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Practical 1

Aim: Write a Python3 program to perform randomized selection of an array.

File Name = randomized_selection.py

Code:

```
from random import randrange


def partition(input_array, pivot_index = 0):
    i = 0
    if pivot_index != 0:
        input_array[0], input_array[pivot_index] =
input_array[pivot_index], input_array[0]
    for j in range(len(input_array) - 1):
        if input_array[j + 1] < input_array[0]:
            input_array[j + 1],input_array[i + 1] = input_array[i
+ 1],input_array[j + 1]
            i += 1
    input_array[0], input_array[i] = input_array[i],
input_array[0]
    return input_array,i


def RSelect(input_array,k):
    if len(input_array) == 1:
        return input_array[0]
    else:
        xpart = partition(input_array,randrange(len(input_array)))
```

```
        input_array = xpart[0] # partitioned array
        j = xpart[1] # pivot index
        if j == k:
            return input_array[j]
        elif j > k:
            return RSelect(input_array[ : j],k)
        else:
            k = k - j - 1
            return RSelect(input_array[(j + 1) : ], k)

input_array = [3,1,8,4,7,9]
print("Input array is", input_array)
print("Selected elements are:")

for i in range(len(input_array)):
    print (Rselect(input_array,i))
```

Output:

```
C:\Users\YASH\Documents\Practicals\Semester 1\Algorithms>python randomized_selection.py
Input array is [3, 1, 8, 4, 7, 9]
Selected elements are:
1
3
4
7
8
9
```

Practical 2

Aim: Write a Python3 program to perform heap sort on an array.

File Name = heap_sort.py

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 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, -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]
print("Input array is:", arr)
print()
heapSort(arr)
n = len(arr)
print ("Sorted array is")
for i in range(n):
    print ("%d" %arr[i])
```

Output:

```
C:\Users\YASH\Documents\Practicals\Semester 1\Algorithms>python heap_sort.py
Input array is: [12, 11, 13, 5, 6, 7]

Sorted array is
5
6
7
11
12
13
```

Practical 3

Aim: Write a Python3 program to perform radix sort on an array.

File Name = radix_sort.py

Code:

```
# 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[ int((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[int((index) % 10)] - 1] = arr[i]
        count[ int((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]
print("Input array is:", arr)
print()
radixSort(arr)

print("Sorted array is:")
for i in range(len(arr)):
    print(arr[i])
```

Output:

```
C:\Users\YASH\Documents\Practicals\Semester 1\Algorithms>python radix_sort.py
Input array is: [170, 45, 75, 90, 802, 24, 2, 66]

Sorted array is:
2
24
45
66
75
90
170
802
```

Practical 4

Aim: Write a Python3 program to perform bucket sort on an array.

File Name = bucket_sort.py

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

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

Output:

```
C:\Users\YASH\Documents\Practicals\Semester 1\Algorithms>python bucket_sort.py
Input array is: [0.897, 0.565, 0.656, 0.1234, 0.665, 0.3434]

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

Practical 5

Aim: Write a Python3 program to perform Floyd-Warshalls algorithm on a weighted graph.

File Name = floyd_warshall.py

Code:

```
# Python 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)
```

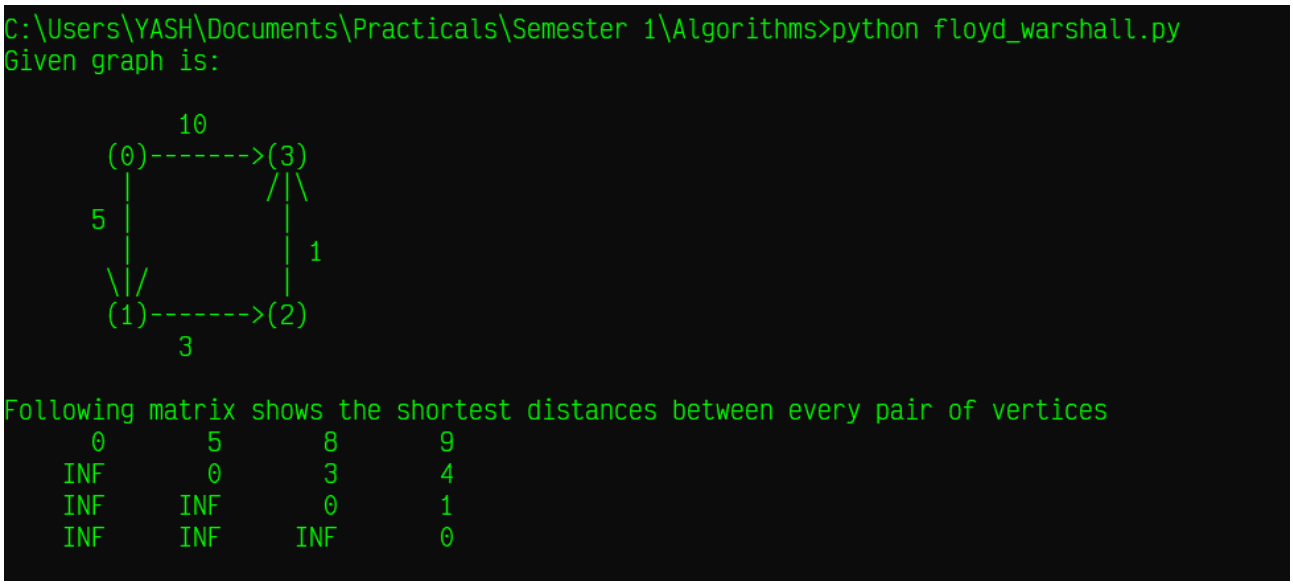
```
# A utility function to print the solution
def printSolution(dist):
    print("Following matrix shows the shortest distances between
every pair of vertices")
    for i in range(V):
        for j in range(V):
            if(dist[i][j] == INF):
                print("%7s" %("INF"), end = " ")
            else:
                print("%7d" %(dist[i][j]), end = " ")
            if j == V-1:
                print(end = "\n")



# Driver program to test the above program
# Let us create the following weighted graph
print("Given graph is:")
print("""
            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:



Practical 6

Aim: Write a Python3 program to perform counting sort on an array.

File Name = counting_sort.py

Code:

```
# 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(256)]

    # Create a count array to store count of inidividul
    # 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"
print("Input string is:", arr)
print()

ans = countSort(arr)
print("Sorted character array is ", ans)
```

Output:

```
C:\Users\YASH\Documents\Practicals\Semester 1\Algorithms>python counting_sort.py
Sorted character array is  ['e', 'e', 'e', 'e', 'f', 'g', 'g', 'k', 'k', 'o', 'r', 's', 's']

C:\Users\YASH\Documents\Practicals\Semester 1\Algorithms>python counting_sort.py
Input string is: geeksforgeeks

Sorted character array is  ['e', 'e', 'e', 'e', 'f', 'g', 'g', 'k', 'k', 'o', 'r', 's', 's']
```

Practical 7

Aim: Write a Python3 program to perform set covering problem.

File Name = set_cover.py

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])]

    print("Universe is", universe)
    print("Subsets are")
    for i in subsets:
        print(i)
    print()

    cover = set_cover(universe, subsets)
    print("Set cover is", cover)

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

Output:

```
Universe is {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}
Subsets are
{1, 2, 3, 8, 9, 10}
{1, 2, 3, 4, 5}
{4, 5, 7}
{5, 6, 7}
{6, 7, 8, 9, 10}

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

Practical 8

Aim: Write a Python3 program to perform subset sum problem.

File Name = subset_sum.py

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, 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
print("Input set is:", set)
print("Target sum is:", sum)
print()

n = len(set)
if (isSubsetSum(set, n, sum) == True) :
    print("Found a subset with given sum")
else :
    print("No subset with given sum")
```

Output:

```
C:\Users\YASH\Documents\Practicals\Semester 1\Algorithms>python set_cover.py
Universe is {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}
Subsets are
{1, 2, 3, 8, 9, 10}
{1, 2, 3, 4, 5}
{4, 5, 7}
{5, 6, 7}
{6, 7, 8, 9, 10}

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