Data Structure

Lab Session #09:
Internal Sorting 2

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Goals

- Implement "**Heap Sort**"
  - ❑ Complete "MinHeap" class in MinHeap.java
  - ❑ Complete "HeapSort" class in HeapSort.java

- Print the sample output corresponding to the sample input
  - ❑ Please carefully observe the I/O specification.

Notice

- After implementing "HeapSort", check if your program works well.
    - Check sample input and output files in the 'testcase' folder.
    - Test your program by using it.

- When you finish implementing the program, you can leave.
    - But, you need to stay for at least an hour.

- Check your attendance.

Build a project

- Download the project for this lab from eTL.

- Extract the project, and open it in IntelliJ.
  - See the slide of 1st lab session to check how to open the project in IntelliJ.

Heap Sort

- Given a series of integers, build min-heap.
- Extract values from the top until the tree empty.
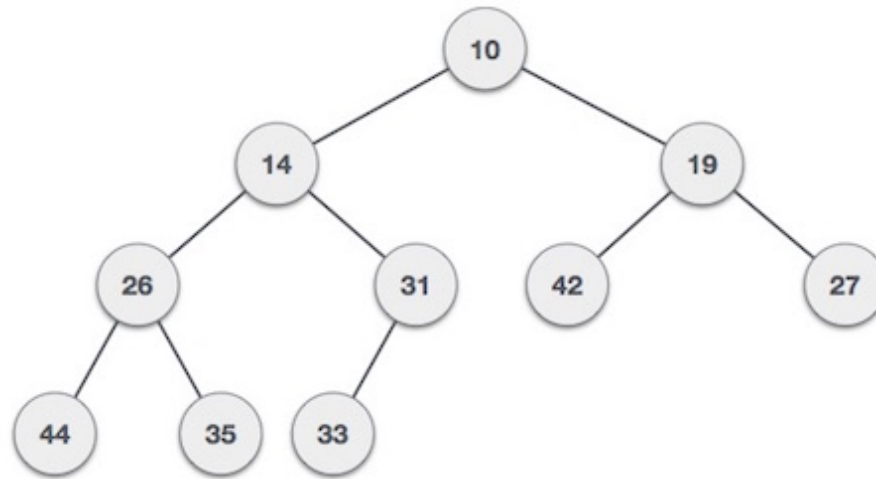- Refer to lec12 if you don't remember heap.

Figure. Min-heap

Function that you need to fill in

- In 'MinHeap':
  - insert
  - remove
  - find
  - siftdown
  - removeMin

- In 'HeapSort':
  - add
  - remove
  - sort

I/O Specification

■ add

Input format	Output format
`add 3`	`(heap_state)`
Description	
- **Add a value into the min-heap.** - **Value is an integer.**	

Example Input	Example Output
`add 3`	`3`
`add 5`	`3 5`

I/O Specification

■ remove

Input format	Output format
`remove`	`(heap_state)`
Description	

- Remove a value from the min-heap.

- Value is an integer.

Example Input	Example Output
`remove 15`	`1 1 9 3 10 15 20 5 (last state)` `1 1 5 3 10 9 20 (after remove 15)`

I/O Specification

■ sort

Input format	Output format
sort_a/sort_d	**(sorted integers)** **(heap_state)**
Description	
- Print out values in ascending(sort_a)/descending(sort_d) order using the min-heap. - (Sorted integers) is a sequence of integers sorted in ascending/ descending order. - After sorting, heapify all elements again and print heap_state.	
Example Input	**Example Output**
sort_a/sort_d	**1 3 5 9 10 15** **/** **20 9 7 5 3 1 1** **1 3 9 5 10 15** **/** **1 3 1 5 9 7 20**

Sample Input

```
add        3
add        5
add        15
add        9
add        10
add        1
sort_a
add        20
add        1
remove     15
add        7
remove     10
sort_d
```

Sample Output

```
op        operand    heap_state
add       3          3
add       5          3 5
add       15         3 5 15
add       9          3 5 15 9
add       10         3 5 15 9 10
add       1          1 5 3 9 10 15
sort_a    1 3 5 9 10 15
                     1 3 9 5 10 15
add       20         1 3 9 5 10 15 20
add       1          1 1 9 3 10 15 20 5
remove    15         1 1 5 3 10 9 20
add       7          1 1 5 3 7 9 20
remove    10         1 1 5 3 7 9 20
sort_d    20 9 7 5 3 1 1
                     1 3 1 5 9 7 20
```

Heap_state may vary depending on how you heapify after sorting, but you have to make sure every heap_state follows heap property.

Questions?