CS 32: Discussion 1D

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Announcements

- Homework 5 due 11 pm Thursday (June 3rd)
- Project 4 due 11 pm Wednesday (June 9th)

Overview

- Hash Tables
- Heap
  - Heap sort

Hash Tables

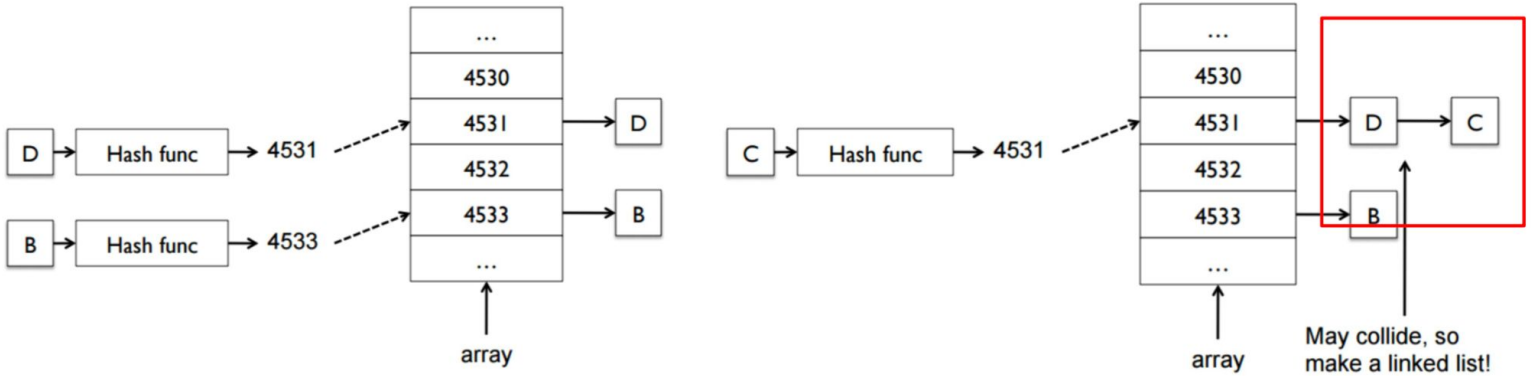
- Hash functions: Take a “key” and map it to a number
- Requirement for hash function: should return the same value for the same key
- Good hash functions:
  - Spreads out the values: two different key are likely to results in different hash values. → Avoid confliction
  - Compute each value quickly.
- Example: FNV-1


```
unsigned int FNV-1(string s) {
  unsigned int h = 2166136261U;
  for (int k = 0; k != s.size(); k++)
  {
    h += s[k];
    h *= 16777619;
  }
  return h;
}
```

Hash Tables: collision

- Example: Use a hash table to store people.
- Use a linked list to collision in the hash function.

*"You should almost **NEVER** assume that collisions are impossible!!!" --David Smallberg*



Hash Tables: operations

- Insert
- Remove
- Search

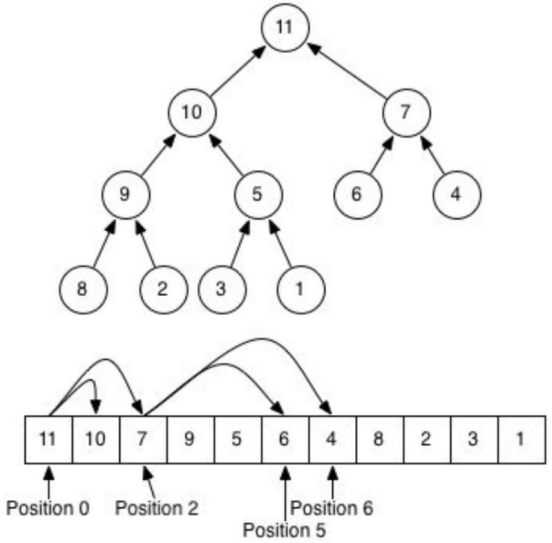
- The complexity depends on your hash tables.
- Closed Hashing
  - Fixed number of buckets
  - All operations are O(n) with a small constant of proportionality
- Open Hashing
  - Consider *#entries / #buckets*
  - Almost O(1) for all operations

Heap: definition and properties

- About heap
  - Heap is considered as complete binary tree.
  - Every nodes carries a value greater than or equal to its children (for MaxHeap).
  - Often implemented as an array.
  - Body structure of priority queue.

Stack

Heap

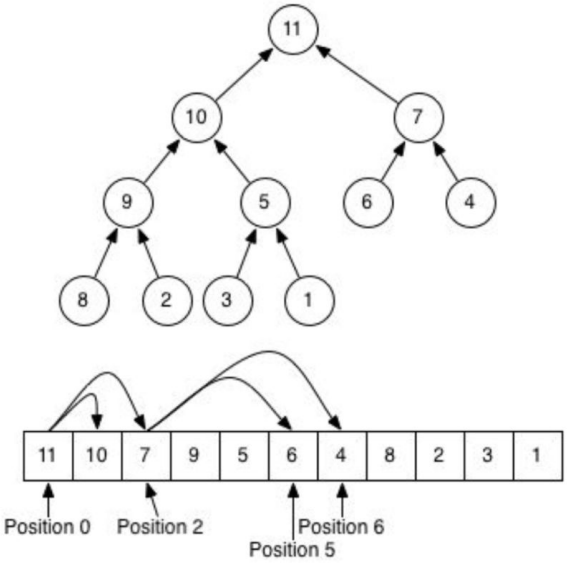


How would you build a MinHeap?

Heap: standard operations

- Three operations of heaps
  - Find Max (search)
  - Insert Node (insert)
  - Delete Max (delete)

- How to implement `FindMax()` function of a heap?
  - Well, that is just too obvious!



Heap: standard operations

- Find Max →
- Insert →
- Delete Max Node →

Heap: standard operations

- Find Max → $O(1)$
- Insert → $O(\log n)$
- Delete Max Node → $O(\log n)$

- Bonus: How can you sort based on heap?

Heap: standard operations

- Find Max → $O(1)$
- Insert → $O(\log n)$
- Delete Max Node → $O(\log n)$

- Bonus: How can you sort based on heap?
  - Insert all elements into a heap.
  - Extract the maximum element from the heap one by one.

- What is the complexity of heapsort?

Heap: standard operations

- Find Max → O(1)
- Insert → O(log *n*)
- Delete Max Node → O(log *n*)

- Bonus: How can you sort based on heap?
  - Insert all elements into a heap.
  - Extract the maximum element from the heap one by one.

- What is the complexity of heapsort?
  - $O(n \log n)$

Break: 5 mins

Worksheet

Codeshare

Room 1

Room 2

Room 3

Room 4

Worksheet Solution