# Python
# Object-oriented programming language
# (OOP)

Both OOP & FP are high level languages
When object interacts with another objects through medium(object) by calling methods or sending messages
(HTTP,JDBC,HTTPS,ODBC)
Example: going from one place to another using a car (object)

Functional programming language: depends on using the functions returned as values according to each program.

OOP:

- accessing an object to create a new object
- You are not in control

FP:

- You are in control when it comes to using applications on your mobile phones.

Scripting language:

- Linux & Unix
- SQL

Low level language:

- Machine language
- ALU: Arithmetic logic units;using binary data to perform AND,OR logic operations

## My Research

Difference between OOP & FP:

OOP: it is how the data is organised in a specific design called data structure for easy & quick access or update. It doesn't focus much on the algorithm itself and how it is computed.
it consists of

- Class . EX: Human
- Objects EX: name
- Attributes for this object EX: email, address
- Methods. EX: eat,walk,run,work; verbs

FP: Alternate program to OOP using functions on large amounts of data to get an output without modifying the original data.

## Interpreting & Compiling

Interpreting: software chipped in the computer as high level language is translated into low level language/machine code line by line (the process here takes more time than compiler ). examples: Python , SQL, Ruby,Java Script.

Compiling: Translating the whole program from high level language to low level language.Examples:Java, C++

Python : is an interpreter language executes line by line and translate each line to the machine language

## Python, Visual studio code,Jupyter Notebook and Code Runner Installation

**Python command lines using Jupyter Notebook:**

```
print('hello world')
hello world
print('welcome')
welcome
a = 10
a= 10 =b
a=10
print('a =',a)

b=print('a=',a,'=b')    # a=10=b
a=10
print('a=',a,sep='dddd',end='\n\n\n')  # here it gives 3 new lines
print('a=',a,sep='0',end='$$$')
a=10
a=dddd10


a=010$$$

#lists
#lists
L1=['John',102,'USA']
L2=[1,2,3,4,5,6]
print(L1)
print(L2)
print(L1+L2)
['John', 102, 'USA']
[1, 2, 3, 4, 5, 6]
['John', 102, 'USA', 1, 2, 3, 4, 5, 6]
```

```
# tuples: it is immutable;means once you declared it,you cannot alter it
tup=('Apple','Mango','Orange','banana')
tup[2]='Strawberry'  print(tup)
----> 3 tup[2]='Strawberry'
      4 print(tup)

TypeError: 'tuple' object does not support item assignment
#once you have more than one element ( , ) it is called tuple otherwise it
is string
tup2=tuple('orange')
print(type(tup2))
print(tup2)
<class 'tuple'>
('o', 'r', 'a', 'n', 'g', 'e')

#dictionaries: contains keys and values
employee={'Name':'Jinesh','salary':5454,'company':'gr'}
print(type(employee))
Month={'jan','feb','march'}
print(type(Month))
<class 'dict'>
<class 'set'>
```

**Print (type(x))** # to check the type of data
**tup=tuple(list_name)** # to turn a list into tuple

Python Application:
Tool used to develop web applications: Django,Flask,Pyramid,Web2py,CherryPy
For Desktop UI Application:
For console
For scientific
For Audio/Video
For 3D
For Image processing
For ERP

**My Research/work**

**Python Command line using Jupyter Notebook**

- Tuples,lists & dictionaries
- Finding the type of the data

```
tu=('orange',)
tu2=('strawberry',)
```

```
print(tu+tu2)
('orange', 'strawberry')
tup=('Apple','Mango','Orange','banana')
list=[]
for word in tup:
    list.append(word)
print(list)
# converting tuple into list using for loop
list=[]
for word in tup:
    list.append(word)
print(list)
['Apple', 'Mango', 'Orange', 'banana']

#dictionaries: contains key & value
employee={'Name':'Jinesh','salary':5454,'company':'gr'}
print(type(employee))
Month={'jan','feb','march'}
print(type(Month))
print(employee.keys())
print(employee.values())
print(employee.items())
print(len(employee))       # gives the number of items in the tuple
<class 'dict'>
<class 'set'>
dict_keys(['Name', 'salary', 'company'])
dict_values(['Jinesh', 5454, 'gr'])
dict_items([('Name', 'Jinesh'), ('salary', 5454), ('company', 'gr')])
3
```

**One of the Immutable data types:**

**frozensets()**

To frozen a list,dictionary or a dataset

```
xample_list = [1,2,3,4,5]
frozen_set = frozenset(example_list)

print(example_list)
print(type(example_list))

print(frozen_set)  # returns a tuple of dictionary
print(type(frozen_set))
[1, 2, 3, 4, 5]
<class 'list'>
frozenset({1, 2, 3, 4, 5})
<class 'frozenset'>
```

## For Loop

it is like a cursor that goes into each value in a list,tuple or a dictionary

```
listing=[1,2,3,4,5,6]
for value in listing:
    print(value)
print('end')
1
2
3
4
5
6
end
```

### My Research/work

For loop:

**Example**: the code reads integer n, and to get all non-negative integers i<n to print i^2

```
n = int(input())

for i in range(0,n):
    print(pow(i,2))
For n=5
0
1
4
9
16
```

The address where the variable is located when a value is stored in it:

```
print(id(a))
print(id(b))  # both is stored in the same location/address as they have the same value
a=500  # immutable
print(id(a))
140704327727432
140704327727432
2579860937136
```

Immutable: int,float,tuple,complex,string,Bytes,string frozen.frozensets().

Mutable: lists

NOTE THAT: until 2pow(8) which is 256 , the variables are stored in the same address. Above that it won't be stored in the same address

```
a=256
b=256
print(id(a))
print(id(b))
140704327734024
140704327734024

a=257
b=257
print(id(a))
print(id(b))
2579860935952
2579860935088
```

## My Research/work

Intern Objects and whether two objects have the same location or not:

```
x = "Lorem ipsum"
y = "Lorem ipsum"
x is y
print(id(x))
print(id(y)) #locations will be different as they are two distinct objects
although they have the same value

#unless they are intern objects;with small integers
x = 'Lorem'
y= 'Lorem'
x is y
print(id(x))
print(id(y))
2579855165616
2579856125488
2579861077744
2579861077744
```

When you assign the second variable to the first one,it is like aliasing to the first variable so both will have the same location

```
x = 'Lorem'
y= x
x is y
print(id(x))
print(id(y))
2579861077744
```

```
2579861077744
```

## Using range

```
for i in reversed(range(5)):
    print(i)                                # here it works

for i in range(7):
    print(i)
4
3
2
1
0
0
1
2
3
4
5
6
#putting range values in list instead of manually write the values
print(list(range(0,15)))
print(list(range(5,25,4)))
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14]
[5, 9, 13, 17, 21]
```

### My Research/work

```
n = int(input())
if 1<=n<=150:
    print(*range(1,n+1),sep='')
#n=5
12345
```

**As range function is not supported in python 3 so we use *range()**

## Using Remainder to get the odd or even numbers

```
tup=(1,2,3,4,5,6)
for number in tup:
    if number%2!=0:
        print(number)
1
3
5
```

## While loop

```
# while loop
# here means that until counter =10 print (python loops)
counter=0
while counter<10:
    counter=counter+3
    print('python loops')
python loops
python loops
python loops
python loops
```

## Pass & Continue uses in loops

```
for string in 'python loops':
    pass
print(string)
S
for string in 'python loops':
    pass              # here it means to go back to continue the process of the
loop; to go to for loop again
print(string)
s
```

## My Research/work

### Difference between Pass & Continue in loops

### For loop

```
for string in 'python loops':
    pass           # here it says to do nothing and to go to the next line
    print(string)
p
y
t
h
o
```

```
n

l
o
o
p
S
for string in 'python loops':
    continue               # here it means to go back to continue the
process of the loop; to go to for loop again
    print(string)
# gives nothing as it keeps go to the for loop only

record={'itika':90,'df':60,'dsde':70}
for (name,mark)in record.items():
    if mark>80:
        print(name,mark)
    else:
        continue
itika 90
```

## Using variables in a string by using (f-strings)

```
# nested loops
student_fn='itika'
student_1='angola'
record={'itika':90,'df':60,'dsde':70}
print(f"Marks of the student {student_fn} are",record[student_fn])  # f here
is just to get the value of one variable in a string like getting the
student_fn's value
Marks of the student itika are 90
```

## Using definitions to make it more flexible or generalised

```
# using definition
def getMyMarks(student):
    return record[student]
print(f'marks of student {student_fn} are',getMyMarks(student_fn))
marks of student itika are 90
```

### My Research/work

To get the marks which is more than 80 for each student

```
def getmark(student):
```

```
    return student,record[student]
for (name,mark)in record.items():
    if mark>80:
        print(getmark(name))
    else:
        continue
('itika', 90)
```

## Using random library(randint() , randrange() )

```
import random    # it gives random integers/range/bytes
new=list()
for i in range(0,11):
    new.append(random.randint(0,11))
print(new)
[11, 4, 4, 9, 3, 2, 10, 1, 7, 8, 3]

for i in range(0,11):
    new.append(random.randrange(0,11,2)) # randrange(start,stop,step)
print(new)
[6, 4, 4, 0, 0, 6, 4, 10, 10, 8, 2]
```

## Using pop() function

```
#using pop function as it gives the values in reverse like if there is
a bucket and you pick up the last item you put in there
list=[1,2,3,4,5,6]
new=[]
while list:
    new.append(list.pop())
print(new)
print(list)    # here the list will become empty as all the values have
been poped out of it to 'new'
[6, 5, 4, 3, 2, 1]
[]
# to duplicate the values in a list
duplic=new*2
print(duplic)
len(new)  # the no. of values in a list
[6, 5, 4, 3, 2, 1, 6, 5, 4, 3, 2, 1]

6
```

## To check if an element/value present in a list,max value and min value

```
print(5 in new)
print(max(new))
print(min(new))
True
6
1
```

## Using Debugging

- Copy and paste the code in separate python file editor not jupyter notebook
- Start run with debugging then press F11 or step into button which will explain each step executed in the code

## Finding the most optimal algorithm to find the sum of values in a list

```
#finding the right/most optimal algorithm to get the summing of some
values in a list
def summing(a,b):
        if a==0:
                abst=listing1[b]
        else:
                abst=listing1[b]-listing1[a-1]
        return abst

listing=[15,21,36,41,54,62]
listing1=[]
i=range(0,len(listing))
sum=0
for value in listing:
        sum=sum+value
        listing1.append(sum)
print(listing1)
print(summing(3,5))
print(listing[3]+listing[4]+listing[5])

print(summing(0,3))
print(listing[0]+listing[1]+listing[2]+listing[3])
```

## Indexes by minus

```
tuple=('python','tuple','ordered','immutable','collection','object')
print(tuple[ :-4])
print(tuple[ :-5])
print(tuple[ :-3])
```

```
('python', 'tuple') # here it counts from backwards starting from -1
and gives the in between
('python',)
('python', 'tuple', 'ordered')
```

## Getting the remainder for a number

**option 1:**

```
#getting the remainder of a number
def factor(N):
    count=0
    for i in range(1,N+1):
        if N%i==0:
            count=count+1
            print('the factor is',i)
    return count
print(factor(24))
print(factor(16))
the factor is 1
the factor is 2
the factor is 3
the factor is 4
the factor is 6
the factor is 8
the factor is 12
the factor is 24
8
the factor is 1
the factor is 2
the factor is 4
the factor is 8
the factor is 16
5
```

**Option 2: the optimised formula**

```
def calculatecountfactorial(N):
    count=0
    for i in range(1,int(math.sqrt(N)+1)):
        if N%i==0:
            if N==i*i:
                count=count+1
            else:
                count=count+2
    return count
N=int(input('enter a number')) #N=25
print(calculatecountfactorial(N))
3
```

## Sum of the natural numbers

```
def sumnaturalnumbers(N):
    s= N*(N+1)/2
    return s
print(sumnaturalnumbers(100))
5050.0
```

## Logarithms

Logarithms allow us to perform calculations using smaller values than the value we get in getting the square root of the same value or the division by 2

## Time Complexity

How many iterations for the loops are executed to give the output?
N represents the number of iterations depending on the size of the data.
It is a way to measure the performance of the algorithm according to the size of the input and its running time.
Ex1:

```
for i in range(N):
    print(i)
```

Here the time complexity is O(N)

Ex2:
For i 1 to N:

For j 1 to M:
Here the time complexity for the first loop is O(N)
And the time complexity for the second loop is O(M)
Then the time complexity for the whole code is O(N+M)

Ex3:
For i 1 to N:

For j 1 to N:
Here the time complexity for the first loop is O(N)
And the time complexity for the second loop is O(N)
Then the time complexity for the whole code is O(N+N)=O(2N)

### My Research

## Time Complexity

Types of time complexity:

- Constant time O(1): it doesn't depend on the input data.

```
if a > b:
    return True
else:
```

```
    return False
```

- Linear time O(N): it scans the values of the data linearly;value by value.

```
for value in data:
    print(value)
```

- Logarithmic time O(logN): it reduces the size of the data input or multiplying it by 2.or we don't need to look at all the values of the data.

```
for index in range(0, len(data), 3):
    print(data[index])
```

- Quasilinear time O(NlogN): it does both linear and logarithmic time;it scans each value of the data input and reduces the size of this value or multiply it by 2.or do logarithmic operations to it.

```
for value in data1:
    result.append(binary_search(data2, value))
```

- Quadratic time O(N^2): to perform a linear operation for each value of the data input

For ex. for value 1 ,we scan all the values in the same data input ;maybe to compare this value 1 with the rest of the values in the same data.

```
for x in data:
    for y in data:
        print(x, y)
Or
For x in data:
    For y in x:
```

- Exponential time O(2^N):when the growth doubles with each addition to the input data set

```
def fibonacci(n):
    if n <= 1:
        return n
    return fibonacci(n-1) + fibonacci(n-2)
```

## Data structure types

**(with OOP used for creating objects and methods to store and manipulate the data in data structure)**

Data structure: it is how the data is organised in the memory to be easily accessed as well as manipulating the data;sorting,replacing,deleting,inserting.Using OOP
Types:

Linear data structure:Array, Queue,Linkedlist and Stack
Non linear: Tree and Graph.

1- Array: is a list of data [ , , , , , ] of the same type stored in a block of memory.

Ex1:

```
# classes
# %%
```

```
class Array(object):

    def __init__(self,sizeOfArray,arrayType = int):
        self.sizeOfArray = len(list(map(arrayType ,range(sizeOfArray))))
        self.arrayItems = [arrayType(0)]*sizeOfArray

    def __len__(self):
        return len(self.arrayItems)

    def insert(self,keyToInsert,position):
        if self.sizeOfArray > position:
            for i in range(self.sizeOfArray-2,position-1,-1):
# the method proceeds to shift the existing elements in the array to make
room for the new element.

                self.arrayItems[i+1]=self.arrayItems[i]
            self.arrayItems[position]=keyToInsert
        else:
            print("Size of array is ",self.sizeOfArray)


a = Array(10,int)
a.insert(2,2)
a.__len__()
a.arrayItems
a.insert(3,4)
a.arrayItems
a.insert(5,1)
a.arrayItems
for i in range(9,0,-1):
    a.insert(i,i)
    print(a.arrayItems)
[0, 5, 0, 2, 0, 3, 0, 0, 0, 9]
[0, 5, 0, 2, 0, 3, 0, 0, 8, 0]
[0, 5, 0, 2, 0, 3, 0, 7, 0, 8]
[0, 5, 0, 2, 0, 3, 6, 0, 7, 0]
[0, 5, 0, 2, 0, 5, 3, 6, 0, 7]
[0, 5, 0, 2, 4, 0, 5, 3, 6, 0]
[0, 5, 0, 3, 2, 4, 0, 5, 3, 6]
[0, 5, 2, 0, 3, 2, 4, 0, 5, 3]
[0, 1, 5, 2, 0, 3, 2, 4, 0, 5]
```

## My Research/work

**The difference between the lists and the arrays**

| Lists | | arrays |
|---|---|---|

| | | |
|---|---|---|
| Stores elements with different data types | Data Type | Stores elements of the same data type |
| The size of the list can be changed (dynamic array) | The size | The size of the array can't be changed once created |
| Less efficient with large data set | Performance | More efficient with large datasets as it is stored in a block in the memory which allows for more efficient memory and caching |
| **- if you want to insert many elements with different data types**<br>**- if you want to change the size of data later** | | **- if you want to store a very large datasets and perform mathematical operations on** |

2- Linkedlist: is a linear data structure consisting of Nodes;head & tails.
EX:Creating a linkedlist.

```
class Node:
    def __init__(self,value):
        self.value=value
        self.next=None
class LinkedList:
    def __init__(self):
        self.head=None
        self.tail=None
    def add_node(self,value):
        new_node=Node(value)
        if self.head is None:
            self.head=new_node
            self.tail=new_node
        else:
            self.tail.next=new_node
            self.tail=new_node
    def print_list(self):
        curr_node = self.head
        while curr_node is not None:
            print(curr_node.value)
            curr_node = curr_node.next


a=LinkedList()
a.add_node(5)
```

```
a.add_node(6)
a.add_node(7)
a.print_list()
#the output of a.print_list()
5
6
7
```

3- Stack: is a collection of items that can be accessed or manipulated based on the concept of ‘last input first output’ LIFO .
It consists of many operations:

- Push: to add the item to the top of the stack;using ‘append’
- Peek : to view the last element in the stack without removing it;using index[-1]
- Pop : to remove the items starting from the last one;using .pop()
- isEmpty: to check whether the stack is empty or not; using len()

EX: creating a stack

```
class Stack:
    def __init__(self):
        self.items=[]

    def push(self, item):   #add element
        self.items.append(item)

    def peek(self):
        return self.items[-1]     # peek operation is to view the last
element inserted in the stack without removing it

    def pop(self):# you can addd check if loop if stack is empty "no poping"
else return
        return self.items.pop()

    def is_empty(self):
        return len(self.items)==0

    def size(self):
        return len(self.items)

my_stack=Stack()
my_stack.push(1)
my_stack.push(2)
my_stack.push(3)
my_stack.peek()
# the output of the last item inserted
3
```

4- Queue: is a collection of items that can be accessed and manipulated like stack but based on the First Input First Output ‘FIFO’
Operations made:

- Enqueue :to add elements to the end of the queue/list;using .append()
- Dequeue:to remove the first element of the queue and returning the value of this element; using .pop(0)
- isEmpty: to check whether the queue is empty or not; using len()==0(false or true)
- Size: to check the size of the queue; using len()
- To check the element removed in dequeue or the size of the queue is by using str()

```
#Queue
# %%
class Queue:
    def __init__(self) :
        self.items= []

    def enqueue(self,items):
        self.items.append(items)

    def dequeue(self):
        if self.is_empty():
            print("Queue is empty")
            return None
        else:
            return self.items.pop(0)
    def is_empty(self):   # a method used for the dequeue method in 'if'
condition
        return len(self.items) == 0


    def sizeOfQueue(self):
        return len(self.items)
q =Queue()
q.enqueue(3)
q.enqueue(4)
q.enqueue(5)
print(str(q.sizeOfQueue())) # the value is converted to string to be able to
be printed to the console
3
print(str(q.dequeue())) # returns the element removed which is the first
element in the Queue
3
print(str(q.sizeOfQueue()))
2
q.is_empty()  # to check whether the queue is empty or not
```

```
False
```

5- Graph :

```
class Graph:
    def __init__(self):
        self.graph={}

    def add_vertex(self,vertex):
        if vertex not in self.graph:
            self.graph[vertex]=[]    #dictionary key is list and value as a
list   B :- []

    def add_edge(self,vertex1,vertex2):
        if vertex1 not in self.graph:
            self.add_vertex(vertex1)

        if vertex2 not in self.graph:
            self.add_vertex(vertex2)

        self.graph[vertex1].append(vertex2)
        self.graph[vertex2].append(vertex1)

    def get_vertice(self):
        return list(self.graph.keys())

 #   def getEdges(self):
  #      edges=[]
   ##     print(self.graph.items())
    #    for vertex in self.graph:
     #       for neighbours in self.graph[vertex]:
      #          edges.append((vertex,neighbours))
       # return edges

    def getEdges(self):
        edges=[]
        for key,value in self.graph.items():
                for edge in value:
                    edges.append((key,edge))
        return edges

g =Graph()
g.add_vertex("A")
g.add_vertex("B")
g.add_vertex("C")

g.add_edge("A","B")
g.add_edge("B","C")
```

```
g.add_edge("C","A")

print(g.getEdges())
[('A', 'B'), ('A', 'C'), ('B', 'A'), ('B', 'C'), ('C', 'B'), ('C', 'A')]
```

6- Tree: a set of nodes connected by branches.

It consists of one parent node and child nodes;each child node can have zero or other child nodes.

When the node doesn't have child nodes then it is called 'leaf node'.

The length of the tree is the longest path from the parent/root node to the leaf node.

Applications where Tree structure is used:

- B-tree in partitioning in SQL to speed the look up process for the data retrieval.
- For file systems
- For family trees

Operations used for Class tree:

- Setting the root/parent node,leaf node and right node; using the __init__
- Insert: is to insert the new nodes in a specific position based on the value;if the value is less than the root node then it goes to the left node. If not then it goes to the right node.
- PrintTree: to sort the data in the tree from the smallest to the largest and print the data
- Searching: to search for a node in a tree; using like a pointer to start from the root/parent node

```
# Tree
class Node:
    def __init__(self,data):
        self.data= data
        self.leftChild=None
        self.rightChild=None

    def printTree(self):
        if self.leftChild:
            self.leftChild.printTree()
        print(self.data)
        if self.rightChild:
            self.rightChild.printTree()

    def insert(self,data):

        if data <self.data:
            if self.leftChild:
                self.leftChild.insert(data)
```

```
            else:
               self.leftChild = Node(data)
               return
        else:
            if self.rightChild:
                self.rightChild.insert(data)
            else:
                self.rightChild = Node(data)
                return

    def search(self,value):
        if self.data==value:
            return ('found:',self.data)
        elif value < self.data and self.leftChild is not None:
            return self.leftChild.search(value)
        elif value > self.data and self.rightChild is not None:
            return self.rightChild.search(value)
        else:
            return ('not found')


root = Node(27)

root.insert(14)
root.insert(35)
root.insert(31)
root.insert(10)
root.insert(19)
root.printTree()
```

**Sorting data Algorithms**
**Different ways to sort a data set**
**Each Algorithm has different space complexity**

- Bubble sort : stable algorithm
- Merge sort : stable algorithm
- Quick sort : unstable algorithm
- Insertion sort : stable

**Option 1: Bubble_sort**

```
def bubble_sort(arr):
    n=len(arr)

    for i in range(n):
        for j in range(0,n-i-1):
            if arr[j]>arr[j+1]:
```

```
                arr[j],arr[j+1]=arr[j+1],arr[j]

a=bubble_sort([14,27,35,10,19])
```

**Option 2:** Merge sort algorithm

```
def mergesort(arr):
    if len(arr) ==1:
        return arr


    #Divide the array in 2 half
    mid=len(arr) // 2
    left_half=arr[:mid]
    right_half=arr[mid:]

    #Recursivel sort each half
    left_sorted=mergesort(left_half)
    right_sorted=mergesort(right_half)

    #merge the halves
    i=j=0
    result=[]
    while i < len(left_sorted) and j <len(right_sorted):
        if left_sorted[i]<right_sorted[j]:
            result.append(left_sorted[i])
            i=i+1
        else:
            result.append(right_sorted[j])
            j=j+1
        result +=left_sorted[i:]
        result+= right_sorted[j:]
    return result
mergesort([27,14,35,10,19])
[10, 14, 27, 35, 19, 19, 35, 14, 27, 35, 19, 19, 35, 27, 35, 19, 19, 35]
```

**Option 3:** Quick sort Algorithm

```
def quicksort(arr):
    if len(arr) < 2:
        return arr

    #choose the pivot element
    pivot = arr[0]

    #Partition the array in two sub arrays
    lesser =[i for i in arr[1:] if i<=pivot]
    right =[i for i in arr[1:] if i > pivot]
```

```
    return quicksort(lesser)+[pivot]+quicksort(right)

quicksort([27,14,35,10,19])
[10, 14, 19, 27, 35]
```

**Option 4: Insertion sort Algorithm**

```
def insertion_sort(arr):
    for i in range(1,len(arr)):
        key=arr[i]
        j=i-1
        while j>=0 and arr[j]>key:
            arr[j+1]=arr[j]
            j=j-1
        arr[j+1]=key
    return arr
insertion_sort([27,14,35,10,19])
[10, 14, 19, 27, 35]
```

## Time & Space complexity

**Time complexity: is the time the algorithm takes to output the data based on the data input.**
**Space complexity: is the amount of memory this algorithm takes based on the data input; measured based on the bytes or the number of variables created.**

**Example:**
**Int takes 4 bytes**
**Long takes 8 bytes**
**Double takes 8 bytes**
**Fun (N:int)** which takes 4 bytes and N here is limited by one value
**{**
**x=N** it will take 4 byte
**y= x*x** it will take 4 byte
**z= x+y** it will take 8 bytes
**}**
Here it all takes 20 bytes
and these are all integers which is time constant so the time and space complexity is O(1)

But
If N is int and unlimited ;varies from 0 to 3000 for example
So z,y and z will vary depend on the value of N
Then the time complexity here is O(N).

## My Research

### Time and Space Complexity for sorting data algorithms

| Sorting data Algorithm type | TC | SC |
|---|---|---|
| Bubble sort | O(N^2)<br>Two 'for' loops | O(1)<br>Variables are Time constant |
| Merge sort | O(NlogN)<br>Log N for `mid=len(arr) // 2`<br>N for while loop in comparing and i+=1 or j+=1 | O(N)<br>N for the array size<br>`result=[]` |
| Quick sort | O(NlogN)<br>For scanning the values linearly and then divide it<br>`lesser =[i for i in arr[1:] if i<=pivot]`<br>`right =[i for i in arr[1:] if i > pivot]` | O(logN)<br>Lesser takes logN<br>Right takes log N<br>logN+logN=2logN<br>`lesser =[i for i in arr[1:] if i<=pivot]`<br>`right =[i for i in arr[1:] if i > pivot]` |
| Insertion sort | O(N^2)<br>For nested loops:<br>'For' and 'while' loops | O(1)<br>Variables are time constant |

### Stability of Algorithms

Stable algorithm : it maintains the order of the inputs having the same value in the output.
Unstable algorithm: there is no guarantee it will maintain the order of the inputs having the same value.

### Time limit Exceeded(TLE)

That occurs when the program takes a long time to give the output which is not the optimal situation so it gives an error of 'time limit exceeded'.

To avoid this error,is to take the input size into consideration for optimisation by:

Checking the number of iterations used in this program/algorithm as a function of the input size. ( the time complexity)

### My Research

To check the time it takes for the program to execute:
Import time
start _time=time.time(); to be written before the input data to be printed
end_time=time.time(); to be written in the end of the program
print(end_time-start_time); to check the time this program took to execute the input data
Here we try different input sizes and check the time executed per each.

## OOP Examples

Defining the initials for a **class** and its **object**:self , **Attribute**:title, **methods** for accessing/updating the data: getTitle and setTitle and **instances** for storing this data into.

Here for each attribute we may define its methods for accessing & updating the data under this attribute;as it is not a good practice to access the data using the initial definition.

```
class book:   #POJO in
    #here title is an instance variable for that we would define
both getTitle for accessing the data/data retrieval and setTitle
for updating the data
    def __init__(self,title):
        self.title=title

    def getTitle(self):           # for accessing the data
        return self.title

    def setTitle(self,title):         # for updating the data
        self.title=title

# TODO create book instance variable b1

b1=book('getting things done')
print(b1.getTitle())
b1.setTitle('diamond dust')
print(b1.getTitle())

getting things done
diamond dust
```

Setting more attributes and more methods in return
Setting an optional attribute & optional method in return;using self._AttrNamesingle underscore
Setting a secret attribute;using self.__AttrName double underscore
Deleting an attribute in an instance;using del instance_name.Attr
Display all the attributes for an instance/printing an instance to get all the Attr.;using display(),__str__() or __repr__()
Equal comparison to compare between two instances ; using __eq__()

```
# inserting more attributes which will have in turn more methods
# inserting optional attribute which will have in return optional method
(setting discount)
class book:   #POJO in
    #here title is an instance variable for that we would define both
getTitle for accessing the data/data retrieval and setTitle for updating the
data
    def __init__(self,title,author,pages,price,secret):
        self.title=title
        self.author=author
        self.pages=pages
        self.price=price
        self.__secret=secret + 'another title'


    def getTitle(self):           # for accessing the data
        return self.title

    def setTitle(self,title):         # for updating the data
        self.title=title
   # optional attribute and method
    def setDiscount(self,discount):
        self._discount=discount/100    # ._discount   the under score here
means that it is an optional method
        return 'done'

    def getPrice(self):
        if hasattr(self,'_discount'):            # here this is an optional
attribute the price may have which is the discount
            return self.price - (self.price*self._discount)
        else:
            return self.price
   # Display function
    def display(self):       # to display all the attributes for an instance
        print('title is %s\nPages are %s pages\nthe author is %s\nprice is
%d euro'%(self.title,self.pages,self.author,self.price))

    def __str__(self):   # used if we want simply to print the instance
```

```
        return f'title:{self.title}\npages:{self.pages}\nPrice:{self.price}'
    def __repr__(self):
        return f'title:{self.title}\npages:{self.pages}\nPrice:{self.price}'
   # Comparison between two instances
   def __eq__(self,value):   # value here is the instance being compared to
'self' which is the first instance
        if not isinstance(value,book):
            raise ValueError('this instance is not found in class book')
        return (self.title==value.title and self.author==value.author)




# TODO create book instance variable b1 and b2
b1=book('getting things done','david allen',300,16,secret='has'
)
print(b1.getTitle())
print(b1.price)  # not a good practice to call the attributes in the initial
print(b1.getPrice())
print(b1.setDiscount(5));print(b1.getPrice())



# Secret Attribute output
print(b1._book__secret)          # to call for a secret attribute
#print(b1.__secret)          # here it will give error to the user because
this is a secret attribute so as an admin we write our secret query
print(b1._book__secret)  # the secret query

# another option is not to add the attr 'secret' and just define it as
self.__secret=secret
 def __init__(self,title,author,pages,price):
        self.title=title
        self.author=author
        self.pages=pages
        self.price=price
        self.__secret='another title'

b1=book('getting things done','david allen',300,16)
print(b1._book__secret)

another title
```

```
# deleting an attribute in an instance
del b1.price
print(b1.getPrice())   # here it will give error that b1 doesn't have
'price' attribute
```

```
# Display & Printing output
b1.display()
print(b1)
print(str(b1))
print(b1.__str__())  # same result as str()
print(repr(b1))    # using the method repr to print the attr.   option 1
print(b1.__repr__())  # option 2: same result as repr()
#output 1
title is getting things done
Pages are 300 pages
the author is david allen
price is 16 euro
# output 2
title:getting things done
pages:300
Price:16

# Comparison output
print(b1==b2)    # here it will give true after doing the __eq__ method
class car:
    def __init__(self,color):
        self.color=color
    def __eq__(self,value):   # value here is the instance being compared to
'self' which is the first instance
        if not isinstance(value,car):
            raise ValueError('this instance is not found in class car')
        return (self.color==value.color)
c1=car('pink')
# print(b1==c1)     # here it will raise the value error
#print(c1==b1)        # here it will raise the value error because b1 is not
instance of the class car
print(b1.__eq__(b2))  # here it does the equal method  b1 is the main
instance to be compared to and b2 is the value
```

## My Research/Work
## HackerRank Practice on Classes

### Task: finding the torsional angle by creating the class and its methods.

You are given four points $A, B, C$ and $D$ in a 3-dimensional Cartesian coordinate system. You are required to print the angle between the plane made by the points $A, B, C$ and $B, C, D$ in degrees(**not radians**). Let the angle be $PHI$.

$Cos(PHI) = (X.Y)/|X||Y|$ where $X = AB$ x $BC$ and $Y = BC$ x $CD$.

Here, $X.Y$ means the dot product of $X$ and $Y$, and $AB$ x $BC$ means the cross product of vectors $AB$ and $BC$. Also, $AB = B - A$.

**Input Format**

One line of input containing the space separated floating number values of the $X, Y$ and $Z$ coordinates of a point.

**Output Format**

Output the angle correct up to two decimal places.

**Sample Input**

```
0 4 5
1 7 6
0 5 9
1 7 2
```

**Sample Output**

```
8.19
```

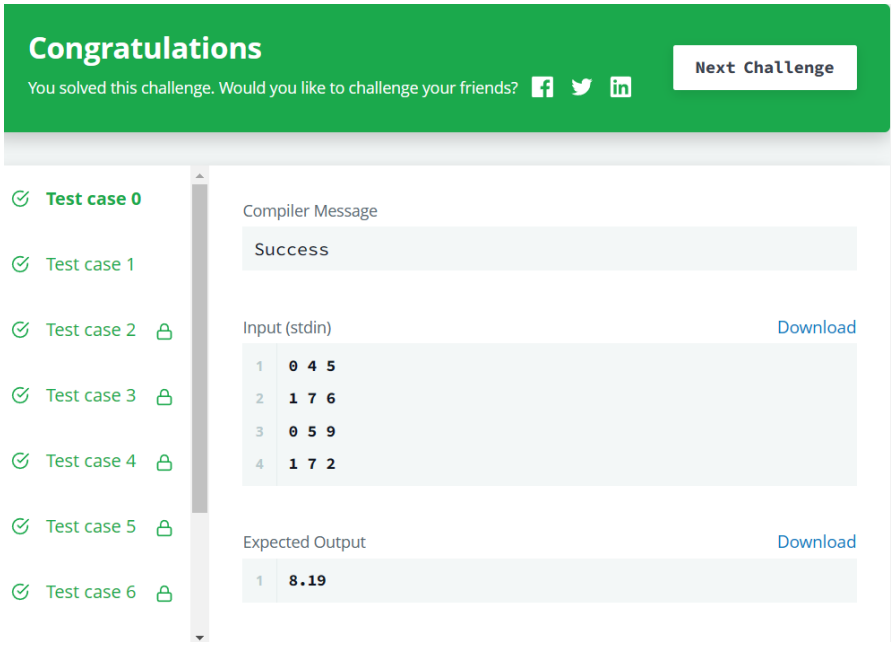
```python
import math

class Points(object):
    def __init__(self, x, y, z):
        self.x=x
        self.y=y
        self.z=z
    def __sub__(self, no):
        return Points(self.x-no.x,self.y-no.y,self.z-no.z)
    def dot(self, no):
        return self.x*no.x+self.y*no.y+self.z*no.z
    def cross(self, other):
        x = self.y * other.z - self.z * other.y
        y = self.z * other.x - self.x * other.z
        z = self.x * other.y - self.y * other.x
        return Points(x, y, z)
    def absolute(self):
        return pow((self.x ** 2 + self.y ** 2 + self.z ** 2), 0.5)
```

```
if __name__ == '__main__':
    points = list()
    for i in range(4):
        a = list(map(float, input().split()))
        points.append(a)

    a, b, c, d = Points(*points[0]), Points(*points[1]),
Points(*points[2]), Points(*points[3])
    x = (b - a).cross(c - b)
    y = (c - b).cross(d - c)
    angle = math.acos(x.dot(y) / (x.absolute() * y.absolute()))

    print("%.2f" % math.degrees(angle))
```




**Difference between instance method,static method and classic method**

- Instance method(bond to the instance variables): Bond to the object of the class (self) and access/manipulate the instance variables
- Static method(bond to the class and not the instance): to access and manipulate the private class variables.
- Classic method(bond to the class and not the instance): to access the class-level constants.

EX: setting counter for each of the instance and the class using instance method,static method and classic method

```
# defining a counter for the instances and for the whole class
class book:   #POJO in JAVA

    __BOOK_COUNT=0
    BOOK_TYPES=('HARDCOVER','PAPERBACK','EBOOK')          # STATIC CONSTANTS
    __BOOK_LISTS=None   # can be secret variable   __BOOKLISTS=NONE
    #here title is an instance variable for that we would define both
getTitle for accessing the data/data retrieval and setTitle for updating the
data
    def __init__(self,title,book_type):
        self.title=title
        self.bookType=book_type
        self.instnc_count=0
        if not book_type in book.BOOK_TYPES:
            raise ValueError('this book type is not supported')
        else:
            self.book_type=book_type

    def getTitle(self):           # for accessing the data
        return self.title

    def setTitle(self,title):         # for updating the data
        self.title=title

    def setCount(self):    #   its asscoiated with that b1 instance variable
is not associated Book( contains 'self' so it is associated with instances)
        self.instnc_count=self.instnc_count+1
        return self.instnc_count

    @staticmethod #this method is to set something at a specific class level
    def getBookList():

        if book.__BOOK_LISTS==None:
            book.__BOOK_LISTS=[]
        return book.__BOOK_LISTS

    def incrementCount(): # related to the whole class not an instance
        book.__BOOK_COUNT = book.__BOOK_COUNT +1


    @classmethod    # this to get a constant from the class level
specified;static constants
    def getBookTypes(cls):
        return cls.BOOK_TYPES

    def returnCount(cls):
        return cls.__BOOK_COUNT
```

```
#print(book.getBookList())                    # before adding any instances' titles or attributes, it will return an empty list

b1 = book("title1","HARDCOVER")
print('count for b1',b1.setCount())
book.incrementCount()
b2= book("title2","PAPERBACK")
book.incrementCount()
print('count for b2',b2.setCount())
print(book.returnCount(book))
#output
count for b1 1
count for b2 1
count for class book 2
```

## Class level variables and instance variables

**What happens when we change the class variable in terms of the instance variables and not the class name?**

```
#07.03.2023
## what happens when we try to change a class-level variable in an instance variable?

class Employee:
    COMPANY_NAME='Wiley'      # class variable / static variable
    def __init__(self,name):
        self.name=name
        print('first')

    def __init__(self,name):
        self.name=name
        print('second')
# trying defining two initials and see which initials will be used
b1=Employee('rovan')           # it will use the second inital

# using instance variable to change the class variable
b1.COMPANY_NAME=5

print(b1.COMPANY_NAME) # gives 5; here the change is made to this instance only
print(Employee.COMPANY_NAME)  # gives wiley; here it is for the whole class which will give the class variable

b2=Employee('abdou')
print(b2.COMPANY_NAME)  # gives wiley; it will give the class-level variable
```

```
print(b1.COMPANY_NAME)
# so if you want to change a class variable, use the class name to change it
and don't use an instance to change this class-level variable!

# getting all the attributes to an instance
print(b1.__dict__)  # it shows all the attributes to this instance
print(b2.__dict__)
#output
{'name': 'rovan', 'COMPANY_NAME': 5}
{'name': 'abdou'}

# getting all the methods that can be used to a class
print(dir(book)) #(get all methods of a class)
['BOOK_TYPES', '__class__', '__delattr__', '__dict__', '__dir__', '__doc__',
'__eq__', '__format__', '__ge__', '__getattribute__', '__getstate__',
'__gt__', '__hash__', '__init__', '__init_subclass__', '__le__', '__lt__',
'__module__', '__ne__', '__new__', '__reduce__', '__reduce_ex__',
'__repr__', '__setattr__', '__sizeof__', '__str__', '__subclasshook__',
'__weakref__', '_book__BOOK_COUNT', '_book__BOOK_LISTS', 'getBookList',
'getBookTypes', 'getTitle', 'incrementCount', 'returnCount', 'setCount',
'setTitle']
```

## INHERITANCE
## Between classes

Inheritance: it is an OOP that a class can borrow the attributes and the methods(for overriding) of another class;using subclass(base class)  subclass=derived class & superclass=base class

**Ex:** 3 classes of book, magazine and newspaper. Each has ‘title’ and ‘price’ attributes.

Books attributes: title,price,author,pages

newspaper/magazine: title,price,period,publisher

Solution here is to get a class or two-class that has the common attributes between the classes

```
class publication:
    def __init__(self,title,price):
        self.title=title
        self.price=price
class periodical(publication):
    def __init__(self, title, price,period,publisher):
        super().__init__(title, price)
        self.period=period
        self.publisher=publisher
class book(publication):
```

```
    def __init__(self, title,author,pages,price):
        super().__init__(title, price)
        self.author=author
        self.pages=pages

class magzine(periodical):
    def __init__(self, title, price, period, publisher):
        super().__init__(title, price, period, publisher)

class Newspaper(periodical):
    def __init__(self, title, price, period, publisher):
        super().__init__(title, price, period, publisher)

b1=book('getting things done','david allen',300,16)
m1=magzine('vogue',13,'monthly','abc')
n1=NewsPaper('new york times',5,'weekly','def')
print(b1.title)
print(b1.__dict__)
print(m1.__dict__)
print(n1.__dict__)
# functions to check the relationship between classes and objects
print(issubclass(magzine,publication)) # is the magazine a subclass of
publication?
print(issubclass(magzine,periodical))
print(isinstance(m1,magzine))  # is the instance m1 belongs to the magazine?
print(isinstance(b1,magzine))
# output
getting things done
{'title': 'getting things done', 'price': 16, 'author': 'david allen',
'pages': 300}
{'title': 'vogue', 'price': 13, 'period': 'monthly', 'publisher': 'abc'}
{'title': 'new york times', 'price': 'def', 'publisher': 5, 'period':
'weekly'}
True
True
True
False
```

## Multiple inheritance

When the class uses the attributes and the methods of two or more classes

```
class A:
    def __init__(self):
        super().__init__()
        self.foo = 'foo'
        self.name ='class A'

class B:
    def __init__(self):
        self.bar = 'bar'
        self.nameb = 'class B'

class D:
    def DD(self):
        print('DD')

class C(A, B):
    def __init__(self,namec):
        super().__init__()
        self.namec=namec

    def showprops(self):
        print(self.namec)
        print(self.name)  # prints the name from A class instance
        print(self.bar)
        print(self.nameb)

c = C('rovan')
c.showprops()
#output
rovan
class A
bar
class B
```

### My Research/work

Ex:Playing the instrument: guitar,piano and guitar piano instruments

```
#multiple inheritance
class Guitar:
    def __init__(self):
        self.type = 'acoustic'
        self.strings = 6
```

```
    def play(self):
        print("Playing the guitar")

class Piano:
    def __init__(self):
        self.type = 'grand'
        self.keys = 88

    def play(self):
        print("Playing the piano")

class AcousticGuitar(Guitar):
    def __init__(self):
        super().__init__()
        self.type = 'acoustic'

    def play(self):
        print("Playing the acoustic guitar")

class ElectricGuitar(Guitar):
    def __init__(self):
        super().__init__()
        self.type = 'electric'

    def play(self):
        print("Playing the electric guitar")

class GrandPiano(Piano):
    def __init__(self):
        super().__init__()
        self.type = 'grand'

    def play(self):
        print("Playing the grand piano")

class GuitarPiano(AcousticGuitar, GrandPiano):
    def __init__(self):
        super().__init__()
        self.type = 'hybrid'

    def play(self):
        print("Playing the guitar and piano at the same time!")

a=ElectricGuitar()
a.play()
b=AcousticGuitar()
b.play()
c=GrandPiano()
```

```
c.play()
d=GuitarPiano()
d.play()
# output
Playing the electric guitar
Playing the acoustic guitar
Playing the grand piano
Playing the guitar and piano at the same time!
```

**NOTE: Here we can use the abstract method for 'def play()' in an 'instrument' class and to use this abstract method in the custom classes;guitar,piano,etc.**
**Abstract method is imported from ABC(Abstract base classes)**

```
# in the previous example, we can use the abstract method for the play() in an 'instrument' class
from abc import ABC,abstractmethod
class instrument(ABC):
    def __init__(self):
        super().__init__()
        self.type=self.__class__.__name__   # here it will return the type of the instrument customised by each class; guitar,piano,etc.

    @abstractmethod

    def play(self):
        pass

class guitar(instrument):
    def __init__(self):
        super().__init__()
        #self.type='guitar'
    def play(self):
        print('playing the guitar')

a=guitar()
A.__dict__   #{'type': 'guitar'}
a.play()
#output
playing the guitar
```

## Overriding Methods used in inheritance between the classes

As the class inherits the attributes and the methods of the superclass, the overriding happens when it comes to the methods inheritance.
Overriding methods happens when you want to change the behaviour of the same method in the subclass which exists in the superclass .

```
#methods overriding with the same instance
# methods overriding is used when you want to change the behaviour of the
method for each class
# if you don't want to and the behaviour is the same anyway; it is better to
user super() method
class Animal:
    def speak(self):
        print("speaking")
class Dog(Animal):
    def speak(self):
        print("barking")

d =Dog()
d.speak()   # here it will print the speak method of Dog class; as it is the
last command written
# output
barking
```

However we can avoid the overriding method using super()
Ex: getting the area of the ‘square’ class from the ‘area’ method in the ‘rectangle’ class and adding to the behaviour of the method using super()

```
# to avoid the overriding methods
class rectangle:
    def __init__(self,x,y):
        self.x=x
        self.y=y
    def area(self):
        print (self.x*self.y)

class square(rectangle):
    def area(self):
        super().area()
        print('the area of the square')

a=rectangle(5,3)
a.area()
b=square(6,4)

b.area()
#output
```

```
15
24
the area of the square
```

**__Post _initial__ method**
**Using data classes library**
**In version 3.7 & later**

Post initial method is used to do additional initialization after the object is initalized and you don't have to create def __init__() but just by declaring the attributes.

```
# using data classes
from dataclasses import dataclass

@dataclass
class book:
    Title:str    # just declaring the attributes without __init__()
    author:str
    pages:int
    price:float
    def __post_init__(self):
        if self.price<=0:
            raise ValueError('insert a price')

b=book('gf','dsz',300,0)
#print(dir(b))
print(b.__dict__)
#output
ValueError: insert a price
```

## My Research/work

**Post init method deals with the attributes of the class;doing mathematical operations/logical operations/finding the value of another attribute/calling methods**

Uses of __Post_initial__():

- Data validation: to make sure the data inserted in the attributes is valid

In the previous example: to make sure the price of the book entered is valid.

- Data Cleaning: to clean the data in the instance variables.

Ex:

```
from dataclasses import dataclass
@dataclass
class student:
```

```
        name: str
        email:str
        def __post_init__(self):
            self.email=self.email.lower().strip()

s=student(name='rovan',email='ROVAN.ELGENDI@gmail.com')
print(s.email)
rovan.elgendi@gmail.com
```

- Computation: to get the result out of two or more instance variables(mathematical operations for example)

Ex: getting the area attribute of a rectangular shape automatically after setting the length and width attributes; computing the third attribute in terms of the other attributes.

```
# 2 using post init method for computation
from dataclasses import dataclass

@dataclass
class Rectangle:
    length: float
    width: float
    area: float = 0.0

    def __post_init__(self):
        self.area = self.length * self.width

# Creating an instance of Rectangle class
#rect=Rectangle(5,3)
# or
rect = Rectangle(length=5.0, width=3.0)
print(rect.area) # Output: 15.0
```

- Dependency : if an attribute value is dependent on another attribute so the post init method is used to do the 'if' statement for ex.

Ex: getting the discount on the price of a book depending on the price itself; one attribute depends on another one

```
# 3 using the post init method for dependency; one attribute is dependent on
another attribute.
from dataclasses import dataclass

@dataclass
```

```python
class Book:
    title: str
    author: str
    price: float
    discount: float = field(default=0.0)

    def __post_init__(self):
        if self.price <= 0:
            raise ValueError("Price must be positive")
        self.discount = self.calculate_discount()

    def calculate_discount(self):
        if self.price >= 100:
            return 0.2
        elif self.price >= 50:
            return 0.1
        else:
            return 0.0

# Creating an instance of Book class
book=Book('dfg','fde',55)
#book = Book(title="The Great Gatsby", author="F. Scott Fitzgerald",
price=120.0)
print(book.discount) # Output: 0.2
print(book.__dict__)
```

```
0.1
{'title': 'dfg', 'author': 'fde', 'price': 55, 'discount': 0.1}
```

## ABC ( Abstract Base Class)

```python
# using ABC to convert some data to JSON
# using abstract method
# ABC means Abstract Base Classes that can be used as a base for custom
classes that uses this abstract class
from abc import ABC,abstractmethod
class GraphicShape(ABC):
    #def __init__(self):
    #    super().__init__()
    # a method with an empty body; if you dont know the logic, you declare
this method abstract and the class which will inherit the abstract method
would have to implement it.
    @abstractmethod
    def CalcArea(self):
        pass
class JSONify(ABC):
```

```
    @abstractmethod
    def toJSON(self):
        pass
class HTML(ABC):
    @abstractmethod
    def toHTML(self):
        pass
class Circle(GraphicShape,JSONify,HTML):
    def __init__(self,radius):
        super().__init__()
        self.radius=radius

    def CalcArea(self):
        return 3.14*(self.radius**2)
    def toJSON(self):
        return f'{{\n\"Circle\":\n {{\n  "radius\":{self.radius},\n
"area\":{self.CalcArea()}\n }}\n}}'
    def toHTML(self):
        return f'<Circle>{self.CalcArea()}</Circle>'
class square(Circle,JSONify):
    def __init__(self, radius):
        super().__init__(radius)
        self.side=radius
    def CalcArea(self):
        return self.side**2
    def toJSON(self):
       print(f'{{\n\"square\":\n {{\n  "each_side\":{self.side},\n
"area\":{self.CalcArea()}\n }}\n}}')


c=Circle(15)
c.CalcArea()
print(c.toJSON())
c.toHTML()
s=square(4)
s.CalcArea()
s.toJSON()
#output
{
"Circle":
 {
  "radius":15,
  "area":706.5
 }
}
{
"square":
```

```
 {
  "each_side":4,
  "area":16
 }
}
```

## Composition

When you use another class attributes in a specific class.
Adv: to decrease the redundancy of data like SQL.

```
#Composition

class Author:
    def __init__(self,fname,lname):
        self.fname=fname
        self.lname=lname
    def __str__(self):
        print(self.fname,self.lname)

class Book:
    def __init__(self,title,price,author=None):
        self.title=title
        self.price=price
        self.author=author

        self.chapters=[]
    def addChapters(self,name,pages):
        self.chapters.append((name,pages))

a1= Author('leo','egxd')
b1=Book('fsgs',39,a1)
b2=Book('rds',55,a1)
b1.addChapters('chapter 1',124)
b1.addChapters('chapter 2',44)

b1.__dict__
```

## Magical Methods & __call__ method

- Magical methods also known as dunder methods; starts and ends with double underscore __

ex: __init__ , __str__ ,__getattribute__,__setattr__ and __getattr__, __getattribute__,__setattr__ and __getattr__: customises the behaviour of the attributes access in the class

- __call__ method: is a built-in method used to a callable

object/instance.whenever you want to treat the object/instance as a function, we use __Call__ method to define the behaviour of this instance.

```
class Book:
    def __init__(self,title,author,pages,price):
        self.title=title
        self.author=author
        self.price=price
        self.pages=pages
        self.discount =0.1

    def __str__(self):
        return f"{self.title} by {self.author}, costs {self.price}"

    def __getattribute__(self,name: str) : # this method is used/get called automatically when there is an attempt to access an attribute whether it is existed or not.you can add any actions/operations or even raise an error if the attr is not existed before setting this attribute

        if (name == "price"):
            p =super().__getattribute__("price")
            d=super().__getattribute__("discount")
            return p -(p * d)
        return super().__getattribute__(name)

    def __setattr__(self,name: str, value: str):  # this method is used/get called automatically when there is an attempt of setting an attribute value in the class
        if name =='price':
            if type(value) is not float:
                raise ValueError("The 'price' attribute must be float")
        return super().__setattr__(name,value)


    def __getattr__(self,name):    # this method is used/get called automatically when there is an attempt to get an attribute that doesn't exist in the class
        return name +" is not a variable in book class!!!"

   def __call__(self,title,author,pages,price):  # here using the call method to update a data in a variable without having to go to each attribute and update it
        self.title=title
        self.title=title
        self.author=author
        self.price=price
        self.pages=pages



b1 = Book("ware and peace","leo tolsty",32332,39.65)
```

```
b2 = Book("the catcher in rye","JD",322,29.65)

b1.price = 38.65
print(b1)

b2.price=float(40)
print(b2)

print(b1.randomprop)
#output
ware and peace by leo tolsty, costs 34.785
the catcher in rye by JD, costs 36.0
randomprop is not a variable in book class!!!

# __call__ output
b1.__call__('tgrd','ghf',150,55.9)
print(b1)
tgrd by ghf, costs 50.31  # after the discount

b1('efdx','tyyy',456,40.30)
print(b1)
efdx by tyyy, costs 36.269999999999996

# comparison output
print(b1 == b2)  # false
print( b2 >=b1)   # it will give error as it is not supported so we define the __gt__
and __lt__ methods
```

## Built-in Comparison Methods

Comparison methods are the comparison between the instances/objects.
Used for:

- Sorting data in ascending/descending order
- Filtering
- Data analysis: take decisions based on the results sorted/filtered.

These methods are : __lt__,__le__,__gt__,__ge__,__eq__,__ne__

```
# to sort objects
class Book:
    def __init__(self,title,author,pages,price):
        self.title=title
        self.author=author
        self.price=price
        self.pages=pages

    def __str__(self):
```

```
        return f"{self.title} by {self.author}, costs {self.price}"
    # its greatr than function
    def __ge__(self,value):
        if not isinstance(value,Book):
            raise ValueError("Can't compare book with a non book")

        return self.price >= value.price
    # its lower than function
    def __lt__(self,value):
        if not isinstance(value,Book):
            raise ValueError("Can't compare book with a non book")

        return self.price < value.price
    def __le__(self,value):
        if not isinstance(value,Book):
            raise ValueError('this object is not in Book class')
        return self.price <= value.price

b1 = Book("ware and peace","leo tolsty",32332,39.65)
b2 = Book("the catcher in rye","JD",322,29.65)
b3 = Book("ware and the peace","JD",322,10.55)
b4 = Book("to kill","JD",322,19.65)

print(b1 == b3)
print(b1 == b2)
print(b4 == b1)

#here first parameter becomes self and and second parameter becomes value in
gt and lt function
print( b2 >=b1)
print(b2 < b1)
print(b3 >=b2)

books=[b1,b4,b3,b2]
books.sort()
# or
#books.sort(reverse=True)    # to sort in descending order
listing=list()
for book in books:
    listing.append(book.__dict__)
print(listing)
# or
```

```
#print([book.__dict__ for book in books ])
print([book.title for book in books ])
#output
False
False
False
False
[{'title': 'ware and the peace', 'author': 'JD', 'price': 10.55, 'pages':
322}, {'title': 'to kill', 'author': 'JD', 'price': 19.65, 'pages': 322},
{'title': 'the catcher in rye', 'author': 'JD', 'price': 29.65, 'pages': 322},
{'title': 'ware and peace', 'author': 'leo tolsty', 'price': 39.65, 'pages':
32332}]
['ware and the peace', 'to kill', 'the catcher in rye', 'ware and peace']
```

## Data Encapsulation

```
# to DEbug
# data encapsulation is the process of restricting direct access to an
object's data or attributes from outside the class.
# This is achieved by making the data private or protected and providing
public methods to access and modify the data.
#Python implements data encapsulation by using naming conventions for
variables and methods.
# By convention, variables and methods that are intended to be private or
protected are prefixed with underscores.
# Example 2: Data Encapsulation in Python

class Employee:
    def __init__(self, name, salary):
        self.name = name
        self.__salary = salary

    def show(self):
        print("Name is ", self.name, "and salary is", self.__salary)

# Outside class
E = Employee("Bella", 60000)
#E.PrintName()
print(E.name)
print(E.__dict__)
#print(E.PrintName())
#print(E.__salary)  # AttributeError: 'Employee' object has no attribute
'__salary'
print(E._Employee__salary)  # here it will access the 'salary' attribute

class Computer:
```

```
    def __init__(self):
        self.__maxprice = 900

    def sell(self):
        print("Selling Price: {}".format(self.__maxprice))   # it is like f
string

    def setMaxPrice(self, price):
        self.__maxprice = price

c = Computer()
c.sell()

# change the price
c.__maxprice = 1000
c.sell()

# using setter function  which is one of the data encapsulation uses '
Getter & Setter '

c.setMaxPrice(1000)
c.sell()

#output 1
Bella
{'name': 'Bella', '_Employee__salary': 60000}
60000

#output 2
Selling Price: 900
Selling Price: 900
Selling Price: 1000
```

## Polyphorism

```
# to Debug
#polymorphism, which is one of the fundamental concepts in object-oriented
programming (OOP).
#Polymorphism allows different objects to be treated in a common way, even
if they have different implementations for the same methods.
# In this case, the Parrot and Penguin classes have different
implementations for the fly method, but they both have a fly method and can
be treated in a common way.
class Parrot:
    def fly(self):
        print("Parrot can fly")

    def swim(self):
```

```
        print("Parrot can't swim")

class Penguin:
    def fly(self):        # overriding method
        print("Penguin can't fly")

    def swim(self):
        print("Penguin can swim")

# common interface
def flying_test(bird):  # polymorphism which acts on the objects that have
the same method (have the overriding methods)
    bird.fly()

#instantiate objects
blu = Parrot()
peggy = Penguin()

# passing the object
flying_test(blu)
flying_test(peggy)
```

## Decorators

*# decorator is a special type of function that is used to modify or extend the behaviour of other functions or classes.*
*# Decorators are themselves functions that take another function as an argument*
*# and return a new function that wraps the original function with some additional functionality.*

```
import datetime
def my_decorator(my_function): # to make an extension of a function
    def inner_decorator(*args):
        print("this happend before")     # you add the balance
        my_function(*args)    # when you call my function the my_decorated
function get executed   # here you do the audit function call
        print(datetime.datetime.utcnow())  # during the process time
        print("this happened after")   # ensure database is updated
        print("This happend at end!!!!")  # drop a message on console
    return inner_decorator

@my_decorator
def my_decorated():
    print("welcome to first lecture of class",datetime.datetime.utcnow())
@my_decorator
def add (a,b):
```

```
    print (a+b)
# whenever you write a python file first function which get invoked is main
function
if __name__ == "__main__":    # these code check name of the function is it
main
    print(datetime.datetime.utcnow())   # the start time
    add(3,4)
    print(datetime.datetime.utcnow())   # the end time
    my_decorated()

# output 1 for add() function
2023-03-09 10:24:37.080842
this happend before
7
2023-03-09 10:24:37.080842

# output 2 for my_decorated() function
this happened after
This happend at end!!!!
2023-03-09 10:24:37.081353
this happend before
welcome to first lecture of class 2023-03-09 10:24:37.081353
2023-03-09 10:24:37.081353
this happened after
This happend at end!!!!
```

## My work on subtracting/summing using decorators

```
#doing summing/subtracting operations
def operations(my_function):
    def inner_decorator(*args,**kwrgs):
    #    print("this happend before")
        try:
            my_function(*args,**kwrgs)
        except Exception as ex:
            print('stop!!',ex)
    return inner_decorator


@operations
def add (*args:int)->int:
    print (sum(args))
@operations
def subtr(*args:float)->float:
   sub=args[0]
   for i in range(1,len(args)):sub=sub-args[i]
```

```
   print(sub)

if __name__ == "__main__":
    add(3,'g')
    add(5,76)
    subtr(4,2.1)
#output
stop!! unsupported operand type(s) for +: 'int' and 'str'
81
1.9
```

```
# using **kwrgs
def operations(my_function):
    def inner_decorator(*args,**kwrgs):
    #    print("this happend before")
        try:
            my_function(*args,**kwrgs)
        except Exception as ex:
            print('stop!!',ex)
    return inner_decorator


@operations
def add (*args:int,**kwrgs)->int:
    x=sum(args)
    for key,value in kwrgs.items(): x=x+value
    print(x)
@operations
def subtr(*args:float)->float:
   sub=args[0]
   for i in range(1,len(args)):sub=sub-args[i]
   print(sub)

if __name__ == "__main__":
    add(3,7,item=30)
    add(item1=4,item2=6)
    add(3,7,item='f')
    subtr(4,2.1)

#output
40
10
stop!! unsupported operand type(s) for +: 'int' and 'str'
1.9
```

## Type of Errors and Error Customisations

## VERY IMPORTANT FOR EXCEPTION/ERROR HANDLING

```
# Error types
try :
    print(1/0)   # failuere codnition code can be written here
    raise RuntimeError("you are wrong")
except ZeroDivisionError as error:   # only when you get an error
    print("an error occured",error)
except Exception as ex:   # only when you get an error
    print("from exception",ex)
finally:  # these is always getting executed
    print("hi how are ayoposadjklasndksanknd")
    print("I am good")
```

```
# customized error
class customerror(Exception):
    def __init__(self,message):
        self.message=message

    def __str__(self):
        return f'{self.__class__.__name__}:{self.message} written by Rovy'

print('welcome')
raise customerror('sorry here is an error for you!')

#output
welcome

---------------------------------------------------------------------------
customerror                               Traceback (most recent call last)
Cell In[991], line 10
      7         return f'{type(self).__name__}:{self.message} written by Rovy'
      9 print('welcome')
---> 10 raise customerror('sorry here is an error for you!')

customerror: customerror:sorry here is an error for you! written by Rovy
```

```
# customized error
# here it can be raised without writting custom message
# both are the same depends on the user prefering
class customerror(Exception):
    pass

print('welcome')
raise customerror('sorry here is an error for you!')
```

```
#output
welcome

---------------------------------------------------------------------------
customerror                               Traceback (most recent call last)
Cell In[998], line 7
      4     pass
      6 print('welcome')
----> 7 raise customerror('sorry here is an error for you!')

customerror: sorry here is an error for you!
```

## Quizes Notes

**1-**

This question has a mistake as we can't add to the tuples but just to do sum operations +('abc',)

Which of the following statements will add an item to a tuple named "trees"?

Select one:

a.

```
trees = ("maple")
```

b.

```
trees.append("maple")
```

c.

```
trees.add("maple")
```

d.

```
trees.insert("maple")
```

**2- good question as i answered it partially correct(the first two options) but the third options to be included as well**

Which of the following statements are true about dictionaries?

Select all appropriate answers:

a.

A dictionary is a collection of items and each item includes a key and a value.

b.

Each key in a dictionary acts as an index on an item in the dictionary, so each key must be unique within the dictionary.

c.

Each value in a dictionary acts as an index on an item in the dictionary, so each value must be unique within the dictionary.

d.

A dictionary allows the developer to define indexes on the values in the collection, rather than depending on Python to assign indexes.