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Algorithm Lab. Class Assignment-11

CSE Group 1

Date: - 8th October 2021

1. **Write a program to implement the file or code compression using Huffman's algorithm.**

Program

```
// Author: Chaudhary Hamdan
// Generated at: Fri Oct  8 12:55:20 2021


#include <stdio.h>
#include <time.h>
#include <stdlib.h>


#define sf(x)          scanf("%d", &x)
#define pf             printf
#define pfs(x)         printf("%d ", x)
#define pfn(x)         printf("%d\n", x)
#define pfc(x)         printf("%d, ", x)
#define FI(i,x,y,inc)   for(int i = x; i < y; i += inc)
#define F(i,x,y)        FI(i, x, y, 1)
#define F0(i,n)         FI(i, 0, n, 1)
#define RF(i,x,y)       for(int i = x; i >= y; i--)
#define sfiarr(i,a,n)   int a[n]; for(int i = 0; i < n; i++) scanf("%d",&a[i])
#define  sfcarr(i,a,n)     char  a[n];  for(int  i  =  0;  i  <  n;  i++){  scanf("%c",&a[i]);
scanf("%c",&a[i]); }
#define pfiarr(i,a,n)   for(int i = 0; i < n-1; i++) pfs(a[i]); pfn(a[n-1])
```

```
#define pfcarr(i,a,n)   for(int i = 0; i < n-1; i++) printf("%c ",a[i]); printf("%c ",a[n-1])
#define MAX_TREE_HT     100

void i_o_from_file() {

#ifndef ONLINE_JUDGE
    freopen("C:\\Users\\KIIT\\input", "r", stdin);
    freopen("C:\\Users\\KIIT\\output", "w", stdout);
#endif
}

struct MinHeapNode {

    char data;
    unsigned freq;
    struct MinHeapNode *left, *right;
};

struct MinHeap {

    unsigned size;
    unsigned capacity;
    struct MinHeapNode** array;
};

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;
}

struct MinHeap* createMinHeap(unsigned capacity) {

    struct MinHeap* minHeap = (struct MinHeap *) malloc(sizeof(struct MinHeap));
    minHeap->size = 0;
    minHeap->capacity = capacity;
    minHeap->array = (struct MinHeapNode**)malloc(minHeap->capacity * sizeof(struct MinHeapNode*));
    return minHeap;
}

void swapMinHeapNode(struct MinHeapNode** a, struct MinHeapNode** b) {

    struct MinHeapNode* t = *a;
    *a = *b;
    *b = t;
}

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);
    }
}

int isSizeOne(struct MinHeap* minHeap) {

    return (minHeap->size == 1);
}

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;
}
```

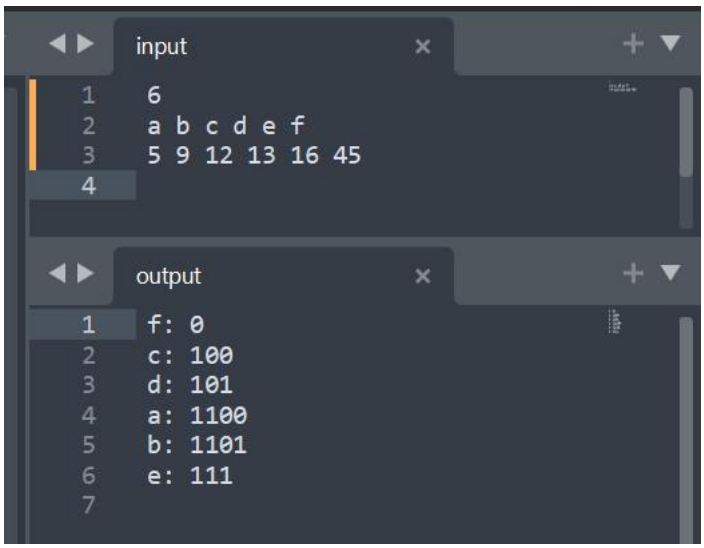
```
void insertMinHeap(struct MinHeap* minHeap, struct MinHeapNode*
minHeapNode) {

    ++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;
}

void buildMinHeap(struct MinHeap* minHeap) {

    int n = minHeap->size - 1;
    int i;
    for (i = (n - 1) / 2; i >= 0; --i)
            minHeapify(minHeap, i);
}

void printArr(int arr[], int n) {

    int i;
    for (i = 0; i < n; ++i)
            printf("%d", arr[i]);
    printf("\n");
}

int isLeaf(struct MinHeapNode* root) {
```

```
    return !(root->left) && !(root->right);
}

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;
}

struct MinHeapNode* buildHuffmanTree(char data[], int freq[], int size) {

    struct MinHeapNode *left, *right, *top;

    struct MinHeap* minHeap
       = createAndBuildMinHeap(data, freq, size);

    while (!isSizeOne(minHeap)) {

            left = extractMin(minHeap);
            right = extractMin(minHeap);

            top = newNode('$', left->freq + right->freq);
```

```
            top->left = left;
            top->right = right;

            insertMinHeap(minHeap, top);
    }
    return extractMin(minHeap);
}

void printCodes(struct MinHeapNode* root, int arr[], int top) {

    if (root->left) {

            arr[top] = 0;
            printCodes(root->left, arr, top + 1);
    }
    if (root->right) {

            arr[top] = 1;
            printCodes(root->right, arr, top + 1);
    }
    if (isLeaf(root)) {

            printf("%c: ", root->data);
            printArr(arr, top);
    }
}

void HuffmanCodes(char data[], int freq[], int size) {

    struct MinHeapNode* root = buildHuffmanTree(data, freq, size);
    int arr[MAX_TREE_HT], top = 0;
```

```
    printCodes(root, arr, top);
}

int main() {

    i_o_from_file();
    /* ********************************************** */

    int n;
    sf(n);

    sfcarr(i, arr, n)
    sfiarr(i, freq, n);

    HuffmanCodes(arr, freq, n);
    return 0;
}
```

Output



2. **Write a C program to implement Breadth First Search.**

Program

```
// Author: Chaudhary Hamdan
// Generated at: Fri Oct  8 14:06:41 2021

#include <stdio.h>
#include <time.h>
#include <stdlib.h>

#define sf(x)          scanf("%d", &x)
#define pf             printf
#define pfs(x)         printf("%d ", x)
#define pfn(x)         printf("%d\n", x)
#define pfc(x)         printf("%d, ", x)
#define FI(i,x,y,inc)   for(int i = x; i < y; i += inc)
#define F(i,x,y)       FI(i, x, y, 1)
#define F0(i,n)        FI(i, 0, n, 1)
#define RF(i,x,y)       for(int i = x; i >= y; i--)
#define pfarr(i,a,n)    for(int i = 0; i < n-1; i++) pfs(a[i]); pfn(a[n-1]);
#define SIZE           40


void i_o_from_file();

struct queue {
    int items[SIZE];
    int front;
    int rear;
};

struct queue* createQueue();
```

```
void enqueue(struct queue* q, int);
int dequeue(struct queue* q);
void display(struct queue* q);
int isEmpty(struct queue* q);
void printQueue(struct queue* q);

struct node {
    int vertex;
    struct node* next;
};

struct node* createNode(int);

struct Graph {
    int numVertices;
    struct node** adjLists;
    int* visited;
};

void bfs(struct Graph* graph, int startVertex) {
    struct queue* q = createQueue();

    graph->visited[startVertex] = 1;
    enqueue(q, startVertex);

    while (!isEmpty(q)) {
            printQueue(q);
            int currentVertex = dequeue(q);
            printf("Visited %d\n", currentVertex);

            struct node* temp = graph->adjLists[currentVertex];
```

```
            while (temp) {
                int adjVertex = temp->vertex;

                if (graph->visited[adjVertex] == 0) {
                    graph->visited[adjVertex] = 1;
                    enqueue(q, adjVertex);
                }
                temp = temp->next;
            }
        }
    }

struct node* createNode(int v) {
    struct node* newNode = malloc(sizeof(struct node));
    newNode->vertex = v;
    newNode->next = NULL;
    return newNode;
}

struct Graph* createGraph(int vertices) {
    struct Graph* graph = malloc(sizeof(struct Graph));
    graph->numVertices = vertices;

    graph->adjLists = malloc(vertices * sizeof(struct node*));
    graph->visited = malloc(vertices * sizeof(int));

    int i;
    for (i = 0; i < vertices; i++) {
        graph->adjLists[i] = NULL;
        graph->visited[i] = 0;
```

```
    }
    return graph;
}

void addEdge(struct Graph* graph, int src, int dest) {
    // Add edge from src to dest
    struct node* newNode = createNode(dest);
    newNode->next = graph->adjLists[src];
    graph->adjLists[src] = newNode;

    // Add edge from dest to src
    newNode = createNode(src);
    newNode->next = graph->adjLists[dest];
    graph->adjLists[dest] = newNode;
}

struct queue* createQueue() {
    struct queue* q = malloc(sizeof(struct queue));
    q->front = -1;
    q->rear = -1;
    return q;
}

int isEmpty(struct queue* q) {
    if (q->rear == -1)
            return 1;
    else
            return 0;
}

void enqueue(struct queue* q, int value) {
```

```
    if (q->rear == SIZE - 1)
        printf("\nQueue is Full!!");
    else {
        if (q->front == -1)
            q->front = 0;
        q->rear++;
        q->items[q->rear] = value;
    }
}

int dequeue(struct queue* q) {
    int item;
    if (isEmpty(q)) {
        printf("Queue is empty");
        item = -1;
    }
    else {
        item = q->items[q->front];
        q->front++;
        if (q->front > q->rear) {
            // printf("Resetting queue ");
            q->front = q->rear = -1;
        }
    }
    return item;
}

void printQueue(struct queue* q) {
    int i = q->front;

    if (isEmpty(q)) {
```

```
            printf("Queue is empty");
    } else {
            printf("\nQueue contains \n");
            for (i = q->front; i < q->rear + 1; i++) {
                    printf("%d ", q->items[i]);
            }
    }
}

int main() {

    i_o_from_file();
    /* ********************************************** */

    int v;
    sf(v);

    struct Graph* graph = createGraph(v);

    while (1) {
            int a, b;
            sf(a);

            if (a == -1) {
                    break;
            }

            sf(b);
            addEdge(graph, a, b);
    }
    bfs(graph, 0);
```

```
    return 0;
}
void i_o_from_file() {

#ifndef ONLINE_JUDGE
    freopen("C:\\Users\\KIIT\\input", "r", stdin);
    freopen("C:\\Users\\KIIT\\output", "w", stdout);
#endif
}
```

Output