Lists as a mutable type

MARCH 2, 2015

The *append* and *extend* methods on lists

- Suppose we want to add an element 10 to the back of a list L. Using what we have learned, we would use the code

```
L = L + [10]
```

to do this.

- There is a more *convenient* and *efficient* way of accomplishing this:

```
L.append(10)
```

- **Example:**

```
>>> L = [1, 25, "hello", -67]
>>> L.append(25)
>>> L [1, 25, 'hello', -67, 25]
>>> L.extend([-1, -2])
>>> L [1, 25, 'hello', -67, 25, -1, -2]
```

Differences between "+" and append, extend

- Say L = [1, 2, 3].
- L.append(17) and L.extend([12, 15]) are examples of *in-place* list operations.
- These operations modify the list L onto which they are applied. They do not create a new list.
- In this sense, L.append(17) and L + [17] are very different from each other.
- L + [17] does not modify L and it evaluates to [1, 2, 3, 17].
- *Strings do not support any in-place operations*. You cannot modify a string – you have to create a new string.

Try append on a string

- Suppose s = "hello"

The s.append("hi") produces an error message.

For s to take on value "hellohi" we have to use

```
s = s + "hi"
```

Lists support other in-place operations

- In addition to append and extend:
  - L[3] = 22

  This assigns 22 to the slot in L indexed by 3. The previous value of L[3] is replaced by 22. L does not change in size.

  - L.insert(3, 22)

  This inserts 22 into slot in L indexed by 3, moving. Elements previously indexed 3, 4, 5, etc. are all moved to the right and have higher indices now.

  Example:

```
L = [0, 1, 2, 3, 4, 5, 6]
L.insert(3, 22)
L
[0, 1, 2, 22, 3, 4, 5, 6]
```

Lists supports other in-place operations

Try these operations:

- L.remove(22)
  - Removes first occurrence of 22 from L. Elements that come after 22 are moved to the left. Length of L decreases by 1.
  - Causes an error if 22 is not in list; so the programmer has to be sure of this before using remove.
- L.sort()
- L.reverse()

Look at Python documentation: Section 5.6.4 on Mutable Sequence Types.

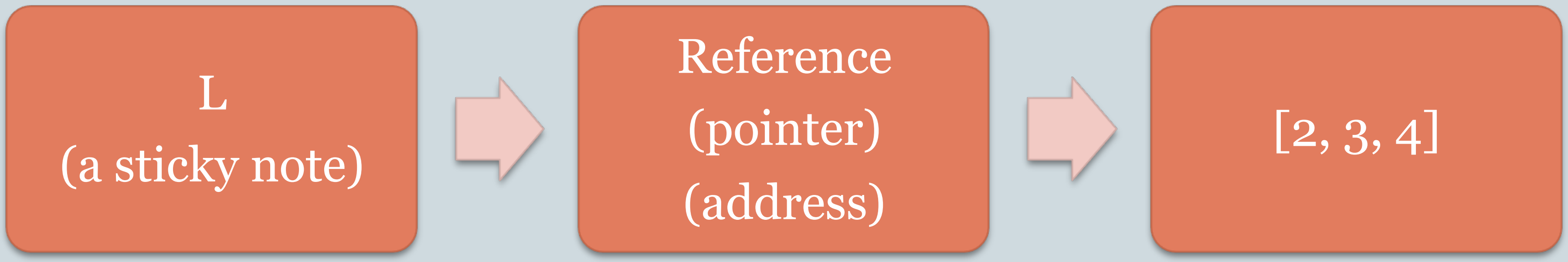
Mutable types

- Lists can support in-place operations and types of this sort in Python are called *mutable types*.
- None of the types we have encountered so far: `int`, `float`, `bool`, `string` are mutable.
- There are fundamental differences in behind-the-scenes implementation between Lists and these other types.
- These differences are important to learn about because they manifest themselves in many different settings.

Behind the Scenes

- The difference between objects of type list and objects of other types is due to an important difference in implementation.
- Consider the assignment: `L = [3, 4, 5]`
- We might think that after this assignment, `L` is a "sticky note" onto the list `[3, 4, 5]`.
- But no! L is a "sticky note" onto something that in turn points to [3, 4, 5].
- In programming language terminology, we say L is a "sticky note" to a *reference* to [3, 4, 5].

Picture



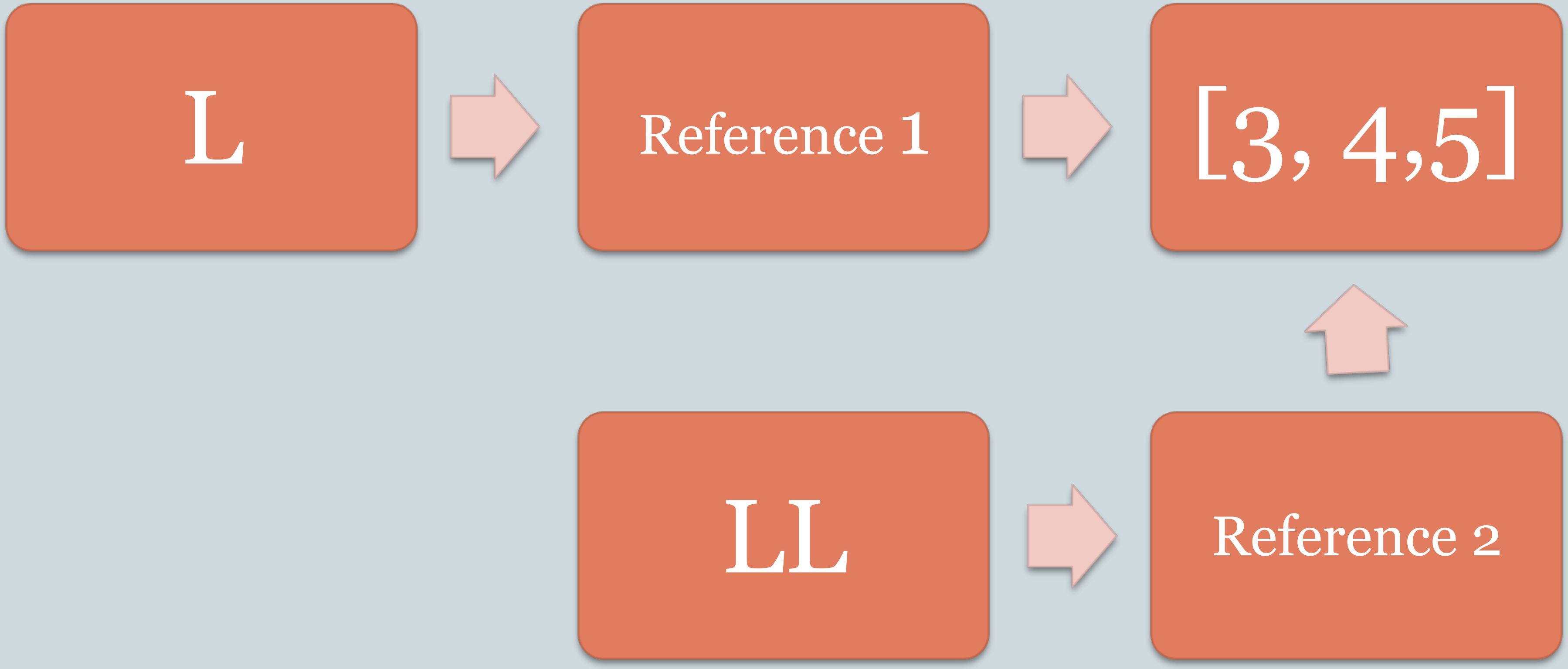
Example

- Consider the example:

```
L= [3,4,5]
LL = L
L.append(6)
LL
[3, 4, 5, 6]
```

- Notice how when we modified L, the list LL also changed. This is not true for any of the data types we have seen so far.
- After the assignment LL = L, LL is a “sticky note” to a reference that also points to the same exact list as L.

Picture



Another Example

```
L = [3, 4, 5]
LCopy = L
M = [3, 4, 5]

L == LCopy, LCopy == M, M == L
(True, True, True)

L[0] = 9
L == LCopy, LCopy == M, M == L
(True, False, False)
```

Implications: Mutations in Functions

```
def test(L):
    x = L[0] + L[1] + L[2]
    L.append(10)
    return x
```

Now consider what happens when this function is called:

```
M = [1, 2, 3, 4]
test(M)
6
M
[1, 2, 3, 4, 10]
```

This is a side-effect of the in-place operation `L.append(10)` performed inside the function.