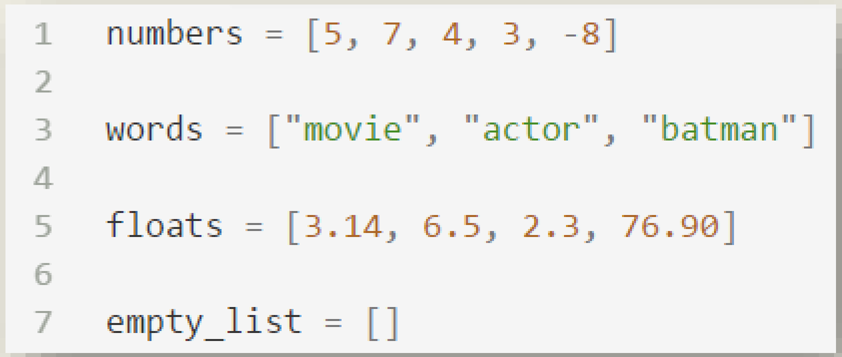
LISTS

LISTS

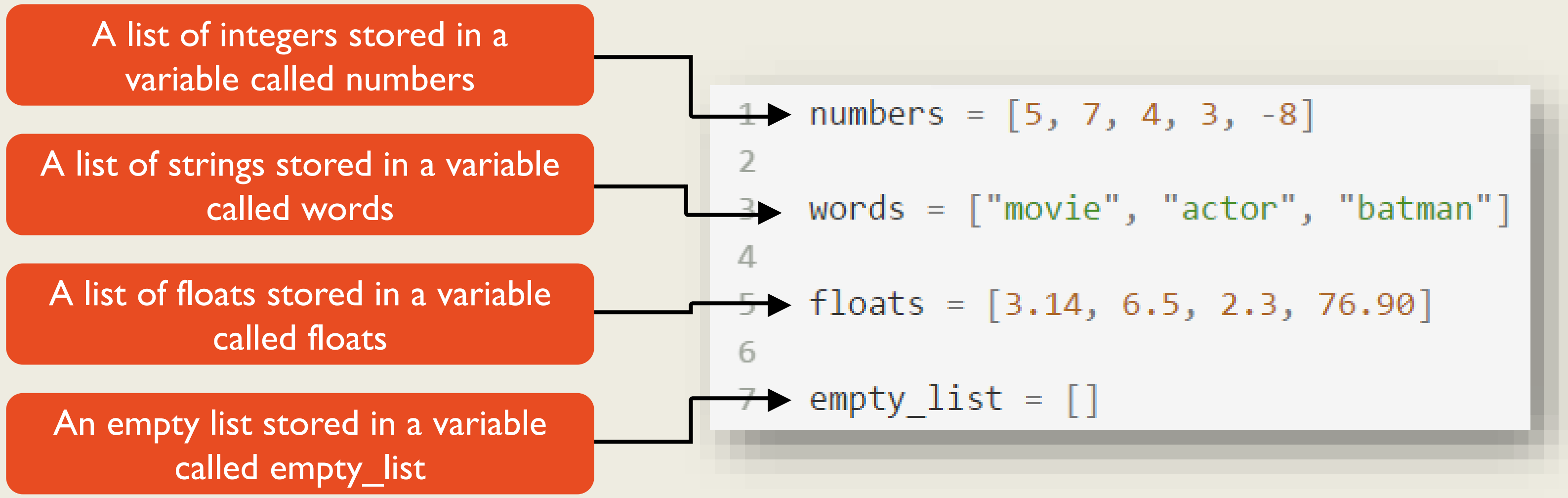
- a list is an ordering of items
  - It can be a sequence of strings, numbers and so on…
- Actually you have seen a sequence before in a string. You can think of a string as a particular kind of list. Think about it for a moment…
- We can create a list with the square brackets [ ]



```python
numbers = [5, 7, 4, 3, -8]

words = ["movie", "actor", "batman"]

floats = [3.14, 6.5, 2.3, 76.90]

empty_list = []
```

LISTS

- When naming variables that store a list it is a good choice to use plural names. That way it is clear that the variable stores more than one value.
- Values of a list are seperated by a comma
- An empty list is simply an opening square bracket and a closing square bracket with nothing between them



A list of integers stored in a variable called numbers

A list of strings stored in a variable called words

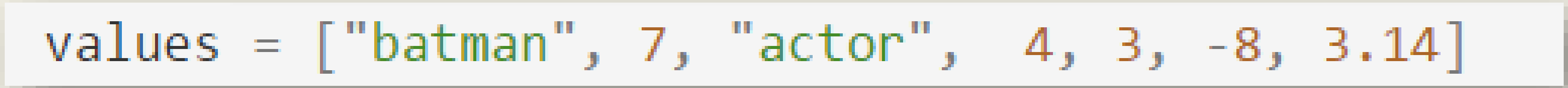
A list of floats stored in a variable called floats

An empty list stored in a variable called empty_list

```
numbers = [5, 7, 4, 3, -8]

words = ["movie", "actor", "batman"]

floats = [3.14, 6.5, 2.3, 76.90]

empty_list = []
```

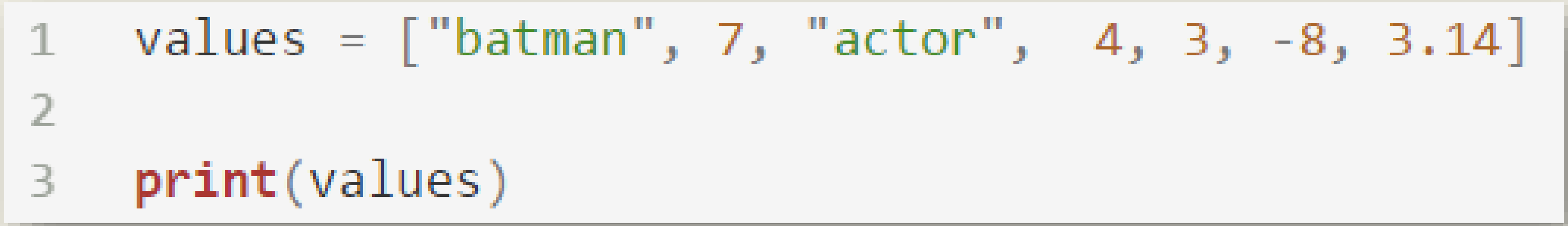
LISTS

- Lists in Python can store different types within the same list
  - This list contains strings, integers and a float



```python
values = ["batman", 7, "actor",  4, 3, -8, 3.14]
```

- Printing lists is pretty easy



```python
values = ["batman", 7, "actor",  4, 3, -8, 3.14]

print(values)
```

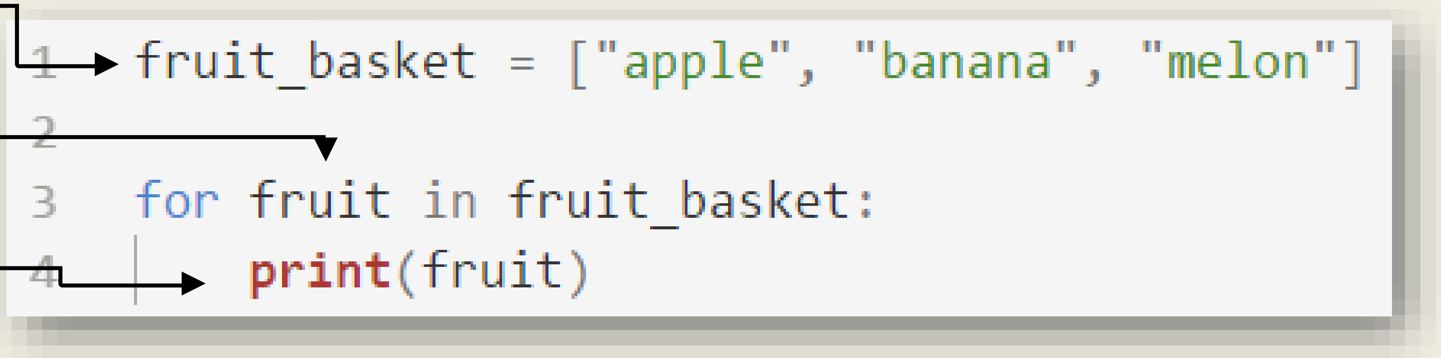
LISTS

- The for loop can be used with lists

fruit_basket is a list of strings

We decide to call the iteration variable **fruit**

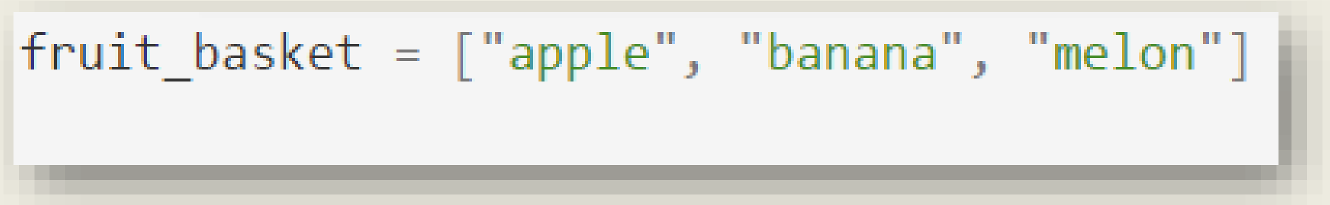
Then we print each value in the list one at a time



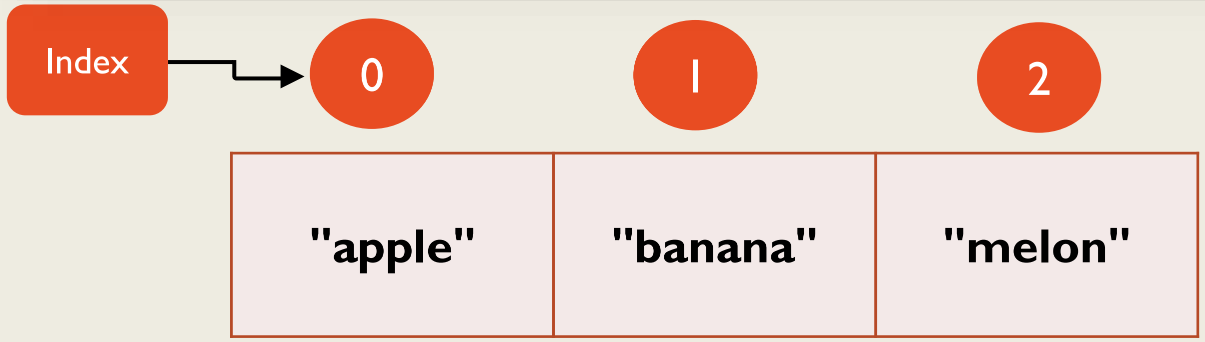
```python
fruit_basket = ["apple", "banana", "melon"]

for fruit in fruit_basket:
    print(fruit)
```

LISTS

- Elements of lists are indexed
  - This means that we can access indvidual elements of a list by using their index
  - But do note that the index is zero based, that means that the first element of a list has the index 0 , not 1



```python
fruit_basket = ["apple", "banana", "melon"]
```

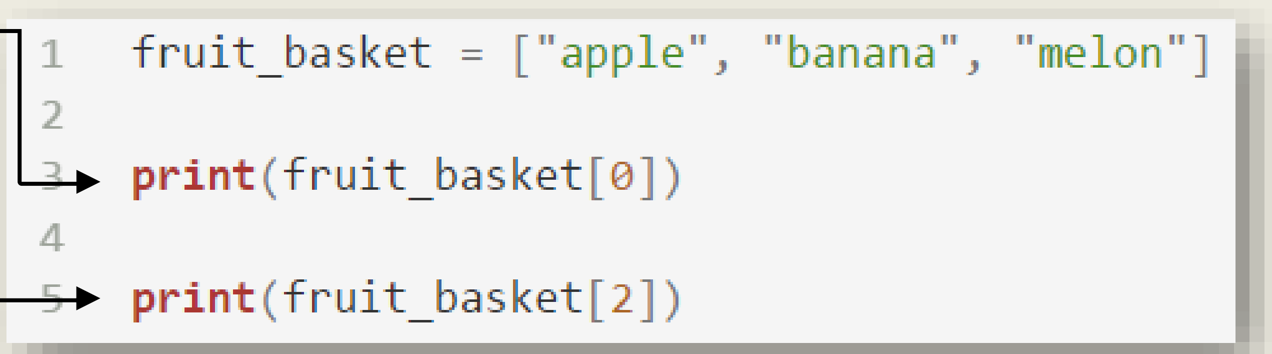


LISTS

- We can access individual elements of a list via the square brackets
  - We put the square brackets behind the name of the variable that stores the list and within the brackets we specify the index

This line will print "apple"

This line will print "melon"



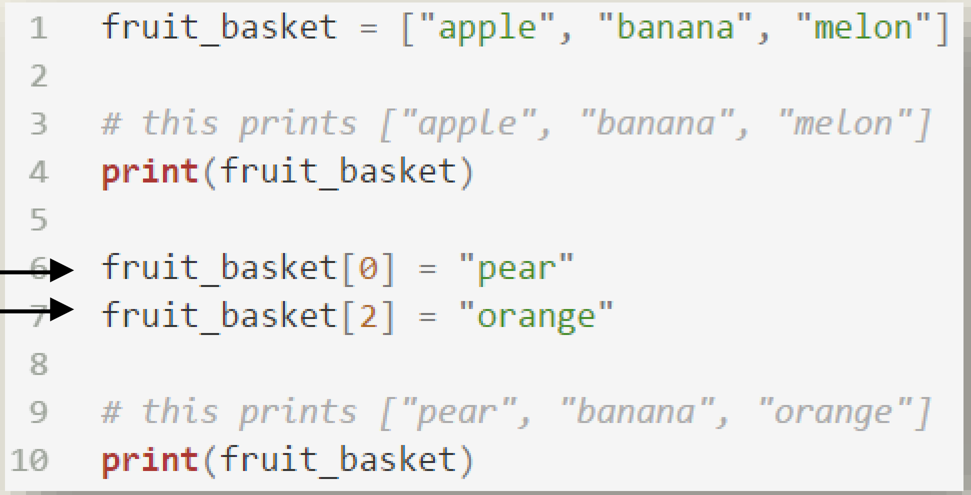
```python
fruit_basket = ["apple", "banana", "melon"]

print(fruit_basket[0])

print(fruit_basket[2])
```

LISTS

- Lists are mutable (changeable)
  - This means that you can change the content of a list

Here we are changing the content at index 0 to the string pear

Here we are changing the content at index 2 to the string orange



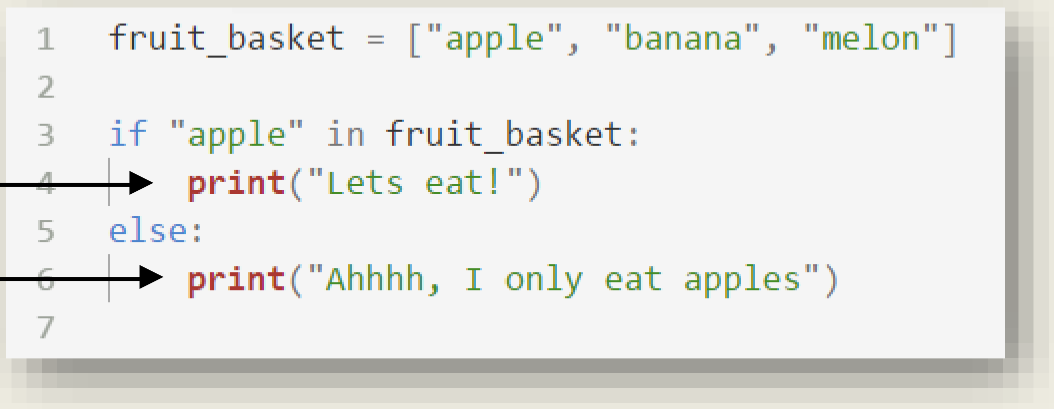
```python
fruit_basket = ["apple", "banana", "melon"]

# this prints ["apple", "banana", "melon"]
print(fruit_basket)

fruit_basket[0] = "pear"
fruit_basket[2] = "orange"

# this prints ["pear", "banana", "orange"]
print(fruit_basket)
```

LISTS

- We can use the **in** operator to check whether a given value is in a list
  - The **in** operator evaluates to **True** or **False**

If the string "apple" is in the list fruit_basket this text will be printed

If the string "apple" is not in the list fruit_basket this text will be printed



```python
fruit_basket = ["apple", "banana", "melon"]

if "apple" in fruit_basket:
    print("Lets eat!")
else:
    print("Ahhhh, I only eat apples")

```

LISTS

- Lists are objects and objects have methods(functions) associated with them
  - You will learn more about objects later
- What this means is that we have some predefined operations we can use on lists such as:
  - Adding to a list
  - Removing an element from a list
  - Sorting a list
  - Etc.

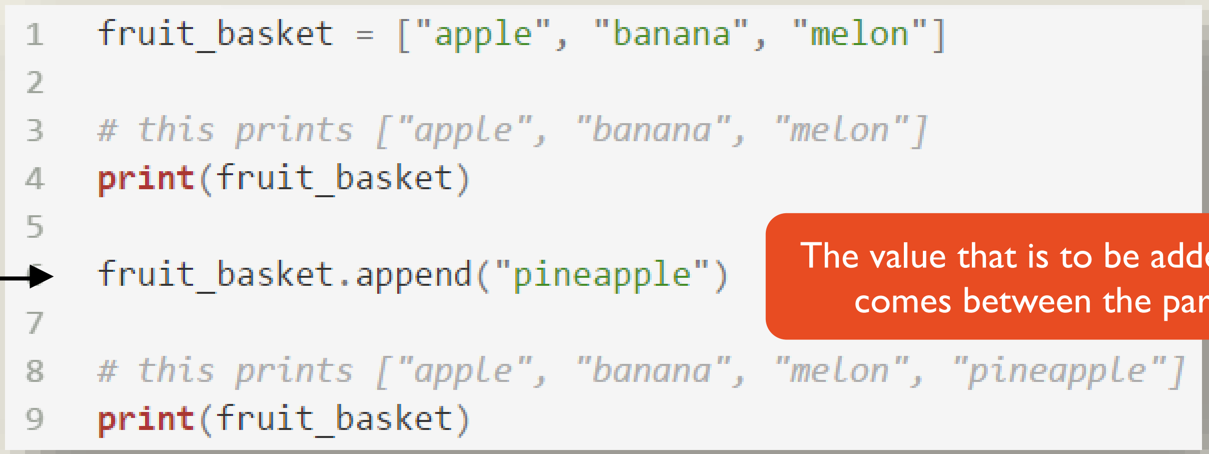
LISTS

- Remember, lists are mutable! That means we can change
- That also means that some of the methods associated with lists will note create a new list but simply change the list
  - These methods will have the return value of None
    - `.append()`
    - `.extend()`
    - `.pop()`
    - `.insert()`
    - `.remove()`
    - `.sort()`
    - `.reverse()`
- This can be confusing at first, especially because we have seen that many string methods return a new string!
- But remember, lists and string have many things in common but they are not the same thing!

LISTS

- We can use the append() method to add an element to the back of a list
- Methods are functions that "belong" to datastructures we are working with
  - The append method "belongs" to a list
  - We call methods with the dot(.) operator

Here we are adding the string "pineapple" to the list fruit_basket



```python
fruit_basket = ["apple", "banana", "melon"]

# this prints ["apple", "banana", "melon"]
print(fruit_basket)

fruit_basket.append("pineapple")

# this prints ["apple", "banana", "melon", "pineapple"]
print(fruit_basket)
```

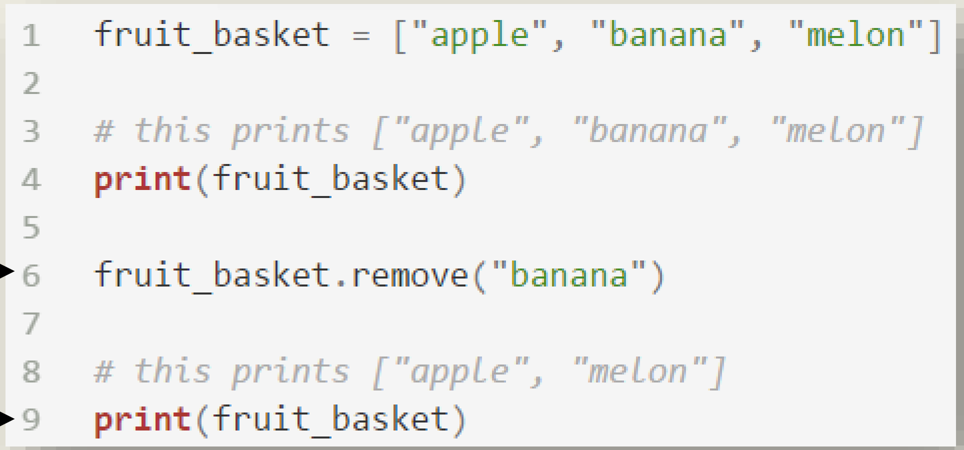
The value that is to be added to the list comes between the parentheses

LISTS

- The remove() method removes an element from a list
  - We need to put the value that is to be removed between the parentheses

Here we call the remove method and pass it the string "banana"

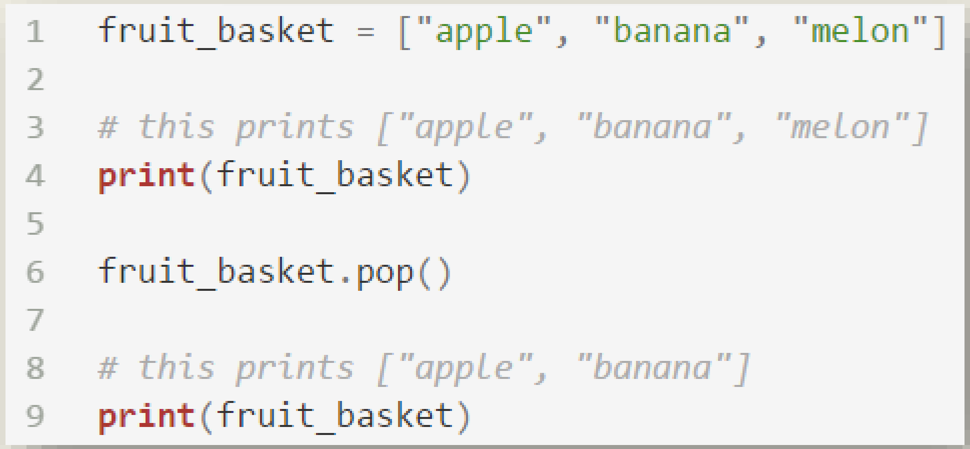
As can be seen here the string "banana" has been removed from the list



```python
fruit_basket = ["apple", "banana", "melon"]

# this prints ["apple", "banana", "melon"]
print(fruit_basket)

fruit_basket.remove("banana")

# this prints ["apple", "melon"]
print(fruit_basket)
```

LISTS

- The pop() method removes an elements from the back of a list
  - The pop() method doesn‘t take any parameters, that is you don‘t need to put anything between the parentheses

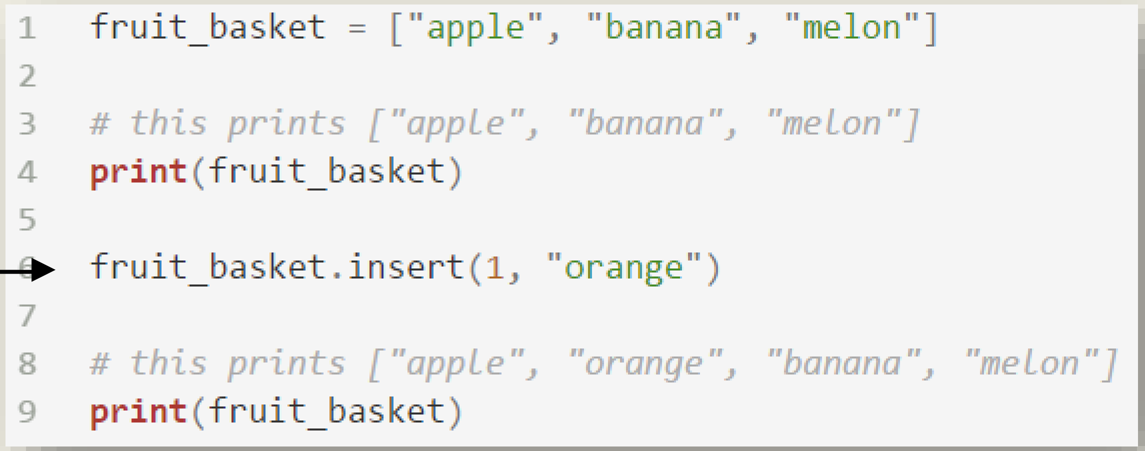


```python
fruit_basket = ["apple", "banana", "melon"]

# this prints ["apple", "banana", "melon"]
print(fruit_basket)

fruit_basket.pop()

# this prints ["apple", "banana"]
print(fruit_basket)
```

LISTS

- We can insert values at a given index in a list using the insert method
- The insert method takes two parameters
  - The first one represents the index in the list and the second one the value that should be added at that index

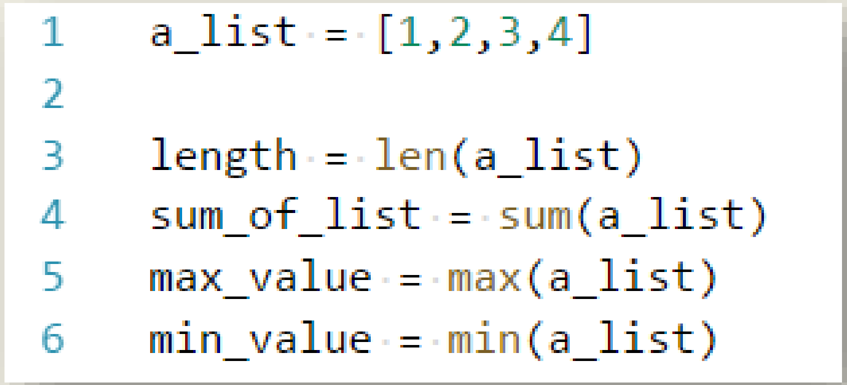
Here we add the string orange at index(position) 1



```python
fruit_basket = ["apple", "banana", "melon"]

# this prints ["apple", "banana", "melon"]
print(fruit_basket)

fruit_basket.insert(1, "orange")

# this prints ["apple", "orange", "banana", "melon"]
print(fruit_basket)
```

LISTS

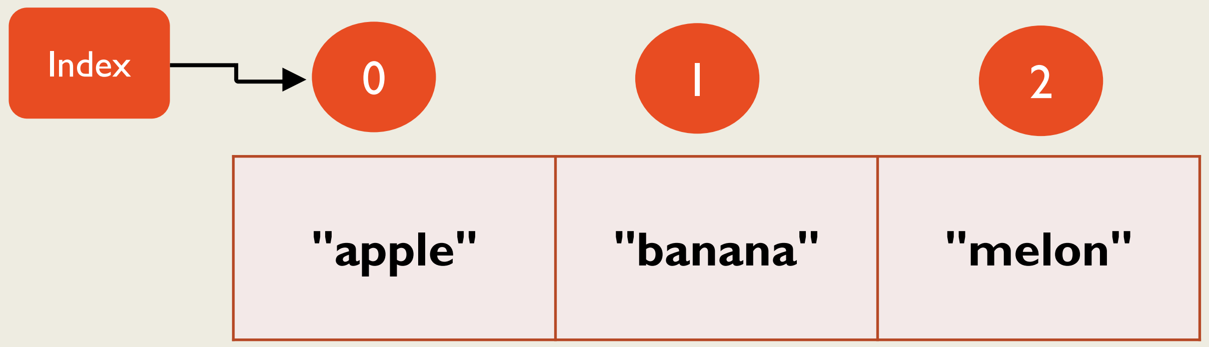
- Here are some functions commonly used with lists

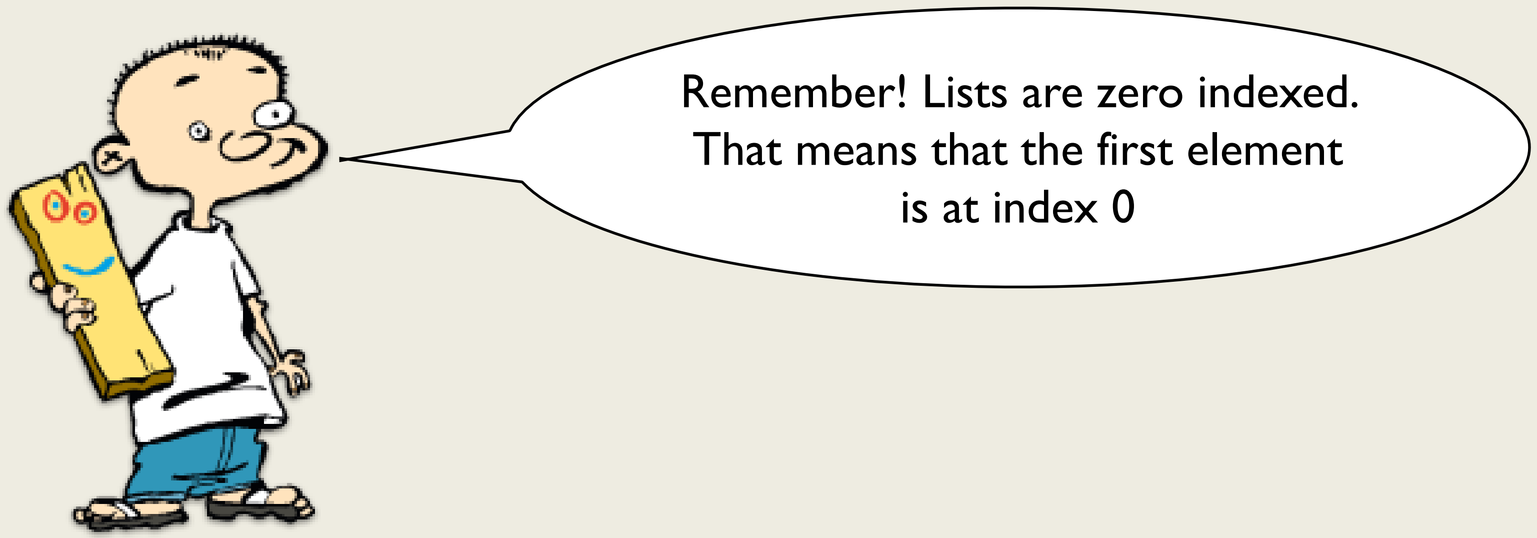


```python
a_list = [1,2,3,4]

length = len(a_list)
sum_of_list = sum(a_list)
max_value = max(a_list)
min_value = min(a_list)
```

- `max(some_list)`: returns the largest element, all elements of the list must be the same type
- `min(some_list)`: returns the smallest element, all elements of the list must be the same type
- `sum(lst)`: returns the sum of the elements, all elements must be of a numeric type

LISTS

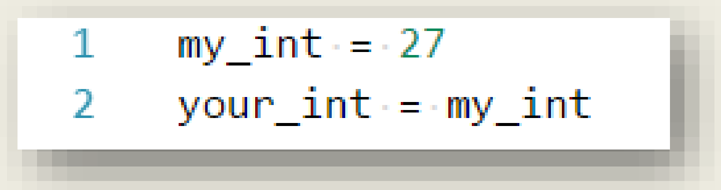

Index
0
1
2
"apple"
"banana"
"melon"


Remember! Lists are zero indexed. That means that the first element is at index 0

LISTS

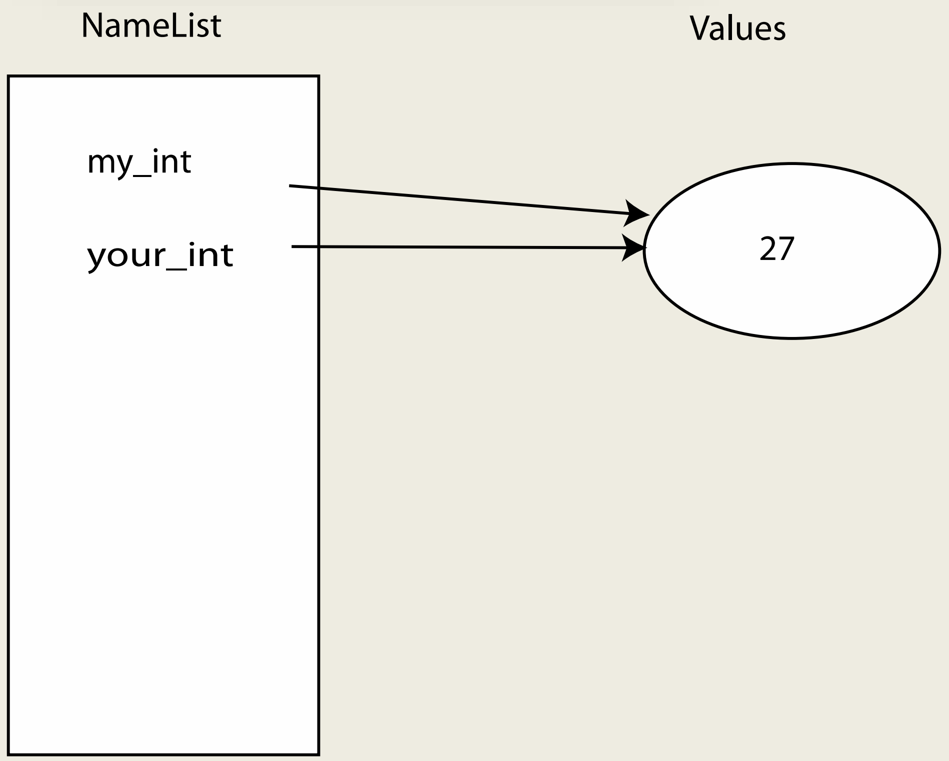
- Lists work a bit differently than the data types we have been working with so far
  - Especially regarding to the computers memory

LISTS

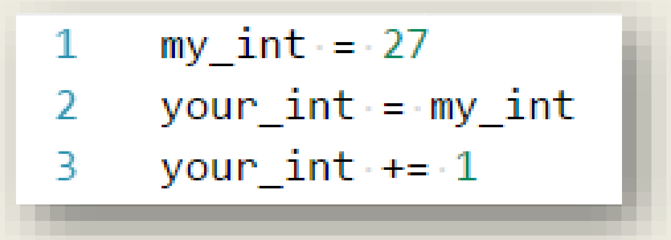


```
my_int = 27
your_int = my_int
```

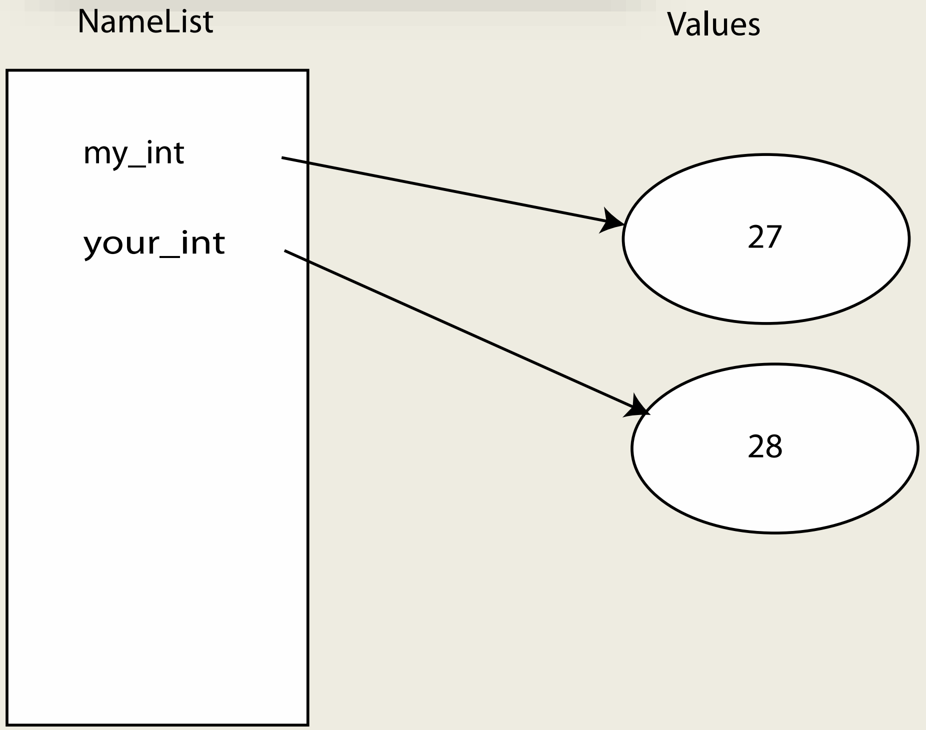
Two variables are created and they reference the same integer in memory



LISTS



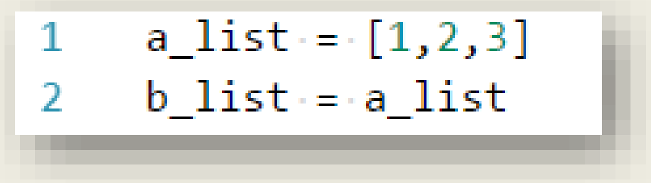
```
my_int = 27
your_int = my_int
your_int += 1
```



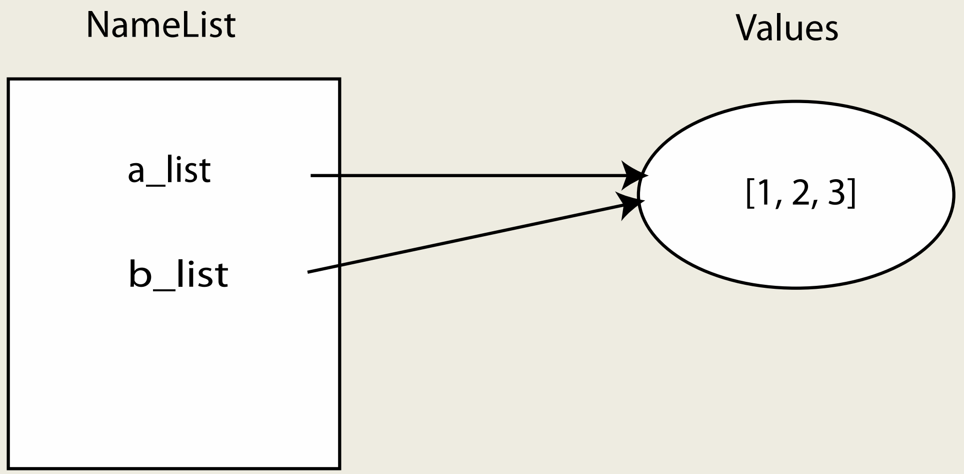
As soon as there is a change regarding the variable your_int a new value is created in memory and the variable your_int will reference the new value

LISTS

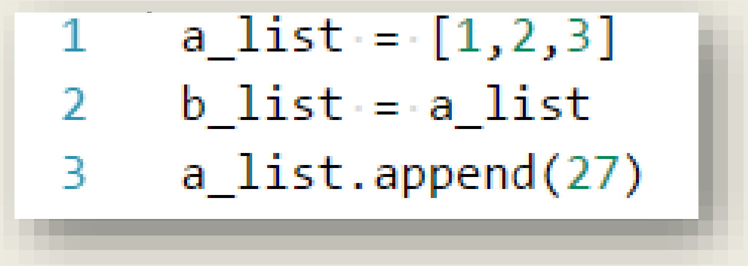
- If two variables associate with the same object, then ***both variables will reflect*** any change to that object
- We say that the two variables reference the object



```python
a_list = [1,2,3]
b_list = a_list
```

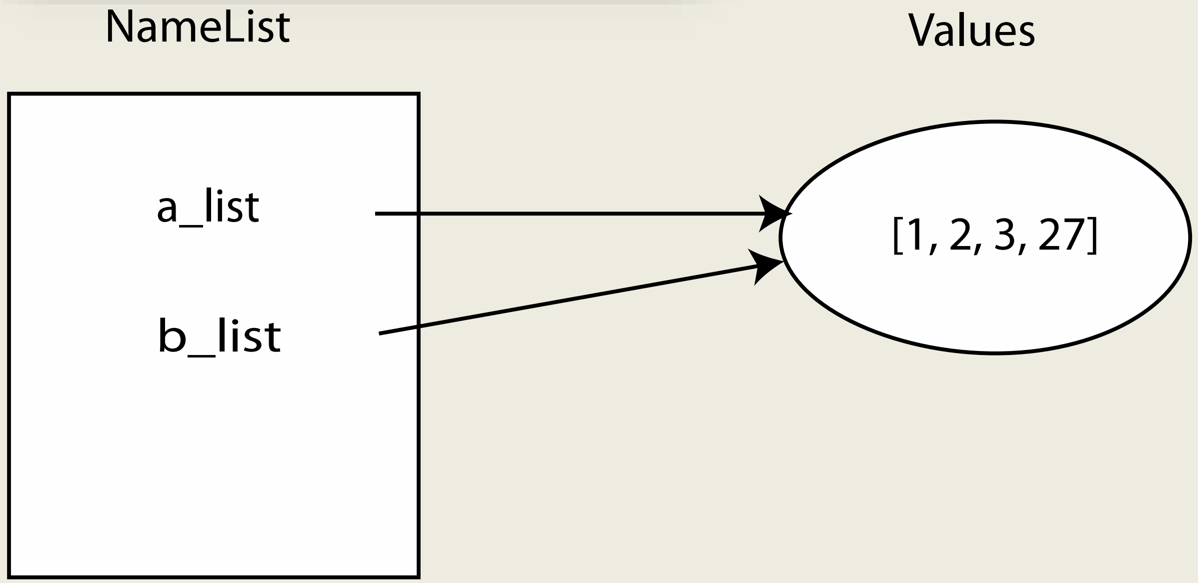


LISTS



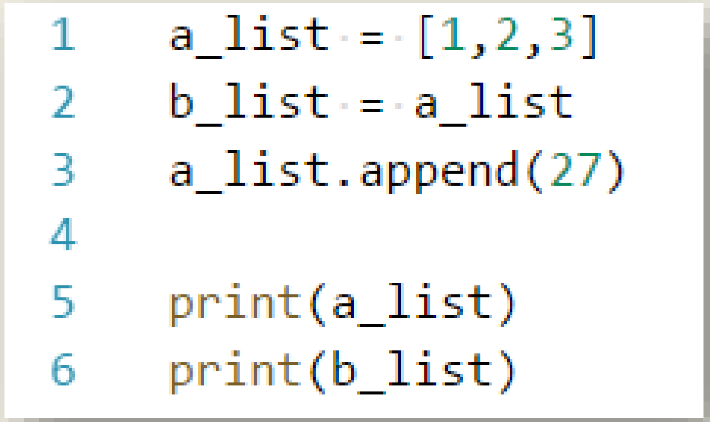
```
a_list = [1,2,3]
b_list = a_list
a_list.append(27)
```

Here we can see that as soon as a change occurs to **a_list** a new object is **not** created! The object simply changes. This is because lists are mutable!

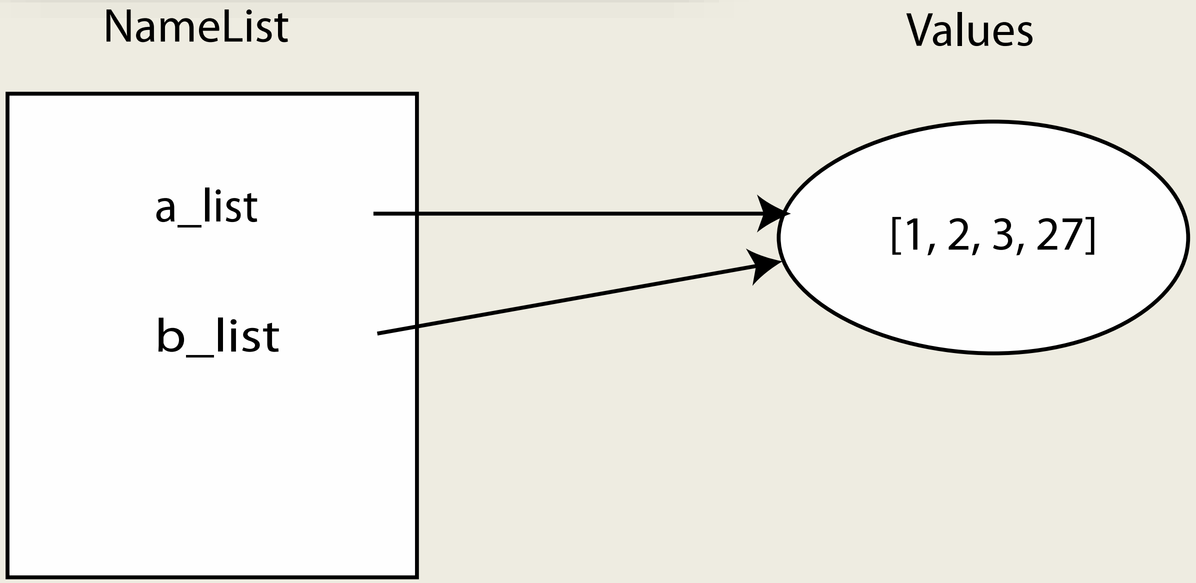


LISTS

When a_list and b_list are printed the values 1,2,3,27 will be printed two times because the two variables reference the same list!



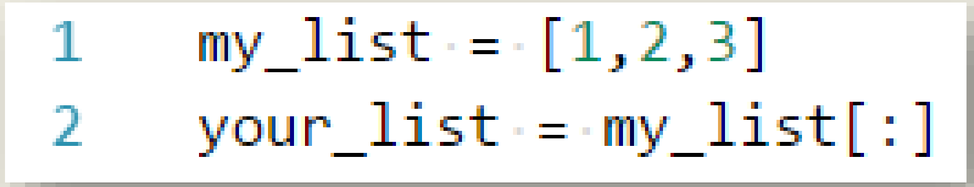
```
a_list = [1,2,3]
b_list = a_list
a_list.append(27)

print(a_list)
print(b_list)
```



LISTS

But what if we want to have two separate list instances in memory?

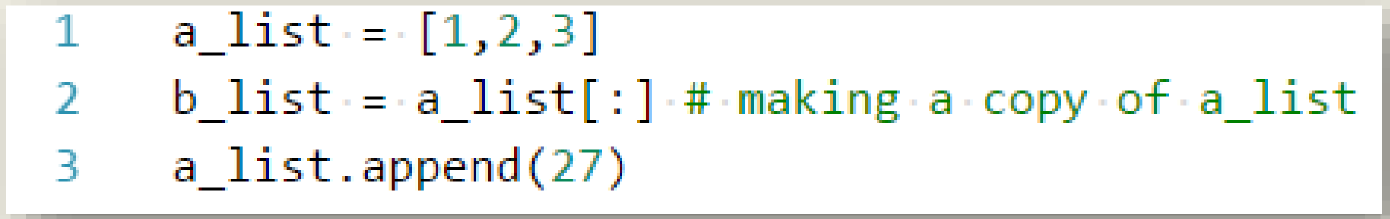
We can copy a list to create a brand new object in memory



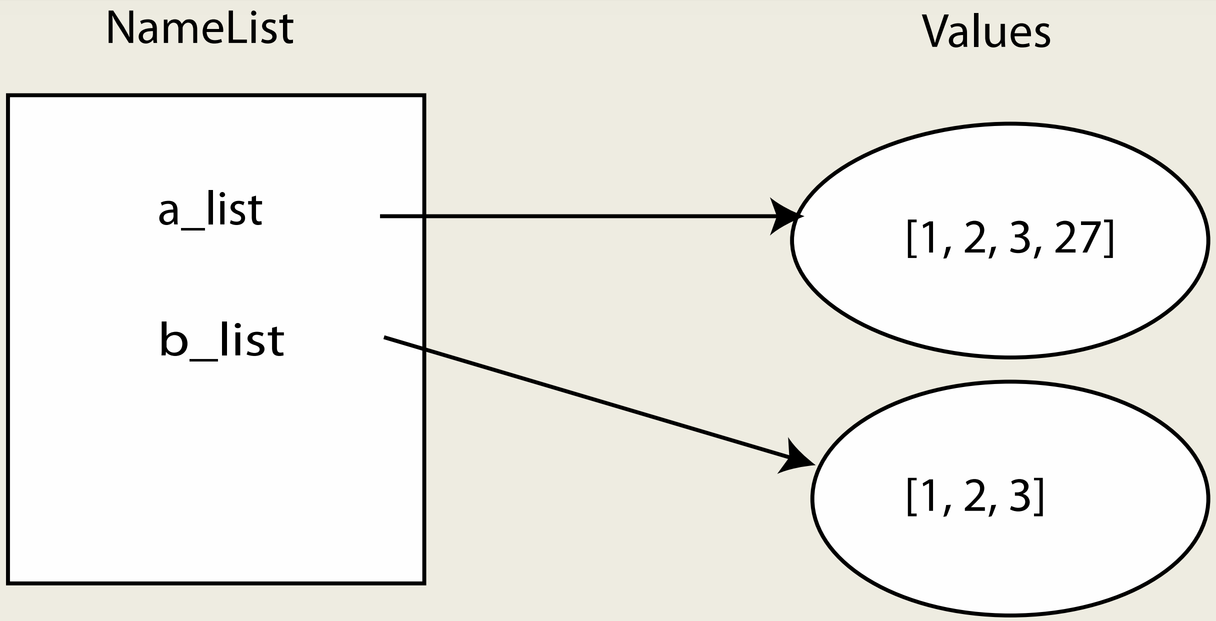
```python
my_list = [1,2,3]
your_list = my_list[:]
```

This will create a brand new list in memory. Notice that this is the same syntax as when copying a string!

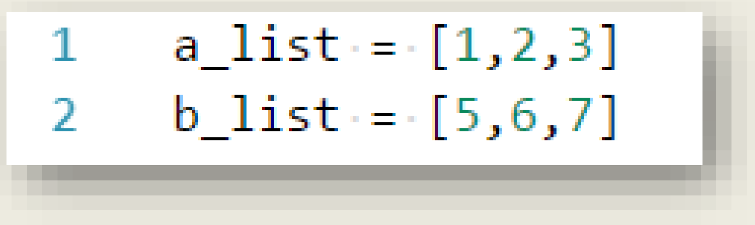
LISTS



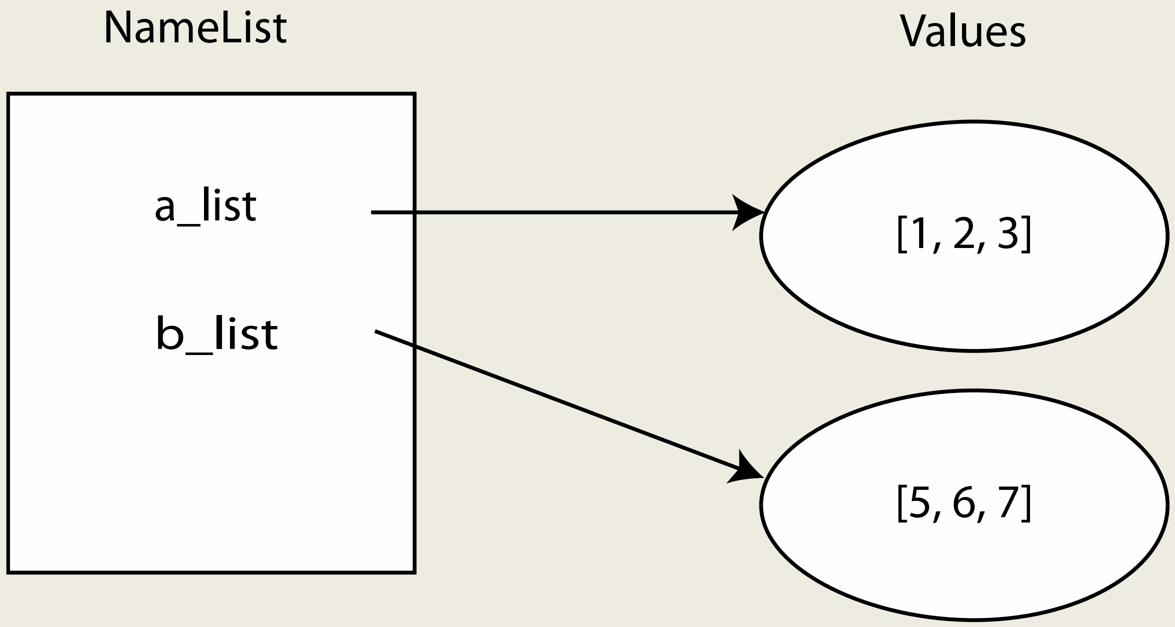
```
a_list = [1,2,3]
b_list = a_list[:] # making a copy of a_list
a_list.append(27)
```



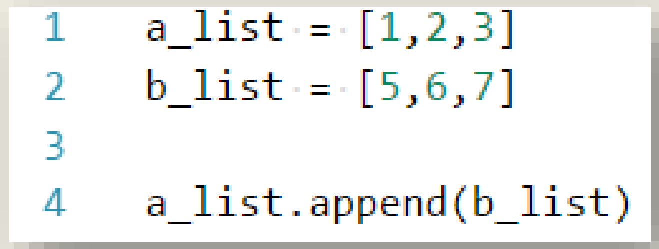
LISTS



```
a_list = [1,2,3]
b_list = [5,6,7]
```

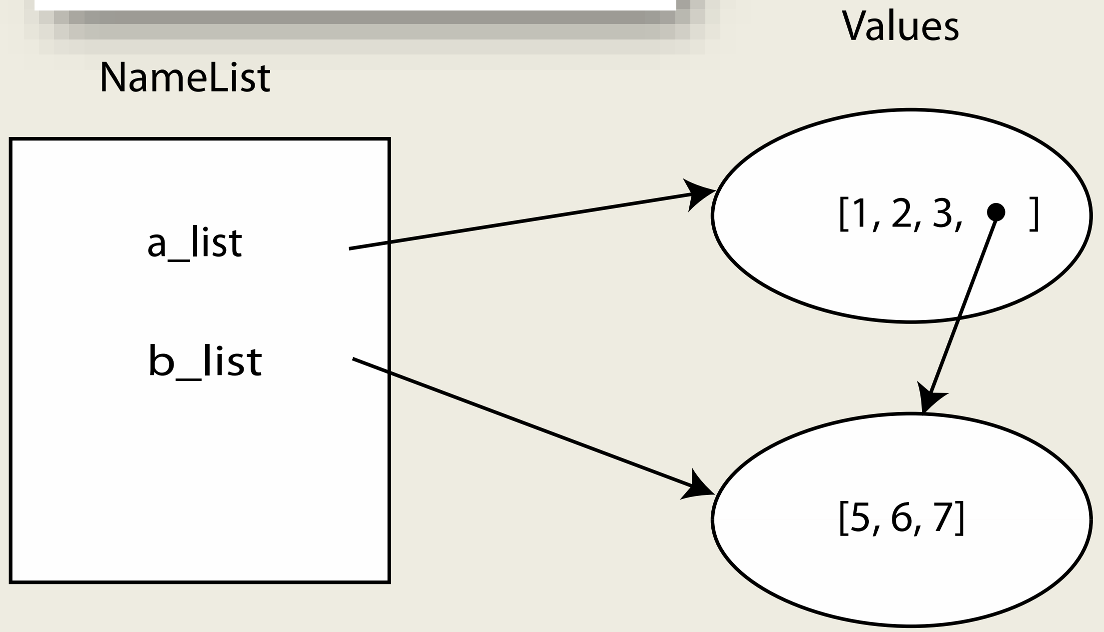


LISTS

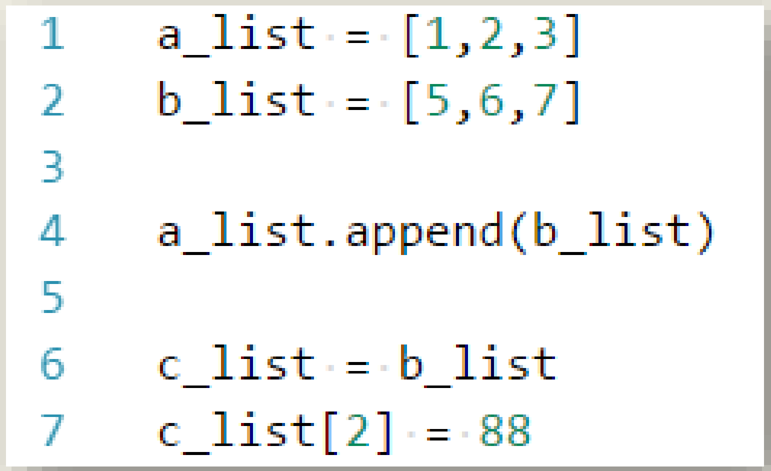


```
a_list = [1,2,3]
b_list = [5,6,7]

a_list.append(b_list)
```

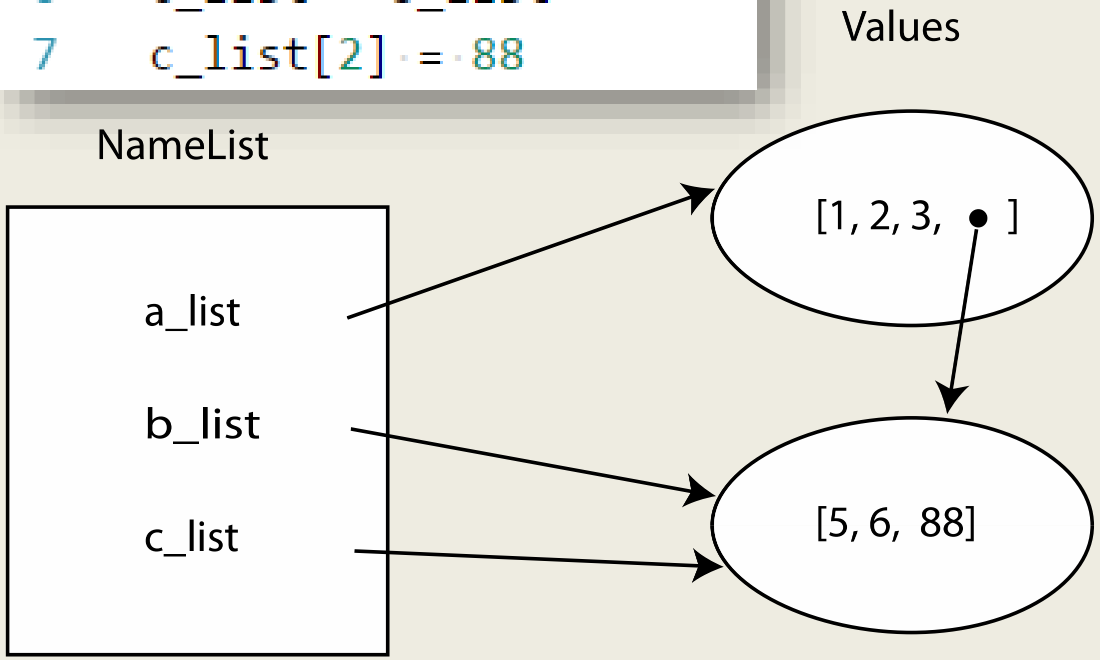
Notice that if we add a b_list reference to a_list the reference is only added to a_list but not the values of b_list!



LISTS

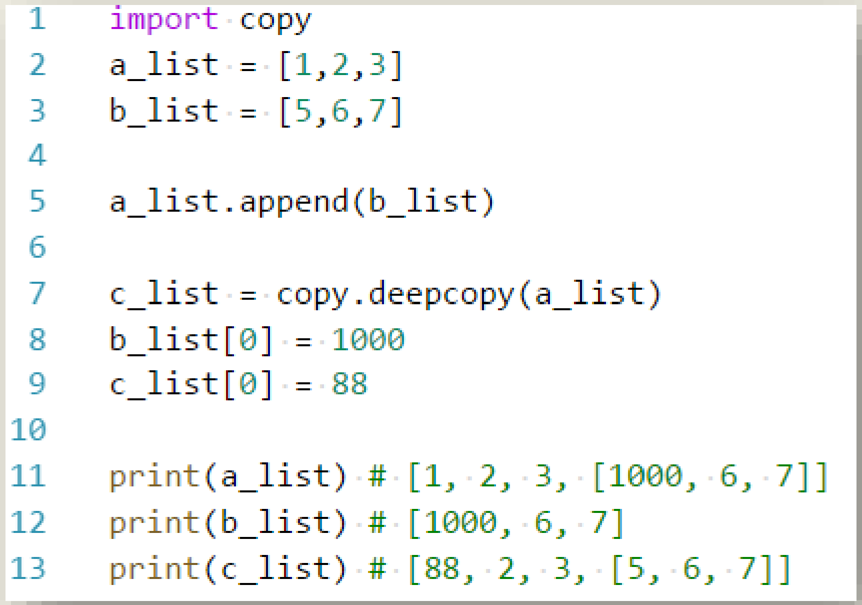


```python
a_list = [1,2,3]
b_list = [5,6,7]

a_list.append(b_list)

c_list = b_list
c_list[2] = 88
```



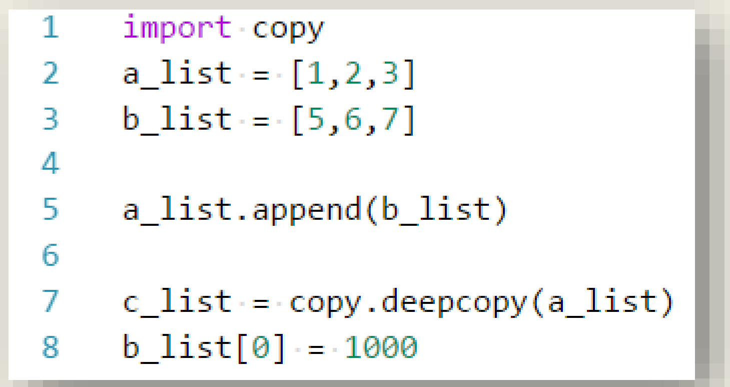
LISTS
SHALLOW COPY VS DEEP COPY

- Regular copy
  - the `[:]` approach, only copies the top level reference/association
- if you want a full copy, you can use deepcopy from the copy module

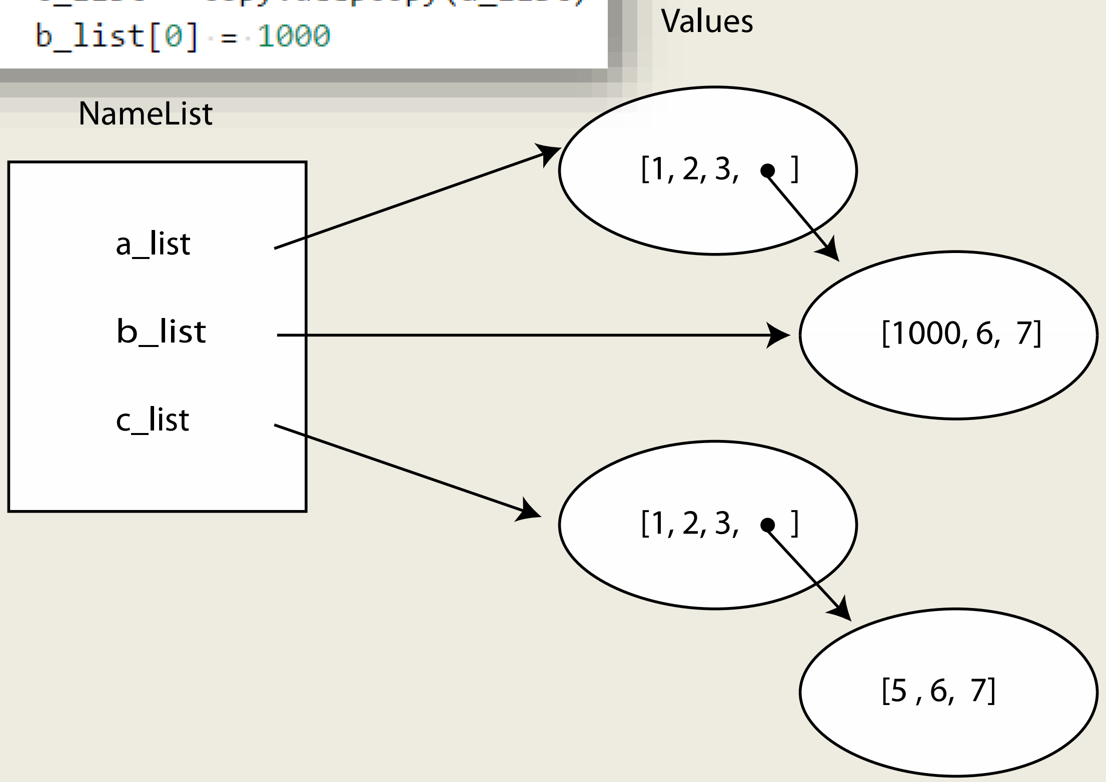


```python
import copy
a_list = [1,2,3]
b_list = [5,6,7]

a_list.append(b_list)

c_list = copy.deepcopy(a_list)
b_list[0] = 1000
c_list[0] = 88

print(a_list) # [1, 2, 3, [1000, 6, 7]]
print(b_list) # [1000, 6, 7]
print(c_list) # [88, 2, 3, [5, 6, 7]]
```

LISTS



```
import copy
a_list = [1,2,3]
b_list = [5,6,7]

a_list.append(b_list)

c_list = copy.deepcopy(a_list)
b_list[0] = 1000
```


Values
NameList
a_list
b_list
c_list
[1, 2, 3, ●]
[1000, 6, 7]
[1, 2, 3, ●]
[5 , 6, 7]