CS 367 - Introduction to Data Structures  
Tuesday, December 6th, 2016  

Final Exam  
- Monday, Dec 19th, 5:05 to 7:05 pm  
- UW ID required  
- See posted exam information

Program 5 due 10 pm **Thursday**, Dec 15th

Homework 10 due 10 pm **Friday Dec 9th**

Last Time  
Graphs  
- Traversal examples  
- Dijkstra’s Shortest Path algorithm and example  

Hashing  
- Concept and Terminology

Today  
Hashing  
- designing a good hash function  
- choosing table size  
- expanding a hash table  
- handling collisions  

Java Support for Hashing  
- Tree Map vs. Hash Map

Next Time  
**Read: Sorting**  
Sorting Intro  
Basic Sorts  
- bubble sort  
- insertion sort  
- selection sort  
Better Sorts  
- heap sort  
- merge sort
Resizing the Hash Table

Naïve Expand

| 30 | 17 | 88 |

Rehashing

1.

2.

Complexity
Collision Handling using Open Addressing

Open Addressing

Linear Probing

166
359
263

440 266 124 246 337 351
Collision Handling using Open Addressing

Quadratic Probing

166
359
263

| 440 | 266 | 124 | 246 | 337 | 351 |

Double Hashing

probe sequences assuming $H_k$ is index 0:

<table>
<thead>
<tr>
<th>Step size</th>
<th>Table size 10</th>
<th>Table size 11</th>
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<tbody>
<tr>
<td>2</td>
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<td>5</td>
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Collision Handling using Buckets

Buckets

Array Buckets

“Chained” Buckets

Tree Buckets
Java API Support for Hashing

hashCode method
- method of Object class
- returns an int
- default hash code is BAD - computed from object’s memory address

Guidelines for overriding hashCode:

Hashtable<K,V> and HashMap<K,V> class
- in java.util package
- implement Map<K,V> interface
  K
  V
  operations:

- constructors allow you to set
  initial capacity (default = 16 for HashMap, 11 for HashTable)
  load factor (default = 0.75)
- handles collisions with chained buckets
- HashMap only:
- Hashtable only:
<table>
<thead>
<tr>
<th>TreeMap</th>
<th>HashMap</th>
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