Lists

Introduction

A list is a standard data type of Python that can store a sequence of values belonging to any type. The **Lists** are contained within square brackets (**[ ]**). Following are some examples of lists in Python:

```
[ ] #Empty list
[1, 2, 3] #List of integers
[1, 2, 5.6, 9.8] #List of numbers (Floating point and Integers)
['a', 'b', 'c'] #List of characters
['a', 1, 4.3, "Zero"] #List of mixed data types
["One", "Two", "Three"] #List of strings
```

Creating Lists

In Python programming, a list is created by placing all the items (elements) inside square brackets **[ ]**, separated by commas.

It can have any number of items and they may be of different types (integer, float, string etc.).

```
list1 = [] #Empty list
list2 = [1, 2, 3] #List of integers
list3 = [1, "One", 3.4] #List with mixed data types
```

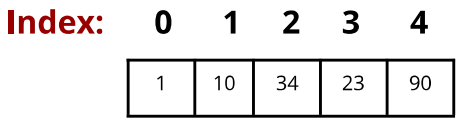
A list can also have another list as an element. Such a list is called a **Nested List**.

```
list4 = ["One", [8, 4, 6], ['Three']] #Nested List
```

Operations On Lists

Accessing Elements in a List

List indices start at 0 and go on till 1 less than the length of the list. We can use the index operator **[ ]** to access a particular item in a list. Eg.



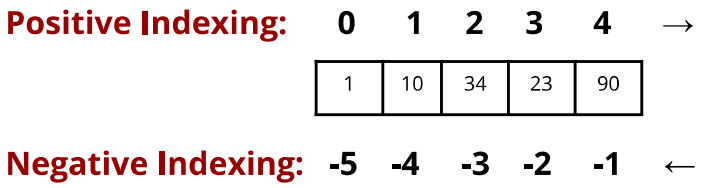
Note: Trying to access indexes out of the range `(0 ,lengthOfList-1)`, will raise an **IndexError**. Also, the index must be an integer. We can't use float or other types, this will result in **TypeError**.

Let us take an example to understand how to access elements in a list:

```
l1 = ['Mother', 'Father', 'Daughter', 10, 23]
>> print(l1[0]) #Output: 'Mother'
>> print(l1[2]) #Output: 'Daughter'
>> print(l1[4]) #Output: 23
```

Negative Indexing

Python allows negative indexing for its sequences. The index of **-1** refers to the last item, **-2** to the second last item, and so on. The negative indexing starts from the last element in the list.



Let us take an example to understand how to access elements using negative indexing in a list:

```
l1 = ['Mother', 'Father', 'Daughter', 10, 23]
>> print(l1[-1]) #Output: 23
>> print(l1[-2]) #Output: 10
>> print(l1[-6]) #Output: IndexOutOfRange error
```

Changing Elements of a List

Once a list is created, we can even change the elements of the list. This is done by using the assignment operator (**=**) to change the value at a particular list index. This can be done as follows:

```
l1 = ['Mother', 'Father', 'Daughter', 10, 23]
l1[-1] = "Daughter" #Changing the last element to "Daughter"
L1[3] = 12 #Changing the element at index 3 to 12
print(l1)
```

Output:

```
['Mother', 'Father', 'Daughter', 12, "Daughter"]
```

Concatenation of Lists

Joining or concatenating two list in Python is very easy. The concatenation operator (**+**), can be used to join two lists. Consider the example given below:

```
l1= [1,2,3] #First List
l2= [3,4,5] #Second List
```

```
l3= l1+l2 #Concatenating both to get a new list
print(l3)
```

Output:

```
[1,2,3,3,4,5]
```

Note: The **+** operator when used with lists requires that both the operands are of list types. You cannot add a number or any other value to a list.

Repeating/Replicating Lists

Like strings, you can use ***** operator to replicate a list specified number of times. Consider the example given below:

```
>>> l1 = [1,2, 10, 23]
>>> print(li*3)
[1,2,10,23,1,2,10,23,1,2,10,23] #Output
```

Notice that the above output has the same list `l1` repeated **3** times within a single list.

List Slicing

List slicing refers to accessing a specific portion or a subset of a list while the original list remains unaffected. You can use indexes of list elements to create list slices as per the following syntax:

```
slice= <List Name>[StartIndex : StopIndex : Steps]
```

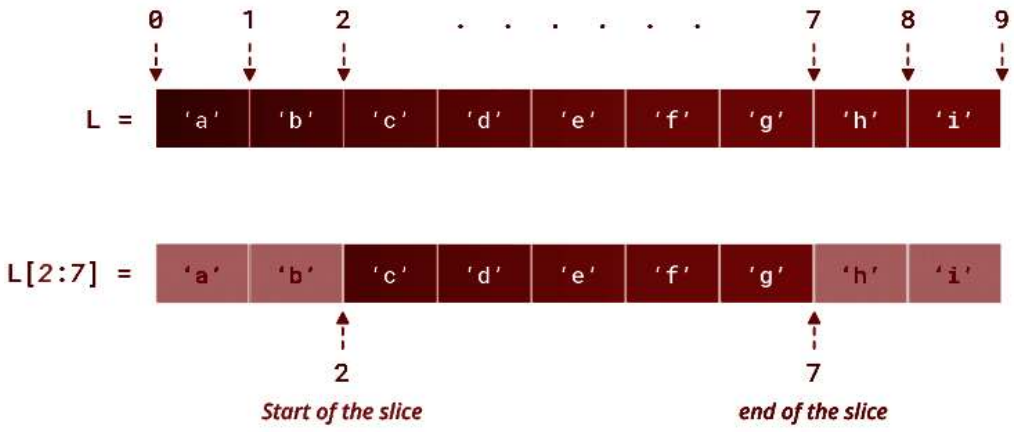
- The `StartIndex` represents the index from where the list slicing is supposed to begin. Its default value is 0, i.e. the list begins from index 0 if no `StartIndex` is specified.
- The `StopIndex` represents the last index up to which the list slicing will go on.

Its default value is `(length(list)-1)` or the index of the last element in the list.

- `steps` represent the number of steps. It is an optional parameter. `steps,` if defined, specifies the number of elements to jump over while counting from StartIndex to StopIndex. By default, it is 1.
- The list slices created, include elements falling between the indexes `StartIndex` and `StopIndex`, including `StartIndex` and not including `StopIndex`.

Here is a basic example of list slicing.

```
L = ['a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i']
print(L[2:7])
```



As, you can see from the figure given above, we get the output as:

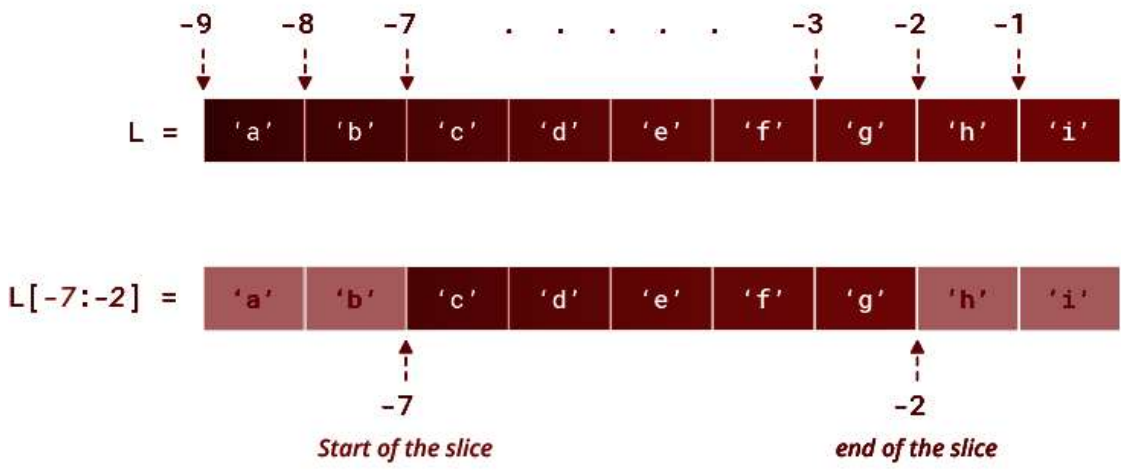
```
['c', 'd', 'e', 'f', 'g']
```

Slice Using Negative Indices

You can also specify negative indices while slicing a list. Consider the example given

below.

```
L = ['a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i']
print(L[-7:-2])
```



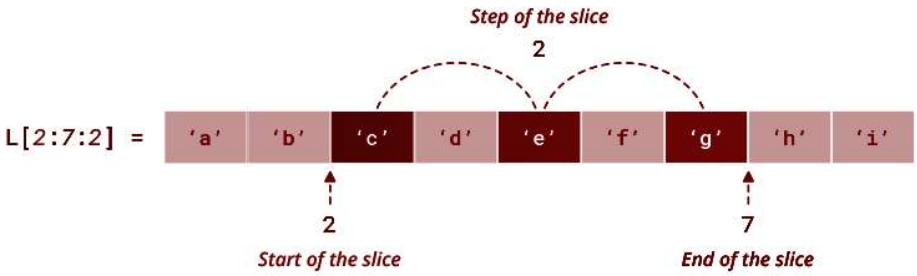
Thus, we get the output as:

```
['c', 'd', 'e', 'f', 'g]
```

Specify Step of the Slicing

You can specify the step of the slicing using the **`steps`** parameter. The **`steps`** parameter is optional and by default 1.

```
# Print every 2nd item between position 2 to 7
L = ['a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i']
print(L[2:7:2])
```



The output will be:

```
['c','e','g']
```

You can even specify a negative step size:

```
# Print every 2nd item between position 6 to 1
L = ['a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i']
print(L[6:1:-2])
```

The output will be:

```
['g','e','c']
```

Slice at Beginning & End

Omitting the `StartIndex` starts the slice from the index 0. Meaning, `L[:stop]` is equivalent to `L[0:stop]`.

```
# Slice the first three items from the list
L = ['a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i']
print(L[:3])
```

Output

```
['a', 'b', 'c']
```

Whereas, omitting the **StopIndex** extends the slice to the end of the list. Meaning, **L[start:]** is equivalent to **L[start:len(L)]**.

```
# Slice the last three items from the list
L = ['a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i']
print(L[6:])
```

Output

```
['g', 'h', 'i']
```

Reversing a List

You can reverse a list by omitting both **StartIndex** and **StopIndex** and specifying **steps** as -1.

```
L = ['a', 'b', 'c', 'd', 'e']
print(L[::-1])
```

Output:

```
['e', 'd', 'c', 'b', 'a'] #Reversed List
```

List Methods

append(): Used for appending/adding elements at the end of a list.

Syntax: `<ListName>.append(element)`

Example:

```
>>> li=[1,2,3,4]
>>> li.append(5) #Append 5 to the end of the list
>>> li
[1,2,3,4,5]
```

`extend()`: Adds the contents of **List2** to the end of **List1**.

Syntax: `<ListName1>.extend(<ListName2)`

Example:

```
>>> l1=[1,2,3,4]
>>> l2=[5,6,7,8]
>>> l1.extend(l2) #Adds contents of l2 to l1 at the end
>>> l1
[1,2,3,4,5,6,7,8]
```

`.append()` vs `.extend()`:

The only difference between `.append()` and `.extend()` is that, the `.append()` method adds an element at the back of a given list *(appends an element at the end of a list)*. On the other hand, the `.extend()` method adds the contents of another list at the end of the given list i.e. it merges two lists *(extends the given list).* See the examples given above for better clarity.

`insert()`: Inserts an element at a specified position/index in a list.

Syntax: `<ListName>(position, element)`

Example:

```
>>> li=[1,2,3,4]
>>> li.insert(2,5) #Insert 5 at the index no. 2
>>> li
[1,2,5,3,4]
```

`sum()` : Returns the sum of all the elements of a List. *(Used only for lists containing numerical values)*

Syntax: `sum(<ListName>)`

Example:

```
>>> l1=[1,2,3,4]
>>> sum1= sum(l1) #Finds the sum of all elements in l1
>>> sum1
10
```

`count()`: Returns the total number of times a given element occurs in a List.

Syntax: `<ListName>.count(element)`

Example:

```
>>> l1=[1,2,3,4,4,3,5,4,4,2]
>>> c= l1.count(4) #Number of times 4 occurs in the list
>>> c
4
```

`len()`: Returns the total length of a List.

Syntax: `len(<ListName>)`

Example:

```
>>> l1=[1,2,3,4,5]
>>> len(l1)
5
```

`index()`: Returns the index of first occurrence of an element in a list. If element is not present, it returns -1.

Syntax: `<ListName>.index(element)`

Example:

```
>>> l1=[1,2,3,4]
>>> l1.index(3)
2
```

`min()` : Returns the minimum element in a List.

Syntax: `min(<ListName>)`

Example:

```
>>> l1=[1,2,3,4]
>>> min(l1)
1
```

`max()`: Returns the maximum element in a List.

Syntax: `max(<ListName>)`

Example:

```
>>> l1=[1,2,3,4]
>>> max(l1)
4
```

`pop()`: It deletes and returns the element at the specified index. If we don't mention the index, it by default pops the last element in the list.

Syntax: `<ListName>.pop([index])`

Example:

```
>>> l1=[1,2,3,4]
```

```
>>> poppedElement= l1.pop(2)
>>> poppedElement #Element popped
3
>>> l1 #List after popping the element
[1,2,4]
```

Note: Index must be in range of the List, otherwise **IndexError** occurs.

`del()` : Element to be deleted is mentioned using list name and index.

Syntax: `del <ListName>[index]`

Example:

```
>>> l1=[1,1,12,3]
>>> del l1[2]
>>> l1
[1,1,3]
```

`remove()`: Element to be deleted is mentioned using list name and element.

Syntax: `<ListName>.remove(element)`

Example:

```
>>> l1=[1,1,12,3]
>>> l1.remove(12)
>>> l1
[1,1,3]
```

Looping On Lists

There are multiple ways to iterate over a list in Python.

Using `for` loop

```
li = [1, 3, 5, 7, 9]
# Using for loop
for i in li:
    print(i) #Print the element in the list
```

Output:

```
1
3
5
7
9
```

Using `for` loop and `range()`

```
list = [1, 3, 5, 7, 9]
length = len(list) #Getting the length of the list
for i in range(length): #Iterations from 0 to (length-1)
    print(i)
```

Output:

```
1
3
5
7
9
```

*You can even use **while()** loops. Try using the **while()** loops on your own.*

Taking Lists as User Inputs

There are two common ways to take lists as user inputs. These are:

- Space Separated Input of Lists
- Line Separated Input of Lists

Line Separated Input Of List

The way to take line separated input of a list is described below:

- Create an empty list.
- Let the number of elements you wish to put in the list be N.
- Run a loop for N iterations and during these N iterations do the following:
    - Take an element as user input using the `input()` function.
    - Append this element to the list we created.
- At the end of N iterations, you would have appended N desired elements to your list.
- In this, different elements will have to be entered by the user in different lines.

Consider the given example:

```
li=[] #Create empty list
for i in range(5): #Run the loop 5 times
      a=int(input()) #Take user input
      li.append(a) #Append it to the list
```

```
print(li) #Print the list
```

The above code will prompt the user to input 5 integers in 5 lines. These 5 integers will be appended to a list and the list will be printed.

Space Separated Input Of List

in Python, a user can take multiple values or inputs in one line by two methods.

- Using **`split()`** method
- Using List comprehension

Using `split()` method

This function helps in taking multiple inputs from the user in a single line . It breaks the given input by the specified **separator.** If a **separator** is not provided then any white space is treated as a separator.

Note: The `split()` method is generally used to split a string.

Syntax :

```
input().split(<separator>) #<separator> is optional
```

Example :

```
In[]: a= input().split()
In[]: print(a)
User[]: 1 2 3 4 5 #User inputs the data (space separated input)
Out[]: ['1','2','3','4','5']
```

Now, say you want to take comma separated inputs, then you will use `","` as the separator. This will be done as follows:

```
In[]: a= input().split(",")
In[]: print(a)
```

```
User[]: 1,2,3,4,5 #User inputs the data (space separated input)
Out[]: ['1','2','3','4','5']
```

Note: Observe that the elements were considered as characters and not integers in the list created using the `split()` function. *(What if you want a list of integers?- Think)*

Using List Comprehension

List comprehension is an elegant way to define and create a list in Python. We can create lists just like mathematical statements in one line only.

A common syntax to take input using list comprehension is given below.

```
inputList= [int(x) for x in input().split()]
```

Example :

```
In[1]: li= [int(x) for x in input().split()]
In[2]: print(li)
User[]: 1 2 3 4 5 #User inputs the data (space separated input)
Out[]: [1,2,3,4,5] #List has integers
```

Here, `In[1]` typecasts **x** in the list `input().split()` to an integer and then makes a list out of all these **x**'s.

Linear Search

Linear search is the simplest searching algorithm that searches for an element in a list in sequential order.

Linear Search Algorithm

We have been given a **`list`** and a **`targetValue`**. We aim to check whether the given **`targetValue`** is present in the given **`list`** or not. If the element is present we are required to print the index of the element in the list and if the element is not present we print **-1**.

(First, let us implement this using a simple loop, then later we will see how to implement linear search using functions.)

The following are the steps in the algorithm:

1. Traverse the given list using a loop.
2. In every iteration, compare the **`targetValue`** with the value of the element in the list in the current iteration.
    - If the values match, print the current index of the list.
    - If the values do not match, move on to the next list element.
3. If no match is found, print -1.

Pseudo-Code

```
for each element in the array:#For loop to traverse the list
    if element == targetValue #Compare the targetValue to the element
         print(indexOf(item))
```

Python Code

```
li= [int(x) for x in input().split()] #Taking list as user input
targetValue= int(input()) #User input for targetValue
```

```
found = False #Boolean value to check if we found the targetValue
for i in li:
    if (i==targetValue): #If we found the targetValue
        print(li.index(i)) #Print the index
        found = True #Set found as True as we found the targetValue
        break #Since we found the targetValue, we break out of loop
if found is False:#If we did not find the targetValue
    print(-1)
```

We have:

```
User[1]: 1 2 4 67 23 12 #User input for list
User[2]: 4 #User input= targetValue
Out[]: 2 #Index of 4
```

Linear Search Through Functions

We will create a function `linearSearch`, which will have the following properties:

- Take `list` and `targetValue` as parameters.
- Run a loop to check the presence of `targetValue` in `list`.
- If it is present then it returns the index of the `targetValue`.
- If it is not present, then it returns **-1**.

We will call this function and then print the return value of the function.

Python Code

```
def linearSearch(li,targetValue):
```

```
    for i in li:
        if (i==targetValue): #If we found the targetValue
            return li.index(i) #Return the index
    return -1 #If not found, return -1
li= [int(x) for x in input().split()] #Taking list as user input
targetValue= int(input()) #User input for targetValue
print(linearSearch(li,targetValue)) #Print the return value
```

Mutable And Immutable Concept

The Python data types can be broadly categorized into *two* - ***Mutable*** and ***Immutable*** types. Let us now discuss these two types in detail.

- Since everything in Python is an Object, every variable holds an object instance.
- When an object is initiated, it is assigned a unique object id (Address in the memory).
- Its type is defined at runtime and once set it can never change.
- However, its state can be changed if it is **mutable**. In other words, the value of a **mutable** object can be changed after it is created, whereas the value of an **immutable** object can't be changed.

Note: *Objects of built-in types like (int, float, bool, str, tuple, Unicode) are* ***immutable****. Objects of built-in types like (list, set, dict) are* ***mutable****. A list is a mutable as we can insert/delete/reassign values in a list.*