**ASSIGNMENT – 2**

**Q1) Write a recursive function power(base, exponent) that, when called, returns *baseexponent***.

**Code: -**

print('''Name: Sidhanta Barik, RegNo: 2241002049

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def power(base, exponent):

    if exponent < 0:

        return power(1/base, -exponent)

    if exponent == 0:

        return 1

    return base \* power(base, exponent-1)

print(power(4,3))

print(power(4,-2))

**OUTPUT: -**

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64

0.0625

**Q2)** **The greatest common divisor of integers x and y is the largest integer that evenly divides into both x and y. Write and test a recursive function gcd that returns the greatest common divisor of x and y. The gcd of x and y is defined recursively as follows: If y is equal to 0, then *gcd(x, y)* is x; otherwise, *gcd(x, y)* is *gcd(y, x%y)*.**

**Code: -**

print('''Name: Sidhanta Barik, RegNo: 2241002049

-----------------------------------------''')

def gcd(x, y):

    if y == 0:

        return x

    return gcd(y, x % y)

print(gcd(125,625))

**OUTPUT: -**

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125

**Q3)** **Write a recursive function that takes a number n as an input parameter and prints n-digit strictly increasing numbers.**

**Code: -**

print('''Name: Sidhanta Barik, RegNo: 2241002049

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def print\_increasing(n, curr="", lastDig = 0):

    if n==0:

        if curr!="":

            print(curr, end = " ")

        else:

            print("Invalid Input!!")

        return

    for i in range(lastDig+1, 10):

        print\_increasing(n-1, curr + str(i),i)

n = int(input("Enter no. of digits: "))

print(f"\n{n}-digit strictly increasing numbers:-")

print\_increasing(n)

**OUTPUT: -**

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Enter no. of digits: 2

2-digit strictly increasing numbers:-

12 13 14 15 16 17 18 19 23 24 25 26 27 28 29 34 35 36 37 38 39 45 46 47 48 49 56 57 58 59 67 68 69 78 79 89

**Q4)** **Implement a recursive solution for computing the nth Fibonacci number. Then, analyze its time complexity. Propose a more efficient solution and compare the two approaches.**

**RECURSIVE Solution: -**

**Code: -**

print('''Name: Sidhanta Barik, RegNo: 2241002049

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def fibo(n):

    if n==0:

        return 0

    if n==1:

        return 1

    return fibo(n-1) + fibo(n-2)

print(fibo(5))

**OUTPUT: -**

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**Time Comlpexity**: O(2^n)

* The time complexity of the recursive solution is exponential. This is because the function calls itself twice for each call, leading to a tree-like structure with 2^n nodes.

**MORE EFFICIENT(ITERATIVE) Solution: -**

**Code: -**

print('''Name: Sidhanta Barik, RegNo: 2241002049

-----------------------------------------''')

def fibo\_efficient(n):

    if n==0:

        return 0

    if n==1:

        return 1

    a = 0

    b = 1

    for i in range(2, n+1):

        c = a + b

        a = b

        b = c

    return c

print(fibo\_efficient(5))

**OUTPUT: -**

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**Time Comlpexity**: O(n)

* The time complexity of the efficient solution is linear. This is because the function iterates n times to calculate the nth Fibonacci number.

**Q5)** **Given an array of N elements, not necessarily in ascending order, devised an algorithm to find the kth largest one. It should run in O(N ) time on random inputs.**

**Code: -**

print('''Name: Sidhanta Barik, RegNo: 2241002049

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import random

def quickSelect(ar, k):

    if ar:

        # random pivot(to avoid worst case. Rarely, worst case may occur)

        pivot = ar[random.randint(0, len(ar)-1)]

        left = [x for x in ar if x < pivot]

        right = [x for x in ar if x > pivot]

        if k == len(right) + 1:

            return pivot

        elif k <= len(right):

            return quickSelect(right, k)

        else:

            return quickSelect(left, k - len(right) - 1)

    return None

print(quickSelect([3, 2, 1, 5, 4], 2))

**OUTPUT: -**

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**time complexity**: O(n) in avg case, O(n^2) in worst case

**Q6)** **For each of the following code snippets, determine the time complexity in terms of Big O. Explain your answer.**

1. **def example1(n):**

**for i in range(n):**

**for j in range(n):**

**print(i, j)**

**Ans: -**

**time complexity**: O(n^2)

The time complexity of the nested loops is quadratic. This is because the inner loop runs n times for each iteration of the outer loop, leading to n^2 iterations in total.

1. **for i in range(n):**

**print(i)**

**Ans: -**

**time complexity**: O(n)

The time complexity of the loop is linear. This is because the loop runs n times, where n is the input to the function.

1. **def example1(n):** **def recursive\_function(n):**

**if n <= 1:**

**return 1**

**return recursive\_function(n - 1) + recursive\_function(n - 1)**

**Ans: -**

**time complexity**: O(2^n)

The time complexity of the recursive function is exponential. This is because the function calls itself twice for each call, leading to a tree-like structure with 2^n nodes.

**Q7)** **Given N points on a circle, centered at the origin, design an algorithm that determines whether there are two points that are antipodal, i.e., the line connecting the two points goes through the origin. Your algorithm should run in time proportional to *N logN*.**

**Code: -**

print('''Name: Sidhanta Barik, RegNo: 2241002049

-----------------------------------------''')

def quadrant(x, y):

    if x >= 0 and y >= 0:

        return 1

    if x < 0 and y >= 0:

        return 2

    if x < 0 and y < 0:

        return 3

    return 4

def custom\_sort(point):

    x, y = point

    q = quadrant(x, y)

    if x != 0:

        slope = y \* 1.0 / x

    else:

        slope = float('inf')

    return (q, slope)

def checkAntipodal(points):

    points.sort(key=custom\_sort)

    n = len(points)

    for i in range(n):

        x1, y1 = points[i]

        for j in range(i + 1, n):

            x2, y2 = points[j]

            if x1 == -x2 and y1 == -y2:

                return True

    return False

points = [(1, 0), (-1, 0), (0, 1), (0, -1), (1, 1), (-1, -1)]

if checkAntipodal(points):

    print("Antipodal points exist.")

else:

    print("Antipodal points do not exist.")

**OUTPUT: -**

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Antipodal points exist.

**Q8)** **Write a Python function *quick\_sort* that implements the quicksort algorithm. The function should include a helper function *quick\_sort\_helper* to handle recursion. The helper function must take a starting and ending index as arguments and sort the array in-place. Demonstrate the function by sorting the given array and printing the sorted output.**

**Code: -**

print('''Name: Sidhanta Barik, RegNo: 2241002049

-----------------------------------------''')

def quick\_sort(ar, s, e):

    if s<e:

        p = partition(ar, s, e)

        quick\_sort(ar, s, p-1)

        quick\_sort(ar, p+1, e)

def partition(ar, s, e):

    pivot = ar[s]

    i = s

    for j in range(s+1, e+1):

        if ar[j] < pivot:

            i += 1

            ar[i], ar[j] = ar[j], ar[i]

    ar[i], ar[s] = ar[s], ar[i]

    return i

ar = [37, 2, 6, 4, 89, 8, 10, 12, 68, 45]

print("Before sorting:", ar)

s = 0

e = len(ar)-1

quick\_sort(ar, s, e)

print("After sorting: ", ar)

**OUTPUT: -**

Name: Sidhanta Barik, RegNo: 2241002049

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Before sorting: [37, 2, 6, 4, 89, 8, 10, 12, 68, 45]

After sorting: [2, 4, 6, 8, 10, 12, 37, 45, 68, 89]

**Q9)** **You are given the following list of famous personalities with their net worth:**

**• Elon Musk: $433.9 Billion**

**• Jeff Bezos: $239.4 Billion**

**• Mark Zuckerberg: $211.8 Billion**

**• Larry Ellison: $204.6 Billion**

**• Bernard Arnault & Family: $181.3 Billion**

**• Larry Page: $161.4 Billion**

**Develop a program to sort the aforementioned details on the basis of net worth using**

**a. Selection sort**

**b. Bubble sort**

**c. Insertion sort.**

**The final sorted data should be the same for all cases. After you obtain the sorted data, present the**

**result in the form of the following dictionary:**

**{’name1’:networth1, ’name2’:networth2, ...}**

**Code: -**

print('''Name: Sidhanta Barik, RegNo: 2241002049

-----------------------------------------''')

class Billionaires:

    def \_\_init\_\_(self, name, net\_worth):

        self.name = name

        self.net\_worth = net\_worth

    def \_\_str\_\_(self):

        return f'{self.name}: {self.net\_worth} Billion'

    def \_\_lt\_\_(self, other):

        return self.net\_worth < other.net\_worth

    def \_\_gt\_\_(self, other):

        return self.net\_worth > other.net\_worth

def insertionSort(l):

    n = len(l)

    if n<1:

        return

    for i in range(1, n):

        key = l[i]

        j = i-1

        while j>=0 and key < l[j]:

            l[j+1] = l[j]

            j -= 1

        l[j+1] = key

    return l

def selectionSort(l):

    n = len(l)

    for i in range(n):

        min = i

        for j in range(i+1, n):

            if l[j] < l[min]:

                min = j

        l[i], l[min] = l[min], l[i]

    return l

def bubbleSort(l):

    n = len(l)

    for i in range(n):

        for j in range(n-i-1):

            if l[j] > l[j+1]:

                l[j], l[j+1] = l[j+1], l[j]

    return l

bData = {

    'Elon Musk': 433.9,

    'Jeff Bezos': 239.4,

    'Mark Zuckerberg': 211.8,

    'Larry Ellison': 204.6,

    'Bernard Arnault & Family': 181.3,

    'Larry Page': 161.4

}

l = [Billionaires(k, v) for k, v in bData.items()]

isl = insertionSort(l[:])

ssl = selectionSort(l[:])

bsl = bubbleSort(l[:])

isd = {x.name: x.net\_worth for x in isl}

ssd = {x.name: x.net\_worth for x in ssl}

bsd = {x.name: x.net\_worth for x in bsl}

print(f"Insertion Sort:-\n{isd}\n")

print(f"Selection Sort:-\n{ssd}\n")

print(f"Bubble Sort:-\n{bsd}")

**OUTPUT: -**

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Insertion Sort:-

{'Larry Page': 161.4, 'Bernard Arnault & Family': 181.3, 'Larry Ellison': 204.6, 'Mark Zuckerberg': 211.8, 'Jeff Bezos': 239.4, 'Elon Musk': 433.9}

Selection Sort:-

{'Larry Page': 161.4, 'Bernard Arnault & Family': 181.3, 'Larry Ellison': 204.6, 'Mark Zuckerberg': 211.8, 'Jeff Bezos': 239.4, 'Elon Musk': 433.9}

Bubble Sort:-

{'Larry Page': 161.4, 'Bernard Arnault & Family': 181.3, 'Larry Ellison': 204.6, 'Mark Zuckerberg': 211.8, 'Jeff Bezos': 239.4, 'Elon Musk': 433.9}

**Q10)** **Use Merge Sort to sort a list of strings alphabetically.**

**Code: -**

print('''Name: Sidhanta Barik, RegNo: 2241002049

-----------------------------------------''')

def mergeSort(ar):

    if len(ar) <= 1:

        return ar

    mid = len(ar) // 2

    left = ar[:mid]

    right = ar[mid:]

    left = mergeSort(left)

    right = mergeSort(right)

    return merge(left, right)

def merge(l, r):

    i = j = 0

    ml = []

    while i<len(l) and j<len(r):

        if l[i] < r[j]:

            ml.append(l[i])

            i += 1

        else:

            ml.append(r[j])

            j += 1

    ml.extend(l[i:])

    ml.extend(r[j:])

    return ml

ar = ['apple', 'orange', 'banana', 'grape']

print(f"Before sorting: {ar}")

l = 0

r = len(ar)-1

print(f"After sorting:  {mergeSort(ar)}")

**OUTPUT: -**

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Before sorting: ['apple', 'orange', 'banana', 'grape']

After sorting: ['apple', 'banana', 'grape', 'orange']

**Q11)** **Without using the built-in sorted() function, write a Python program to merge two pre-sorted lists into a single sorted list using the logic of Merge Sort.**

**Code: -**

print('''Name: Sidhanta Barik, RegNo: 2241002049

-----------------------------------------''')

def merge(l, r):

    i = j = 0

    ml = []

    while i<len(l) and j<len(r):

        if l[i] < r[j]:

            ml.append(l[i])

            i += 1

        else:

            ml.append(r[j])

            j += 1

    ml.extend(l[i:])

    ml.extend(r[j:])

    return ml

sortedList1 = [1,3,5,7]

sortedList2 = [2,4,6,8]

mergedList = merge(sortedList1, sortedList2)

print(f"Sorted Merged List: {mergedList}")

**OUTPUT: -**

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Sorted List 1: [1, 3, 5, 7]

Sorted List 1: [2, 4, 6, 8]

Sorted Merged List: [1, 2, 3, 4, 5, 6, 7, 8]