1. **Huffman code using greedy approach.**

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

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;
```

```c
    int right = 2 * idx + 2;
    if (left < (int)minHeap->size && minHeap->array[left]->freq < minHeap->array[smallest]->freq)
        smallest = left;
    if (right < (int)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;
    for (int i = (n - 1) / 2; i >= 0; --i)
        minHeapify(minHeap, i);
}

int isLeaf(struct MinHeapNode* root) {
    return !(root->left) && !(root->right);
}
```

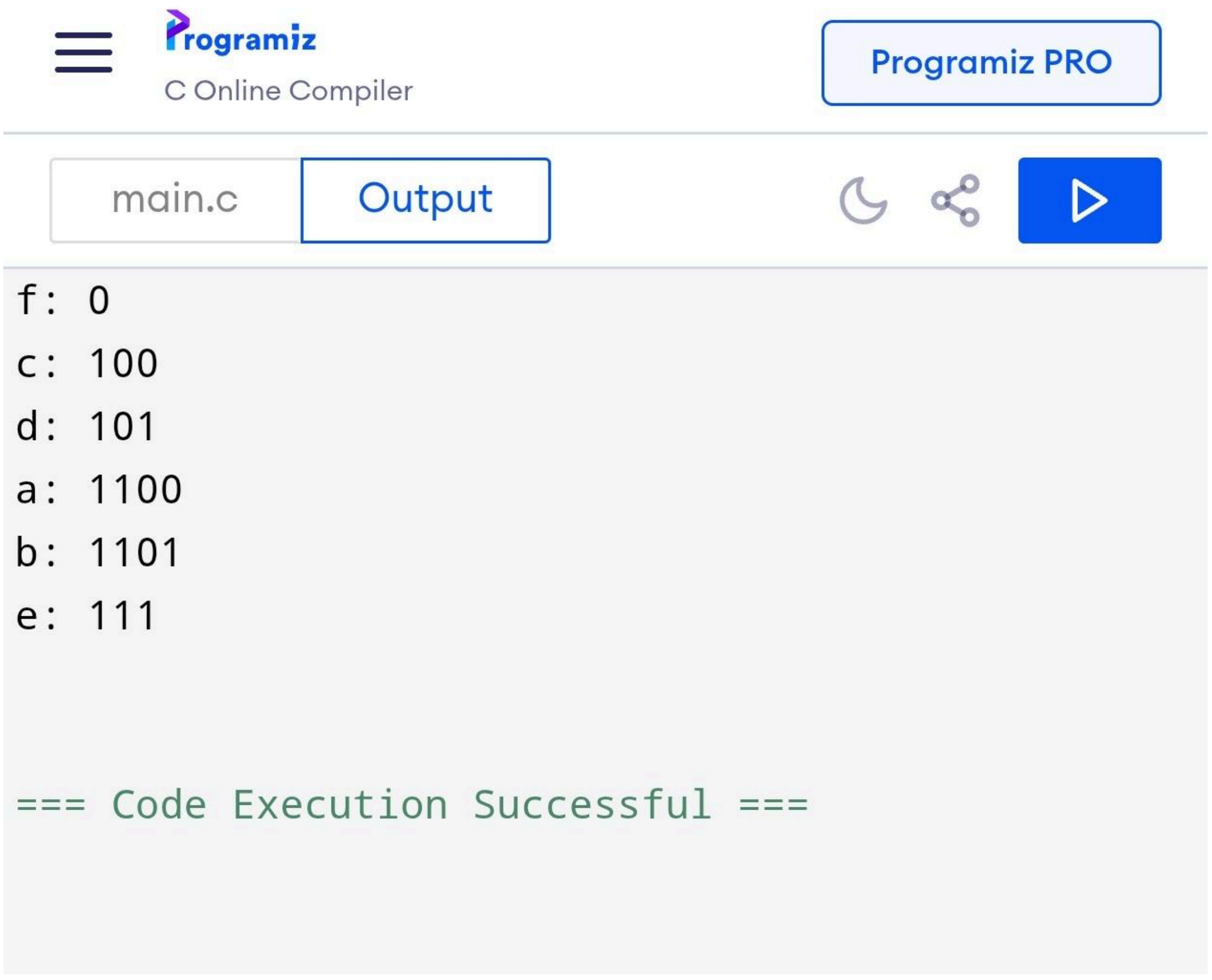
```
struct MinHeap* createAndBuildMinHeap(char data[], int freq[], int size) {
    struct MinHeap* minHeap = createMinHeap(size);
    for (int i = 0; i < size; ++i)
        minHeap->array[i] = newNode(data[i], freq[i]);
    minHeap->size = size;
    buildMinHeap(minHeap);
    return minHeap;
}

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

void HuffmanCodes(char data[], int freq[], int size) {
    struct MinHeapNode* root = buildHuffmanTree(data, freq, size);
    int arr[100], top = 0;
    printCodes(root, arr, top);
}

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;
}
```



```
f: 0
c: 100
d: 101
a: 1100
b: 1101
e: 111


=== Code Execution Successful ===
```