Class 3 - Sequence Types and Dictionaries

[w200] MIDS Python Summer 2018

Week 3 | Agenda

Week 2 Assignment and Polls

Sequences

Lists

Ranges, Tuples, and Sets - Activity 1

Dictionaries - Activity 2

Mutability Pitfalls - Activity 3

Course Content | First 8 Weeks - Programming

Unit 1 | Introduction, the Command Line, Source Control

Unit 2 | Starting Out with Python

Unit 3 | Sequence Types and Dictionaries

Unit 4 | More About Control and Algorithms

Unit 5 | Functions

Unit 6 | Modules and Packages

Unit 7 | Classes

Unit 8 | Object-Oriented Programming

Review | Logistics

Asynchronous, class meetings, and breakout sessions

Using github to get and submit your assignments

https://github.com/MIDS-INFO-W18/assignments_upstream_summer18

The Google group list

https://groups.google.com/forum/#!forum/w200-python-2018-summer

Course Schedule:
https://docs.google.com/spreadsheets/d/11DxadnNwyFaJIPYLUJSPUlNGCtTenBCR4yaR1CbFBKg

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Week 3 Polls | Check in

Homework:

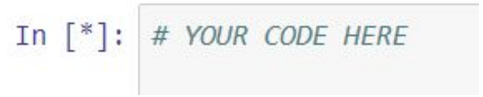
What was the hardest part of HW2?

Are there any specific questions about HW2?

Assignment 1 Feedback

- How comfortable do people feel on github?
- Github folder structure – Please put week_01 homework files under SUBMISSIONS/week_01 folder (week_02 files would be under SUBMISSIONS/week_02, etc.)
- Reason to make file references relative – Some folks started with a cd to a long directory on their local computer. This won't run on a general user's computer since that user won't have that directory
- Capitalization matters! There is a programming difference between s1 and S1, which could cause errors if the two get mixed up.

Jupyter Notebook Stops Working

- If jupyter notebook looks like this for a long period of time:
  - 

    ```
    In [*]: # YOUR CODE HERE
    ```

    Notice the: [*]
  - The [*] means that block of code is running and either:
    - There is an infinite loop in that code somewhere so it never finishes, or
    - The calculations are taking a long time to do (which probably isn’t correct either)
  - This will prevent you from running any other blocks of code in that notebook!
- To get out of this state:
  - 1) Try: (menu) Kernel -> Interrupt (only works sometimes)
  - 2) Try: (menu) Kernel -> Restart (pop-up) - Restart (works most of the time)
  - 3) Shutdown / exit out of Jupyter Notebook and manually restart
    (This could cause a loss of work if not saved recently.)

Jupyter Notebook Variable Space

- Variables in Jupyter:
  - For example: x =4; print(x) in Jupyter
  - If you delete the x=4; you can still print(x)
  - x is stored in the notebook memory even though it isn't defined anymore
- This is a problem:
  - When we re-run your code “x” is not in our notebook's memory
  - Code crashes with: “x is undefined” error
  - Please go to the Kernel menu - restart and clear output
  - Then re-run all of your code blocks before turning it in!

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Sequences

What are sequences?

- **Define**
- **Name some**

What are some types that are not sequences?

Sequences

What are sequences?

Define

Name some

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

What are some types that are not sequences?

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

Methods for Sequences | Part 1

- index or slice with [ ]
  - Starts with 0
  - index is offset
- len()
- in # (e.g. “5 in list_X”)
- not in
- + # can ‘add’ to concatenate

Methods for Sequences | Part 2

- max()
- min()
- seqX.index(‘x’) # locate the first instance of ‘x’
- seqX.count(‘x’) # count how many times ‘x’ is in the sequence

What are the purpose of the parentheses?

When do we use the “.” (dot) notation?

Methods for Sequences | Part 2

- **max()**
- **min()**
- **seqX.index(‘x’)** **# locate the first instance of ‘x’**
- **seqX.count(‘x’)** **# count how many times ‘x’ is in the sequence**

What are the purpose of the parentheses?

The parentheses are used to pass arguments to a function (e.g., ‘x’). Some functions do not need arguments.

When do we use the “.” (dot) notation?

The dot notation indicates that a function is defined within a specific object. In the example above, the object “seqX” has both “index()” and a “count()” functions associated with it. In Python, all sequence objects have these functions defined.

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Lists

Lists are a particularly versatile type of sequence

Lists are **<u>mutable</u>**

What does it mean to be mutable?

What other types are mutable? Which are not?

Lists

Lists are a particularly versatile type of sequence

Lists are **mutable**

What does it mean to be mutable?

Mutability refers to the ability to modify the object, in place, in memory.

What other types are mutable? Which are not?

Dictionaries and sets are mutable. Tuples and strings are not, though tuples can hold mutable objects within them. Primitive data types such as int, and float are also immutable.

Lists

Lists are a particularly versatile type of sequence

Lists are **composite types**

- **What does it mean to be a composite type?**
- **What other types are composite? Which are not?**

Lists

Lists are a particularly versatile type of sequence

Lists are **composite types**

What does it mean to be a composite type?

Composite types are comprised of other types. Lists, for example, can contain any other object within them.

What other types are composite? Which are not?

Tuples, dictionaries and sets are all composite types. Strings are not. Primitive objects such as ints and floats are also not composite types.

Mutation Methods for Lists | Part 1

```
ls_X.insert(index, value)

ls_X.pop(x)          # pops last value by default but can instead take index argument “x”

ls_X.remove()        # use remove command to remove first instance of value

ls_X.sort()          # this mutates the list

sorted(ls_X)         # this returns a new list

ls_X.reverse()       # reverses list
```

Note that the “sorted()” function is not called using the dot notation! It requires assignment:

```
list_2 = sorted(list_1)
```

Mutation Methods for Lists | Part 2

```
ls_x.append(x)          # adds x to end of list

ls_x.extend(list2)      # adds items from list2 to the end of the ls_x

ls_x[a] =               # swaps out the item at index [a] with whatever is provided

ls_x.clear()            # clears list

del(ls_x[a])            #  deletes item from index a
```

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Tuples, Ranges, Sets

Ranges

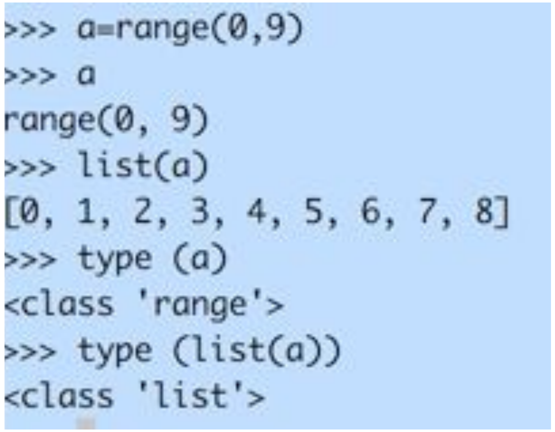
- a sequence
- need to be listed to yield the elements
- range(start, stop, step)

Tuples

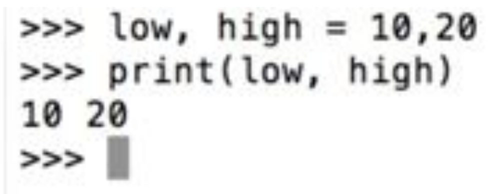
- a sequence
- like a list but immutable
- instantiate: tup_X=(1,2,3) or tup(1,2,3)
- Can use a tuple to create multiple objects

Sets

- Unordered and mutable
- *Unique, keys only



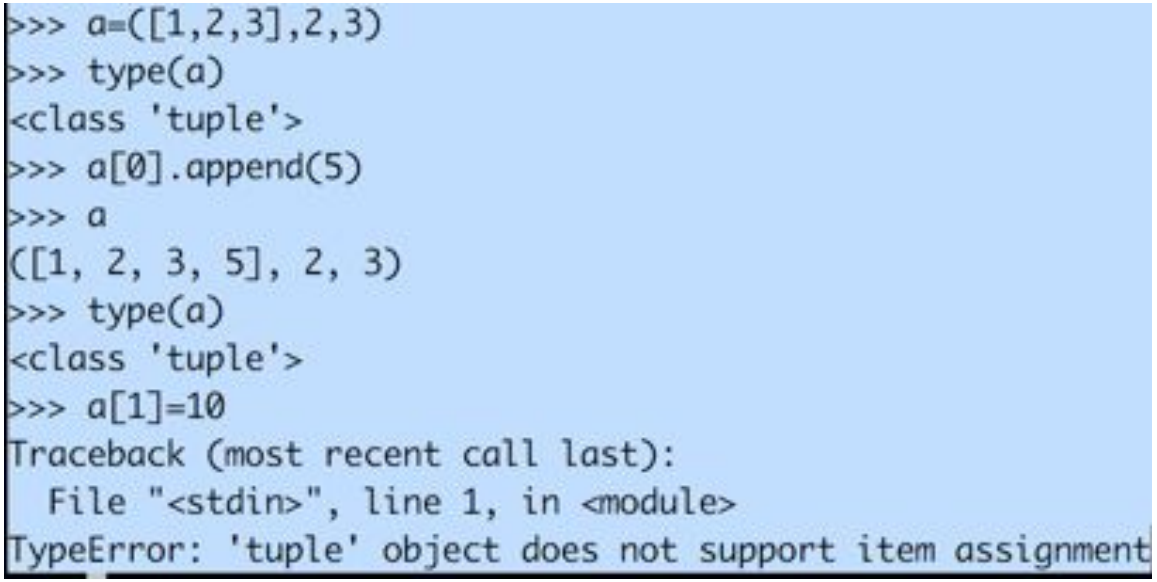
```
>>> a=range(0,9)
>>> a
range(0, 9)
>>> list(a)
[0, 1, 2, 3, 4, 5, 6, 7, 8]
>>> type (a)
<class 'range'>
>>> type (list(a))
<class 'list'>
```



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

Tuples | food for thought

Tuples are immutable but they can contain mutable data types!
What is 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
```

Range Activity | Make these sequences

range(start, stop(exclusive), step)

[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]

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Dictionaries | Define

- **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}
  - a = {‘names’: {‘fred’:1, ‘frank’:3, ‘ben’:1}} **# can be nested (JSON)**
- **Values can be any type**
- **Keys need to be hashable** **# should be immutable**

Dictionaries | Define

- **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}
  - a = {‘names’: {‘fred’:1, ‘frank’:3, ‘ben’:1}} **# can be nested (JSON)**
- **Values can be any type**
- **Keys need to be hashable** **# should be immutable**

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.

Dictionaries | Indexing

<u>instantiation</u>

- dict_x=dict(fred=1, frank=3, ben=1) # assign values to variables (no quotes)
- 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 (single object)
- dict_x=dict ([[‘fred’,1],[’frank’,3], [‘ben’, 1]]) # as a list of lists (single object)

<u>Index by key to get value</u>

```
Dict_x[‘fred’]          # indexing by key name

Dict_x.fred              # dot notation when there are no spaces
```

Dictionaries | More Methods

- **del**(dict_X[‘key']) # delete by key reference
- dict_X.**pop**(‘key’, “default val”) # pop the value for key from dictionary. If the key does not exist, the function will return the default
- dict_X.**get**(‘key’, “default value’)
- dict_X.**clear**()
- dict_X.**update**(dict2) # appends a second dictionary to the first
- dict_X.**keys**()
- dict_X.**values**()
- dict_X.**items**() # get the key:value pairs

List and Dictionary Activity

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.

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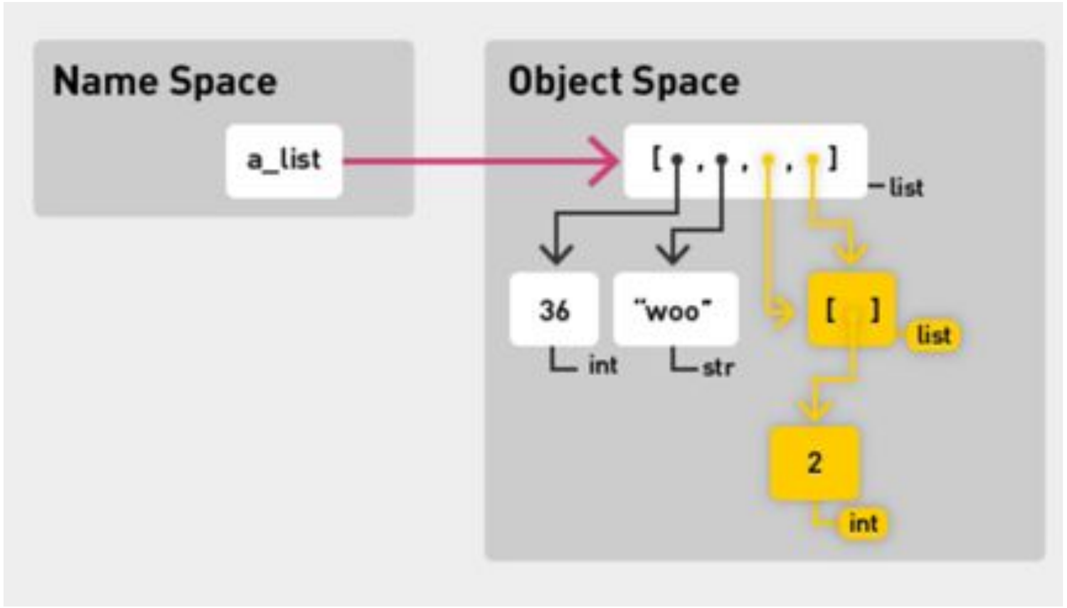
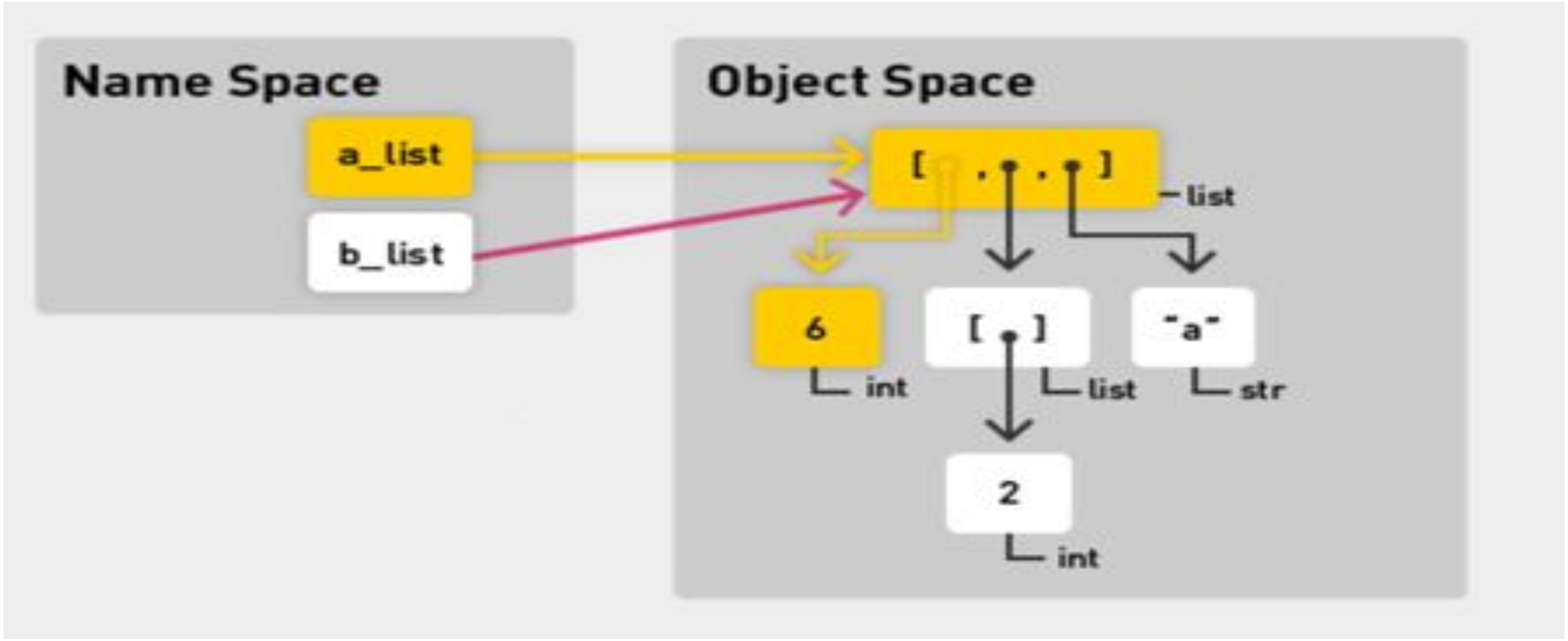
Mutability | Gotcha 1- this list is ***pointing to the same*** object

i.e. items 3 and 4 are the same object.

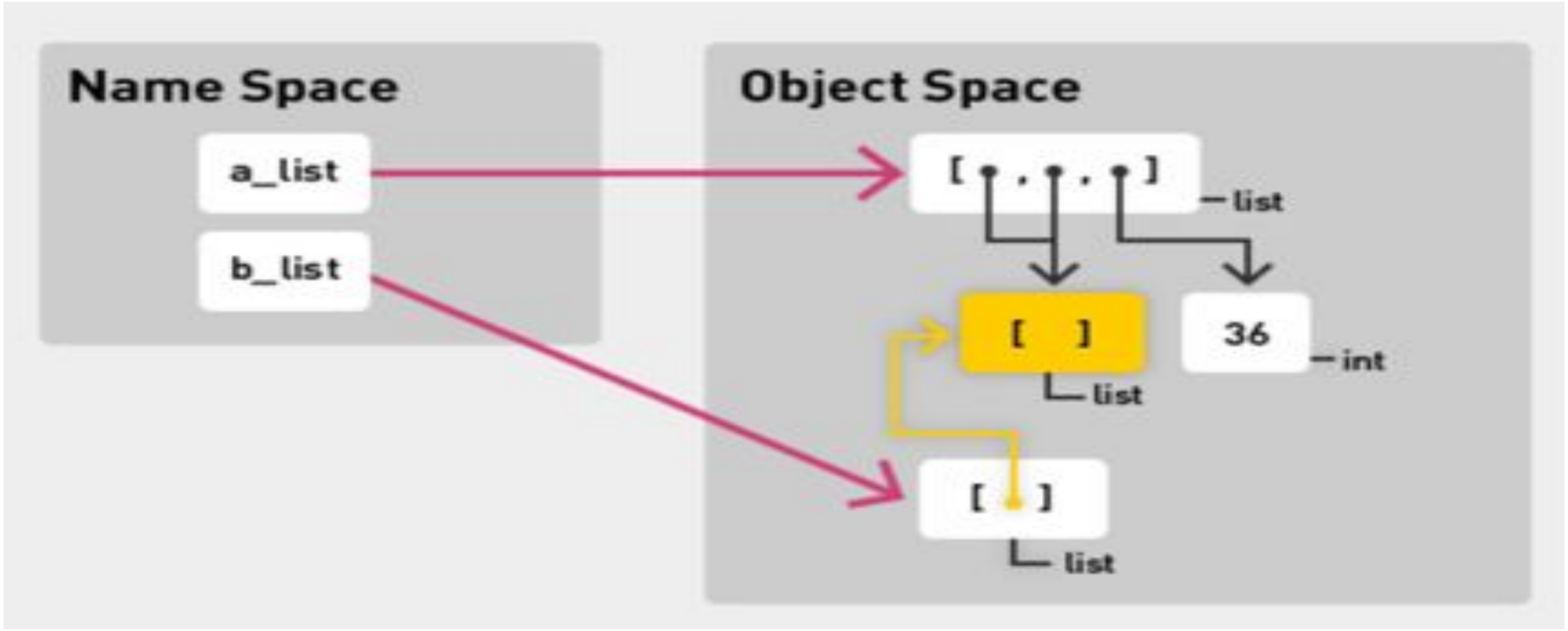
```
[36,"woo", [2], [2]]
```



Mutability | Gotcha 2- object has multiple names



Mutability | Gotcha 3 - object is in distinct lists



Copy and Deep Copy

Consider the code:

```
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’
```

What is copy?

How does copy differ from deepcopy?

What is the final value of Ls_x_cp and Ls_x_deep?

Copy and Deep Copy

Consider the code:

```
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’
```

What is copy?

Copy will create an independent copy of all list elements at the first level of the list

How does copy differ from deepcopy?

Deep copy will create an independent copy of all list elements at all levels

What is the final value of Ls_x_cp and Ls_x_deep?

Ls_x_cp is [1, 2, 3, [‘Frank’, ‘Mufasa’]]   Ls_x_deep is [1, 2, 3, [‘Frank’, ‘Fred’]]

Mutability Activity

A score board reports the ranking and team color of contestants over a week long contest.

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

Your job is to programmatically change the score board as indicated in the exercise

Hint: use copy and/or deep copy if required