CS177 Python Programming

Recitation 6:
Loop Structures and Booleans

Before starting, let’s review

- Variables: “mutable” vs “non-mutable”
- Garbage Collection
- How we pass arguments to a function

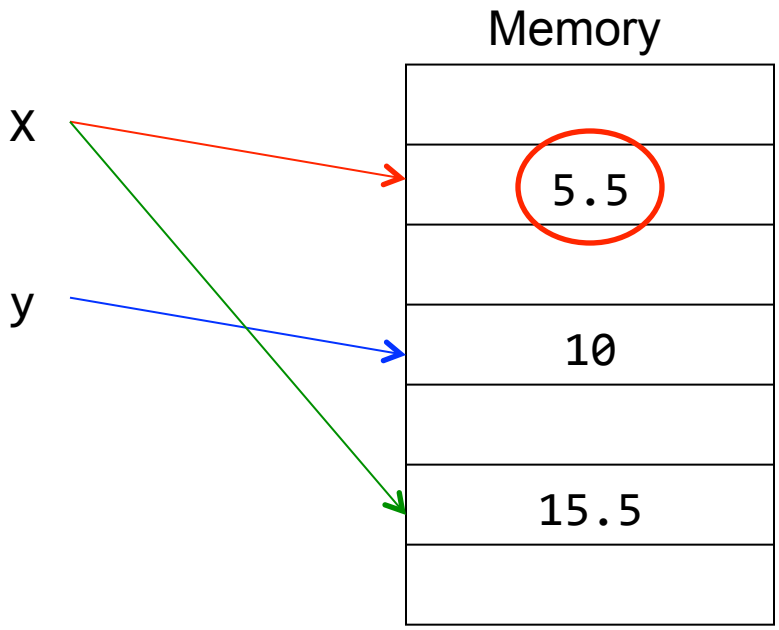
Mutable vs Non-Mutable

- Mutable Variables:
  - lists
- Non-Mutable Variables:
  - int, float, string

What does it mean?

Non-Mutable Variables: int, float

```
def main():
    x = 5.5

    y = 10

    x = x + y
```

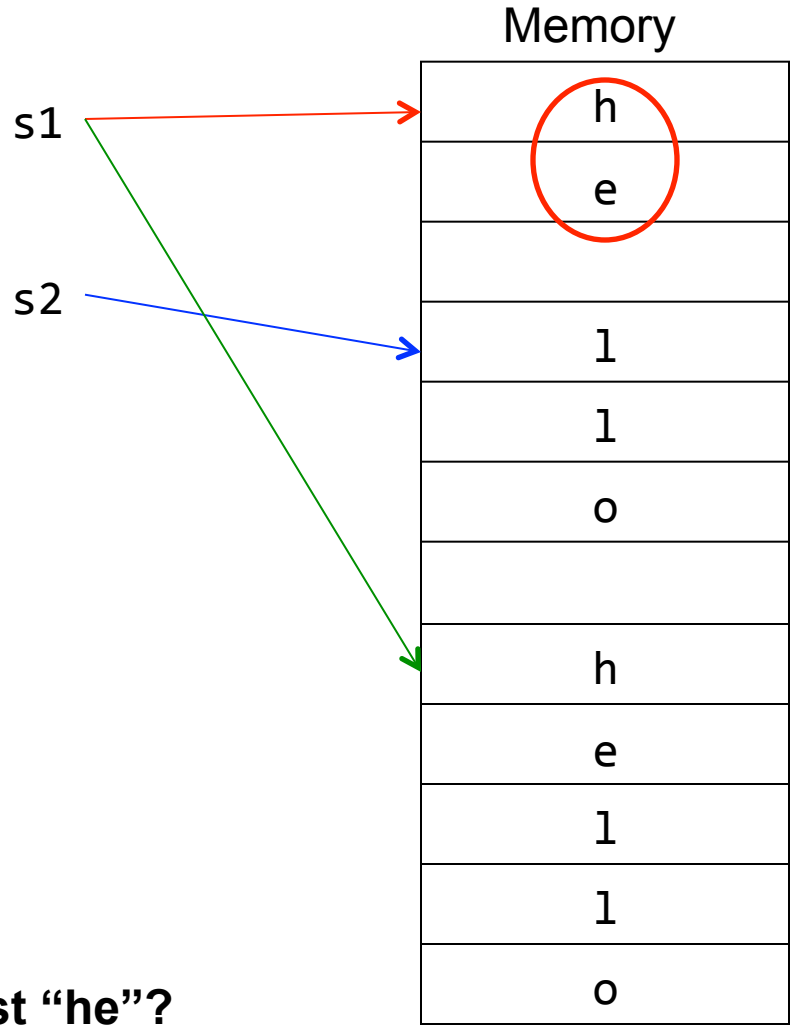


What happens with the first 5.5?

The **Garbage Gollection** process will eventually remove it when there is no any variable referencing to it any more.

Non-Mutable Variables: Strings

```
def main():
  s1 = “he”

  s2 =“llo”

  s1 = s1 + s2
```

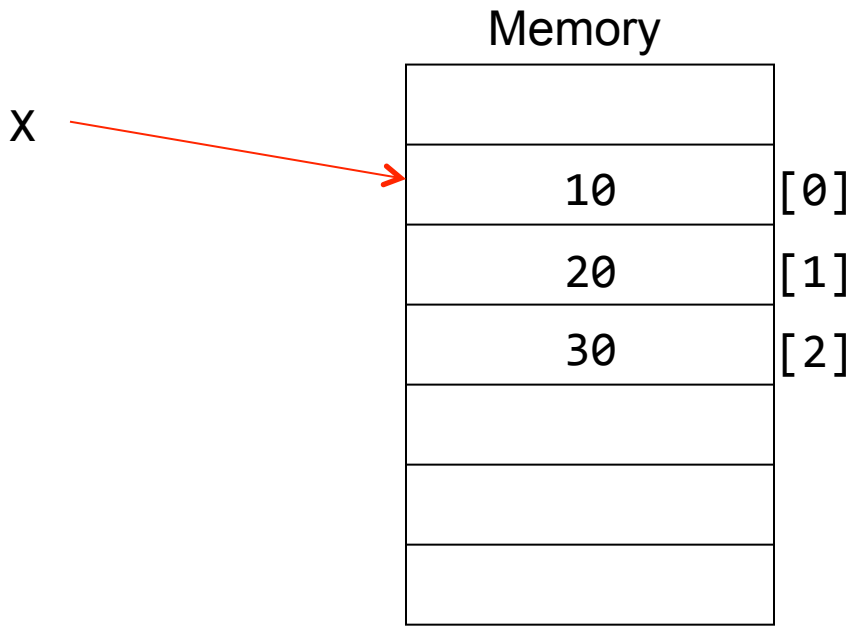


What happens with the first “he”?

The **Garbage Collection** process will eventually remove it when there is no any variable referencing to it any more.

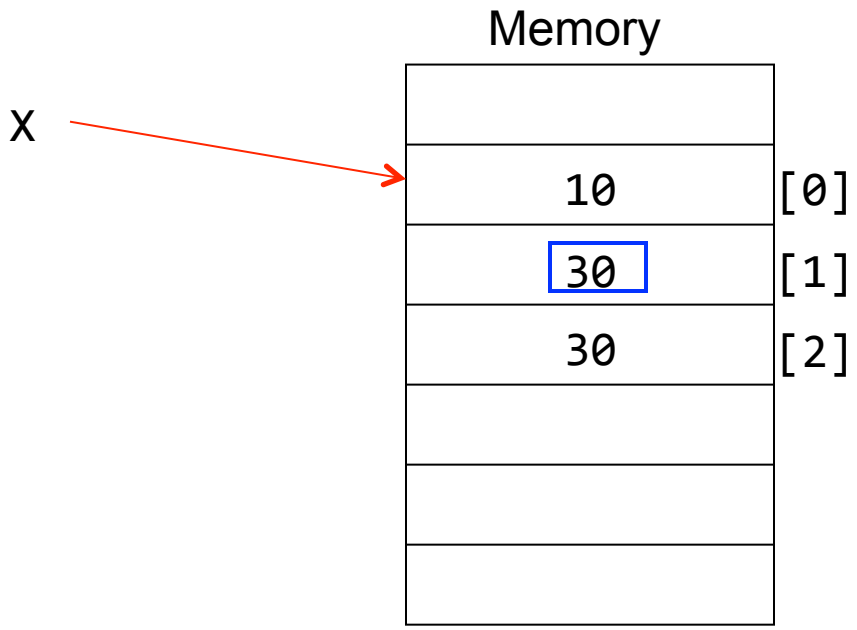
Mutable Variables: Lists

```
def main():
  x = [10,20,30]

  x[1] = x[1] + 10

  x[2] = x[1] + 10
```



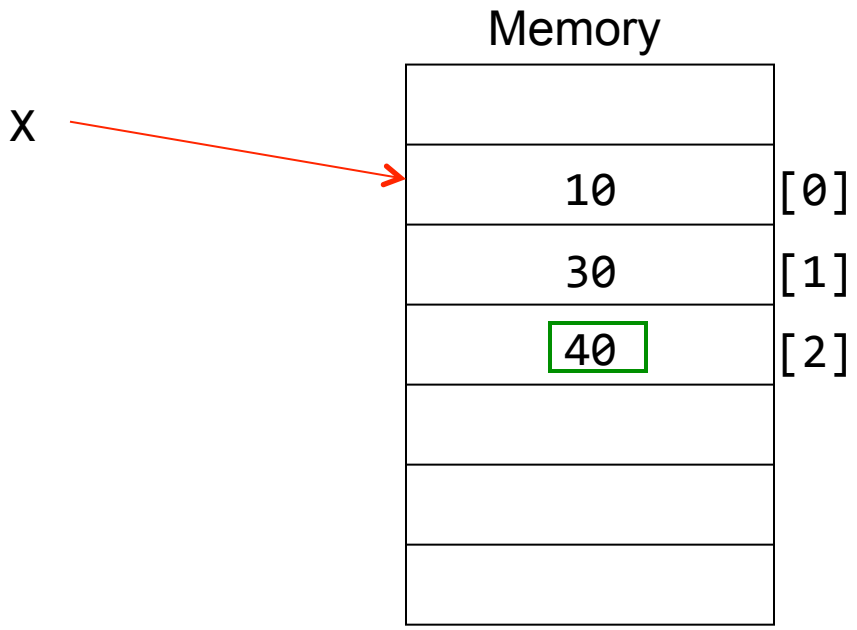
Mutable Variables: Lists

```
def main():
  x = [10,20,30]

  x[1] = x[1] + 10

  x[2] = x[1] + 10
```



Mutable Variables: Lists

```
def main():
  x = [10,20,30]

  x[1] = x[1] + 10

  x[2] = x[1] + 20
```



See the difference

- Values of a list are continuously stored in memory
- Changes are stored in the same memory location
- **Garbage Collection** mechanism does not operate here

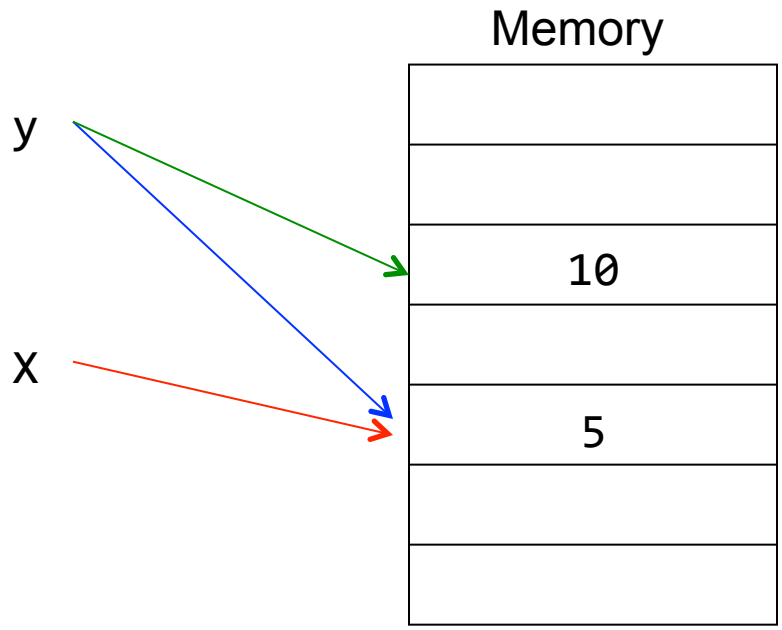
How does it affect passing arguments to functions

- Mutable Variables:
  - Changes done to the variable in the called function will be reflected in the caller function
- Non-Mutable
  - Changes done to the variable in the called function will NOT be reflected in the caller funtion

Let's see why

Passing Non-Mutable Variables

```
def test(y):
    y = y + 5

def main():
    x = 5

    test(x)

    print(x)
```



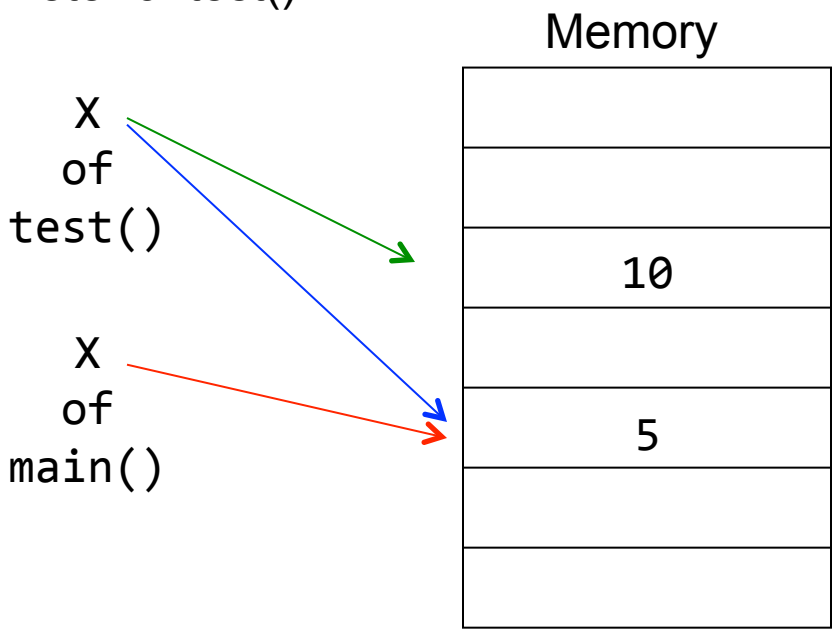
Notice:

- In test() changes to the **y** variable will be stored in a new position. The **x** variable in main will continue referencing to the number 5.
- The print (x) statement in main will generate 5.

Passing Non-Mutable Variables

Would it be different if the parameter of test() is called **x** instead of **y**?

```
def test(x):
    x = x + 5

def main():
    x = 5
    test(x)
    print(x)
```

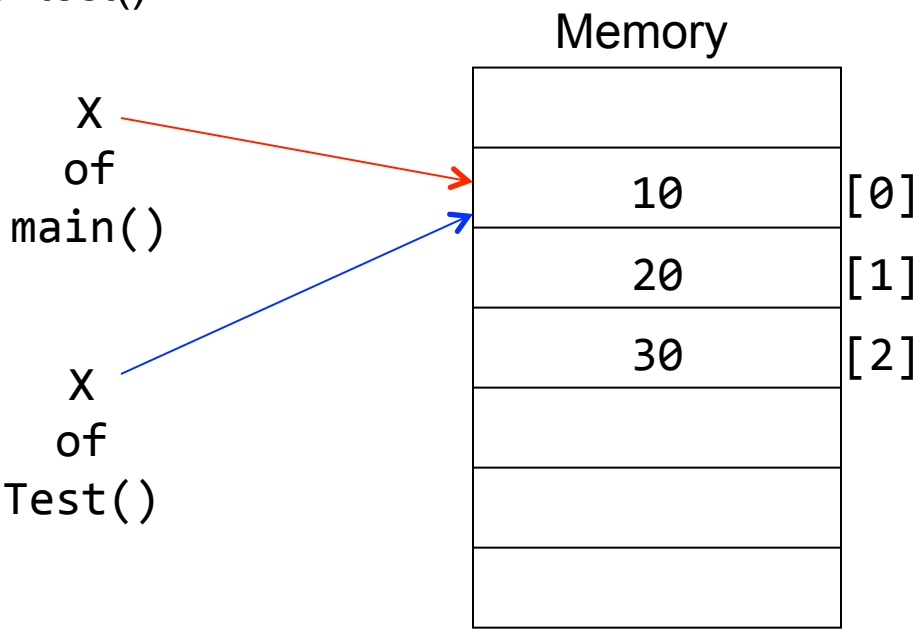


NO…print(x) in main() will generate 5

Passing Mutable Variables

Would it be different if the parameter of test() is called **x** instead of **y**?

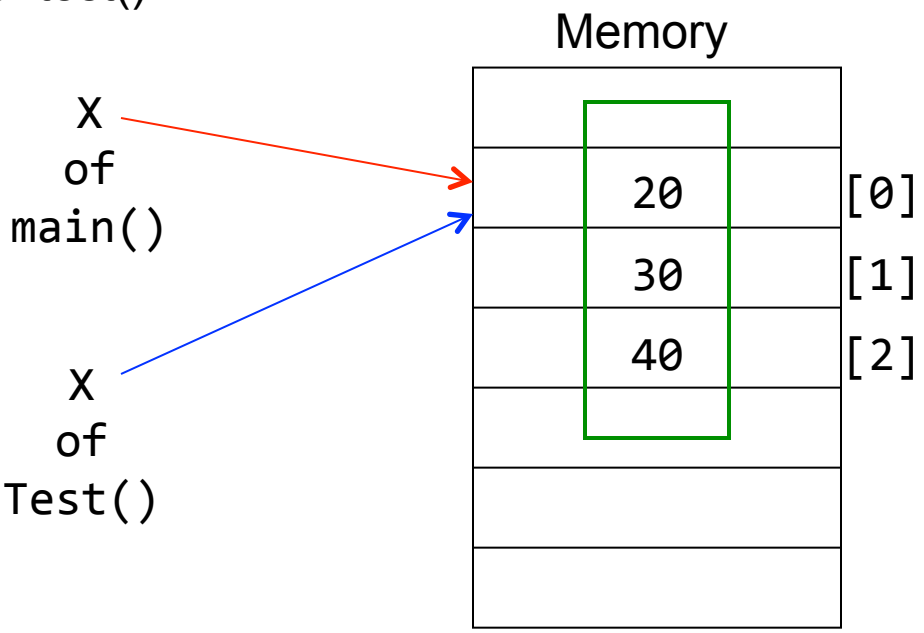
```
def test(x):
    for i in range (len(x)):
        x[i] = x[i] + 10

def main():
    x = [10,20,30]

    test(x)

    print(x)
```



Passing Mutable Variables

Would it be different if the parameter of test() is called **x** instead of **y**?

```
def test(x):
    for i in range (len(x)):
        x[i] = x[i] + 10

def main():
    x = [10,20,30]

    test(x)

    print(x)
```



print(x) in main will generate [20, 30, 40]

Today's topics

- Exception Handling (Chapter 7)
- Chapter 8:
  - Loop Structures
  - Booleans

Exception Handling

- Let's consider a program that solve quadratic equations? Let's call it quadratic solver.
- What can go wrong at first glance?

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

This can be negative and produce an **ValueError**

What can you do then?

Exception Handling

- You might use decision structures and check that the value is non-negative before using math.sqrt()

Exception Handling

```
# quadratic4.py
import math

def main():
    print "This program finds the real solutions to a quadratic\n"

    a, b, c = input("Please enter the coefficients (a, b, c): ")

    discrim = b * b - 4 * a * c
    if discrim < 0:
        print "\nThe equation has no real roots!"
    elif discrim == 0:
        root = -b / (2 * a)
        print "\nThere is a double root at", root
    else:
        discRoot = math.sqrt(b * b - 4 * a * c)
        root1 = (-b + discRoot) / (2 * a)
        root2 = (-b - discRoot) / (2 * a)
        print "\nThe solutions are:", root1, root2
```

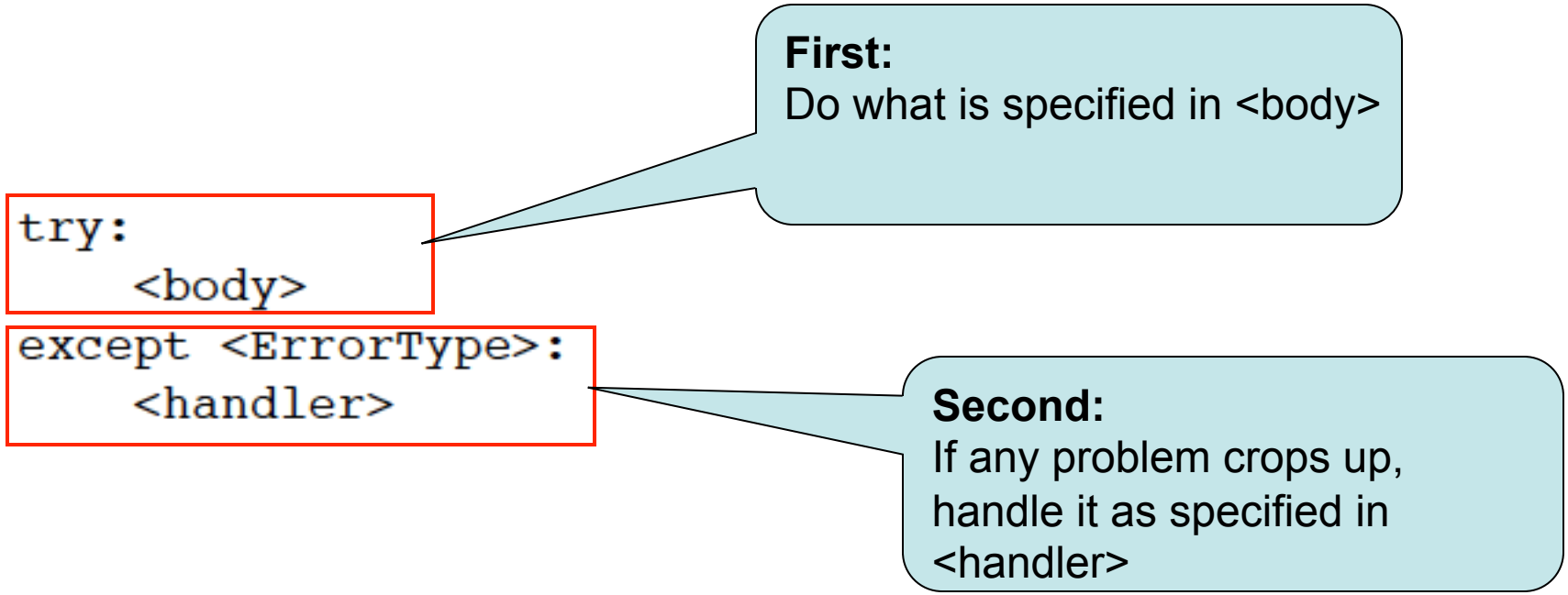
Exception Handling

What is wrong with this mechanism?

- This is “old-fashion” manner. Programming languages such as C require this.
- You can have a program that will need checking too many special cases… you **will code a lot** just to avoid errors
- There can be many causes of errors… How to know what to check?

Exception Handling

- Python includes in its design an Exception Handling mechanism to solve this limitation



Let's see how to use try…except with the same example

Exception Handling

```
# quadratic5.py
import math

def main():
    print "This program finds the real solutions to a quadratic\n"

    try:
        a, b, c = input("Please enter the coefficients (a, b, c): ")
        discRoot = math.sqrt(b * b - 4 * a * c)
        root1 = (-b + discRoot) / (2 * a)
        root2 = (-b - discRoot) / (2 * a)
        print "\nThe solutions are:", root1, root2
    except OverflowError:
        print "\nNo real roots"
```

The Magic Words: Here we first attempt and in case of error we print a message

Exception Handling

What is nice with try…except?

- It can be used to catch any kind of error
- Besides error caused for using math.sqrt() with a negative number (**ValueError**) we have:
  - User fails to type correct inputs (different type of **ValueError**)
  - If user types an identifier instead of a number (**NameError**)
  - If input is not a valid Python expression (**SyntaxError**)
  - If user types a valid Python expression that produces non-numerical results (**TypeError**)

Exception Handling

The Magic Words dealing with several types of errors

```
# quadratic6.py
import math

def main():
    print "This program finds the real solutions to a quadratic\n"

    try:
        a, b, c = input("Please enter the coefficients (a, b, c): ")
        discRoot = math.sqrt(b * b - 4 * a * c)
        root1 = (-b + discRoot) / (2 * a)
        root2 = (-b - discRoot) / (2 * a)
        print "\nThe solutions are:", root1, root2
    except OverflowError:
        print "\nNo real roots"
    except ValueError:
        print "\nYou didn't give me three coefficients."
    except NameError:
        print "\nYou didn't enter three numbers"
    except TypeError:
        print "\nYour inputs were not all numbers"
    except:
        print "\nSomething went wrong, sorry!"
```

Loop Structures

Definite Loop:

```
for <var> in <sequence>:
    <body>
```

Example:

```
for i in range(10):
    print(i)
```

Here, it will iterate through a pre-defined sequence.

Indefinite Loop:

```
while <condition>:
    <body>
```

Here, it will iterate while the condition is True.

Example:

```
i = 0
While i < 10:
    print(i)
    i = i + 1
```

Note: if i is not incremented it will loop for ever

Loop Structures

Definite Loop:

```
for <var> in <sequence>:
    <body>
```

Results:

```
>>> for i in range(10):
        print(i)


0
1
2
3
4
5
6
7
8
9
>>>
```

Indefinite Loop:

```
while <condition>:
    <body>
```

Results:

```
>>> i = 0
>>> while i < 10:
        print(i)
        i = i + 1


0
1
2
3
4
5
6
7
8
9
>>>
```

Loop Structures

Let's define a problem to be able to compare:

Problem: Find the average of series of numbers entered by the user

$$\overline{X} = \frac{X_1 + X_2 + X_3 + \ldots + X_n}{n}$$

Loop Structures

Solution to the problem using **for**:

Algorithm:

```
Input the count of the numbers, n
Initialize sum to 0
Loop n times
    Input a number, x
    Add x to sum
Output average as sum / n
```

Output

```
How many numbers do you have? 5
Enter a number >> 32
Enter a number >> 45
Enter a number >> 34
Enter a number >> 76
Enter a number >> 45

The average of the numbers is 46.4
```

Code:

```
# average1.py

def main():
    n = input("How many numbers do you have? ")
    sum = 0.0
    for i in range(n):
        x = input("Enter a number >> ")
        sum = sum + x
    print "\nThe average of the numbers is", sum / n
```

Here, the value of n is entered before looping

Loop Structures

Solution to the problem using **interactive loop with while**:

Algorithm:

```
set moredata to "yes"
while moredata is "yes"
    get the next data item
    process the item
    ask user if there is moredata
```

Output

```
Enter a number >> 32
Do you have more numbers (yes or no)? yes
Enter a number >> 45
Do you have more numbers (yes or no)? y
Enter a number >> 34
Do you have more numbers (yes or no)? y
Enter a number >> 76
Do you have more numbers (yes or no)? y
Enter a number >> 45
Do you have more numbers (yes or no)? nope
The average of the numbers is 46.5
```

Code:

```
# average2.py

def main():
    sum = 0.0
    count = 0
    moredata = "yes"
    while moredata[0] == "y":
        x = input("Enter a number >> ")
        sum = sum + x
        count = count + 1
        moredata = raw_input("Do you have more numbers (yes or no)? ")
    print "\nThe average of the numbers is", sum / count
```

Condition is validated: y[0] is the first letter

User decides if there is another input value

Loop Structures

Solution to the problem using **sentinel loop with while**:

Algorithm:

```
get the first data item
while item is not the sentinel
    process the item
    get the next data item
```

Output

```
Enter a number (negative to quit) >> 32
Enter a number (negative to quit) >> 45
Enter a number (negative to quit) >> 34
Enter a number (negative to quit) >> 76
Enter a number (negative to quit) >> 45
Enter a number (negative to quit) >> -1

The average of the numbers is 46.4
```

Code:

```
# average3.py

def main():
    sum = 0.0
    count = 0
    x = input("Enter a number (negative to quit) >> ")
    while x >= 0:
        sum = sum + x
        count = count + 1
        x = input("Enter a number (negative to quit) >> ")
    print "\nThe average of the numbers is", sum / count
```

Here one of the input values entered by the user is checked in the condition

Value entered by the user (no question required)

Loop Structures

What can go wrong with interactive loop and sentinel loop?

- What if a user makes a mistake when entering the 98^{th} number to be averaged?

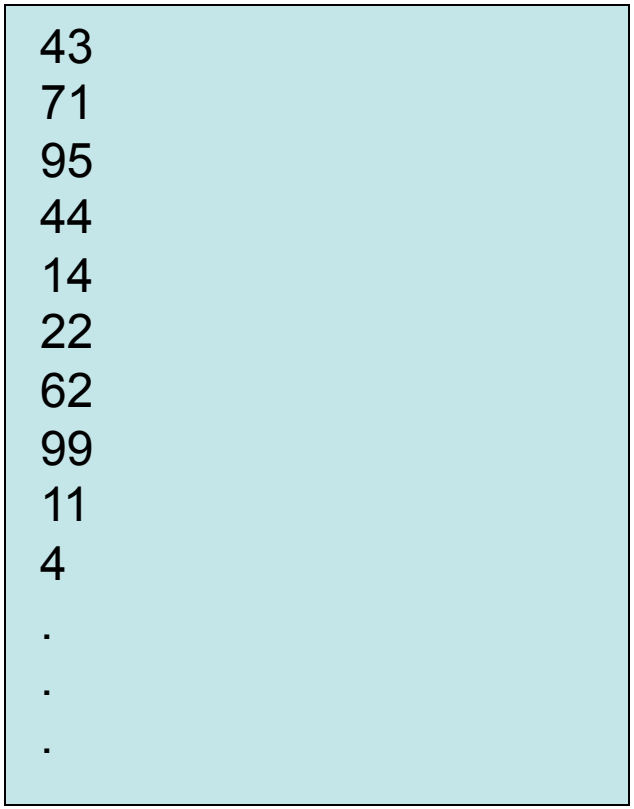
- Does he have to start over?

- What if the user write all the values in a file (one number per line) and just read the file and compute the average. **Let's see this implementation with both for and while**

Loop Structures

Solution to the problem using **file loops:**

File with the numbers to be averaged



List_Numbers.txt

Loop Structures

Solution to the problem using **file loop with for**:

```
# average5.py

def main():
    fileName = raw_input("What file are the numbers in? ")
    infile = open(fileName,'r')
    sum = 0.0
    count = 0
    for line in infile.readlines():
        sum = sum + eval(line)
        count = count + 1
    print "\nThe average of the numbers is", sum / count
```

Read name of the file from user

Remember readlines() reads a file as a list of strings where each element is a line of the file. In this case just one of the numbers to be averaged

Loop Structures

Solution to the problem using **file loop with while**:

```
# average6.py

def main():
    fileName = raw_input("What file are the numbers in? ")
    infile = open(fileName,'r')
    sum = 0.0
    count = 0
    line = infile.readline()
    while line != "":
        sum = sum + eval(line)
        count = count + 1
        line = infile.readline()
    print "\nThe average of the numbers is", sum / count
```

Read name of the file from user

readline() reads next line of the file as a string. In this case just one of the numbers to be averaged

Loop Structures

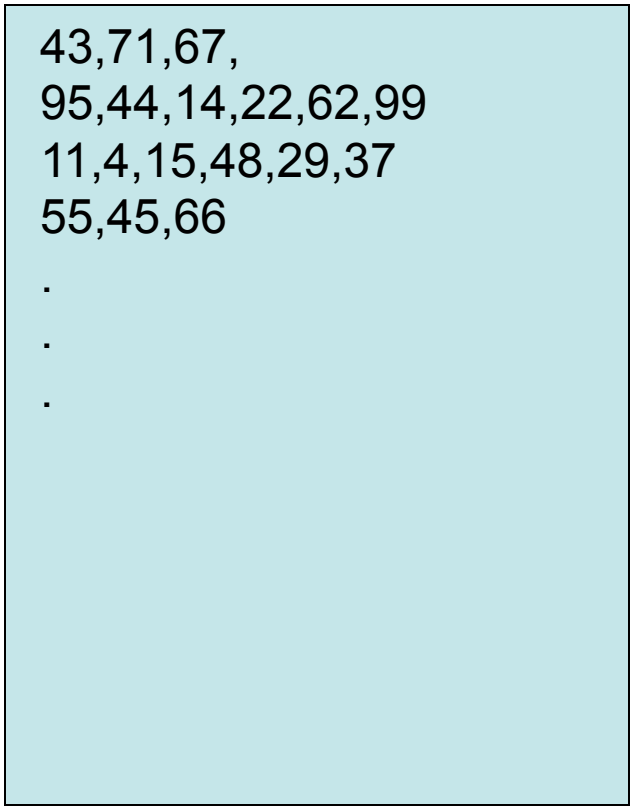
What would happen if the file contains several numbers separated by comma in the same line?

- We could treat each line as a sub-file and apply any of the algorithms previously seen.
- **How? Using Nested Loops**

Loop Structures

Solution to the problem using **nested loops:**

File with the numbers to be averaged



List_Numbers.txt

Loop Structures

Solution to the problem using **nested loops**:

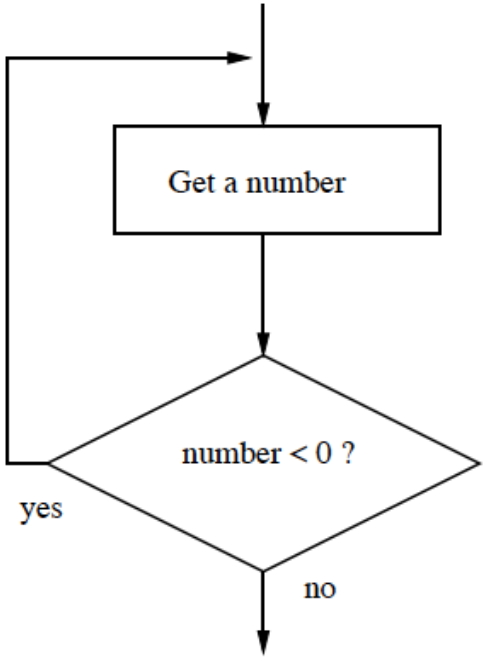
```
# average7.py
import string

def main():
    fileName = raw_input("What file are the numbers in? ")
    infile = open(fileName,'r')
    sum = 0.0
    count = 0
    line = infile.readline()
    while line != "":
        # update sum and count for values in line
        for xStr in string.split(line):
            sum = sum + eval(xStr)
            count = count + 1
        line = infile.readline()
    print "\nThe average of the numbers is", sum / count
```

Read name of the file from user

Outer loop: ends when it finds a empty line

Inner loop: iterate over every number in the line

Loop Structures



Other common patterns

```
repeat
    get a number from the user
until number is >= 0
```

Two ways to implement it:

Way 1:

```
number = -1  # Start with an illegal value to get into the loop.
while number < 0:
    number = input("Enter a positive number: ")
```

Way 2: Known as Loop and A Half

```
while 1:
    number = input("Enter a positive number: ")
    if x >= 0: break # Exit loop if number is valid.
```

Pay attention to the new key word “break”

Booleans

Let's say we want to know if two points objects are in the same position?

Instead of this:

```
if p1.getX() == p2.getX():
    if p1.getY() == p2.getY():
        # points are the same
    else:
        # points are different
else:
    # points are different
```

We do:

```
if p1.getX() == p2.getX() and p2.getY() == p1.getY():
    # points are the same
else:
    # points are different
```

One of the boolean operators. I addition we will see OR and NOT

Booleans

Remember, in a previous class we saw the True Tables of the boolean operators

P	Q	P and Q
T	T	T
T	F	F
F	T	F
F	F	F

P	Q	P or Q
T	T	T
T	F	T
F	T	T
F	F	F

P	not P
T	F
F	T

SUMMARY:

AND: True when **both** P and Q are **True**

OR: True when **any or both** are **True**. Also you can remember that it is False when both P and Q are False

Booleans

You can use algebra to remember some results

Algebra	Boolean algebra
$a * 0 = 0$	a and false == false
$a * 1 = a$	a and true == a
$a + 0 = a$	a or false == a

SUMMARY:

False = 0

True = 1

AND = * (Multiplication)

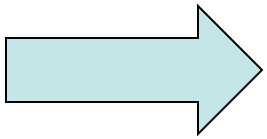
OR = + (Addition)

a = our boolean variable

Booleans

How the conversion of values is evaluated?

```
>>> bool(0)
False
>>> bool(1)
True
>>> bool(32)
True
>>> bool("hello")
True
>>> bool("")
False
>>> bool([1,2,3])
True
>>> bool([])
False
>>>
```



```
>>> while 32:
        print(3)


3
3
3
3
3
3
3
3
3
3
```

The while() statement includes an implicit cast boolean() to any specified condition

Thank you!