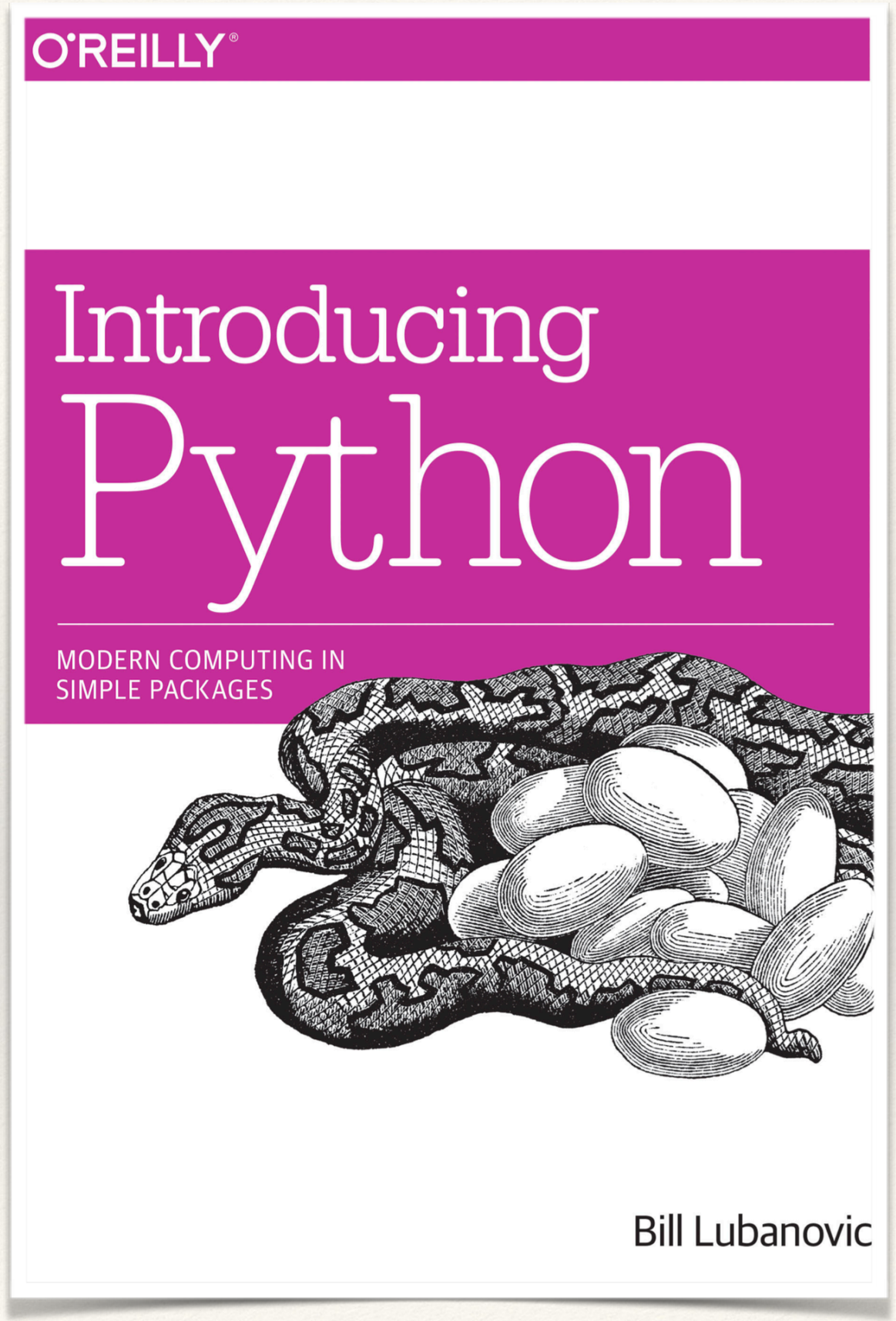
Introduction to Data Science Programming

03: Sequences, Types & Dictionaries

Checking In
Sequences & Other Types
Lists, Ranges, Tuples, Sets (activity 1)
Dictionaries (activity 2)
Mutability & Gotchas (activity 3)



Checking In

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- How is it going?
- What was the hardest part of the homework? The easiest?

Sequences & Other Types

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- What are they?

Notice this string is a sequence,
read starting from the first character.

In Python, a sequence is a generic term for objects with an ordered group.
Examples include
lists,
tuples, and
strings.

- What's not a sequence?

Any data types without an inherent order, such as
dictionaries,
sets,
ints, and
floats.

Lists

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- Sequences share a lot of common methods (but not all). Include or slice with []. The offset starts with 0.
  E.g., `myList = ['Lars', 'Juan', 'Pierre', 'Marie', 'Tan']`
  - How many elements in the list?
    `len(myList)`
  - I'm looking for "Lars" - is he in the list?

"'Lars' in myList"

```
>>> mylist = ['lars','fish']
>>> print(('lars' in mylist))
True
```

- How to add (concatenate) 2 lists?

```
a = list()
a.append("tom")
a[0] = "tom"
```

https://docs.python.org/3/tutorial/datastructures.html
https://docs.python.org/3/library/stdtypes.html

Lists

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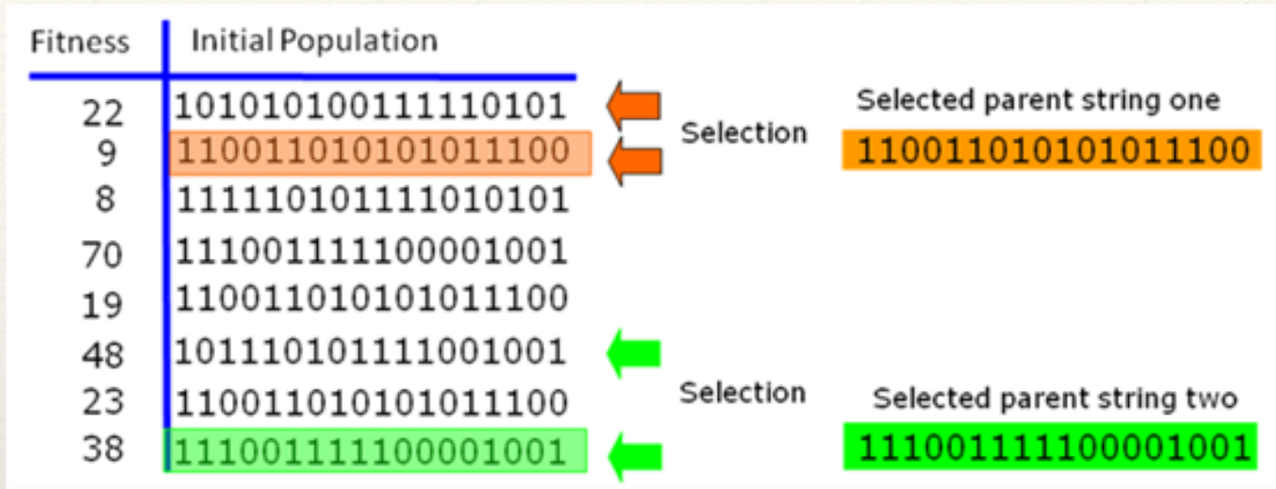
- Sequences are helpful! Their methods tell us about the size, min/max values, counts (occurrences) of an object, and more!
  - **myList = [1,2,3,4]**
    - min(myList)
    - max(myList)
  - **myList = [‘a’, ‘b’, ‘c’, ‘d’]**
    - myList.index(‘x’) # locate the first instance of “x”
    - myList.count(‘x’) # how many times of “x”
  - What’s up with the dot? And the parentheses?

Parentheses hold the arguments we’re passing to the function, e.g., len(myList).
Not all functions require arguments.
The dot notation indicates that a function is defined in the specific object before the dot.

Lists



While there are better techniques we'll encounter in NumPy and Pandas, we can imagine using the <list>.index and <list>.count to test for existence of an interesting value and then count them for fitness.

Composites

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- A **list** is a composite type - what does that mean?

- Other examples?
  - A composite type comprises other types. Lists, tuples, dictionaries are composite because they can contain other objects. int, float, string are not composites.

0 1 2 3

- E.g., `demo = ['cat','dog',33,['j', 'k', 'l']]`

- `print(demo[3])` *outputs* `'j','k','l'`

List Methods

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- `myList.insert(index, value)`
- `myList.pop(x)` # pops last value by default but can take instead index argument “x”)
- `myList.remove()` # use remove to eliminate the first instance of a value
- `myList.sort()` # mutate the list - sorting by default in ascending order
- `sorted(myList)` # this returns a new list
- `myList.reverse()` # reverses the list.

List Methods (continued)

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- `myList.append("x")` # adds "x" to the end of the list
- `myList.extend(otherList)` # adds items from otherList to the end of myList
- `myList[a] = "z"` #swaps out the item at index [a] with whatever z stands for
- `myList.clear()` #clears out the list elements
- `del(myList[x])` # deletes item from index x

Ranges, Tuples, Sets

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- **Ranges**
  - a sequence
  - need to be listed to yield the elements
  - range(start, stop, step)
- **Tuples**
  - a sequence
  - like a list but immutable
  - instantiate: `tup_X=(1,2,3)` or `tup(1,2,3)`
  - Can use a tuple to create multiple objects
- **Sets**
  - Unordered and mutable
  - *Unique, keys only

```
>>> a=range(0,9)
>>> a
range(0, 9)
>>> list(a)
[0, 1, 2, 3, 4, 5, 6, 7, 8]
>>> type (a)
<class 'range'>
>>> type (list(a))
<class 'list'>
```

```
>>> low, high = 10,20
>>> print(low, high)
10 20
>>>
```

More About Tuples

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- Tuples are like lists - but they are immutable. What's happening here?

```
>>> a=([1,2,3],2,3)
>>> type(a)
<class 'tuple'>
>>> a[0].append(5)
>>> a
([1, 2, 3, 5], 2, 3)
>>> type(a)
<class 'tuple'>
>>> a[1]=10
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: 'tuple' object does not support item assignment
```

Activity 1

- `range(start, stop(exclusive), step)`

- Practice creating these outputs:
  - `[1, 2, 3, 4, 5, 6, 7, 8, 9]`
  - `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10]`
  - `[2, 4, 6, 8, 10, 12]`
  - `[2, 4, 6, 8, 10, 12, 13, 14, 15, 17, 19, 21]`
  - `[-1, 0, 1, 2, 3]`
  - `[10, 9, 8, 7, 6, 5, 4, 3, 2, 1]`

Dictionaries

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- Instantiation (many ways)

```
dict_x = {'fred':1, 'frank':3, 'ben':1}
```

As a dict literal

```
dict_x = dict([('fred',1),('frank',3),('ben',1)])
```

As a list of tuples

Index by key to get value

```
dict_x['fred']          # indexing by key name
```

Dictionary Methods

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```
del(dict_x['key'])                          # delete by key reference
dict_x.pop('key','default value')           # pop the value for key from dictionary. If the
                                            key doesn't exist, the function will return the
                                            default
dict_x.get('key','default value')
dict_x.clear()
dict_x.update(dict2)                        # appends a second diction to the first
dict_x.keys()
dict_x.values()
dict_x.items()                              # get the key:value pairs
```

Sample .json structures

```
{ people
    [name, tom]
    [name,
fifi]
}
```

Just a note in passing …
JavaScript Object Notation (.json) files are used a lot to share data. Notice that GitHub files (in "raw") mode show the underlying .json that's converted to a useful tool in Jupyter.

```
{"menu":
    { "id": "file",
      "value": "File",
      "popup":
            { "menuitem": [
               {"value": "New",
                "onclick": "CreateNewDoc()"
            },
            { "value": "Open",
              "onclick": "OpenDoc()"
            },
            { "value": "Close",
              "onclick": "CloseDoc()"
            } ]
            }
}
}
```

https://json.org/example.html

Activity 2 - Dictionaries

- Mutable, what does that imply?
- Not a sequence, what does that mean?
- Maps keys to values # aka: map, key:value store
  - `a = {'fred':1, 'frank':3, 'ben':1}`
  - `book = {'changjing':'555-1212', 'jim':'333-234'}`
  - `a = {'names': {'fred':404, 'frank':3, 'ben':1}}` # can be nested (JSON)

Python uses a hash function to quickly locate items stored in a dictionary. The key, when passed through the hash function, points to a unique place in the computer's memory. This makes finding the value extremely fast. Keys cannot be mutable, since if they were, the hash function would not return the same result.

- Values can be any type
- Keys need to be hashable # should be immutable

Mutability

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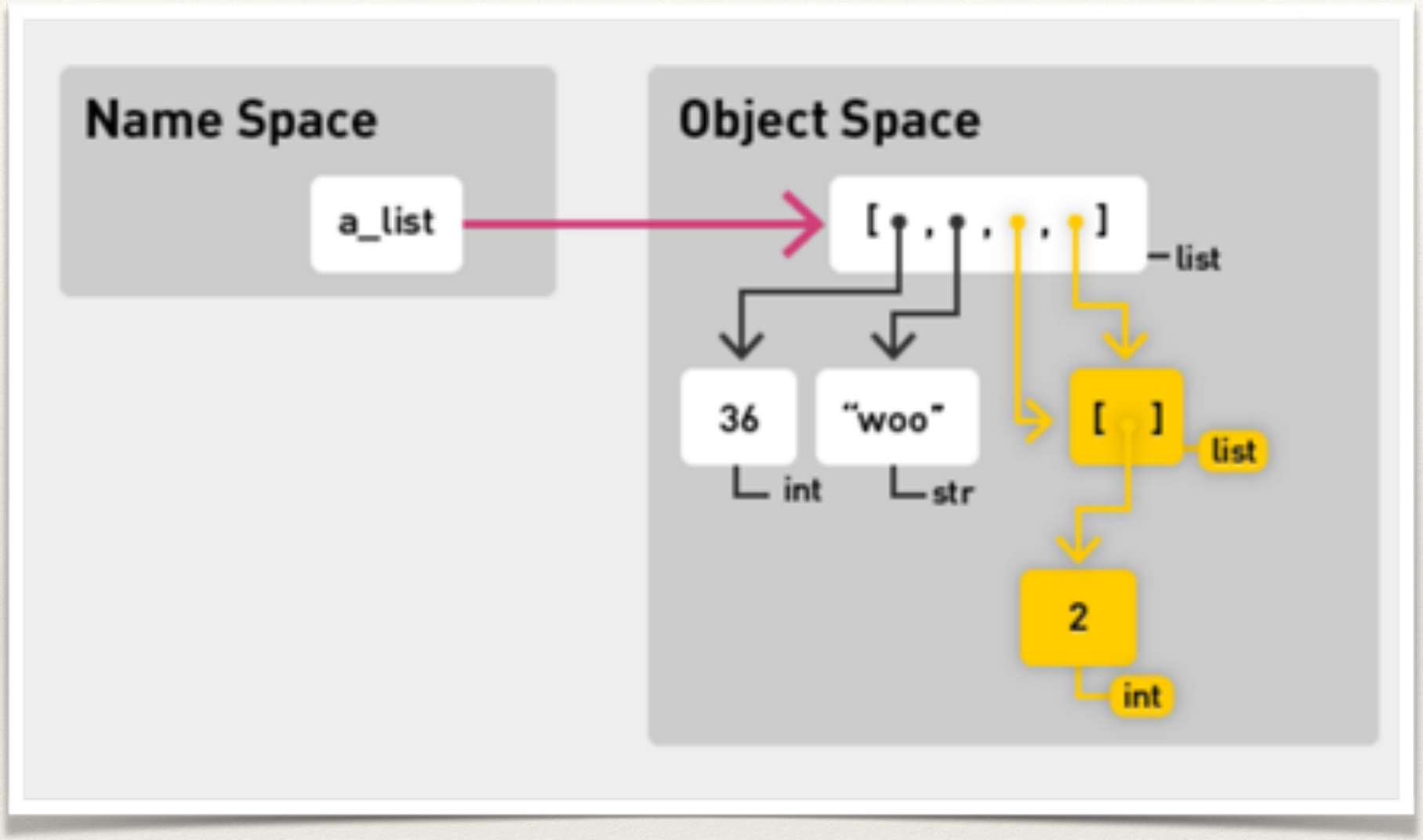
- Mutability: a list is mutable, meaning we can change the length and content. E.g.,
  - `alist = []`
  - `aList.append('cat')`
  - `bList = ['a','b','c']`
  - `aList.extend(bList)`
  - `print(aList)`
  - `['cat','a','b','c']`
- Which data types are mutable? Immutable?

- Mutability means the object can be changed;
  - dictionaries, lists, and sets are mutable;
  - tuples and strings are immutable.
- Primitive data types such as ints and floats are also immutable.

Mutability Gotchas



Note, items 3 and 4 are the same object: [36, “woo”, [2], [2]]

Mutability Gotchas (con't)

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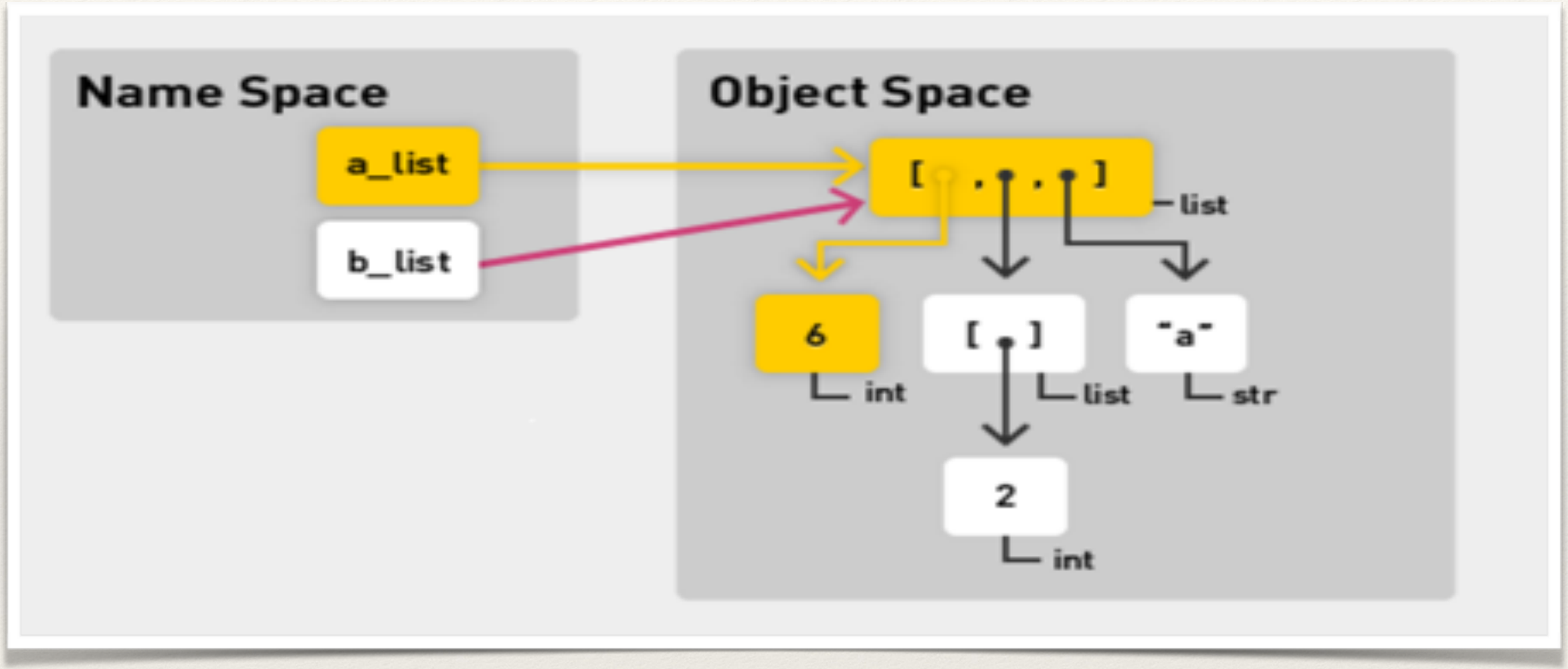
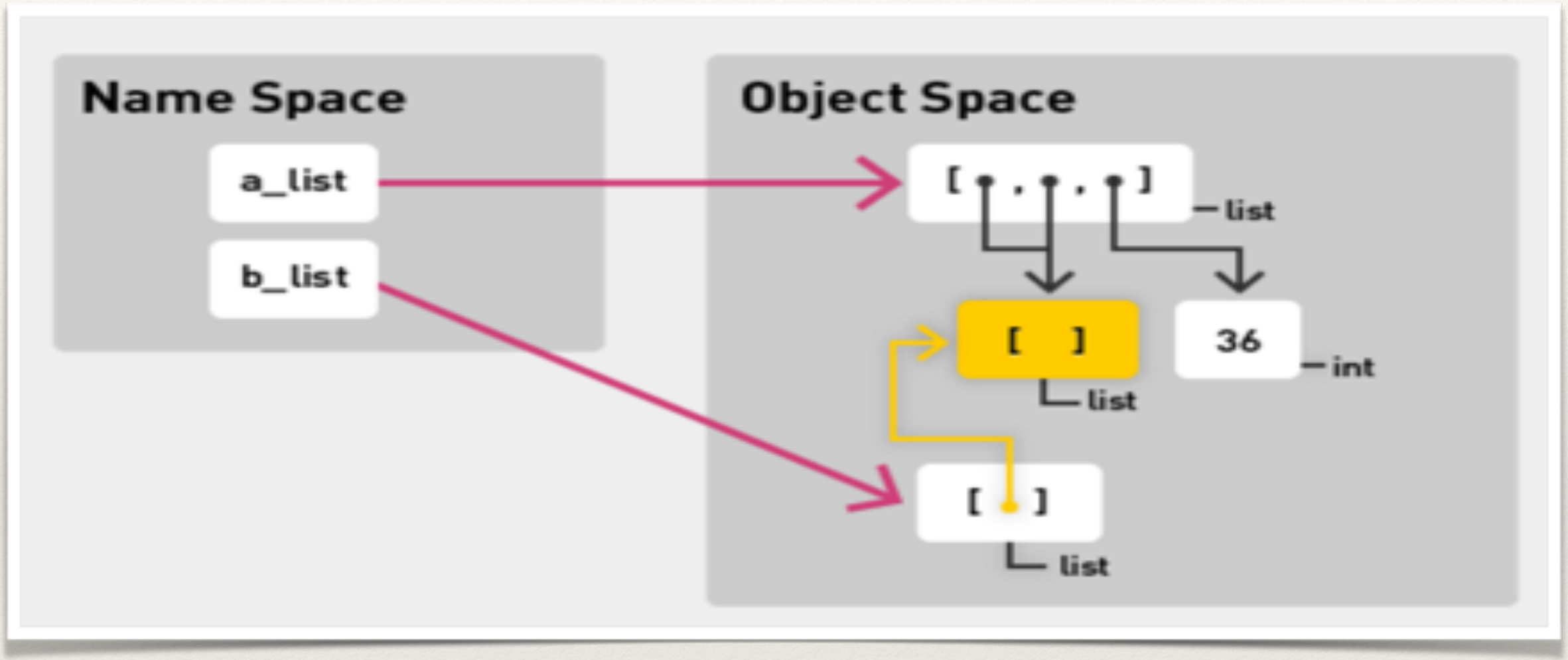


Mutability Gotchas (con't)



Copy & Deepcopy

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- Consider this snippet:

```
Ls_x = [ 1, 2, 3, ['Frank', 'Fred']]
Ls_x_cp = Ls_x.copy()

from copy import deepcopy
Ls_x_deep = deepcopy(Ls_x)
Ls_x[3][1] = 'Mufasa'
```

Copy & Deepcopy (con't)

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- What is `copy`?
  - Copy creates an independent copy of all list elements at the first level of the list.
- How does copy differ from `deepcopy`?
  - Deepcopy creates an independent copy of all list elements at all levels.
- What is the final value of Ls_x_cp and Ls_x_deep?
  - `Lx_x_cp is [1,2,3,['Frank','Mufasa']`
  - `Lx_x_deep is [1,2,3,['Frank','Fred']`

List & Dictionary Activity

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- We are now going to solve a very popular problem: *How do you count the words in a document?*
- While the solution here is simple, you will see in later courses that this is an excellent first problem when learning how to massively parallelize your code across a cluster of computers.
- The activity will guide you to the solution in a series of steps.
- As you will see next week, the "`while`" loop in this activity could be better represented by a "`for`" loop. For now, please work with the "while" loop.

Activity 3 - Mutability

- Mutability Activity:
  - Read about and update a scoreboard reporting ranking and team color of contestants.

```
Contestants = [{“name”;”fred”, “teamColor”:”Red”},
    {“name”:”Layla”, “teamColor”:”Yellow”},
    {“name”:”Tammy”, “teamColor”:”Green”},
    {“name”:”Buba”, “teamColor”:”Blue”}]
```

- Your job? Programmatically change the scoreboard as indicated. Hint! Use `copy` and/or `deepcopy` if required.

That's It

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- Remember that scores & comments are listed in ISVC site.
- If you want to redo assignment 1, go ahead.
- Home works are very important - communicate with each other, with the instructors, etc. If you're spending too much time, step away and rest … then tackle with fresh eyes.
- At this point in our studies we might slog thru some code … There is almost always a more efficient way of doing things and we're going to encounter many of them in the coming weeks.