Lists as a Mutable Data Type

MARCH 6TH 2013

The swap function

- Consider the following "integer swap" function:

```
def swapInts(a, b):
    temp = a
    a = b
    b = temp
```

- Let us call this function as follows:

```
x = 5
y = 10
swapInts(x, y)
```

- What are values of variables `x` and `y` now?

This is not unexpected!

- The fact that `x` and `y` remain unchanged is not unexpected.
- Recall that when the function `swapInts` is called, the parameter `a` is a local variable that takes of the value of `x` (which is 5).
- Similarly, the parameter `b` is a local variable that takes on the value of `y` (which is 10).
- The variables `a` and `b` are swapped in `swapInts`.
- However, nothing happens to `x` and `y` since these and and the variables a and b are distinct.

Let us now try swapping string elements

- Consider the code for **swap** that was part of **selectionSort**:

```
def swap(L, i, j):
    temp = L[i]
    L[i] = L[j]
    L[j] = temp
```

- What happens when we call it as follows?

```
s = "hello"
swap(s, 1, 2)
```

This is a key difference between strings and lists

- Both lists and strings allow the *access* of elements via an index. In other words, we can look at L[i] or s[i].
- However, we can *assign* to list elements via an index, but not to string elements.
- **Example:**

```
s = "hello"
s[2] = "p"
```

produces an error saying `str` object cannot support assignment.

In-place operations

- Say L = [1, 2, 3].
- L[2] = 10 and L.append(17) 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.

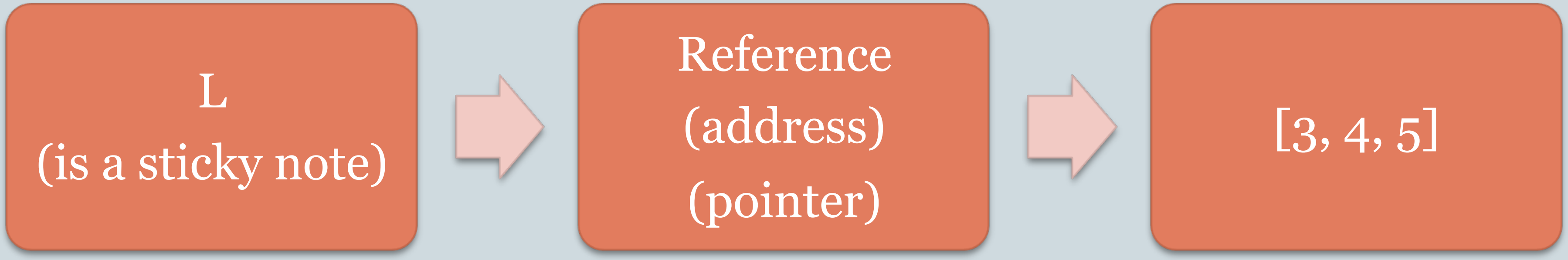
Lists support many other in-place operations

- Try these operations!
  - `L.append(10)`
  - `L.extend([1, 2, 3])`
  - `L.insert(2, “hello”)`
  - `L.remove(“hello”)`
  - `L.sort()`
  - `L.reverse()`
- None of these work on strings.
- Look at Section 5.6.4 on “Mutable Sequence Types” in Python v.2.7.3 documentation.

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` points to the list `[3, 4, 5]`. But no! `L` points to something that in turn points to `[3, 4, 5]`.
- In programming language terminology, we say `L` points to a *reference* to `[3, 4, 5]`.

Picture



Indirection

Implications: list assignment

- Consider the example:

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

- Notice how when 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 points to a reference that points to the same list as L.

Another Example using List Assignment

```
>>> 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):
  L[0] = 7
   return sum(L)

# main program
J = [3, 4, 5]
print test(J)
print J
```

- When you run this and print `J`, you will see that `J` has become `[7, 4, 5]`.
- When `J` is sent in as argument to test, `L` is given a copy of `J`.
- But, since `J` is pointing to a reference to a list, *`L` ends up pointing to a copy of the reference, but to the same physical list*.
- This provides another way of communicating between a main program and functions (and between functions).