**Binary Heap Operations**

# Binary Heap Operations

* Insert
* Decrease
* Extract
* Delete
* Heapify

# Implementation in C++

// C++ program to demonstrate common Binary Heap Operations

#include <iostream>

#include <climits>

using namespace std;

// Prototype of a utility function to swap two integers

void swap(int \*x, int \*y);

// A class for Min Heap

class MinHeap {

int \*harr; // pointer to array of elements in heap

int capacity; // maximum possible size of min heap

int heap\_size; // Current number of elements in min heap

public:

// Constructor

MinHeap(int capacity);

// to heapify a subtree with root at given index

void MinHeapify(int );

int parent(int i) { return (i-1)/2; }

// to get index of left child of node at index i

int left(int i) { return (2\*i + 1); }

// to get index of right child of node at index i

int right(int i) { return (2\*i + 2); }

// to extract the root which is the minimum element

int extractMin();

// Decreases key value of key at index i to new\_val

void decreaseKey(int i, int new\_val);

// Returns the minimum key (key at root) from min heap

int getMin() { return harr[0]; }

// Deletes a key stored at index i

void deleteKey(int i);

// Inserts a new key 'k'

void insertKey(int k);

};

// Constructor: Builds a heap from a given array a[] of given size

MinHeap::MinHeap(int cap) {

heap\_size = 0;

capacity = cap;

harr = new int[cap];

}

// Inserts a new key 'k'

void MinHeap::insertKey(int k) {

if (heap\_size == capacity) {

cout << "\nOverflow: Could not insertKey\n";

return;

}

// First insert the new key at the end

heap\_size++;

int i = heap\_size - 1;

harr[i] = k;

// Fix the min heap property if it is violated

while (i != 0 && harr[parent(i)] > harr[i]) {

swap(&harr[i], &harr[parent(i)]);

i = parent(i);

}

}

// Decreases value of key at index 'i' to new\_val. It is assumed that new\_val is smaller than harr[i].

void MinHeap::decreaseKey(int i, int new\_val) {

harr[i] = new\_val;

while (i != 0 && harr[parent(i)] > harr[i]) {

swap(&harr[i], &harr[parent(i)]);

i = parent(i);

}

}

// Method to remove minimum element (or root) from min heap

int MinHeap::extractMin() {

if (heap\_size <= 0)

return INT\_MAX;

if (heap\_size == 1) {

heap\_size--;

return harr[0];

}

// Store the minimum value, and remove it from heap

int root = harr[0];

harr[0] = harr[heap\_size-1];

heap\_size--;

MinHeapify(0);

return root;

}

// This function deletes key at index i. It first reduced value to minus infinite, then calls extractMin()

void MinHeap::deleteKey(int i) {

decreaseKey(i, INT\_MIN);

extractMin();

}

// A recursive method to heapify a subtree with root at given index

// This method assumes that the subtrees are already heapified

void MinHeap::MinHeapify(int i) {

int l = left(i);

int r = right(i);

int smallest = i;

if (l < heap\_size && harr[l] < harr[i])

smallest = l;

if (r < heap\_size && harr[r] < harr[smallest])

smallest = r;

if (smallest != i) {

swap(&harr[i], &harr[smallest]);

MinHeapify(smallest);

}

}

// A utility function to swap two elements

void swap(int \*x, int \*y) {

int temp = \*x;

\*x = \*y;

\*y = temp;

}

// Driver program to test above functions

int main() {

MinHeap h(11);

h.insertKey(3);

h.insertKey(2);

h.deleteKey(1);

h.insertKey(15);

h.insertKey(5);

h.insertKey(4);

h.insertKey(45);

cout << h.extractMin() << " ";

cout << h.getMin() << " ";

h.decreaseKey(2, 1);

cout << h.getMin();

return 0;

}

Output:

2 4 1

# References

<https://www.geeksforgeeks.org/heap-data-structure/>