MSc. (Computer Science) Semester - I

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Paper I (Analysis of Algorithms and Researching Computing)

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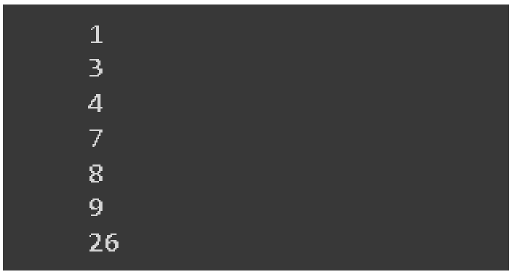
Practical 1

Aim: Write a Program for Randomized Selection Algorithm

Code:

```python
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=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=[3,1,8,4,26,7,9]
for i in range(len(x)):
    print(RSelect(x,i))
```

Output:



```
1
3
4
7
8
9
26
```

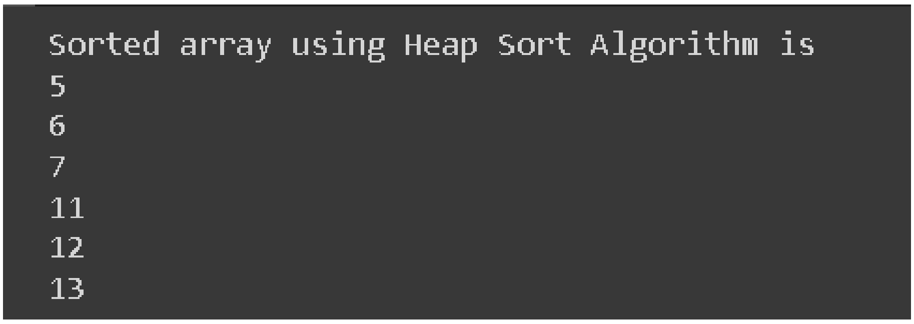
Practical 2

Aim: Write a Program for Heap Sort Algorithm

Code:

```
# 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[i] < 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(arr, n, largest)#Heapify the root.

# The main function to sort an array of given size
def heapSort(arr):
    n = len(arr)
    # Build a maxheap.
    # Since last parent will be at ((n//2)-1) we can start at that location.
    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 code to test above
arr = [12, 11, 13, 5, 6, 7, ]
heapSort(arr)
n = len(arr)
print('Sorted array using Heap Sort Algorithm is')
for i in range(n):
    print(arr[i])
```

Output:



```
Sorted array using Heap Sort Algorithm is
5
6
7
11
12
13
```

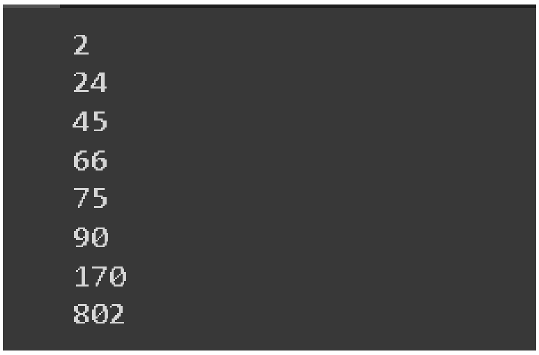
Practical 3

Aim: Write a Program for Radix Sort Algorithm

Code:

```
#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 > 0:
        countingSort(arr,exp)
        exp *= 10

# Driver code to test above
arr = [ 170, 45, 75, 90, 802, 24, 2, 66]
radixSort(arr)

for i in range(len(arr)):
    print(arr[i])
```

Output:



```
2
24
45
66
75
90
170
802
```

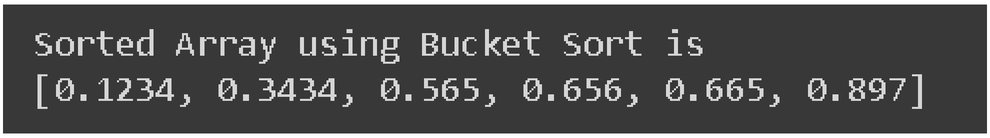
Practical 4

Aim: Write a Program to Perform Bucket Sort Algorithm

Code:

```
# 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

x = [0.897, 0.565, 0.656, 0.1234, 0.665, 0.3434]
print("Sorted Array using Bucket Sort is")
print(bucketSort(x))
```

Output:



```
Sorted Array using Bucket Sort is
[0.1234, 0.3434, 0.565, 0.656, 0.665, 0.897]
```

Practical 5

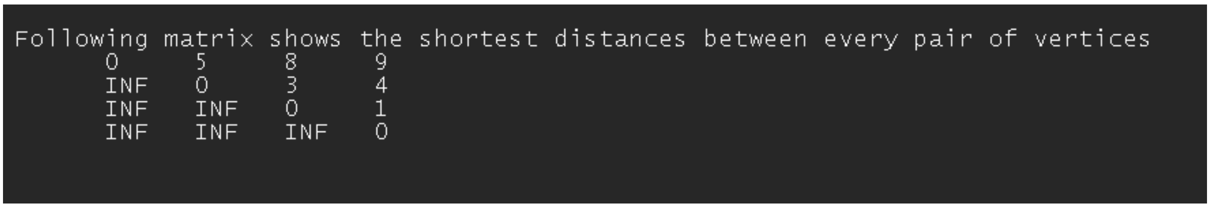
Aim: Write a Program to Perform Floyd Warshall algorithm

Code:

```
v = 4

INF = 99999

def floydWarshall(graph):
    dist = list(map(lambda i: list(map(lambda j:j, i)) ,graph))
    for k in range(v):
        for i in range(v):
            for j in range(v):
                dist[i][j] = min(dist[i][j] , dist[i][k]+dist[k][j])
    printSolution(dist)

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"),)
            else:
                print('%7d\t' %(dist[i][j]),)
            if j == v-1:
                print(" ")
# Driver program to test the above program
# Let us create the following weighted graph
"""
      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]]
#Print the solution
floydWarshall(graph);
```

Output:



```
Following matrix shows the shortest distances between every pair of vertices
      0      5      8      9
      INF    0      3      4
      INF    INF    0      1
      INF    INF    INF    0
```

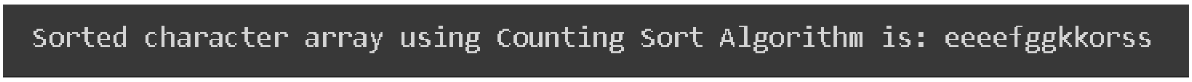
Practical 6

Aim: Write a Program for Counting Sort Algorithm

Code:

```
# The main function that sort the given string arr[] in  alphabetical order
def countSort(arr):

    # The output character array that will have sorted array
    output = [0 for i in range(256)]

    # 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 program to test above function
arr = "geeksforgeeks"
ans = countSort(arr)
print("Sorted character array using Counting Sort Algorithm is: %s"  %("".join(ans)))
```

Output:



```
Sorted character array using Counting Sort Algorithm is: eeeefggkkorss
```

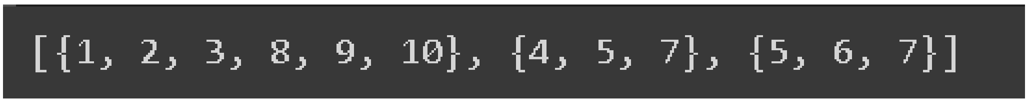
Practical 7

Aim: Write a program for Set Covering Problem

Code:

```
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:



```
[{1, 2, 3, 8, 9, 10}, {4, 5, 7}, {5, 6, 7}]
```

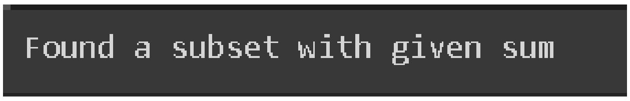
Practical 8

Aim: Write a Program for ‘found a subset with given sum’

Code:

```
# 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, heck 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:



```
Found a subset with given sum
```