Velagapudi Ramakrishna Siddhartha Engineering College

Kanuru, 520001

ADVANCE PROGRAMMING LAB - III

Code : 20IT6353

WEEK – 1

Aim : Implement and validate the Stack Sequences.

Program :

```
class Solution:
    def validateStackSequences(self, pushed: List[int], popped: List[int]) -> bool:
        stack=[]
        for i in pushed:
            stack.append(i)
            while stack and popped and stack[-1] == popped[0]:  # stack top
                stack.pop()
                popped.pop(0)
        return not stack
```

Output :

Result : Sucessfully Executed the Program.

Aim : There are a number of plants in a garden. Each of the plants has been treated with some amount of pesticide. After each day, if any plant has more pesticide than the plant on its left, being weaker than the left one, it dies.

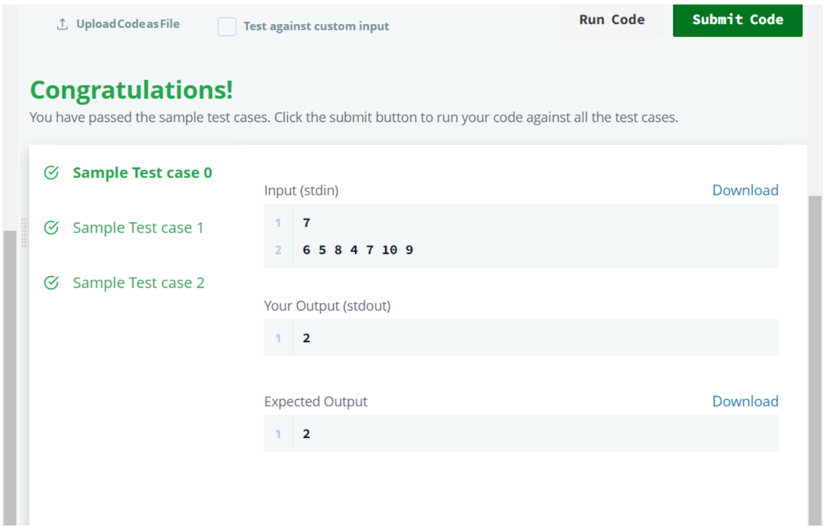
You are given the initial values of the pesticide in each of the plants. Determine the number of days after which no plant dies, i.e. the time after which there is no plant with more pesticide content than the plant to its left.

Program :

```
import math
import os
import random
import re
import sys
def poisonousPlants(p):
    stack = []
    max_days = 0
    for i in range(len(p)-1, -1, -1):
        kills = 0
        while (len(stack) > 0) and stack[-1][0] > p[i]:
            kills = max(kills + 1, stack.pop()[1])
        max_days = max(max_days, kills)
        stack.append((p[i], kills))
    return max_days
if __name__ == '__main__':
    fptr = open(os.environ['OUTPUT_PATH'], 'w')
```

```
n = int(input().strip())

p = list(map(int, input().rstrip().split()))

result = poisonousPlants(p)

fptr.write(str(result) + '\n')

fptr.close()
```

Output :



Result : Sucessfully Executed the Program

Week – 2

Aim : implement Stacks using Queues.

Program :

```
from collections import deque
  class MyStack:
   def __init__(self):
       self.queue1 = deque()
       self.queue2 = deque()
   def push(self, x: int) -> None:
       self.queue1.append(x)
   def pop(self) -> int:
       while len(self.queue1) > 1:
           self.queue2.append(self.queue1.popleft())
       item = self.queue1.popleft()
       self.queue1, self.queue2 = self.queue2, self.queue1
       return item
   def top(self) -> int:
       while len(self.queue1) > 1:
           self.queue2.append(self.queue1.popleft())
       item = self.queue1.popleft()
       self.queue2.append(item)
       self.queue1, self.queue2 = self.queue2, self.queue1
       return item
```

```
def empty(self) -> bool:
    return len(self.queue1) == 0
```

Output :

Accepted Runtime: 41 ms

• Case 1

Input

```
["MyStack","push","push","top","pop","empty"]
```

```
[[],[1],[2],[],[],[]]
```

Output

```
[null,null,null,2,2,false]
```

Expected

```
[null,null,null,2,2,false]
```

Result : Sucessfully Executed The Program.

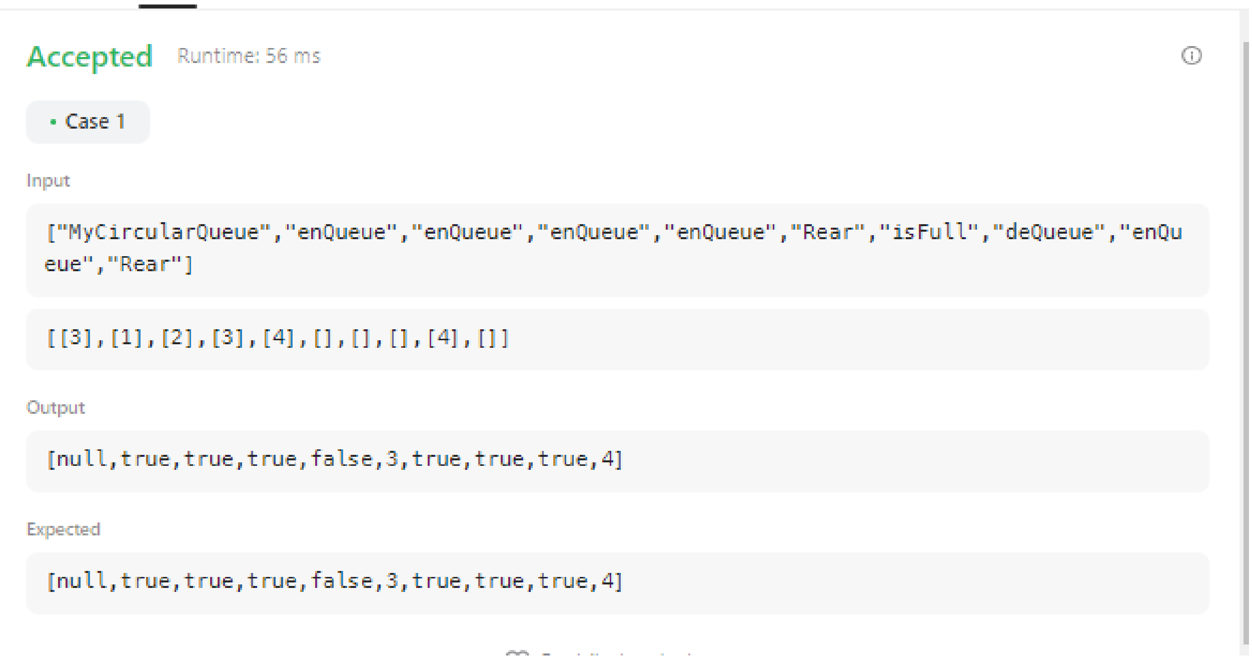
Aim : Implement Circular Queue using OOPS Concepts.

Program :

```
class MyCircularQueue:
    def __init__(self, k: int):
        self.queue = [None] * k
        self.head = 0
        self.tail = 0
        self.size = 0
        self.capacity = k
    def enQueue(self, value: int) -> bool:
        if self.isFull():
            return False
        self.queue[self.tail] = value
        self.tail = (self.tail + 1) % self.capacity
        self.size += 1
        return True
    def deQueue(self) -> bool:
        if self.isEmpty():
            return False
        self.head = (self.head + 1) % self.capacity
        self.size -= 1
        return True
    def Front(self) -> int:
        if self.isEmpty():
```

```
            return -1
        return self.queue[self.head]
    def Rear(self) -> int:
        if self.isEmpty():
            return -1
        return self.queue[(self.tail - 1 + self.capacity) % self.capacity]
    def isEmpty(self) -> bool:
        return self.size == 0
    def isFull(self) -> bool:
        return self.size == self.capacity
```

Output :



Result : Sucessfully Executed The Program.

WEEK – 3

Aim : Given pointers to the head nodes of linked lists that merge together at some point, find the node where the two lists merge. The merge point is where both lists point to the same node, i.e. they reference the same memory location. It is guaranteed that the two head nodes will be different, and neither will be NULL. If the lists share a common node, return that node's data value.

Note: After the merge point, both lists will share the same node pointers.

Example :

In the diagram below, the two lists converge at Node x:

```
[List #1] a--->b--->c
                     \
                      x--->y--->z--->NULL
                     /
     [List #2] p--->q
```

Program :

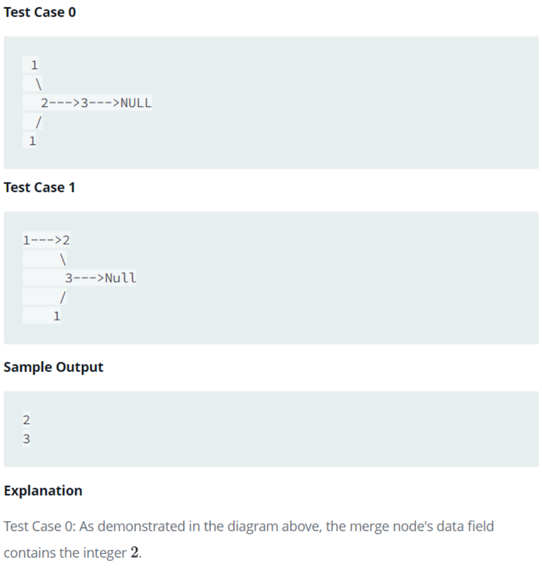
```
import math

import os

import random

import re

import sys

class SinglyLinkedListNode:

    def __init__(self, node_data):

        self.data = node_data

        self.next = None
```

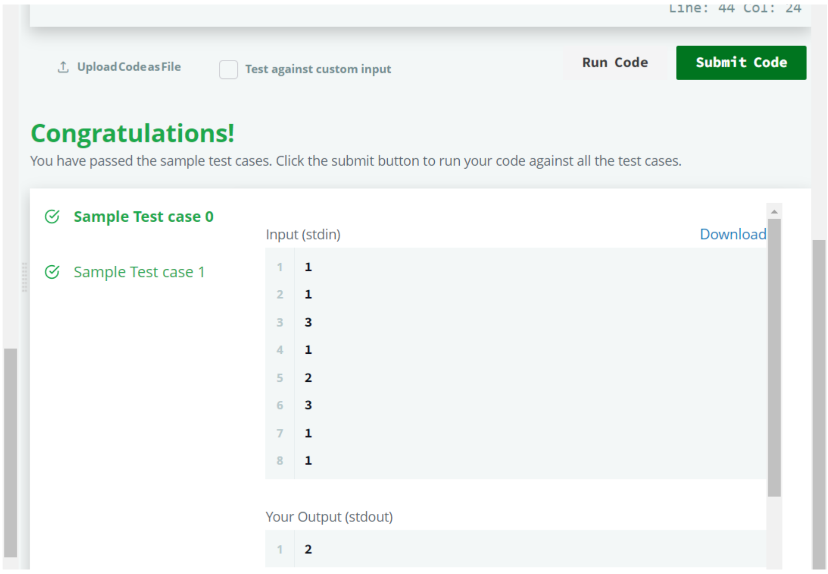
```
class SinglyLinkedList:
    def __init__(self):
        self.head = None
        self.tail = None
    def insert_node(self, node_data):
        node = SinglyLinkedListNode(node_data)
        if not self.head:
            self.head = node
        else:
            self.tail.next = node
        self.tail = node
def print_singly_linked_list(node, sep, fptr):
    while node:
        fptr.write(str(node.data))
        node = node.next
        if node:
            fptr.write(sep)
def findMergeNode(head1, head2):
    li=[]
    while head1 :
        li.append(head1)
        head1=head1.next
    temp=head2
    while head2:
        if head2 in li:
```

```
        return head2.data
      head2=head2.next
if __name__ == '__main__':
  fptr = open(os.environ['OUTPUT_PATH'], 'w')
  tests = int(input())
  for tests_itr in range(tests):
      index = int(input())
      llist1_count = int(input())
      llist1 = SinglyLinkedList()
      for _ in range(llist1_count):
          llist1_item = int(input())
          llist1.insert_node(llist1_item)
      llist2_count = int(input())
      llist2 = SinglyLinkedList()
      for _ in range(llist2_count):
          llist2_item = int(input())
          llist2.insert_node(llist2_item)
      ptr1 = llist1.head;
      ptr2 = llist2.head;
      for i in range(llist1_count):
          if i < index:
              ptr1 = ptr1.next
      for i in range(llist2_count):
          if i != llist2_count-1:
              ptr2 = ptr2.next
```

```
    ptr2.next = ptr1
    result = findMergeNode(llist1.head, llist2.head)
    fptr.write(str(result) + '\n')
fptr.close()
```

Output :





Result : Sucessfully Executed The Program.

Aim : Given pointers to the heads of two sorted linked lists, merge them into a single, sorted linked list. Either head pointer may be null meaning that the corresponding list is empty.

Example

$headA$ refers to $1 \rightarrow 3 \rightarrow 7 \rightarrow NULL$

$headB$ refers to $1 \rightarrow 2 \rightarrow NULL$

The new list is $1 \rightarrow 1 \rightarrow 2 \rightarrow 3 \rightarrow 7 \rightarrow NULL$

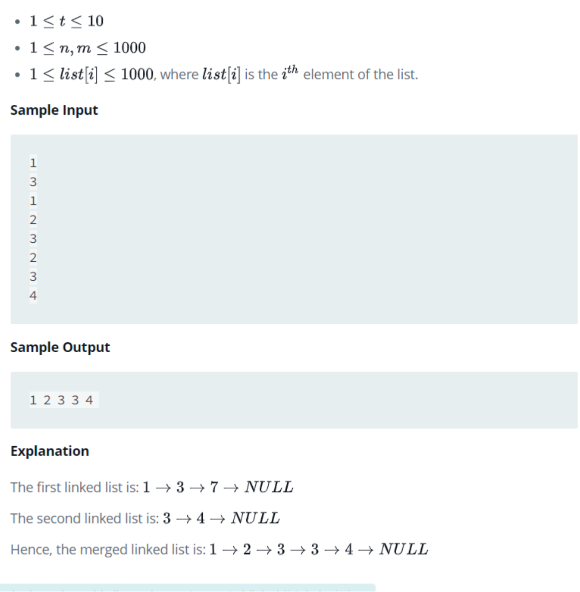
Program :

```
import math

import os

import random

import re

import sys

class SinglyLinkedListNode:

    def __init__(self, node_data):

        self.data = node_data

        self.next = None

class SinglyLinkedList:

    def __init__(self):

        self.head = None

        self.tail = None

    def insert_node(self, node_data):

        node = SinglyLinkedListNode(node_data)
```

```
        if not self.head:
            self.head = node
        else:
            self.tail.next = node
        self.tail = node
def print_singly_linked_list(node, sep, fptr):
    while node:
        fptr.write(str(node.data))
        node = node.next
        if node:
            fptr.write(sep)
def mergeLists(head1, head2):
    li=[]
    temp1=head1
    temp2=head2
    while temp1 is not None:
        li.append(temp1.data)
        temp1=temp1.next
    while temp2 is not None:
        li.append(temp2.data)
        temp2=temp2.next
    li.sort()
    ll=SinglyLinkedList()
    for i in range(0,len(li)):
        ll.insert_node(li[i])
```

```
    return ll.head


if __name__ == '__main__':
    fptr = open(os.environ['OUTPUT_PATH'], 'w')
    tests = int(input())

    for tests_itr in range(tests):
        llist1_count = int(input())
        llist1 = SinglyLinkedList()

        for _ in range(llist1_count):
            llist1_item = int(input())
            llist1.insert_node(llist1_item)

        llist2_count = int(input())
        llist2 = SinglyLinkedList()

        for _ in range(llist2_count):
            llist2_item = int(input())
            llist2.insert_node(llist2_item)
        llist3 = mergeLists(llist1.head, llist2.head)
        print_singly_linked_list(llist3, ' ', fptr)
        fptr.write('\n')
    fptr.close()
```

Output :



- $1 \leq t \leq 10$
- $1 \leq n, m \leq 1000$
- $1 \leq list[i] \leq 1000$, where $list[i]$ is the i^{th} element of the list.

Sample Input

```
1
3
1
2
3
2
3
4
```

Sample Output

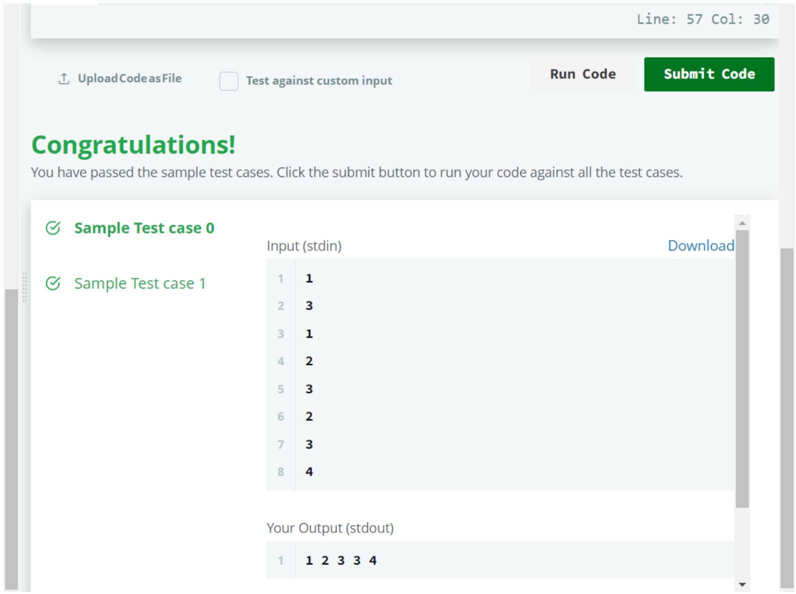
```
1 2 3 3 4
```

Explanation

The first linked list is: $1 \rightarrow 3 \rightarrow 7 \rightarrow NULL$

The second linked list is: $3 \rightarrow 4 \rightarrow NULL$

Hence, the merged linked list is: $1 \rightarrow 2 \rightarrow 3 \rightarrow 3 \rightarrow 4 \rightarrow NULL$



Result : Sucessfully Executed The Program .

WEEK – 4

Aim : Given the pointer to the head node of a doubly linked list, reverse the order of the nodes in place. That is, change the *next* and *prev* pointers of the nodes so that the direction of the list is reversed. Return a reference to the head node of the reversed list.

Note: The head node might be NULL to indicate that the list is empty.

Function Description :

Complete the *reverse* function in the editor below.

reverse has the following parameter(s):

- *DoublyLinkedListNode head*: a reference to the head of a DoublyLinkedList

Returns
- *DoublyLinkedListNode*: a reference to the head of the reversed list

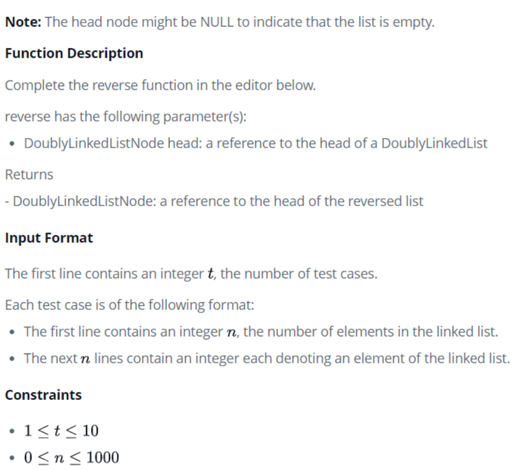
Program :

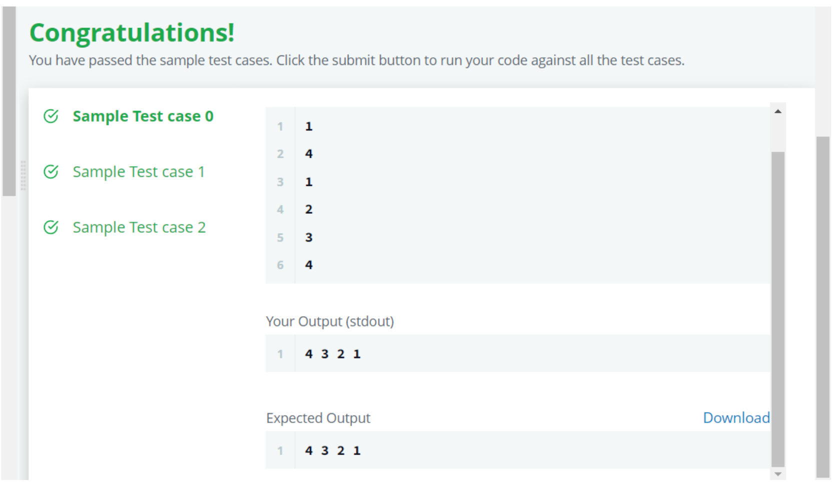
```
import math

import os

import random

import re

import sys

class DoublyLinkedListNode:

    def __init__(self, node_data):

        self.data = node_data

        self.next = None

        self.prev = None

class DoublyLinkedList:

    def __init__(self):
```

```
        self.head = None
        self.tail = None
    def insert_node(self, node_data):
        node = DoublyLinkedListNode(node_data)
        if not self.head:
            self.head = node
        else:
            self.tail.next = node
            node.prev = self.tail
        self.tail = node
def print_doubly_linked_list(node, sep, fptr):
    while node:
        fptr.write(str(node.data))
        node = node.next
        if node:
            fptr.write(sep)
def reverse(llist):
    # Write your code here
    head = llist
    while llist:
        curr = llist.prev
        llist.prev = llist.next
        llist.next = curr
        head = llist
        llist = llist.prev
```

```
    return head
if __name__ == '__main__':
    fptr = open(os.environ['OUTPUT_PATH'], 'w')
    t = int(input())
    for t_itr in range(t):
        llist_count = int(input())
        llist = DoublyLinkedList()
        for _ in range(llist_count):
            llist_item = int(input())
            llist.insert_node(llist_item)
        llist1 = reverse(llist.head)
        print_doubly_linked_list(llist1, ' ', fptr)
        fptr.write('\n')
    fptr.close()
```

Output :





Result : Sucessfully Executed The Program.

Aim : You have a browser of one tab where you start on the homepage and you can visit another url, get back in the history number of steps or move forward in the history number of steps.

Implement the BrowserHistory class:

BrowserHistory(string homepage) Initializes the object with the homepage of the browser.

void visit(string url) Visits url from the current page. It clears up all the forward history.

string back(int steps) Move steps back in history. If you can only return x steps in the history and steps > x, you will return only x steps. Return the current url after moving back in history at most steps.

string forward(int steps) Move steps forward in history. If you can only forward x steps in the history and steps > x, you will forward only x steps. Return the current url after forwarding in history at most steps.

Program :

```
class BrowserHistory:
    def __init__(self, homepage: str):
        self.history = [homepage]
        self.current = 0
    def visit(self, url: str) -> None:
        self.history = self.history[:self.current+1] + [url]
        self.current += 1
    def back(self, steps: int) -> str:
        self.current = max(0, self.current - steps)
        return self.history[self.current]
```

```
    def forward(self, steps: int) -> str:
        self.current = min(len(self.history)-1, self.current + steps)
        return self.history[self.current]
# Your BrowserHistory object will be instantiated and called as such:
# obj = BrowserHistory(homepage)
# obj.visit(url)
# param_2 = obj.back(steps)
# param_3 = obj.forward(steps)
```

Output :

Result : Sucessfully Executed The Program .

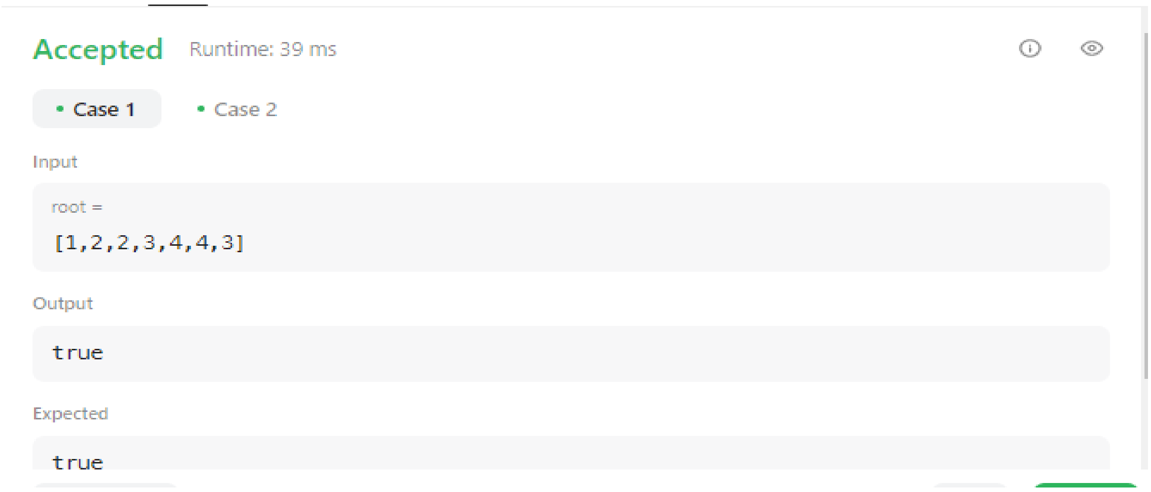
WEEK – 5

Aim : Implement Symmentric Tree

Program :

```
class Solution:
  def isSymmetric(self, root):
    if root is None:
      return True
    else:
      return self.isMirror(root.left, root.right)
  def isMirror(self, left, right):
    if left is None and right is None:
      return True
    if left is None or right is None:
      return False
    if left.val == right.val:
      outPair = self.isMirror(left.left, right.right)
      inPiar = self.isMirror(left.right, right.left)
      return outPair and inPiar
    else:
      return False
```

Output :



Result : Sucessfully Executed The Program.

Aim : Given the root of a binary tree, determine if it is a valid binary search tree (BST).

A valid BST is defined as follows:

The left subtree of a node contains only nodes with keys less than the node's key.

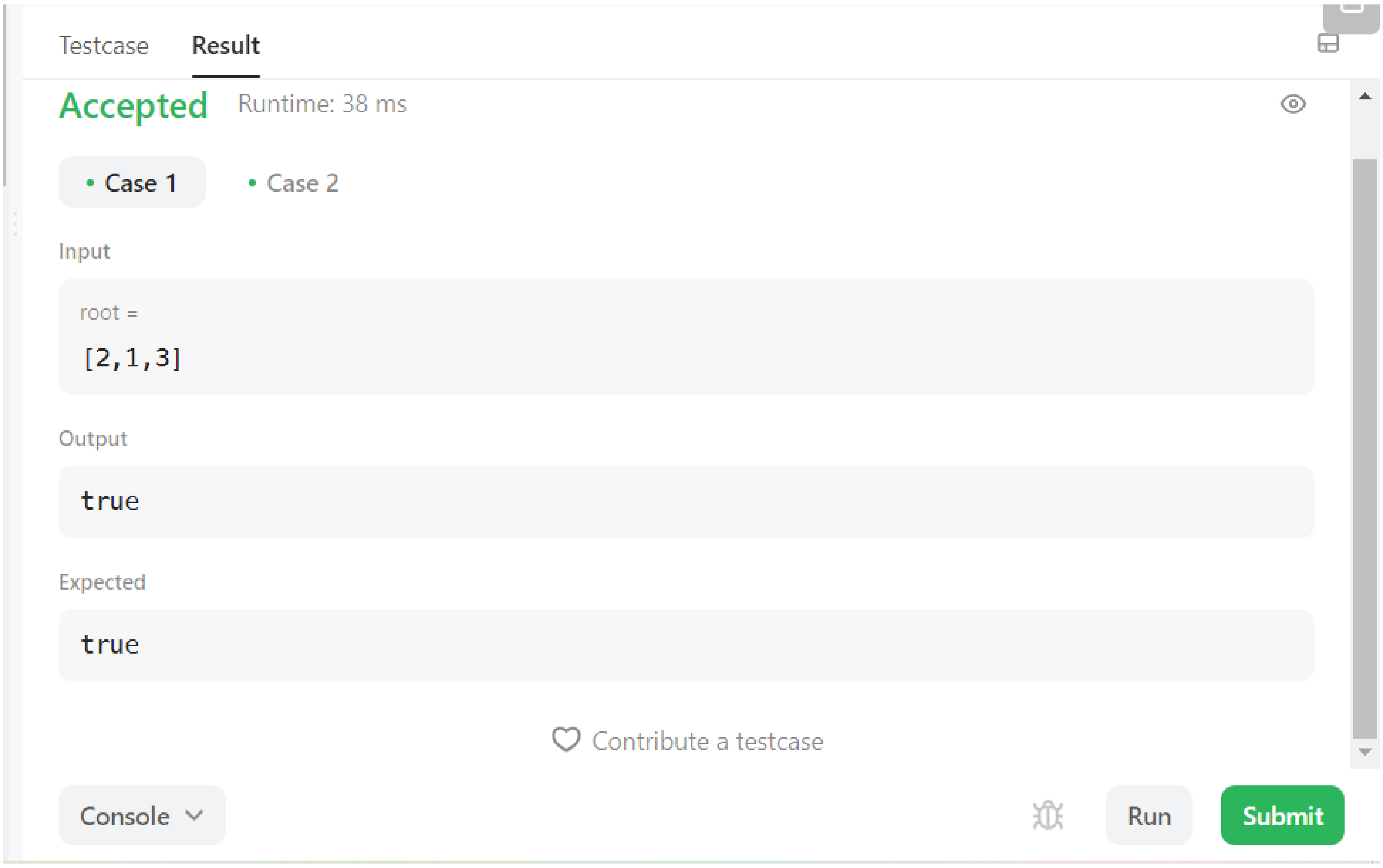
The right subtree of a node contains only nodes with keys greater than the node's key.

Both the left and right subtrees must also be binary search trees.

Program :

```
class Solution:
    def isValidBST(self, root: Optional[TreeNode]) -> bool:
        low, high = float("-inf"), float("inf")
        def isValidbst(root, low, high):
            if not root:
                return True
            if root.val <= high and root.val >= low:
                left_sub_tree = isValidbst(root.left, low, root.val - 1)
                right_sub_tree = isValidbst(root.right, root.val + 1, high)
                return left_sub_tree and right_sub_tree
            else:
                return False
        return isValidbst(root, low, high)
```

Output :



Result : Sucessfully Executed The Program.

WEEK – 6

Aim : Given an integer array nums where the elements are sorted in ascending order, convert it to a height-balanced binary search tree.

Program :

```
# Definition for a binary tree node.
# class TreeNode:
#     def __init__(self, val=0, left=None, right=None):
#         self.val = val
#         self.left = left
#         self.right = right
class Solution:
    def sortedArrayToBST(self, nums: List[int]) -> Optional[TreeNode]:
        total_nums = len(nums)
        if not total_nums:
            return None

        mid_node = total_nums // 2
        return TreeNode(
            nums[mid_node],
            self.sortedArrayToBST(nums[:mid_node]),
self.sortedArrayToBST(nums[mid_node + 1 :])
        )
```

Output :

Result : Sucessfully Executed the Program.

Aim : You are given two binary trees root1 and root2.

Imagine that when you put one of them to cover the other, some nodes of the two trees are overlapped while the others are not. You need to merge the two trees into a new binary tree. The merge rule is that if two nodes overlap, then sum node values up as the new value of the merged node. Otherwise, the NOT null node will be used as the node of the new tree.

Return the merged tree.

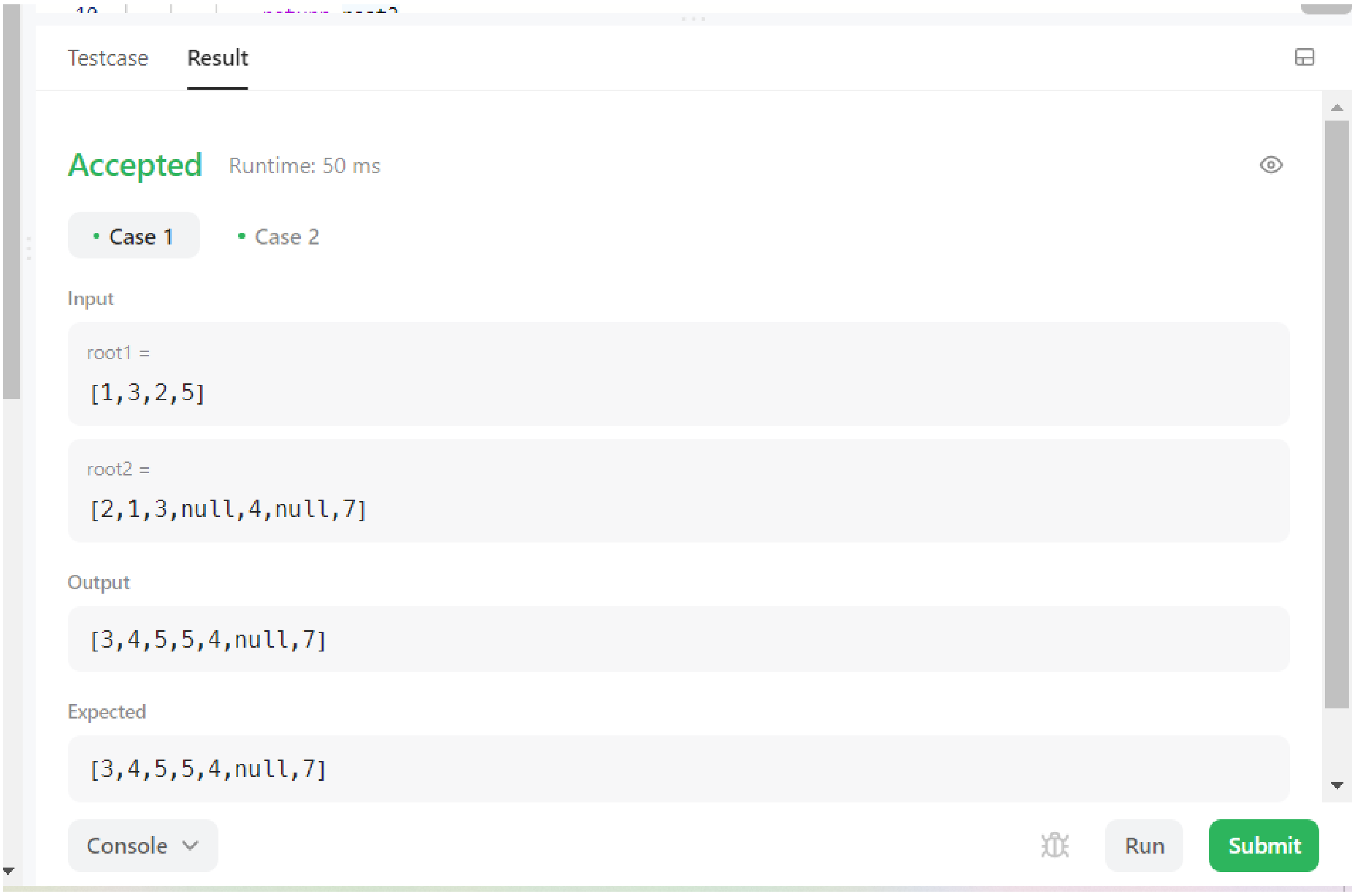
Note: The merging process must start from the root nodes of both trees.

Program :

```
#Definition for a binary tree node.
class TreeNode:
    def __init__(self, val=0, left=None, right=None):
        self.val = val
        self.left = left
        self.right = right

class Solution:
    def mergeTrees(self, root1: TreeNode, root2: TreeNode) -> TreeNode:
        if not root1:
            return root2
        if not root2:
            return root1
        # merge the nodes that are overlapped
        root1.val += root2.val
        root1.left = self.mergeTrees(root1.left, root2.left)
```

```
root1.right = self.mergeTrees(root1.right, root2.right)
return root1
```

Output :



Result : Sucessfully Executed The Program.

WEEK – 7

Aim : You are given an array of variable pairs equations and an array of real numbers values, where equations[i] = [Ai, Bi] and values[i] represent the equation Ai / Bi = values[i]. Each Ai or Bi is a string that represents a single variable.

You are also given some queries, where queries[j] = [Cj, Dj] represents the jth query where you must find the answer for Cj / Dj = ?.

Return the answers to all queries. If a single answer cannot be determined, return -1.0.

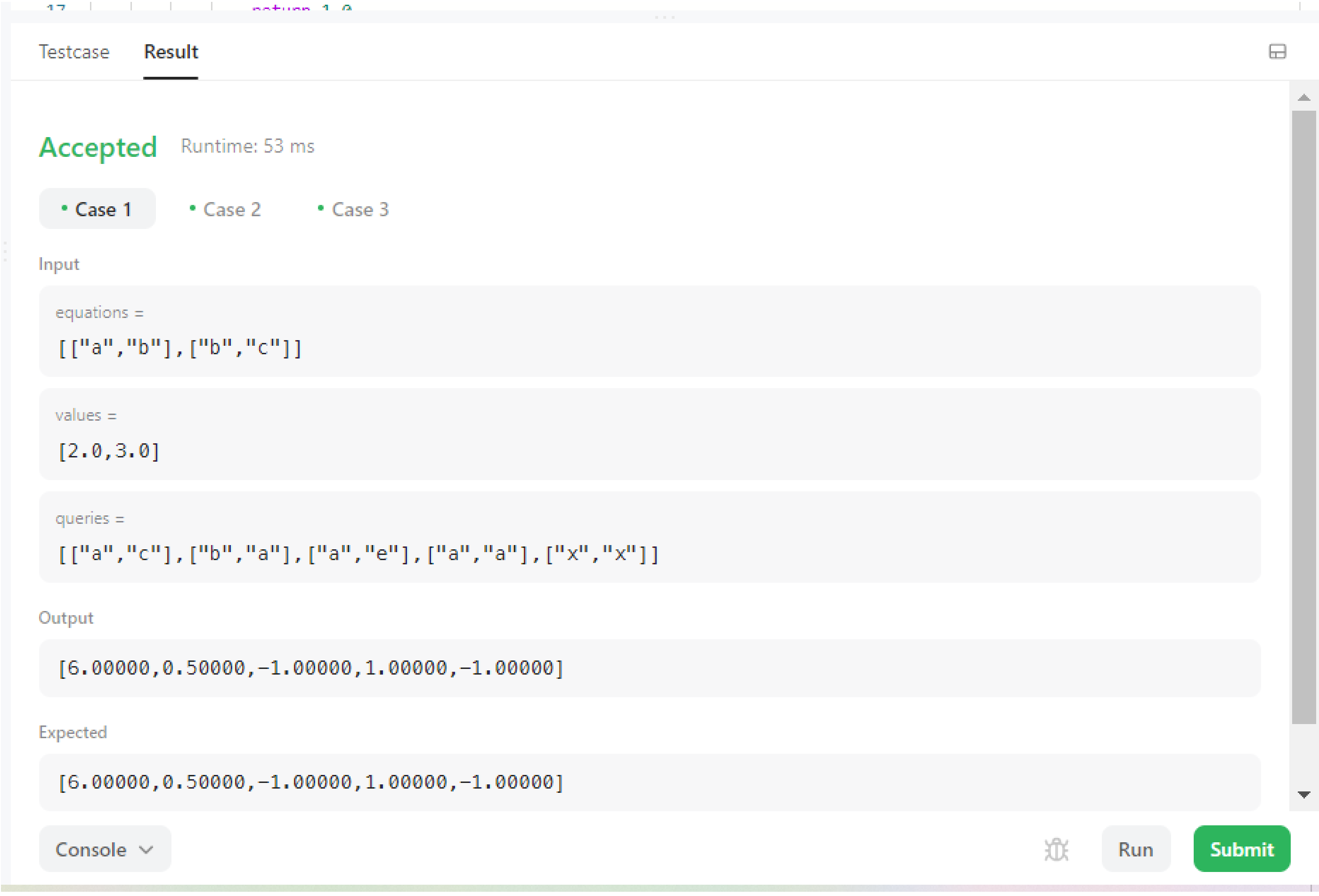
Note: The input is always valid. You may assume that evaluating the queries will not result in division by zero and that there is no contradiction.

Program :

```
class Solution:
    def calcEquation(self, equations: List[List[str]], values: List[float], queries: List[List[str]]) -> List[float]:
        # Build the graph
        graph = defaultdict(dict)
        for i in range(len(equations)):
            u, v = equations[i]
            graph[u][v] = values[i]
            graph[v][u] = 1 / values[i]
        # Helper function to perform DFS and find the path value
        def dfs(start, end, visited):
            # If we have already visited this node or it doesn't exist in the graph, return -1.0
            if start in visited or start not in graph:
```

```
            return -1.0
        # If we have reached the end node, return the path value
        if start == end:
            return 1.0
        # Mark the current node as visited
        visited.add(start)
        # Traverse the neighbors and find the path value recursively
        for neighbor, value in graph[start].items():
            path_value = dfs(neighbor, end, visited)
            # If we have found a valid path, return the product of the current value
and path value
            if path_value != -1.0:
                return value * path_value
        # If we haven't found a valid path, return -1.0
        return -1.0

    # Calculate the answer for each query
    result = []
    for query in queries:
        start, end = query
        # Perform DFS to find the path value
        result.append(dfs(start, end, set()))

    return result
```

Output :



Result : Sucessfully Executed The program.

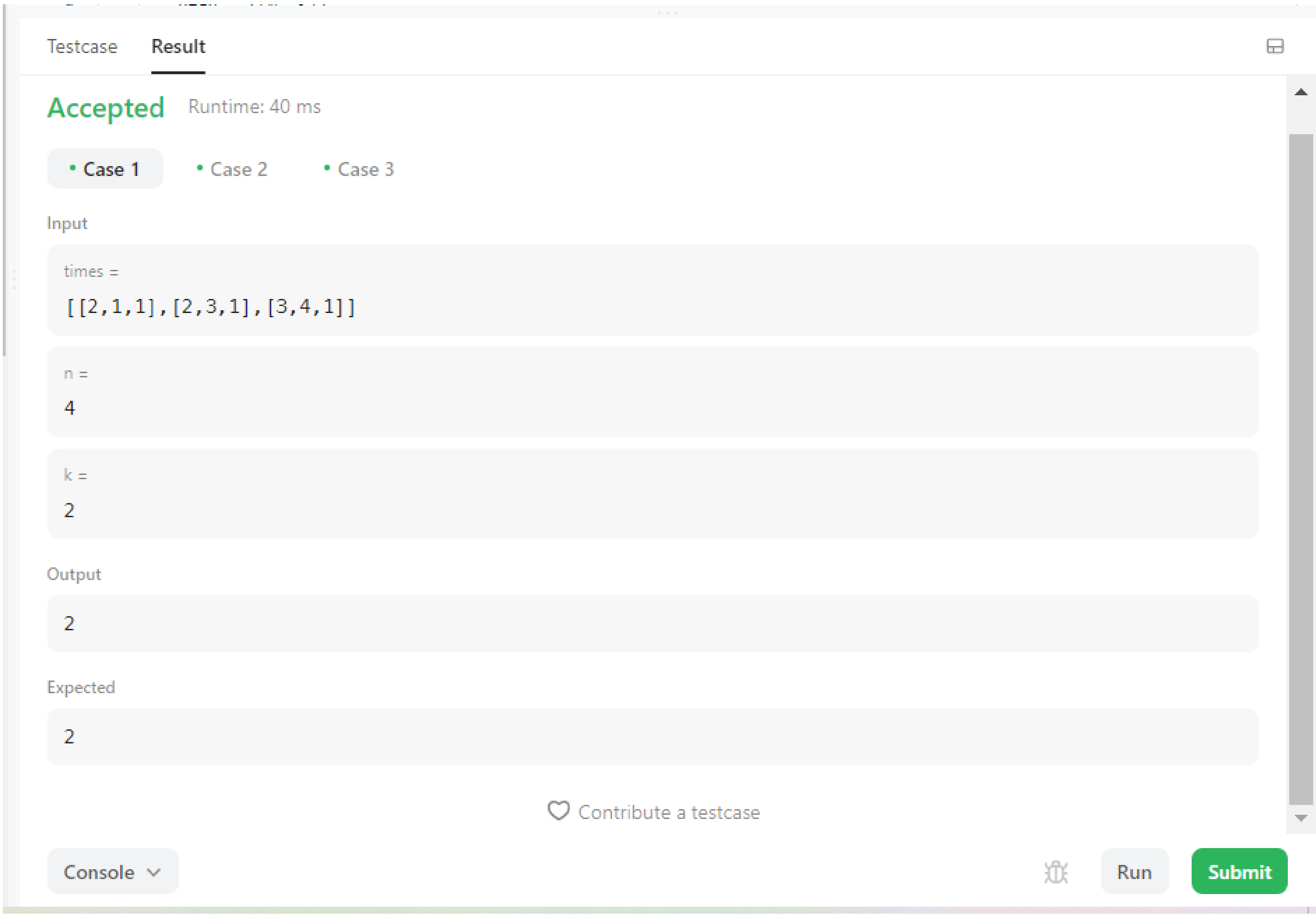
Aim : You are given a network of n nodes, labeled from 1 to n. You are also given times, a list of travel times as directed edges times[i] = (ui, vi, wi), where ui is the source node, vi is the target node, and wi is the time it takes for a signal to travel from source to target.

We will send a signal from a given node k. Return the minimum time it takes for all the n nodes to receive the signal. If it is impossible for all the n nodes to receive the signal, return -1.

Program :

```
class Solution:
    def networkDelayTime(self, times: List[List[int]], n: int, k: int) -> int:
        adj_list = defaultdict(list)
        for x,y,w in times:
            adj_list[x].append((w, y))
        visited=set()
        heap = [(0, k)]
        while heap:
            travel_time, node = heapq.heappop(heap)
            visited.add(node)
            if len(visited)==n:
                return travel_time

            for time, adjacent_node in adj_list[node]:
                if adjacent_node not in visited:
                    heapq.heappush(heap, (travel_time+time, adjacent_node))
        return -1
```

Output :



Result : Sucessfully Executed The Program.

WEEK – 8

Aim : Kitty has a tree,T , consisting of n nodes where each node is uniquely labeled from 1 to n. Her friend Alex gave her q sets, where each set contains k distinct nodes. Kitty needs to calculate the following expression on each set:

$$\left(\sum_{\{u,v\}} u \cdot v \cdot dist(u,v)\right) \bmod (10^9 + 7)$$

Program :

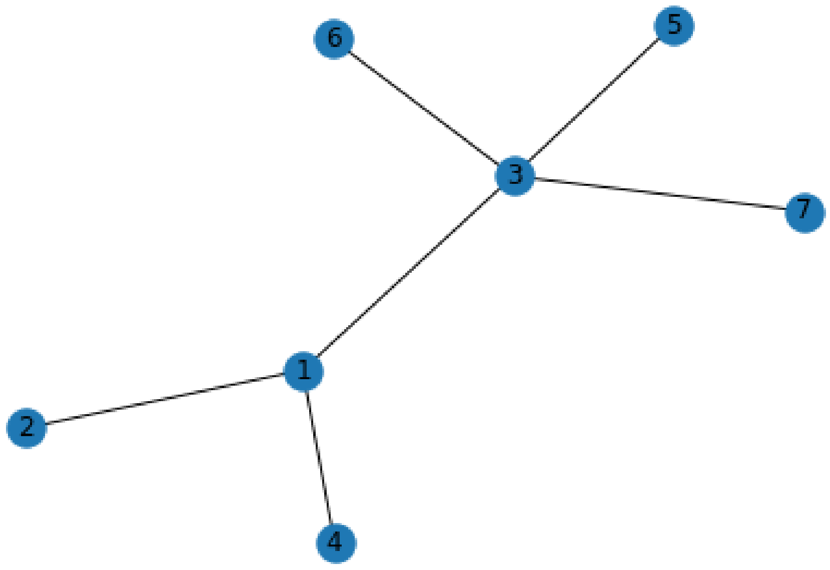
```
import networkx as nx
from itertools import combinations
import matplotlib.pyplot as plt
def dist(u,v):
 #print("Distance Nodes : " , int(sp[u][v]))
 duv = sp[u][v]
 return duv
def product_tuple(x):
 prodt = 1
 for i in range(len(x)):
  prodt *= x[i]
 return prodt
def kitty_formula(combi):
 res = 1
 for k in range(len(combi)):
  dtup = combi[k]
  temp = product_tuple(dtup) * dist(dtup[0], dtup[1])
```

```
    res = res + temp
  print("\n\nFinal Result : ", res-1)
# inputs taking
nodes, queries = map(int, input("Enter Nodes And Queries : ").split())
#print(nodes, queries)
edges = []
for i in range(nodes-1):
  edge = list(map(int, input("Enter intial and final nodes : ").split()))
  #print("edge entered is : ", edge)
  edges.append(edge)
print("All Edge List : ", edges)
for i in range(queries):
  lq = int(input("Enter length of the query set : "))
  q1 = list(map(int, input("Enter a pair : ").split()[:lq]))
  #print("q1 : ", q1)
  if len(q1) == 1:
    # calculation Start
    print("Final result : ", 0)
  else:
    # calculation Start
    combi = list(combinations(q1, 2))
    G = nx.Graph()
    G.add_nodes_from([h for h in range(1, nodes+1)])
    G.add_edges_from(edges)
    sp = dict(nx.all_pairs_shortest_path_length(G))
```

```
    kitty_formula(combi)
nx.draw(G, with_labels=True)
plt.show()
```

Output :

```
Enter Nodes And Queries : 7 3
Enter intial and final nodes : 1 2
Enter intial and final nodes : 1 3
Enter intial and final nodes : 1 4
Enter intial and final nodes : 3 5
Enter intial and final nodes : 3 6
Enter intial and final nodes : 3 7
All Edge List :  [[1, 2], [1, 3], [1, 4], [3, 5], [3, 6], [3, 7]]
Enter length of the query set : 2
Enter a pair : 2 4
Final Result :  16
Enter length of the query set : 1
Enter a pair : 5
Final result :  0
Enter length of the query set : 3
Enter a pair : 2 4 5
Final Result :  106
```



Result : Sucessfully Executed The Program.

Aim : Implement Emergence Of Connectivity Problem Using Networkx module.

Program :

```
import networkx as nx
import matplotlib.pyplot as plt
import random
import numpy as np
# Add n number of nodes in  the graph and return it.
def add_nodes(n):
   G = nx.Graph()
   G.add_nodes_from(range(n))
   return G
# add one random edge
def add_random_edge(G):
   v1 = random.choice(list(G.nodes()))
   v2 = random.choice(list(G.nodes()))
   if v1 != v2:
      G.add_edge(v1,v2)
   return G
# it add random edges in graph until it becomes connected
def add_till_connectivity(G):
   while nx.is_connected(G) == False:
      G = add_random_edge(G)
   return G
# creates an instance od entire process. it takes as input number of nodes and
```

```
# returns the number of edges for connectivity.
def create_instance(n):
    G = add_nodes(n)
    G = add_till_connectivity(G)
    return G.number_of_edges()
# Average it over 100 instances
def create_avg_instance(n):
    list1 = []
    for i in range(0,100):
        list1.append(create_instance(n))
    return np.average(list1)
# plot the desired for different number of edges
def plot_connectivity():
    x = []
    y = []
    i = 10 # it tells no of nodes
    while i <= 100:
        x.append(i)
        y.append(create_avg_instance(i))
        i = i + 10
    plt.xlabel("Number of Nodes")
    plt.ylabel("Number of edges required to connect the graph")
    plt.title("Emergence of Connectivity")
    plt.plot(x,y)
```

```
    x1 = []
    y1 = []
    i1 = 10
    while i1 <= 100:
        x1.append(i1)
        y1.append(i1*np.log(i1))
        # y1.append(i1*float(np.log(i1))//2)
        i1 = i1 + 10
    plt.plot(x1, y1)
    plt.show()


g = add_nodes(10)
print("No of nodes : ", g.number_of_nodes())
print("Connected or not : ", nx.is_connected(g))
g1 = add_random_edge(g)
print("new edge added : ", g1.edges())
g2 = add_till_connectivity(g1)
print("Total edges in a g2 : ", g2.edges())
print("Total no of edges : ", g2.number_of_edges())
print("Connected or not : ", nx.is_connected(g2))
d = create_instance(10)
print("No of edges required for connectivity : ", d)
plot_connectivity()
```

Output :

No of nodes : 10

Connected or not : False

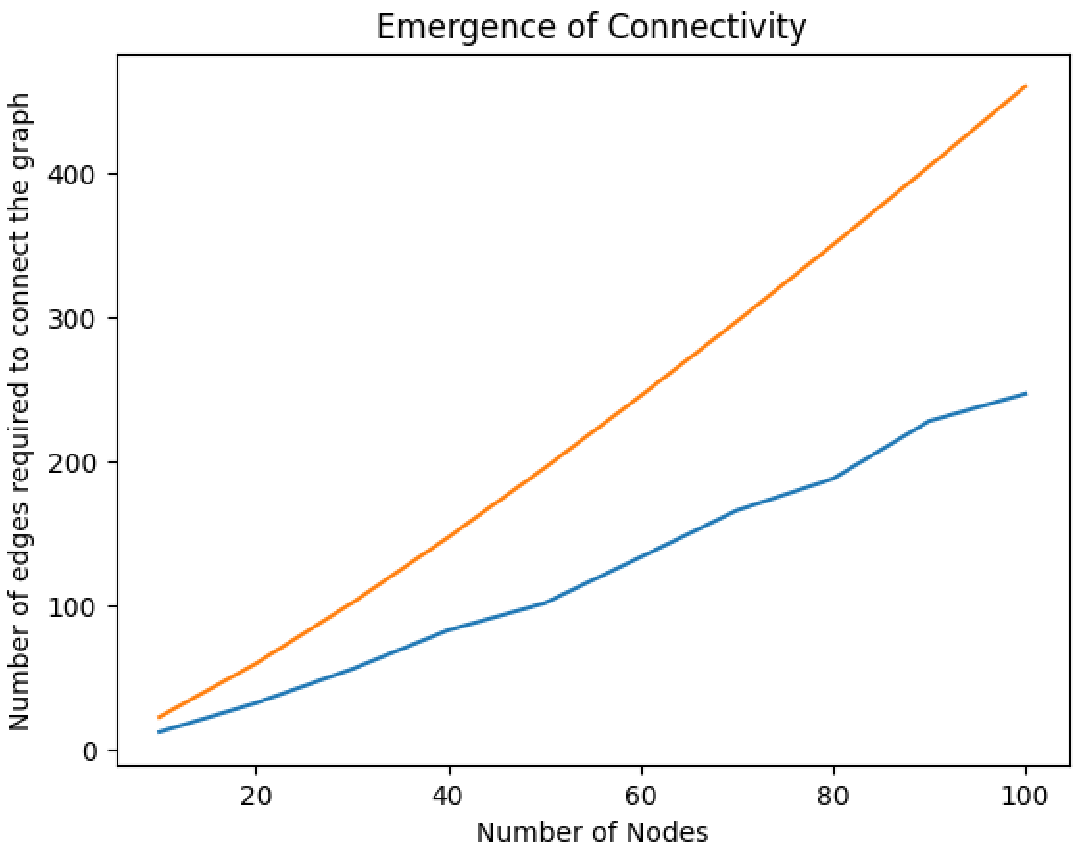
new edge added : [(2, 9)]

Total edges in a g2 : [(0, 8), (0, 6), (1, 9), (1, 7), (2, 9), (3, 9), (3, 4), (3, 7), (3, 5), (5, 6)]

Total no of edges : 10

Connected or not : True

No of edges required for connectivity : 13



Result : Sucessfully Executed The Program.