UCS415 – Design and Analysis of Algorithms

Lab Assignment 2

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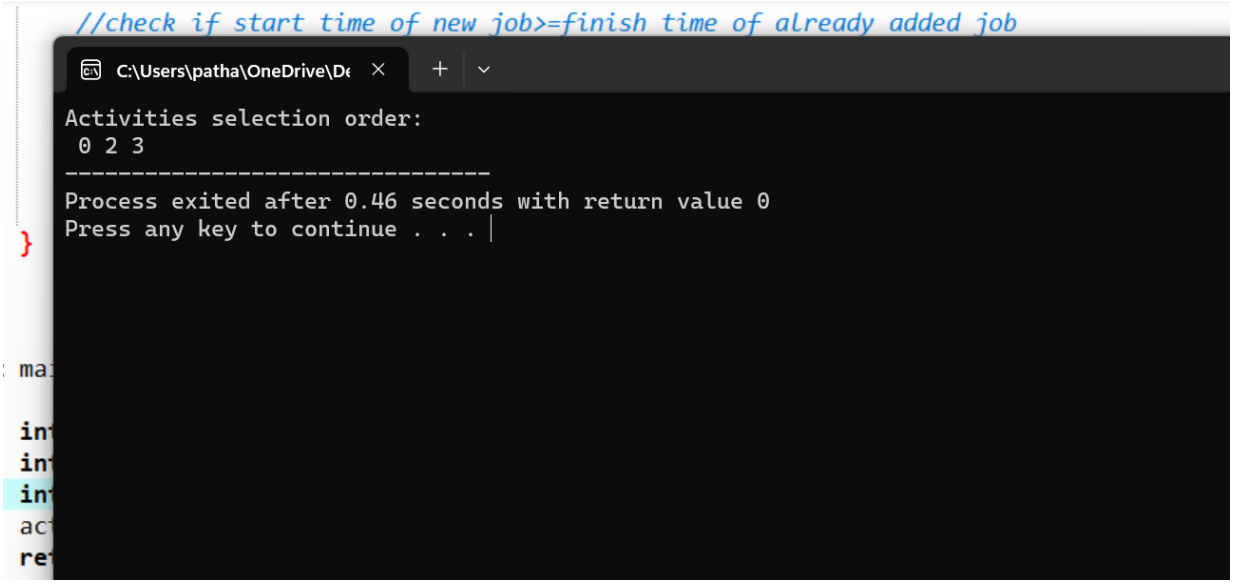
Write a program to solve the following problems using greedy Greedy approach:

- **Activity selection**

```
/*
1. Activity Selection problem
*/
#include<iostream>
using namespace std;

void activity_selector(int s[],int f[],int n){
    int k=0;
    cout<<"Activities selection order: \n "<<k<<" ";
    //traverse from second activity to nth one (index from 0 so start from 1)
    for(int m=1;m<n;m++){
    //check if start time of new job>=finish time of already added job
    if(s[m]>=f[k]){
            //add it to soln
            cout<<m<<" ";
            //set k to new inserted
            k=m;
    }
    }

}

int main()
```

```
{
    int s[]={0,1,3,4,5};
    int f[]={2,3,4,6,7};
    int n=sizeof(s)/sizeof(s[0]);          //store number of activities in n
    activity_selector(s,f,n);
    return 0;
    }
```

OUTPUT:

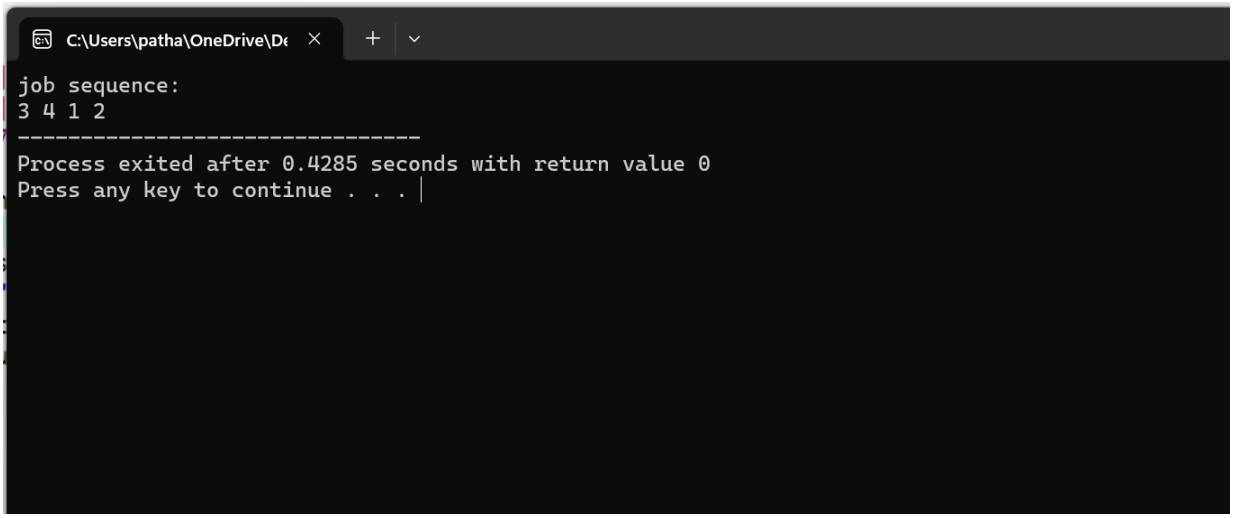


- **Job sequencing**

```
/*
2. Job sequencing with deadlines
*/

#include<iostream>
using namespace std;

int job_seq(int d[],int j[],int n){

    //initialise first elements of d,j array
    d[0]=j[0]=0;

    //include 1st job of maxm profit
    j[1]=1;

    //k represents no of jobs considered
    int k=1;

    //loop from second to last job
    for(int i=2;i<=n;i++){
    //search for position r to insert job i
```

```
    int r=k;

    while(d[j[r]]>d[i] && d[j[r]]!=r){
        r=r-1;
    }

    //check if job can be inserted
    if(d[j[r]]<=d[i] && d[i]>r){
        //make space for new job by shifting rest downwards
        for(int q=k;q>=r+1;q--){
            j[q+1]=j[q];
        }
        //insert
        j[r+1]=i;
        //increase count of k ie no of jbs considered
        k=k+1;
    }
    }
    return k;           //ie no of jobs considered
}

int main()
{
    int d[]={3,4,4,2,3,1,2};
    int p[]={35,30,25,20,15,12,5};
    int n=7;

    int j[n+1];         //array to store job sequence

    int ans=job_seq(d,j,n);
    cout<<"job sequence: \n";
    for(int i=1;i<=ans;i++){
    cout<<j[i]<<" ";
    }


    return 0;
    }
```

OUTPUT:

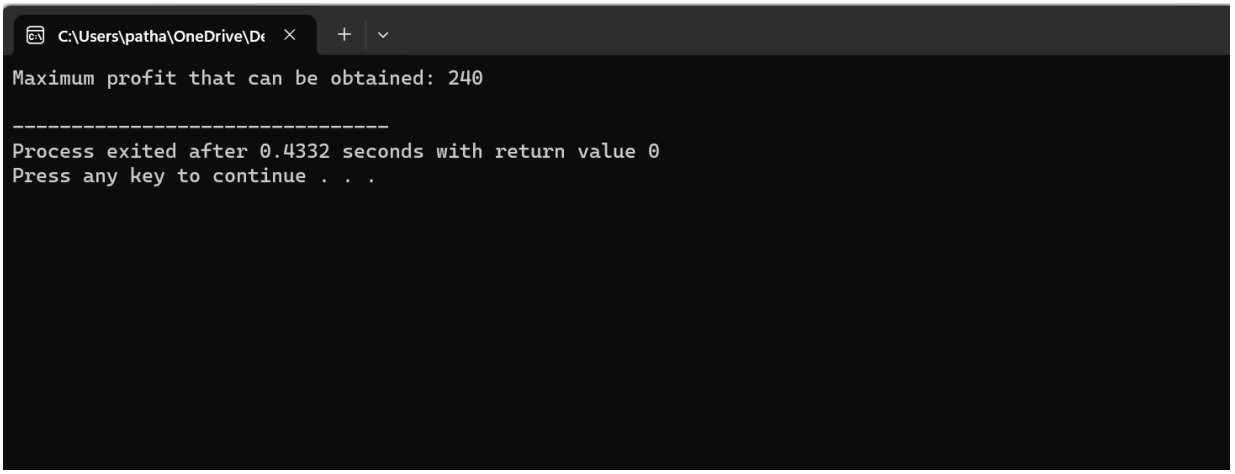


- **Fractional knapsack**

```
/*
3. Fractional knapsack
*/

#include<iostream>
#include <algorithm>                //to use sort fnc
using namespace std;

struct item{
   int profit;
   int weight;
};



bool compareItems(const item &a,const item &b) {
   return (1.0*a.profit/a.weight)>(1.0*b.profit/b.weight);
}

double knapsack(item objects[],int n,int M) {
   //to sort items in descending order of profit/weight (per-unit profit)
   sort(objects,objects+n,compareItems);

   double totalval = 0.0;
   for(int i=0; i<n; i++) {
     //curr item weight> knapsack remain capacity then take fractional
      if(objects[i].weight>M){
```

```
            //take fraction
            totalval=totalval+M*(1.0*objects[i].profit/objects[i].weight);
            M=0;
            break;
        }
      else{
            //take full item
            totalval=totalval+objects[i].profit;
            M=M-objects[i].weight;
        }
    }
    return totalval;
}

int main()
{
      //no of items
      int n=3;
      //capacity of knapsack
    int M=50;

    //add profit,weight
    item objects[n]={{60,10},{100,20},{120,30}};
    cout<<"Maximum profit that can be obtained: "<<knapsack(objects,n,M)<<endl;

      return 0;
}
```

OUTPUT:



- **Huffman Coding**

```
/*
4. Huffman Coding
*/

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

//maximum height of huffman tree
#define MAX_TREE_HT 100

//defining node of huffman tree
struct MinHeapNode{
     //characters of msg
   char data;
   //frequncy/count of character in msg
   int freq;
   //left n right child
   struct MinHeapNode *left,*right;
};

//creating a collection of huffman tree nodes
struct MinHeap{
     //current size of min heap
   int size;
   //capacity of min heap
   int capacity;
   //array of min heap node pointers
   struct MinHeapNode** array;
};

//creating node of character n its frequency
struct MinHeapNode* newNode(char data, int freq){
   struct MinHeapNode* temp=(struct MinHeapNode*)malloc(sizeof(struct
     MinHeapNode));
   temp->left=temp->right=NULL;
   temp->data=data;
```

```
    temp->freq=freq;
    return temp;
}

//to create min heap of given capcity
struct MinHeap* createMinHeap(int capacity){
    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;
}

//fnc to swap 2 min heap nodes
void swapMinHeapNode(struct MinHeapNode** a, struct MinHeapNode** b){
    struct MinHeapNode* t=*a;
    *a=*b;
    *b=t;
}

//min heapify fn
void minHeapify(struct MinHeap* minHeap, int idx){
    int smallest=idx, left=2 * idx + 1, 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);
    }
}

//to check if size of heap is 1 or not
int isSizeOne(struct MinHeap* minHeap){
    return(minHeap->size==1);
```

```
}

//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;
}

//to insert new node in min heap
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;
}

//to build min heap
void buildMinHeap(struct MinHeap* minHeap){
    int n=minHeap->size-1;
    for(int i=(n-1)/ 2; i >= 0; --i)
        minHeapify(minHeap, i);
}

//to print array of size n
void printArr(int arr[], int n){
    for(int i=0; i<n; ++i)printf("%d", arr[i]);
    printf("\n");
}

//to check if node is leaf node or not
int isLeaf(struct MinHeapNode* root){
    return !(root->left)&& !(root->right);
}
```

```
//To create a min heap of capacity=size and inserts all ip character in min heap
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;
}

//builds huffman tree
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);
}

//print codes from root to leaf
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);
    }
```

```
}

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

    return 0;
}
```

OUTPUT: