Running Time:
Linear Probing:
• Successful: $\frac{1}{2}(1 + \frac{1}{(1-\alpha)})$
• Unsuccessful: $\frac{1}{2}(1 + \frac{1}{(1-\alpha)})^2$

Double Hashing:
• Successful: $\frac{1}{\alpha} \cdot \ln(\frac{1}{1-\alpha})$
• Unsuccessful: $\frac{1}{1-\alpha}$

Separate Chaining:
• Successful: $1 + \frac{\alpha}{2}$
• Unsuccessful: $1 + \alpha$

Running Time Observations:
1. As $\alpha$ increases:
2. If $\alpha$ is held constant:

Running Time Observations:

ReHashing:
What happens when the array fills?

Algorithm:

Which collision resolution strategy is better?
• Big Records:
• Structure Speed:

What structure do hash tables replace?

What constraint exists on hashing that doesn’t exist with BSTs?

Why talk about BSTs at all?

Analysis of Dictionary-based Data Structures

<table>
<thead>
<tr>
<th></th>
<th>Hash Table</th>
<th>AVL</th>
<th>List</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SUHA</td>
<td>Worst Case</td>
<td></td>
</tr>
<tr>
<td>Find</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insert</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Space</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A Secret, Mystery Data Structure:

ADT:
 insert
 remove
 isEmpty

Implementation of ________________
<table>
<thead>
<tr>
<th>insert</th>
<th>removeMin</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>O(n)</td>
<td>O(n)</td>
<td>Unsorted Array</td>
</tr>
<tr>
<td>O(1)</td>
<td>O(n)</td>
<td>Unsorted List</td>
</tr>
<tr>
<td>O(lg(n))</td>
<td>O(1)</td>
<td>Sorted Array</td>
</tr>
<tr>
<td>O(lg(n))</td>
<td>O(1)</td>
<td>Sorted List</td>
</tr>
</tbody>
</table>

**Q1:** What errors exist in this table? (Fix them!)

**Q2:** Which algorithm would we use?

---

**A New Tree-like Structure:**

A complete binary tree T is a min-heap if:
- 
- 

---

**Implementing a (min)Heap as an Array**

---

**Operations:**

leftChild(index) :=

rightChild(index) :=

parent(index) :=

---

**Insert:**

---

**CS 225 – Things To Be Doing:**

1. Exam 2 starts tomorrow.
2. mp_mosaics EC deadline is today – earn the extra credit!
3. lab_hash released Thursday
4. Daily POTDs are ongoing!