Collections: Lists, Tuples, Aliasing

Overview

- ***Collections***
  - ***Sequences***
    - ~~Strings~~
    - **Lists**
    - **Tuples**

Collections

collection **are data type composed of smaller pieces**

- **Strings**
- **Lists**
- Tuples
- **Dictionaries**
- Sets

Lists

- A list is a linear data structure, meaning that its elements have a linear ordering.
- List is a sequential collection of data objects
- Items in a list can be accessed by indexing, and sublists can be accessed by slicing.
- Lists are mutable; individual items or entire slices can be replaced through assignment statements.
- Lists support a number of convenient and frequently used methods.
- Lists will grow and shrink as needed. With append, access insert, update, concatenate and delete operations.

Lists

- A list is a linear data structure, meaning that its elements have a linear ordering.
- An example of a list is sequence of daily temperatures for a given week:

0:	68.8
1:	70.2
2:	67.2
3:	71.8
4:	73.2
5:	75.6
6:	74.0

The location at index 0 stores the temperature for Sunday, the location at index 1 stored the temperature for Monday, and so on. It is customary in programming languages to begin numbering sequences of items with an index value of 0 rather than 1. **This is referred to as** *zero-based indexing*.

Lists: Basics

- Like strings, except the list items can be any type, even strings or even other lists

```
pets = ['ant', 'bat', 'cod', 'dog','elk’]

lst = [0, 1, 'two', 'three', [4, 'five’]]

nums = [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
```

- A list within a list is nested – inner list can be referred to as sublist

Accessing List Elements

- List items are accessed through indexes
- `pets = ['ant', "bird", 'cod', 'dog', 'elk']`
- `pets[1] = 'bird'`

- `mixlist = [44, 'bird', 12.9, [False, 'dog'], True ]`

- `mixlist[2]` → `12.9`
- `mixlist[3]` → `[False, 'dog']`
- `mixlist[3][1]` → `'dog'`

Common List Operations

- Many operations are similar to strings: `len, in and not in, concatenation (+), repetition, slicing`
- `mixlist = [44, "bird", 12.9, [False, 'dog'], True ]`
- `len(mixlist)` → `5`

- Operations directly work on the top level of the list, not the nested elements.
- `len(mixlist[3])` → `2`
- `len(mixlist[3][1])` → `3`

Lists are Mutable

```
mixlist = [44, 'bird', 12.9, [False,
'dog'], True ]
```

```
mixlist[1] = 'animal'
```

→ `[44, 'animal', 12.9, [False, 'dog'], True ]`

```
mixlist[3:5] = []                #deletion
```

→ `[44, 'animal', 12.9 ]`

List Methods: Adding and Removing elements

- `lst.append(item)`: Adds item to the end
- `lst.insert(position,item)`: Adds item at position
- `lst.pop(position)`: Removes and returns the item at postions – last item by default
- `lst.sort(), lst.reverse()`

- `lst.remove(item)`: removes first occurrence of item
- `lst.index(item)`: return pos of first occurrence of item
- `lst.count(item)`: return # of occurrences of the item

Lists: Review

- A **list traversal** is a means of accessing, one-by-one, each element of a list.

- List traversal may be used, for example, to:
  - search for a particular item in a list
  - add up all the elements of a list

Lists: Review

- List can be accessed in loops

- Directly with items

```
listofnames = [‘Mary’, ‘Susan’, ‘John’]
for name in listofnames:
                …
```

- Or through indices

```
        for i in range(len(listofnames)):
                name = listofnames[i]
                …
```

Lists (Sequences) in Python

- A **list** in Python is a mutable, linear data structure of variable length, allowing mixed-type elements.

- By *mutable* is meant that the contents of the list may be altered. **Lists in Python use zero-based indexing**. Thus, all lists have index values 0..n-1, where n is the number of elements in the list.

Examples

- **Lists are denoted by a** comma-separated list of elements within square brackets,
- [1, 2, 3] ['one', 'two', 'three'] ['apples', 50, True]
- An empty list is denoted by an empty pair of square brackets, []. Elements of a list are accessed by use of an index value within square brackets,
- For lst = [1, 2, 3],

  lst[0] → 1 access of first element

  lst[1] → 2 access of second element

  lst[2] → 3 access of third element

-

Examples

- The following prints the first element of list lst,

```
print (lst[0])
```

- The elements of lst can be summed as follows,

```
sum = lst[0] + lst[2] + lst[2]
```

- To update, lst[2] = 4 replacement of 3 with 4 at index 2
- To delete, del lst[2] removal of 4 at index 2
- To insert, lst.insert(1,3) insertion of 3 at index 1
- To append, lst.append(4) appends 4 to end of list

Operation	`fruit = ['banana', 'apple, 'cherry']`	
Replace	`fruit[2] = 'coconut'`	`['banana', 'apple', 'coconut']`
Delete	`del fruit[0]`	`['apple', 'cherry']`
Insert	`fruit.insert(2, 'pear')`	`['banana', 'apple', 'pear', 'cherry']`
Append	`fruit.append('peach')`	`['banana', 'apple', 'cherry', 'peach']`
Sort	`fruit.sort()`	`['apple', 'banana', 'cherry']`
Reverse	`fruit.reverse()`	`['cherry', 'apple', 'banana']`

Let's Try It

From the Python Shell, enter the following and observe the results.

From the Python Shell, enter the following and observe the results.

```
>>> lst = [10, 20, 30]
>>> lst
???

>>> lst[0]
???

>>> lst[0] = 5
>>> lst
???
```

```
>>> del lst[2]
>>> lst
???

>>> lst.insert(1, 15)
>>> lst
???

>>> lst.append(40)
>>> lst
???
```

Tuples

- A **tuple** is an *immutable* linear data structure. Thus, in contrast to lists, once a tuple is defined it cannot be altered. Otherwise, tuples and lists are essentially the same.

- To distinguish tuples from lists, tuples are denoted by parentheses instead of square brackets as given below,

```
nums = (10, 20, 30)
student = ('John Smith', 48, 'Computer Science', 3.42)
```

Single Element Tuples

- Another difference of tuples and lists is that tuples of one element must include a comma following the element. Otherwise, the parenthesized element will not be made into a tuple, as shown below,
-
-

CORRECT	WRONG
>>> (1,)	>>> (1)
(1)	**1**

Accessing Tuples

- An empty tuple is represented by a set of empty parentheses, ().
- The elements of tuples are accessed the same as lists, with square brackets,

```
>>> nums[0]
10
```

```
>>> student[0]
'John Smith'
```

- **Any attempt to alter a tuple is invalid.** Thus, delete, update, insert and append operations are not defined on tuples.

Sequences

- A **sequence** in Python is a **linearly-ordered set of elements accessed by index number**.

- Lists, tuples and strings are all sequences. Strings, like tuples, are immutable, therefore they cannot be altered.

Operation		String s = 'hello' w = '!'	Tuple s = (1,2,3,4) w = (5,6)	List s = [1,2,3,4] w = [5,6]
Length	`len(s)`	5	4	4
Select	`s[0]`	'h'	1	1
Slice	`s[1:4]` `s[1:]`	'ell' 'ello'	(2, 3, 4) (2, 3 ,4)	[2 ,3, 4] [2, 3, 4]
Count	`s.count('e')` `s.count(4)`	1 --	-- 1	-- 1
Index	`s.index('e')` `s.index(3)`	1 --	-- 2	-- 2
Membership	`'h' in s`	True	False	False
Concatenation	`s + w`	'hello!'	(1, 2, 3, 4, 5, 6)	[1, 2, 3, 4, 5, 6]
Minimum Value	`min(s)`	'e'	1	1
Maximum Value	`max(s)`	'o'	4	4
Sum	`sum(s)`	n/a	10	10

Let's Try It

From the Python Shell, enter the following and observe the results.

```
>>> s = 'coconut'
>>> s[4:7]
???

>>> s.count('o')
???

>>> s.index('o')
???

>>> s + ' juice'
???
```

```
>>> s = (10, 30, 20, 10)
>>> s[1:3]
???

>>> s.count(10)
???

>>> s.index(10)
???

>>> s + (40, 50)
???
```

```
>>> s = [10, 30 ,20, 10]
>>> s[1:3]
???

>>> s.count(10)
???

>>> s.index(10)
???

>>> s + [40, 50]
???
```

Nested Lists

- **Lists and tuples can contain elements of any type**, including other sequences.

- Thus, **lists and tuples can be nested** to create arbitrarily complex data structures

```
class_grades = [ [85, 91, 89], [78, 81, 86], [62, 75, 77], …]
```

This list stores three exam grades for each student.

`class_grades[0]` equals `[85, 91, 89]`
`class_grades[1]` equals `[78, 81, 86]`

To access the first exam grade of the first student in the list,

```
student1_grades = class_grades[0]  → [85, 91, 89]
student1_exam1 = student1_grades[0] → 85
```

OR

```
class_grades[0][0] →   85
```

To calculate the average on the first exam for group of students, a while loop can be constructed that iterates over the first grade of each student's list of grades,

```
sum = 0
k = 0

while k < len(class_grades):
    sum = sum + class_grades[k][0]
    k = k + 1

average_exam1 = sum / float(len(grades))
```

To produce a new list names `exam_avgs` containing the exam average for each student in the class,

```
exam_avgs = []
k = 0

while k < len(class_grades):
      avg = (class_grades[k][0] + \
             class_grades[k][1] + \
             class_grades[k][2]) / 3.0

       exam_avgs.append(avg)
        k = k + 1
```

Let's Try It

From the Python Shell, enter the following and observe the results.

```
>>> lst = [[1, 2 ,3], [4, 5, 6], [7, 8, 9]]
>>> lst[0]
???
>>> lst[0][1]
???
```

```
>>> for k in lst:
        print(k)
???
>>> for k in lst[0]:
        print(k)
```

Storage of Objects

```
x  = 'myname'
y  = 'myname'
```

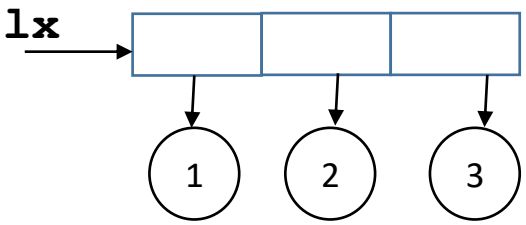
How many copies of the string are in memory?

`x == y` (The values of the variables is same)

`x is y?` (it is the same object in memory)

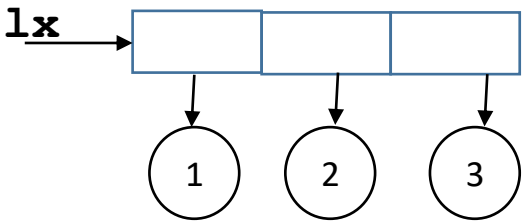
Storage of List Objects

```
lx  = [1, 2, 3]
ly  = [1, 2, 3]
```



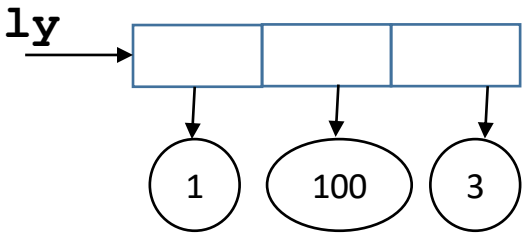
Storage of List Objects

```
lx  = [1, 2, 3]
ly = lx          (Aliasing)
lz = lx[:]       (Cloning)
```

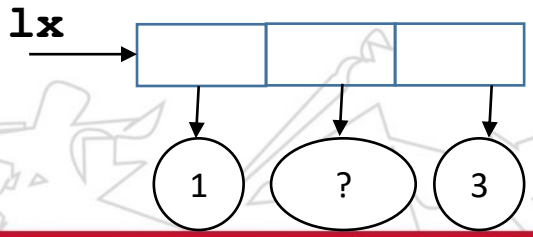


Passing Lists as Parameters

```
def listfun (lpar):
      lpar[1]=100
      return lpar
lx  = [1, 2, 3]
ly = listfun(lx)
print (ly)
```



print (lx)



Pure Functions

Function Side Effects: Changes to variable values in the calling program as a result of function call

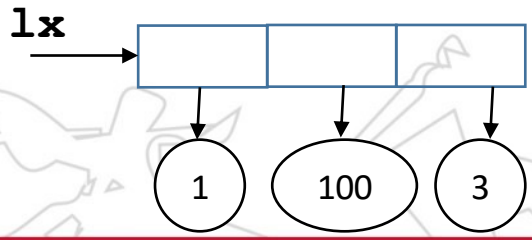
A pure function has no side effects!

(Functions should preferably not have side effects but there are exceptions)

Pure Function?

```
def listfun (lpar):
      lpar[1]=100
      return lpar

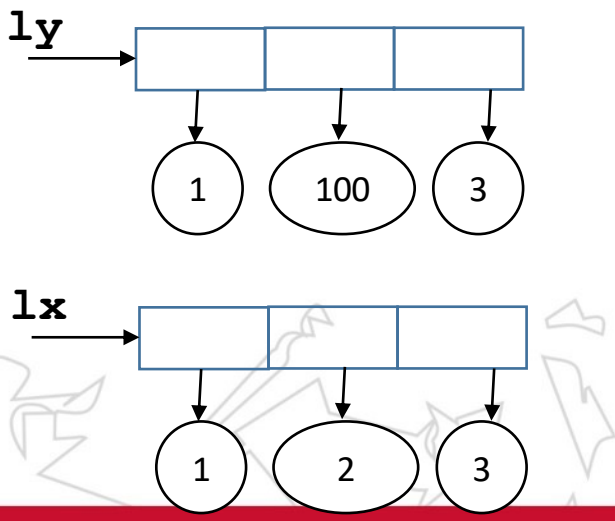

lx  = [1, 2, 3]
ly = listfun(lx)
print (ly)
print (lx)
```



Pure Function?

```
def listfun (lpar):
      loclist = lpar[:]
      loclist[1]=100
      return loclist

lx  = [1, 2, 3]
ly = listfun(lx)
print (ly)
print (lx)
```



Self-Test Questions

1. For `nums = [10,30,20,40]`, what does the following for loop output?

```
for k in nums:
    print(k)
```

(a) 10 20 30 40 (b) 10 30 20 40 (c) 10 30 20

2. For `nums = [10, 30, 20, 40]`, what does the following for loop output?

```
for k in range(1, 4):
    print ( nums[k] )
```

(a) 10 30 20 (b) 30 20 40 (c) 10 30 20 40

3. For `fruit = 'strawberry'`, what does the following for loop output?

```
for k in range(0, len(fruit), 2):
    print ( fruit[k] )
```

(a) `srwer` (b) `tabry`

4. For `nums = [12, 4, 11, 23, 18, 41, 27]`, what is the value of `k` when the while loop terminates?

```
k = 0
while k < len(nums) and nums[k] != 18:
    k = k + 1
```

(a) 3 (b) 4 (c) 5

ANSWERS:

Self-Test Questions

1. For `nums = [10,30,20,40]`, what does the following for loop output?

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for k in nums:
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(a) 3 (b) 4 (c) 5

ANSWERS: 1. (b).

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(a) 3 (b) 4 (c) 5

ANSWERS: 1. (b) 2. (b),

Self-Test Questions

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(a) `srwer` (b) `tabry`

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(a) 3 (b) 4 (c) 5

ANSWERS: 1. (b), 2. (b), 3. (a),

Self-Test Questions

1. For `nums = [10,30,20,40]`, what does the following for loop output?

```
for k in nums:
    print(k)
```

(a)
```
10
20
30
40
```

(b)
```
10
30
20
40
```

(c)
```
10
30
20
```

2. For `nums = [10, 30, 20, 40]`, what does the following for loop output?

```
for k in range(1, 4):
    print ( nums[k] )
```

(a)
```
10
30
20
```

(b)
```
30
20
40
```

(c)
```
10
30
20
40
```

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while k < len(nums) and nums[k] != 18:
    k = k + 1
```

(a) 3 (b) 4 (c) 5

ANSWERS: 1. (b), 2. (b), 3. (a), 4. (b)

List Comprehension

- The range function allows for the generation of sequences of integers in fixed increments.

- **List comprehensions** in Python can be used to generate more varied sequences.

List Comprehension

Example List Comprehensions	Resulting List
(a) `[x**2 for x in [1, 2, 3]]`	`[1, 4, 9]`
(b) `[x**2 for x in range(5)]`	`[0, 1, 4, 9, 16]`
(c) `nums = [-1, 1, -2, 2, -3, 3, -4, 4]` `[x for x in nums if x >= 0]`	`[1, 2, 3, 4]`
(d) `[ord(ch) for ch in 'Hello']`	`[72, 101, 108, 108, 111]`

(e) `vowels = ('a', 'e', 'i', 'o', 'u')`
`w = 'Hello'`
`[ch for ch in w if ch in vowels]`
	`['e', 'o']`

Let's Try It

From the Python Shell, enter the following and observe the results.

```
>>> temperatures = [88, 94, 97, 89, 101, 98, 102, 95, 100]
>>> [t for t in temperatures if t >= 100]
???

>>> [(t - 32) * 5/9.0 for t in temps]
???
```

Classwork

- Write a program to take a number K as input, reads K names (one at a time), store them in a list, and then print them in reverse (prefer not to use the reverse method)