Lists

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Week 8 Lecture 7

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(note: there is no lecture 6)

Warm Up Exercises: Recalling Strings

1. What will Python return?

```
>>> s='Clearwater, Florida'
```

a) s[16:]

b) s[5]+s[2:5]

c) (s[:5] + s[11]) *2 + s[5].upper() + s[6:10] + "!"

2. Write a function **`space_2_underscore`** that will process each character in a string. If it finds a space, it should replace it with an underscore. Return the result.

Warm Up Exercises: Recalling Strings

1. What will Python return?

```
>>> s='Clearwater, Florida'
```

a) s[16:]

```
>>> s[16:]
'ida'
```

b) s[5]+s[2:5]

```
>>> s[5]+s[2:5]
'wear'
```

c) (s[:5] + s[11]) *2 + s[5].upper() + s[6:10] + "!"

```
>>> (s[:5] + s[11]) *2 + s[5].upper() + s[6:10] + "!"
'Clear Clear Water!'
```

Warm Up Exercises: Recalling Strings

Write a function that will process each character in a string. If it finds a space, it should replace it with an underscore. Return the result.

```
def space_2_underscore(s):
    # signature: str -> str
    # converts spaces to underscore
    acc=""
    for i in s:
        if i==' ': # if it is a space
              acc += '_'
        else:
            acc += i
    return acc
```

```
==== RESTART: F:/09_Python_course  S17/01_Lecture/
>>> space_2_underscore("Palm Beach, Florida!")
'Palm_Beach,_Florida!'
```

Learning Objectives

- Compare and contrast lists and strings
- Learn list syntax
- Perform common tasks similar to those for strings
- Loop over lists
- Mutate lists
- Knowledge integration: Combine new list skills with flow control and functions to write programs

Lists vs. Strings

- Lists and strings bear many similarities
  - They can be manipulated in many ways that parallel strings
  - They may contain multiple elements
  - Their elements can be processed in loops
- They differ in two important ways
  - Lists may have elements of various types; they are not limited to characters.
  - Lists are *mutable*; the contents can be changed after they are created

Why lists are useful:
A preview of lists in action

```
# program average_with_variables
score1 = 98.5
score2 = 100.0
score3 = 87.4
score4 = 90.1
score5 = 88.7

scoreT=score1+score2+score3+score4+score5
scoreAvg = scoreT / 5

print ('Your average is',scoreAvg,'.')
```

```
# program average_with_list
scores=[98.5, 100.0, 87.4, 90.1, 88.7]

scoreT=0
for score in scores:
    scoreT += score
scoreAvg = scoreT/len(scores)

print ('Your average is',scoreAvg,'.')
```

Lists: Syntax

- Enclose a list in the square brackets, and separate elements by a comma
- An empty list is just the brackets []
- The index of the items in the list begins at 0

Syntax:

```
<list> = [ <element_0>, <element_1>, …, <element_n>]
    #Indices:  0                1          2      n              len=n+1
```

Examples:

list containing three integers

```
>>> [1, 2, 3]
[1, 2, 3]
```

list called A contains three strings

```
>>> A = ['a', 'b', 'c']
>>> A
['a', 'b', 'c']
```

list called B contains three strings

```
>>> B = ['bobcat','bluebird', 'bear']
>>> B
['bobcat', 'bluebird', 'bear']
```

list called prices contains three floats

```
>>> prices=[7.99, 4.50, 3.99]
>>> prices
[7.99, 4.5, 3.99]
```

List Homogeneity

- **Homogeneous list** - all elements of the list are of the same type
- **Inhomogeneous list** – the elements of the list are of mixed type
- The scope of this course is limited to homogeneous lists

Examples:

Homogeneous lists

```
Alpha = ['a', 'b', 'c'] # elements of type str
Ints = [ 12, 14, 16] # elements of type int
Floats= [ 5.5, 22/7, 4.3 + 7.9 ]
```

Inhomogeneous list

```
Mix = [4.50, 'boat', 9] # elements of type float, str, and int
```

Familiar Tasks Overloaded for Lists

List Indexing and Slicing

- Indexing and slicing work analogously to how they work with strings
- Indexing returns a value, whereas slicing returns a list

Indexing Syntax:
<list>[index]

Example:

```
>>> cities=['Tampa','Orlando','Boca Raton']
>>> cities[0]
'Tampa'
>>> cities[-2]
'Orlando'
```

Slicing Syntax:
<list>[<start_index>:<stop_index>]

Example:

```
>>> cities=['Tampa','Orlando','Boca Raton']
>>> cities[:2]
['Tampa', 'Orlando']
>>> cities[-2:]
['Orlando', 'Boca Raton']
```

List Addition and Repetition

- The + (concatenation) and * (repetition) operators are overloaded for lists

Concatenation Syntax:

<list1> + <list2>

Repetition Syntax:

<list1> * <int>

Examples:

```
>>> ['a','b','c'] + ['d', 'e']
['a', 'b', 'c', 'd', 'e']
>>> [1, 2, 3]*2
[1, 2, 3, 1, 2, 3]
>>> ['cat','dog'] * 2
['cat', 'dog', 'cat', 'dog']
```

List Coercion Function

- The **`list`** function can be used to generate a list out of a string

Syntax:
`list(<string>)`

Example:

```
>>> list ('Ft. Lauderdale')
['F', 't', '.', ' ', 'L', 'a', 'u', 'd', 'e', 'r', 'd', 'a', 'l', 'e']
```

List Comparisons

- The comparison operators < , >, >=, and <= are overloaded for lists to do comparisons of lists.

Syntax:

Examples:

<list1> < <list2>

```
>>> [0, 0] < [1, 0]
True
```

<list1> > <list2>

```
>>> [0,5] > [0,7]
False
```

<list1> <= <list2>

```
>>> ['Zoo','bark']<=['aardvark','Dog']
True
```

<list1> >= <list2>

```
>>> ['lion','tiger'] >= ['lion','monkey']
True
```

Length

- **`len()`** can be used on lists similar to how it is used on strings
- Returns the number of elements in the list

Syntax:

`len(<list>)`

Example:

```
>>> cities = ['Miami','Ocala','Daytona','Tallahassee'
,'Pensacola','Boca Raton']
>>> len(cities)
6
```

`in` Operator

- **`in`** can be used on lists similar to how it is used on strings
- Returns a Boolean to indicate if the query is in the list

Syntax:

`<query> in <list>`

Examples:

```
>>> mylist = ['Miami','Tampa','Clearwater']
>>> 'Miami' in mylist
True
>>> 'Boston' in mylist
False
```

Looping Over Lists

`for` Loops and Lists

- **`for`** loops can be used with lists
- The loop variable is assigned to each element in the list in turn

Syntax:

```
for <variable> in <list>:
    <loop_body>
```

Example:

```
cities = ['Tampa','Orlando','Boca Raton']

for city in cities:
    print('Visit sunny', city, 'in the sunshine state!')
```

```
==== RESTART: F:/09_Python_course  S17/01_Lecture
Visit sunny Tampa in the sunshine state!
Visit sunny Orlando in the sunshine state!
Visit sunny Boca Raton in the sunshine state!
```

Revisiting Average Score Computation

```
# program average_with_list
scores=[98.5, 100.0, 87.4, 90.1, 88.7]

scoreT=0
for score in scores:
    scoreT += score
scoreAvg = scoreT/len(scores)

print ('Your average is',scoreAvg,'.')
```

```
== RESTART: F:\09_Python_course  S17\01_Lecture\lecture6_week8
Your average is 92.94 .
```

Exercise: `for` Loops and Lists

Write a function **`get_longest`** that determines which city in a list of cities has the longest name. The input is a list of cities. The function should return the name of the longest city. If a tie happens to occur, the function should return ‘tie’. A test list is given.

```
cities = ['Orlando','Tampa','Boca Raton']
```

Exercise: `for` Loops and Lists

```
def get_longest(cities):
    # signature: list (str) -> str
    # determines which city has longest name
    # or reports a tie

    longest = 0          # initialize to 0
    for city in cities:
        if len(city) > longest: # new longest city found
            longest = len(city) # update longest length
            longcity = city     # update corresponding city
        elif len(city) == longest:     # dealing with a tie
            longcity = 'tie'
    return longcity

cities = ['Orlando','Tampa','Boca Raton']

print(get_longest(cities))
```

```
==== RESTART: F:/09_Python_course
Boca Raton
```

List Mutability and Aliasing

Assignment vs. Mutation

- The contents of lists can be **mutated** after they are created
- This differs from assignment and reassignment

```
>>> zoo=['lion','tiger','monkey']    # list assignment
>>> zoo=['elephant','zebra','kangaroo']    # list reassignment
```

- What if you want to change a specific element or elements?
  - Mutate the list by **index assignment** or **slice assignment**

List Mutation with Index Assignment

- Unlike strings, lists can be **mutated** after they are created; they can be changed.
- Use **index assignment** to mutate the list such that the value of an element of a list at the indicated index is changed.

Syntax:

```
<list> [<index>] = <new_element>
```

- Example:

```
>>> cities
['Tampa', 'Orlando', 'Boca Raton']
>>> cities[1] = 'Ft. Lauderdale'
>>> cities
['Tampa', 'Ft. Lauderdale', 'Boca Raton']
```

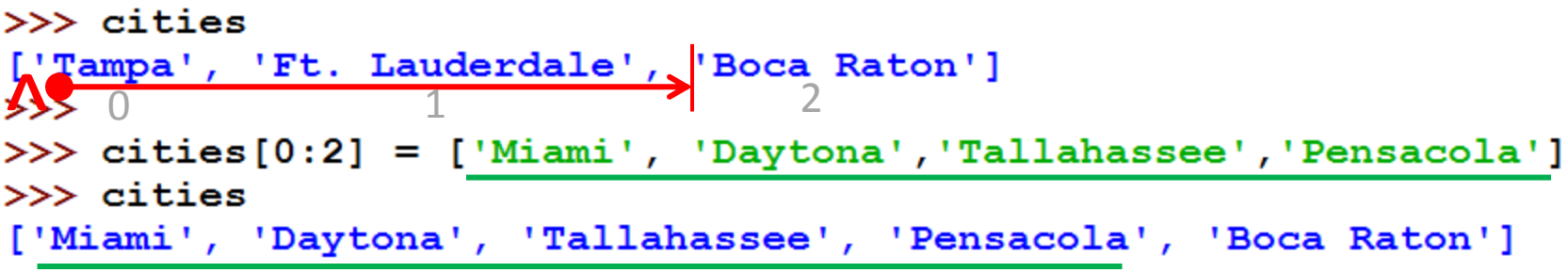
List Mutability and Slice Assignment

- A slice can be cut out and replaced by new entries using the **slice operator.**
- The length of what is spliced out does not need to be the same as the length of what is spliced in.

Syntax:

```
<list> [<start_index>:<stop_index>] = <splice_list>
```

Example:



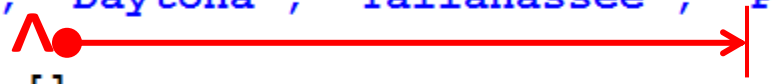
List Mutability and Slice Assignment: Special Cases

- **Insertion:** If the list that is cut has length 0, the effect is an insert at that point

```
>>> cities = ['Miami', 'Daytona', 'Tallahassee', 'Pensacola',
'Boca Raton']
>>> cities[1:1] = ['Ocala']
>>> cities
['Miami', 'Ocala', 'Daytona', 'Tallahassee', 'Pensacola', 'Bo
ca Raton']
```

- **Deletion:** If the new splice list has length 0, the effect is a deletion of the region to be cut

```
>>> cities
['Miami', 'Ocala', 'Daytona', 'Tallahassee', 'Pensacola', 'Bo
ca Raton']
>>> cities[2:4] = []
>>> cities
['Miami', 'Ocala', 'Pensacola', 'Boca Raton']
```



What is an Alias?

Definition of ALIAS

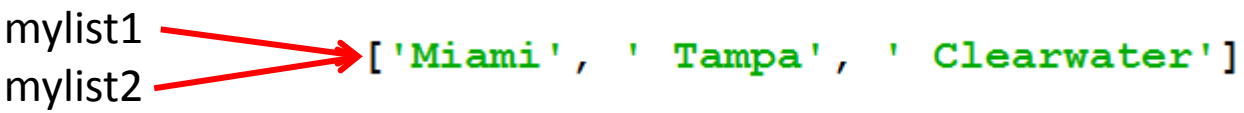
: an assumed or additional name that a person (such as a criminal) sometimes uses • a fugitive using several *aliases* • He checked into the hotel using an *alias*. • John Smith, who goes by the *alias* Richard Jones

The famous gangster Alphonsus Capone of Chicago. Also known as: Al, Scarface, Albert Costa

```
# Creation of an alias

>>> mylist1 = ['Miami', ' Tampa', ' Clearwater']
>>> mylist2 = mylist1

# one list has two names
```

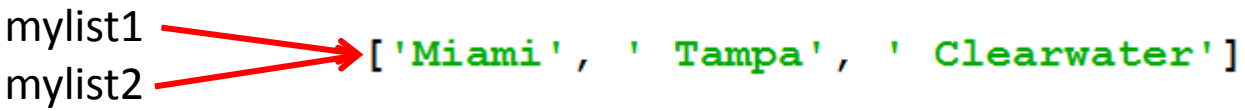


Aliasing and Mutability

- **Aliasing** occurs when two variables refer to the same list

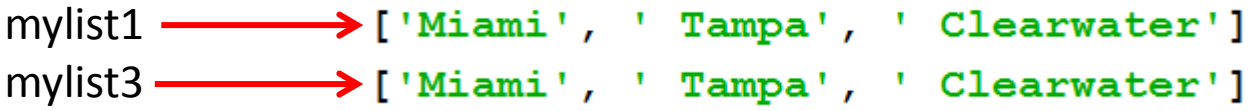
both variables point to the exact same list . Aliasing has occurred.

```
>>> mylist1 = ['Miami', ' Tampa', ' Clearwater']
>>> mylist2 = mylist1
```



each variable points to its own copy of the list.

```
>>> mylist1 = ['Miami', ' Tampa', ' Clearwater']
>>> mylist3 = ['Miami', ' Tampa', ' Clearwater']
```



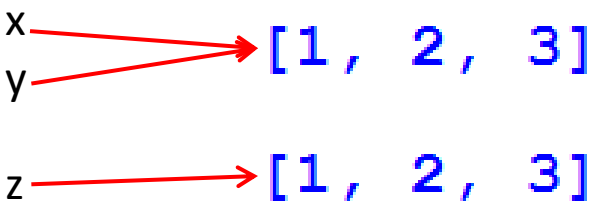
Aliasing and Mutability Example

- Consider the following snippet of code.
  - How many copies of the list exist?
  - Which list(s), x, y, or z, point to which one? Draw a diagram to show this.
  - What will the lists x, y and z be after the mutation?

```
>>> x = [1, 2, 3]
>>> y = x
>>> z = [1, 2, 3]
>>> y[1]=0
```

Aliasing and Mutability: Solution

- Consider the following snippet of code.
  - How many copies of the list exist? 2
  - Which list(s), x, y, or z, point to which one? Draw a diagram to show this.



(Note: shown before the mutation occurs)

- What will the lists x, y and z be after the mutation?

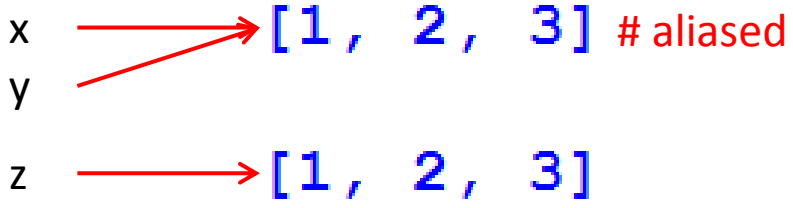
```
>>> x = [1, 2, 3]
>>> y = x
>>> z = [1, 2, 3]
>>> y[1]=0
```

```
>>> x
[1, 0, 3]
>>> y
[1, 0, 3]
>>> z
[1, 2, 3]
```

Detecting Aliasing

- Using `==` and `!=` compares the values but does not compare the reference, so aliasing will not be detected.

```
>>> x = [1, 2, 3]
>>> z = [1, 2, 3]
>>> x == z # not aliased but this
True       isn't detected with ==
```



- Use **`is`** or **`is not`** to determine whether two references alias the same value.

Syntax:

```
<ref1> is <ref2>
<ref1> is not <ref2>
```

```
>>> x is z
False
>>> x is y
True
>>> y is x
True
>>> y is z
False
```

```
>>> x is not z
True
>>> x is not y
False
>>> y is not x
False
>>> y is not z
True
```

aliasing is detected with **`is`** and **`is not`**

Functions and Mutation

```
def square(data):
    # signature: list(int) -> list(int )
    # squares the elements in data

    newdata = [] # empty list   # a new list is created
    for x in data:
        newdata.append(x**2)
    return newdata                # the new list is returned

data = [2, 3, 5]
print('data before function call:', data)
print('function returns: ',square(data))
print ('data after function call:', data)
```

Will **`data`** be mutated by the **`square`** function?

Functions and Mutation

```
def square(data):
    # signature: list(int) -> list(int )
    # squares the elements in data

    newdata = [] # empty list    # a new list is created
    for x in data:
        newdata.append(x**2)
    return newdata                # the new list is returned

data = [2, 3, 5]
print('data before function call:', data)
print('function returns: ',square(data))
print ('data after function call:', data)
```

```
==== RESTART: F:/09_Python_course  S17/01_Lecture/
data before function call: [2, 3, 5]    # the list called data is the same before...
function returns:  [4, 9, 25]
data after function call: [2, 3, 5]     # ... and after the function call
```

Functions and Mutation

```
def square_v2(data):
    # signature: list(int) -> NoneType
    # squares the elements in data

    i = 0
    while i < len(data):
        data[i] = data[i]**2
        i += 1
    return

data = [2, 3, 5]
print('data before function call:', data)
print('function returns: ',square_v2(data))
print ('data after function call:', data)
```

Will **`data`** be mutated by the **`square_v2`** function?

Functions and Mutation

```
def square_v2(data):
    # signature: list(int) -> NoneType
    # squares the elements in data

    i = 0
    while i < len(data):
        data[i] = data[i]**2
        i += 1
    return

data = [2, 3, 5]
print('data before function call:', data)
print('function returns: ',square_v2(data))
print ('data after function call:', data)
```

```
==== RESTART: F:/09_Python_course  S17/01_Lecture/
data before function call: [2, 3, 5]
function returns:  None
data after function call: [4, 9, 25]
```

the list called **`data`** before function call…

#… differs from **`data`** after function call

Methods Pertaining to Lists

Methods to Add Items to a List

```
<list>.insert (<insert_index>, <item>)
>>> mylist =['a','b','d']
>>>                    ^
>>> mylist.insert(2,'c') # Insert  'c' at element 2
>>> mylist
['a', 'b', 'c', 'd']
```

```
<list>.append (<item>)
>>> mylist = ['a', 'b','c']
>>> mylist.append('d')
>>> mylist
['a', 'b', 'c', 'd']
```

```
<list>.extend(<list_to_add>)
>>> mylist = ['a', 'b','c']
>>> mylist.extend(['d','e','f'])
>>> mylist
['a', 'b', 'c', 'd', 'e', 'f']
```

Methods to Remove Items from a List

```
<list>.pop (<index>)
>>> mylist
['a', 'b', 'c', 'd', 'e', 'f']
>>> popped = mylist.pop(1)   # pop the item with index 1 from the list
>>> popped
'b'
>>> mylist
['a', 'c', 'd', 'e', 'f']
```

```
<list>.remove (<list_item>)
>>> mylist = ['a','b','c','d','e']
>>> mylist.remove('a') # remove the item with the value 'a' from the list
>>> mylist
['b', 'c', 'd', 'e']
```

Methods for Splitting and Joining

```
str.split(<string>,<delimiter>)
>>> mystring = 'Miami, Tampa, Clearwater'
>>> str.split(mystring)   # split on whitespace by default
['Miami,', 'Tampa,', 'Clearwater']
>>> str.split(mystring,',') # split on commas
['Miami', ' Tampa', ' Clearwater']
```

```
str.splitlines(<string>)
>>> text = 'Line 1 a b c \nLine 2 d e f \nLine 3 g h i'
>>> str.splitlines(text)  # recall: \n is the newline character
['Line 1 a b c ', 'Line 2 d e f ', 'Line 3 g h i']
```

```
str.join(<delimiter>,<list>)
>>> mylist = ['Miami','Tampa','Clearwater']
>>> str.join('', mylist)    # join list elements  without a delimiter
'MiamiTampaClearwater'
>>> str.join(', ', mylist) # join list elements  separated by  a comma
'Miami, Tampa, Clearwater'  and space
```