**King Fahd University of Petroleum & Minerals**

**College of Computer Science and Engineering**

**Information and Computer Science Department**

**ICS 202 – Data Structures**

# Binary Heaps

**Objectives**

The objective of this lab is to design, implement and use Binary Heaps.

**Outcomes**

After completing this Lab, students are expected to:

• Design classes for Binary Heaps.

• Use Binary Heaps for a real life application.

**Lab Tasks**

1. Complete the class **BinaryHeap.java** by providing the code for **percolateUp, percolateDown, buildHeapBottomUp**  and **buildHeapTopDown** methods. Test your methods by modifying the provided test class **BinaryHeapDriver.java**. Are you getting the same result using **topDown** and **bottomUp** methods?

Your output should be as follows: For bottom-up heap construction:

The original array is: [10, 2, 8, 9, 1, 6, 3, 4, 0, 5]  
The min-heap is: [0, 1, 3, 2, 5, 6, 8, 4, 9, 10]  
The sorted array is: [0, 1, 2, 3, 4, 5, 6, 8, 9, 10]

For top-down heap construction (comment the bottom-up statement in the BinaryHeap constructor)

The original array is: [10, 2, 8, 9, 1, 6, 3, 4, 0, 5]  
The min-heap is: [0, 1, 3, 2, 5, 8, 6, 10, 4, 9]  
The sorted array is: [0, 1, 2, 3, 4, 5, 6, 8, 9, 10]

(Observe the difference in the order of the elements 6, 8, 4, 9 and 10 in the constructed heap).

1. Patients arrive at a hospital with varying priorities. Each patient has the following attributes: **name** (String), **emergencyLevel** (integer: 1 is the most urgent and 5 is the least urgent), and **arrivalOrder** (integer: the smaller the value, the higher the arrival priority).

Write a class **Patient implements Comparable<Patient>**. Two patients can be compared based on their emergency level. If the emergency level is the same, then their comparison is based on the arrival order [i.e., the patient with low arrival order is served first].

Now create an array of 10 patients at random in a main class (**Hospital**). [Provide their names, but generate the emergency levels randomly]. (a) Print the array, (b) Create a binary heap of these patients using **enqueue**, (c) Now heapsort these and print them.

This application illustrates use of a heap as a priority queue. Sample program runs are:

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| The original order of patients arrival is:  Name: Ali, Emergency Level: 4, ArrivalOrder: 1 Name: Saleem, Emergency Level: 4, ArrivalOrder: 2 Name: Jamaal, Emergency Level: 1, ArrivalOrder: 3 Name: Thamer, Emergency Level: 5, ArrivalOrder: 4 Name: Muhsin, Emergency Level: 4, ArrivalOrder: 5 Name: Said, Emergency Level: 3, ArrivalOrder: 6 Name: Qasim, Emergency Level: 5, ArrivalOrder: 7 Name: Maryam, Emergency Level: 4, ArrivalOrder: 8 Name: Ramadhan, Emergency Level: 1, ArrivalOrder: 9 Name: Zainab, Emergency Level: 1, ArrivalOrder: 10  The TREATMENT order of patients is:  Name: Jamaal, Emergency Level: 1, ArrivalOrder: 3 Name: Ramadhan, Emergency Level: 1, ArrivalOrder: 9 Name: Zainab, Emergency Level: 1, ArrivalOrder: 10 Name: Said, Emergency Level: 3, ArrivalOrder: 6 Name: Ali, Emergency Level: 4, ArrivalOrder: 1 Name: Saleem, Emergency Level: 4, ArrivalOrder: 2 Name: Muhsin, Emergency Level: 4, ArrivalOrder: 5 Name: Maryam, Emergency Level: 4, ArrivalOrder: 8 Name: Thamer, Emergency Level: 5, ArrivalOrder: 4 Name: Qasim, Emergency Level: 5, ArrivalOrder: 7 |
| The original order of patients arrival is:  Name: Ali, Emergency Level: 1, ArrivalOrder: 1 Name: Saleem, Emergency Level: 4, ArrivalOrder: 2 Name: Jamaal, Emergency Level: 4, ArrivalOrder: 3 Name: Thamer, Emergency Level: 3, ArrivalOrder: 4 Name: Muhsin, Emergency Level: 3, ArrivalOrder: 5 Name: Said, Emergency Level: 5, ArrivalOrder: 6 Name: Qasim, Emergency Level: 3, ArrivalOrder: 7 Name: Maryam, Emergency Level: 2, ArrivalOrder: 8 Name: Ramadhan, Emergency Level: 1, ArrivalOrder: 9 Name: Zainab, Emergency Level: 2, ArrivalOrder: 10  The TREATMENT order of patients is:  Name: Ali, Emergency Level: 1, ArrivalOrder: 1 Name: Ramadhan, Emergency Level: 1, ArrivalOrder: 9 Name: Maryam, Emergency Level: 2, ArrivalOrder: 8 Name: Zainab, Emergency Level: 2, ArrivalOrder: 10 Name: Thamer, Emergency Level: 3, ArrivalOrder: 4 Name: Muhsin, Emergency Level: 3, ArrivalOrder: 5 Name: Qasim, Emergency Level: 3, ArrivalOrder: 7 Name: Saleem, Emergency Level: 4, ArrivalOrder: 2 Name: Jamaal, Emergency Level: 4, ArrivalOrder: 3 Name: Said, Emergency Level: 5, ArrivalOrder: 6 |