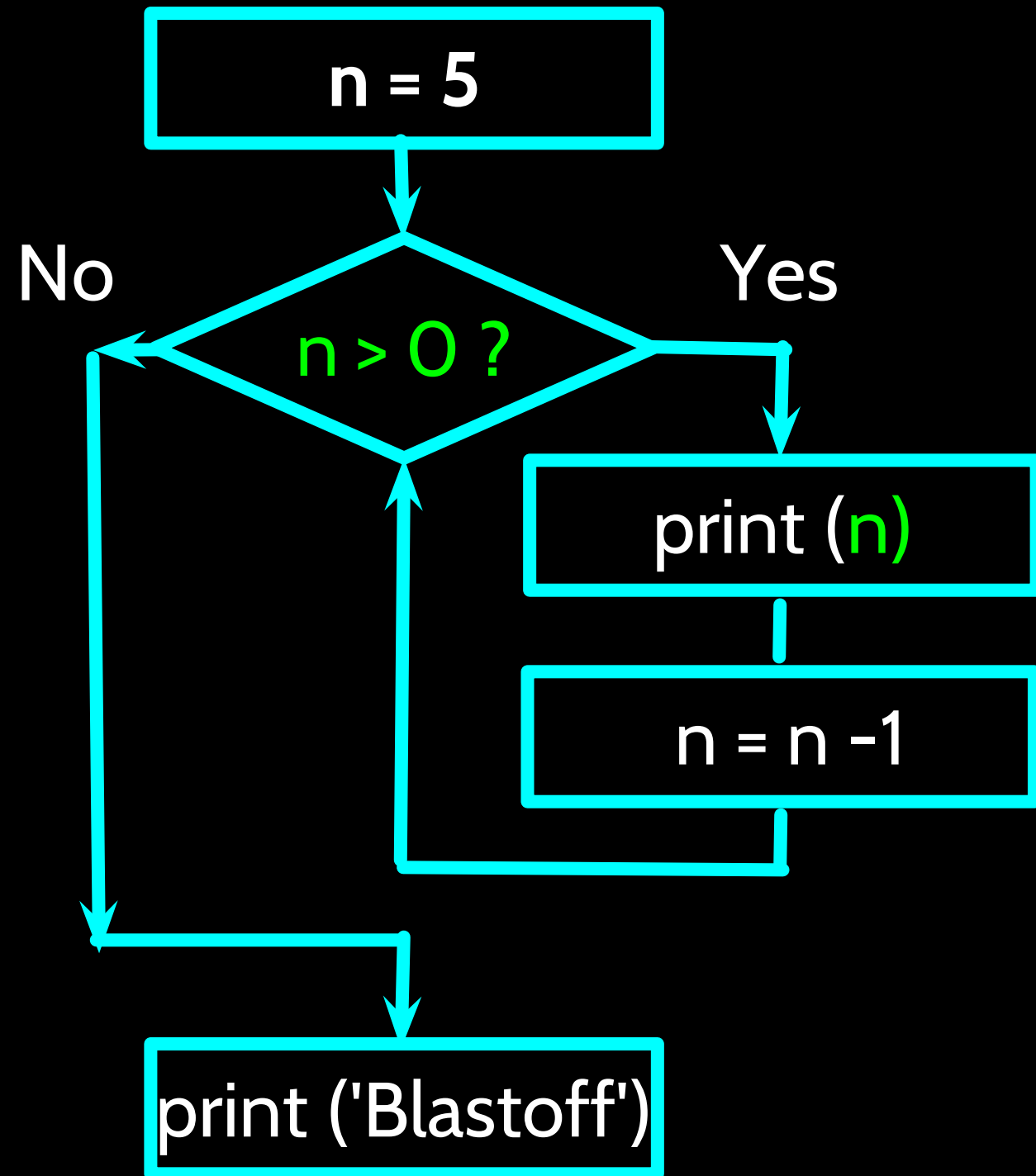


# Loops and Iteration

## Chapter 5

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

# Repeated Steps



Program:

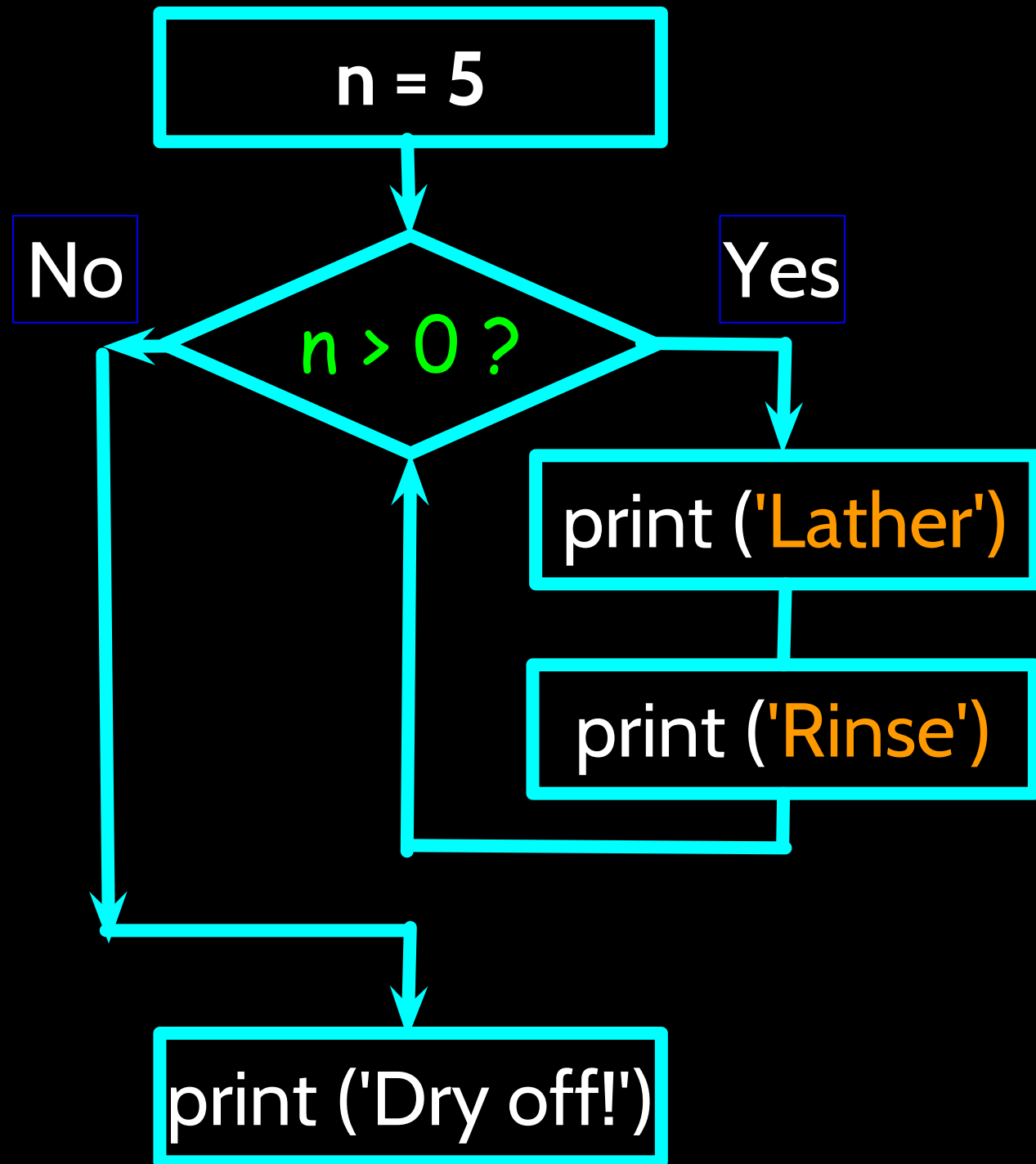
```
n = 5
while n > 0 :
    print (n)
    n = n - 1
print ('Blastoff!')
print (n)
```

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.

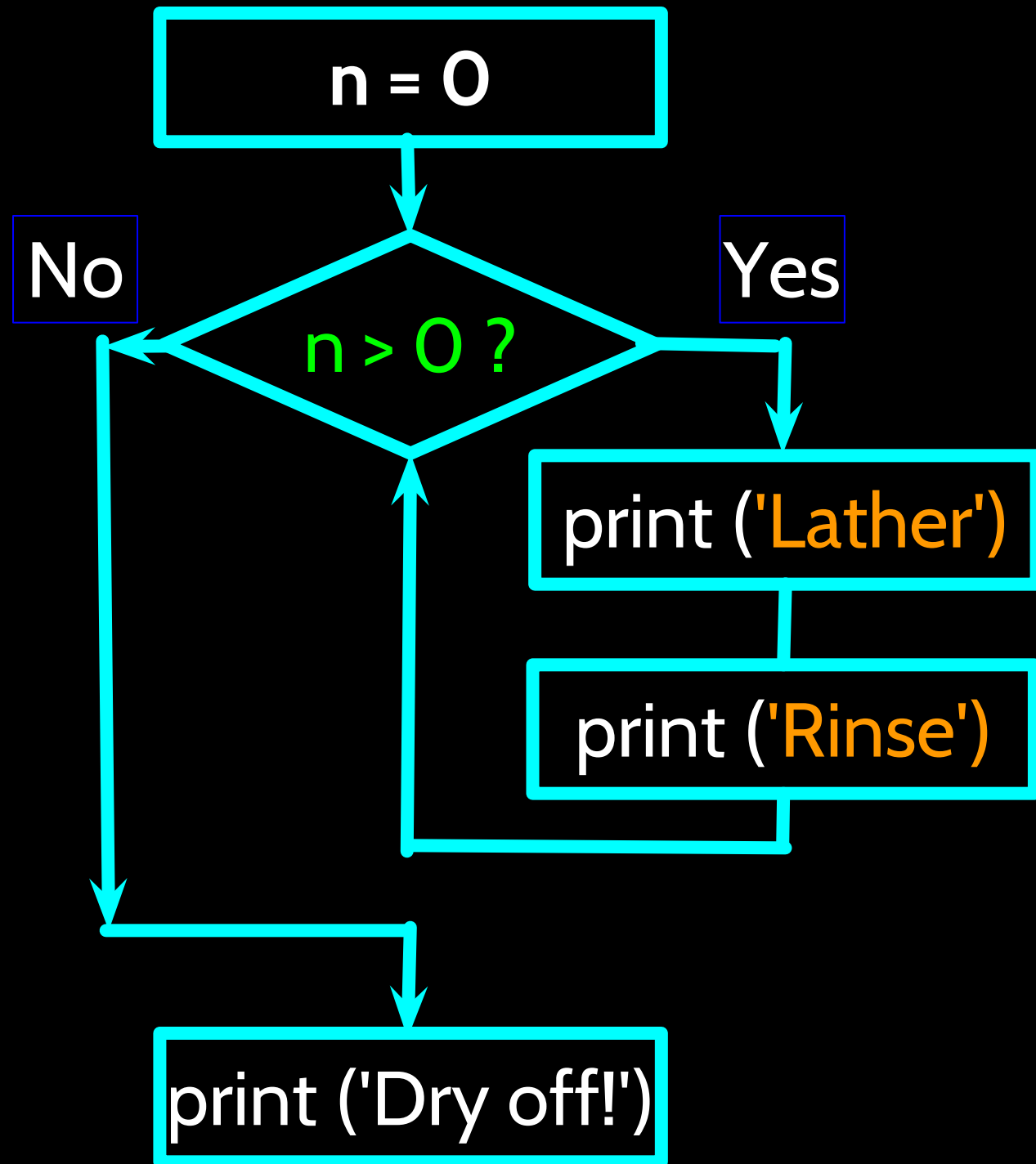
# An Infinite Loop



```
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

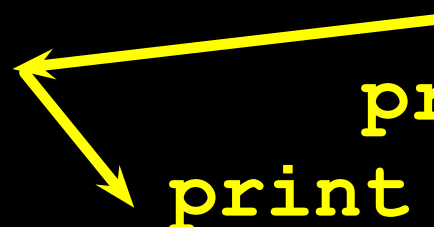
```
while True:
    line = input('> ')
    if line == 'done' :
        break
    print (line)
print ('Done!')
```

```
> 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!')
```

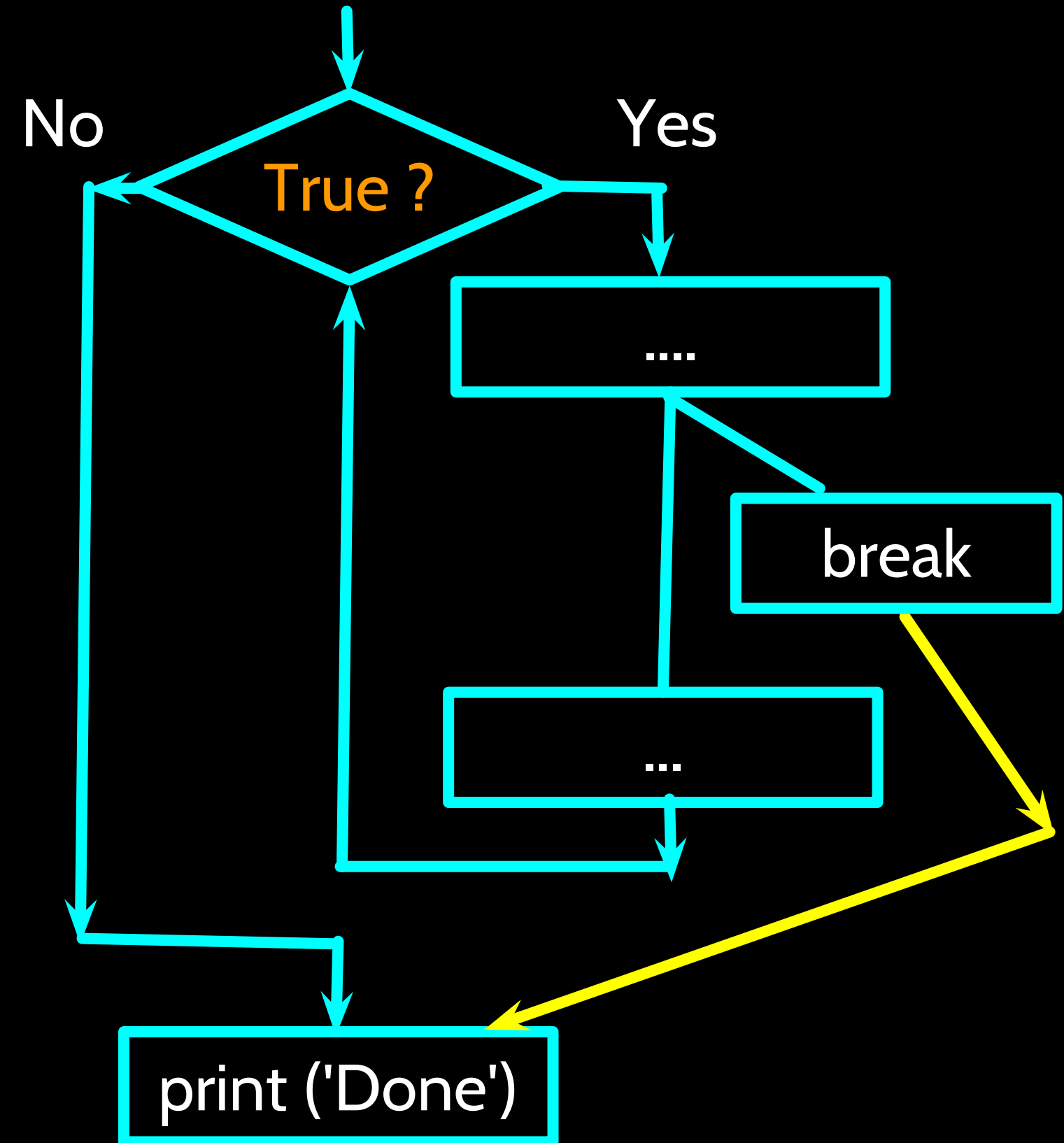


```
> hello there
hello there
> finished
finished
> done
Done!
```

```

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

```



# 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!')
```

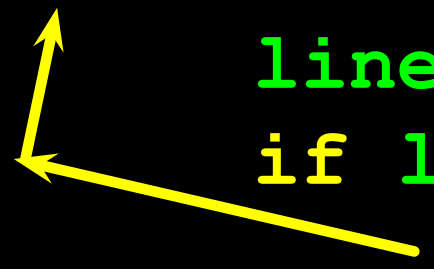
```
> hello there
hello there
> # don't print this
> print this!
print this!
> done
Done!
```



# Finishing an Iteration with continue

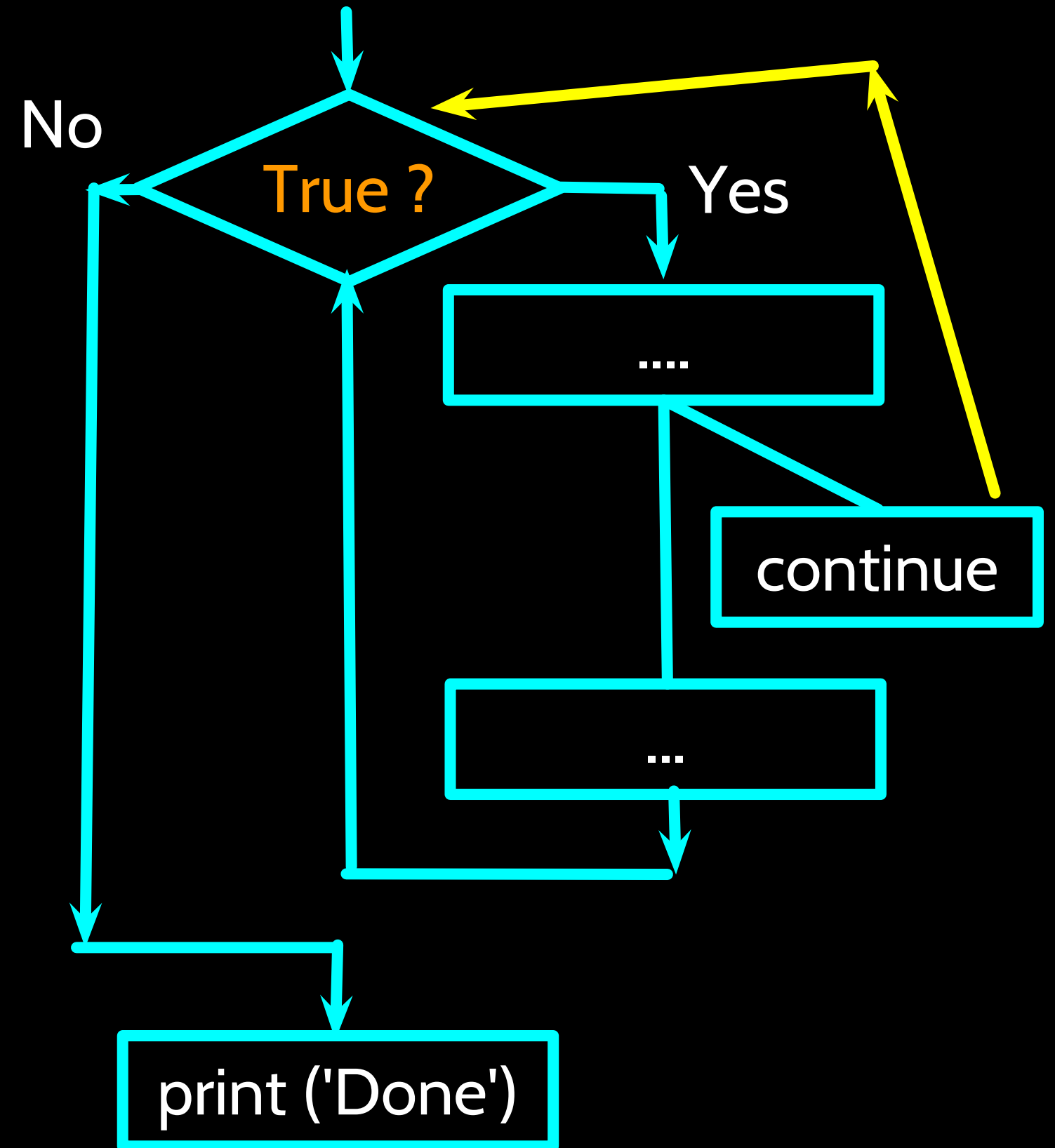
The **continue** statement ends the *current iteration* and jumps to the **top of the loop** and starts the next iteration

```
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 = 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!')
```

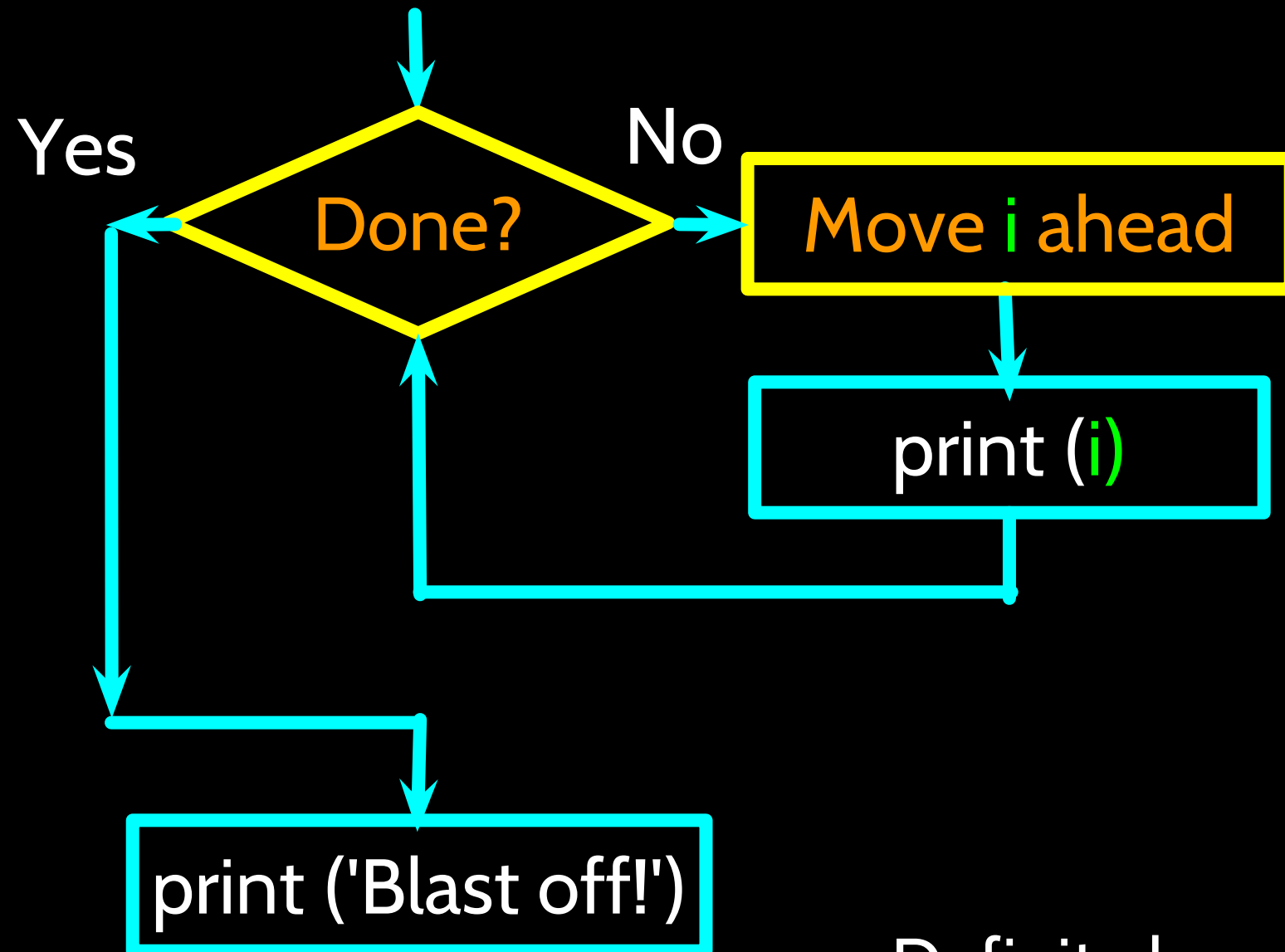
Happy New Year: Joseph

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!')
```

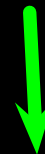
5  
4  
3  
2  
1  
Blastoff!

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

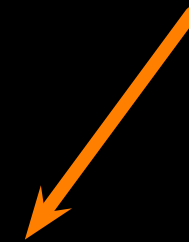
# Looking at In...

- 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

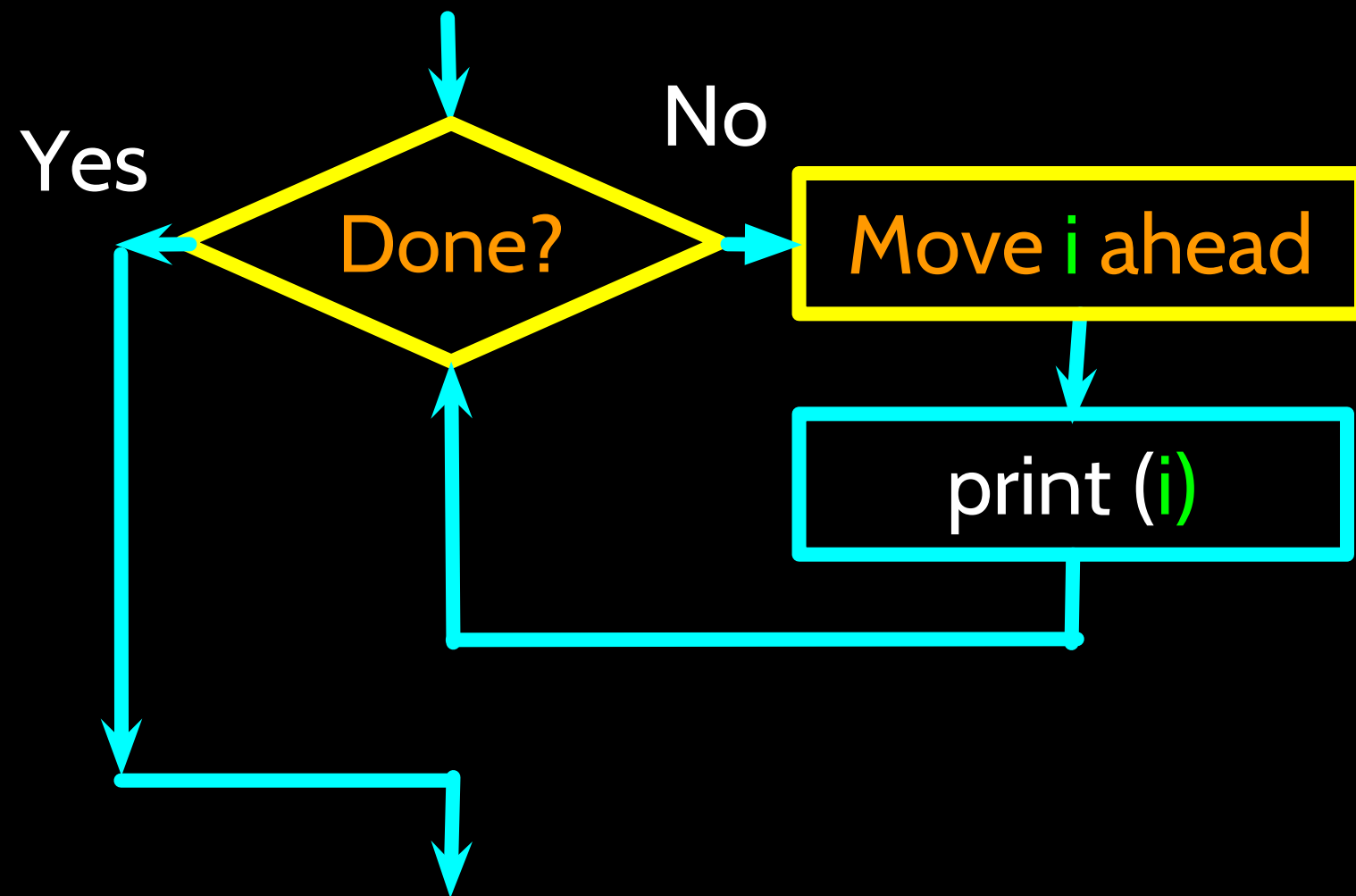


Five-element sequence



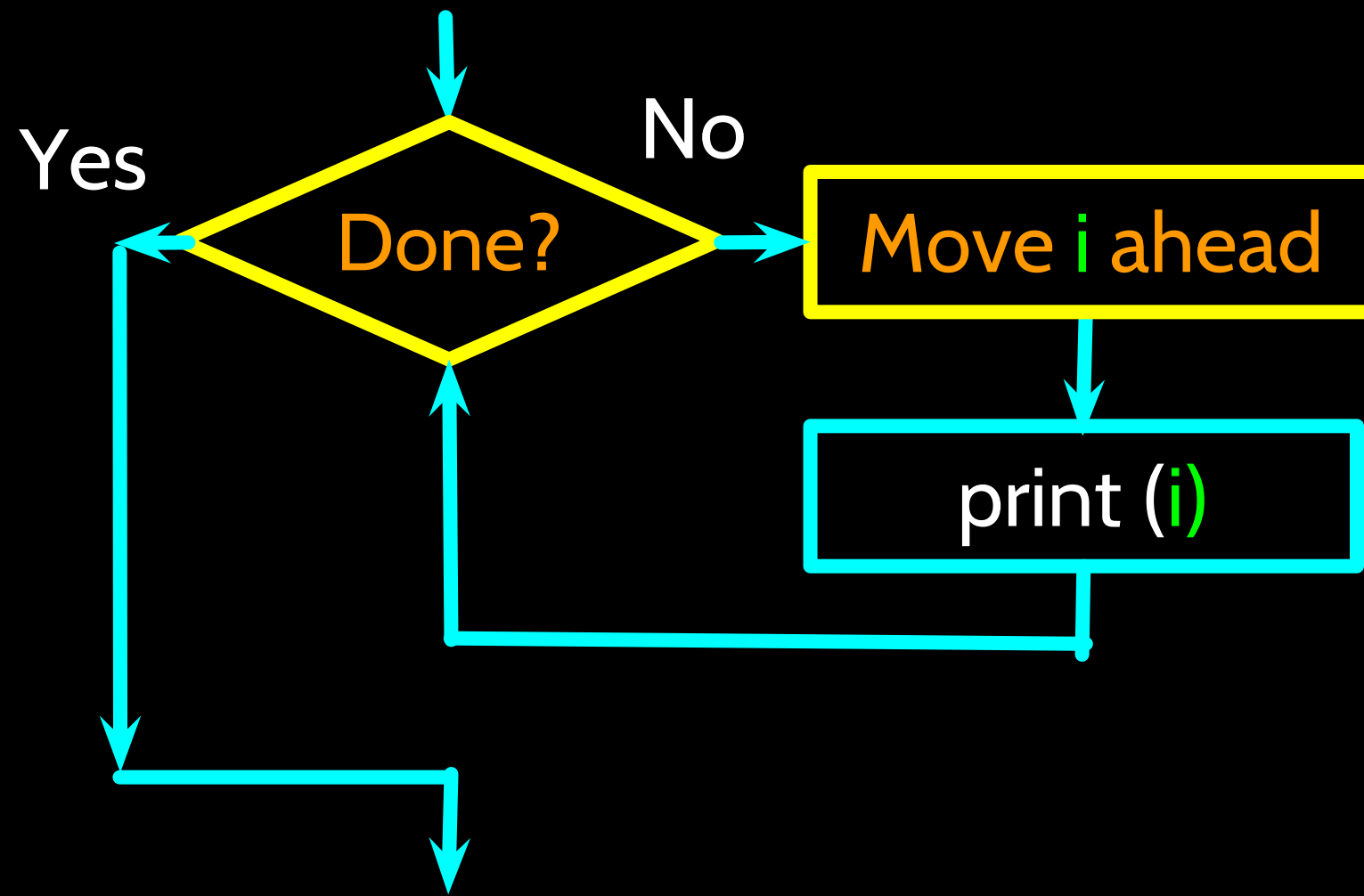
```
for i in [5, 4, 3, 2, 1] :  
    print (i)
```



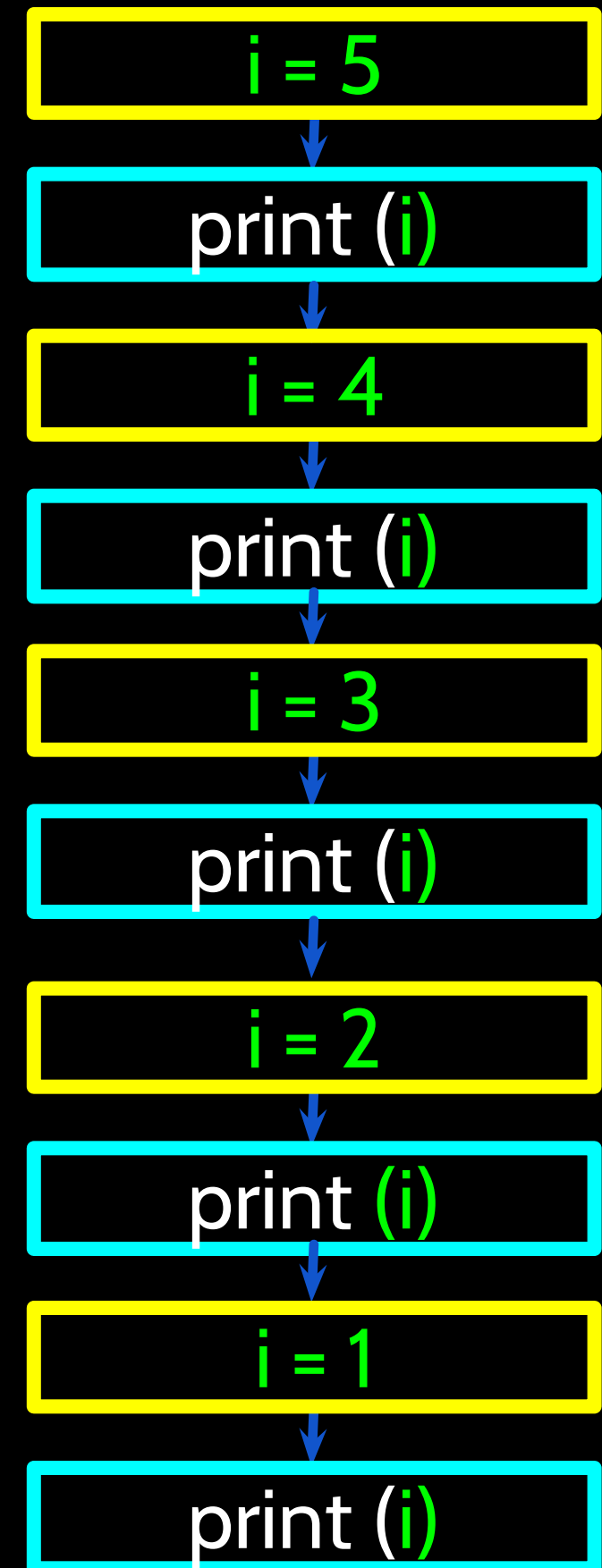


```
for i in [5, 4, 3, 2, 1] :  
    print (i)
```

- 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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Initial Development: Charles Severance, University of Michigan School of Information

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