

CS 395 Homework 9

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Due April 30th, 2012

Grade: _____

PROBLEMS

1.

The **maximum** number of elements in a heap happens when the heap is entirely filled out on the lowest level, meaning it is entirely filled out. This can be found with the equation $2^{k+1} - 1$.

The **minimum** number of elements in a heap happens when the lowest level only has one node. The levels above the last level are complete, so the minimum can be found with the equation $2^{(k-1)+1} - 1 + 1 = 2^k$.

2.

The tree is **not a max heap**, as it violates the max heap property with the node value 6:

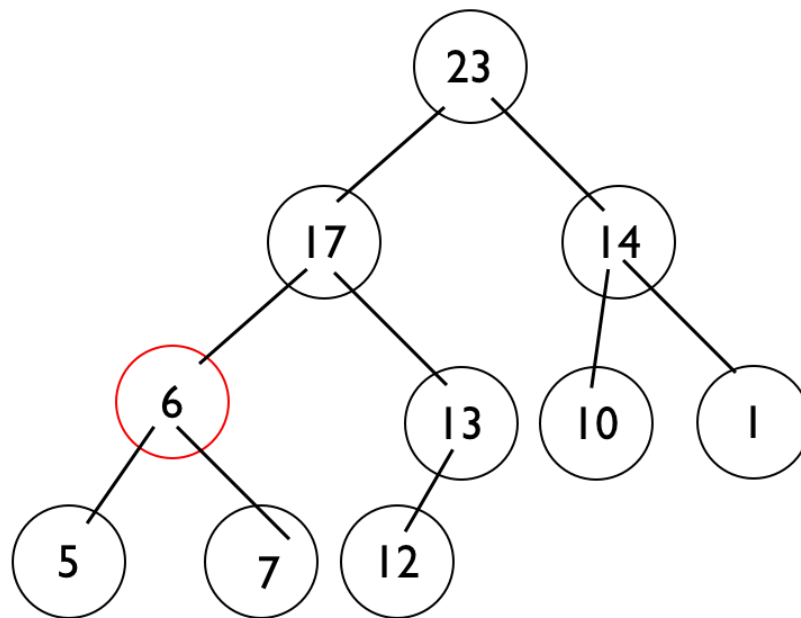


Figure 1: Heap for the array $\{23, 17, 14, 6, 13, 10, 1, 5, 7, 12\}$

3.

Consider the operations on heap $\{27, 17, 3, 16, 13, 10, 1, 5, 7, 12, 4, 8, 9, 0\}$ for MAX_HEAPIFY:

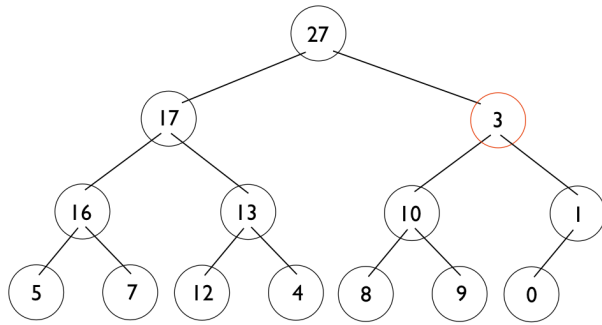


Figure 2: Step 1

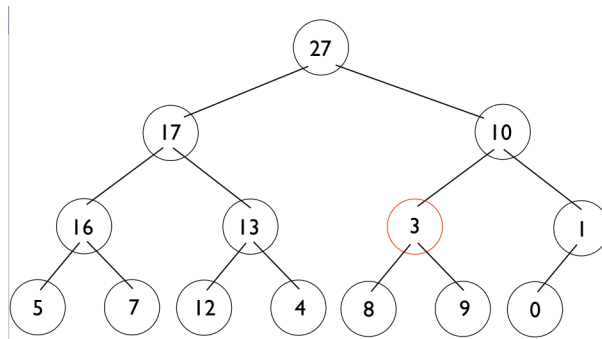


Figure 3: Step 2

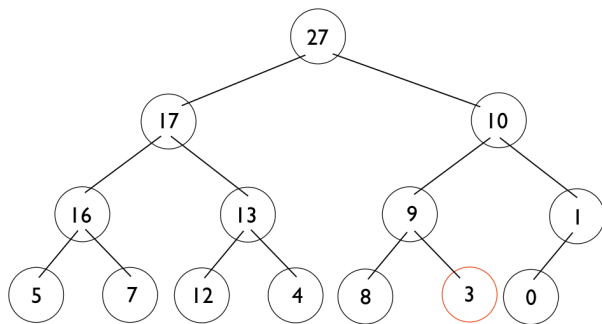


Figure 4: Step 3

4.

Consider the operations on heap $\{5, 3, 17, 10, 84, 19, 6, 22, 9\}$ for BUILD_MAX_HEAP:

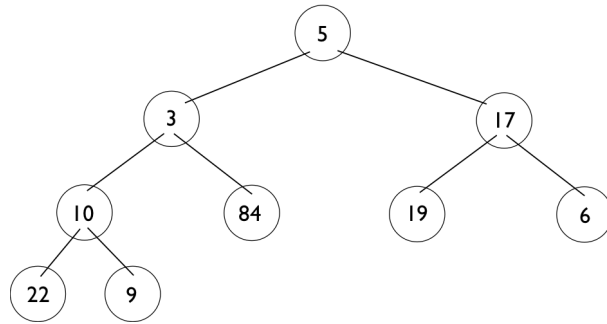


Figure 5: Step 1

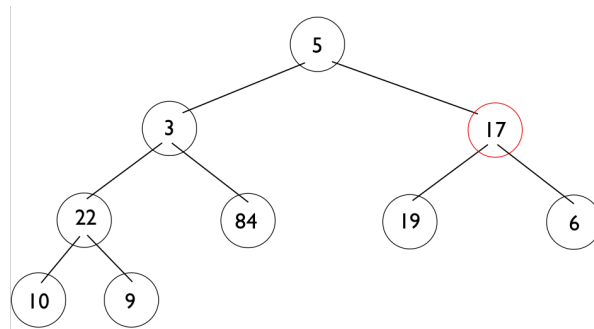


Figure 6: Step 2

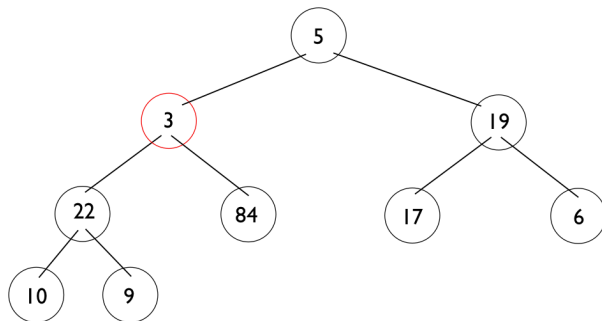


Figure 7: Step 3

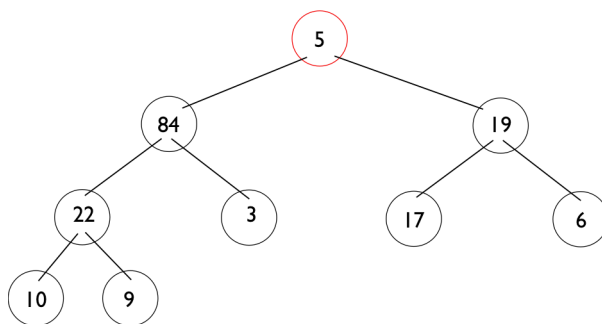


Figure 8: Step 4

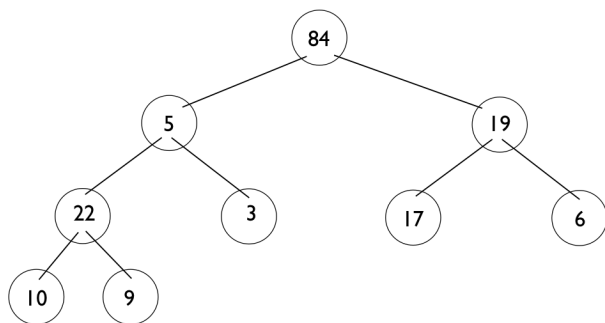


Figure 9: Step 5

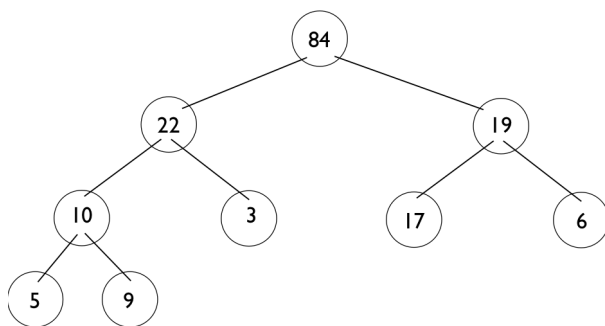


Figure 10: Step 6

5.

Consider the operations on heap $\{5, 13, 2, 25, 7, 17, 20, 8, 4\}$ for BUILD_MAX_HEAP:

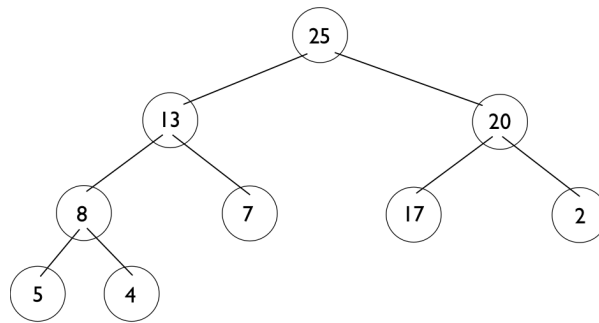


Figure 11: Step 1

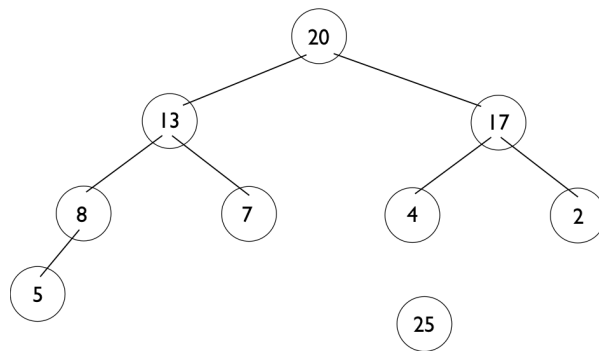


Figure 12: Step 2

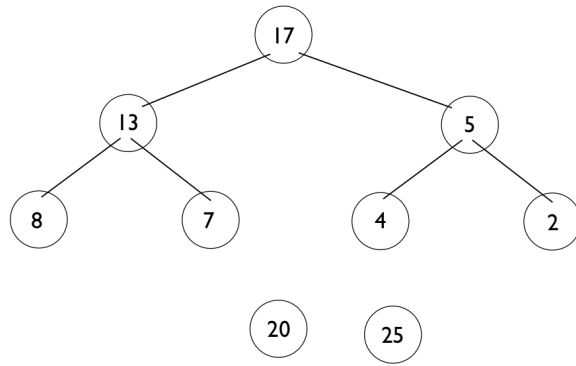


Figure 13: Step 3

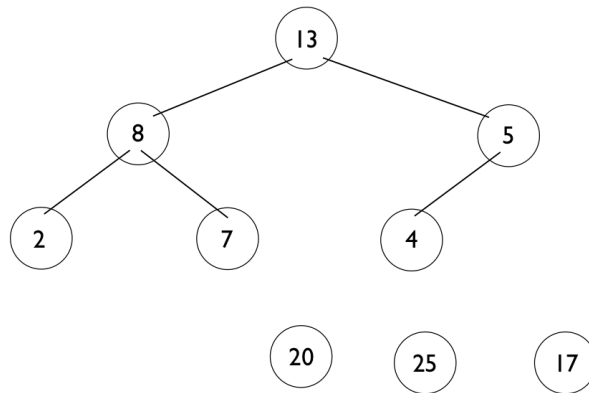


Figure 14: Step 4

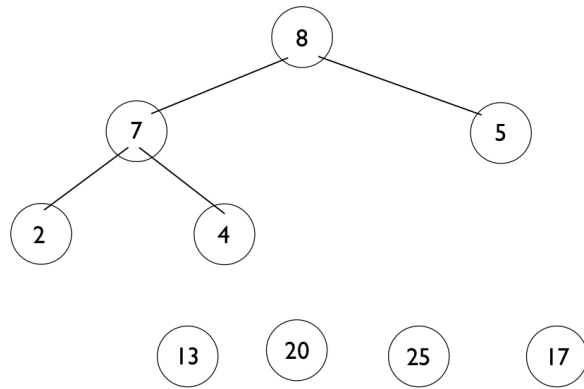


Figure 15: Step 5

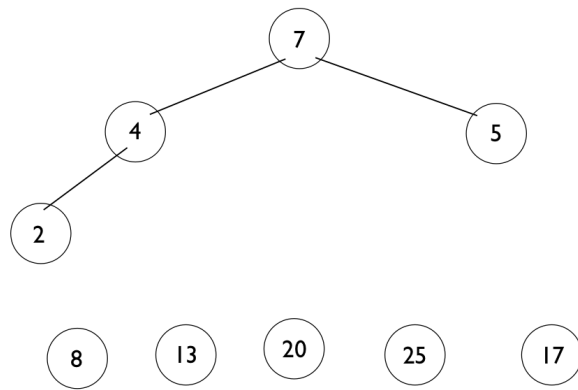


Figure 16: Step 6

6.

Consider the operations on heap $\{15,13,9,5,12,8,7,4,0,6,2,1\}$ for `HEAP_EXTRACT_MAX`:

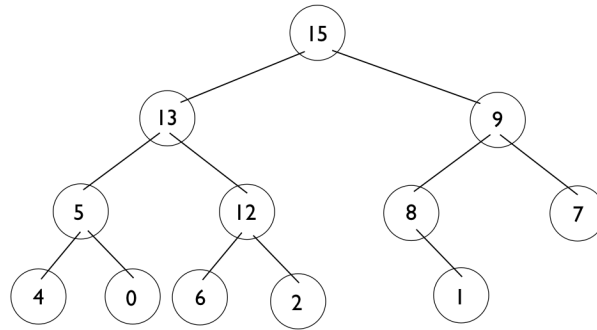


Figure 17: Step 1

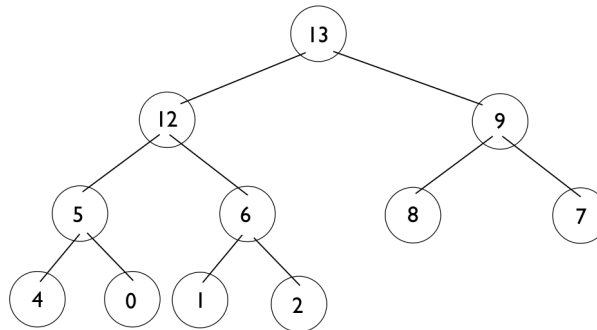


Figure 18: Step 2

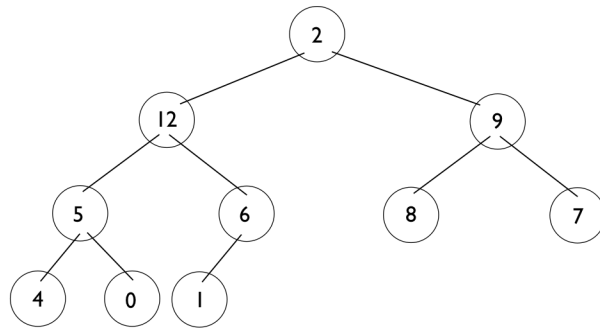


Figure 19: Step 3

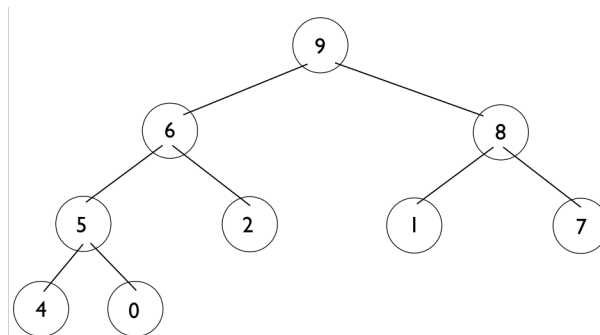


Figure 20: Step 4

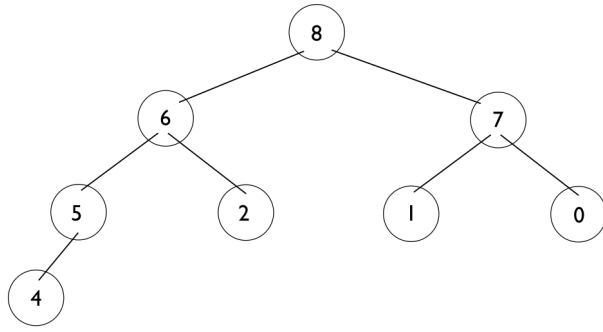


Figure 21: Step 5

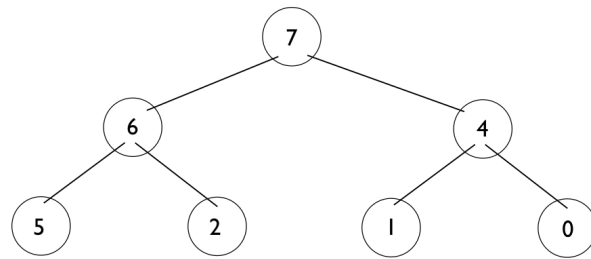


Figure 22: Step 6

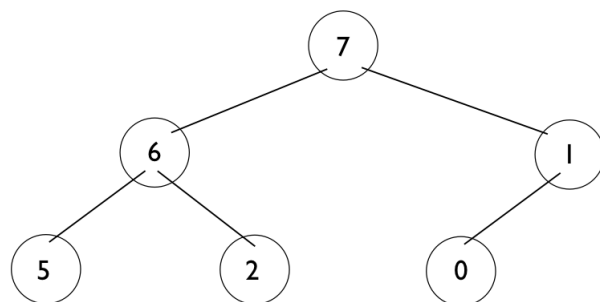


Figure 23: Step 7

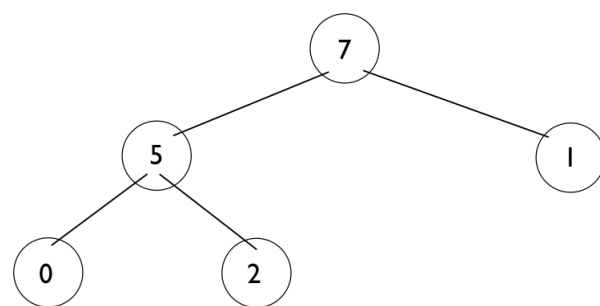


Figure 24: Step 8

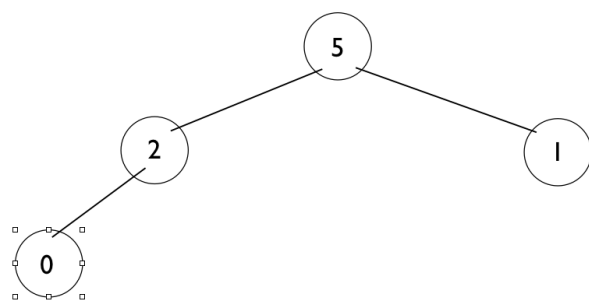


Figure 25: Step 9

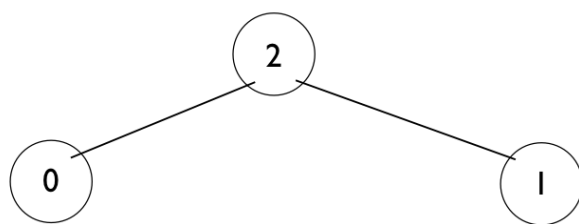


Figure 26: Step 10

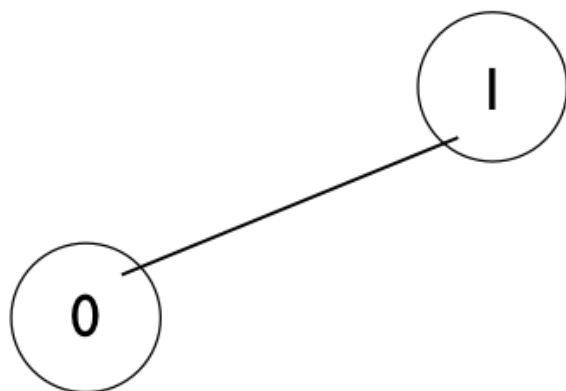


Figure 27: Step 11

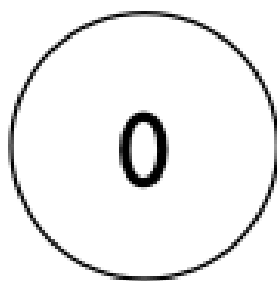


Figure 28: Step 12

7.

Consider the operations on heap $\{15,13,9,5,12,8,7,4,0,6,2,1\}$ for MAX_HEAP_INSERT:

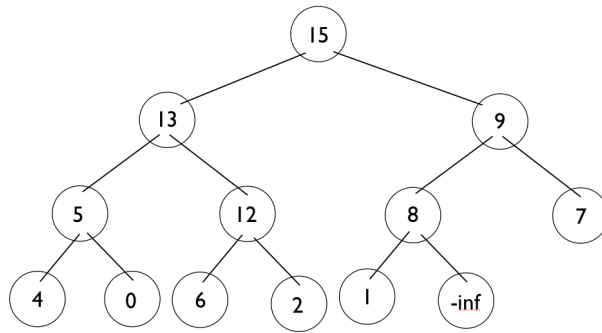


Figure 29: Step 1

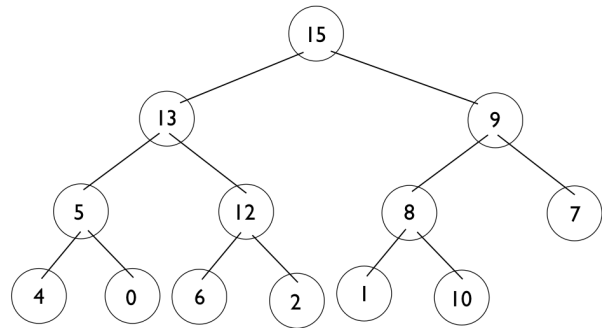


Figure 30: Step 2

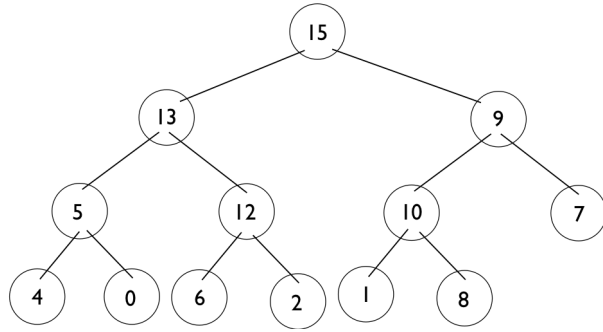


Figure 31: Step 3

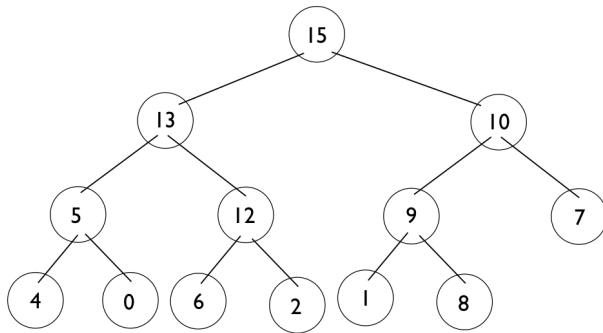


Figure 32: Step 4