Brief Python

First Python Course for Beginners

Chapter 3: Loops

Dr. Eric Chou IEEE Senior Member

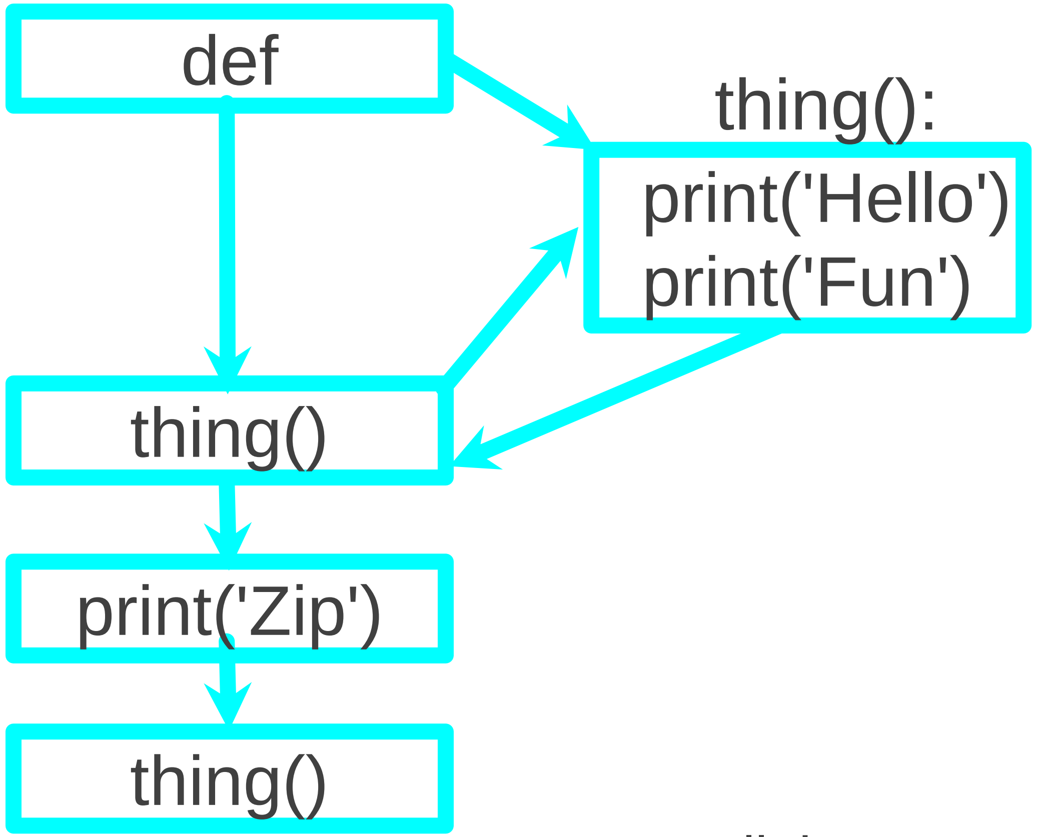
Objectives

- Function
- Loops

Function

LECTURE 1

Stored (and reused) Steps



Program:

```
def thing():
    print('Hello')
    print('Fun')

thing()
print('Zip')
thing()
```

Output:

```
Hello
Fun
Zip
Hello
Fun
```

We call these reusable pieces of code “functions”

Python Functions

- There are two kinds of functions in Python.
  - - Built-in functions that are provided as part of Python - print(), input(), type(), float(), int() ...
  - - Functions that we define ourselves and then use
- We treat the built-in function names as “new” reserved words
  (i.e., we avoid them as variable names)

Function Definition

- In Python a function is some reusable code that takes arguments(s) as input, does some computation, and then returns a result or results
- We define a function using the def reserved word
- We call/invoke the function by using the function name, parentheses, and arguments in an expression

Built-in Functions

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Argument

big = max('Hello world')

Assignment

'w'

Result

```
>>> big = max('Hello world')
>>> print(big)
w
>>> tiny = min('Hello world')
>>> print(tiny)

>>>
```

Max Function

```
>>> big = max('Hello world')
>>> print(big)
w
```

A function is some stored code that we use. A function takes some input and produces an output.

'Hello world'
(a string)

max()
function

'w'
(a string)

Guido wrote this code

Max Function

```
>>> big = max('Hello world')
>>> print(big)
w
```

A function is some stored code that we use. A function takes some input and produces an output.

'Hello world'
(a string)

```
def max(inp):
   blah
   blah
   for x in inp:
     blah
     blah
```

'w'
(a string)

Guido wrote this code

Type Conversions

- When you put an integer and floating point in an expression, the integer is implicitly converted to a float
- You can control this with the built-in functions int() and float()

```
>>> print(float(99) / 100)
0.99
>>> i = 42
>>> type(i)
<class 'int'>
>>> f = float(i)
>>> print(f)
42.0
>>> type(f)
<class 'float'>
>>> print(1 + 2 * float(3) / 4 - 5)
-2.5
>>>
```

String Conversions

- You can also use int() and float() to convert between strings and integers
- You will get an error if the string does not contain numeric characters

```
>>> sval = '123'
>>> type(sval)
<class 'str'>
>>> print(sval + 1)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: cannot concatenate 'str'
and 'int'
>>> ival = int(sval)
>>> type(ival)
<class 'int'>
>>> print(ival + 1)
124
>>> nsv = 'hello bob'
>>> niv = int(nsv)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: invalid literal for int()
```

Custom Functions

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Building our Own Functions

- We create a new function using the def keyword followed by optional parameters in parentheses
- We indent the body of the function
- This defines the function but does not execute the body of the function

```
def print_lyrics():
    print("I'm a lumberjack, and I'm okay.")
    print('I sleep all night and I work all 
day.')
```

print_lyrics():

```
print("I'm a lumberjack, and I'm okay.")
print('I sleep all night and I work all day.')
```

```
x = 5
print('Hello')

def print_lyrics():
    print("I'm a lumberjack, and I'm okay.")
    print('I sleep all night and I work all day.')

print('Yo')
x = x + 2
print(x)
```

```
Hello
Yo
7
```

Definitions and Uses

- Once we have defined a function, we can call (or invoke) it as many times as we like
- This is the store and reuse pattern

```
x = 5
print('Hello')

def print_lyrics():
    print("I'm a lumberjack, and I'm okay.")
    print('I sleep all night and I work all day.')

print('Yo')
print_lyrics()
x = x + 2
print(x)
```

```
Hello
Yo
I'm a lumberjack, and I'm okay.
I sleep all night and I work all day.
7
```

Parameters

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Arguments

- An argument is a value we pass into the function as its input when we call the function
- We use arguments so we can direct the function to do different kinds of work when we call it at different times
- We put the arguments in parentheses after the name of the function

```
big = max('Hello world')
```

Argument

Parameters

- A parameter is a variable which we use in the function definition. It is a "handle" that allows the code in the function to access the arguments for a particular function invocation.

```
>>> def greet(lang):
...     if lang == 'es':
...        print('Hola')
...     elif lang == 'fr':
...        print('Bonjour')
...     else:
...        print('Hello')
...
>>> greet('en')
Hello
>>> greet('es')
Hola
>>> greet('fr')
Bonjour
>>>
```

Return Values

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Return Values

- Often a function will take its arguments, do some computation, and return a value to be used as the value of the function call in the calling expression. The return keyword is used for this.

```
def greet():
    return "Hello"

print(greet(), "Glenn")
print(greet(), "Sally")
```

```
Hello Glenn
Hello Sally
```

Return Value

- A “fruitful” function is one that produces a result (or return value)
- The return statement ends the function execution and “sends back” the result of the function

```
>>> def greet(lang):
...     if lang == 'es':
...         return 'Hola'
...     elif lang == 'fr':
...         return 'Bonjour'
...     else:
...         return 'Hello'
...
>>> print(greet('en'),'Glenn')
Hello Glenn
>>> print(greet('es'),'Sally')
Hola Sally
>>> print(greet('fr'),'Michael')
Bonjour Michael
>>>
```

Putting Things Together

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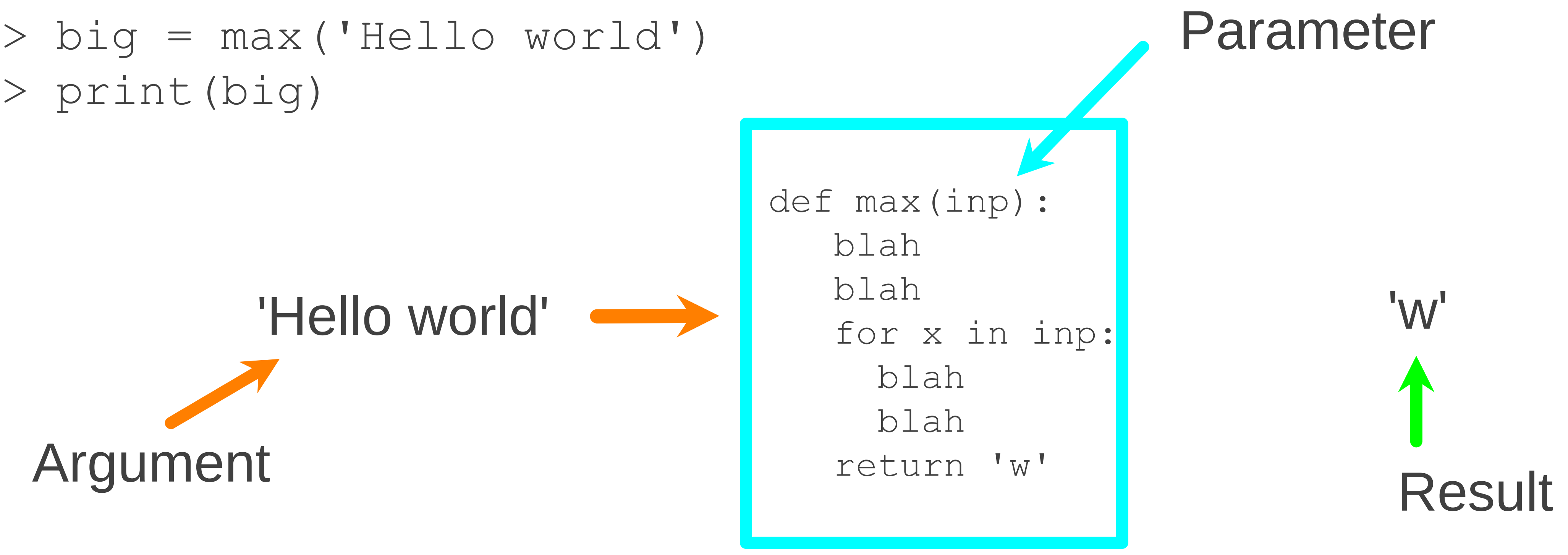
Arguments, Parameters, and Results

```
>>> big = max('Hello world')
>>> print(big)
w
```



```
def max(inp):
   blah
   blah
   for x in inp:
     blah
     blah
   return 'w'
```

Multiple Parameters / Arguments

- We can define more than one parameter in the function definition
- We simply add more arguments when we call the function
- We match the number and order of arguments and parameters

```
def addtwo(a, b):
    added = a + b
    return added

x = addtwo(3, 5)
print(x)

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```

Void (non-fruitful) Functions

- When a function does not return a value, we call it a “void” function
- Functions that return values are “fruitful” functions

Void functions are “not fruitful”

To function or not to function...

- Organize your code into “paragraphs” - capture a complete thought and “name it”
- Don’t repeat yourself - make it work once and then reuse it
- If something gets too long or complex, break it up into logical chunks and put those chunks in functions
- Make a library of common stuff that you do over and over - perhaps share this with your friends...

Loops

LECTURE 1

Repetition

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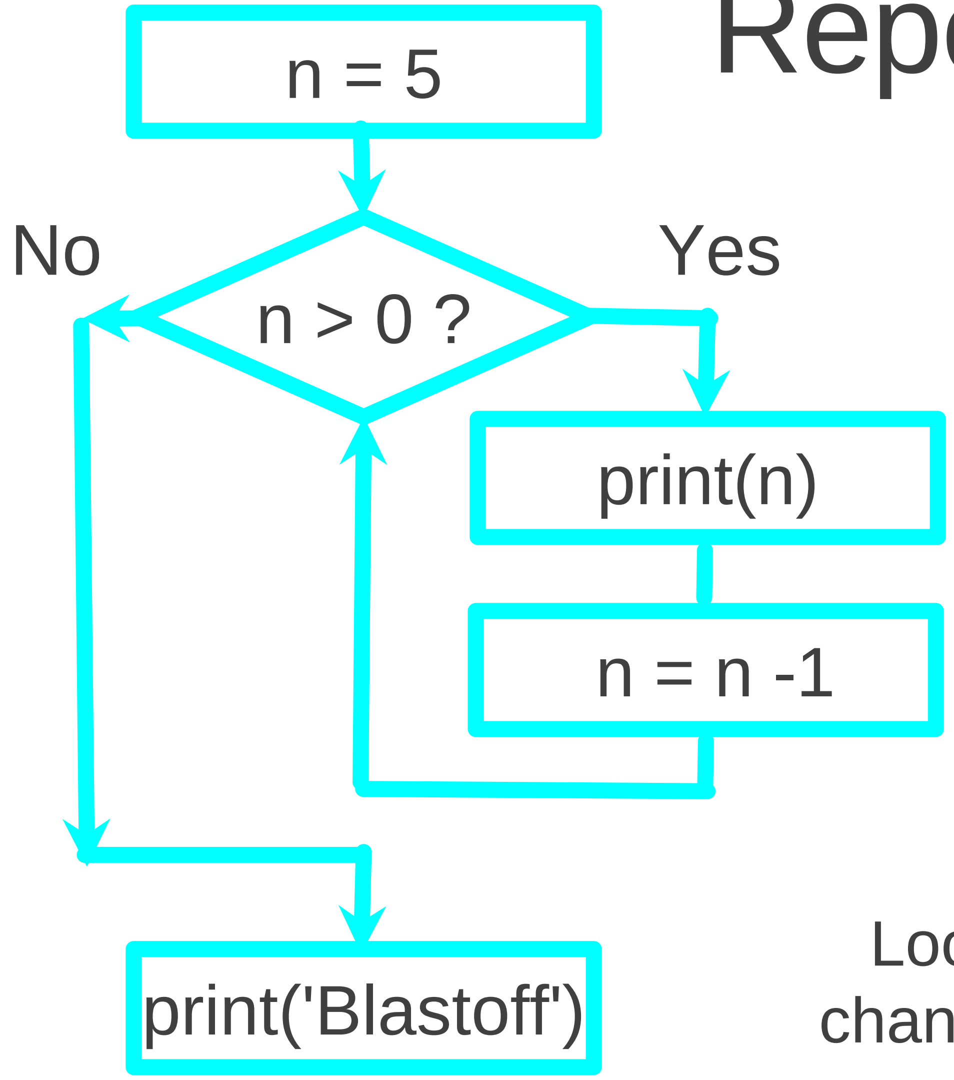
Repeated Steps



Program:

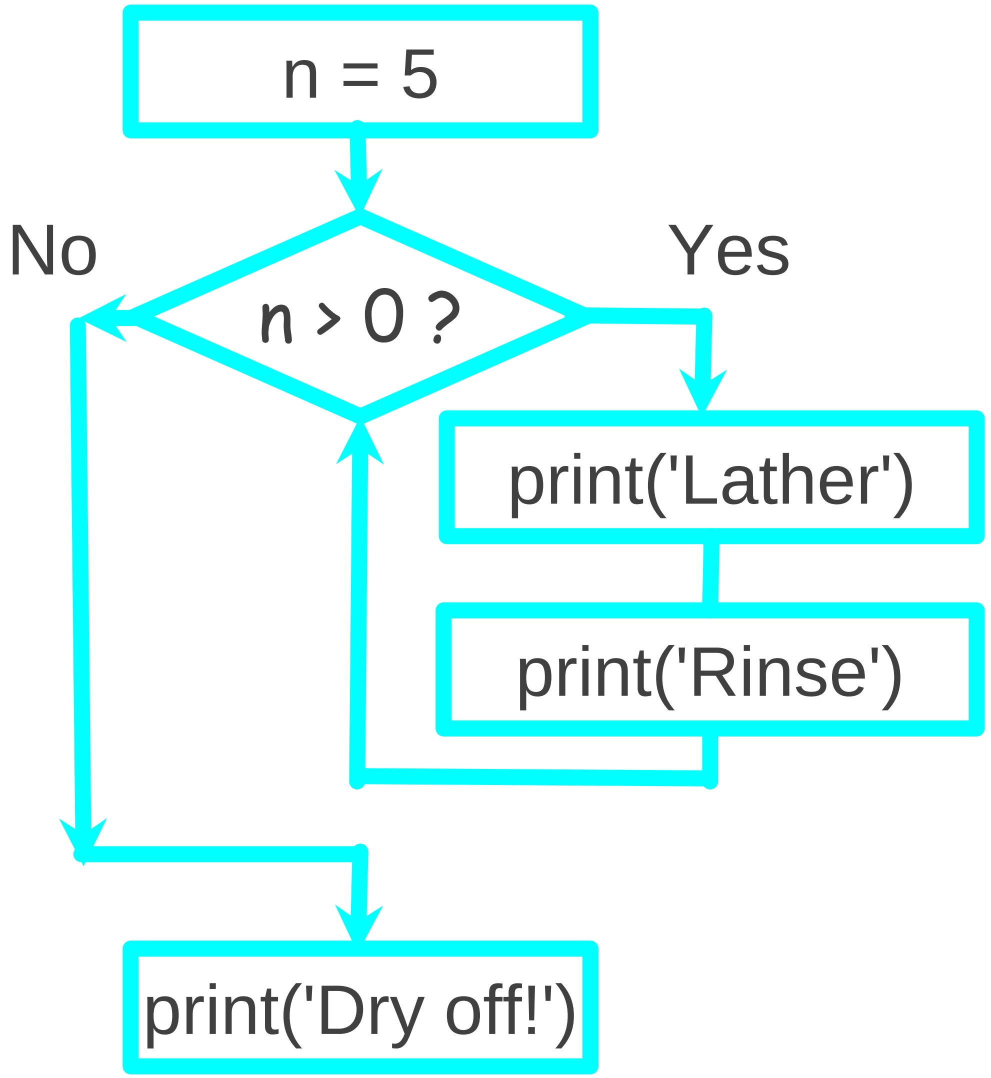
```
n = 5
while n > 0 :
    print(n)
    n = n – 1
print('Blastoff!')
print(n)
```

Output:

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

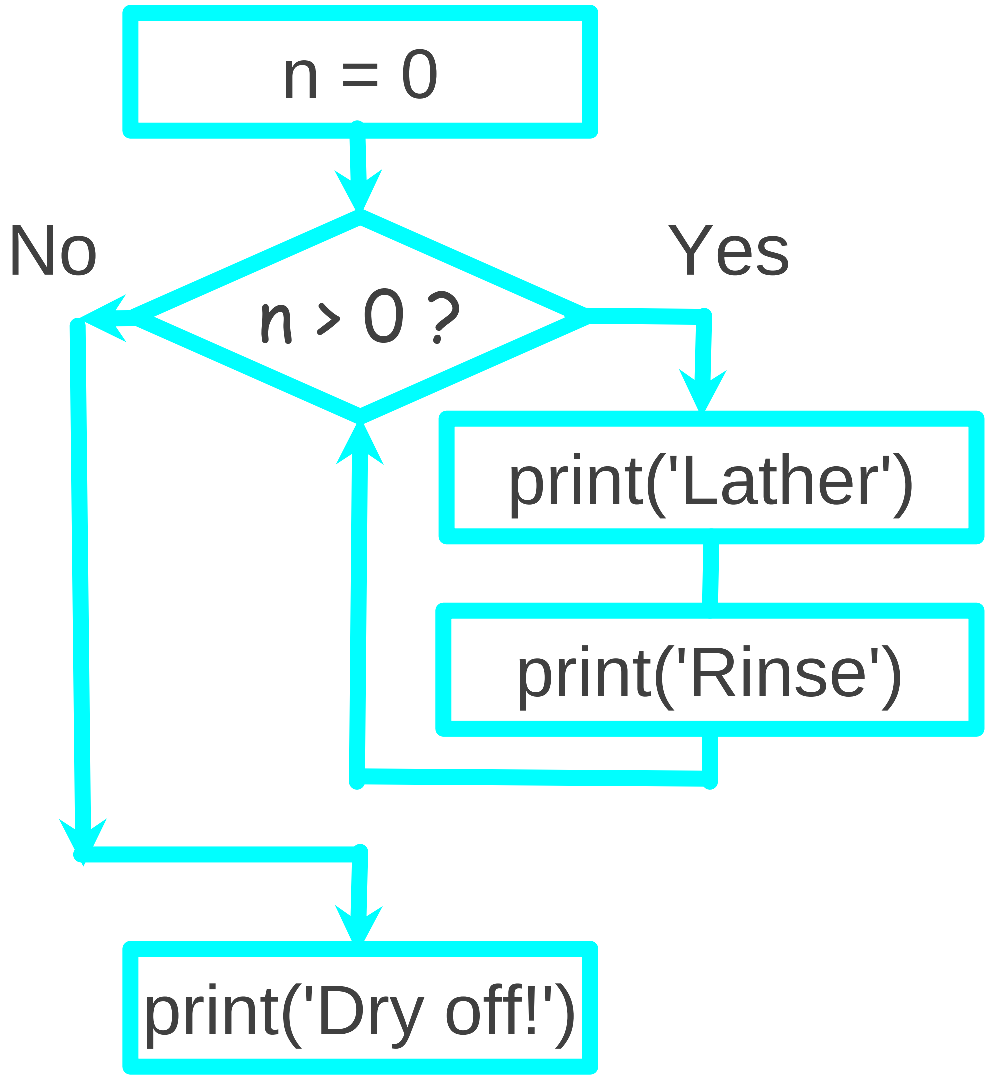
Loops (repeated steps) have iteration variables that change each time through a loop. Often these iteration variables go through a sequence of numbers.

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 is this loop doing?

Input Loops

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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 = input('> ')
    if line == 'done' :
        break
    print(line)
print('Done!')
```

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

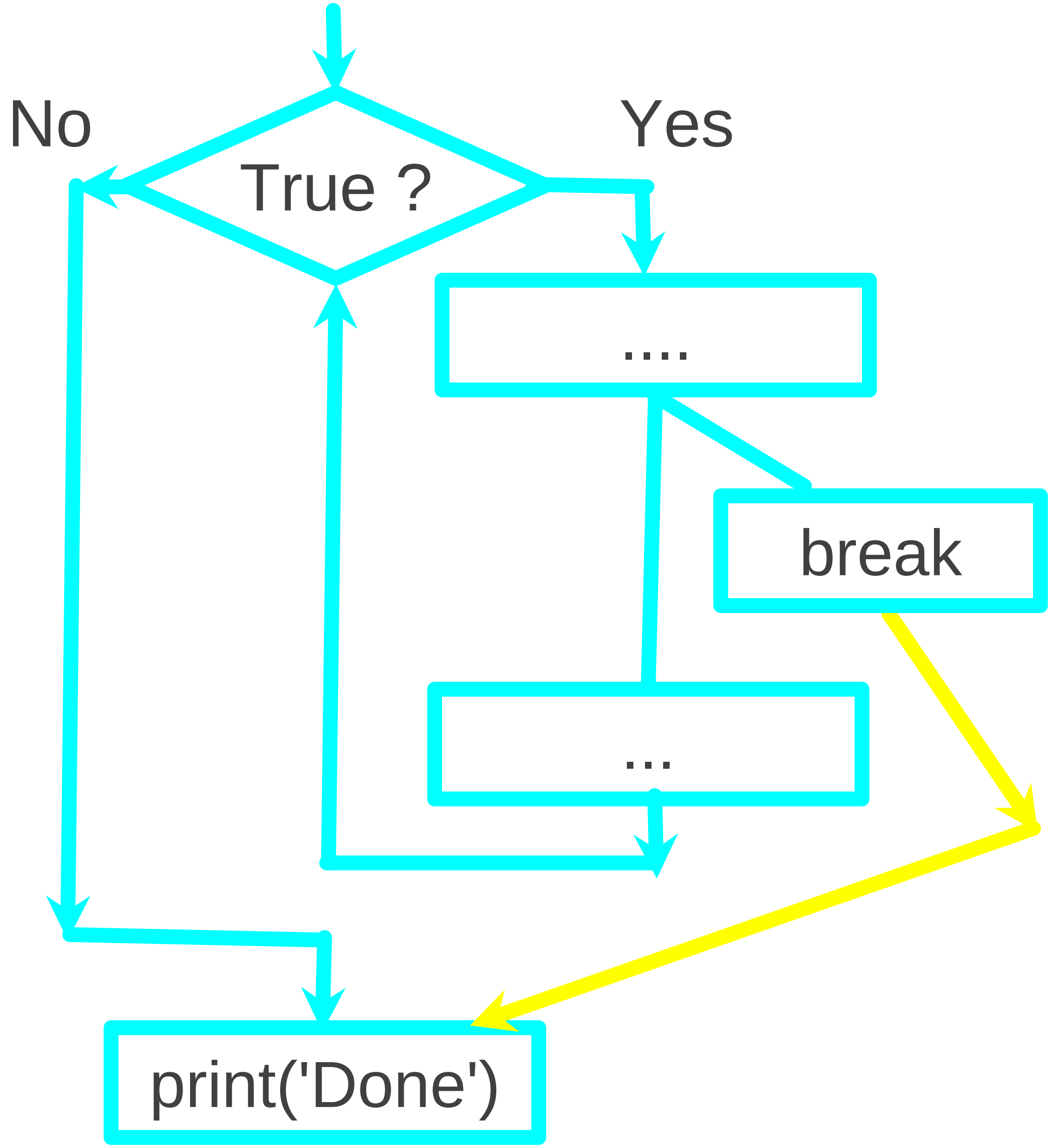
Breaking Out of a Loop

- 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 = input('> ')
    if line == 'done' :
        break
    print(line)
print('Done!')
```

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

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



Break levels

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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 = 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!
```

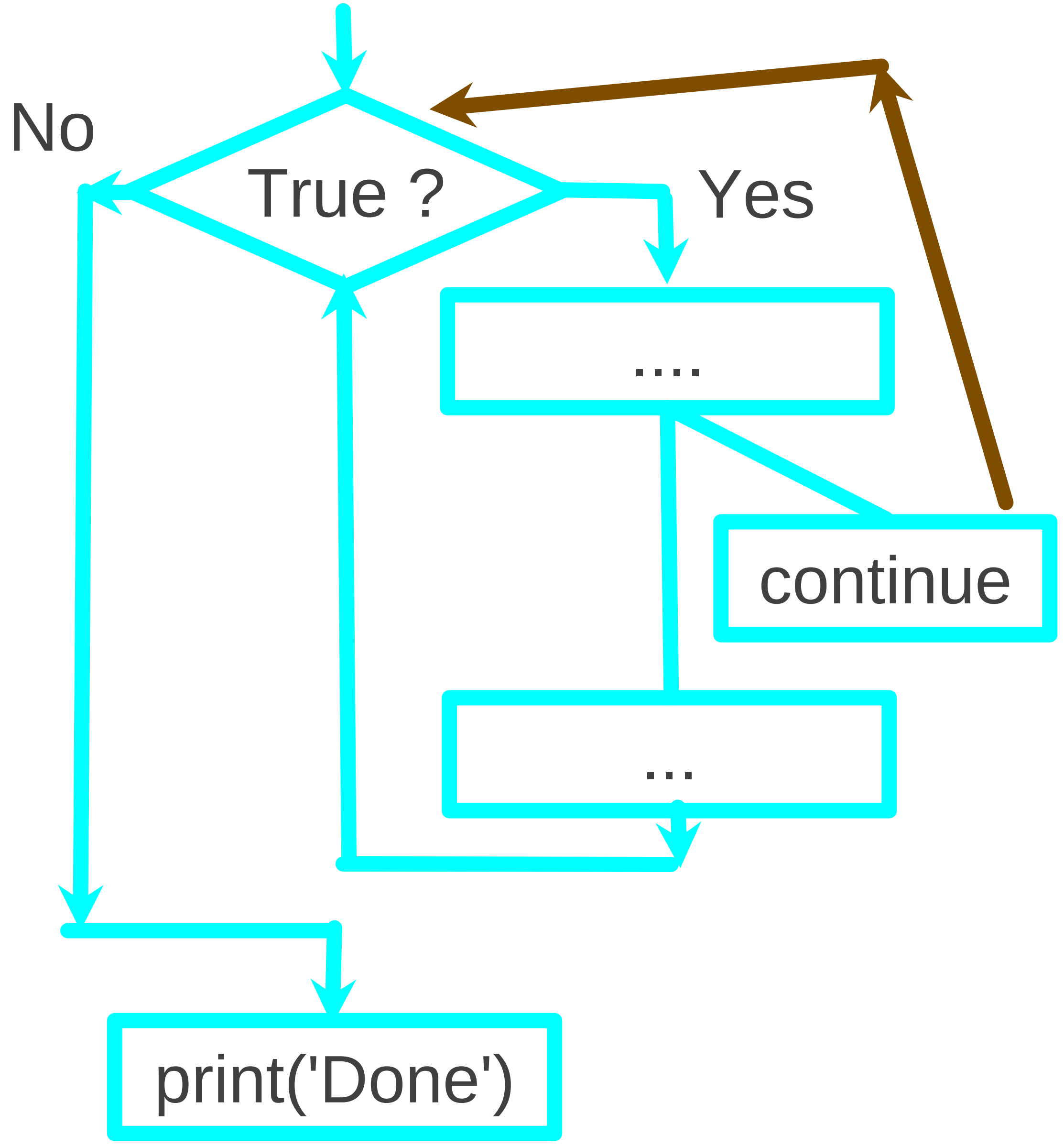
Finishing an Iteration with continue

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

```
while True:
    line = 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

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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!
```

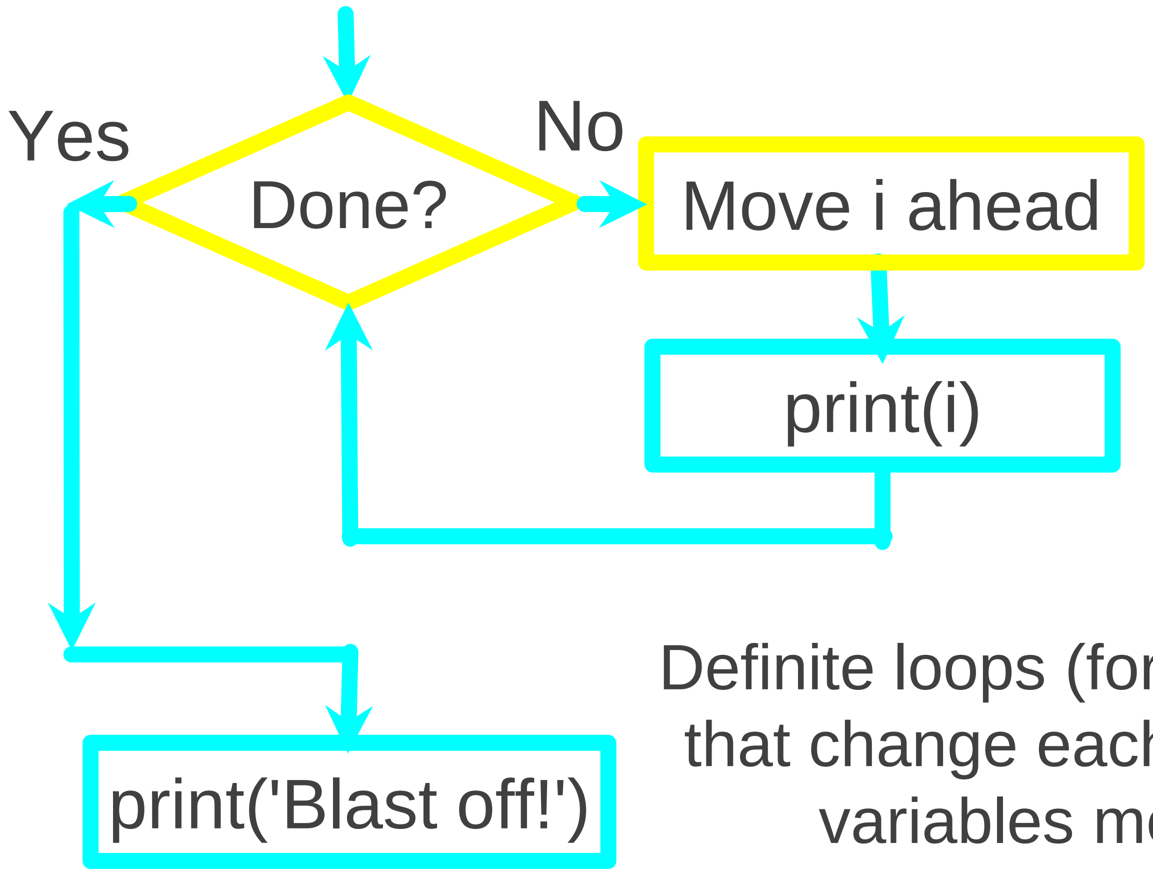
A Definite Loop with Strings

```
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.

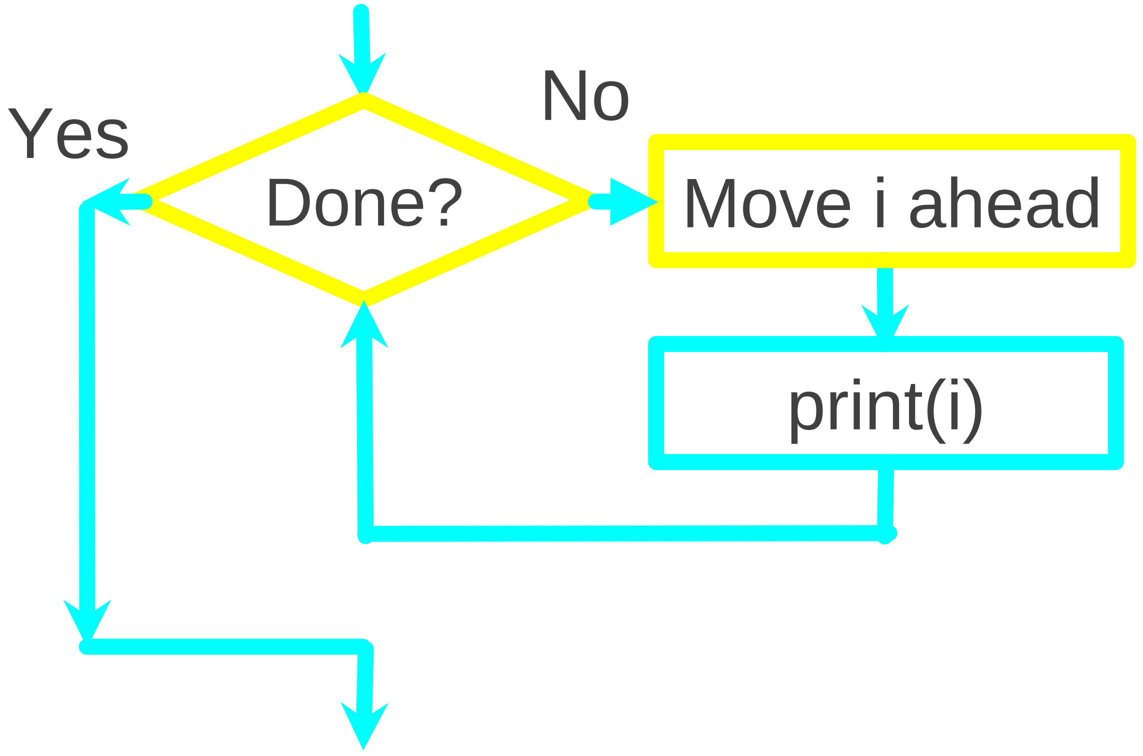
Looking at in…

- 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

Five-element sequence

Iteration variable

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

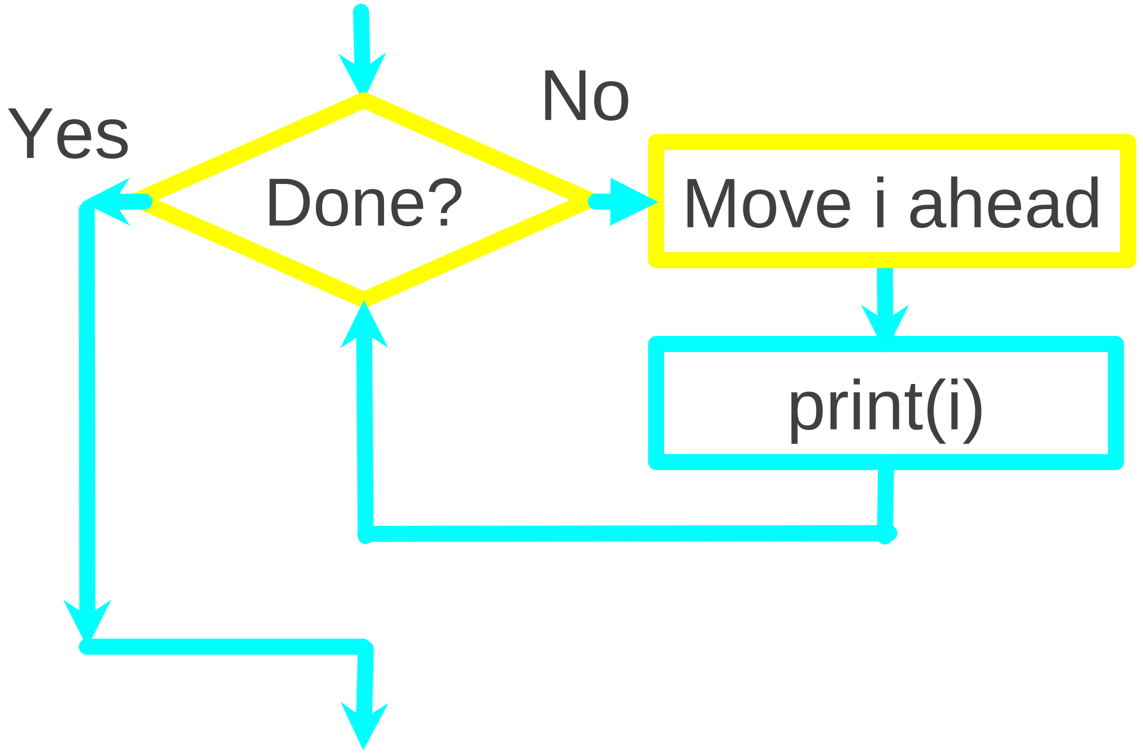


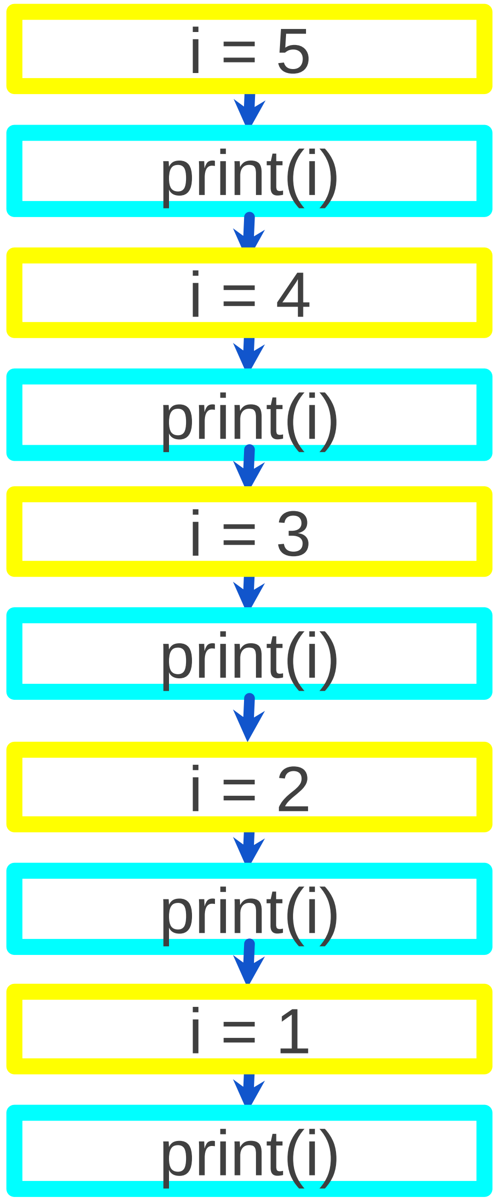
```
for i in [5, 4, 3, 2, 1] :
    print(i)
```

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)
```

Loop Applications

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Loop Applications

- Control loop (Control variable/state variable)
- Indexed loop
- Counting loop
- Sentinel Loop
- Statistics
- Input Validation Loop
- 2-D index space
- Histogram

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
```

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 25.666
```

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.

How to Find the Smallest 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
```

How would we change this to make it find the smallest value in the list?

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 switched the variable name to smallest_so_far and switched the > to <

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)
```

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

We switched the variable name to smallest_so_far and switched the > to <

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** 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