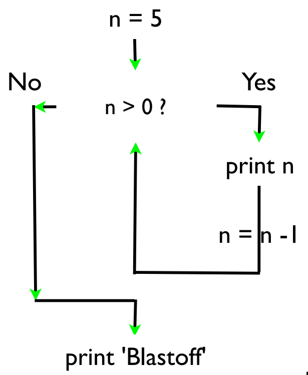
Loops and Iteration

Chapter 5

Python for Informatics: Exploring Information
www.pythonlearn.com

Repeated Steps



Program:

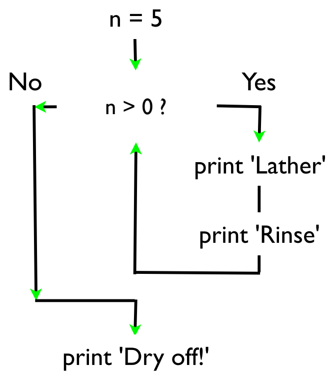
```
n = 5
while n > 0 :
    print n
    n = n - 1
print 'Blastoff!'
print n
```

Output:

```
5
4
3
2
1
Blastoff!
0
```

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

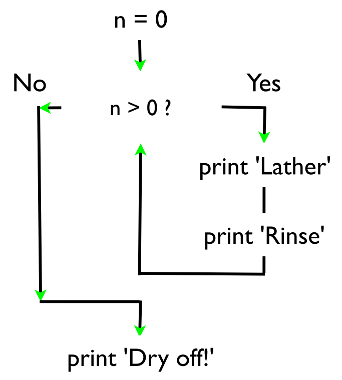
An Infinite Loop



```
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

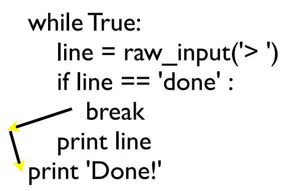
- The break statement ends the current loop and jumps to the statement immediately following the loop
- It is like a loop test that can happen anywhere in the body of the loop

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

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

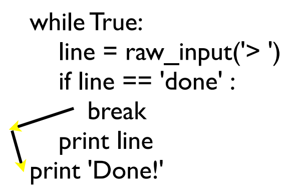
Breaking Out of a Loop

- 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



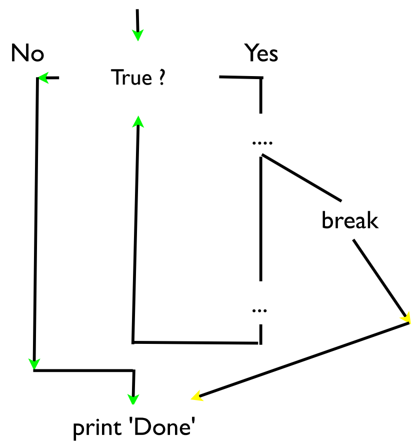
```
while True:
    line = raw_input('> ')
    if line == 'done' :
        break
    print line
print 'Done!'
```

```
> 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)



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!
```

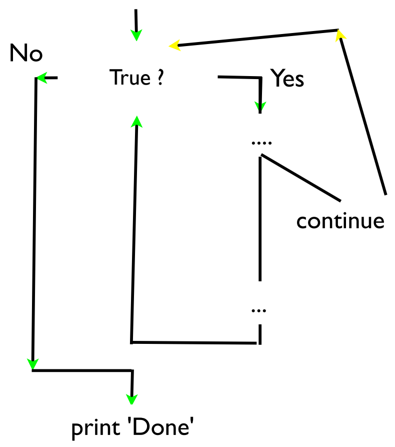
Finishing an Iteration with continue

- 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

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

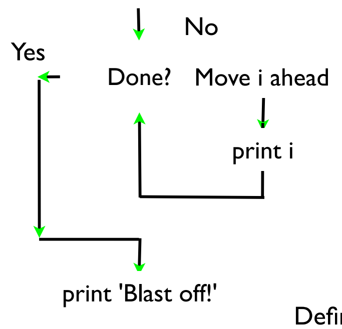
```
friends = ['Joseph', 'Glenn', 'Sally']

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.

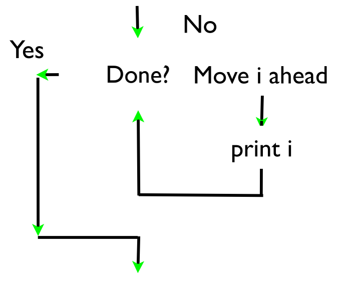
Looking at In...

- The iteration variable "iterates" though 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" though the sequence (ordered set)
- The block (body) of code is executed once for each value in the sequence
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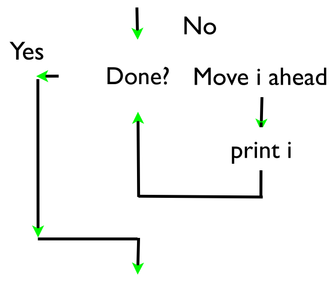
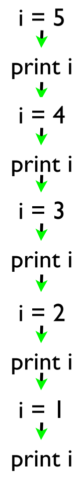


```
for i in [5, 4, 3, 2, 1] :
    print i
```



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

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.
```

Looping through a Set

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

```
$ python basicloop.py
Before
9
41
12
3
74
15
After
```

What is the Largest Number?

What is the Largest Number?

largest_so_far

-1 9 41 74

Finding the largest value

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

print 'After', largest_so_far
```

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

We make a variable that contains the largest value we have seen so far. If the current number we are looking at is larger, it is the new largest value we have seen so far.

Counting in a Loop

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

```
$ python countloop.py
Before 0
1 9
2 41
3 12
4 3
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 [9, 41, 12, 3, 74, 15] :
    zork = zork + thing
    print zork, thing
print 'After', zork
```

```
$ python countloop.py
Before 0
9 9
50 41
62 12
65 3
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 [9, 41, 12, 3, 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 9 9
2 50 41
3 62 12
4 65 3
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 [9, 41, 12, 3, 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 [9, 41, 12, 3, 74, 15] :
    if value == 3 :
        found = True
    print found, value

print 'After', found
```

```
$ python search1.py
Before False
False 9
False 41
False 12
True 3
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_so_far = -1
print 'Before', largest_so_far
for the_num in [9, 41, 12, 3, 74, 15] :
    if the_num > largest_so_far :
        largest_so_far = the_num
    print largest_so_far, the_num

print 'After', largest_so_far
```

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

We make a variable that contains the largest value we have seen so far. If the current number we are looking at is larger, it is the new largest value we have seen so far.

Finding the smallest value?

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

print 'After', smallest_so_far
```

We make a variable that contains the smallest value we have seen so far. If the current number we are looking at is smaller, it is the new smallest value we have seen so far.

What is the Smallest Number?

smallest_so_far $\boxed{-1}$

Finding the smallest value

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

print 'After', smallest_so_far
```

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

We make a variable that contains the smallest value we have seen so far. If the current number we are looking at is smaller, it is 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 [3, 41, 12, 9, 74, 15] :
    if smallest is None :
        smallest = value
    elif value < smallest :
        smallest = value
    print smallest, value

print 'After', smallest
```

- Python has an "is" operaror 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