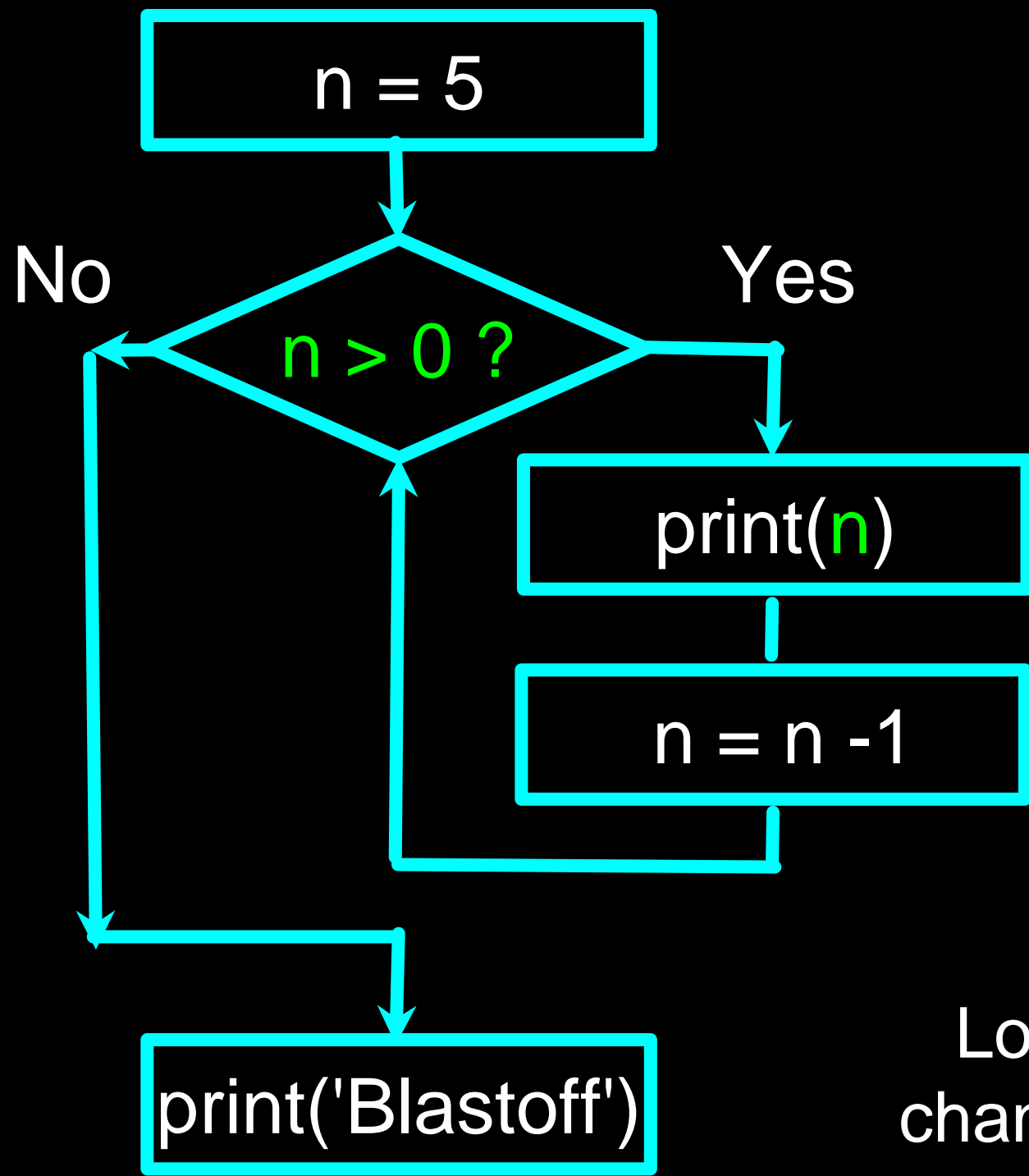


Loops

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Repeated Steps



Program:

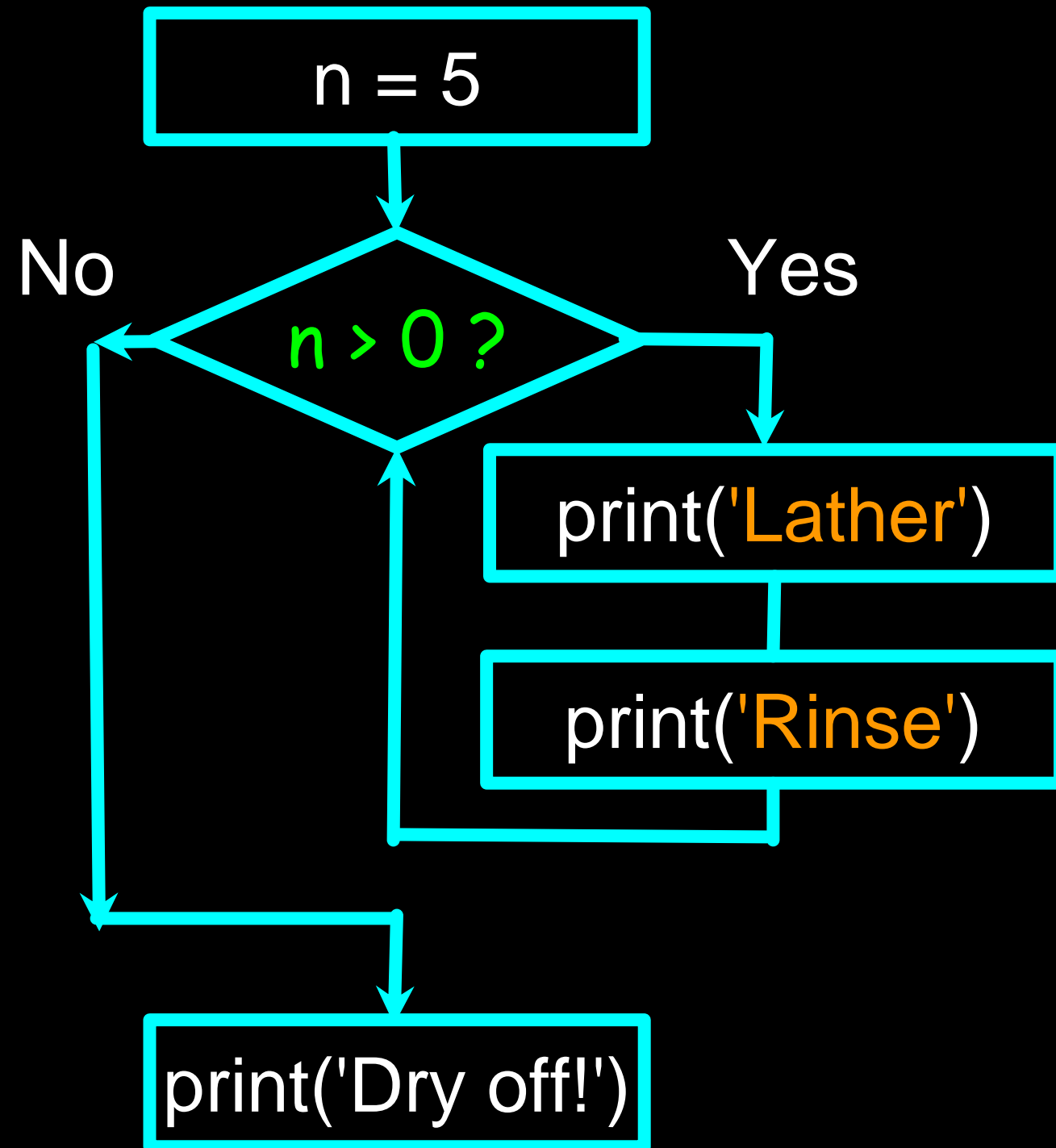
```
n = 5
while n > 0 :
    print(n)
    n = n - 1
print('Blastoff!')
print(n)
```

Output:

5
4
3
2
1
Blastoff!
0

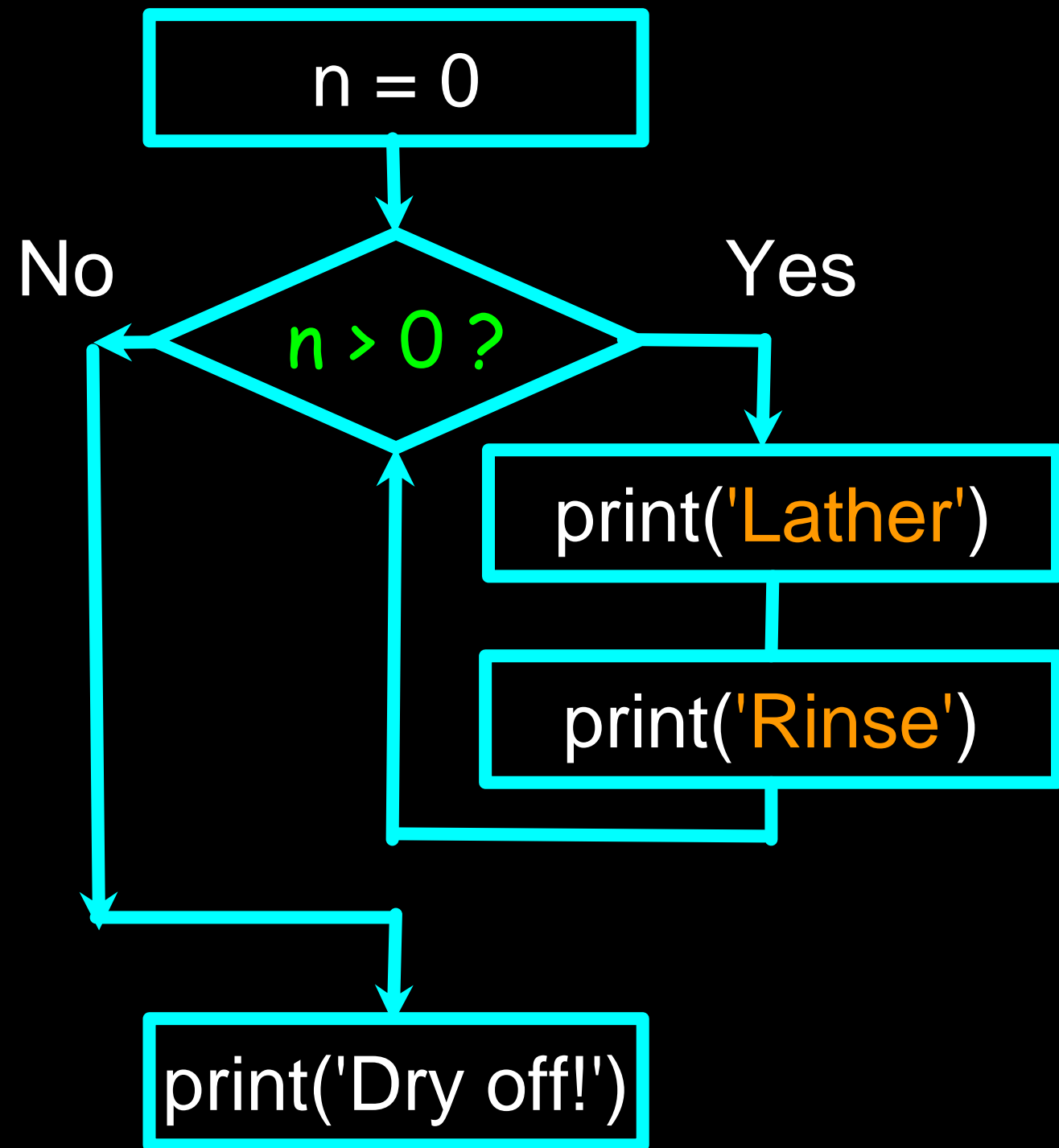
Loops (repeated steps) have **iteration variables** that change each time through a loop. Often these **iteration variables** go through a sequence of numbers.

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?

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

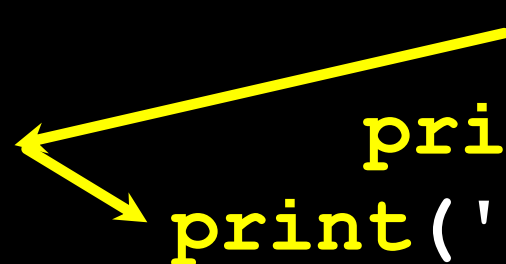
```
while True:
    line = input('> ')
    if line == 'done' :
        break
    print(line)
print('Done!')
```

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

Breaking Out of a Loop

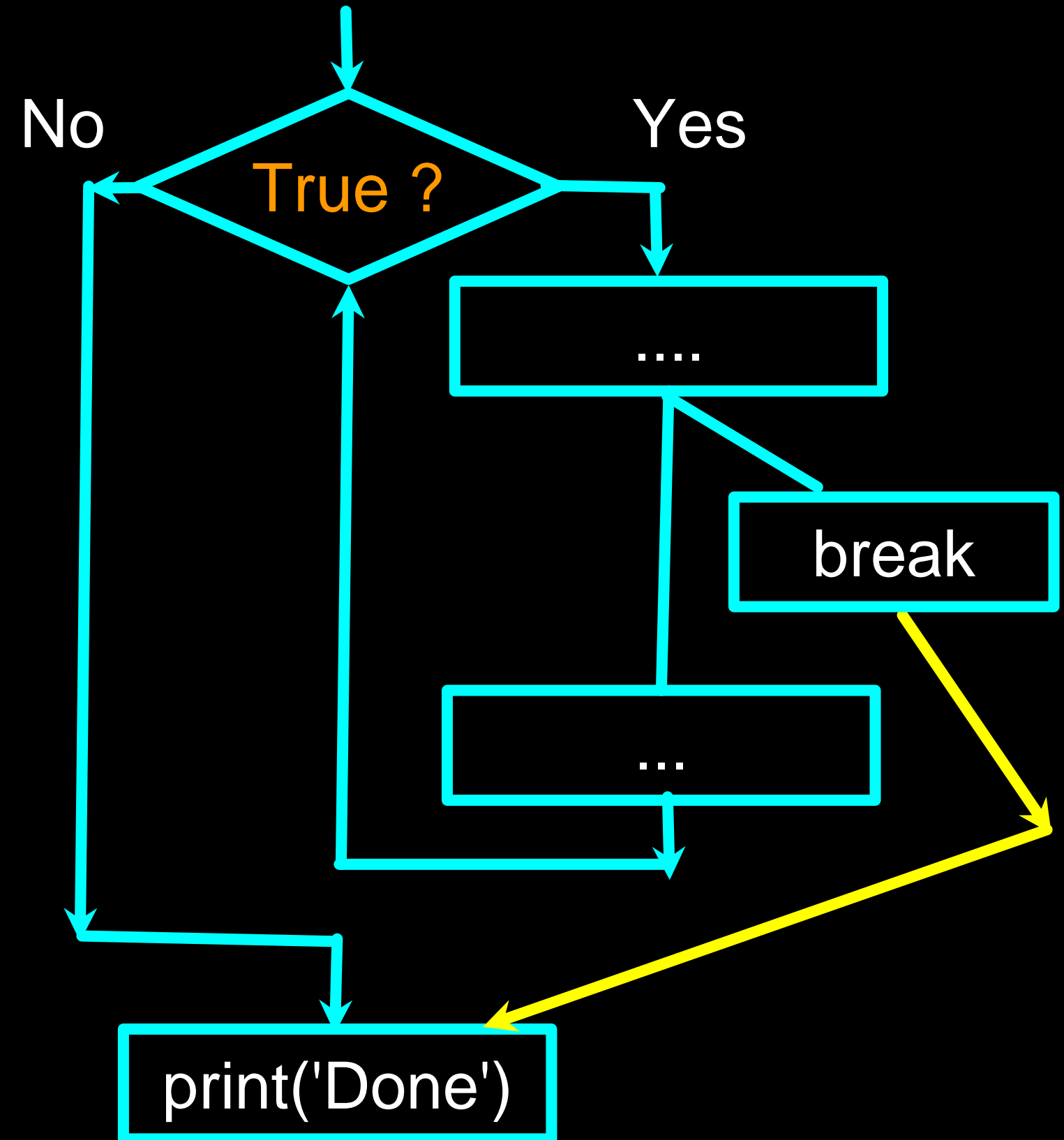
- The **break** statement ends the current loop and jumps to the statement immediately following the loop
- It is like a loop test that can happen anywhere in the body of the loop

```
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

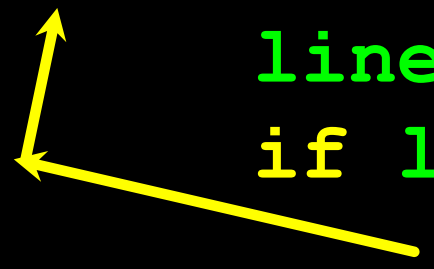
```
while True:
    line = input('> ')
    if line[0] == '#' :
        continue
    if line == 'done' :
        break
    print(line)
print('Done!')
```

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


Finishing an Iteration with continue

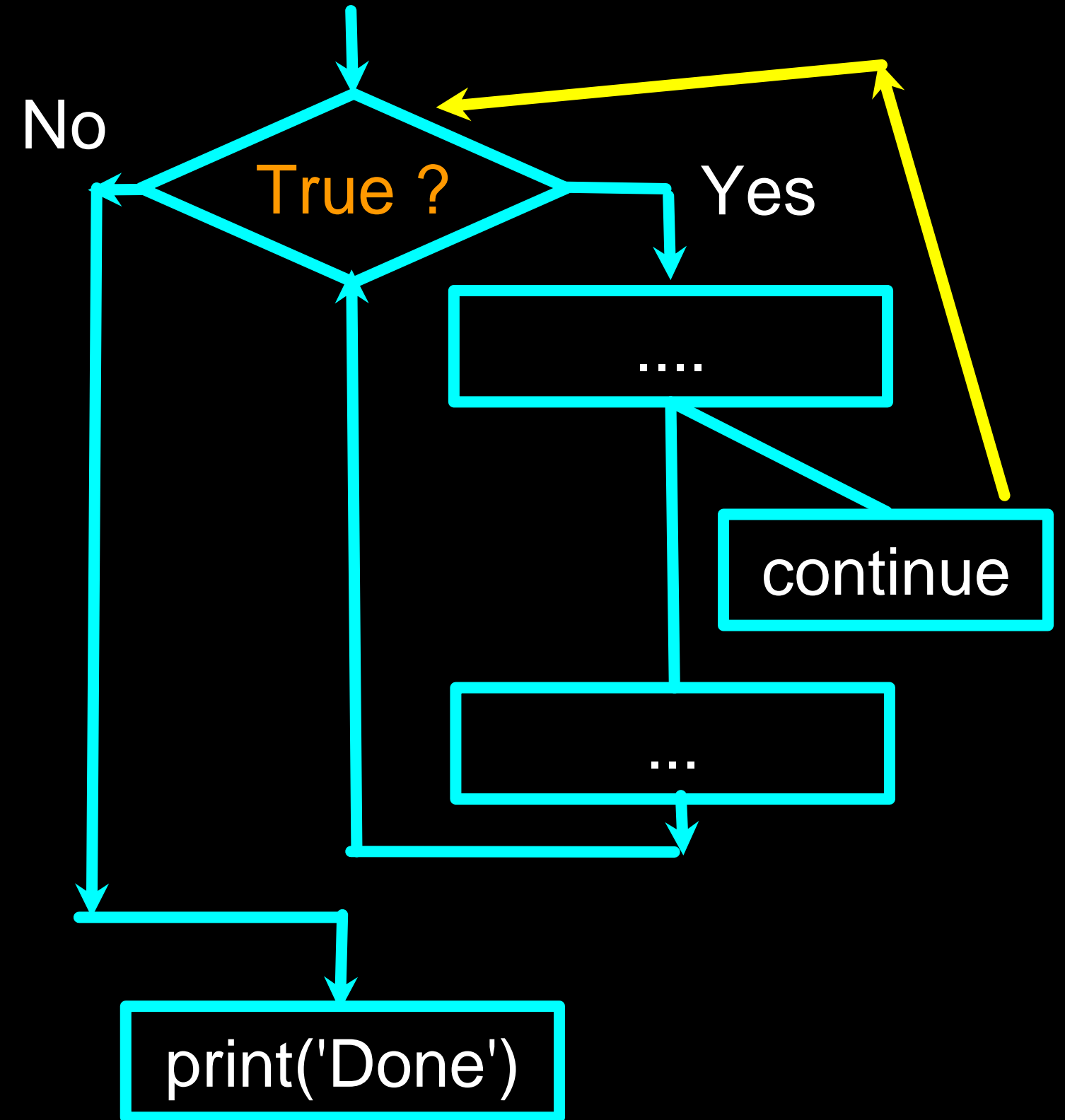
The **continue** statement ends the **current iteration** and jumps to the **top of the loop** and starts the next iteration

```
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 = 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

Iterating over a set of items...

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!

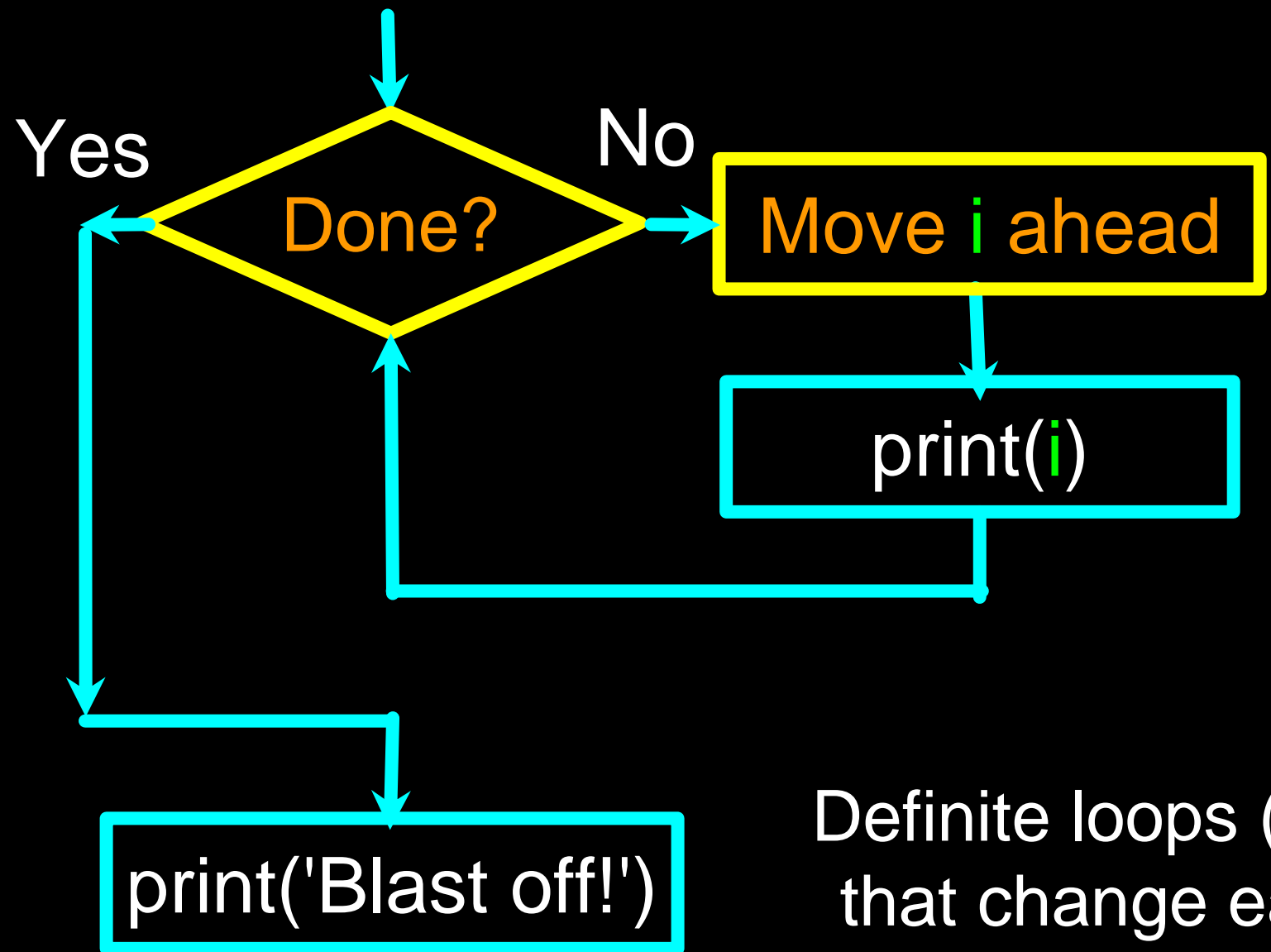
A Definite Loop with Strings

```
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!')
```

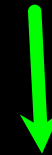
5
4
3
2
1
Blastoff!

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**

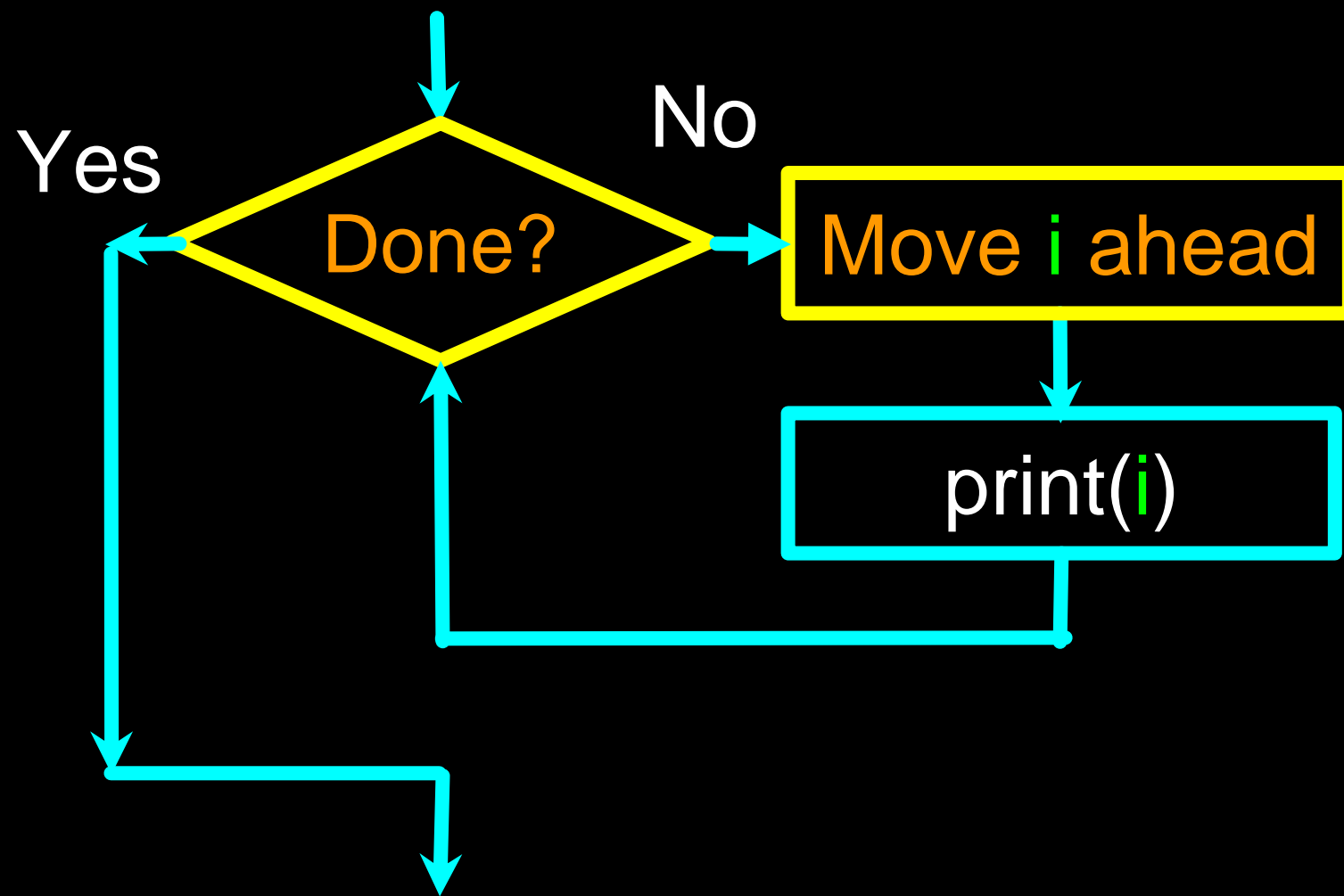
Iteration variable



Five-element
sequence

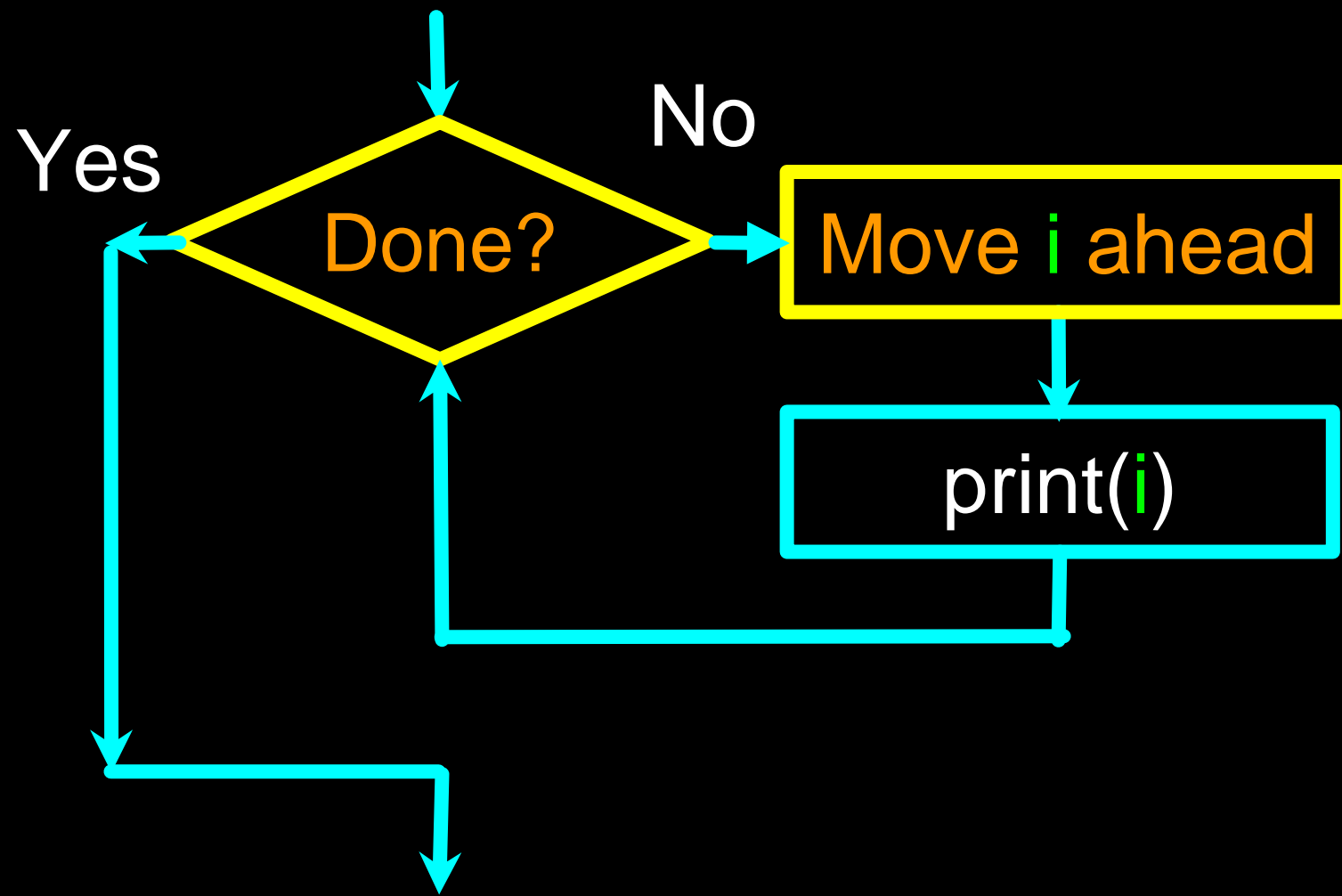


```
for i in [5, 4, 3, 2, 1] :  
    print(i)
```

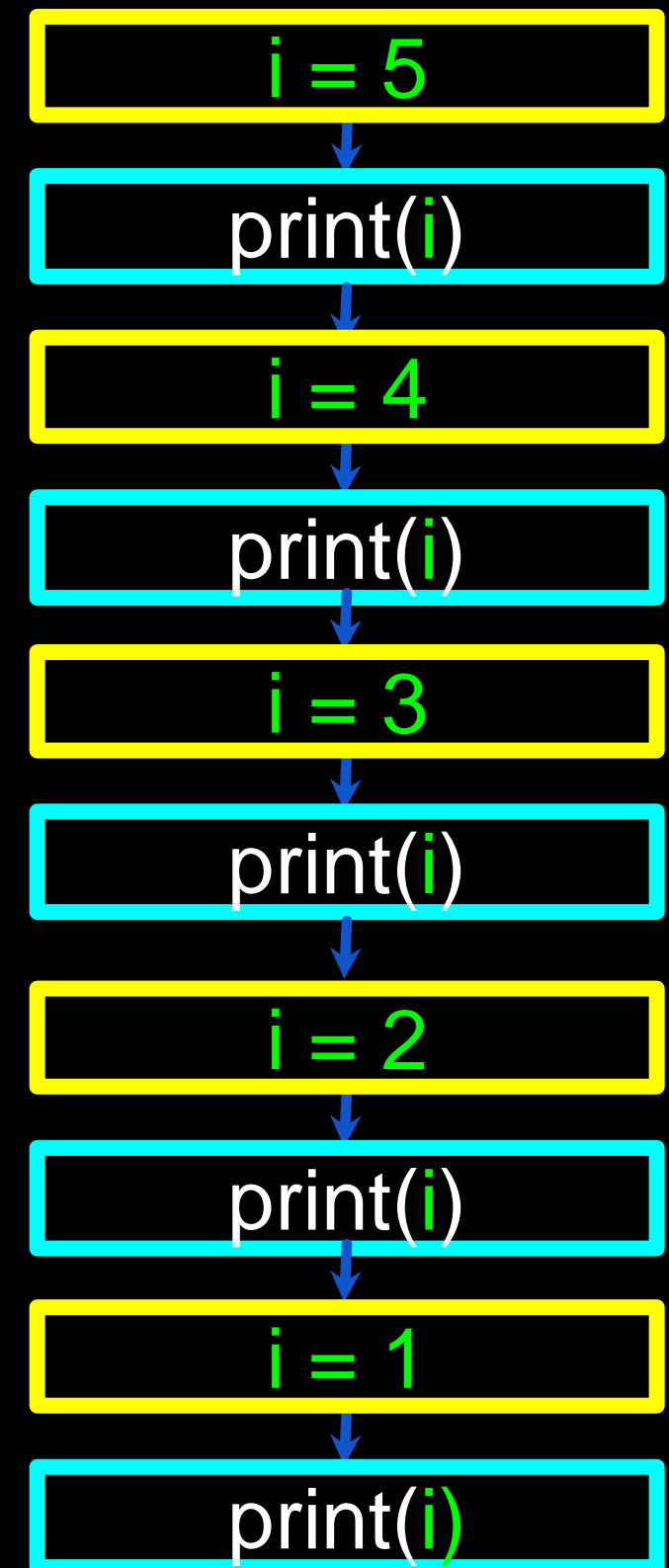


```
for i in [5, 4, 3, 2, 1] :  
    print(i)
```

- 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)
```



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')
```

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

74

What is the Largest Number?

3 41 12 9 74 15

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)
```

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.

More Loop Patterns...

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)
```

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)
```

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)
```

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')
```

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)
```

```
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)
```

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)
```

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)
```

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