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Class- MSc CS – I

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Subject – Algorithm Practicals

Practical No: 1

Q.1) Write a Program for Randomized Selection Algorithm

```
from random import randrange
def partition(x, pivot_index = 0):
    i = 0
    if pivot_index !=0: x[0],x[pivot_index] = x[pivot_index],x[0]
    for j in range(len(x)-1):
        if x[j+1] < x[0]:
            x[j+1],x[i+1] = x[i+1],x[j+1]
            i += 1
    x[0],x[i] = x[i],x[0]
    return x,i
def RSelect(x,k):
    if len(x) == 1:
        return x[0]
    else:
        xpart = partition(x,randrange(len(x)))
        x = xpart[0] # partitioned array
        j = xpart[1] # pivot index
        if j == k:
            return x[j]
        elif j > k:
            return RSelect(x[:j],k)
        else:
            k = k - j - 1
            return RSelect(x[(j+1):], k)
x = [3,1,8,4,7,9]
for i in range(len(x)):
    print (RSelect(x,i)),
```

Output:

```
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PS E:\Python codes> python -u "e:\Python codes\Randomize.py"
1
3
4
7
8
9
```

Practical 2

Q.2) Write a Program for Heap Sort Algorithm

```
# Python program for implementation of heap Sort

# To heapify subtree rooted at index i.
# n is size of heap


def heapify(arr, N, i):
    largest = i # Initialize largest as root
    l = 2 * i + 1    # left = 2*i + 1
    r = 2 * i + 2    # right = 2*i + 2

    # See if left child of root exists and is
    # greater than root
    if l < N and arr[largest] < arr[l]:
        largest = l

    # See if right child of root exists and is
    # greater than root
    if r < N and arr[largest] < arr[r]:
        largest = r

    # Change root, if needed
    if largest != i:
        arr[i], arr[largest] = arr[largest], arr[i] # swap

        # Heapify the root.
        heapify(arr, N, largest)

# The main function to sort an array of given size


def heapSort(arr):
    N = len(arr)

    # Build a maxheap.
    for i in range(N//2 - 1, -1, -1):
        heapify(arr, N, i)

    # One by one extract elements
    for i in range(N-1, 0, -1):
        arr[i], arr[0] = arr[0], arr[i] # swap
        heapify(arr, i, 0)


# Driver's code
if __name__ == '__main__':
    arr = [12, 11, 13, 5, 6, 7]

    # Function call
```

```
    heapSort(arr)
    N = len(arr)

    print("Sorted array is")
    for i in range(N):
        print("%d" % arr[i], end=" ")
```

Output:

```
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PS E:\Python codes> python -u "e:\Python codes\heap_sort.py"
Sorted array is
5 6 7 11 12 13
```

Practical 3

Q3) Write a Program to perform Radix Sort Algorithm.

```
# Python program for implementation of Radix Sort
# A function to do counting sort of arr[] according to
# the digit represented by exp.

def countingSort(arr, exp1):

    n = len(arr)

    # The output array elements that will have sorted arr
    output = [0] * (n)

    # initialize count array as 0
    count = [0] * (10)

    # Store count of occurrences in count[]
    for i in range(0, n):
        index = arr[i] // exp1
        count[index % 10] += 1

    # Change count[i] so that count[i] now contains actual
    # position of this digit in output array
    for i in range(1, 10):
        count[i] += count[i - 1]

    # Build the output array
    i = n - 1
    while i >= 0:
        index = arr[i] // exp1
        output[count[index % 10] - 1] = arr[i]
        count[index % 10] -= 1
        i -= 1

    # Copying the output array to arr[],
    # so that arr now contains sorted numbers
    i = 0
    for i in range(0, len(arr)):
        arr[i] = output[i]

# Method to do Radix Sort
def radixSort(arr):

    # Find the maximum number to know number of digits
    max1 = max(arr)

    # Do counting sort for every digit. Note that instead
    # of passing digit number, exp is passed. exp is 10^i
    # where i is current digit number
    exp = 1
```

```
    while max1 / exp >= 1:
        countingSort(arr, exp)
        exp *= 10


# Driver code
arr = [170, 45, 75, 90, 802, 24, 2, 66]

# Function Call
radixSort(arr)

for i in range(len(arr)):
    print(arr[i],end=" ")
```

Output:

Practical 4

Q4) Write a Program to Perform Bucket Sort Algorithm.

```
# Python3 program to sort an array
# using bucket sort
def insertionSort(b):
    for i in range(1, len(b)):
        up = b[i]
        j = i - 1
        while j >= 0 and b[j] > up:
            b[j + 1] = b[j]
            j -= 1
        b[j + 1] = up
    return b

def bucketSort(x):
    arr = []
    slot_num = 10 # 10 means 10 slots, each
                # slot's size is 0.1
    for i in range(slot_num):
        arr.append([])

    # Put array elements in different buckets
    for j in x:
        index_b = int(slot_num * j)
        arr[index_b].append(j)

    # Sort individual buckets
    for i in range(slot_num):
        arr[i] = insertionSort(arr[i])

    # concatenate the result
    k = 0
    for i in range(slot_num):
        for j in range(len(arr[i])):
            x[k] = arr[i][j]
            k += 1
    return x

# Driver Code
x = [0.897, 0.565, 0.656,
    0.1234, 0.665, 0.3434]
print("Sorted Array is")
print(bucketSort(x))
```

Output:

```
PS E:\Python codes> python -u "e:\Python codes\bucket_sort.py"
Sorted Array is
[0.1234, 0.3434, 0.565, 0.656, 0.665, 0.897]
```

Practical 5

Q5) Write a Program to Perform Floyd-Warshall algorithm.

```
# Python3 Program for Floyd Warshall Algorithm

# Number of vertices in the graph
V = 4

# Define infinity as the large
# enough value. This value will be
# used for vertices not connected to each other
INF = 99999

# Solves all pair shortest path
# via Floyd Warshall Algorithm


def floydWarshall(graph):
    """ dist[][] will be the output
    matrix that will finally
        have the shortest distances
        between every pair of vertices """
    """ initializing the solution matrix
    same as input graph matrix
    OR we can say that the initial
    values of shortest distances
    are based on shortest paths considering no
    intermediate vertices """

    dist = list(map(lambda i: list(map(lambda j: j, i)), graph))

    """ Add all vertices one by one
    to the set of intermediate
    vertices.
    ---> Before start of an iteration,
    we have shortest distances
    between all pairs of vertices
    such that the shortest
    distances consider only the
    vertices in the set
    {0, 1, 2, .. k-1} as intermediate vertices.
    ----> After the end of a
    iteration, vertex no. k is
    added to the set of intermediate
    vertices and the
    set becomes {0, 1, 2, .. k}
    """
    for k in range(V):

        # pick all vertices as source one by one
        for i in range(V):
```

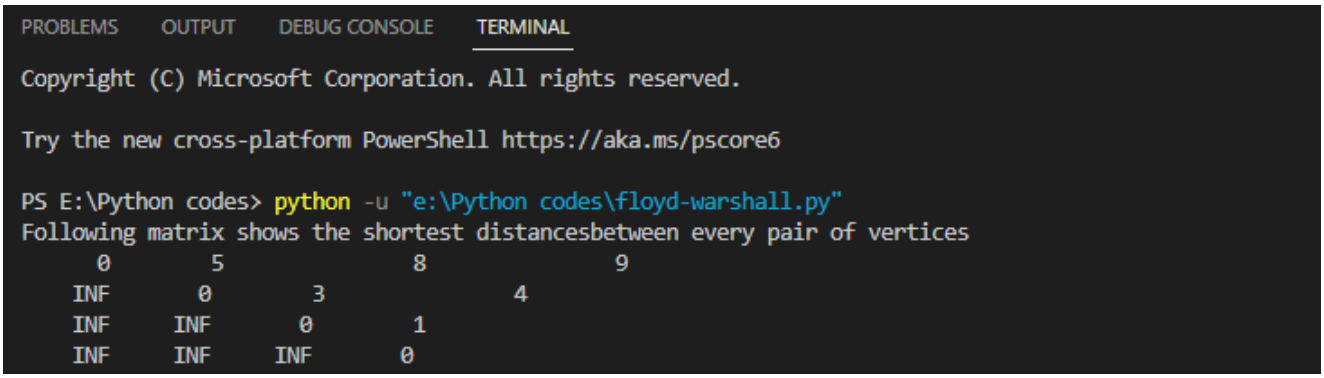
```
            # Pick all vertices as destination for the
            # above picked source
            for j in range(V):

                # If vertex k is on the shortest path from
                # i to j, then update the value of dist[i][j]
                dist[i][j] = min(dist[i][j],
                                 dist[i][k] + dist[k][j]
                                 )
    printSolution(dist)


# A utility function to print the solution
def printSolution(dist):
    print("Following matrix shows the shortest distances\
between every pair of vertices")
    for i in range(V):
        for j in range(V):
            if(dist[i][j] == INF):
                print("%7s" % ("INF"), end=" ")
            else:
                print("%7d\t" % (dist[i][j]), end=' ')
            if j == V-1:
                print()


# Driver's code
if __name__ == "__main__":
    """
            10
        (0)------->(3)
        |         /|\
        5 |       |
        |         | 1
        \|/       |
        (1)------->(2)
            3         """
graph = [[0, 5, INF, 10],
        [INF, 0, 3, INF],
        [INF, INF, 0, 1],
        [INF, INF, INF, 0]
        ]
# Function call
floydWarshall(graph)
```

Output:


PROBLEMS
OUTPUT
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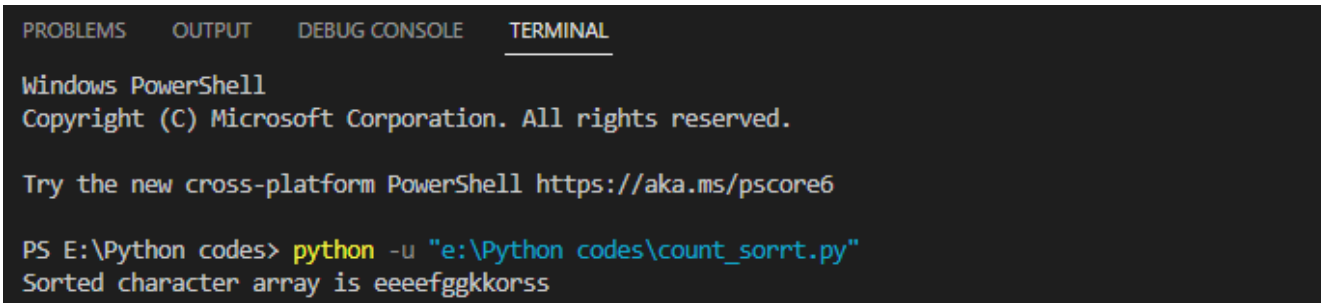
PS E:\Python codes> python -u "e:\Python codes\floyd-warshall.py"
Following matrix shows the shortest distancesbetween every pair of vertices
0 5 8 9
INF 0 3 4
INF INF 0 1
INF INF INF 0

Practical 6

Q6) Write a Program for Counting Sort Algorithm in python.

```python
# Python3 program for counting sort

# The main function that sort the given string arr[] in
# alphabetical order


def countSort(arr):

    # The output character array that will have sorted arr
    output = [0 for i in range(len(arr))]

    # Create a count array to store count of individual
    # characters and initialize count array as 0
    count = [0 for i in range(256)]

    # For storing the resulting answer since the
    # string is immutable
    ans = ["" for _ in arr]

    # Store count of each character
    for i in arr:
        count[ord(i)] += 1

    # Change count[i] so that count[i] now contains actual
    # position of this character in output array
    for i in range(256):
        count[i] += count[i-1]

    # Build the output character array
    for i in range(len(arr)):
        output[count[ord(arr[i])]-1] = arr[i]
        count[ord(arr[i])] -= 1

    # Copy the output array to arr, so that arr now
    # contains sorted characters
    for i in range(len(arr)):
        ans[i] = output[i]
    return ans


# Driver code
if __name__ == '__main__':
    arr = "geeksforgeeks"
    ans = countSort(arr)
    print("Sorted character array is % s" % ("".join(ans)))
```

Output:


PROBLEMS
OUTPUT
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Windows PowerShell
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PS E:\Python codes> python -u "e:\Python codes\count_sorrt.py"
Sorted character array is eeeefggkkorss

Practical 7

Q7) Write a program for Set Covering Problem.

```python
def set_cover(universe, subsets):
    """Find a family of subsets that covers the universal set"""
    elements = set(e for s in subsets for e in s)
    # Check the subsets cover the universe
    if elements != universe:
        return None
    covered = set()
    cover = []
    # Greedily add the subsets with the most uncovered points
    while covered != elements:
        subset = max(subsets, key=lambda s: len(s - covered))
        cover.append(subset)
        covered |= subset

    return cover

def main():
    universe = set(range(1, 11))
    subsets = [set([1, 2, 3, 8, 9, 10]),
        set([1, 2, 3, 4, 5]),
        set([4, 5, 7]),
        set([5, 6, 7]),
        set([6, 7, 8, 9, 10])]
    cover = set_cover(universe, subsets)
    print(cover)

if __name__ == '__main__':
    main()
```

Output:

```
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PS E:\Python codes> python -u "e:\Python codes\set covering.py"
[{1, 2, 3, 8, 9, 10}, {4, 5, 7}, {5, 6, 7}]
```

Practical 8

Q8) Write a Program for found a subset with given sum.

```
# A recursive solution for subset sum
# problem

# Returns true if there is a subset
# of set[] with sun equal to given sum
def isSubsetSum(set,n, sum) :

    # Base Cases
    if (sum == 0) :
        return True
    if (n == 0 and sum != 0) :
        return False

    # If last element is greater than
    # sum, then ignore it
    if (set[n - 1] > sum) :
        return isSubsetSum(set, n - 1, sum);

    # else, check if sum can be obtained
    # by any of the following
    # (a) including the last element
    # (b) excluding the last element
    return isSubsetSum(set, n-1, sum) or isSubsetSum(set, n-1, sum-set[n-1])


# Driver program to test above function
set = [3, 34, 4, 12, 5, 2]
sum = 9
n = len(set)
if (isSubsetSum(set, n, sum) == True) :
    print("Found a subset with given sum")
else :
    print("No subset with given sum")
```

Output:

```
PROBLEMS   OUTPUT   DEBUG CONSOLE   TERMINAL

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PS E:\Python codes> python -u "e:\Python codes\subset sum.py"
Found a subset with given sum
```