FALL – SEMESTER

Course Code: MCSE502P

Course-Title: – Design and Analysis of Algorithms

DIGITAL ASSIGNMENT - 5

(LAB)

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Slot- L35+L36

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1. Implement Linear programming: Simplex method.
2. Implement the Travelling salesman Problem.

1. Implement Linear programming: Simplex method.

Code :-

```
import numpy as np
from fractions import Fraction # so that numbers are not displayed in
decimal.

print("\n                              ****SiMplex Algorithm ****\n\n")

# inputs

# A will contain the coefficients of the constraints
A = np.array([[1, 1, 0, 1], [2, 1, 1, 0]])
# b will contain the amount of resources
b = np.array([8, 10])
# c will contain coefficients of objective function Z
c = np.array([1, 1, 0, 0])

# B will contain the basic variables that make identity matrix
cb = np.array(c[3])
B = np.array([[3], [2]])
```

```
# cb contains their corresponding coefficients in Z
cb = np.vstack((cb, c[2]))
xb = np.transpose([b])
# combine matrices B and cb
table = np.hstack((B, cb))
table = np.hstack((table, xb))
# combine matrices B, cb and xb
# finally combine matrix A to form the complete simplex table
table = np.hstack((table, A))
# change the type of table to float
table = np.array(table, dtype ='float')
# inputs end

# if min problem, make this var 1
MIN = 0

print("Table at itr = 0")
print("B \tCB \tXB \ty1 \ty2 \ty3 \ty4")
for row in table:
    for el in row:
                # limit the denominator under 100
        print(Fraction(str(el)).limit_denominator(100), end ='\t')
    print()
print()
print("Simplex Working....")

# when optimality reached it will be made 1
reached = 0
itr = 1
unbounded = 0
alternate = 0
```

```
while reached == 0:

        print("Iteration: ", end =' ')
        print(itr)
        print("B \tCB \tXB \ty1 \ty2 \ty3 \ty4")
        for row in table:
                for el in row:
                        print(Fraction(str(el)).limit_denominator(100), end ='\t')
                print()

        # calculate Relative profits-> cj - zj for non-basics
        i = 0
        rel_prof = []
        while i<len(A[0]):
                rel_prof.append(c[i] - np.sum(table[:, 1]*table[:, 3 + i]))
                i = i + 1

        print("rel profit: ", end =" ")
        for profit in rel_prof:
                print(Fraction(str(profit)).limit_denominator(100), end =", ")
        print()
        i = 0

        b_var = table[:, 0]
        # checking for alternate solution
        while i<len(A[0]):
                j = 0
                present = 0
                while j<len(b_var):
                        if int(b_var[j]) == i:
```

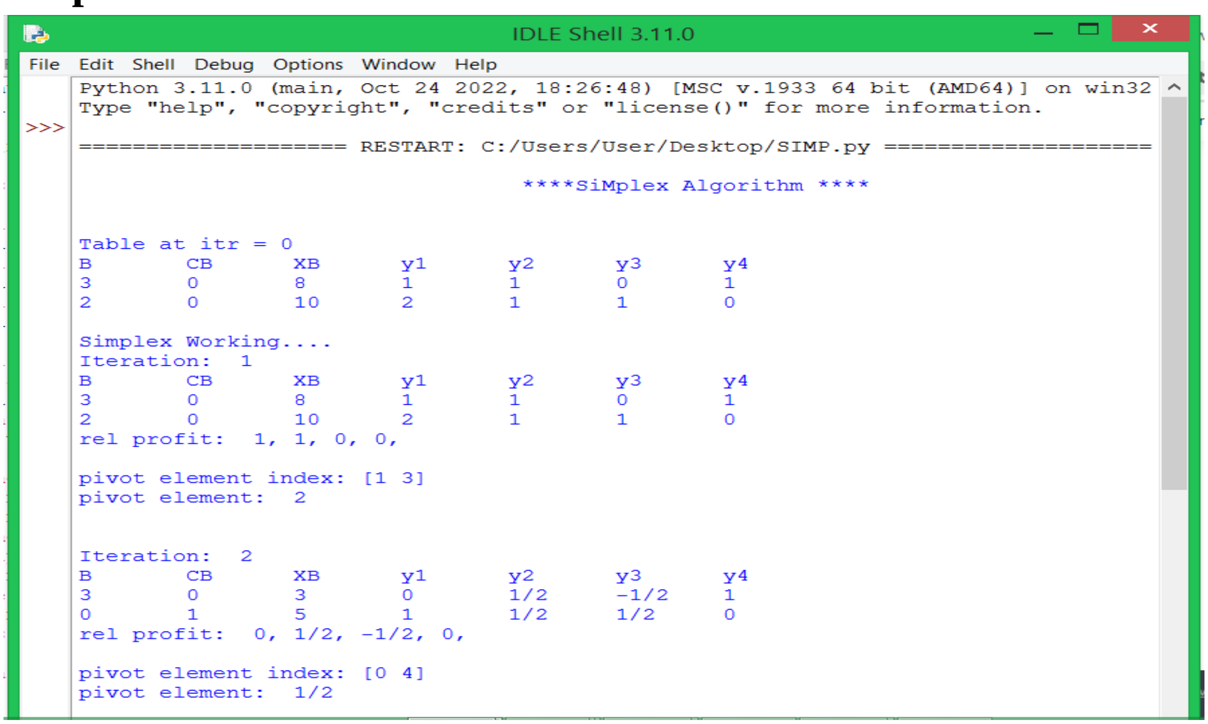
```
                present = 1
                break;
            j+= 1
        if present == 0:
            if rel_prof[i] == 0:
                alternate = 1
                print("Case of Alternate found")
                # print(i, end =" ")
        i+= 1
    print()
    flag = 0
    for profit in rel_prof:
        if profit>0:
            flag = 1
            break
        # if all relative profits <= 0
    if flag == 0:
        print("All profits are <= 0, optimality reached")
        reached = 1
        break

    # kth var will enter the basis
    k = rel_prof.index(max(rel_prof))
    min = 99999
    i = 0;
    r = -1
    # min ratio test (only positive values)
    while i<len(table):
        if (table[:, 2][i]>0 and table[:, 3 + k][i]>0):
            val = table[:, 2][i]/table[:, 3 + k][i]
            if val<min:
```

```
                    min = val
                    r = i   # leaving variable
        i+= 1

        # if no min ratio test was performed
    if r ==-1:
        unbounded = 1
        print("Case of Unbounded")
        break

    print("pivot element index:", end =' ')
    print(np.array([r, 3 + k]))

    pivot = table[r][3 + k]
    print("pivot element: ", end =" ")
    print(Fraction(pivot).limit_denominator(100))

        # perform row operations
    # divide the pivot row with the pivot element
    table[r, 2:len(table[0])] = table[
            r, 2:len(table[0])] / pivot

    # do row operation on other rows
    i = 0
    while i<len(table):
        if i != r:
            table[i, 2:len(table[0])] = table[i, 2:len(table[0])] -
table[i][3 + k] *table[r, 2:len(table[0])]
        i += 1
```

```
        # assign the new basic variable
        table[r][0] = k
        table[r][1] = c[k]

        print()
        print()
        itr+= 1



print()

print("**************************************************************
*********")
if unbounded == 1:
        print("UNBOUNDED LPP")
        exit()
if alternate == 1:
        print("ALTERNATE Solution")

print("optimal table:")
print("B \tCB \tXB \ty1 \ty2 \ty3 \ty4")
for row in table:
        for el in row:
                print(Fraction(str(el)).limit_denominator(100), end ='\t')
        print()
print()
print("value of Z at optimality: ", end =" ")

basis = []
i = 0
sum = 0
```

```
while i<len(table):
        sum += c[int(table[i][0])]*table[i][2]
        temp = "x"+str(int(table[i][0])+1)
        basis.append(temp)
        i+= 1
# if MIN problem make z negative
if MIN == 1:
        print(-Fraction(str(sum)).limit_denominator(100))
else:
        print(Fraction(str(sum)).limit_denominator(100))
print("Final Basis: ", end =" ")
print(basis)

print("Simplex Finished...")
print()
```

Output :-



```
IDLE Shell 3.11.0
File  Edit  Shell  Debug  Options  Window  Help
pivot element:  2


Iteration:  2
B       CB      XB      y1      y2      y3      y4
3       0       3       0       1/2     -1/2    1
0       1       5       1       1/2     1/2     0
rel profit:  0, 1/2, -1/2, 0,

pivot element index: [0 4]
pivot element:  1/2


Iteration:  3
B       CB      XB      y1      y2      y3      y4
1       1       6       0       1       -1      2
0       1       2       1       0       1       -1
rel profit:  0, 0, 0, -1,
Case of Alternate found

All profits are <= 0, optimality reached

***************************************************************
ALTERNATE Solution
optimal table:
B       CB      XB      y1      y2      y3      y4
1       1       6       0       1       -1      2
0       1       2       1       0       1       -1

value of Z at optimality:  8
Final Basis:  ['x2', 'x1']
Simplex Finished...
```

2. Implement the Travelling salesman Problem.

Code :-

```c
#include<stdio.h>

int ary[10][10],completed[10],n,cost=0;

void takeInput()
{
int i,j;

printf("Enter the number of villages: ");
scanf("%d",&n);
```

```c
printf("\nEnter the Cost Matrix\n");

for(i=0;i < n;i++)
{
printf("\nEnter Elements of Row: %d\n",i+1);

for( j=0;j < n;j++)
scanf("%d",&ary[i][j]);

completed[i]=0;
}

printf("\n\nThe cost list is:");

for( i=0;i < n;i++)
{
printf("\n");

for(j=0;j < n;j++)
printf("\t%d",ary[i][j]);
}
}

void mincost(int city)
{
int i,ncity;

completed[city]=1;

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

if(ncity==999)
{
ncity=0;
printf("%d",ncity+1);
cost+=ary[city][ncity];

return;
}
```

```
mincost(ncity);
}

int least(int c)
{
int i,nc=999;
int min=999,kmin;

for(i=0;i < n;i++)
{
if((ary[c][i]!=0)&&(completed[i]==0))
if(ary[c][i]+ary[i][c] < min)
{
min=ary[i][0]+ary[c][i];
kmin=ary[c][i];
nc=i;
}
}

if(min!=999)
cost+=kmin;

return nc;
}

int main()
{
takeInput();

printf("\n\nThe Path is:\n");
mincost(0); //passing 0 because starting vertex

printf("\n\nMinimum cost is %d\n ",cost);

return 0;
}
```

Output :-

```
PS C:\Users\User\Desktop\c_program\ALGO_LAB> ./tsp
Enter the number of villages: 5

Enter the Cost Matrix

Enter Elements of Row: 1
1
1
0
1
0

Enter Elements of Row: 2
11
1
1
1
1

Enter Elements of Row: 3
0
0
0
0
```

```
Enter Elements of Row: 4
1
0
1
0
1

Enter Elements of Row: 5
0
1
0
1
0


The cost list is:
        1       1       0       1       0
        11      1       1       1       1
        0       0       0       0       0
        1       0       1       0       1
        0       1       0       1       0

The Path is:
1--->4--->3--->1
```

```
The cost list is:
        1       1       0       1       0
        11      1       1       1       1
        0       0       0       0       0
        1       0       1       0       1
        0       1       0       1       0

The Path is:
1--->4--->3--->1

Minimum cost is 2
 PS C:\Users\User\Desktop\c_program\ALGO_LAB> 0
```