CSI 2110 Fall 2015
Computer Science University of Ottawa

Assignment #2
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Question 1

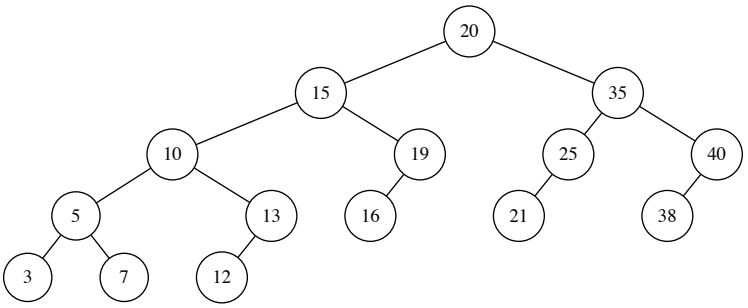
a) 20, 15, 10, 5, 3, 7, 13, 12, 19, 16, 35, 25, 40, 38

b) 3, 7, 5, 12, 13, 10, 16, 19, 15, 25, 38, 40, 35, 20

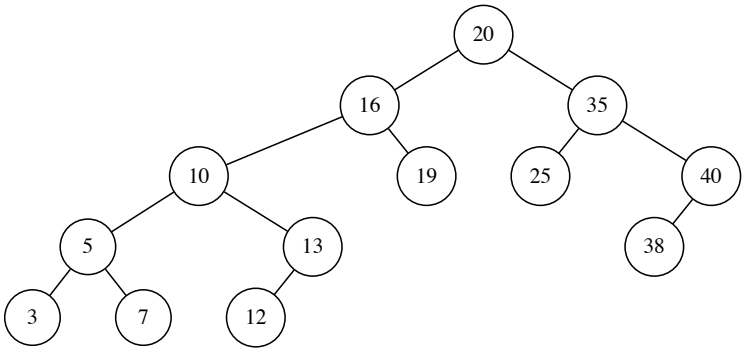
c) Searches for the largest value in a binary tree.

```
findMax(Node n) {
    if (n.hasRightChild()) {
        return findMax(n.rightChild());
    }
    return n;
}
```

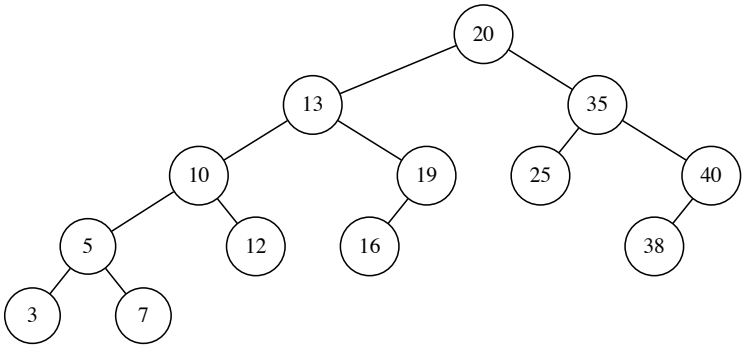
d) *Insert element:* 21



e) Case 1: Replace 15 with the left most node of the right subtree. Then remove the leftmost node of the right subtree.



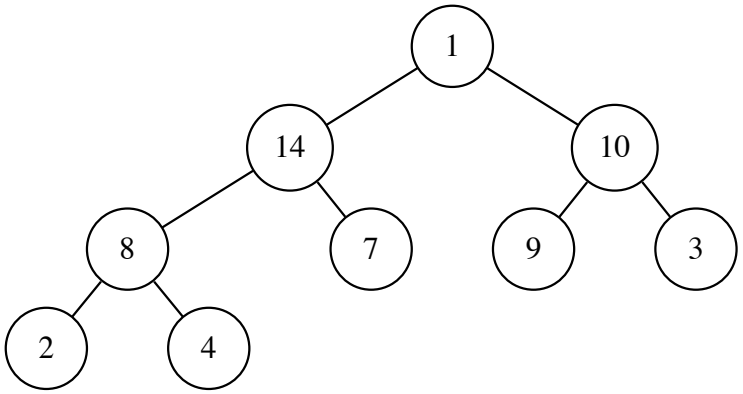
Case 2: Replace 15 with the right most node of the left subtree. Any children of the right most node become children of the right most node's parent.



Question 2

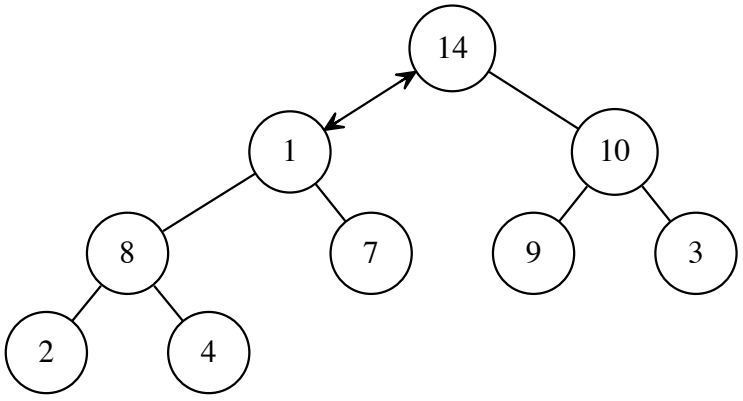
a) Step 1: Replace node with the last node in the heap

1	14	10	8	7	9	3	2	4



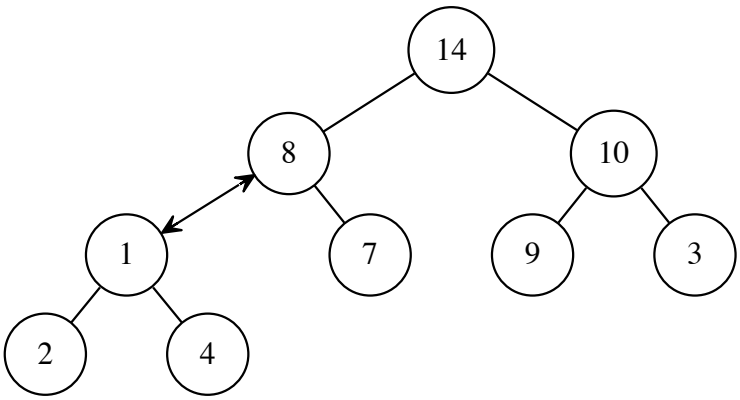
Step 2: Downheap while the children are larger

14	1	10	8	7	9	3	2	4



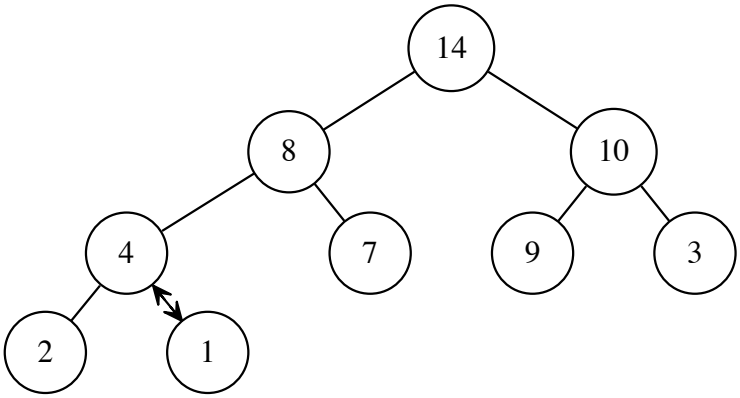
Step 3: Downheap while the children are larger

14	8	10	1	7	9	3	2	4



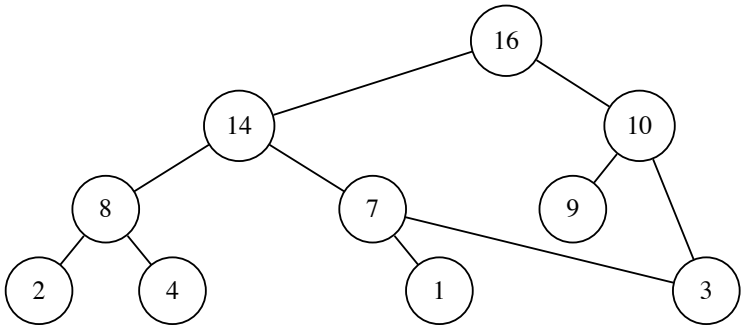
Step 4: Downheap to become a leaf node

14	8	10	4	7	9	3	2	1



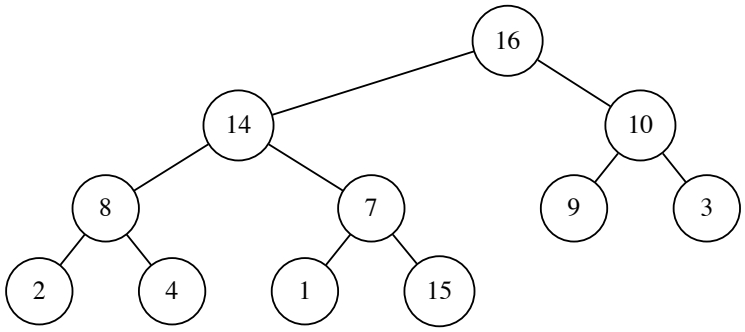
b) Insert element 3 at the left most position on the empty row. No further changes are required as the $7 \geq 3$ property of the max heap is satisfied

16	14	10	8	7	9	3	2	4	1	3



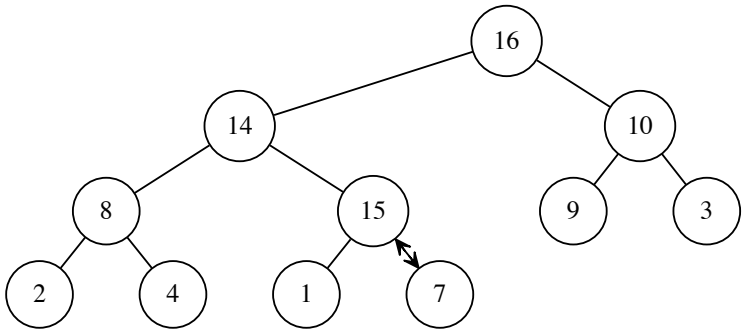
c) Step 1: Insert at left most node in the empty row

16	14	10	8	7	9	3	2	4	1	15



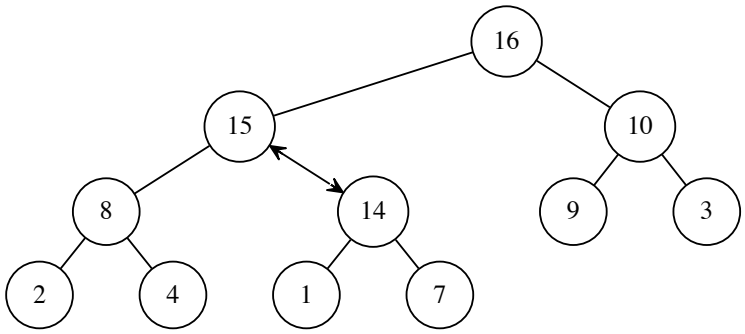
Step 2: Upheap 15 until max heap property *parent* $\geq$ *child* is met

16	14	10	8	15	9	3	2	4	1	7



Step 3: Upheap once more to satisfy the max-heap property.

16	15	10	8	14	9	3	2	4	1	7



d) Calculate the height of a 2000 element heap:

$$h(n) = \lfloor log_2(n) \rfloor$$
$$h(2000) = \lfloor log_2(2000) \rfloor$$
$$h(2000) = 10$$

$\therefore$ the height of a 2000 node heap is 10.