

Loops and Iteration

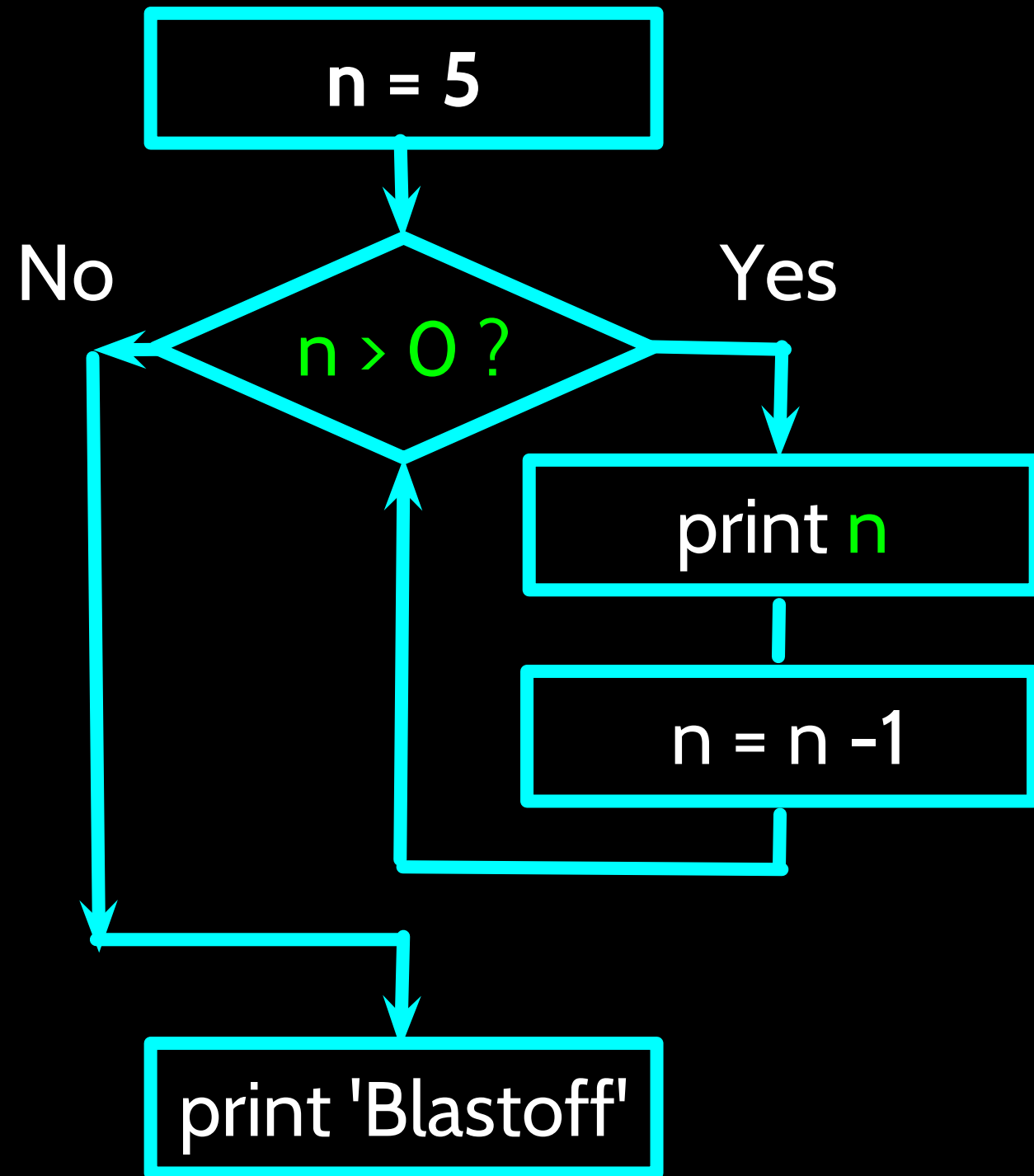
Chapter 5



Python for Informatics: Exploring Information
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Repeated Steps



Program:

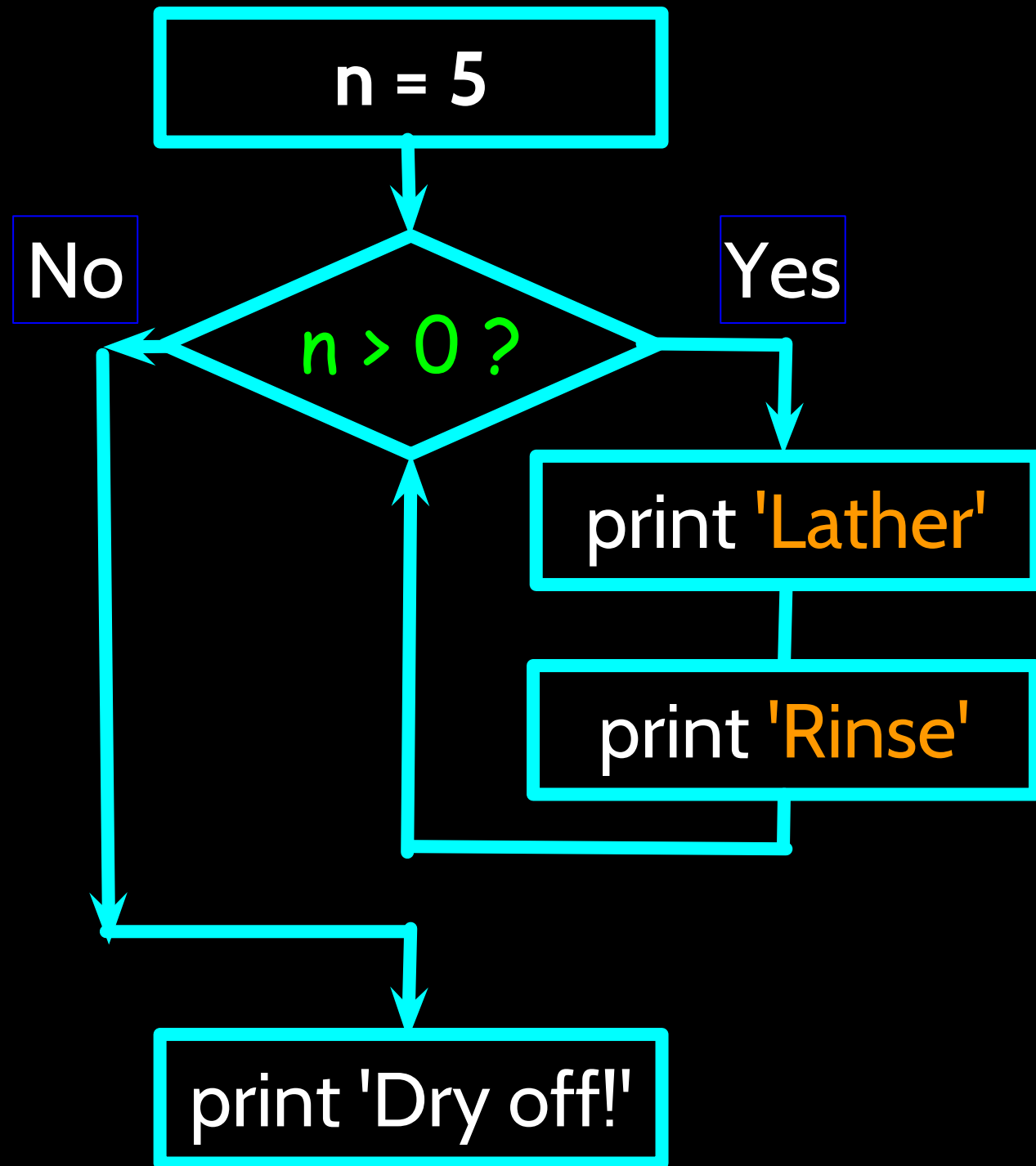
```
n = 5
while n > 0 :
    print n
    n = n - 1
print 'Blastoff!'
print n
```

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.

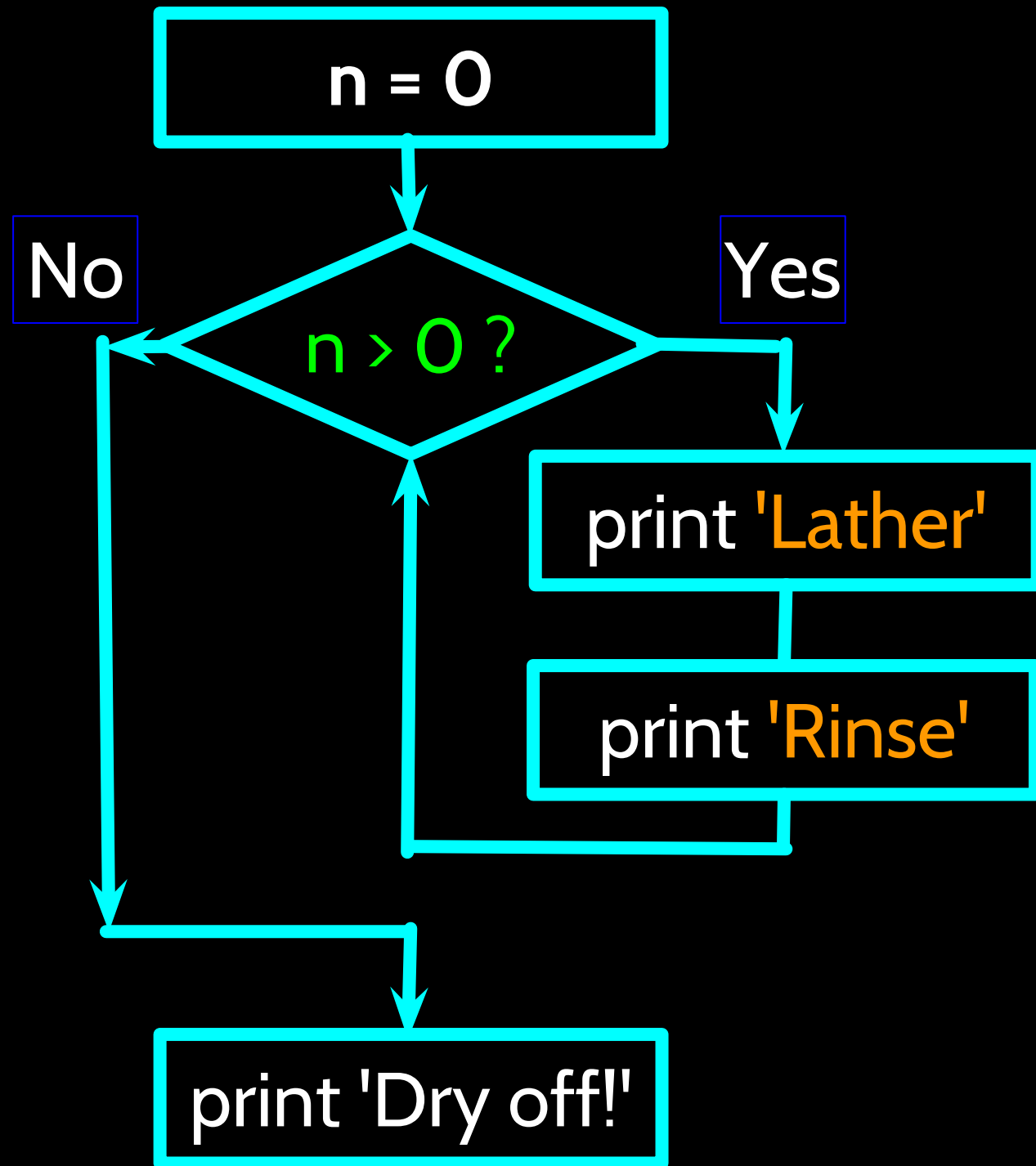
An Infinite Loop



```
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

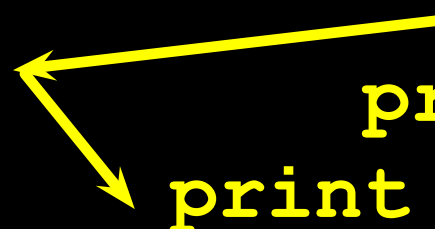
```
while True:
    line = raw_input('> ')
    if line == 'done' :
        break
    print line
print 'Done!'
```

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

Breaking Out of a Loop

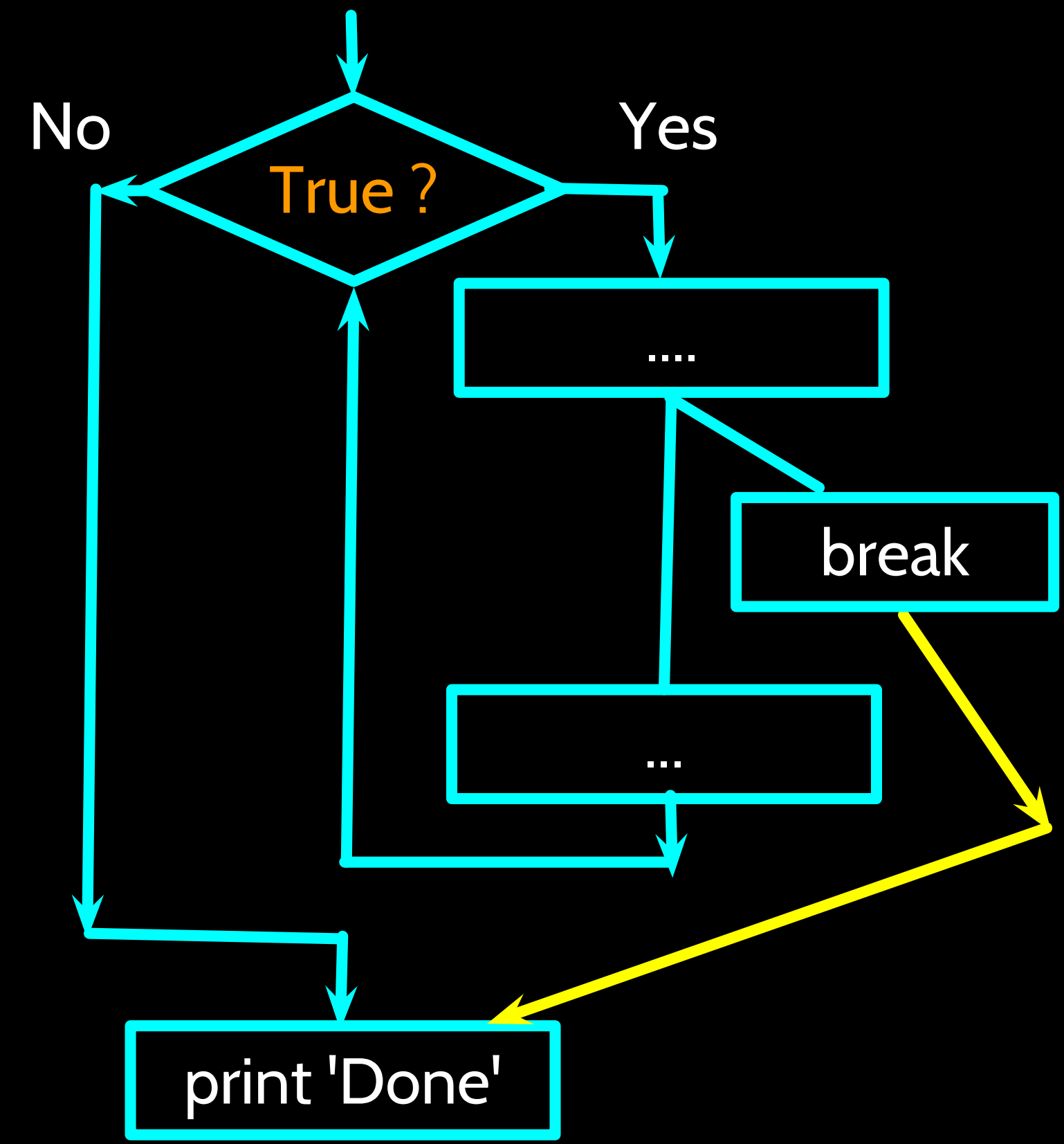
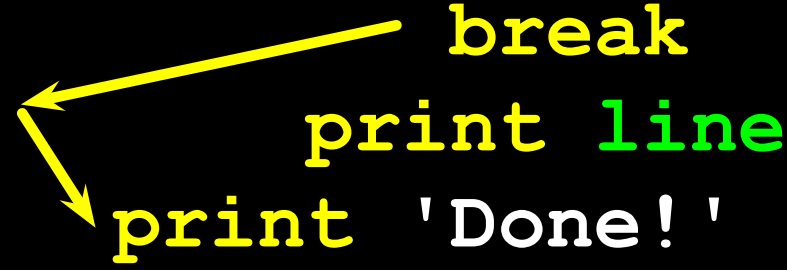
- The **break** statement ends the current loop and jumps to the statement immediately following the loop
- It is like a loop test that can happen anywhere in the body of the loop

```
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!'
```



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

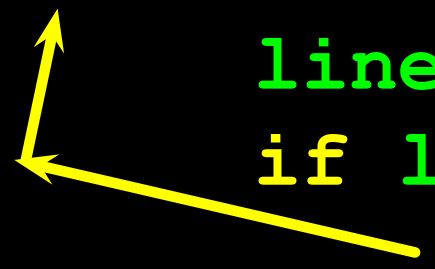
```
while True:
    line = raw_input('> ')
    if line[0] == '#':
        continue
    if line == 'done':
        break
    print line
print 'Done!'
```

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


Finishing an Iteration with continue

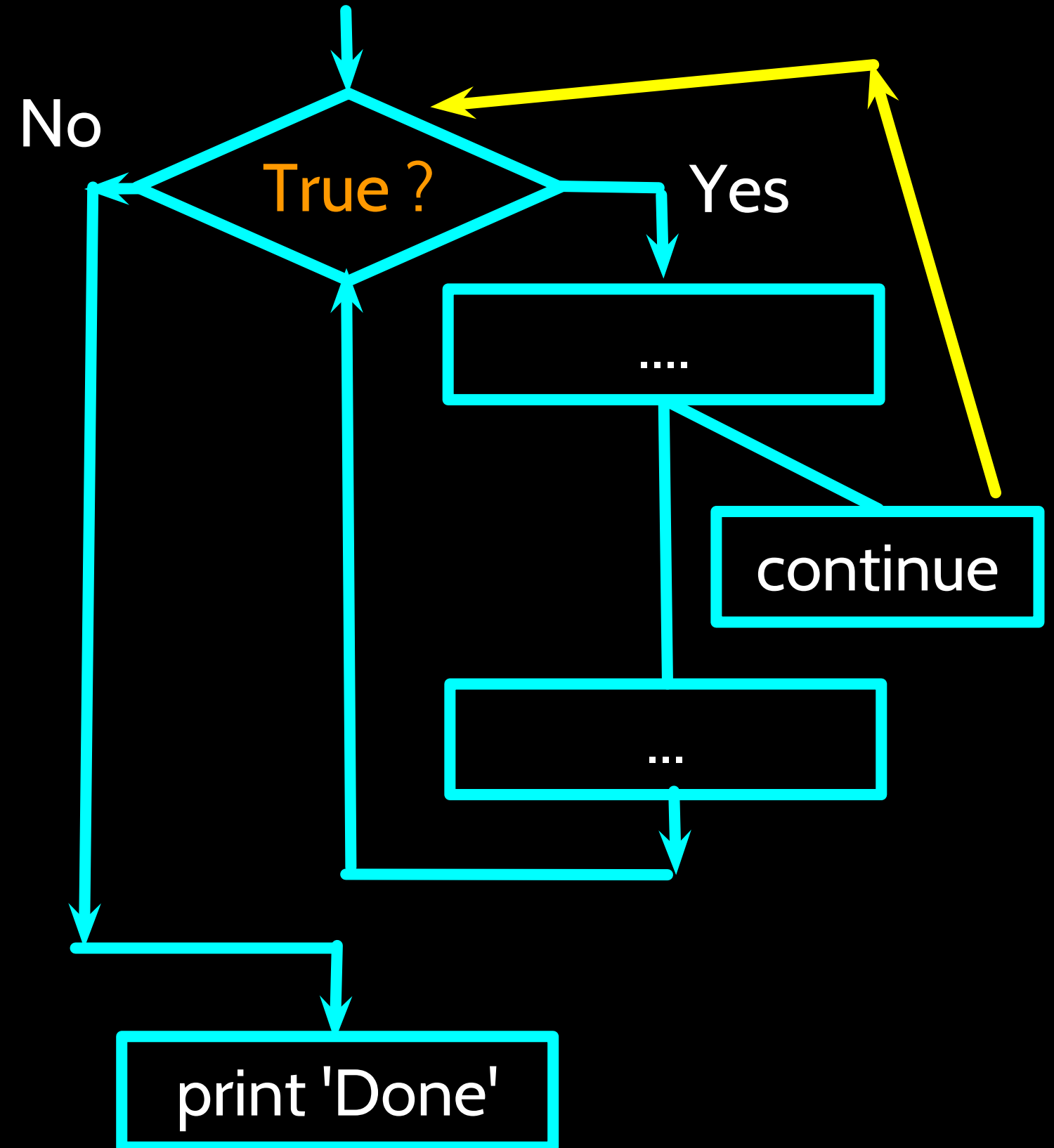
The **continue** statement ends the *current iteration* and jumps to the **top of the loop** and starts the next iteration

```
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

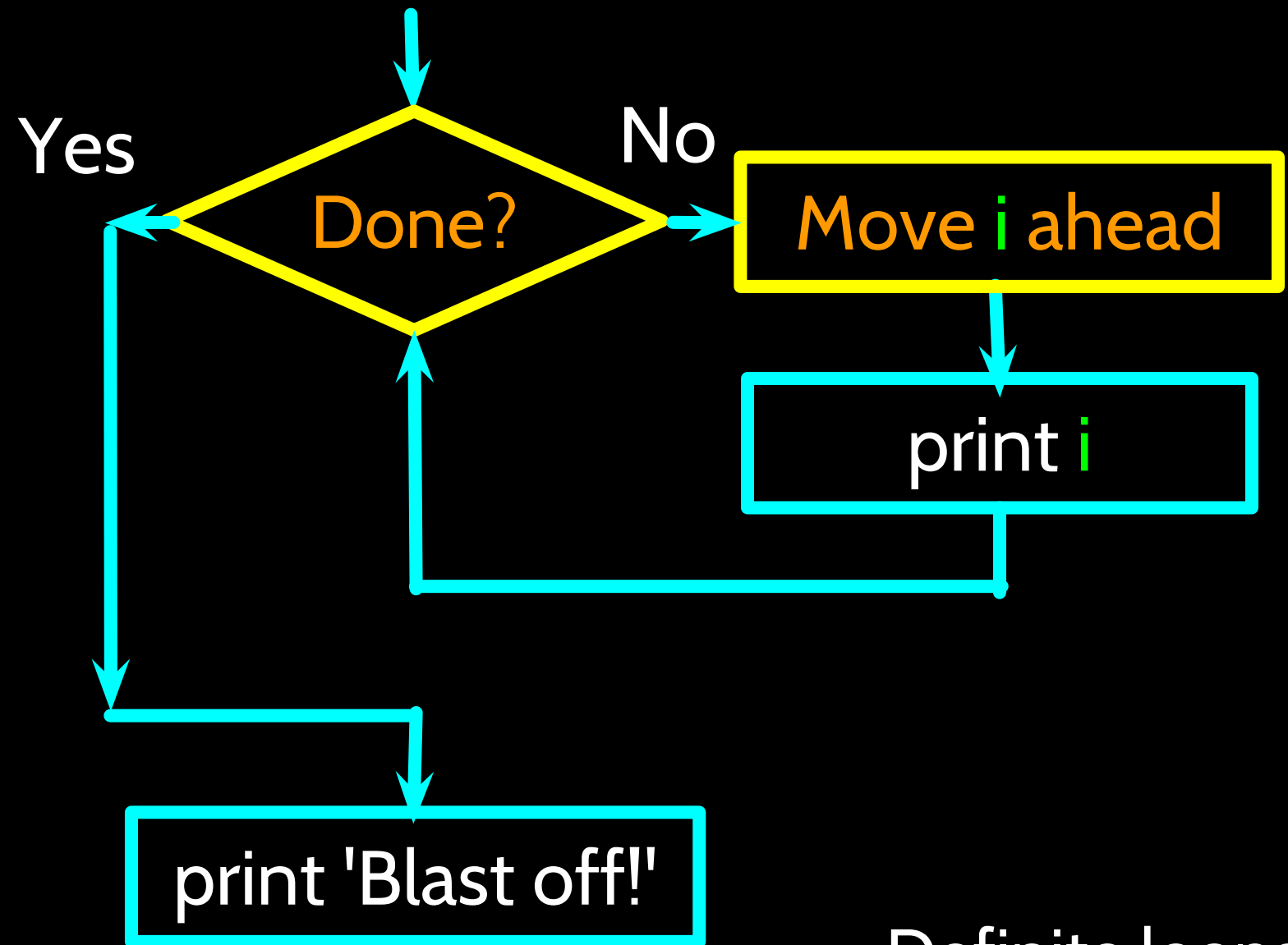
Blastoff!

A 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.

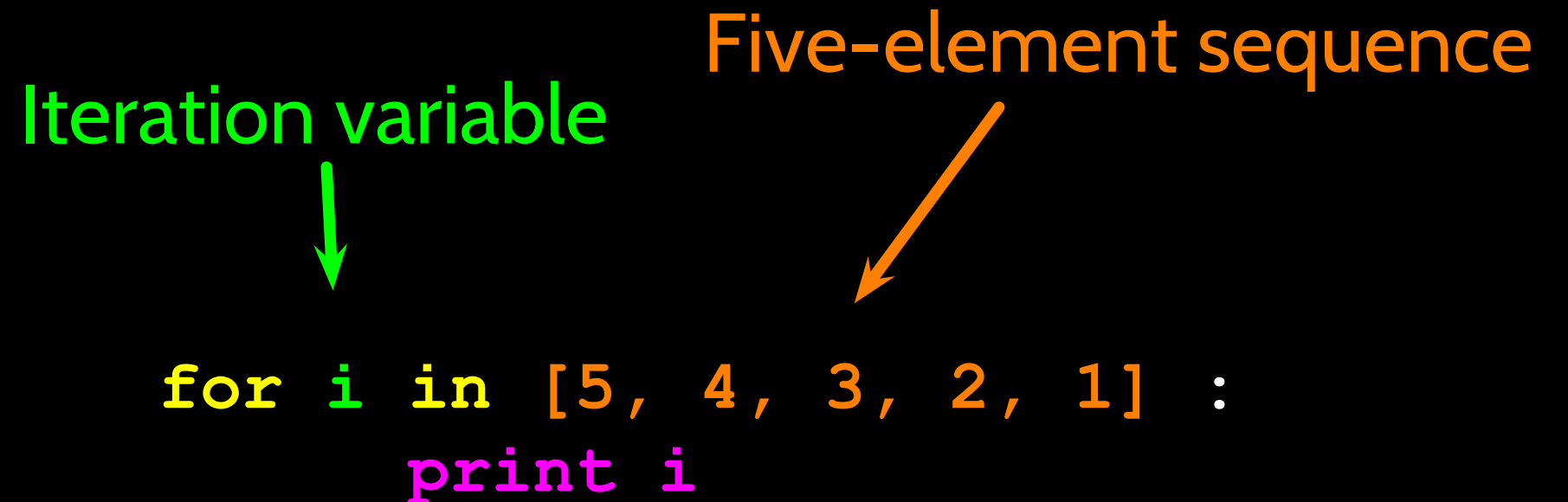
Looking at In...

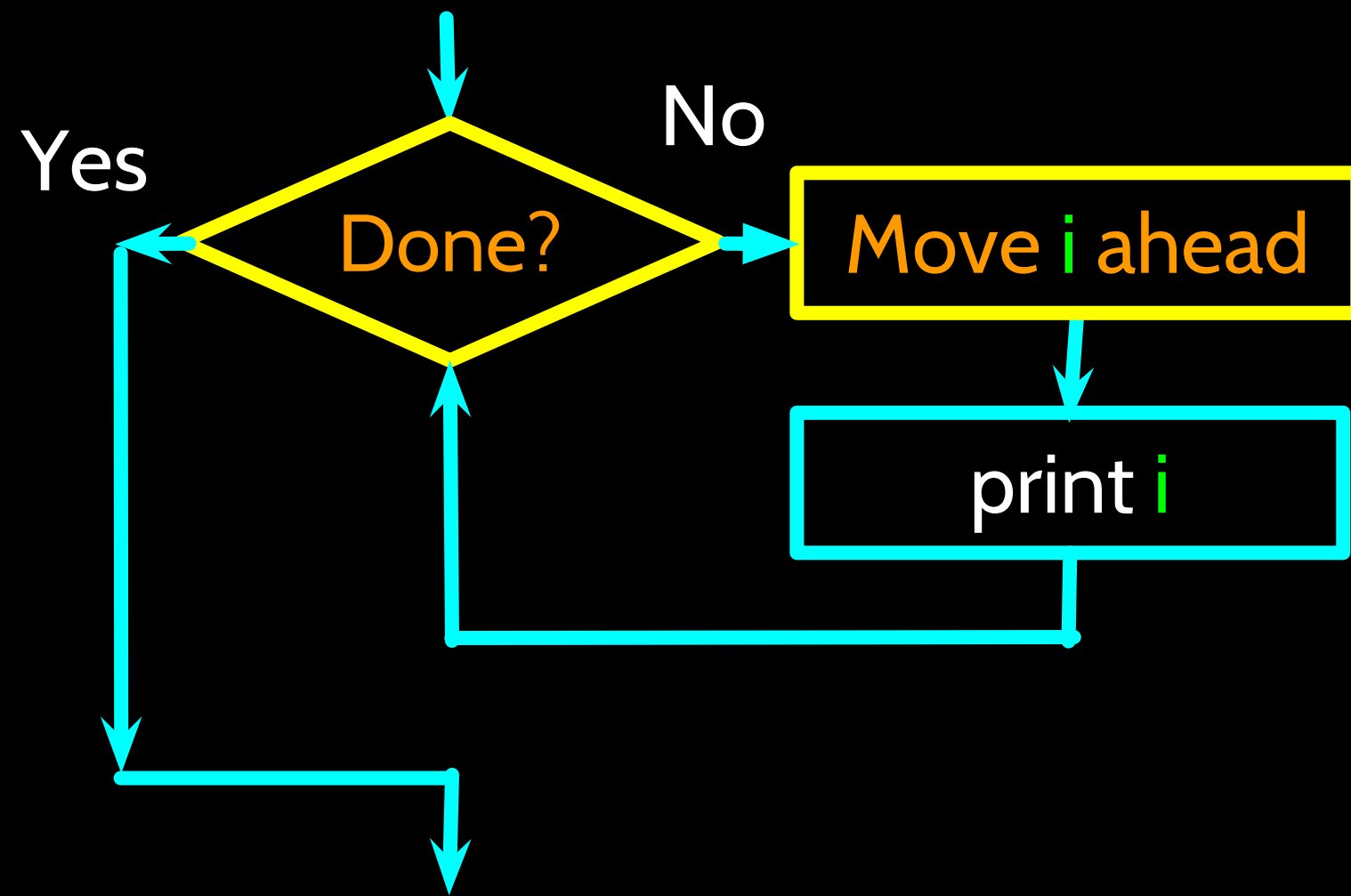
- The **iteration variable** “iterates” through the **sequence** (ordered set)
- The **block (body)** of code is executed once for each value **in** the **sequence**
- The **iteration variable** moves through all of the values **in** the **sequence**

Iteration variable

Five-element sequence

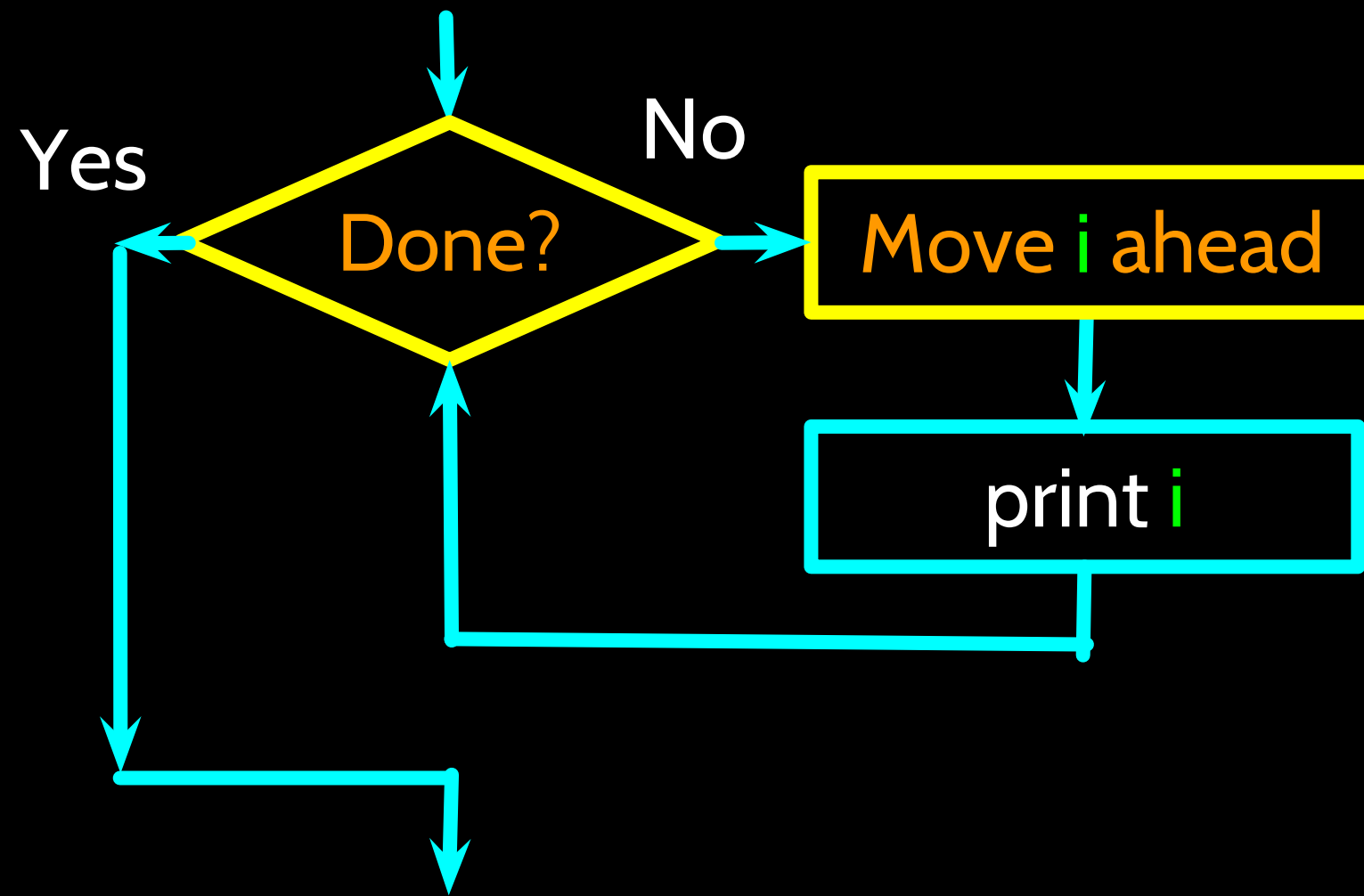
```
for i in [5, 4, 3, 2, 1] :  
    print i
```



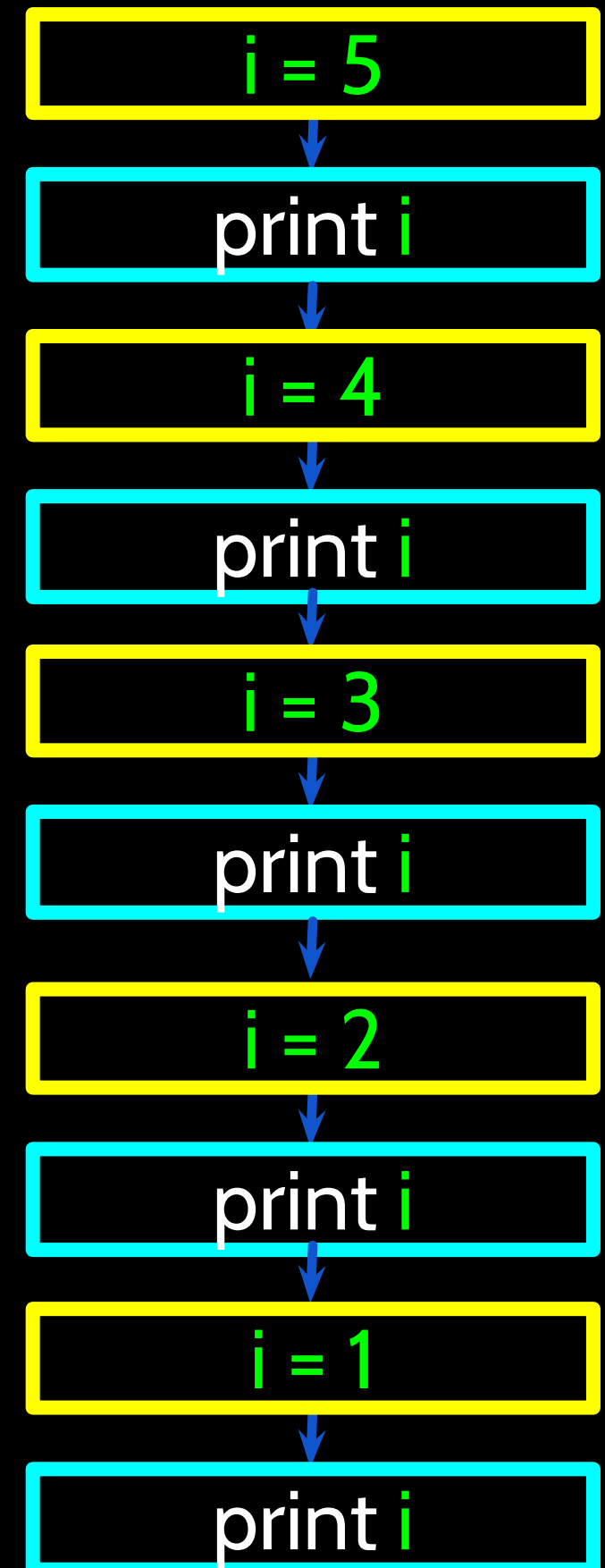


```
for i in [5, 4, 3, 2, 1] :  
    print i
```

- 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

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?

3

What is the Largest Number?

41

What is the Largest Number?

12

What is the Largest Number?

9

What is the Largest Number?

74

What is the Largest Number?

15

What is the Largest Number?

What is the Largest Number?

3 41 12 9 74 15

What is the Largest Number?

largest_so_far

-1

What is the Largest Number?

3

largest_so_far

3

What is the Largest Number?

41

largest_so_far

41

What is the Largest Number?

12

largest_so_far

41

What is the Largest Number?

9

largest_so_far

41

What is the Largest Number?

74

largest_so_far

74

What is the Largest Number?

15

largest_so_far

74

What is the Largest Number?

3 41 12 9 74 15

largest_so_far

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.

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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