Analysis and Design of Algorithms

Semester III, Year **2021-22**

Lab - 6 Date : 18-11-2021

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AIM:

1. Implement to find the nth element of Fibonacci number using

   a. brute - force approach
   b. using dynamic programming using memorisation, additionally also compute the number of calls computed for both the cases.
   c. Using bottom-up approach

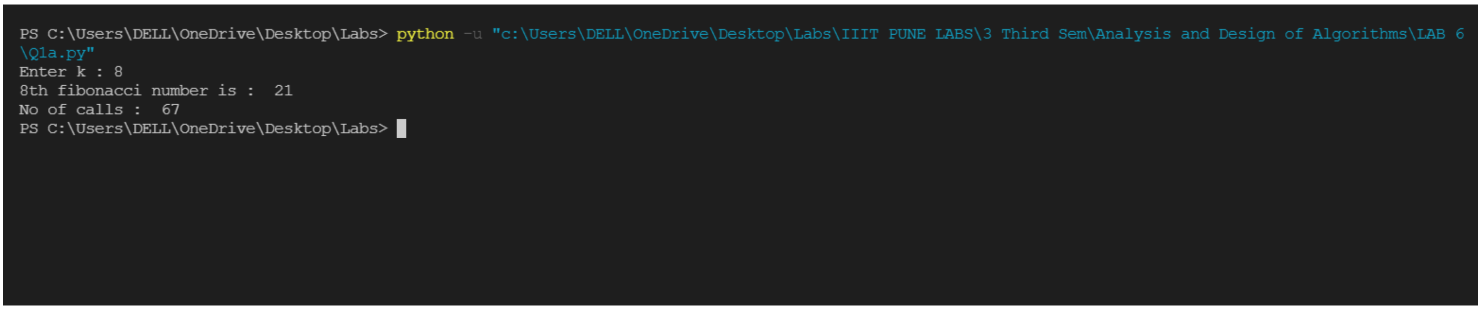
2. Write a program to find the longest common sub-sequence using Dynamic Programming (memorization and tabular method).

3. Implement a classic 0/1 knapsack using Dynamic Programming using memorization and tabular method.

Question 1a:
Pseudo Code:

```
START
counter <- 0
FUNCTION fibonacci(n):
    global counter
    counter += 1

    IF n <= 1:
        RETURN n
    ENDIF
    RETURN fibonacci(n-1)+fibonacci(n-2)
ENDFUNCTION

n <- int(input('Enter n : '))
OUTPUT 'nth fibonacci no. is : ',fibonacci(n)
OUTPUT 'No of calls using brute force : ', counter
END
```

Output:

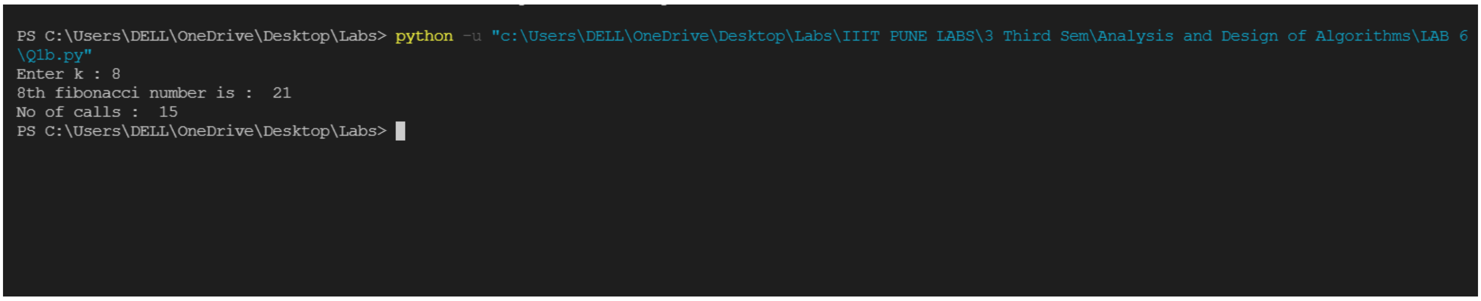


```
PS C:\Users\DELL\OneDrive\Desktop\Labs> python -u "c:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 6
\Q1a.py"
Enter k : 8
8th fibonacci number is :  21
No of calls :  67
PS C:\Users\DELL\OneDrive\Desktop\Labs> 
```

Question 1b:
Pseudo Code:

```
START
counter <- 0
Fib_Dict <- [0]*100
FUNCTION fibonacci_memo(n):
    global counter
    counter += 1
    IF Fib_Dict[n] > 0:
        RETURN Fib_Dict[n]

    ENDIF
    IF n <= 1:
        RETURN n
    ENDIF
    Fib_Dict[n] <- fibonacci_memo(n-2) + fibonacci_memo(n-1)
    RETURN Fib_Dict[n]
ENDFUNCTION

n <- int(input('Enter n : '))
OUTPUT 'nth fibonacci no. is : ', fibonacci_memo(n)
OUTPUT 'No of calls using memo. : ', counter
END
```

Output:

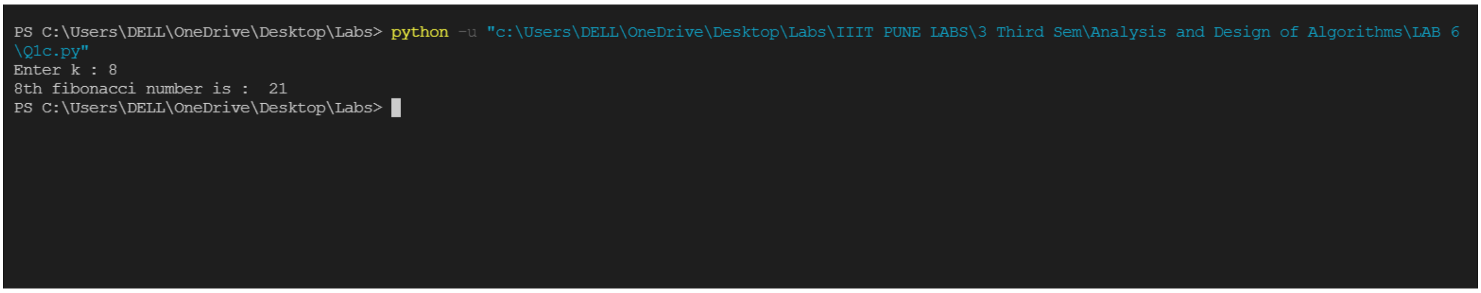


```
PS C:\Users\DELL\OneDrive\Desktop\Labs> python -u "c:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 6
\Q1b.py"
Enter k : 8
8th fibonacci number is :  21
No of calls :  15
PS C:\Users\DELL\OneDrive\Desktop\Labs>
```

Question 1c:
Pseudo Code:

```
START
counter <- 0
FUNCTION fibonacci_bottom(n):
    table <- [0]*100
    table[0] <- 0
    table[1] <- 1
    for i in range(2, n+1):
        table[i] <- table[i-2] + table[i-1]
        global counter
        counter +=1
    ENDFOR
    RETURN table[n]
ENDFUNCTION

n <- int(input('Enter n : '))
OUTPUT 'nth fibonacci no. is : ',fibonacci_bottom(n)
OUTPUT 'No of calls using bottom up : ', counter
END
```

Output:



```
PS C:\Users\DELL\OneDrive\Desktop\Labs> python -u "c:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 6
\Q1c.py"
Enter k : 8
8th fibonacci number is :  21
PS C:\Users\DELL\OneDrive\Desktop\Labs>
```

Question 2:
Pseudo Code:

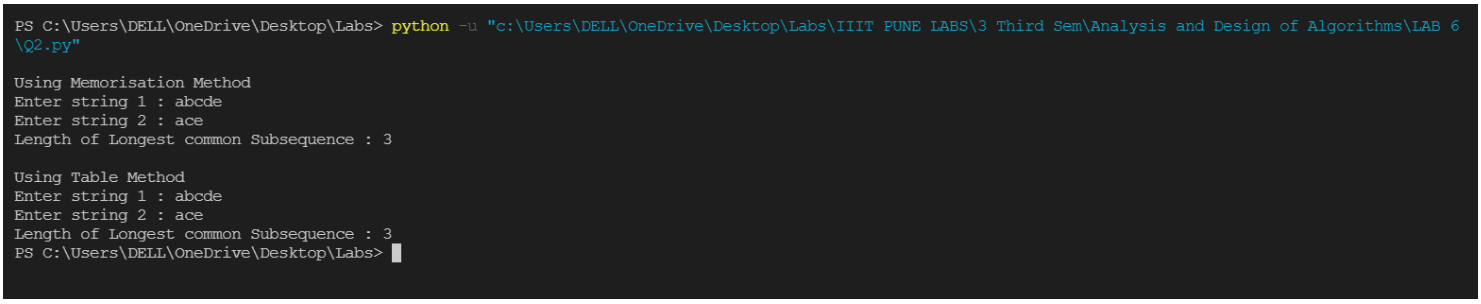
Memorization approach

```
START
CLASS Memorisation:
    FUNCTION Memorisation(self, x: str, y: str) -> int:
        FUNCTION lcs(i: int, j: int, t=dict()) -> int:
            IF i==0 OR j==0:
                RETURN 0
            ELSE:
                key <- (i,j)
                IF key not in t:
                    IF x[i-1] = y[j-1]:
                        t[key] <- lcs(i-1,j-1,t) + 1
                    ELSE:
                        t[key] <- max(lcs(i,j-1,t), lcs(i-1,j,t))
            ENDIF
                ENDIF
                    ENDIF
            RETURN t[key]
        ENDFUNCTION

        RETURN lcs(len(x), len(y))
    ENDFUNCTION

ENDCLASS

string1 <- input('Enter string 1 : ')
string2 <- input('Enter string 2 : ')
OUTPUT Memorisation().Memorisation(string1, string2)
END
```

Tabular approach

```
START
CLASS Table:
    FUNCTION Table(self, string1: str, string2: str) -> int:
        dp <- [[0 for x in range(len(string2)+1)] for y in range(len(string1)+1)]
                 ENDFOR
        IF len(string1) = 0 OR len(string2) = 0:
            RETURN 0
        ELSE:
            for i in range(1,len(string1)+1):
                for j in range(1,len(string2)+1):
                    IF(string1[i-1] = string2[j-1]):
                        dp[i][j] <- 1 + dp[i-1][j-1]
                    ELSE:
                        dp[i][j] <- max(dp[i-1][j],dp[i][j-1])
                    ENDIF
            ENDFOR
                ENDFOR
            RETURN dp[len(string1)][len(string2)]
        ENDIF
    ENDFUNCTION

ENDCLASS

string1 <- input('Enter string 1 : ')
string2 <- input('Enter string 2 : ')
OUTPUT Table().Table(string1, string2)
END
```

Output:



```
PS C:\Users\DELL\OneDrive\Desktop\Labs> python -u "c:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 6
\Q2.py"

Using Memorisation Method
Enter string 1 : abcde
Enter string 2 : ace
Length of Longest common Subsequence : 3

Using Table Method
Enter string 1 : abcde
Enter string 2 : ace
Length of Longest common Subsequence : 3
PS C:\Users\DELL\OneDrive\Desktop\Labs> 
```

Question 3:
Pseudo Code:

Memorization approach

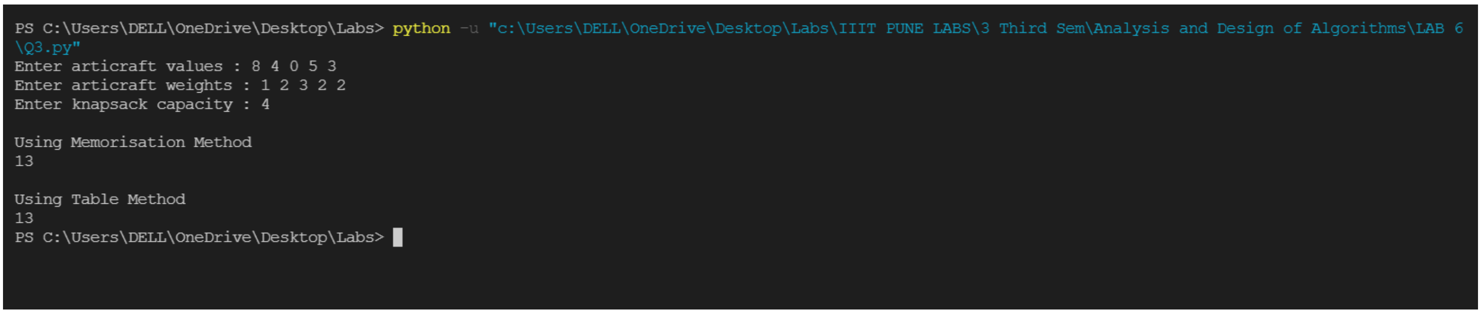
```
START
FUNCTION knapsack(weights, values, cap, n):
    IF n = 0 OR cap = 0:
        RETURN 0
    ENDIF
    IF t[n][cap] != -1:
        RETURN t[n][cap]
    ENDIF
    IF weights[n-1] <= cap:
        t[n][cap] <- max(
            values[n-1] + knapsack(
                weights, values, cap-weights[n-1], n-1),
            knapsack(weights, values, cap, n-1))
        RETURN t[n][cap]
    ELSEIF weights[n-1] > cap:
        t[n][cap] <- knapsack(weights, values, cap, n-1)
        RETURN t[n][cap]
    ENDIF
ENDFUNCTION

values <- list(map(int, input('Enter all the Values : ').split()))
weights <- list(map(int, input('Enter Weights : ').split()))
cap <- int(input('Enter Capacity : '))
n <- len(values)
t <- [[-1 for i in range(cap + 1)] for j in range(n + 1)]
         ENDFOR
OUTPUT knapsack(weights, values, cap, n
END
```

Tabular approach

```
START
FUNCTION Table(cap, weights, value, n):
    T <- [[0 for x in range(cap+1)] for x in range(n+1) ]
            ENDFOR
    for i in range(n+1):
        for j in range(cap+1):
            IF i = 0 OR j = 0:
                T[i][j] <- 0
            ELSEIF weights[i-1] <= j:
                T[i][j] <- max(value[i-1] + T[i-1][j-weights[i-1]], T[i-1][j])
            ELSE:
                T[i][j] <- T[i-1][j]
            ENDIF
    ENDFOR
        ENDFOR
    RETURN T[n][cap]
ENDFUNCTION
```

```
value <- list(map(int, input('Enter all the Values : ').split()))
weights <- list(map(int, input('Enter respective Weights : ').split()))
cap <- int(input('Enter Total Capacity : '))
n <- len(value)
t <- [[-1 for i in range(cap + 1)] for j in range(n + 1)]
       ENDFOR
OUTPUT Table(cap, weights, value, n)
END
```

Output:



```
PS C:\Users\DELL\OneDrive\Desktop\Labs> python -u "c:\Users\DELL\OneDrive\Desktop\Labs\IIIT PUNE LABS\3 Third Sem\Analysis and Design of Algorithms\LAB 6
\Q3.py"
Enter articraft values : 8 4 0 5 3
Enter articraft weights : 1 2 3 2 2
Enter knapsack capacity : 4

Using Memorisation Method
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Using Table Method
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PS C:\Users\DELL\OneDrive\Desktop\Labs> 
```