

# **Data Mutation and Related Topics**

**CS 8: Introduction to Computer Science, Winter 2019**  
**Lecture #5**

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# Administrative

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- Lab03 – due Friday (*make sure your submission is on there*)
- Hw02 – due today!
- Hw03 – due next week on **MONDAY**
- You can check old homework on GradeScope

# Homework Etiquette

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- Print the PDF for the homework **double sided**.
- Use **dark ink**.
- Write your name **CLEARLY**.
- Do **not staple** your homework.
- Write your name **on each page**.
- Do **not fold, cut or rip** your assignment.
- Keep the homework **stack neat**.

# Lecture Outline

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- Print vs. Return
- The `range()` Function
- Mutability of Variables in Python
  - Caution: may cause temporary headaches! :{

# Print vs. Return

What's the difference between these 2 functions?

```
def return_dbl( x ):  
    return x*2
```

```
def print_dbl( x ):  
    print(x*2)
```

What happens if I do this *in IDLE*?

```
>>> a = 13  
>>> return_dbl(a)  
>>> print_dbl(a)
```

What happens if I do this *in a program*?

```
a = 13  
return_dbl(a)  
print_dbl(a)
```

# Print vs. Return

```
def return dbl( x ):  
    return x*2
```

```
def print dbl( x ):  
    print(x*2)
```

What happens if I do this in IDLE?

```
>>> a = 13  
>>> print(return dbl(a))  
>>> print(print dbl(a))
```

Would it be different in a program?

***Printing vs. returning the output can lead to very different behaviors!!!!***

# Reassignment

- *Def:* change the value of a variable by assigning (using the `=` op.) again

Example:

```
>>> x = 9  
>>> print(x + 4)  
>>> x = 23          # x is reassigned  
etc...
```

# Mutability of Variables

- Consider this function:

```
def DoIt( a, b ):  
    a = b + 1  
    b = a/2  
    print(a, ", ", b)
```

What happens if I do this in IDLE?

```
>>> x = 67  
>>> y = 13  
>>> DoIt( y, x )
```

Answers:

- A. It will print      **67, 13**
- B. It will print      **68, 34**
- C. It will print      **14, 7**
- D. It will print      **8, 7**
- E. Something else

# Mutability of Variables

- Consider this function:

```
def DoIt( a, b ):  
    a = b + 1  
    b = a/2  
    print(a, ", ", b)
```

*Why didn't the **DoIt()** function NOT change the value of the Python shell variables **a, b** ?*

What happens if I do this *in IDLE*?

```
>>> a = 67  
>>> b = 13  
>>> DoIt( b, a )  
>>> print(a, ", ", b)
```

**Answers:**

- A. Prints **68 , 34** then **68 , 34** on another line
- B. Prints **68 , 34** then **67 , 13** on another line
- C. Prints **14 , 7** then **14 , 7** on another line
- D. Prints **14 , 7** then **67 , 13** on another line
- E. Something else

# Mutability of Variables

- Consider this function:

```
def DoIt( a, b ):  
    a = b + 1  
    b = a/2  
    print(a, ", ", b)
```

Why didn't the **DoIt()** function NOT change the value of the Python shell variables *a*, *b* ?

What happens if I do this in IDLE?

```
>>> a = 67  
>>> b = 13  
>>> DoIt( b, a)  
>>> print(a, ", ", b)
```

*These are treated as different a's and b's!*  
*Reassignment within the function has NO EFFECT on the variables in the Python shell / rest of the Python program.*

# Mutability of Variables

- Let's try another one:

```
def mutate( a ):  
    a[0] = a[1] + 1  
    a[1] = a[0]/2  
    print(a[0], ", " , a[1])
```

What happens if I do this in IDLE?

```
>>> x = [ 67, 13 ]  
>>> mutate(x)  
>>> print(x)
```

Answer:

It prints:

```
[ 14 , 7 ]
```

# Mutability of Variables

- Let's try another one:

```
def mutate( a ):  
    a[0] = a[1] + 1  
    a[1] = a[0]/2  
    print(a[0], ", " , a[1])
```

What happens if I do this in IDLE?

```
>>> x = [ 67, 13 ]  
>>> mutate(x)  
>>> print(x)
```

Answer:

It prints:

```
[ 14 , 7 ]  
[ 14 , 7 ]
```

**The list WAS changed by the function!!**

# Mutable vs. Immutable data

Changeable types

list

Turtle (more on this later)

dictionary (more on this later)

*Any user-defined object*

**vs.**

Unchangeable types

float int

str bool

# Lists are Mutable Data

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For example, if the list `myL` is defined as follows:

```
myL = [ 1, 2, 3, 4]
```

and then I do this: `myL[3] = 42`

`myL` now becomes: `[1, 2, 3, 42]`

# The `range()` Function

- Built-in function in Python provides a handy list
- Simplest use: `range(n)`
  - Creates a *something that looks like a list* with `n` items: `[0, 1, 2, ..., n-1]`

- Example:

```
>>> print( list(range(5)) )
```

Will print out:

```
[0, 1, 2, 3, 4]
```

# The `range()` Function

- You can also do a `range()` with **start & stop** parameters.
- Example:

```
>>> print (list( range(5, 8) ) )
```

This will print out the list [5, 6, 7] (note it excludes 8)

- Or you can have **start, stop and step** parameters.
- Example:

```
>>> print (list( range(1, 11, 4) ) )
```

This will print out the list [1, 5, 9]

Will come in **very** handy when we learn about loops!

# Reassignment vs. Data Mutation

If I do this:

```
myL = list(range(1, 5))      myL = [1, 2, 3, 4]
```

Then I do this:

```
myL = list(range(10, 13))   mL = [10, 11, 12]
```

This is a REASSIGNMENT of the variable **myL**  
(I *completely changed* variable **myL**)

# Reassignment vs. Data Mutation

But, if I do this (again):

```
myL = list(range(1, 5))      myL = [1, 2, 3, 4]
```

Then I do this:

```
myL[1] = 10                  mL = [1, 10, 11, 4]  
myL[2] = 11
```

This is ***changing the object*** that **myL** references!  
It's NOT a reassignment of **myL**!

# So What...?

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- It matters because variables are really a *reference* to some value
- Note that if I do the following:

```
>>> myL = list(range(1,5))
>>> yourL = myL
>>> print (yourL[1])          # this prints 2
```

# But Wait!...

- And now note  
that if I do this:

## Explanation

- **myL** references [1,2,3,4]
- **yourL** references what **myL** references
- If something in **yourL** changes, then it is reflected in **myL** also!

```
>>> myL = list(range(1,5))
>>> yourL = myL
>>> yourL[1] = 100
>>> print (myL[1])          # prints 100, not 1!!!
```

# One More Thing...

- Now note that if I do this:

```
>>> myL = list(range(1,5))
>>> yourL = myL
>>> myL = list(range(7, 10))
>>> myL[1] = 42
>>> print(yourL[1])          # prints 2, not 42!!!
```

## Explanation

- `myL` references [1,2,3,4]
- `yourL` references what `myL` references
- I reassigned `myL` completely: this “detaches” `yourL` from `myL`’s reference
- If I change something in `myL`, it’s not reflected anymore on `yourL`

# Summary of Findings...

- **Mutable** is a type of variable that can be changed (Lists are mutable)
- **Immutables** are the objects whose state *cannot* be changed once the object is created (Strings and numbers are immutable)

*Example:*

```
msg = "Hello"  
msg = msg + " World"  
print(msg)    # Will print out "Hello World"
```

- On appending the variable `msg` with a string value, the following events occur:
  - The existing value of string `msg` is retrieved
- "World" is appended to the existing value of string `msg`
- The resultant value is then allocated to a new block of memory
- The `msg` object now points to the *newly created memory space*

# Functions and Immutable Variables

- Let's say I have  $x = 7$  and  $y = 9$  and I want to swap their values, so that  $x = 9$  and  $y = 7$ 
  - There's a classic algorithm for that...

```
tmp = x  
x = y  
y = tmp
```

- But, what if I want to do this through a function `swap(a,b)`
- **Can I do that?**
  - Let's see...

# Swap Function: Will it Work or Not?

```
>>> def swap(a,b):  
    temp = a  
    a = b  
    b = temp
```

```
>>> x = 5  
>>> y = 10  
>>> swap(x,y)  
>>> print(x, y)  
5 10
```

⌚ D'oh!

## Explanation

- That's because I was dealing with **immutable objects** (ints)!!!!

# Functions and *Mutable* Variables

- Let's say I have a list `myL = [ 2, 4, 6 ]` and I want to swap the values in position 1 and position 2
  - That is, I want `myL` to become `[ 2, 6, 4 ]`
- I want to do this through a function `swap(L, p1, p2)`
- **Can I do that?**
  - Let's see...

# Swap Function: Will it Work or Not?

```
>>> def swap(L, p1, p2):
    temp = L[p1]
    L[p1] = L[p2]
    L[p2] = temp
>>> myL = [2, 4, 6]
>>> swap(myL, 1, 2)
>>> print(myL)
[2, 6, 4]  Yay!
```

## Explanation

- That's because I was dealing with **mutable objects** (a list)!!!!

# Big Conclusion!

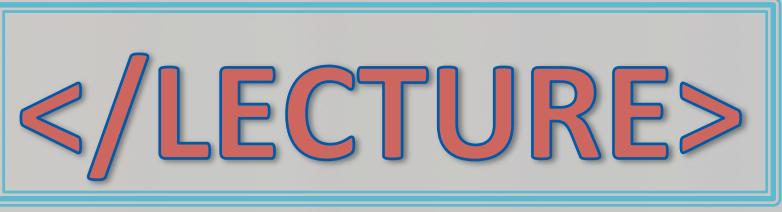
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- You can change **the contents of lists** inside **functions** that take those lists as input.
  - Actually, lists or any *mutable object*...
- Those changes will be visible **everywhere**.
  - Immutable objects (like ints) are safe from these shinanigans, however...

# YOUR TO-DOS

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- Finish reading **Chapter 3**
- Start reading **Chapter 5**
- Start on **HW3** (due next **MONDAY**)
- Do **Lab2** (turn it in by **Friday**)
  
- Dance like you mean it



</LECTURE>