****

Assignment No: 5

Title Name: Huffman Coding

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Class : BE -1 **Div**: A **Batch**: C

Exam Seat No/Roll No: 405A85

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Program:

```
/*
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   Class - BE 1             Batch - C



   DAA: Assignment No - 5
   Title : Huffman coding

*/
#include <iostream>
#include <cstdlib>
using namespace std;
// This constant can be avoided by explicitly
// calculating height of Huffman Tree
#define MAX_TREE_HT 100
// A Huffman tree node
struct MinHeapNode {
// One of the input characters
char data;
// Frequency of the character
```

```
unsigned freq;
// Left and right child of this node
struct MinHeapNode *left, *right;
};
// A Min Heap: Collection of
// min-heap (or Huffman tree) nodes
struct MinHeap {
// Current size of min heap
unsigned size;
// capacity of min heap
unsigned capacity;
// Array of minheap node pointers
struct MinHeapNode** array;
};
// A utility function allocate a new
// min heap node with given character
// and frequency of the character
struct MinHeapNode* newNode(char data, unsigned freq)
{
struct MinHeapNode* temp
 = (struct MinHeapNode*)malloc
(sizeof(struct MinHeapNode));
temp->left = temp->right = NULL;
temp->data = data;
temp->freq = freq;
return temp;
}
// A utility function to create
// a min heap of given capacity
struct MinHeap* createMinHeap(unsigned capacity)
```

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{
struct MinHeap* minHeap
 = (struct MinHeap*)malloc(sizeof(struct MinHeap));
// current size is 0
minHeap->size = 0;
minHeap->capacity = capacity;
minHeap->array
 = (struct MinHeapNode**)malloc(minHeap->
capacity * sizeof(struct MinHeapNode*));
return minHeap;
}
// A utility function to
// swap two min heap nodes
void swapMinHeapNode(struct MinHeapNode** a,
 struct MinHeapNode** b)
{
struct MinHeapNode* t = *a;
*a = *b;
*b = t;
}
// The standard minHeapify function.
void minHeapify(struct MinHeap* minHeap, int idx)
{
int smallest = idx;
int left = 2 * idx + 1;
int right = 2 * idx + 2;
if (left < minHeap->size && minHeap->array[left]->
freq < minHeap->array[smallest]->freq)
 smallest = left;
if (right < minHeap->size && minHeap->array[right]->
```

```
freq < minHeap->array[smallest]->freq)
 smallest = right;
if (smallest != idx) {
 swapMinHeapNode(&minHeap->array[smallest],
 &minHeap->array[idx]);
 minHeapify(minHeap, smallest);
}
}
// A utility function to check
// if size of heap is 1 or not
int isSizeOne(struct MinHeap* minHeap)
{
return (minHeap->size == 1);
}
// A standard function to extract
// minimum value node from heap
struct MinHeapNode* extractMin(struct MinHeap* minHeap)
{
struct MinHeapNode* temp = minHeap->array[0];
minHeap->array[0]
 = minHeap->array[minHeap->size - 1];
--minHeap->size;
minHeapify(minHeap, 0);
return temp;
}
// A utility function to insert
// a new node to Min Heap
void insertMinHeap(struct MinHeap* minHeap,
 struct MinHeapNode* minHeapNode)
{
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```
++minHeap->size;
int i = minHeap->size - 1;
while (i && minHeapNode->freq < minHeap->array[(i - 1) / 2]->freq) {
 minHeap->array[i] = minHeap->array[(i - 1) / 2];
 i = (i - 1) / 2;
}
minHeap->array[i] = minHeapNode;
}
// A standard function to build min heap
void buildMinHeap(struct MinHeap* minHeap)
{
int n = minHeap->size - 1;
int i;
for (i = (n - 1) / 2; i >= 0; --i)
 minHeapify(minHeap, i);
}
// A utility function to print an array of size n
void printArr(int arr[], int n)
{
int i;
for (i = 0; i < n; ++i)
 cout<< arr[i];
cout<<"\n";
}
// Utility function to check if this node is leaf
int isLeaf(struct MinHeapNode* root)
{
return !(root->left) && !(root->right);
}
// Creates a min heap of capacity
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// equal to size and inserts all character of
// data[] in min heap. Initially size of
// min heap is equal to capacity
struct MinHeap* createAndBuildMinHeap(char data[], int freq[], int size)
{
struct MinHeap* minHeap = createMinHeap(size);
for (int i = 0; i < size; ++i)
 minHeap->array[i] = newNode(data[i], freq[i]);
minHeap->size = size;
buildMinHeap(minHeap);
return minHeap;
}
// The main function that builds Huffman tree
struct MinHeapNode* buildHuffmanTree(char data[], int freq[], int size)
{
struct MinHeapNode *left, *right, *top;
// Step 1: Create a min heap of capacity
// equal to size. Initially, there are
// modes equal to size.
struct MinHeap* minHeap = createAndBuildMinHeap(data, freq, size);
// Iterate while size of heap doesn't become 1
while (!isSizeOne(minHeap)) {
 // Step 2: Extract the two minimum
 // freq items from min heap
 left = extractMin(minHeap);
 right = extractMin(minHeap);
 // Step 3: Create a new internal
 // node with frequency equal to the
 // sum of the two nodes frequencies.
 // Make the two extracted node as
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 // left and right children of this new node.
 // Add this node to the min heap
 // '$' is a special value for internal nodes, not used
 top = newNode('$', left->freq + right->freq);
 top->left = left;
 top->right = right;
 insertMinHeap(minHeap, top);
}
// Step 4: The remaining node is the
// root node and the tree is complete.
return extractMin(minHeap);
}
// Prints huffman codes from the root of Huffman Tree.
// It uses arr[] to store codes
void printCodes(struct MinHeapNode* root, int arr[], int top)
{
// Assign 0 to left edge and recur
if (root->left) {
 arr[top] = 0;
 printCodes(root->left, arr, top + 1);
}
// Assign 1 to right edge and recur
if (root->right) {
 arr[top] = 1;
 printCodes(root->right, arr, top + 1);
}
// If this is a leaf node, then
// it contains one of the input
// characters, print the character
// and its code from arr[]
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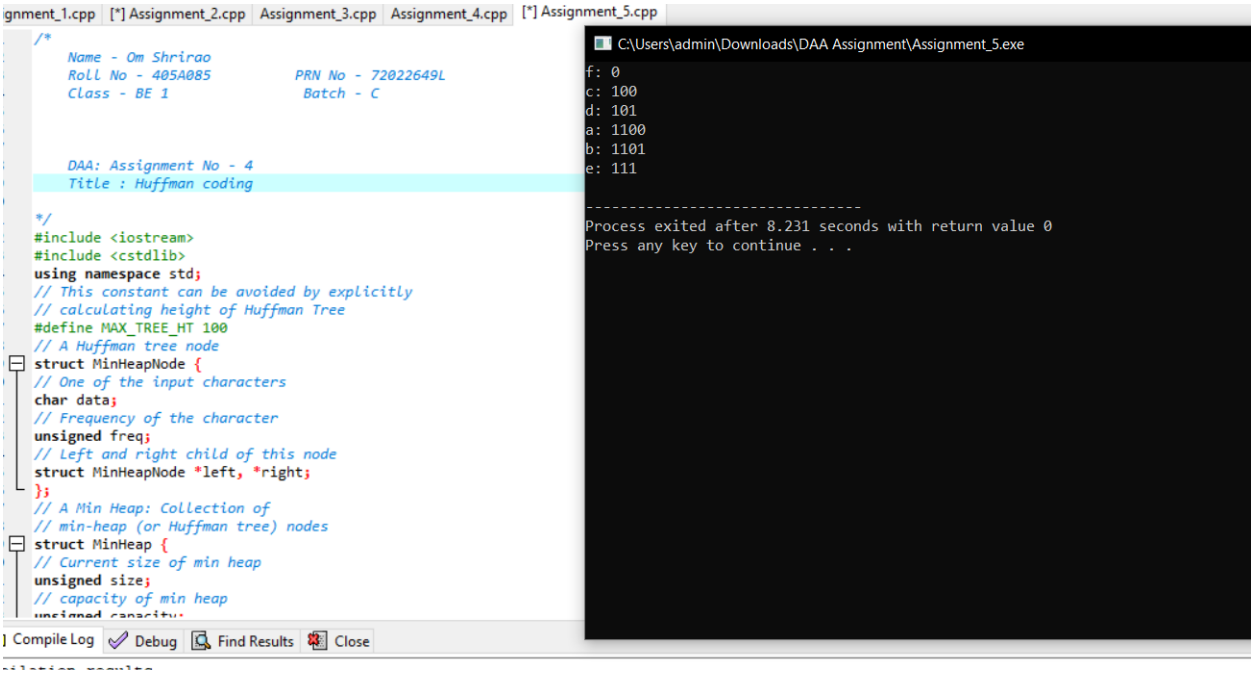
```
if (isLeaf(root)) {
 cout<< root->data <<": ";
 printArr(arr, top);
}
}
// The main function that builds a
// Huffman Tree and print codes by traversing
// the built Huffman Tree
void HuffmanCodes(char data[], int freq[], int size)
{
// Construct Huffman Tree
struct MinHeapNode* root
 = buildHuffmanTree(data, freq, size);
// Print Huffman codes using
// the Huffman tree built above
int arr[MAX_TREE_HT], top = 0;
printCodes(root, arr, top);
}
// Driver code
int main()
{
char arr[] = { 'a', 'b', 'c', 'd', 'e', 'f' };
int freq[] = { 5, 9, 12, 13, 16, 45 };
int size = sizeof(arr) / sizeof(arr[0]);
HuffmanCodes(arr, freq, size);
return 0;
}
```
Output:


ignment_1.cpp
[*] Assignment_2.cpp
Assignment_3.cpp
Assignment_4.cpp
[*] Assignment_5.cpp
/*
Name - Om Shrirao
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Class - BE 1 Batch - C
DAA: Assignment No - 4
Title : Huffman coding
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};
// A Min Heap: Collection of
// min-heap (or Huffman tree) nodes
struct MinHeap {
// Current size of min heap
unsigned size;
// capacity of min heap
unsigned capacity;
Compile Log
Debug
Find Results
Close
C:\Users\admin\Downloads\DAA Assignment\Assignment_5.exe
f: 0
c: 100
d: 101
a: 1100
b: 1101
e: 111

Process exited after 8.231 seconds with return value 0
Press any key to continue . . .