◆ Heap কী?

Heap হলো এক ধরনের **Complete Binary Tree**, যেখানে সবগুলো লেভেল পূর্ণ থাকে এবং শেষ লেভেল বাম থেকে ডানে পূরণ হয়।

দুই ধরনের Heap হয়ঃ

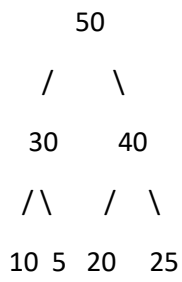
✓ 1. Max Heap

☞ প্রতিটি নোডের মান তার চাইল্ডদের চেয়ে **বড় বা সমান** হয়।
☞ অর্থাৎ: **Parent ≥ Left Child, Right Child**

✓ 2. Min Heap

☞ প্রতিটি নোডের মান তার চাইল্ডদের চেয়ে **ছোট বা সমান** হয়।
☞ অর্থাৎ: **Parent ≤ Left Child, Right Child**

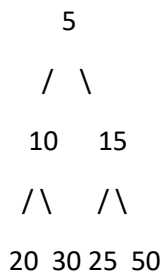
MAX HEAP:




```java
package Heap;
import java.util.PriorityQueue;
import java.util.Collections;

public class maxHeap {
    public static void main(String[] args) {
        PriorityQueue<Integer> maxH=new
PriorityQueue<>(Collections.reverseOrder());

        maxH.add(10);
        maxH.add(30);
        maxH.add(20);
        maxH.add(5);

        while (!maxH.isEmpty()) {
```

```
            System.out.println(maxH.poll()+" ");
        }
    }
}
```

MIN HEAP:




```
package Heap;

import java.util.PriorityQueue;

public class MinHeap {
    public static void main(String[] args) {
        PriorityQueue<Integer> minHeap=new PriorityQueue<>();
        minHeap.add(10);
        minHeap.add(30);
        minHeap.add(20);
        minHeap.add(5);

        while (!minHeap.isEmpty()) {
            System.out.println(minHeap.poll()+" ");
        }
    }
}
```

MAX HEAP ADD(ARRAY)

```
package Heap;

import java.util.Scanner;
```

```java
public class maxHeapArray {
    public static void main(String[] args) {
        Scanner sc=new Scanner(System.in);
        System.out.print("Enter number of elemnts: ");
        int n=sc.nextInt();

        int[] A=new int[n+1];
        A[0]=0;

        for(int i=1;i<=n;i++){
            int temp=sc.nextInt();

            int k=i;
            while (k>1 && A[k/2]<temp) {
                A[k]=A[k/2];
                k=k/2;
            }
            A[k]=temp;
        }
        System.out.println("Max Heap");
        for(int i=1;i<=n;i++){
            System.out.println(A[i]+" ");
        }
    }
}


    // public static void main(String[] args) {
    //     int[] A = {0, 10, 20, 5, 6, 1, 8}; // index 0 unused for easier
parent-child calculation
    //     int n = A.length - 1; // Because we are not using index 0

    //     // Heap construction begins
    //     for (int i = 2; i <= n; ++i) {
    //         int temp = A[i]; // Step 1: temp holds current element
    //         int k = i;

    //         // Step 2: Bubble up if parent is smaller (for max heap)
    //         while (k > 1 && A[k / 2] < temp) {
    //             A[k] = A[k / 2]; // Move parent's value down
    //             k = k / 2;       // Move up to parent's index
    //         }

    //         A[k] = temp; // Step 3: place temp in correct position
```

```
    //     }

    //     // Output the heap
    //     System.out.println("Heap Array:");
    //     for (int i = 1; i <= n; i++) {
    //         System.out.print(A[i] + " ");
    //     }
    // }
```

//DELETE

```
package Heap;

public class maxDelete {
    public static void heapifyDown(int[] heap, int n, int i) {
        int largest = i;
        int left = 2 * i + 1; // left child
        int right = 2 * i + 2; // right child

        if (left < n && heap[left] > heap[largest])
            largest = left;

        if (right < n && heap[right] > heap[largest])
            largest = right;

        if (largest != i) {
            int temp = heap[i];
            heap[i] = heap[largest];
            heap[largest] = temp;
            heapifyDown(heap, n, largest);
        }
    }

    public static int deleteMax(int[] heap, int n) {
        if (n <= 0) return -1;

        int max = heap[0];
        heap[0] = heap[n - 1]; // Last element goes to root
        heapifyDown(heap, n - 1, 0);
        return max;
    }

    public static void main(String[] args) {
```

```
        int[] heap = {50, 30, 40, 10, 20, 35, 25};
        int n = heap.length;

        int deleted = deleteMax(heap, n);

        System.out.println("Deleted Max: " + deleted);
        System.out.print("Updated Heap: ");
        for (int i = 0; i < n - 1; i++) {
            System.out.print(heap[i] + " ");
        }
    }
}
```

In Queue

```
package Heap;

import java.util.Collections;
import java.util.PriorityQueue;

public class maxHeapDeleteQueue {
    public static void main(String[] args) {
        // Max Heap using PriorityQueue
        PriorityQueue<Integer> maxH = new
PriorityQueue<>(Collections.reverseOrder());

        // Adding elements to heap
        maxH.add(50);
        maxH.add(30);
        maxH.add(40);
        maxH.add(10);
        maxH.add(20);
        maxH.add(35);
        maxH.add(25);

        System.out.println("Max Heap: " + maxH);

        // Deleting the max (root)
        int deleted = maxH.poll(); // Removes and returns max

        System.out.println("Deleted Max: " + deleted);
        System.out.println("Heap after deletion: " + maxH);
```

```
    }
}
```