

# Loops and Iteration

## Chapter 5



Python for Informatics: Exploring Information  
[www.py4inf.com](http://www.py4inf.com)



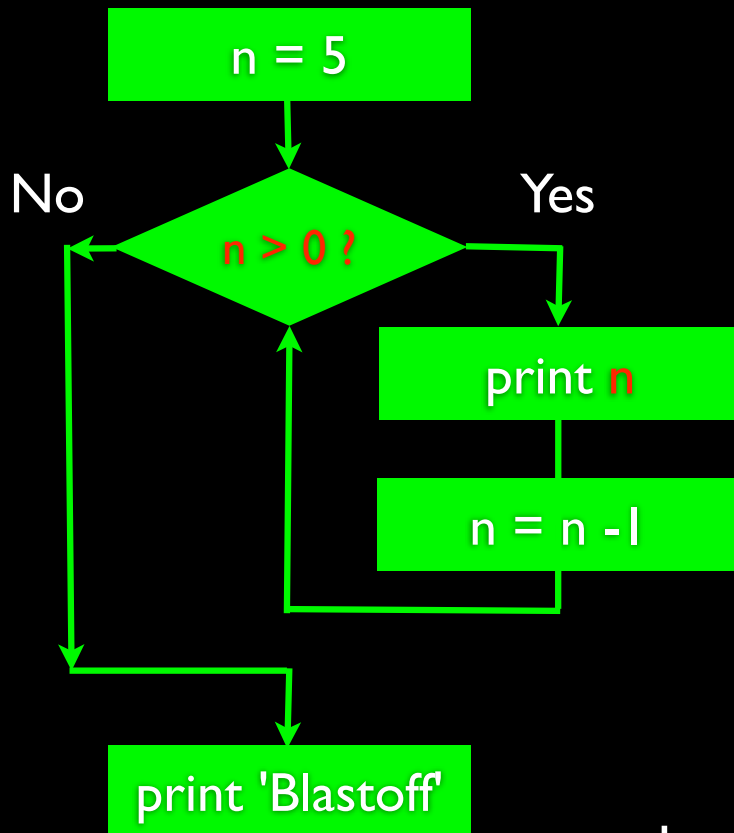
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# Repeated Steps



Program:

```
n = 5
while n > 0 :
    print n
    n = n - 1
print 'Blastoff!'
```

Output:

```
5
4
3
2
1
Blastoff!
```

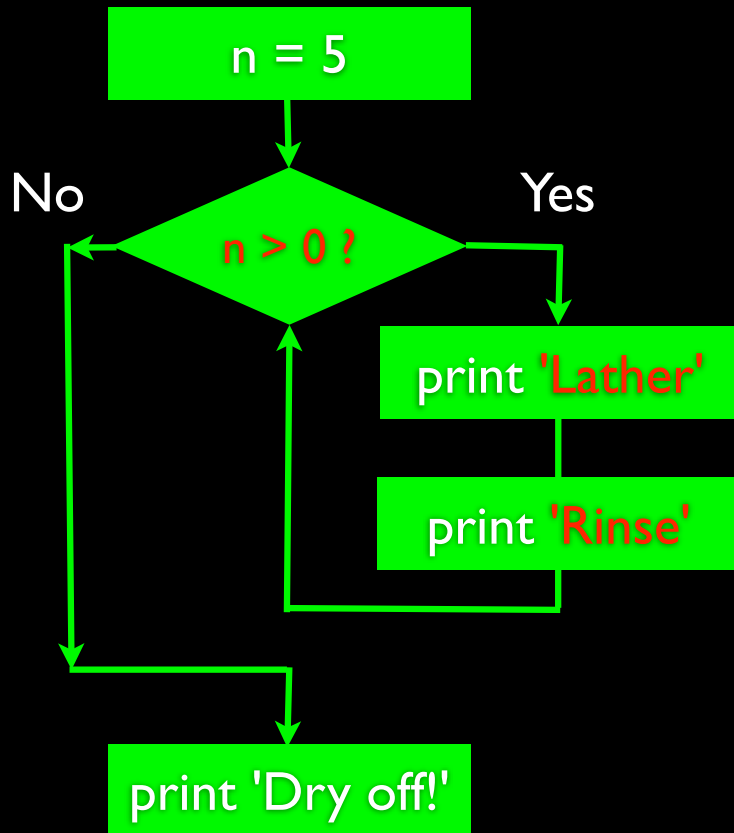
Loops (repeated steps) have **iteration variables** that change each time through a loop. Often these **iteration variables** go through a sequence of numbers.

# An Infinite Loop

```
n = 5
while n > 0 :
    print 'Lather'
    print 'Rinse'

print 'Dry off!'
```

What is wrong with this loop?

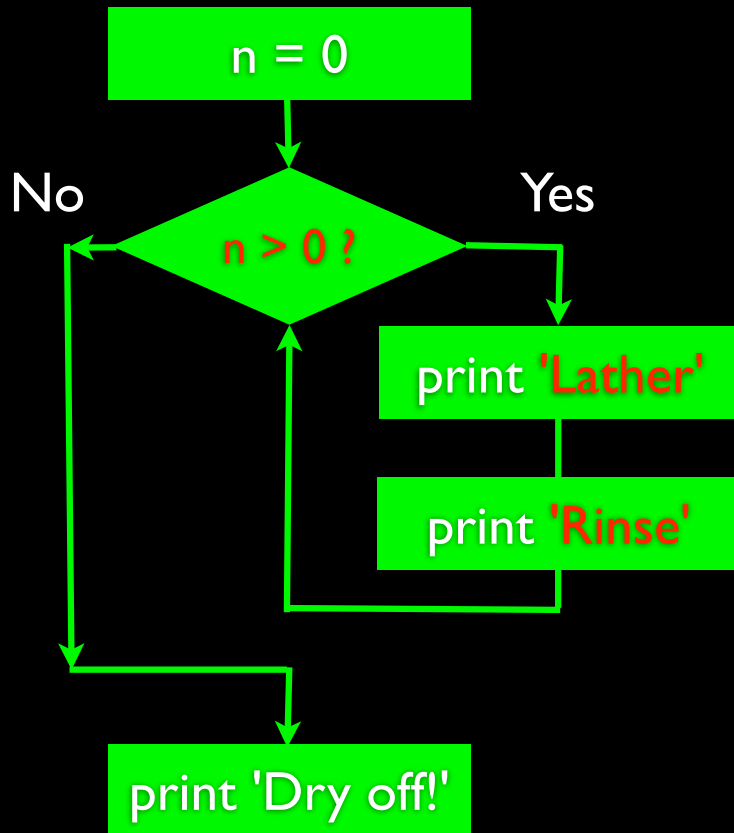


# Another Loop

```
n = 0
while n > 0 :
    print 'Lather'
    print 'Rinse'

print 'Dry off!'
```

What does this loop do?



# Breaking Out of a Loop

- The **break** statement ends the current loop and jumps to the statement immediately following the loop
- It is like a loop test that can happen anywhere in the body of the loop

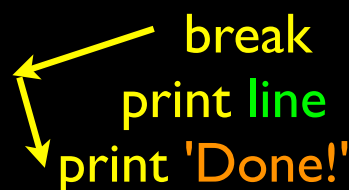
```
while True:
    line = raw_input('> ')
    if line == 'done':
        break
    print line
print 'Done!'
```

```
> hello there
hello there
> finished
finished
> done
Done!
```

# Breaking Out of a Loop

- The **break** statement ends the current loop and jumps to the statement immediately following the loop
- It is like a loop test that can happen anywhere in the body of the loop

```
while True:
    line = raw_input('> ')
    if line == 'done':
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    print line
print 'Done!'
```

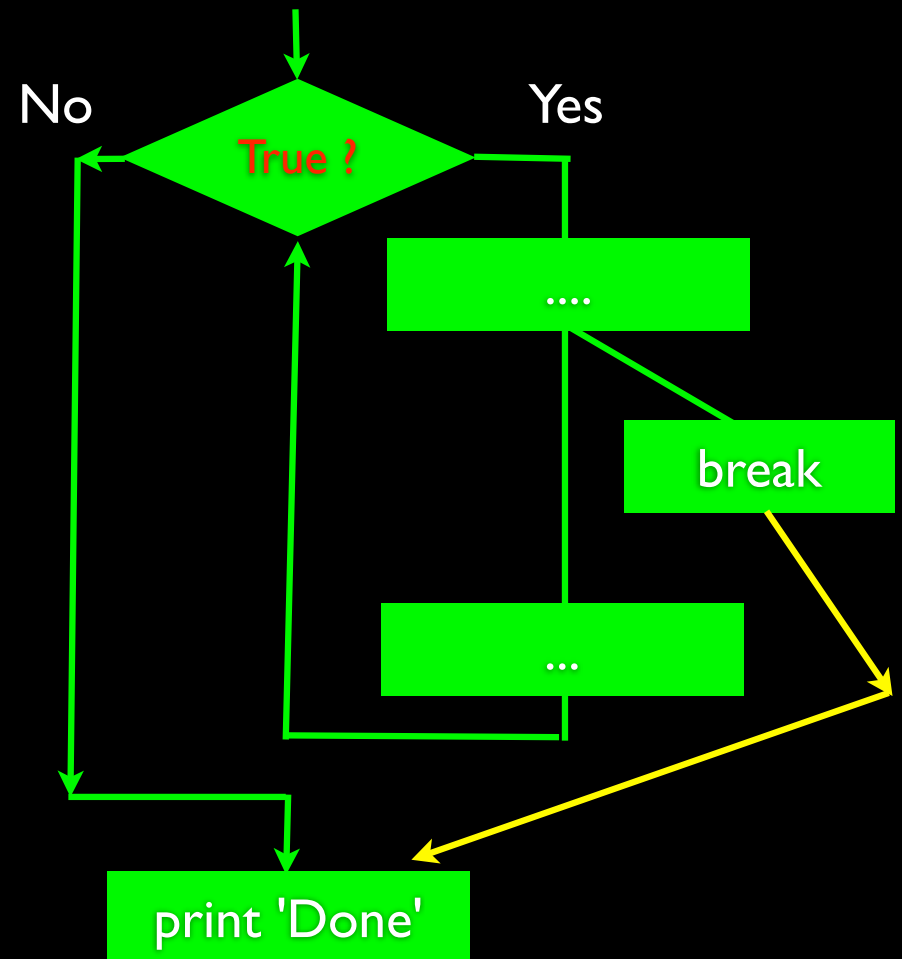


```
> hello there
hello there
> finished
finished
> done
Done!
```

```
while True:
    line = raw_input('> ')
    if line == 'done':
        break
    print line
print 'Done!'
```



[http://en.wikipedia.org/wiki/Transporter\\_\(Star\\_Trek\)](http://en.wikipedia.org/wiki/Transporter_(Star_Trek))



# Finishing an Iteration with continue

- The `continue` statement ends the current iteration and jumps to the top of the loop and starts the next iteration

```
while True:
    line = raw_input('> ')
    if line[0] == '#':
        continue
    if line == 'done':
        break
    print line
print 'Done!'
```

```
> hello there
hello there
> # don't print this
> print this!
print this!
> done
Done!
```

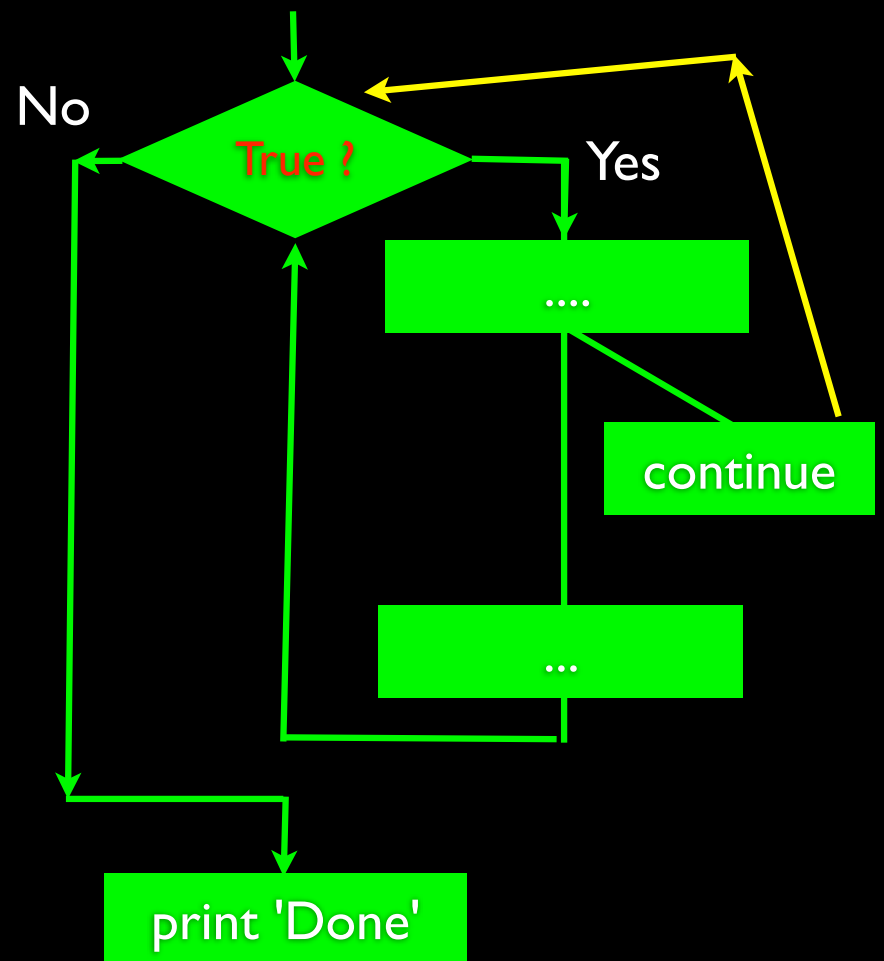
# Finishing an Iteration with continue

- The `continue` statement ends the *current iteration* and jumps to the **top of the loop** and starts the next iteration

```
while True:
    line = raw_input('> ')
    if line[0] == '#':
        continue
    if line == 'done':
        break
    print line
print 'Done!'
```

```
> hello there
hello there
> # don't print this
> print this!
print this!
> done
Done!
```

```
while True:
    line = raw_input('> ')
    if line[0] == '#':
        continue
    if line == 'done':
        break
    print line
print 'Done!'
```



# Indefinite Loops

- While loops are called "indefinite loops" because they keep going until a logical condition becomes **False**
- The loops we have seen so far are pretty easy to examine to see if they will terminate or if they will be "infinite loops"
- Sometimes it is a little harder to be sure if a loop will terminate

# Does this loop terminate?

- Collatz Conjecture

```
python sequence.py
```

```
Enter a Number:3
```

```
3 10 5 16 8 4 2
```

```
python sequence.py
```

```
Enter a Number:16
```

```
16 8 4 2
```

```
python sequence.py
```

```
Enter a Number:50
```

```
50 25 76 38 19 58 29 88 44 22 11 34 17 52 26 13 40 20 10 5 16 8 4 2
```

```
inp = raw_input('Enter a Number:')
n = int(inp)
while n != 1 :
    print n,
    if n % 2 == 0 :      # n is even
        n = n / 2
    else :              # n is odd
        n = n * 3 + 1
```

# Definite Loops

- Quite often we have a **list** of items of the **lines in a file** - effectively a **finite set** of things
- We can write a loop to run the loop once for each of the items in a set using the Python **for** construct
- These loops are called "**definite loops**" because they execute an exact number of times
- We say that "**definite loops iterate through the members of a set**"

# A Simple Definite Loop

```
for i in [5, 4, 3, 2, 1]:  
    print i
```

```
print 'Blastoff!'
```

```
5  
4  
3  
2  
1  
Blastoff!
```

# A Simple Definite Loop

```
friends = ['Joseph', 'Glenn', 'Sally']
```

```
for friend in friends :
```

```
    print 'Happy New Year:', friend
```

```
print 'Done!'
```

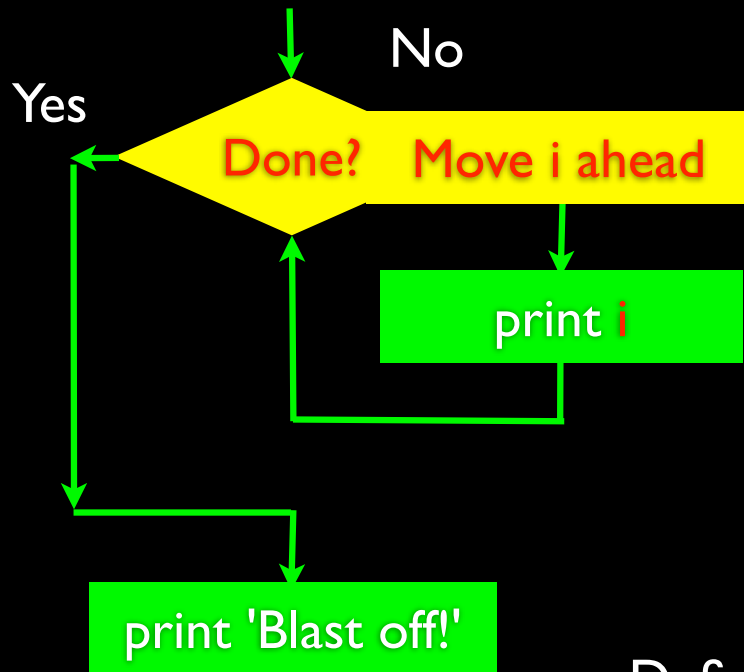
Happy New Year: Joseph

Happy New Year: Glenn

Happy New Year: Sally

Done!

# A Simple Definite Loop



```
for i in [5, 4, 3, 2, 1] :  
    print i  
  
print 'Blastoff!'
```

5  
4  
3  
2  
1  
Blastoff!

Definite loops (for loops) have explicit **iteration variables** that change each time through a loop. These **iteration variables** move through the sequence or set.

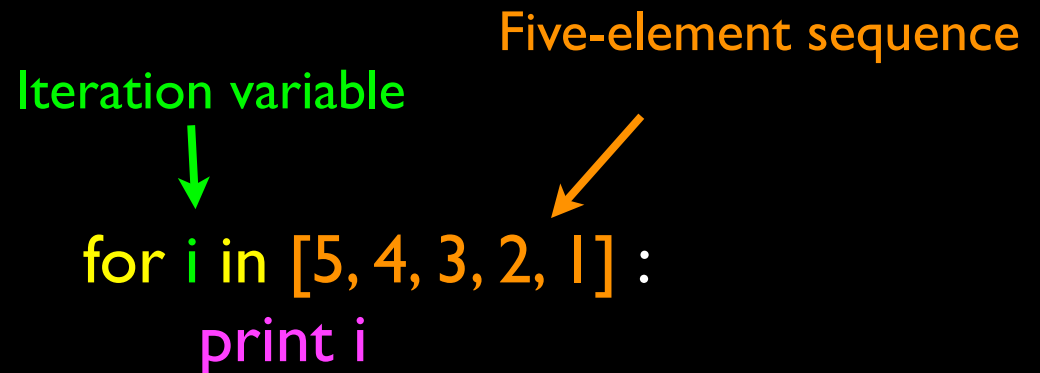
# Looking at **in**...

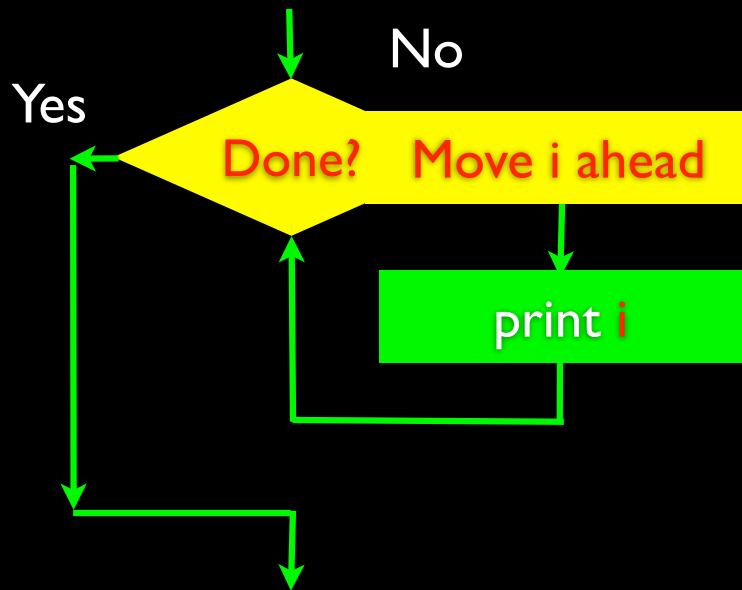
- The **iteration variable** “iterates” through the **sequence** (ordered set)
- The **block (body)** of code is executed once for each value **in** the **sequence**
- The **iteration variable** moves through all of the values **in** the **sequence**

Iteration variable

Five-element sequence

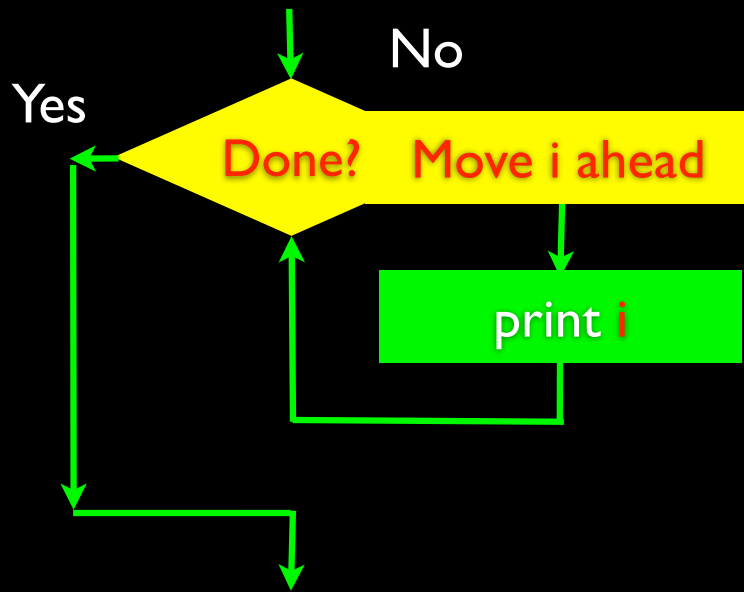
```
for i in [5, 4, 3, 2, 1]:  
    print i
```



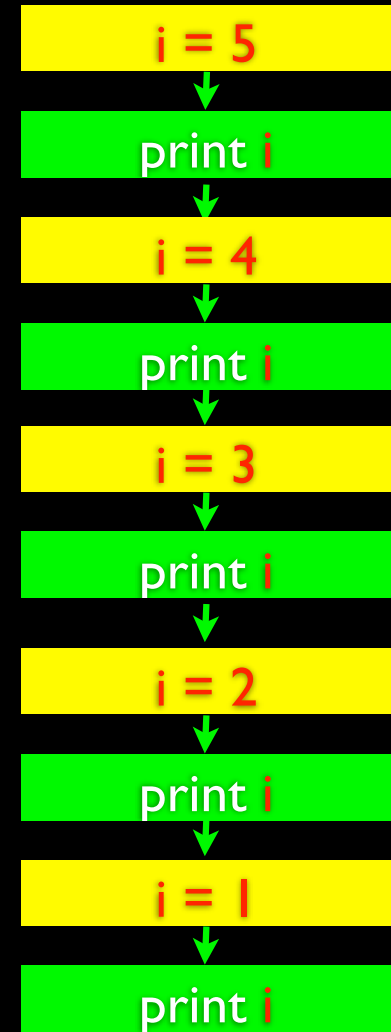


```
for i in [5, 4, 3, 2, 1]:  
    print i
```

- The **iteration variable** “iterates” through the **sequence** (ordered set)
- The **block (body)** of code is executed once for each value **in** the **sequence**
- The **iteration variable** moves through all of the values **in** the **sequence**



```
for i in [5, 4, 3, 2, 1]:  
    print i
```



# Definite Loops

- Quite often we have a **list** of items of the **lines in a file** - effectively a **finite set** of things
- We can write a loop to run the loop once for each of the items in a set using the Python **for** construct
- These loops are called "**definite loops**" because they execute an exact number of times
- We say that "**definite loops iterate through the members of a set**"

# Loop Idioms

## What We Do in Loops

Note: Even though these examples are simple, the patterns apply to all kinds of loops

What is the Largest Number?

# What is the Largest Number?

largest\_so\_far

-13 41 74

# Looping through a Set

```
print 'Before'  
for thing in [3, 41, 12, 9, 74, 15]:  
    print thing  
print 'After'
```

```
$ python basicloop.py
```

```
Before
```

```
3
```

```
41
```

```
12
```

```
9
```

```
74
```

```
15
```

```
After
```

# Finding the **largest** value

```
largest = -1
print 'Before', largest
for value in [3, 41, 12, 9, 74, 15]:
    if value > largest:
        largest = value
    print largest, value

print 'After', largest
```

```
$ python largest.py
Before -1
3 3
41 41
41 12
41 9
74 74
74 15
After 74
```

We make a **variable** that contains the **largest value we have seen so far**. If the current **value** is larger, it becomes the new **largest value we have seen so far**.

# Making “smart” loops

- The trick is “knowing” something about the whole loop when you are stuck writing code that only sees one entry at a time

Set some variables to initial values

for thing in data:

Look for something or do something to each entry separately, updating a variable.

Look at the variables.

# Counting in a Loop

```
zork = 0
print 'Before', zork
for thing in [3, 41, 12, 9, 74, 15]:
    zork = zork + 1
    print zork, thing
print 'After', zork
```

```
$ python countloop.py
Before 0
1 3
2 41
3 12
4 9
5 74
6 15
After 6
```

To **count** how many times we execute a loop we introduce a **counter** variable that starts at 0 and we add one to it each time through the loop.

# Summing in a Loop

```
zork = 0
print 'Before', zork
for thing in [3, 41, 12, 9, 74, 15]:
    zork = zork + thing
    print zork, thing
print 'After', zork
```

```
$ python countloop.py
Before 0
3 3
44 41
56 12
65 9
139 74
154 15
After 154
```

To **add up** a **value** we encounter in a loop, we introduce a **sum variable that starts at 0** and we add the **value** to the sum each time through the loop.

# Finding the Average in a Loop

```
count = 0
sum = 0
print 'Before', count, sum
for value in [3, 41, 12, 9, 74, 15]:
    count = count + 1
    sum = sum + value
    print count, sum, value
print 'After', count, sum, sum / count
```

```
$ python averageloop.py
Before 0 0
1 3 3
2 44 41
3 56 12
4 65 9
5 139 74
6 154 15
After 6 154 25
```

An **average** just combines the **counting** and **sum** patterns and **divides** when the loop is done.

# Filtering in a Loop

```
print 'Before'  
for value in [3, 41, 12, 9, 74, 15] :  
    if value > 20:  
        print 'Large number',value  
print 'After'
```

```
$ python search1.py  
Before  
Large number 41  
Large number 74  
After
```

We use an **if statement** in the **loop** to catch / filter the values we are looking for.

# Search Using a Boolean Variable

```
found = False
print 'Before', found
for value in [3, 41, 12, 9, 74, 15]:
    if value == 9:
        found = True
        print found, value

print 'After', found
```

```
$ python search1.py
Before False
False 3
False 41
False 12
True 9
True 74
True 15
After True
```

If we just want to search and **know if a value was found** - we use a **variable** that starts at **False** and is set to **True** as soon as we **find** what we are looking for.

# Finding the **largest** value

```
largest = -1
print 'Before', largest
for value in [3, 41, 12, 9, 74, 15]:
    if value > largest:
        largest = value
    print largest, value

print 'After', largest
```

```
$ python largest.py
Before -1
3 3
41 41
41 12
41 9
74 74
74 15
After 74
```

We make a **variable** that contains the **largest value we have seen so far**. If the current **value** is larger, it becomes the new **largest value we have seen so far**.

# Finding the **smallest** value?

```
smallest = -1
print 'Before', smallest
for value in [3, 41, 12, 9, 74, 15]:
    if value < smallest:
        smallest = value
    print smallest, value

print 'After', smallest
```

We make a **variable** that contains the **smallest value we have seen so far**. If the current **value** is smaller, it becomes the new **smallest value we have seen so far**.

# What is the Smallest Number?

smallest

- |

# Finding the **smallest** value?

```
smallest = -1
print 'Before', largest
for value in [3, 41, 12, 9, 74, 15]:
    if value < smallest:
        smallest = value
    print smallest, value

print 'After', smallest
```

We make a **variable** that contains the **smallest value we have seen so far**. If the current **value** is smaller, it becomes the new **smallest value we have seen so far**.

## Finding the **smallest** value

```
smallest = None
print 'Before'
for value in [9, 41, 12, 3, 74, 15] :
    if smallest is None :
        smallest = value
    elif value < smallest :
        smallest = value
    print smallest, value

print 'After', smallest
```

```
$ python smallest.py
```

```
Before
```

```
9 9
```

```
9 41
```

```
9 12
```

```
3 3
```

```
3 74
```

```
3 15
```

```
After 3
```

We still have a variable that is the **smallest** so far. The first time through the loop **smallest** is **None** so we take the first **value** to be the **smallest**.

# The "is" and "is not" Operators

```
smallest = None
print 'Before'
for value in [9, 41, 12, 3, 74, 15]:
    if smallest is None:
        smallest = value
    elif value < smallest:
        smallest = value
    print smallest, value
print 'After', smallest
```

- Python has an "is" operator that can be used in logical expressions
- Implies 'is the same as'
- Similar to, but stronger than ==
- 'is not' also is a logical operator

# Summary

- While loops (indefinite)
- Infinite loops
- Using break
- Using continue
- For loops (definite)
- Iteration variables
- Counting in loops
- Summing in loops
- Averaging in loops
- Searching in loops
- Detecting in loops
- Largest or smallest