AFRAAZ HUSSAIN
20BDS0374
DESIGN AND ANALYSIS OF ALGORITHMS
LAB ASSESSMENT 1

QUESTION:

Write menu-driven program to implement 0/1 and fractional knapsack problem using greedy approach.

PSEUDOCODE:

```
function main():
    numberOfItems, knapsackSize = input()

    choice = input()
    if choice = 'A':
        print(zeroByOneKnapsack(numberOfItems, knapsackSize))
    else:
        print(fractionalKnapSack(numberOfItems, knapsackSize))

function zeroByOneKnapsack():
    items[numberOfItems][3] = input(itemValue, itemWeight, itemNumber)

    float: ratio[numberOfItems]
    for element in items:
        ratio[element] = element[0] / element[1]

    items.sort(descendingly, ratio)
    value = 0

    for element in sortedItems:
        if element[1] <= knapsackSize:
            value += element[0]
            knapsackSize -= element[1]

    return value

function zeroByOneKnapsack():
    items[numberOfItems][3] = input(itemValue, itemWeight, itemNumber)

    float: ratio[numberOfItems]
    for element in items:
        ratio[element] = element[0] / element[1]

    items.sort(descendingly, ratio)
    value = 0

    for element in sortedItems:
        if element[1] <= knapsackSize:
            value += element[0]
```

```
            knapsackSize -= element[1]

        else:
            if ratio[element] <= knapsackSize:
                value += ratio[element] * knapsackSize

    return value
```

CODE:

```
#include <stdio.h>



void zeroByOneKnapsack(int numberOfItems, int knapsackSize)
{
    int itemsToInclude[numberOfItems], items[numberOfItems][3],
temporaryStorage[1][3], value = 0, index, secondaryIndex, counter = 0;
    float temporaryRatio, ratio[numberOfItems];

    printf("\n\n");
    for (index = 0; index < numberOfItems; index++)
    {
        printf("Please enter the value and weight of item %d: ", index + 1);
        scanf("%d %d", &items[index][0], &items[index][1]);
        ratio[index] = (float)items[index][0] / (float)items[index][1];
        items[index][2] = index + 1;
    }

    for (index = 0; index < numberOfItems; ++index)
    {
        for (secondaryIndex = index + 1; secondaryIndex < numberOfItems;
++secondaryIndex)
        {
            if (items[index][2] < items[secondaryIndex][2])
            {
                temporaryStorage[0][0] = items[index][0];
                temporaryStorage[0][1] = items[index][1];
                temporaryStorage[0][2] = items[index][2];
                temporaryRatio = ratio[index];
                items[index][0] = items[secondaryIndex][0];
                items[index][1] = items[secondaryIndex][1];
                items[index][2] = items[secondaryIndex][2];
                ratio[index] = ratio[secondaryIndex];
                items[secondaryIndex][0] = temporaryStorage[0][0];
                items[secondaryIndex][1] = temporaryStorage[0][1];
```

```
                items[secondaryIndex][2] = temporaryStorage[0][2];
                ratio[secondaryIndex] = temporaryRatio;
            }
        }
    }

    if (items[0][1] > knapsackSize)
        {
            printf("\n\nNone of the items can be in the knapsack of given
size.");
            return;
        }
    for (index = 0; index < numberOfItems; index++)
    {
        if (items[index][1] <= knapsackSize)
        {
            itemsToInclude[counter] = items[index][2];
            value += items[index][0];
            knapsackSize -= items[index][1];
            counter++;
        }

        else break;
    }

    printf("\n\nThe following are the items that can be put in the
knapsack:");
    for (index = 0; index < counter; index++) printf(" %d",
itemsToInclude[index]);
    printf("\nThe total profit was calculated to be: %d", value);

    return;
}

void fractionalKnapsack(int numberOfItems, int knapsackSize)
{
    int itemsToInclude[numberOfItems], items[numberOfItems][3],
temporaryStorage[1][3], index, secondaryIndex, counter = 0, additionalItem =
0;
    float temporaryRatio, ratio[numberOfItems], value = 0;

    printf("\n\n");
    for (index = 0; index < numberOfItems; index++)
    {
        printf("Please enter the value and weight of item %d: ", index + 1);
        scanf("%d %d", &items[index][0], &items[index][1]);
```

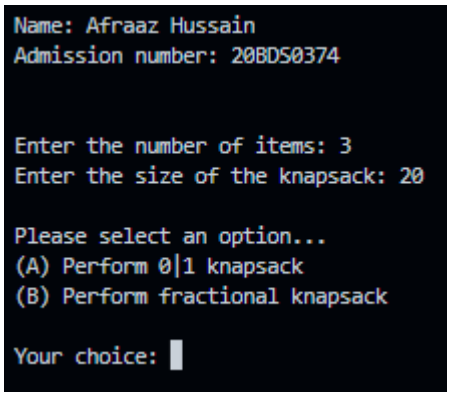
```
        ratio[index] = (float)items[index][0] / (float)items[index][1];
        items[index][2] = index + 1;
    }

    for (index = 0; index < numberOfItems; ++index)
    {
        for (secondaryIndex = index + 1; secondaryIndex < numberOfItems;
++secondaryIndex)
        {
            if (items[index][2] < items[secondaryIndex][2])
            {
                temporaryStorage[0][0] = items[index][0];
                temporaryStorage[0][1] = items[index][1];
                temporaryStorage[0][2] = items[index][2];
                temporaryRatio = ratio[index];
                items[index][0] = items[secondaryIndex][0];
                items[index][1] = items[secondaryIndex][1];
                items[index][2] = items[secondaryIndex][2];
                ratio[index] = ratio[secondaryIndex];
                items[secondaryIndex][0] = temporaryStorage[0][0];
                items[secondaryIndex][1] = temporaryStorage[0][1];
                items[secondaryIndex][2] = temporaryStorage[0][2];
                ratio[secondaryIndex] = temporaryRatio;
            }
        }
    }

    if (items[0][1] > knapsackSize)
        {
            printf("\n\nNone of the items can be in the knapsack of given
size.");
            return;
        }
    for (index = 0; index < numberOfItems; index++)
    {
        if (items[index][1] <= knapsackSize)
        {
            itemsToInclude[counter] = items[index][2];
            value += items[index][0];
            knapsackSize -= items[index][1];
            counter++;
        }

        else
        {
            if (ratio[index] < knapsackSize)
```

```
            {
                value += ratio[index] * (float)knapsackSize;
                additionalItem = items[index][2];
                knapsackSize = 0;
                break;
            }
        }
    }

    printf("\n\nThe following are the items that can be put in the
knapsack:");
    for (index = 0; index < counter; index++) printf(" %d",
itemsToInclude[index]);
    if (additionalItem != 0) printf(" %d", additionalItem);
    printf("\nThe total profit was calculated to be: %f", value);

    return;
}



void main()
{
    printf("Name: Afraaz Hussain\nAdmission number: 20BDS0374\n\n\n");

    int knapsackSize, numberOfItems;

    printf("Enter the number of items: ");
    scanf("%d", &numberOfItems);
    printf("Enter the size of the knapsack: ");
    scanf("%d", &knapsackSize);

    while (1)
    {
        char choice;

        printf("\nPlease select an option...\n");
        printf("(A) Perform 0|1 knapsack\n");
        printf("(B) Perform fractional knapsack\n");
        printf("\nYour choice: ");
        scanf(" %c", &choice);

        if (choice == 'a' || choice == 'A')
        {
            zeroByOneKnapsack(numberOfItems, knapsackSize);
            break;
```

```
        }
        else if (choice == 'b' || choice == 'B')
        {
            fractionalKnapsack(numberOfItems, knapsackSize);
            break;
        }
        else
        {
            printf("\nPlease try again by choosing a valid option...\n\n");
            continue;
        }
    }
}
```

OUTPUT:

- Menu:



- 0/1 knapsack:

```
Name: Afraaz Hussain
Admission number: 20BDS0374


Enter the number of items: 3
Enter the size of the knapsack: 20

Please select an option...
(A) Perform 0|1 knapsack
(B) Perform fractional knapsack

Your choice: A


Please enter the value and weight of item 1: 25 18
Please enter the value and weight of item 2: 24 15
Please enter the value and weight of item 3: 25 10


The following are the items that can be put in the knapsack: 3
The total profit was calculated to be: 25
```

- Fractional knapsack:

```
Name: Afraaz Hussain
Admission number: 20BDS0374


Enter the number of items: 3
Enter the size of the knapsack: 20

Please select an option...
(A) Perform 0|1 knapsack
(B) Perform fractional knapsack

Your choice: B


Please enter the value and weight of item 1: 25 18
Please enter the value and weight of item 2: 24 15
Please enter the value and weight of item 3: 25 10


The following are the items that can be put in the knapsack: 3 2
The total profit was calculated to be: 41.000000
```

AFRAAZ HUSSAIN
20BDS0374
DESIGN AND ANALYSIS OF ALGORITHMS
LAB ASSESSMENT 1

QUESTION:

Design and implement Huffman encoding algorithm using greedy approach.

PSEUDOCODE:

```
function main():
    huffmanEncoding()

function huffmanEncoding():
    int: numberOfCharacters, index, secondaryIndex
    numberOfCharacters = input()

    char: characters[numberOfCharacters]
    int: frequency[numberOfCharacters]

    for (index = 0; index < numberOfCharacters; index++)
    {
        printf("Enter character %d and its frequency: ", index + 1)
        scanf(" %c %d", &characters[index], &frequency[index])
    }

    struct MinHeapNode: *left, *right, *top

    priority_queue<MinHeapNode*, vector<MinHeapNode*>, compare> minHeap;

    for (int index = 0; index < numberOfCharacters; ++index)
        minHeap.push(new MinHeapNode(characters[index], frequency[index]));

    while minHeap.size() is not 1:
        left = minHeap.top()
        minHeap.pop()
        right = minHeap.top()
        minHeap.pop()
        top = new MinHeapNode('$', left->frequency + right->frequency)
        top->left = left
        top->right = right
        minHeap.push(top)
    printCodes(minHeap.top(), "")

function printCodes(struct MinHeapNode: root, str):
    if not root return

    if root -> data not '$' print(root -> data + ": " + str)

    printCodes(root -> left, str = '0')
```

```
    printCodes(root -> right, str + '1')

structure compare:
    bool operator()(MinHeapNode* l, MinHeapNode* r) return 1 -> frequency > r
-> frequency

structure MinHeapNode:
    char: dataunsigned: frequency
    MinHeapNode: *left, *right

    function MinHeapNode(data, frequency):
        left = right = NULL
        self.data = data
        self.frequency = frequency
```

CODE:

```
#include <bits/stdc++.h>

using namespace std;



struct MinHeapNode
{

    char data;
    unsigned frequency;

    MinHeapNode *left, *right;

    MinHeapNode(char data, unsigned frequency)
    {

        left = right = NULL;
        this->data = data;
        this->frequency = frequency;
    }
};

struct compare
{
    bool operator()(MinHeapNode* l, MinHeapNode* r)
    {
        return (l->frequency > r->frequency);
    }
```

```
};

void printCodes(struct MinHeapNode* root, string str)
{

    if (!root)
        return;

    if (root->data != '$')
        cout << root->data << ": " << str << "\n";

    printCodes(root->left, str + "0");
    printCodes(root->right, str + "1");
}

void huffmanEncoding()
{
    int numberOfCharacters, index, secondaryIndex;
    printf("Enter the number of characters: ");
    scanf("%d", &numberOfCharacters);

    char characters[numberOfCharacters];
    int frequency[numberOfCharacters];

    for (index = 0; index < numberOfCharacters; index++);
    {
        printf("Enter character %d and its frequency: ", index + 1);
        scanf(" %c %d", &characters[index], &frequency[index]);
    }

    struct MinHeapNode *left, *right, *top;

    // Create a min heap & inserts all characters of data[]
    priority_queue<MinHeapNode*, vector<MinHeapNode*>, compare> minHeap;

    for (int index = 0; index < numberOfCharacters; ++index)
        minHeap.push(new MinHeapNode(characters[index], frequency[index]));

    // Iterate while size of heap doesn't become 1
    while (minHeap.size() != 1) {


        left = minHeap.top();
        minHeap.pop();

        right = minHeap.top();
```

```
        minHeap.pop();

        top = new MinHeapNode('$', left->frequency + right->frequency);

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

        minHeap.push(top);
    }

    printCodes(minHeap.top(), "");
}


int main()
{
    printf("Name: Afraaz Hussain\nAdmission number: 20BDs0374\n\n\n");

    huffmanEncoding();

    return 0;
}
```

OUTPUT:

```
Name: Afraaz Hussain
Admission number: 20BDs0374


Enter the number of characters: 6
F: 0
C: 100
D: 101
A: 1100
B: 1101
E: 111
```

AFRAAZ HUSSAIN
20BDS0374
DESIGN AND ANALYSIS OF ALGORITHMS
LAB ASSESSMENT 1

QUESTION:

Implement 0/1 knapsack problem using dynamic programming technique.

PSEUDOCODE:

```
function zeroByOneKnapsack(numberOfItems, knapsackSize):

    items[numberOfItems][2]
    ratios[numberOfItems]

    for index from 0 to numberOfItems:
        input(values)
        ratios[index] = items[index][0] / items[index][1]

    for index from 0 to knapsackSize:
        knapsack[0, index] = 0

    for index from 1 to numberOfItems:
        knapsack[index, 0] = 0
        for secondaryIndex from 1 to knapsackSize:
            if items[index][1] <= secondaryIndex:
                if items[index][0] + knapsack[index - 1, secondaryIndex -
items[index][1]]:
                    knapsack[index, secondaryIndex] = knapsack[index - 1,
secondaryIndex]
                else:
                    knapsack[index, secondaryIndex] = knapsack[index - 1,
secondaryIndex]
            else:
                knapsack[index, secondaryIndex] = knapsack[index - 1,
secondaryIndex]

    Total profit is knapsack[numberOfItems][knapsackSize]
```

CODE:

```
#include <stdio.h>



int findMaximum(int numberOne, int numberTwo) { return (numberOne >
numberTwo) ? numberOne : numberTwo; }
```

AFRAAZ HUSSAIN
20BDS0374
DESIGN AND ANALYSIS OF ALGORITHMS
LAB ASSESSMENT 1

```
void zeroByOneKnapsack(int numberOfItems, int knapsackSize)
{
    int itemsToInclude[numberOfItems], items[numberOfItems][3],
temporaryStorage[1][3], value = 0, index, secondaryIndex, counter = 0;
    float temporaryRatio, ratio[numberOfItems];

    printf("\n\n");
    for (index = 0; index < numberOfItems; index++)
    {
        printf("Please enter the value and weight of item %d: ", index + 1);
        scanf("%d %d", &items[index][0], &items[index][1]);
        ratio[index] = (float)items[index][0] / (float)items[index][1];
        items[index][2] = index + 1;
    }

    int knapsack[numberOfItems + 1][knapsackSize + 1];

    for (index = 0; index <= numberOfItems; index++)
    {
        for (secondaryIndex = 0; secondaryIndex <= knapsackSize;
secondaryIndex++)
        {
            if (index == 0 || secondaryIndex == 0)
knapsack[index][secondaryIndex] = 0;
            else if (items[index - 1][1] <= secondaryIndex)
knapsack[index][secondaryIndex] = findMaximum(items[index - 1][0] +
knapsack[index - 1][secondaryIndex - items[index - 1][1]],  knapsack[index -
1][secondaryIndex]);
            else knapsack[index][secondaryIndex] = knapsack[index -
1][secondaryIndex];
        }
    }

    printf("\nThe total profit was calculated to be: %d",
knapsack[numberOfItems][knapsackSize]);

    return;
}



void main()
{
    printf("Name: Afraaz Hussain\nAdmission number: 20BDS0374\n\n\n");

    int knapsackSize, numberOfItems;
```

```
    printf("Enter the number of items: ");
    scanf("%d", &numberOfItems);
    printf("Enter the size of the knapsack: ");
    scanf("%d", &knapsackSize);
    zeroByOneKnapsack(numberOfItems, knapsackSize);
}
```

OUTPUT:

```
Name: Afraaz Hussain
Admission number: 20BDS0374


Enter the number of items: 3
Enter the size of the knapsack: 20


Please enter the value and weight of item 1: 25 28
Please enter the value and weight of item 2: 24 15
Please enter the value and weight of item 3: 25 10

The total profit was calculated to be: 25
```

AFRAAZ HUSSAIN
20BDS0374
DESIGN AND ANALYSIS OF ALGORITHMS
LAB ASSESSMENT 1

QUESTION:

Implement LCS problem using dynamic programming technique.

PSEUDOCODE:

```
sequenceOne = input()
sequenceTwo = input()

lCSTable[length(sequenceOne)][length(sequenceTwo)]

sequenceOne.label = sequenceOne
sequenceTwo.label = sequenceTwo

lCSTable[0][] = 0
lCSTable[][0] = 0

Start from lCSTable[1][1]
Compare sequenceOne[row] and sequenceTwo[column]
    if sequenceOne[row] = sequenceTwo[column]
        lCSTable[row][column] = 1 + lCSTable[row - 1, column - 1]
        Point an arrow to lCSTable[row][column]
    else
        lCSTable[row][column] = max(lCSTable[row - 1][column],
lCSTable[row][column - 1])
        Point an arrow to max(lCSTable[row - 1][column], lCSTable[row][column
- 1])
```

CODE:

```c
#include <stdio.h>
#include <string.h>



void longestCommonSubsequence()
{
    int lCSTable[20][20], index, secondaryIndex;
    char stringOne[20], stringTwo[20], crossMatrix[20][20];

    printf("Enter the first string: ");
    scanf("%s", stringOne);
    printf("Enter the second string: ");
    scanf("%s", stringTwo);
```

```
    int lengthOne = strlen(stringOne), lengthTwo = strlen(stringTwo);

    for (index = 0; index <= lengthOne; index++) lCSTable[index][0] = 0;
    for (index = 0; index <= lengthTwo; index++) lCSTable[0][index] = 0;

    for (index = 1; index <= lengthOne; index++)
    {
        for (secondaryIndex = 1; secondaryIndex <= lengthTwo;
secondaryIndex++)
        {
            if (stringOne[index - 1] == stringTwo[secondaryIndex - 1])
lCSTable[index][secondaryIndex] = lCSTable[index - 1][secondaryIndex - 1] + 1;
            else if (lCSTable[index - 1][secondaryIndex] >=
lCSTable[index][secondaryIndex - 1]) lCSTable[index][secondaryIndex] =
lCSTable[index - 1][secondaryIndex];
            else lCSTable[index][secondaryIndex] =
lCSTable[index][secondaryIndex - 1];
        }
    }

    int element = lCSTable[lengthOne][lengthTwo], counter = 0;
    char lCSAlgorithm[element + 1];
    lCSAlgorithm[index] = '\0';
    index = lengthOne;
    secondaryIndex = lengthTwo;

    while (index > 0 && secondaryIndex > 0)
    {
        if (stringOne[index - 1] == stringTwo[secondaryIndex - 1])
        {
            lCSAlgorithm[element - 1] = stringOne[index - 1];
            index--;
            secondaryIndex--;
            element--;
            counter++;
        }
        else if (lCSTable[index - 1][secondaryIndex] >
lCSTable[index][secondaryIndex - 1]) index--;
        else secondaryIndex--;
    }
    lCSAlgorithm[counter] = '\0';

    printf("\n\nString one: %s \nString two: %s\n\n", stringOne, stringTwo);
    printf("Longest Common Subsequence: %s", lCSAlgorithm);
```

```
}



int main()
{
    printf("Name: Afraaz Hussain\nAdmission number: 20BDS0374\n\n\n");

    longestCommonSubsequence();
}
```

OUTPUT:

```
Name: Afraaz Hussain
Admission number: 20BDS0374


Enter the first string: ABDECG
Enter the second string: ADFHIG


String one: ABDECG
String two: ADFHIG

Longest Common Subsequence: ADG
```

AFRAAZ HUSSAIN
20BDS0374
DESIGN AND ANALYSIS OF ALGORITHMS
LAB ASSESSMENT 1

QUESTION:

Design an algorithm and implement travelling salesman problem using dynamic programming approach.

PSEUDOCODE:

```
globalVariables:
    int: costMatrix[10][10], visitedNode[10], numberOfCities, cost = 0

function main():
    travellingSalemanProblem()

    print("The path is: ", minimumPath(startingCity))
    print("The least cost was calculated to be: ", cost)

function minimumCost(city):
    int: index, cityID

    visitedNode[city] = 1

    print(city + 1 + " -> ")
    cityID = least(city)

    if cityID = 999:
        cityID, cost = 0, cost + costMatrix[city][cityID]
        return

    minimumCost(cityID)

function least(number):
    int: index, newCity = 999, minimumValue = 999, kMinimumValue

    for index in range(numberOfCities):
        if((costMatrix[number][index] != 0) && (visitedNode[index] == 0)):
            if(costMatrix[number][index] + costMatrix[index][number] <
minimumValue):
                minimumValue = costMatrix[index][0] +
costMatrix[number][index]
                kMinimumValue = costMatrix[number][index]
                newCity = index
        if minimumValue is not equal to 999:
            cost += kMinimumValue

        retun newCity
```

AFRAAZ HUSSAIN
20BDS0374
DESIGN AND ANALYSIS OF ALGORITHMS
LAB ASSESSMENT 1

```
function travellingSalemanProblem():
    int: index, secondaryIndex

    numberOfCities = input()
    costMatrix = input()
    visitedNode[index] = 0
```

CODE:

```
#include<stdio.h>




int costMatrix[10][10], visitedNode[10], numberOfCities, cost = 0;

void travellingSalesmanProblem()
{
    int index, secondryIndex;

    printf("Enter the number of cities: ");
    scanf("%d", &numberOfCities);

    printf("\nEnter the cost matrix...\n");

    for(index = 0; index < numberOfCities; index++)
    {
        printf("Enter the cost from city %d to other cities: ", index + 1);

        for( secondryIndex = 0; secondryIndex < numberOfCities;
secondryIndex++) scanf(" %d", &costMatrix[index][secondryIndex]);

        visitedNode[index] = 0;
    }
}

void minimumCost(int city)
{
    int index, cityID;

    visitedNode[city] = 1;

    printf("%d -> ", city + 1);
    cityID = least(city);

    if(cityID == 999)
```

```
    {
        cityID = 0;
        cost += costMatrix[city][cityID];
        return;
    }

    minimumCost(cityID);
}

int least(int number)
{
    int index, newCity = 999, minimumValue = 999, kMinimumValue;

    for(index = 0; index < numberOfCities; index++)
    {
        if((costMatrix[number][index] != 0) && (visitedNode[index] == 0))
        if(costMatrix[number][index] + costMatrix[index][number] <
minimumValue)
        {
            minimumValue = costMatrix[index][0] + costMatrix[number][index];
            kMinimumValue = costMatrix[number][index];
            newCity = index;
        }
    }

    if(minimumValue != 999) cost += kMinimumValue;

    return newCity;
}



int main()
{
    printf("Name: Afraaz Hussain\nAdmission number: 20BDS0374\n\n\n");

    travellingSalesmanProblem();

    printf("\n\nThe Path is:\n");
    minimumCost(0);

    printf("\nThe minimum cost to travel all the cities was calculated to
be: %d", cost);

    return 0;
}
```

OUTPUT:

```
Name: Afraaz Hussain
Admission number: 20BDS0374


Enter the number of cities: 4

Enter the cost matrix...
Enter the cost from city 1 to other cities: 2 3 1 2
Enter the cost from city 2 to other cities: 4 2 1 5
Enter the cost from city 3 to other cities: 2 3 1 7
Enter the cost from city 4 to other cities: 8 3 4 1


The Path is:
1 -> 3 -> 2 -> 4 ->
The minimum cost to travel all the cities was calculated to be: 17
```