Disjoint Sets
- Worst case running time of find(k):
- Worst case running time of union(r1, r2), given roots:
- Iterated log: \( \log^*(n) = \text{number of times you can take a log} \)
- Overall running time:
  - A total of \( m \) union/find operation runs in:

A Review of Major Data Structures so Far

<table>
<thead>
<tr>
<th>Array-based</th>
<th>List/Pointer-based</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Sorted Array</td>
<td>- Singly Linked List</td>
</tr>
<tr>
<td>- Unsorted Array</td>
<td>- Doubly Linked List</td>
</tr>
<tr>
<td>- Stacks</td>
<td>- Skip Lists</td>
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<tr>
<td>- Queues</td>
<td>- Trees</td>
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<tr>
<td>- Hashing</td>
<td>- BTree</td>
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<tr>
<td>- Heaps</td>
<td>- Binary Tree</td>
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<tr>
<td>- Priority Queues</td>
<td>- Huffman Encoding</td>
</tr>
<tr>
<td>- UpTrees</td>
<td>- kd-Tree</td>
</tr>
<tr>
<td>- Disjoint Sets</td>
<td>- AVL Tree</td>
</tr>
</tbody>
</table>

An Introduction to Graphs

HAMLET

TROILUS AND CRESSIDA
Motivation:
Graphs are awesome data structures that allow us to represent an enormous range of problems. To study these problems, we need:
1. A common vocabulary to talk about graphs
2. Implementation(s) of a graph
3. Traversals on graphs
4. Algorithms on graphs

Graph Vocabulary
Consider a graph $G$ with vertices $V$ and edges $E$, $G=(V,E)$.

Incident Edges:
$I(v) = \{ (x, v) \text{ in } E \}$

Degree(v): $|I|$

Adjacent Vertices:
$A(v) = \{ x : (x, v) \text{ in } E \}$

Path($G_2$): Sequence of vertices connected by edges

Cycle($G_1$): Path with a common begin and end vertex.

Simple Graph($G$): A graph with no self loops or multi-edges.

Subgraph($G$): $G' = (V', E')$:
$V' \in V, E' \in E, \text{ and } (u, v) \in E \rightarrow u \in V', v \in V'$

Graphs that we will study this semester include:
Complete subgraph($G$)
Connected subgraph($G$)
Connected component($G$)
Acyclic subgraph($G$)
Spanning tree($G$)

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CS 225 – Things To Be Doing:

1. Theory Exam 3 final day is today
2. lab_heaps due Sunday, April 8\textsuperscript{th}
3. MP6 released; Extra Credit deadline on Monday, April 9\textsuperscript{th}
4. Daily POTDs are ongoing!