Comprehension in Action

Python

Getting the listing of a directory

- Task: Generate a listing of all files in a directory that end in “.py”
  - Tool: import the os module and use listdir

```
[filename for filename in os.listdir(directoryname)
     if filename.endswith(".py")]
```

Creating sub-directories

- Task: We want to create a sub-dictionary of a dictionary where the keys are restricted by a condition
    - Use dictionary comprehension

```
def evenkeys(dictionary):
    return { i:dictionary[i] for i in dictionary if i%2==0}
```

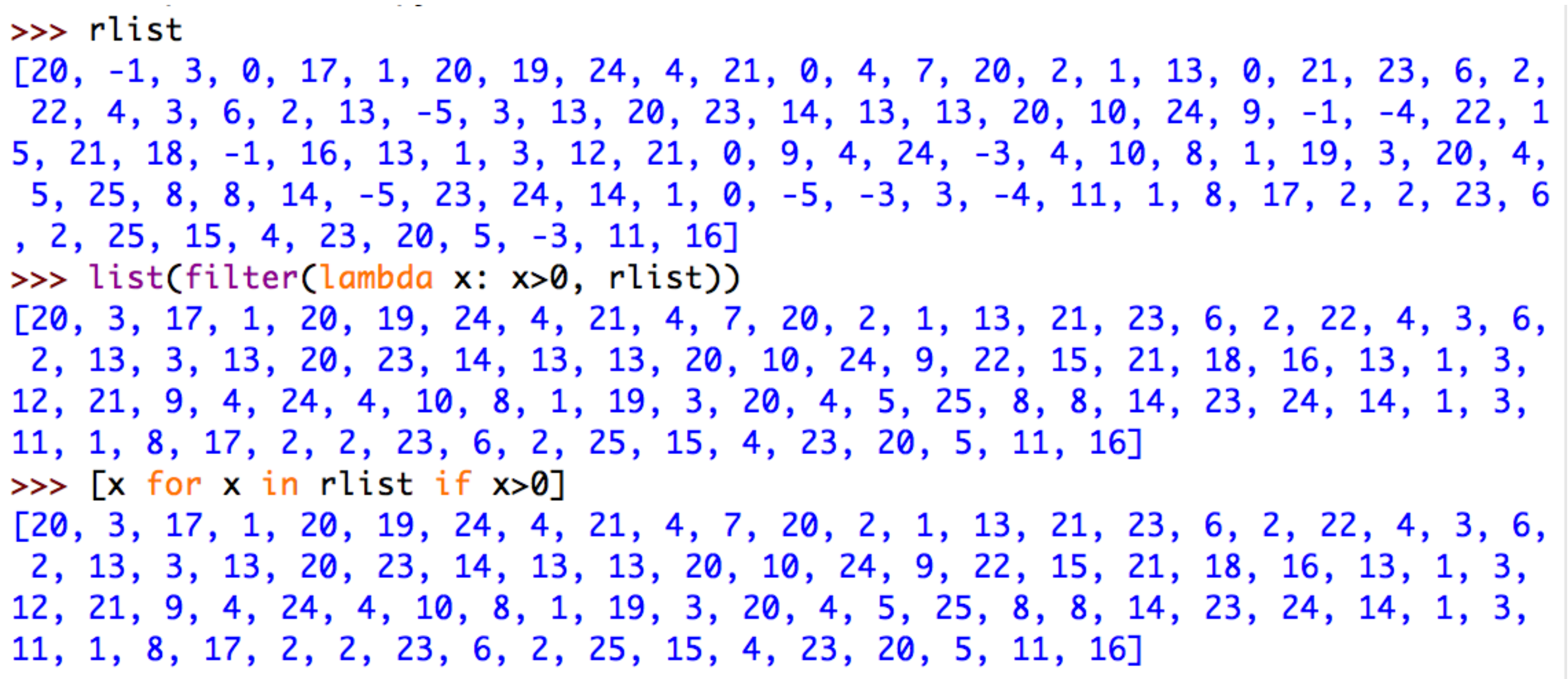
Filtering a list

- We want to filter a list using a criterion

1. We can use the filter function

2. We can use list comprehension, which is often simpler

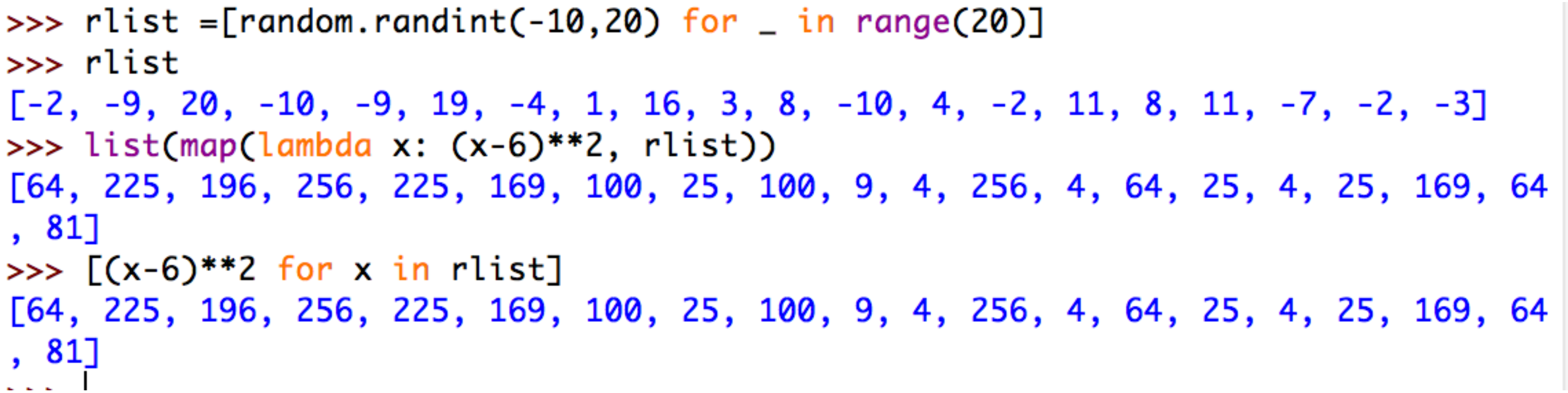
- Example: Only display the positive elements of this large list



```
>>> rlist
[20, -1, 3, 0, 17, 1, 20, 19, 24, 4, 21, 0, 4, 7, 20, 2, 1, 13, 0, 21, 23, 6, 2,
 22, 4, 3, 6, 2, 13, -5, 3, 13, 20, 23, 14, 13, 13, 20, 10, 24, 9, -1, -4, 22, 1
5, 21, 18, -1, 16, 13, 1, 3, 12, 21, 0, 9, 4, 24, -3, 4, 10, 8, 1, 19, 3, 20, 4,
 5, 25, 8, 8, 14, -5, 23, 24, 14, 1, 0, -5, -3, 3, -4, 11, 1, 8, 17, 2, 2, 23, 6
, 2, 25, 15, 4, 23, 20, 5, -3, 11, 16]
>>> list(filter(lambda x: x>0, rlist))
[20, 3, 17, 1, 20, 19, 24, 4, 21, 4, 7, 20, 2, 1, 13, 21, 23, 6, 2, 22, 4, 3, 6,
 2, 13, 3, 13, 20, 23, 14, 13, 13, 20, 10, 24, 9, 22, 15, 21, 18, 16, 13, 1, 3,
12, 21, 9, 4, 24, 4, 10, 8, 1, 19, 3, 20, 4, 5, 25, 8, 8, 14, 23, 24, 14, 1, 3,
11, 1, 8, 17, 2, 2, 23, 6, 2, 25, 15, 4, 23, 20, 5, 11, 16]
>>> [x for x in rlist if x>0]
[20, 3, 17, 1, 20, 19, 24, 4, 21, 4, 7, 20, 2, 1, 13, 21, 23, 6, 2, 22, 4, 3, 6,
 2, 13, 3, 13, 20, 23, 14, 13, 13, 20, 10, 24, 9, 22, 15, 21, 18, 16, 13, 1, 3,
12, 21, 9, 4, 24, 4, 10, 8, 1, 19, 3, 20, 4, 5, 25, 8, 8, 14, 23, 24, 14, 1, 3,
11, 1, 8, 17, 2, 2, 23, 6, 2, 25, 15, 4, 23, 20, 5, 11, 16]
```

Mapping a list

- We want to apply a function to all elements in a list



```
>>> rlist =[random.randint(-10,20) for _ in range(20)]
>>> rlist
[-2, -9, 20, -10, -9, 19, -4, 1, 16, 3, 8, -10, 4, -2, 11, 8, 11, -7, -2, -3]
>>> list(map(lambda x: (x-6)**2, rlist))
[64, 225, 196, 256, 225, 169, 100, 25, 100, 9, 4, 256, 4, 64, 25, 4, 25, 169, 64
, 81]
>>> [(x-6)**2 for x in rlist]
[64, 225, 196, 256, 225, 169, 100, 25, 100, 9, 4, 256, 4, 64, 25, 4, 25, 169, 64
, 81]
>>>
```

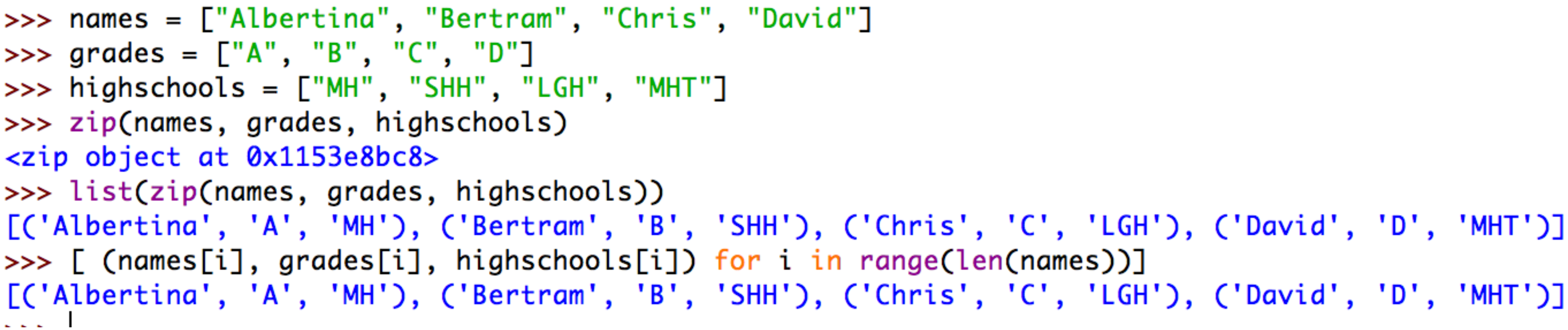
Zip

Zip

- Often we have related data in a number of lists
  - Example: list of student names, list of grades, list of high school
    - [“Frankieboy”, “Violet”, “Kumar”, “Dshenghis”]
    - [“D”, “A”, “B”, “C”]
    - [“MPS1”, “MH”, “MH”, “MPS59”]
  - Zipping will create a zip object that generates the tuples (“Frankieboy”, “D”, “MPS1”), (“Violet”,“A”,”MH”), (“Kumar”, “B”, “MH”), (“Dshenghis”,”C”, “MPS59”)

Zip

- We can reach the same effect with list comprehension, but since we cannot enumerate in parallel through several iterables, we need to use indices.



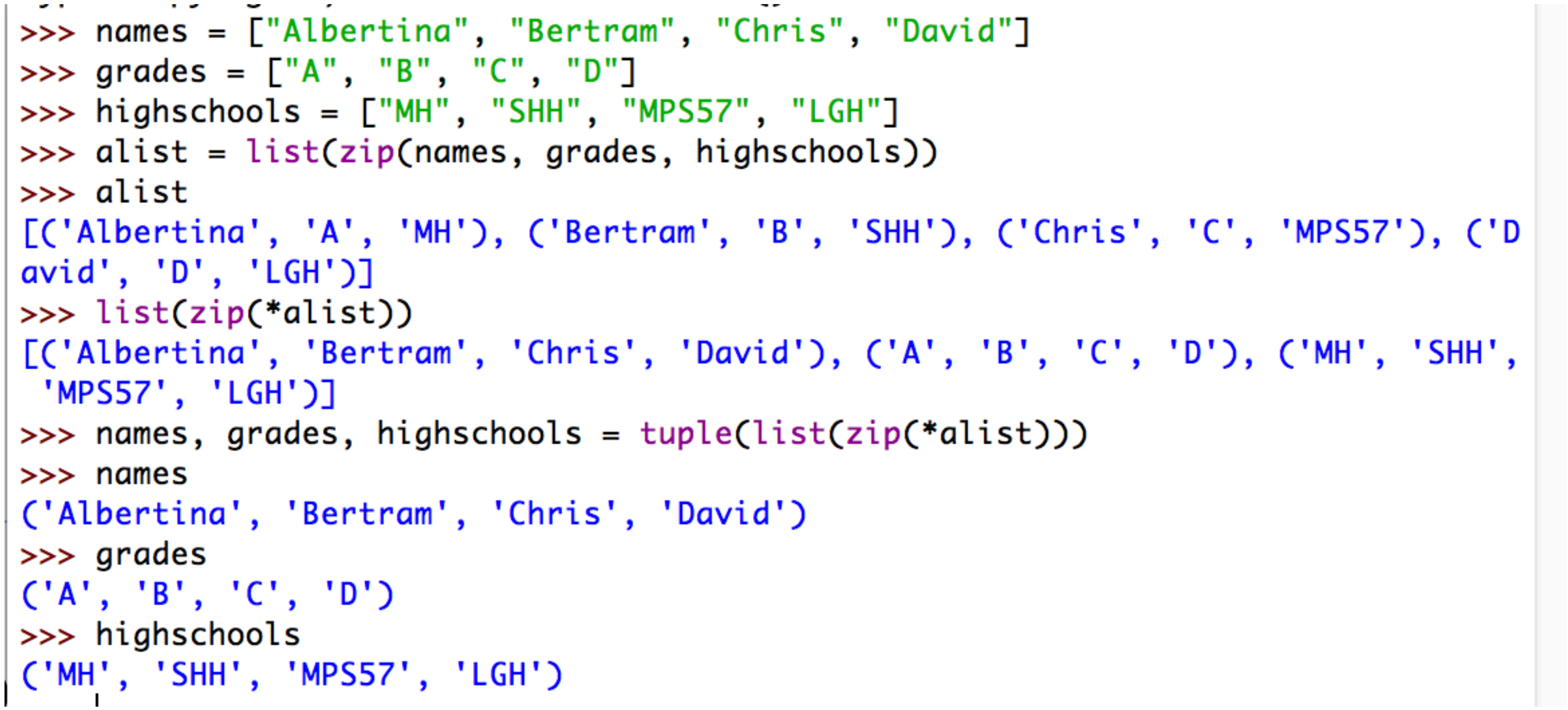
```
>>> names = ["Albertina", "Bertram", "Chris", "David"]
>>> grades = ["A", "B", "C", "D"]
>>> highschools = ["MH", "SHH", "LGH", "MHT"]
>>> zip(names, grades, highschools)
<zip object at 0x1153e8bc8>
>>> list(zip(names, grades, highschools))
[('Albertina', 'A', 'MH'), ('Bertram', 'B', 'SHH'), ('Chris', 'C', 'LGH'), ('David', 'D', 'MHT')]
>>> [ (names[i], grades[i], highschools[i]) for i in range(len(names))]
[('Albertina', 'A', 'MH'), ('Bertram', 'B', 'SHH'), ('Chris', 'C', 'LGH'), ('David', 'D', 'MHT')]
...
```

Zip

- What happens if you give zip iterables of different length
  - E.g. a list of 5, a list of 4 and a list of 3 elements?
  - The result is a zip object of length the minimum of the lengths.

Zip

- Undoing a zip:
    - If you make a list `alist` out of a zip object, you can break it apart with the `zip(*alist)` command



```
>>> names = ["Albertina", "Bertram", "Chris", "David"]
>>> grades = ["A", "B", "C", "D"]
>>> highschools = ["MH", "SHH", "MPS57", "LGH"]
>>> alist = list(zip(names, grades, highschools))
>>> alist
[('Albertina', 'A', 'MH'), ('Bertram', 'B', 'SHH'), ('Chris', 'C', 'MPS57'), ('D
avid', 'D', 'LGH')]
>>> list(zip(*alist))
[('Albertina', 'Bertram', 'Chris', 'David'), ('A', 'B', 'C', 'D'), ('MH', 'SHH',
 'MPS57', 'LGH')]
>>> names, grades, highschools = tuple(list(zip(*alist)))
>>> names
('Albertina', 'Bertram', 'Chris', 'David')
>>> grades
('A', 'B', 'C', 'D')
>>> highschools
('MH', 'SHH', 'MPS57', 'LGH')
```

And now for something completely different

Copying Data Structures

- Copying and assignment are two different things

Copying Data Structures

- Copying and assignment are two different things
  - We have an object a

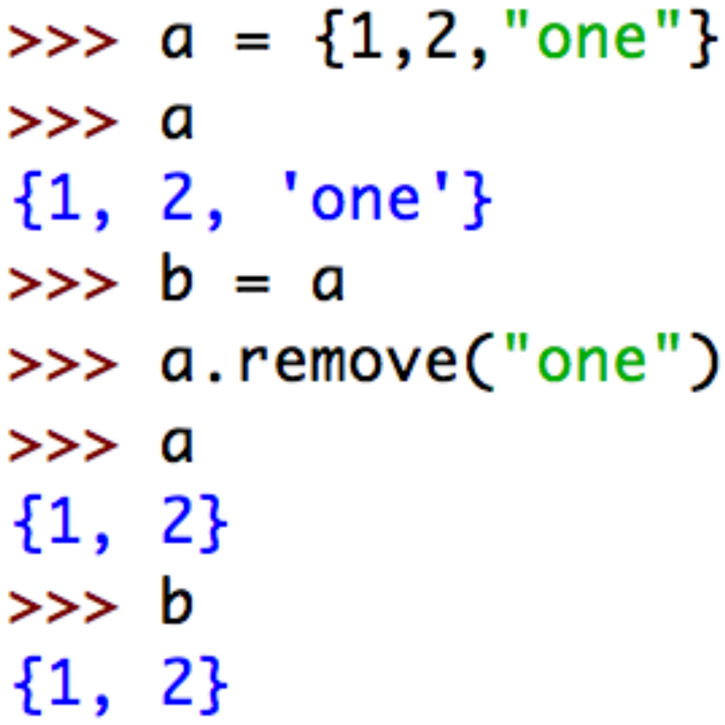
```
a = set(1, 2, “one”)
```

  - We assign a to b
  - But the two objects are still linked:

Copying Data Structures

- Copying and assignment are two different things

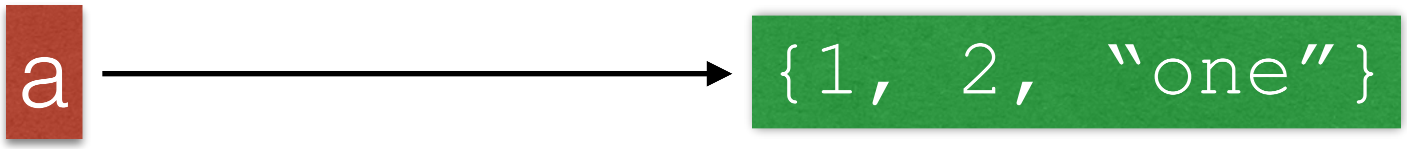
```
a = set([1, 2, "one"])
print(a)
b = a
print(b)
# Now we change set a
a.remove("one")
# Which also changes set b
print(b)
```



```
>>> a = {1,2,"one"}
>>> a
{1, 2, 'one'}
>>> b = a
>>> a.remove("one")
>>> a
{1, 2}
>>> b
{1, 2}
```

Copying Data Structures

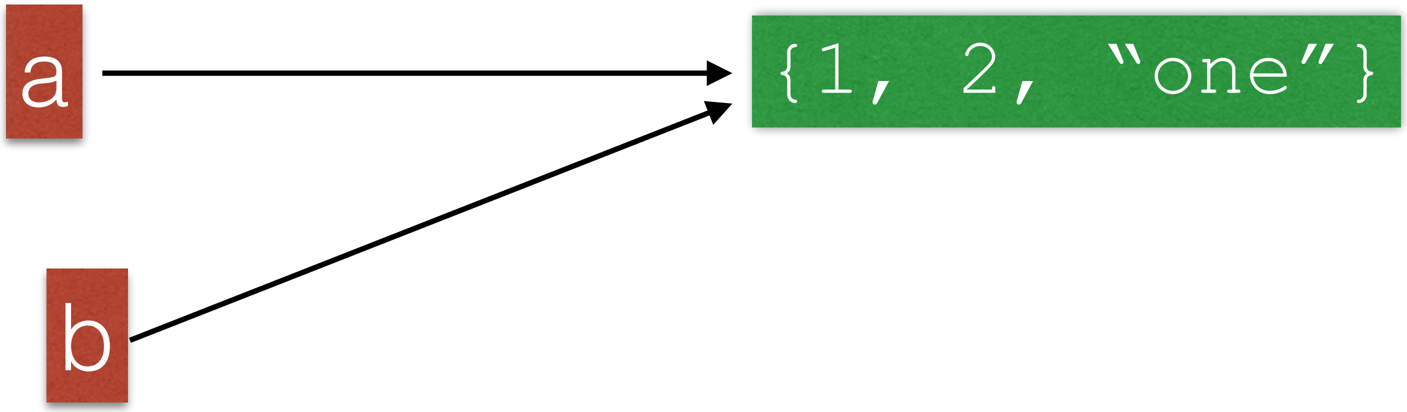
- Copying and assignment are two different things
  - Here is what happens
    - In Python, names point to objects



a

{1, 2, “one”}

    - Assigning adds a name to the same object



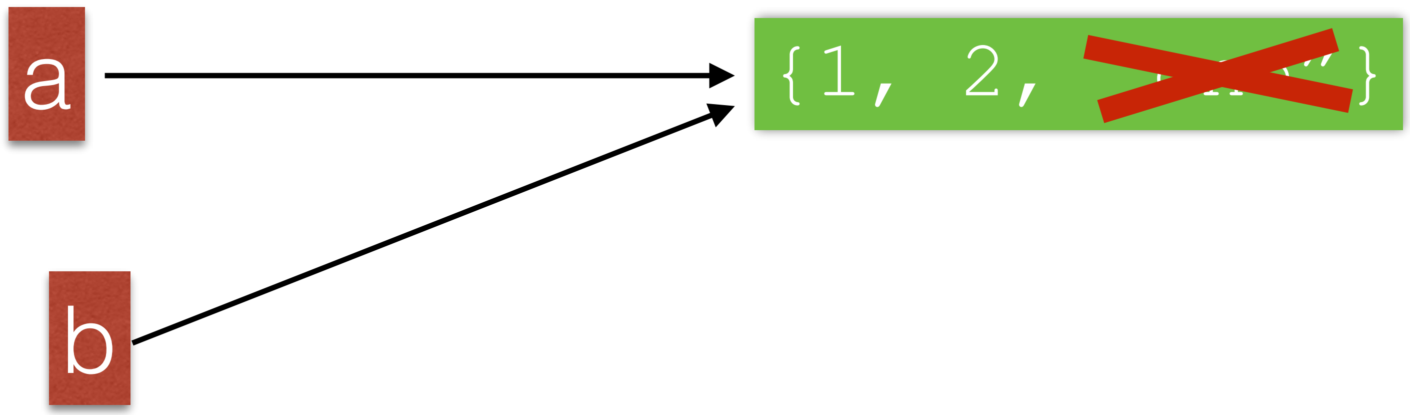
a

b

{1, 2, “one”}

Copying Data Structures

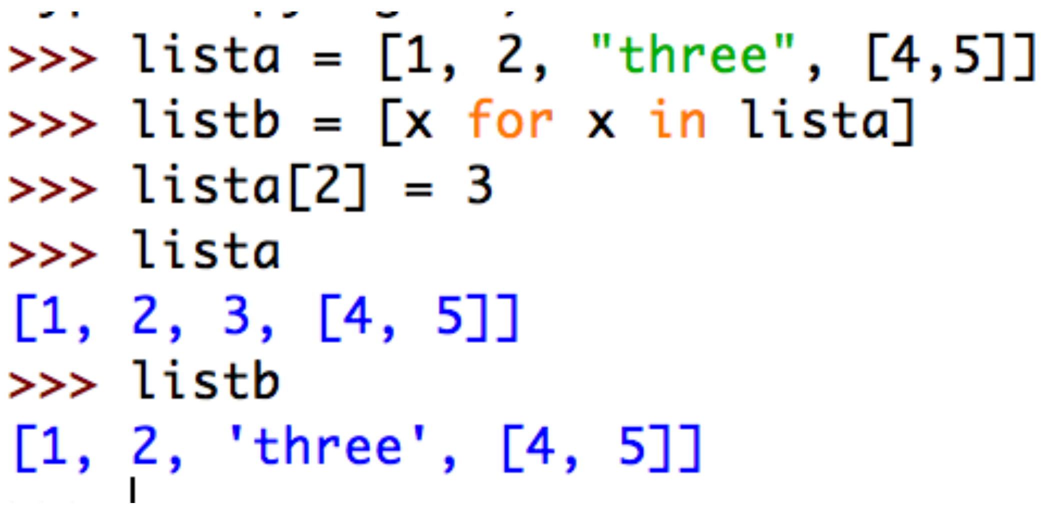
- Copying and assignment are two different things
  - Since there is only one object, I can manipulate the object through either name



Copying Data Structures

- Copying and assignment are two different things
  - If I want to copy, I need to do so explicitly

```
lista = [1, 2, "three", [4,5]]
listb = [x for x in lista]
lista[2] = 3
print(lista)
print(listb)
```



```
>>> lista = [1, 2, "three", [4,5]]
>>> listb = [x for x in lista]
>>> lista[2] = 3
>>> lista
[1, 2, 3, [4, 5]]
>>> listb
[1, 2, 'three', [4, 5]]
```

- Now changes to one do not change the other!

Copying Data Structures

- Copying and assignment are two different things
  - One can use slices to copy lists

  -
    ```
    listb = lista[0:4]
    ```

Copying Data Structures

- Copying becomes difficult if we have compound objects
  - E.g.: A list which contains lists, sets, …
- Shallow copy:
  - Resulting copies have shared elements

Copying Data Structures

- Example: A matrix as a list of rows
    - Create zero row by multiplying list with an integer

```
matrix = 3*[ 4*[0]]
```

- One might think it creates a structure like

```
[  [0, 0, 0, 0],
   [0, 0, 0, 0],
   [0, 0, 0, 0]]
```

- which is not entirely false

Copying Data Structures

- We can get the elements as we should

```
matrix = 3*[ 4*[0]]
print(matrix[3][2])
```

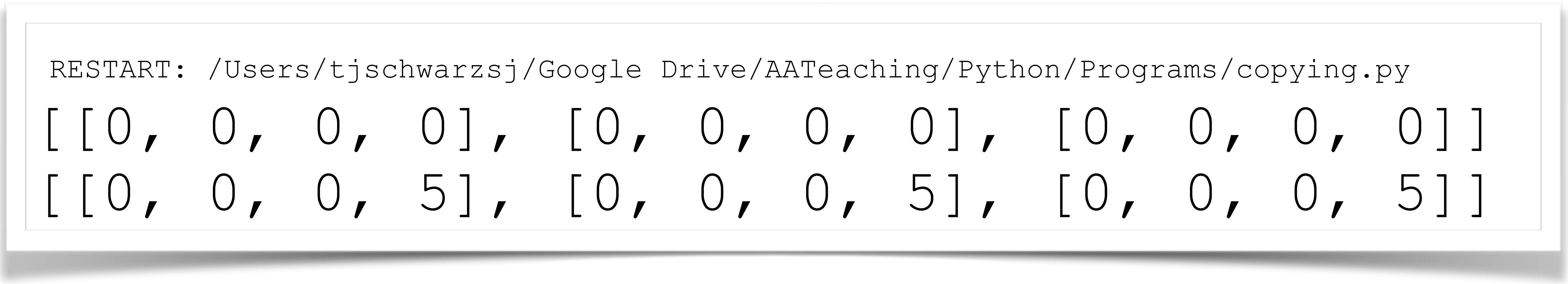
- And we can set elements

```
matrix = 3*[ 4*[0]]
matrix[3][2] = 5
```

- But now we see that we got three times the same row

Copying Data Structures

```
matrix = 3*[ 4*[0] ]
print(matrix)
matrix[2][3] = 5
print(matrix)
```



```
RESTART: /Users/tjschwarzsj/Google Drive/AATeaching/Python/Programs/copying.py
[[0, 0, 0, 0], [0, 0, 0, 0], [0, 0, 0, 0]]
[[0, 0, 0, 5], [0, 0, 0, 5], [0, 0, 0, 5]]
```

Copying Data Structures

- How can we do this:
    - Need to construct the zero rows independently
        - Use e.g. list comprehension

```
matrix = [ [0 for _ in range(4)] for i in range(3)]
```

Copying Data Structures

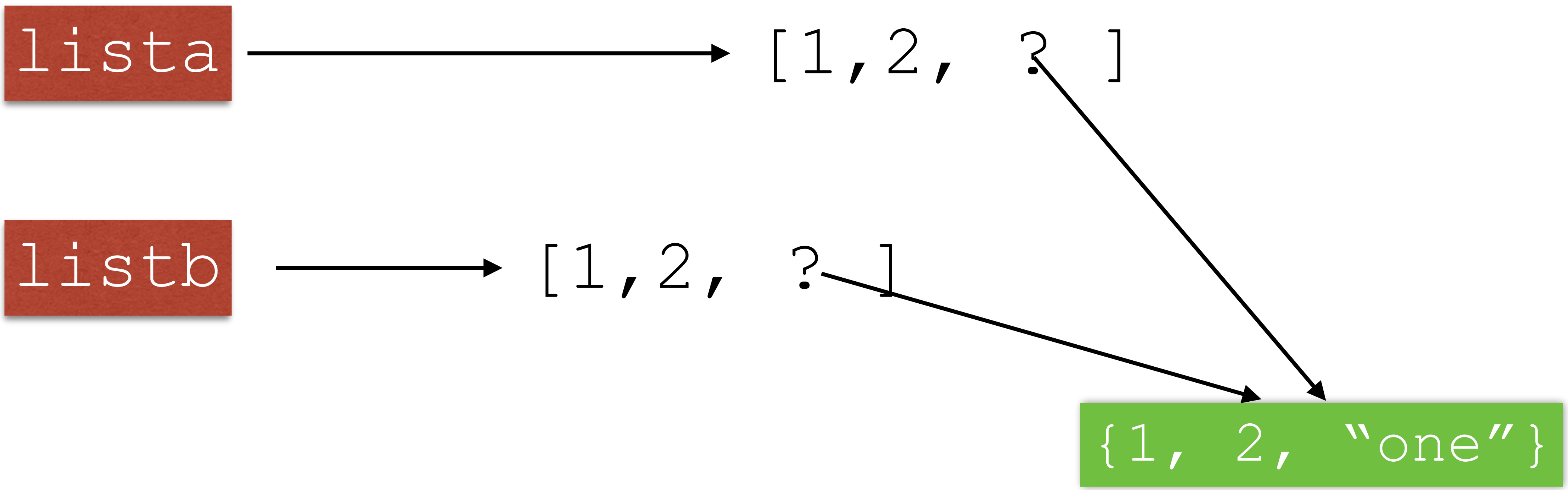
- Shallow copy: Assume we have

```
lista = [1, 2, [3,4,5]]
```

- We create a shallow copy by

```
lista = [1, 2, [3, 4, 5]]
listb = lista[:]
```

- But here is what is happening



lista

[1,2, ?]

listb

[1,2, ?]

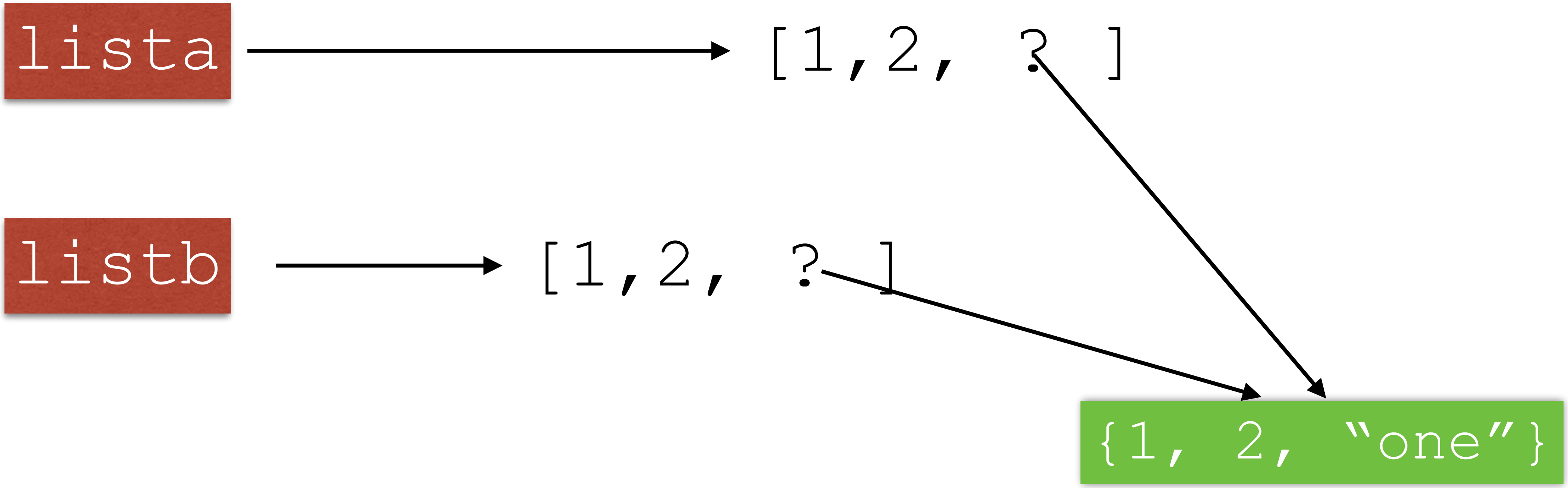
{1, 2, “one”}

```
lista = [1, 2, [3, 4, 5]]
listb = lista[:]
```

The two lists still share a component. We can change this component in one list and change it in the other one as well.

Copying Data Structures

- We have two copies of the list, but the third element are two different names for the same object



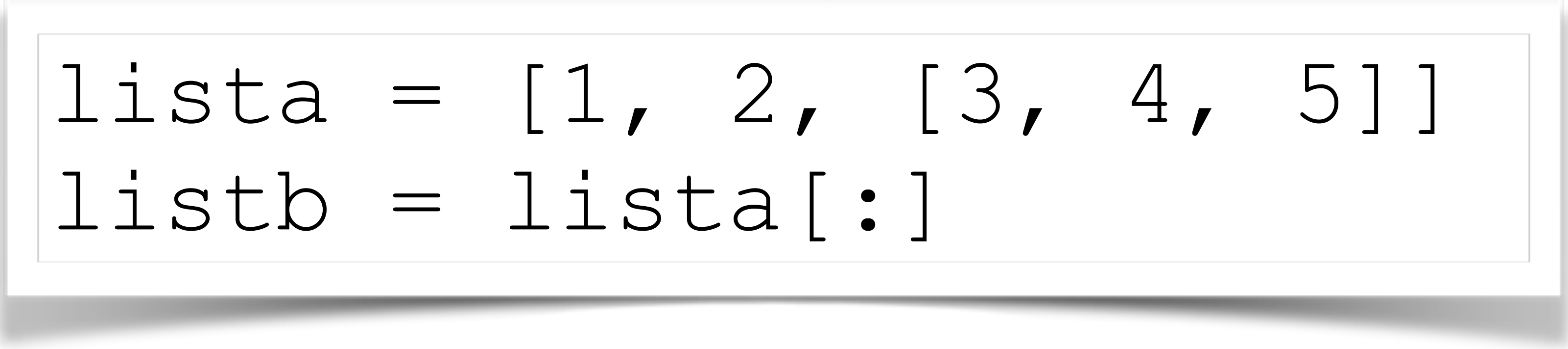
lista

[1,2, ?]

listb

[1,2, ?]

{1, 2, “one”}



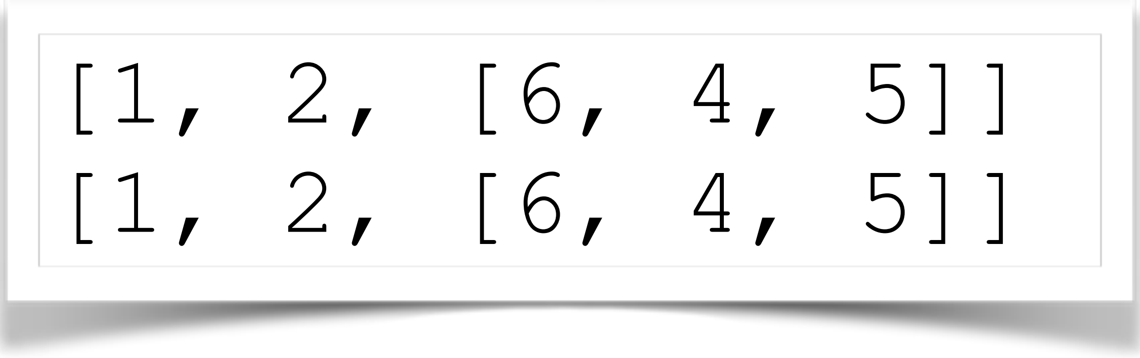
```
lista = [1, 2, [3, 4, 5]]
listb = lista[:]
```

Copying Data Structures

- In consequence, I can alter the same element in the list which is element number 2

```
lista = [1, 2, [3, 4, 5]]
listb = lista[:]
lista[2][0] = 6
print(lista)
print(listb)
```

- prints out



```
[1, 2, [6, 4, 5]]
[1, 2, [6, 4, 5]]
```

Copying Data Structures

- I need to use a deep copy
    - Easiest:
        - Use the module `copy`
            - Use `copy.deepcopy(object)` for deep copying
            - Use `copy.copy(object)` for shallow copying

Copying Data Structures

- This is a famous Python gotcha
    - Behavior is not intuitive.