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Problem #1

1. A heap is a complete binary tree, a binary tree in which every level, except possibly the last, is completely filled, and all nodes on the last level are as far left as possible. It can have between 1 and 2*h* nodes on the last level *h*.

Therefore, while *h* = 7, the last level of a binary tree can contain 1 ~ 27 nodes, and there must be 1 + 2 + 22 + … + 26 = 27 – 1 nodes on the higher levels.

So, in the minimum case, there are 1 + (27 – 1) = 128 nodes.

In the maximum case, there are 27 + (27 – 1) = 255 nodes.

1. A diagram of numbers and circles

   Description automatically generatedThe initial ordering is [26, 15, 10, 35, 29, 17, 22], as represented by the tree below:

To start the BUILD-MAX-HEAP procedure, we know heap\_size = 7, so i loops from 3 to 1.

While i = 3: MAX-HEAPIFY on element 10. Let 10 compare with its children. Since 22 is the largest element, elements 10 and 22 are swapped. The current ordering is [26, 15, 22, 35, 29, 17, 10]. Then, MAX\_HEAPIFY on element 10 yields no change.

A diagram of numbers and circles

Description automatically generated

While i = 2: MAX\_HEAPIFY on element 15. Let 15 compare with its children. Since 35 is the largest element, elements 15 and 35 are swapped. The current ordering is [26, 35, 22, 15, 29, 17, 10]. Then, MAX\_HEAPIFY on element 15 yields no change.

A diagram of numbers and circles

Description automatically generated

A diagram of numbers and circles

Description automatically generatedWhile i = 1, MAX\_HEAPIFY on element 26. Let 26 compare with its children. Since 35 is the largest element, elements 26 and 35 are swapped. The current ordering is [35, 26, 22, 15, 29, 17, 10].

Then, MAX\_HEAPIFY on element 26. Let 26 compare with its children. Since 29 is the largest element, elements 26 and 29 are swapped. The current ordering is [35, 29, 22, 15, 26, 17, 10]. Then, MAX\_HEAPIFY on element 26 yields no change.

A diagram of numbers and circles

Description automatically generated