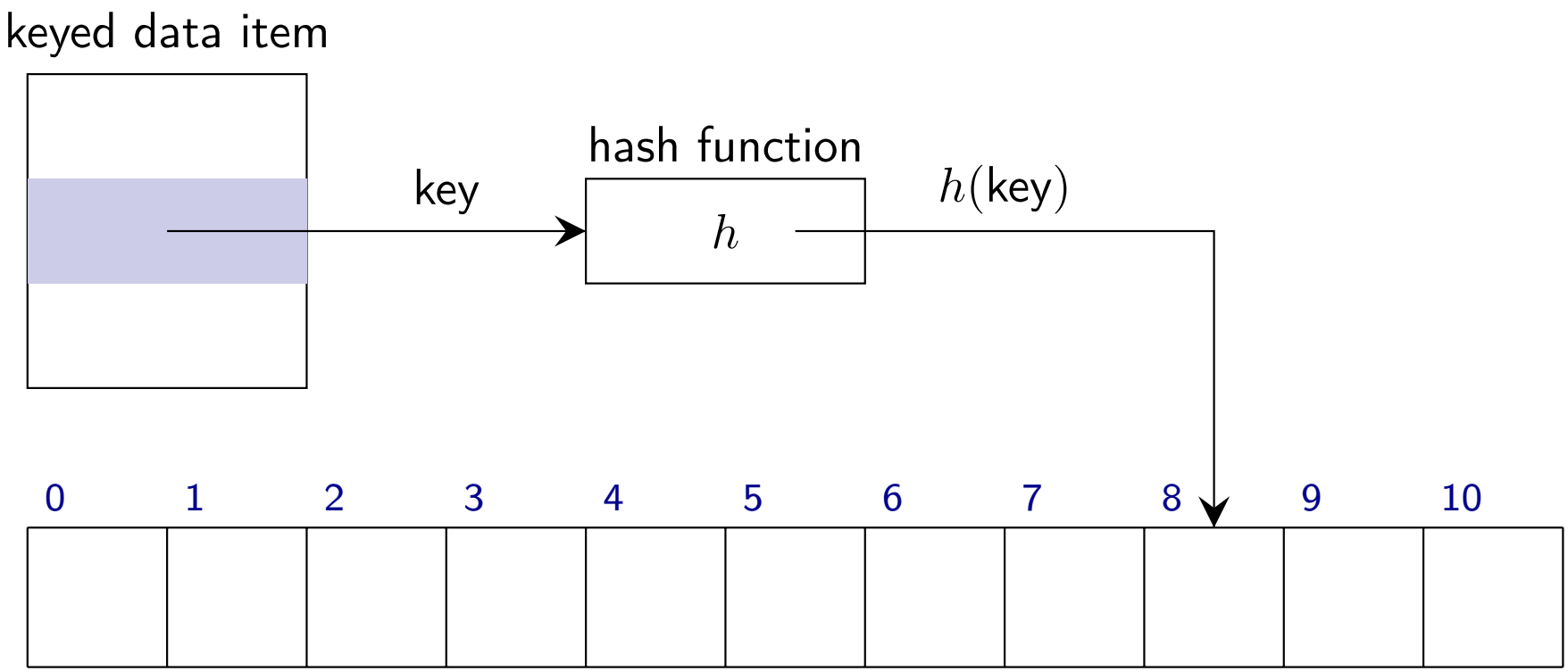
References

- Textbook, Chapter 15

Hash Tables

Basic idea:



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,

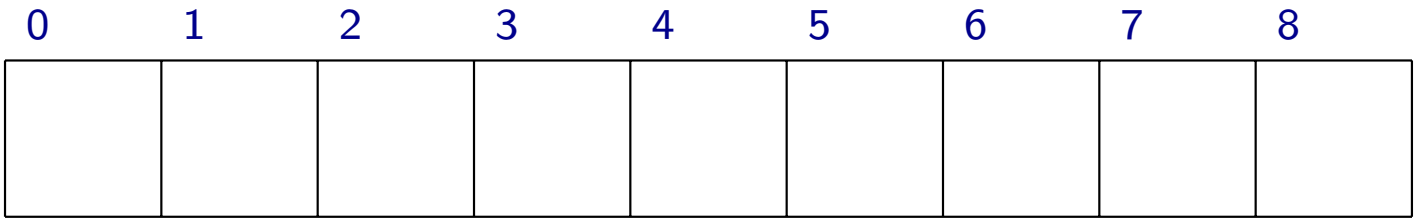
(a) Determine the hash values of the keys: 7, 9, 26, 48

(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:

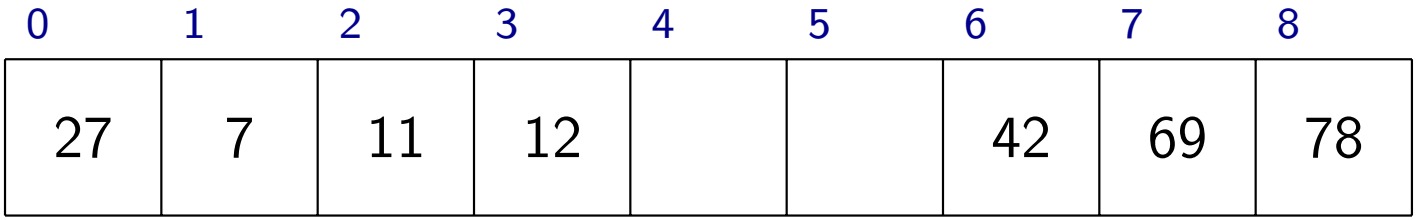


(a) using linear probing for collision resolution; $p(j) = j$

(b) using quadratic probing for collision resolution;
$p(j) = (-1)^{j-1} \left(\frac{j+1}{2}\right)^2$

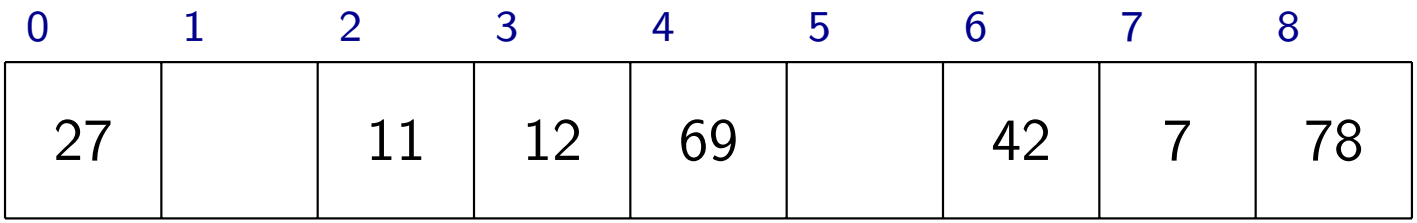
(c) using double hashing; $p(j) = h_2(k) \cdot j$,
$h_2(k) = k \bmod 7 + 1$

Exercise 3



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

Exercise 4



- 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.