

Loops and Iteration

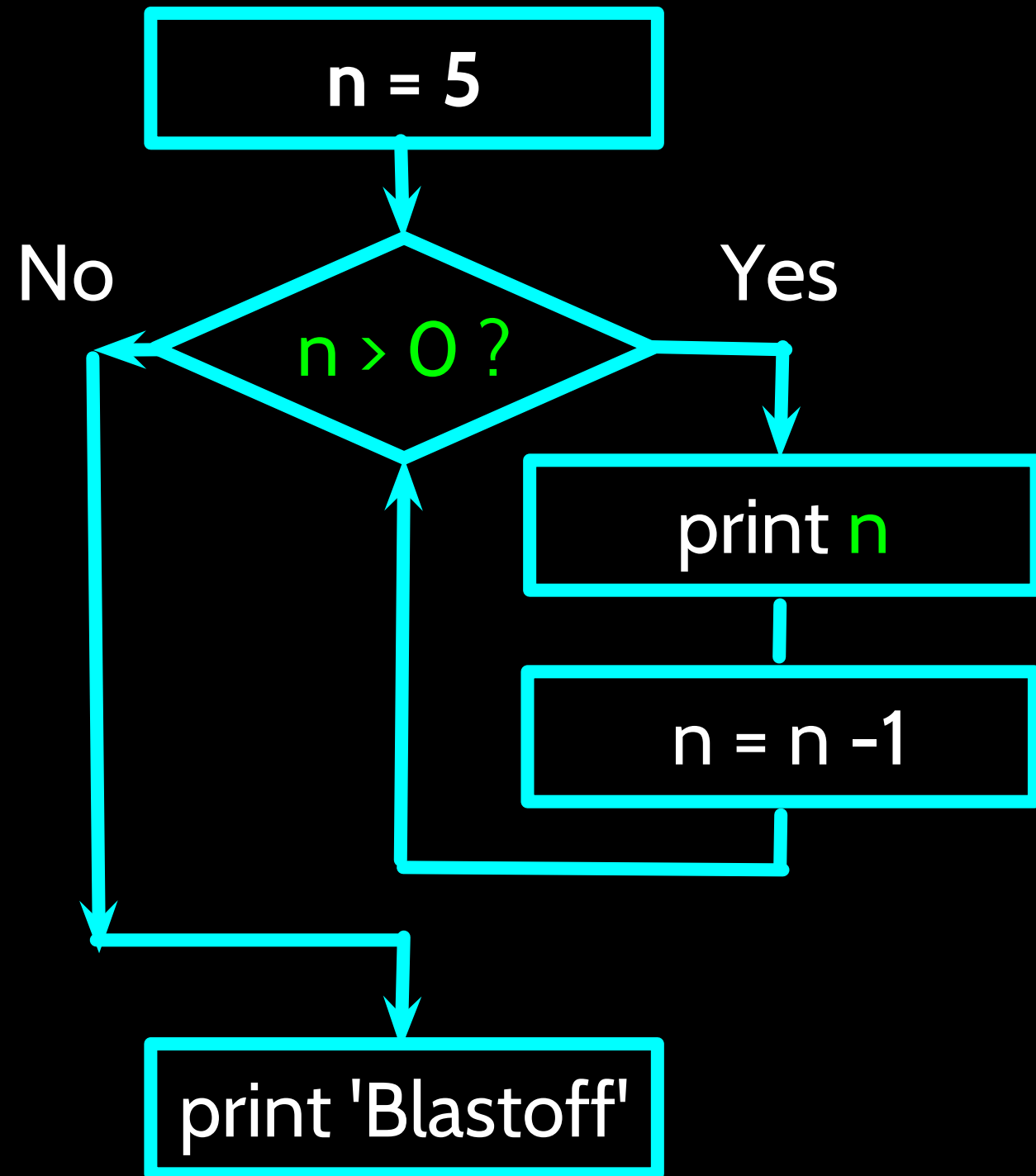
Chapter 5



Python for Informatics: Exploring Information
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Repeated Steps



Program:

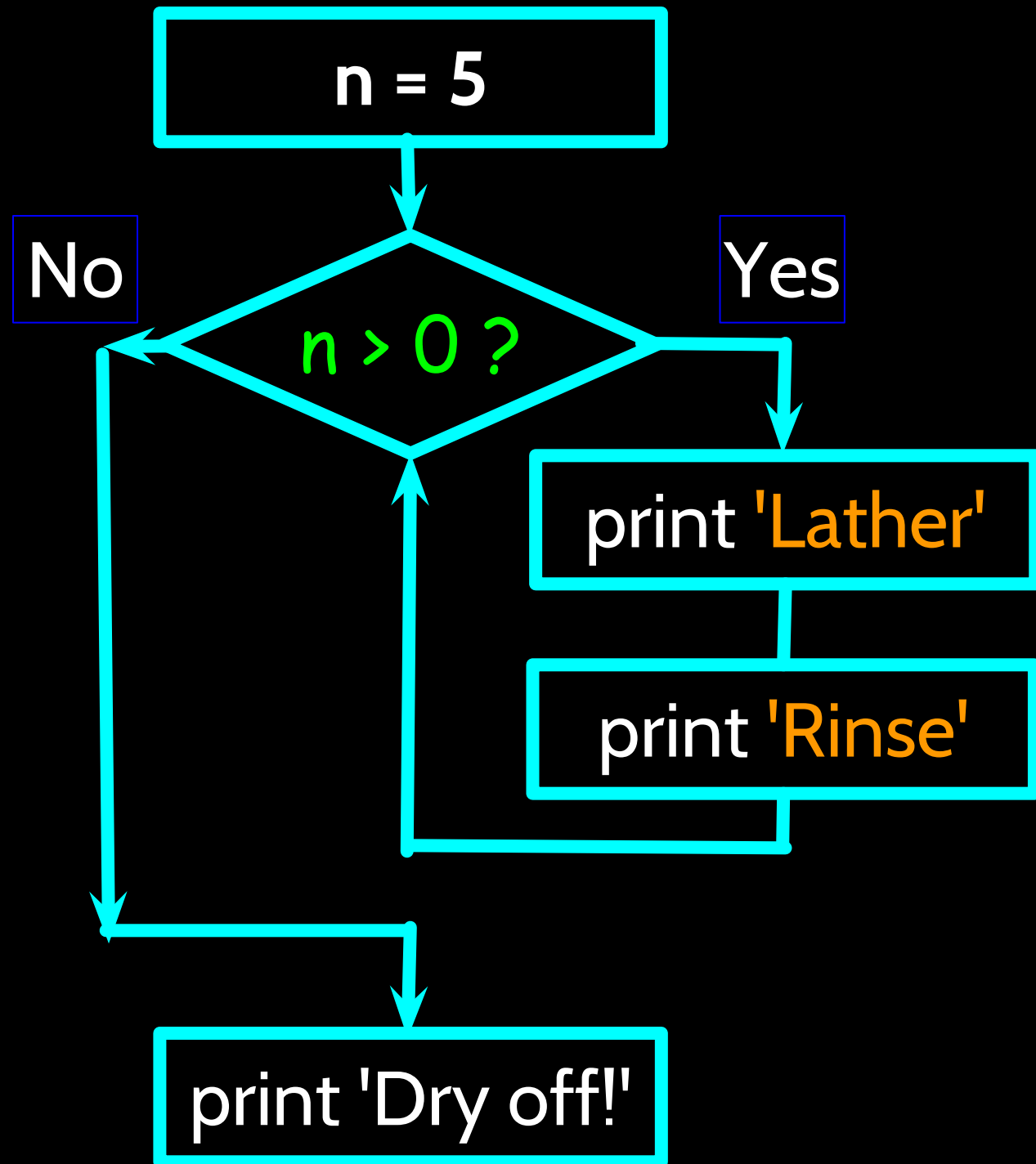
```
n = 5
while n > 0 :
    print n
    n = n - 1
print 'Blastoff!'
print n
```

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.

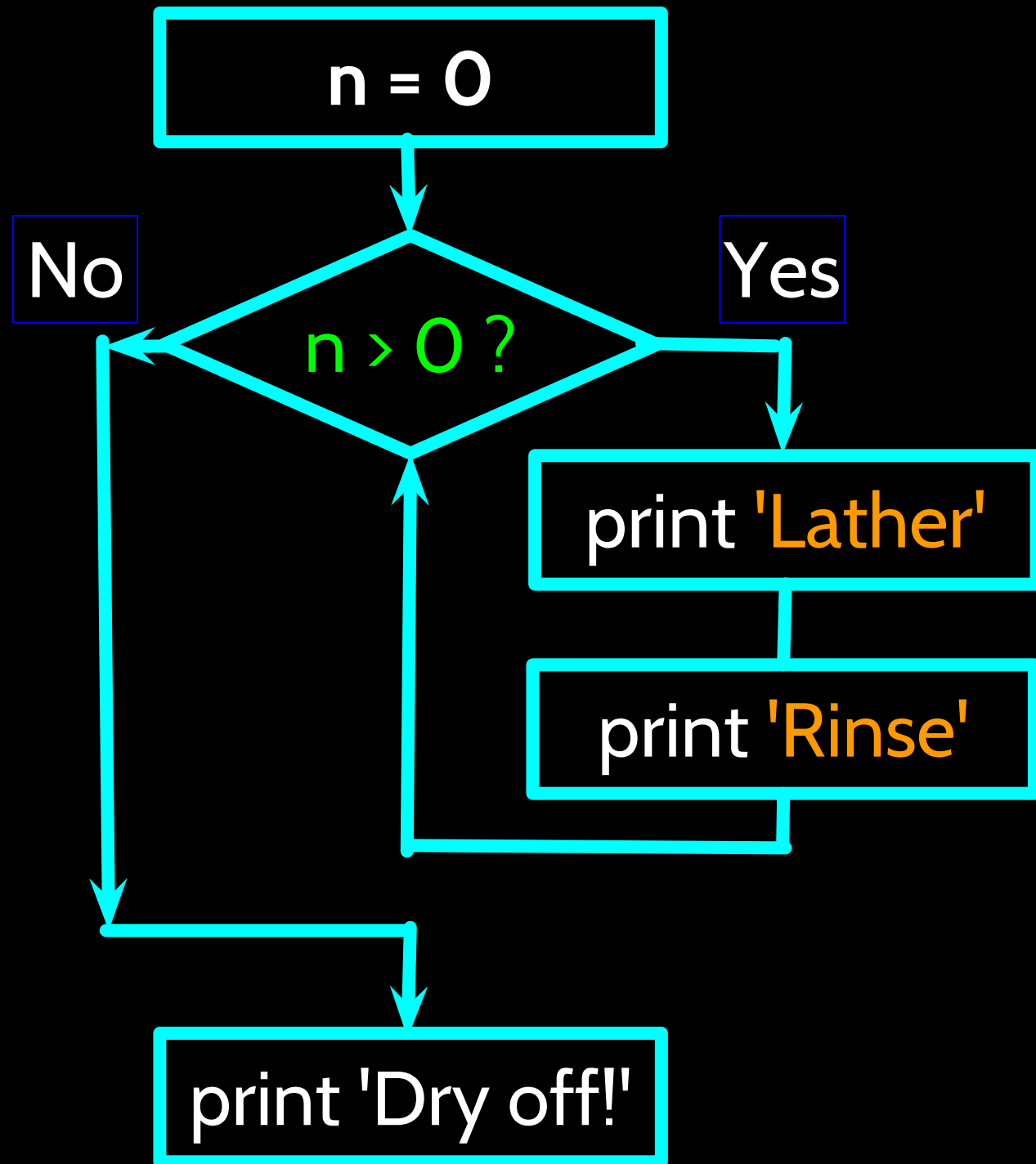
An Infinite Loop



```
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 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!
```

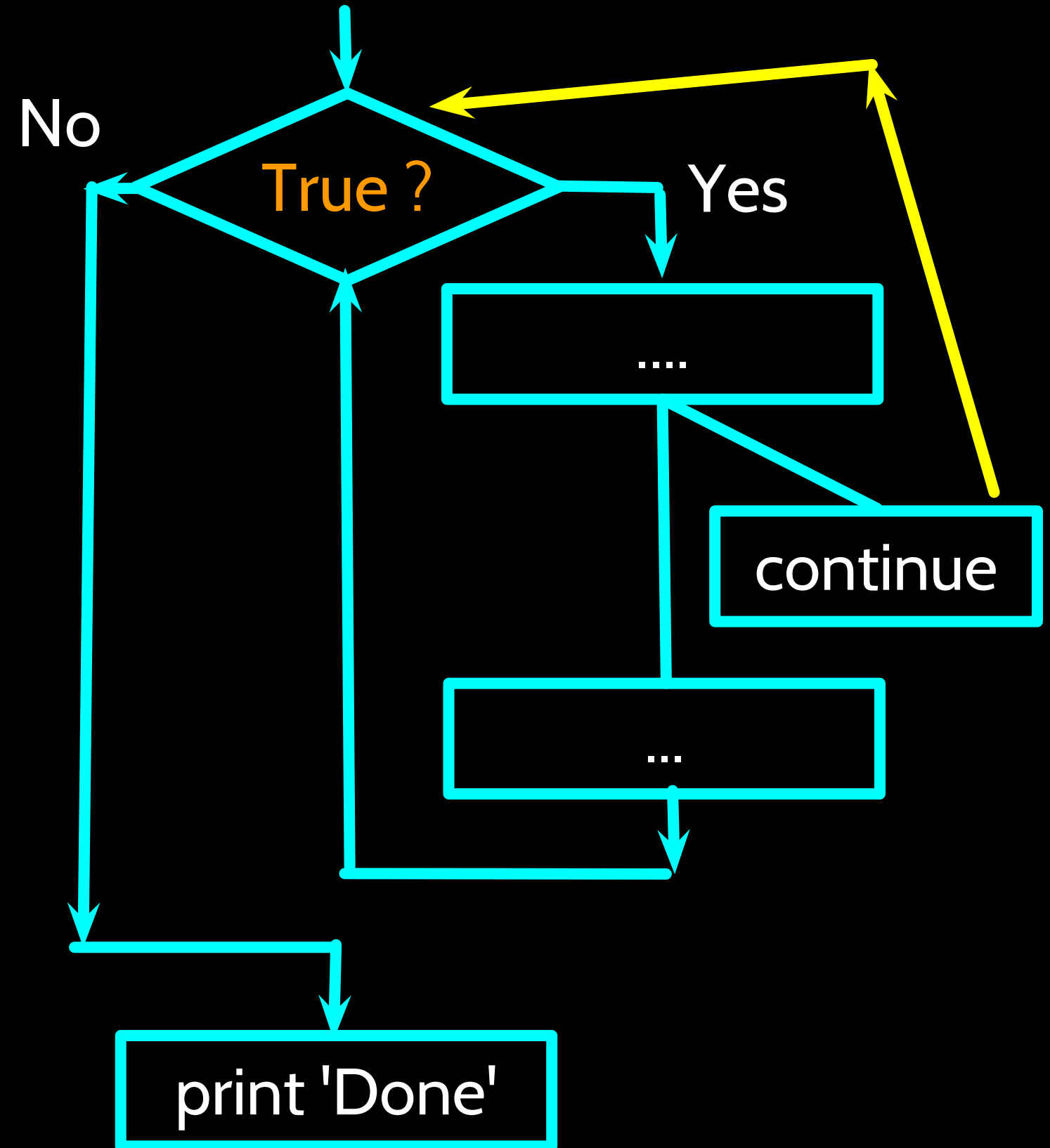
Finishing an Iteration with continue

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 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!

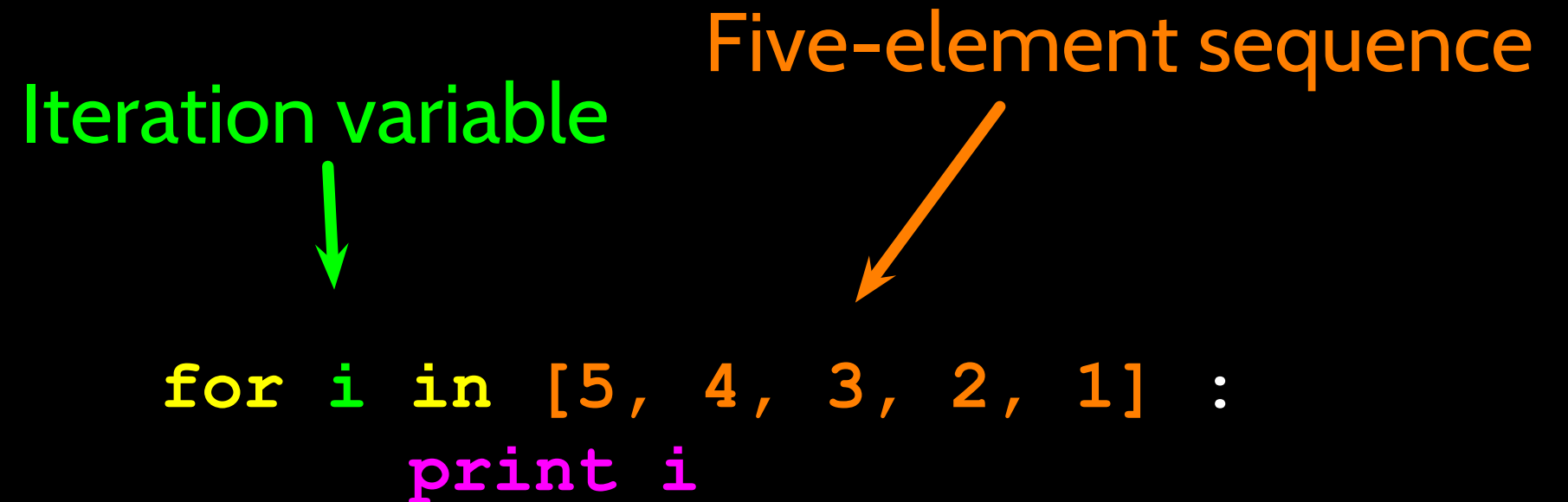
Looking at In...

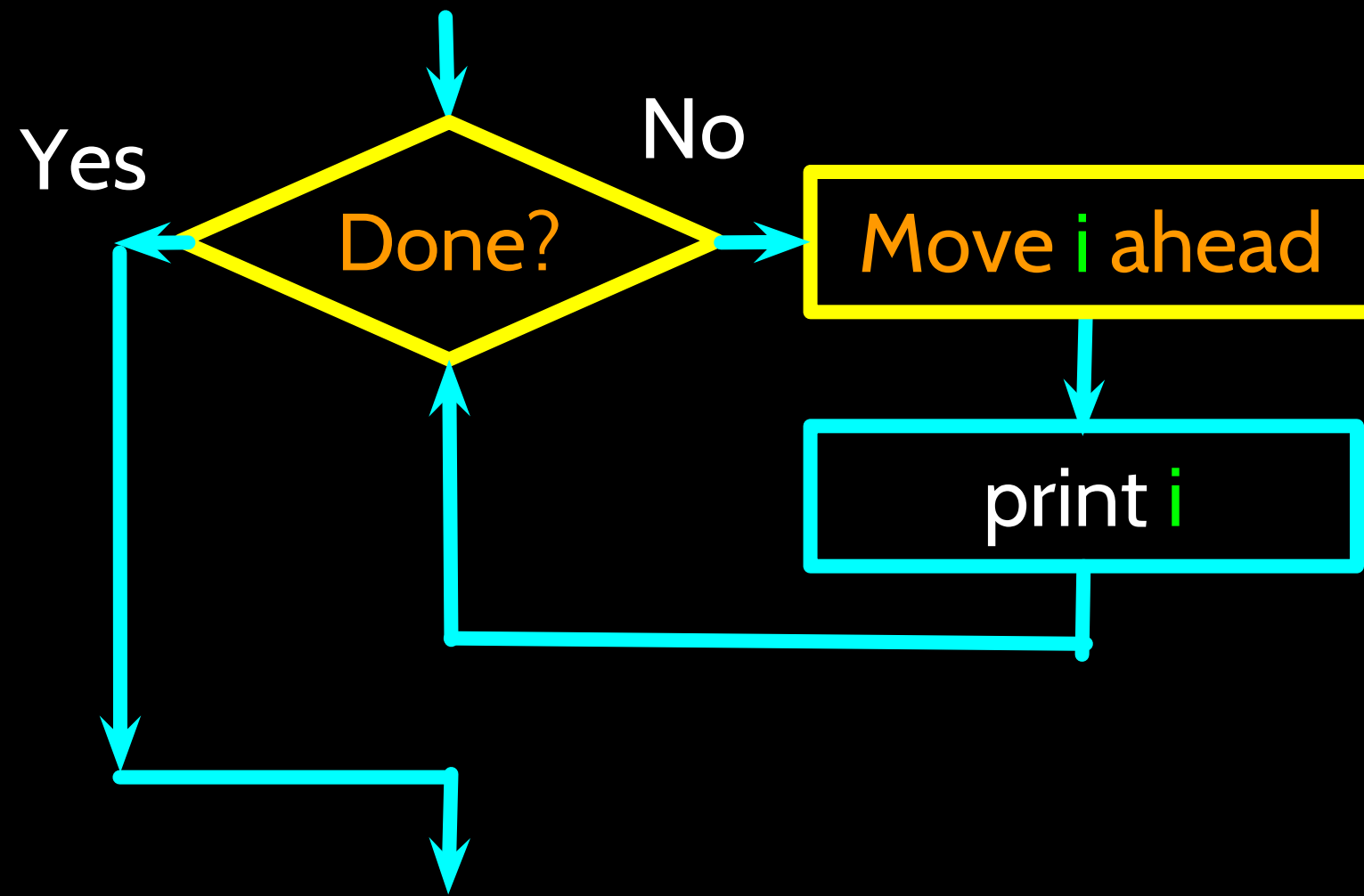
- The **iteration variable** “iterates” through the **sequence** (ordered set)
- The **block (body)** of code is executed once for each value **in** the **sequence**
- The **iteration variable** moves through all of the values **in** the **sequence**

Iteration variable

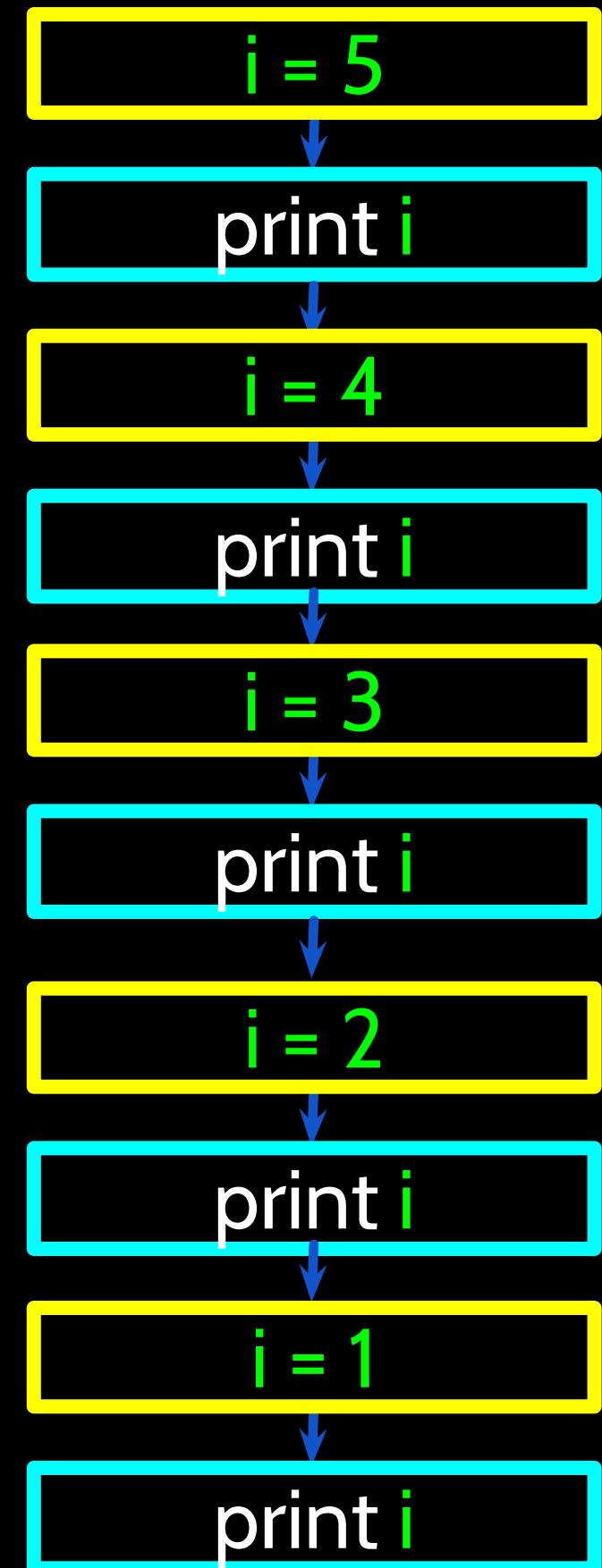
Five-element sequence

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





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



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**”

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
```

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 switch the variable name to `smallest_so_far` and switch 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 switch the variable name to `smallest_so_far` and switch 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

Summary

- While loops (indefinite)
- Infinite loops
- Using break
- Using continue
- For loops (definite)
- Iteration variables
- Loop idioms
- Largest or smallest



Acknowledgements / Contributions



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