Recursion

Recursion is when a function is calling itself (multiple time) with the smaller input till it reaches to base case/ trivial case.

Thus, resulting in reducing the size of problem (i.e., Converging the problem towards base case/ trivial case).

Math behind the Recursion

**PMI (Principle of Mathematical Induction)**

For a function f(x)

Step 1: To prove for lower value like f(0) or f(1) is true | ***Base Case/ Trivial Case***

Step 2: Assume f(k) is true | ***Induction hypothesis***

Step 3: Prove f(k+1) is true using step 1 and step 2| ***Induction Step***

**Extended form of PMI**

Step 1: Assume f(0), f(1), f(2), … f(k) is true

Step 2: Using all f(0)…f(k), prove f(k+1) is true

Printing numbers 1 to 10 and vice-versa

*def* Printer(*n*):

    if n == 0:

        return

    Printer(n - 1) # print while function are popping out from stack

    print(n) # printing after all the function are returned

Printer(10) #1, 2, 3, 4, … 10

*def* Printer(*n*):

    if n == 0:

        return

    print(n) # printing before and then calling the next function

    Printer(n - 1) # printing before function are inserting into the stack

Printer(10) #10, 9, 8, … 1

**Note:** Fibonacci series requires 2 base cases in a recursion. (**Extended PMI**)

RecursionError: maximum recursion depth exceeded in comparison

The reason we get it is because every recursion call uses some system memory and python has certain memory limit to use by recursive call if it gets exceeded, it gives us a recursion error.

import sys

sys.setrecursionlimit(3000) # to increase the recursion limit in python

First & Last Index using Recursion

#First index using multiple copy of array

arr = [20, 12, 3, 33, 20, 2]

key = 2

*def* FirstIndex(*a*, *k*):

    if len(a) == 0:

        return -1

    if a[0] == k:

        return 0

    OP = FirstIndex(a[1:], k) # OP = output

    if OP == -1:

        return -1

    else:

        return OP + 1

print(FirstIndex(arr, key)) #5

#First index using index as a third parameter

arr = [20, 12, 3, 33, 20, 2]

key = 2

index = 0

*def* FirstIndex(*a*, *k*, *i*):

    if i >= len(a):

        return -1

    if a[i] == k:

        return i

    return FirstIndex(a, k, i+1)

print(FirstIndex(arr, key, index))

#Last Index using index as a third parameter

arr = [20, 2, 3, 33, 20, 62]

key = 2

index = len(arr) - 1

*def* LastIndex(*a*, *k*, *i*):

    if i < 0:

        return -1

    if a[i] == k:

        return i

    return LastIndex(a, k, i-1)

print(LastIndex(arr, key, index)) # 1

#Last index using multiple copy of array

arr = [20, 12, 3, 33, 20, 2]

key = 2

*def* LastIndex(*a*, *k*):

    if len(a) == 0:

        return -1

    output = LastIndex(a[1:], k)

    if output == -1:

        if a[0] == k:

            return 0

        else:

            return -1

    else:

        return output +1

print(LastIndex(arr, key))