

Introduction to Python

Lists

Topics

- 1) Lists
- 2) List indexing
- 3) Traversing and modifying a list
- 4) Summing a list
- 5) Maximum/Minimum of a list
- 6) List Methods

Containers

Python includes several built-in sequences: *lists*, *tuples*, *strings*. We will discuss these in the next few lectures. Here's a broad overview:

Lists and *tuples* are *container sequences*, which can hold items of different type. String is a flat sequence which holds item of one type(characters).

Another way of grouping sequence types is by *mutability*. Lists are *mutable*(*can be modified*) sequences while strings and tuples are *immutable* sequences. We discuss lists in this lecture.

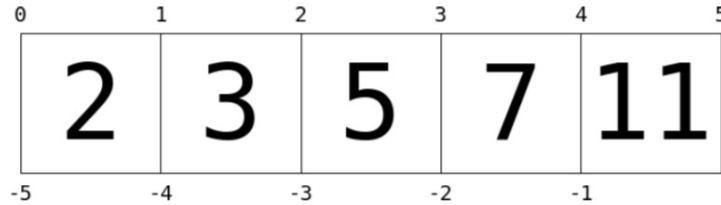
Lists

Lists are the basic *ordered* and *mutable* data collection type in Python. They can be defined with comma-separated values between square brackets.

```
L = [2, 3, 5, 7]
print(len(L))           # 4, len() also works with strings
L.append(11)            # append to the end of the list
print(L)                # [2, 3, 5, 7, 11]
```

Indexing

Indexing is a means the fetching of a single value from the list. This is a 0-based indexing scheme.



```
L = [2, 3, 5, 7, 11]
```

```
print(L[0])           # 2
```

```
print(L[1])           # 3
```

```
print(L[5])           # index out of bounds error.
```

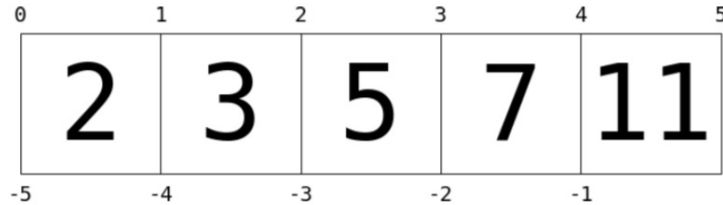
Lists can contain different types of objects

List can contain different types and even other lists.

```
L = [1, 'two', 3.14, [-2, 3, 5]]
print(L[0])           # 1
print(L[1])           # two
print(L[3])           # [-2, 3, 5]
print(L[3][0])        # -2
print(L[3][1])        # 3
print(L[3][2])        # 5
```

Modifying a List

Indexing can be used to set elements as well as access them.



```
L = [2, 3, 5, 7, 11]
```

```
L[0] = 100
```

```
print(L)           # [100, 3, 5, 7, 11]
```

```
L[2] = -4
```

```
print(L)           # [100, 3, -4, 7, 11]
```

Slicing

We saw in the previous lecture that we can slice a string by specifying a start-index and stop-index, and the result is a subsequence of the items contained within the slice.

Slicing also works with lists!(As well as many important data structures in Python) Slicing can be done using the syntax:

```
my_list[start:stop:step]
```

where

start: index of beginning of the slice(included), default is 0

stop: index of the end of the slice(excluded), default is length of the list

step: increment size at each step, default is 1.

List Slicing

```
L = [10, -2, 1, 6, 2]
print(L[1:3])      # [-2, 1]
print(L[:3])      # [10, -2, 1]
print(L[1:])      # [-2, 1, 6, 2]
print(L[0:4:2])   # [10, 1]
print(L[:])       # [10, -2, 1, 6, 2]
print(L[::-1])    # [2, 6, 1, -2, 10]
```

Traversing a list

We can traverse through a list using a for loop. We have seen this before with strings! There are two options:

1) for each loop:

```
nums = [2, -1, 3, 4, -3]
```

Looping through each value

```
for x in nums:
```

```
    print(x, end=" ")
```

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

2) loop using indices

```
nums = [2, -1, 3, 4, -3]
```

Looping through each index

i takes on values: 0,1,2,3,4.

```
for i in range(len(nums)):
```

```
    print(nums[i], end=" ")
```

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

Modifying a list

Consider the following code that is intended to change all even numbers in a list to 0.

```
nums = [24, 3, 34, 6, -5, 4]
for x in nums:
    if x % 2 == 0:
        x = 0
print(nums)
```

Output:

```
[24, 3, 34, 6, -5, 4]
```

Note: The list is unchanged? Why? How can we fix it?

Modifying a list

Here's the correct code to change all even numbers in a list to 0. Compare the following code to the previous slide.

```
nums = [24, 3, 34, 6, -5, 4]
for i in range(len(nums)):
    if nums[i] % 2 == 0:
        nums[i] = 0
print(nums)
```

Output:

```
[0, 3, 0, 0, -5, 0]
```

Creating a list

If you want to create a list containing the first five perfect squares, then you can complete these steps in three lines of code:

```
squares = []          # create empty list
for i in range(5):
    squares.append(i ** 2) # add each square to list
print(squares)
```

Output:

```
[0, 1, 4, 9, 16]
```

There is a much simpler way to create this list using list comprehensions.

Creating a list with list comprehensions

List comprehensions is a way to create a list in Python that is concise and elegant. Its main use is to create a new list from a given list.

Instead of:

```
squares = []           # create empty list
for i in range(5):
    squares.append(i ** 2) # add each square to list
```

Do this:

```
squares = [i ** 2 for i in range(5)]           # one line!
```

List comprehensions allow you to use a conditional.

```
even_squares = [i ** 2 for i in range(5) if i % 2 == 0]
print(even_squares)    # [0, 4, 16]
```

Algorithms to know

The following algorithms are useful. Know how to implement these algorithms!

- 1) Find sum of a list of numbers.
- 2) Find the average of a list of numbers.
- 3) Find the maximum/minimum of a list of numbers.

Sum of a list

Given a list, find the sum of its elements. We can do this by traversing through the list using a for loop.

```
nums = [2, -1, 3, 4, -3]
```

```
s = 0
```

```
for x in nums:
```

```
    s += x
```

```
print(s)
```

Whenever we have a piece of code that accomplish a useful task, we should put it in a function.

Sum Function

Write a function that accepts a list of numbers as a parameter and returns its sum.

```
def sum(nums):  
    s = 0  
    for x in nums:  
        s += x  
    return s  
  
lst = [2, -1, 3, 4, -3]  
print(sum(lst)) # 5  
  
lst2 = [1, 5, 4, 2]  
a = sum(lst2)  
print(a) # 12
```

Average Function

Write a function that accepts a list of numbers as a parameter and returns its average.

```
def average(nums):  
    s = 0  
    for x in nums:  
        s += x  
    return s/len(nums)
```

```
lst = [2, 5, 4, 3]  
a = average(lst)  
print(a)          # 3.5
```

Conditional Summing

Write a function that accepts a list of numbers as a parameter and returns the sum of all even numbers in the list.

```
def sum(nums):  
    s = 0  
    for x in nums:  
        if x % 2 == 0:  
            s += x  
    return s
```

Find Maximum Function

Write a function that accepts a nonempty list of numbers as a parameter and returns its maximum value. Does the code below work?

```
def maximum(nums):  
    current_max = 0  
    for x in nums:  
        if x > current_max:  
            current_max = x  
    return current_max
```

```
lst = [-2, -5, -12, -3]  
a = maximum(lst)  
print(a)          # 0 INCORRECT!
```

No! What if the list contains only negative numbers? This function returns 0 which is not even in the list!

Find Maximum Function

Here's the correct implementation of maximum. The minimum function is similar.

```
def maximum(nums):  
    current_max = nums[0]    # the first value is maximum  
    for x in nums:          # until a bigger value shows up  
        if x > current_max:  
            current_max = x  
    return current_max
```

```
lst = [2, 5, 12, 3, 4, 11]  
a = maximum(lst)  
print(a)    # 12
```

List Methods

The following is a short list of useful list methods.

<code>append(value)</code>	appends value to the end of the list
<code>insert(index, value)</code>	inserts value at position given by index, shifts elements to the right.
<code>pop(index)</code>	removes object at index from list, shifts elements left and returns removed object. Returns last element if index is omitted. The index parameter is optional (default to last element).
<code>split()</code>	splits a string into a list. A separator can be specified. The default separator is any whitespace. Note that this is a string method not a list method.

List Methods

```
L = [3, "hi", -4, 6]
```

```
L.append(2)
```

```
L.insert(1, "hello")
```

```
a = L.pop(3)
```

```
print(a)
```

```
L.pop()
```

```
print(L)
```

```
# L = [3, "hi", -4, 6, 2]
```

```
# L = [3, "hello", "hi", -4, 6, 2]
```

```
# L = [3, "hello", "hi", 6, 2]
```

```
# -4
```

```
# ok to not store popped value
```

```
# [3, "hello", "hi", 6]
```

split()

The `split()` method splits a string into a list. A separator can be specified. The default separator is any whitespace.

```
fruits = "apple mango banana grape"
```

```
fruits_lst = fruits.split()
```

```
print(list_fruits) # ['apple', 'mango', 'banana', 'grape']
```

```
greeting = "hi,I am Mike,I just graduate."
```

```
greet_lst = greeting.split(",")
```

```
print(greet_lst) # ['hi', 'I am Mike', 'I just graduate.']
```

```
nums = "4 24 12"
```

```
nums_lst = nums.split()
```

```
print(nums_lst) # ['4', '24', '12'], these are still strings
```


Create a list from user inputs

Ask the user to enter a list of numbers **of any length** separated by spaces. Generate a list containing those numbers. The `split()` function can be used here.

```
nums = input("Enter list of numbers separated by spaces: ").split()  
print(nums)
```

Sample output:

```
Enter list of numbers separated by spaces: 4 6 | 23
```

```
['4', '6', '|', '23']
```

Note that the list above is a list of strings! We like this to be a list of integers.

Create a list from user inputs

From the previous example, we can change each string in the list by manually casting it to an integer.

```
nums = input().split()
for i in range(len(nums)):
    nums[i] = int(num[i])      # cast string to integer
print(nums)
```

Sample output:

4 6 | 23

[4, 6, 1, 23]

We can further simplify the code above using list comprehensions! **This code below can used in many of the replit Teams problems for this lecture.**

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

AP Exam: Lists API

Text:

```
aList ← [value1, value2, value3, ...]
```

Block:

```
aList ← [value1, value2, value3]
```

Creates a new list that contains the values `value1`, `value2`, `value3`, and `...` at indices 1, 2, 3, and `...` respectively and assigns it to `aList`.

Text:

```
aList ← []
```

Block:

```
aList ← []
```

Creates an empty list and assigns it to `aList`.

Text:

```
aList ← bList
```

Block:

```
aList ← bList
```

Assigns a copy of the list `bList` to the list `aList`.

For example, if `bList` contains `[20, 40, 60]`, then `aList` will also contain `[20, 40, 60]` after the assignment.

Text:

```
aList[i]
```

Block:

```
aList [i]
```

Accesses the element of `aList` at index `i`. The first element of `aList` is at index 1 and is accessed using the notation `aList[1]`.

AP Exam: Lists API

Text:

```
x ← aList[i]
```

Block:

```
x ← aList[i]
```

Assigns the value of `aList[i]` to the variable `x`.

Text:

```
aList[i] ← x
```

Block:

```
aList[i] ← x
```

Assigns the value of `x` to `aList[i]`.

Text:

```
aList[i] ← aList[j]
```

Block:

```
aList[i] ← aList[j]
```

Assigns the value of `aList[j]` to `aList[i]`.

AP Exam: Lists API

Text:

```
INSERT(aList, i, value)
```

Block:

```
INSERT aList, i, value
```

Any values in `aList` at indices greater than or equal to `i` are shifted one position to the right. The length of the list is increased by 1, and `value` is placed at index `i` in `aList`.

Text:

```
APPEND(aList, value)
```

Block:

```
APPEND aList, value
```

The length of `aList` is increased by 1, and `value` is placed at the end of `aList`.

Text:

```
REMOVE(aList, i)
```

Block:

```
REMOVE aList, i
```

Removes the item at index `i` in `aList` and shifts to the left any values at indices greater than `i`. The length of `aList` is decreased by 1.

Text:

```
LENGTH(aList)
```

Block:

```
LENGTH aList
```

Evaluates to the number of elements in `aList`.

AP Exam: Lists API

Text:

```
FOR EACH item IN aList  
{  
  <block of statements>  
}
```

Block:

```
FOR EACH item IN aList
```

```
  block of statements
```

The variable `item` is assigned the value of each element of `aList` sequentially, in order, from the first element to the last element. The code in **block of statements** is executed once for each assignment of `item`.

Lab I

Create a new repl on repl.it

- 1) Create this list and assign it to a variable `[3,41,62,87,101, 88]`. Use a for loop to compute the sum. Print out the sum.
- 2) Use a for loop to compute the sum of odd numbers from the list above.
- 3) Use a for loop to compute the sum of values located at even indices.(Use the `len()` function).

References

- 1) Vanderplas, Jake, *A Whirlwind Tour of Python*, O'reilly Media.
- 2) Luciano, Ramalho, *Fluent Python*, O'reilly Media.