B+Tree Practice Problems

- Insert Problems
- Delete Problems
- Maximum Height

What does the tree look like after 45 is inserted?

What does the tree look like after 70 is inserted?

What does the tree look like after 130 is deleted?

What does the tree look like after 260 is deleted?

What does the tree look like after 20 is deleted?
1. What range of values can be found in each subtree of the order 5 B+tree shown above?

2. Suppose the search keys in the order 5 B+tree shown above are integers and there are no duplicate keys.
   a. What is the maximum height of each subtree?
   b. What is the maximum height of the tree?

### Range of Values and Number of Values in Each Subtree

<table>
<thead>
<tr>
<th>Subtree</th>
<th>Range</th>
<th>Number of values</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₀</td>
<td>MININT...9</td>
<td>9</td>
</tr>
<tr>
<td>T₁</td>
<td>10...199</td>
<td>190</td>
</tr>
<tr>
<td>T₂</td>
<td>200...309</td>
<td>110</td>
</tr>
<tr>
<td>T₃</td>
<td>310...499</td>
<td>190</td>
</tr>
<tr>
<td>T₄</td>
<td>500...MAXINT</td>
<td></td>
</tr>
</tbody>
</table>

### Maximum Height

- T₂ has the smallest range of values so find the maximum height of T₂
  - Height 0: Minimum number of values in leaves
    - 0: 2
    - 1: $3^1 \times 2 = 6$
    - 2: $3^2 \times 2 = 18$
    - 3: $3^3 \times 2 = 54$
    - 4: $3^4 \times 2 = 162$ TOO BIG!

**Maximum Height**

- T₂ has maximum height of 3 so all subtrees have a maximum height of 3
- Height of the whole tree is 3+1 = 4