ALGORITHMS ASSIGNMENT

Huffman Code

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SYED TAFREED NUMAN
Sc ID 18-15-043

Solution 1:

Implementation Done. Code and Output Table Pasted Below.

Solution 2: Algorithms Used

1(a)Priority Queue

HEAP-EXTRACT-MIN(A)

1. *If A.heapsize<1*
2. *error "heap underflow"*
3. *min=A[1]*
4. *A[1] = A[A.heapsize]*
5. *A.heapsize = A.heapsize-1*
6. *MIN-HEAPIFY(A,1)*
7. *return min*

HEAP-INSERT-KEY(A,key)

1. *A.heapsize = A.heapsize+1;*
2. *A[A.heapszie]=key*
3. *i = A.heapsize*
4. *while i>1 and A[PARENT(i)]>A[i]*
5. *exchange A[i] with A[PARENT(i)]*
6. *i=PARENT(i)*

PARENT(i)

1. *return floor(i/2)*

1(b)Merging Two nodes

HUFFMAN-NODES-MERGE(A)

1. *while A.heapsize!=1*
2. *allocate a new node Z*
3. *Z.left=x=HEAP-EXTRACT-MIN(A)*
4. *Z.right=y= HEAP-EXTRACT-MIN(A)*
5. *Z.freq=x.freq+y.freq*
6. *HEAP-INSERT-KEY(A,Z)*
7. *Return HEAP-EXTRACT-MIN(A)*

1 (c) COMIBINING to make Huffman code

HUFFMAN-CODE(A,Data,Freq)

1. *for i=1 upto Data.size*
2. *A[i].data=Data[i]*
3. *A[i].freq=Freq[i]*
4. *BUILD-MIN-HEAP(A)*
5. *root = HUFFMAN-NODES-MERGE(A)*
6. *create array "code"*
7. *top=0*
8. *PRINT-HUFFMAN-CODE(root,code,top)*

1(d) Decoding and Printing the Codes

PRINT-HUFFMAN-CODE(root,code,top)

1. *If root->left*
2. *code[top] = 0*
3. *PRINT-HUFFMAN-CODE(root->left,code,top+1)*
4. *If root->right*
5. *code[top] = 0*
6. *PRINT-HUFFMAN-CODE(root->right,code,top+1)*
7. *If root is a leaf node*
8. *print array "code"*

1(e) STRUCTURE OF NODES

```
Struct heapnode{
    Char data;
    Int freq;
    Struct heapnode *left, *right;
}
```

Solution 3

CODE:

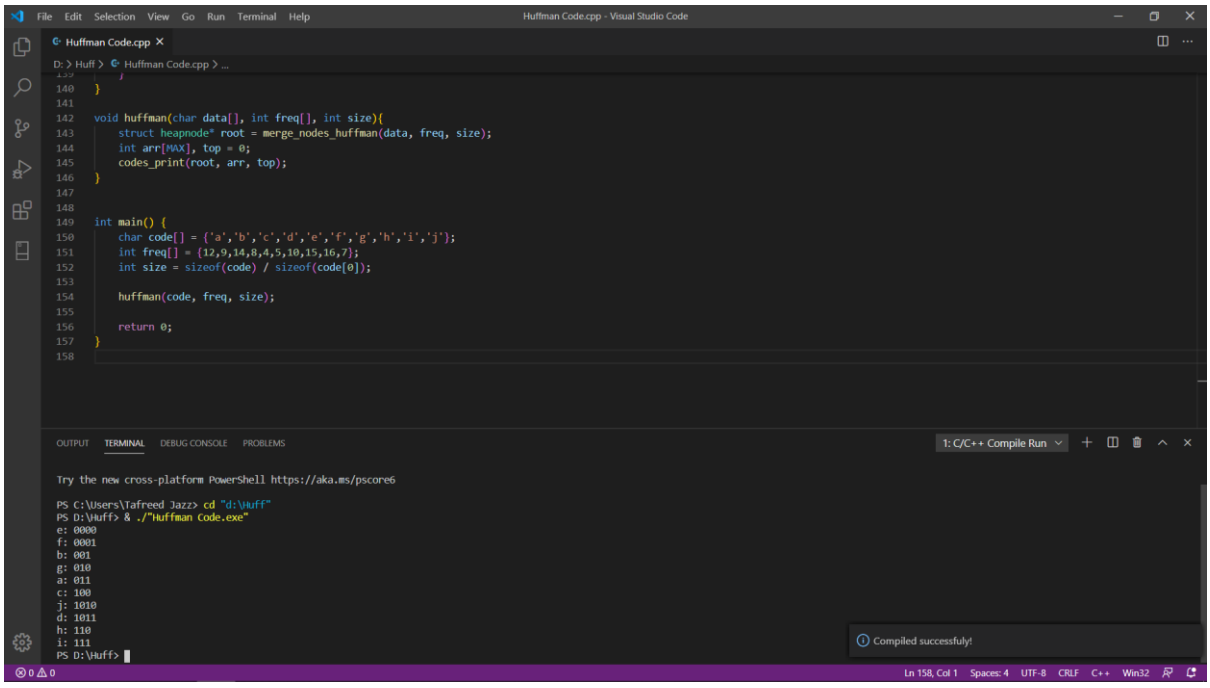
```
#include<bits/stdc++.h>
using namespace std;

#define MAX 100

struct heapnode{

   char data;
   int freq;
   struct heapnode *left, *right;
};

struct heap{

   int size;

   int heapsize;

   struct heapnode** arr;

};

struct heapnode* new_node(char data, unsigned freq){

   struct heapnode* temp = (struct heapnode*)malloc(sizeof(struct heapnode));

   temp->left = temp->right = NULL;

   temp->data = data;

   temp->freq = freq;

   return temp;

}

struct heap* create(unsigned heapsize){

   struct heap* heap = (struct heap*)malloc(sizeof(struct heap));

   heap->size = 0;

   heap->heapsize = heapsize;

   heap->arr = (struct heapnode**)malloc(heap->

   heapsize * sizeof(struct heapnode*));

   return heap;

}
```

```
void swap_node(struct heapnode** node1,struct heapnode** node2){
   struct heapnode* temp = *node1;
   *node1 = *node2;
   *node2 = temp;
}


void heapify(struct heap* heap, int index){
   int small = index;
   int left = 2 * index + 1;
   int right = 2 * index + 2;
   if (left < heap->size && heap->arr[left]->freq < heap->arr[small]->freq)
      small = left;
   if (right < heap->size && heap->arr[right]->freq < heap->arr[small]->freq)
      small = right;
   if (small != index) {
      swap_node(&heap->arr[small],&heap->arr[index]);
      heapify(heap, small);
   }
}

int size_check(struct heap* heap){
   return (heap->size == 1);
}

struct heapnode* extractMin(struct heap* heap){
   struct heapnode* temp = heap->arr[0];
   heap->arr[0]
      = heap->arr[heap->size - 1];
   --heap->size;
   heapify(heap, 0);

   return temp;
}
void insertheap(struct heap* heap,struct heapnode* heapnode){
```

```
    ++heap->size;
    int i = heap->size - 1;
    while (i && heapnode->freq < heap->arr[(i - 1) / 2]->freq) {
        heap->arr[i] = heap->arr[(i - 1) / 2];
        i = (i - 1) / 2;
    }
    heap->arr[i] = heapnode;
}

void buildheap(struct heap* heap){
    int n = heap->size - 1;
    int i;
    for (i = (n - 1) / 2; i >= 0; --i)
        heapify(heap, i);
}
void printArr(int arr[], int n){
    int i;
    for (i = 0; i < n; ++i)
        cout << arr[i];
    cout << endl;
}
int leaf_check(struct heapnode* root){
    return !(root->left) && !(root->right);
}
struct heap* createAndBuildheap(char data[], int freq[], int size) {
    struct heap* heap = create(size);
    for (int i = 0; i < size; ++i)
        heap->arr[i] = new_node(data[i], freq[i]);
    heap->size = size;
    buildheap(heap);
    return heap;
}
struct heapnode* merge_nodes_huffman(char data[], int freq[], int size){
    struct heapnode *left, *right, *top;
    struct heap* heap = createAndBuildheap(data, freq, size);
    while (!size_check(heap)){
        left = extractMin(heap);
```

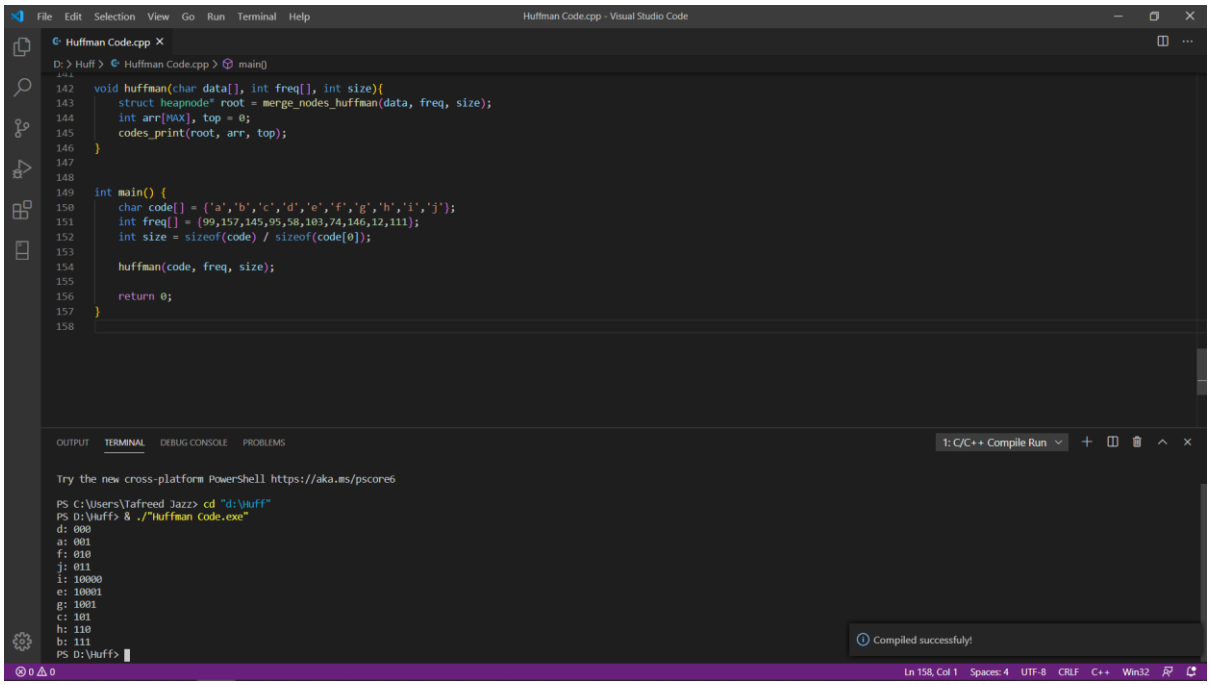
```
        right = extractMin(heap);
        top = new_node('$', left->freq + right->freq);
        top->left = left;
        top->right = right;
        insertheap(heap, top);
    }
    return extractMin(heap);
}

void codes_print(struct heapnode* root, int arr[], int top){
    if (root->left) {
        arr[top] = 0;
        codes_print(root->left, arr, top + 1);
    }
    if (root->right) {
        arr[top] = 1;
        codes_print(root->right, arr, top + 1);
    }
    if (leaf_check(root)) {
        cout<< root->data <<": ";
        printArr(arr, top);
    }
}
void huffman(char data[], int freq[], int size){
    struct heapnode* root = merge_nodes_huffman(data, freq, size);
    int arr[MAX], top = 0;
    codes_print(root, arr, top);
}
  int main() {
    char code[] = {'a','b','c','d','e','f','g','h','i','j'};
    int freq[] = {1097,178,1357,759,1009,598,951,1417,1533,1101};
    int size = sizeof(code) / sizeof(code[0]);

    huffman(code, freq, size);

    return 0;
}
```

SNAPSHOT OF OUTPUT(TEXT-1 ,TEXT-2, TEXT-3)



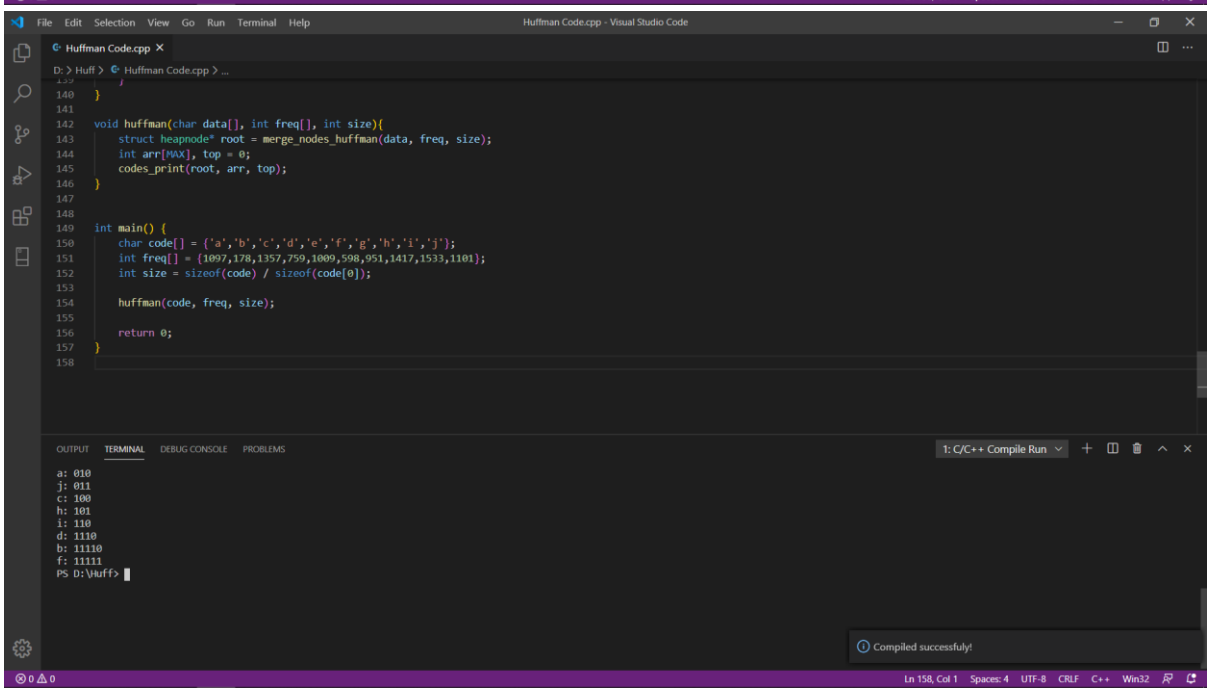
```
}

void huffman(char data[], int freq[], int size){
    struct heapnode* root = merge_nodes_huffman(data, freq, size);
    int arr[MAX], top = 0;
    codes_print(root, arr, top);
}


int main() {
    char code[] = {'a','b','c','d','e','f','g','h','i','j'};
    int freq[] = {12,9,14,8,4,5,10,15,16,7};
    int size = sizeof(code) / sizeof(code[0]);

    huffman(code, freq, size);

    return 0;
}
```

```
Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\Tafreed Jazz> cd "d:\Huff"
PS D:\Huff> & ./"Huffman Code.exe"
e: 0000
f: 0001
b: 001
g: 010
a: 011
c: 100
j: 1010
d: 1011
h: 110
i: 111
PS D:\Huff>
```



```
void huffman(char data[], int freq[], int size){
    struct heapnode* root = merge_nodes_huffman(data, freq, size);
    int arr[MAX], top = 0;
    codes_print(root, arr, top);
}


int main() {
    char code[] = {'a','b','c','d','e','f','g','h','i','j'};
    int freq[] = {99,157,145,95,58,103,74,146,12,111};
    int size = sizeof(code) / sizeof(code[0]);

    huffman(code, freq, size);

    return 0;
}
```

```
Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\Tafreed Jazz> cd "d:\Huff"
PS D:\Huff> & ./"Huffman Code.exe"
d: 000
a: 001
f: 010
j: 011
i: 10000
e: 10001
g: 1001
c: 101
h: 110
b: 111
PS D:\Huff>
```



```
}

void huffman(char data[], int freq[], int size){
    struct heapnode* root = merge_nodes_huffman(data, freq, size);
    int arr[MAX], top = 0;
    codes_print(root, arr, top);
}


int main() {
    char code[] = {'a','b','c','d','e','f','g','h','i','j'};
    int freq[] = {1097,178,1357,759,1009,598,951,1417,1533,1101};
    int size = sizeof(code) / sizeof(code[0]);

    huffman(code, freq, size);

    return 0;
}
```

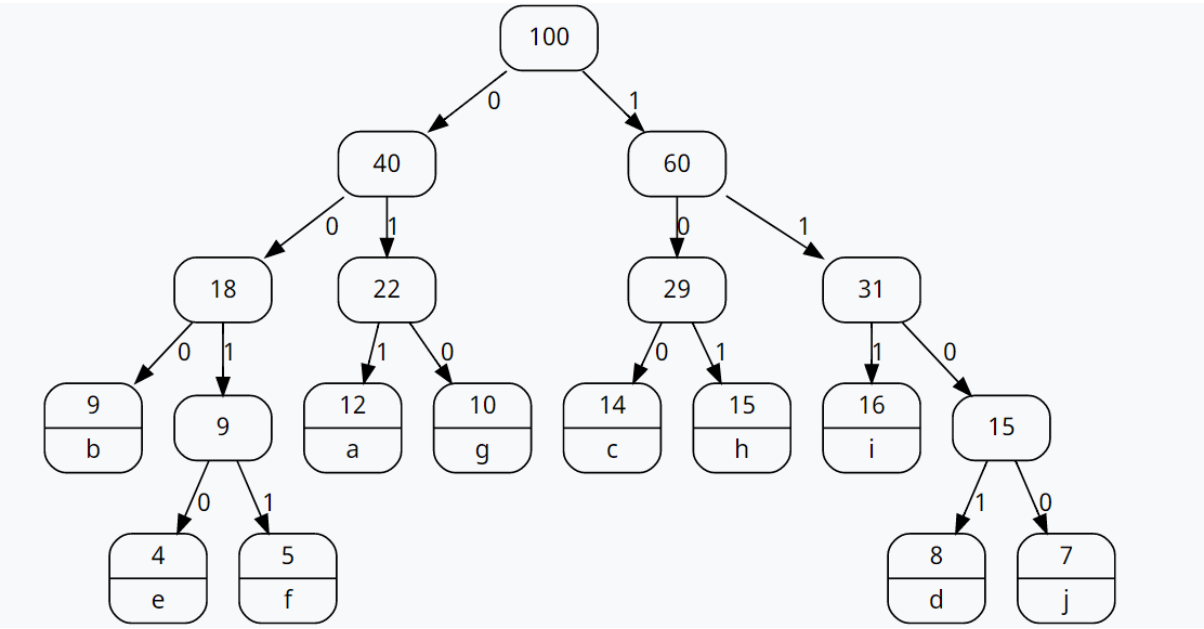
```
a: 010
j: 011
c: 100
h: 101
i: 110
d: 1110
b: 11110
f: 11111
PS D:\Huff>
```

OUTPUT TABLE:

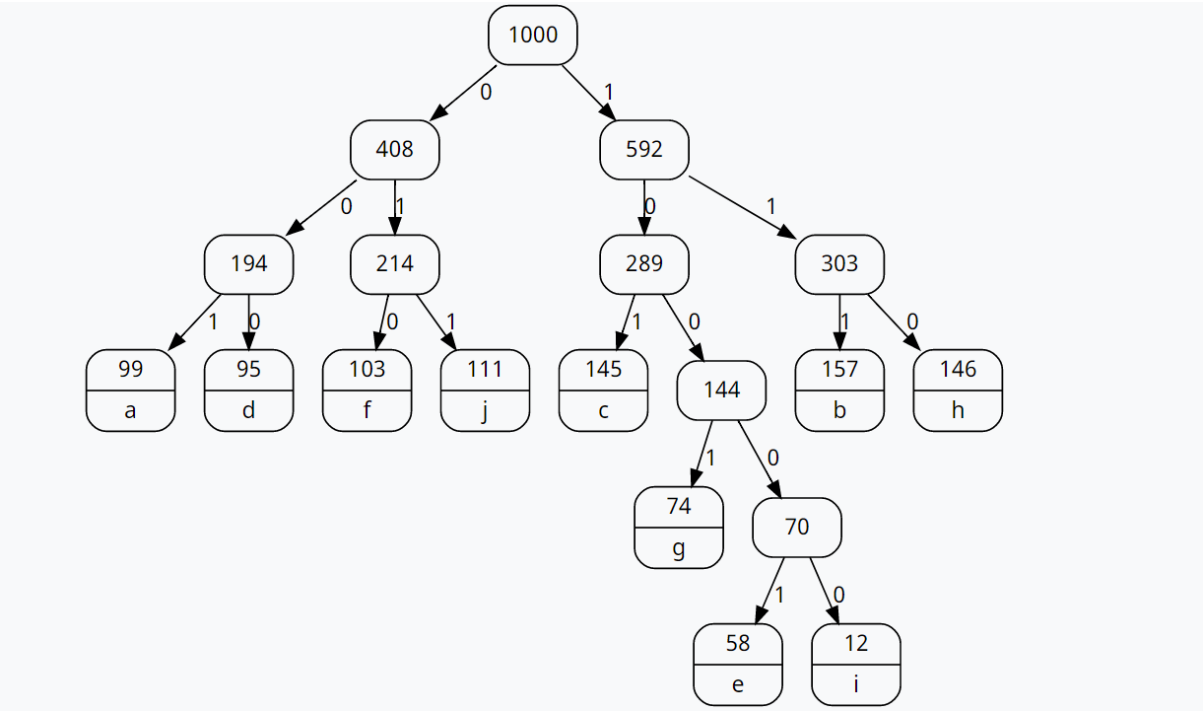
Character	TEXT 1 (Length 100)		TEXT 2 (Length 1000)		TEXT 3 (Length 10000)	
a	12	011	99	001	1097	010
b	9	001	157	111	178	11110
c	14	100	145	101	1357	100
d	8	1011	95	000	759	1110
e	4	0000	58	10001	1009	001
f	5	0001	103	010	598	11111
g	10	010	74	1001	951	000
h	15	110	146	110	1417	101
i	16	111	12	10000	1533	110
j	7	1010	111	011	1101	011

SOLUTION 4: Structure of Huffman Tree

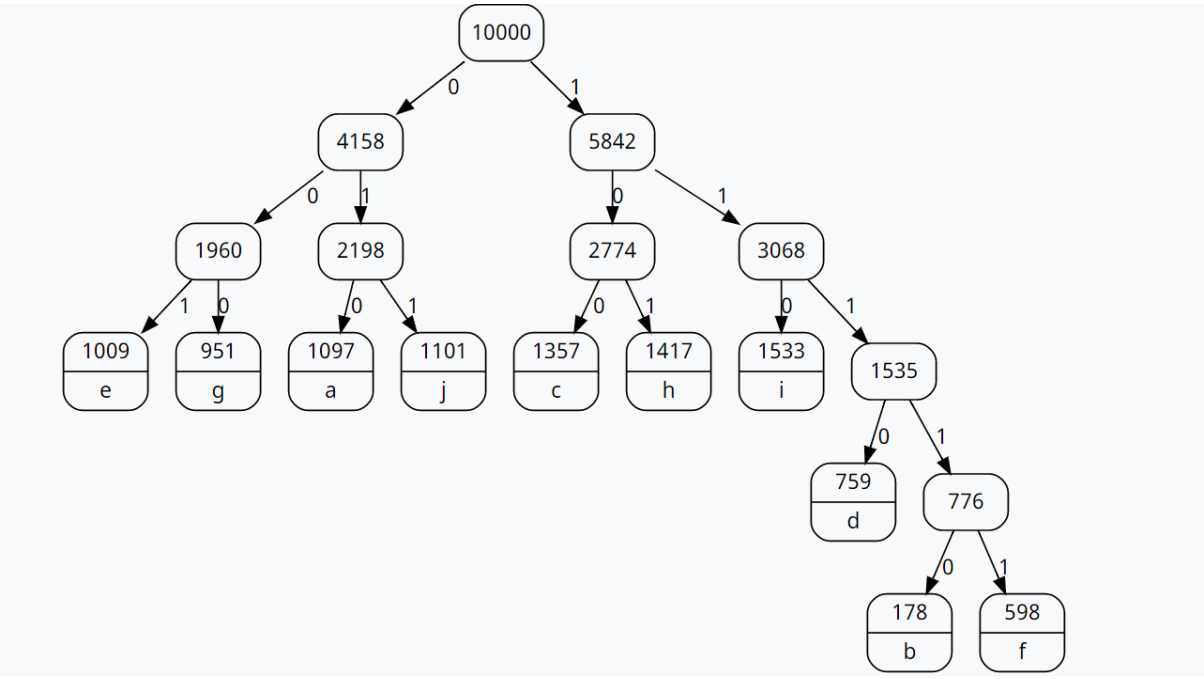
For TEXT-1(Length 100)



For TEXT-2(Length 1000)



For TEXT-2(Length 10000)



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