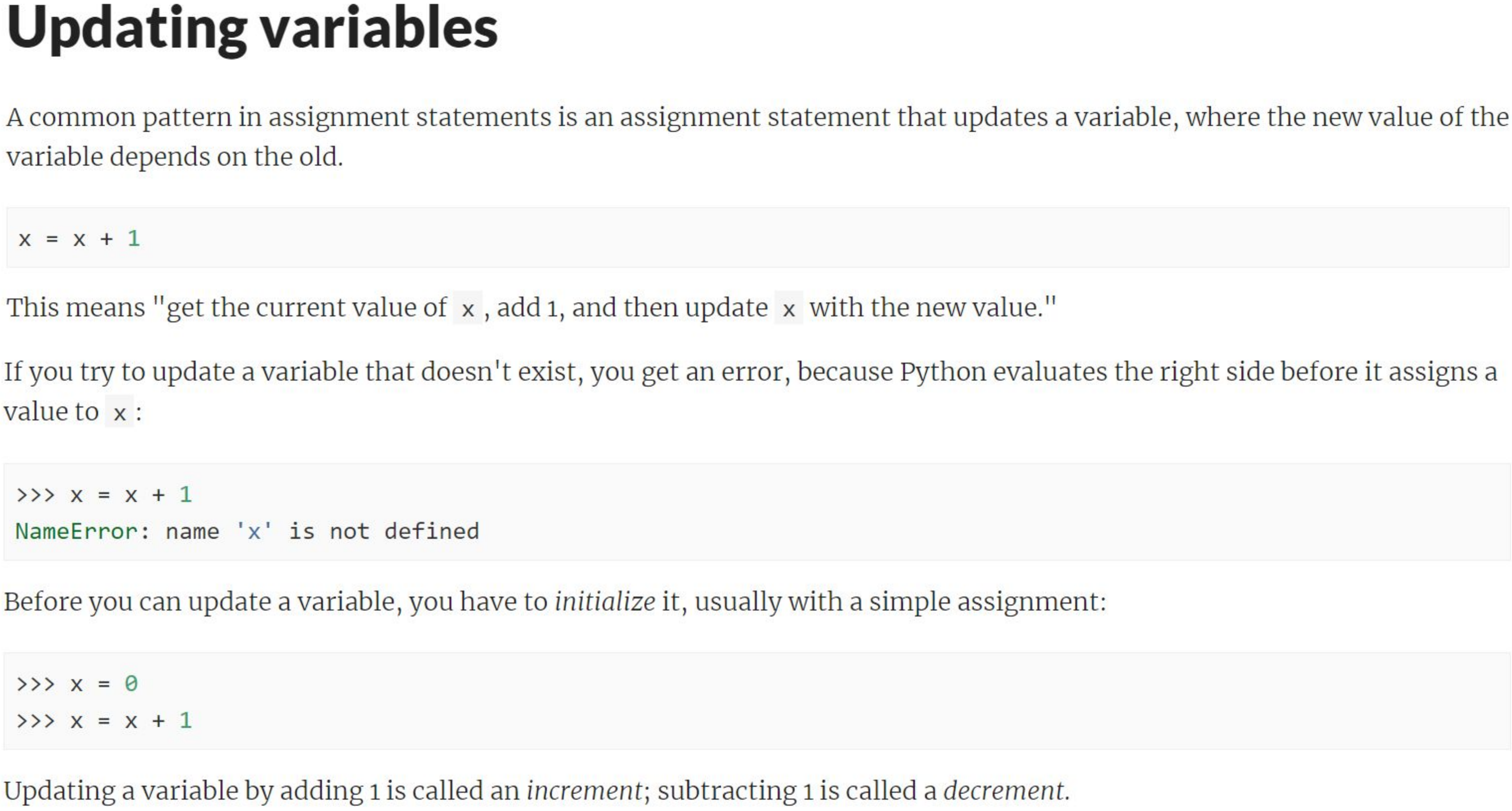
Introduction to Python

Topic 6: Iteration

Aim: How can we write expressions associated with iteration?



Updating variables

A common pattern in assignment statements is an assignment statement that updates a variable, where the new value of the variable depends on the old.

```
x = x + 1
```

This means "get the current value of `x`, add 1, and then update `x` with the new value."

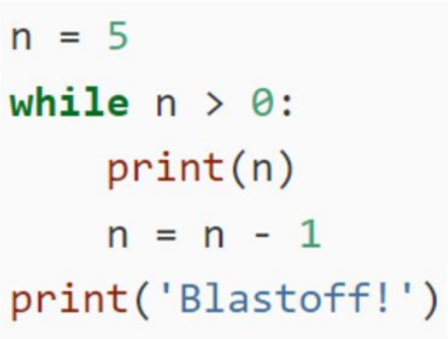
If you try to update a variable that doesn't exist, you get an error, because Python evaluates the right side before it assigns a value to `x`:

```
>>> x = x + 1
NameError: name 'x' is not defined
```

Before you can update a variable, you have to *initialize* it, usually with a simple assignment:

```
>>> x = 0
>>> x = x + 1
```

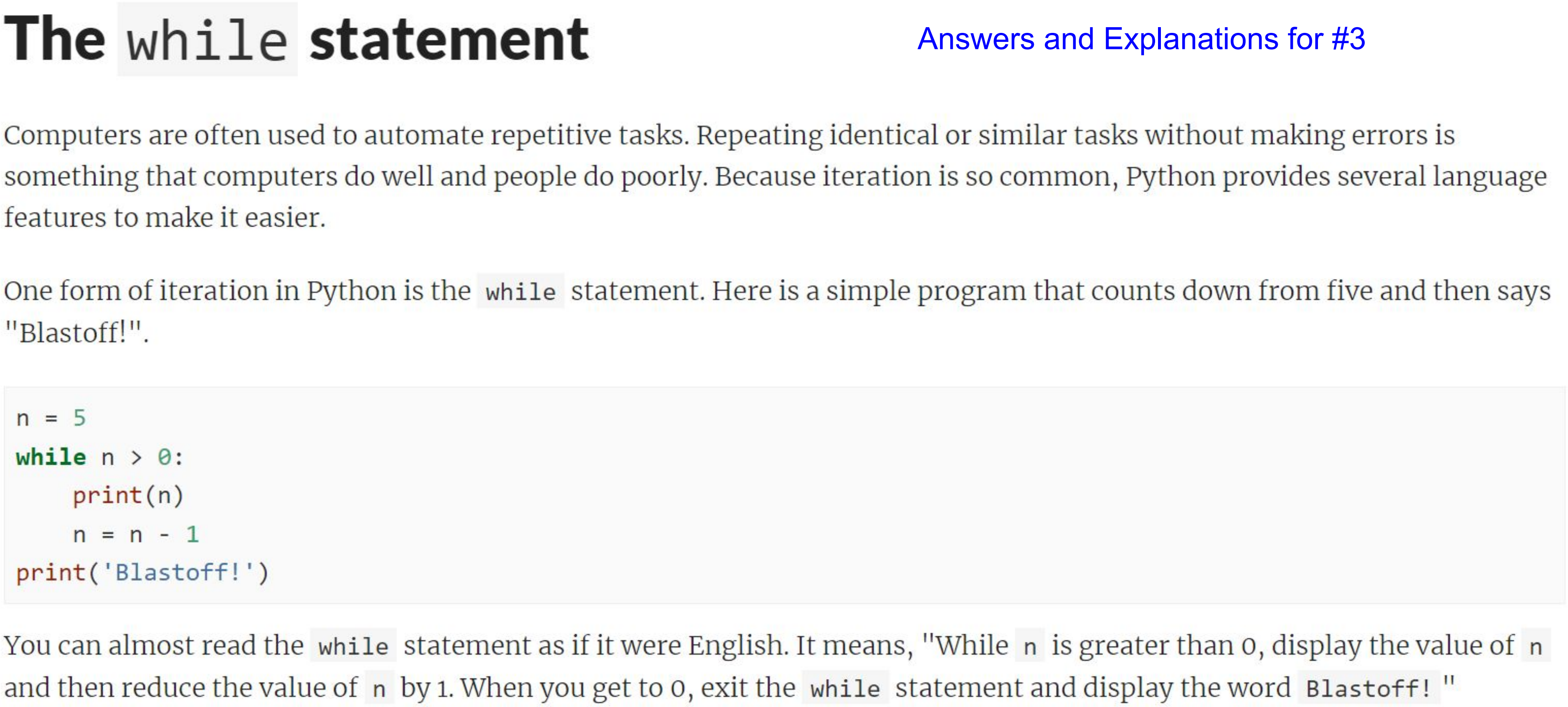
Updating a variable by adding 1 is called an *increment*; subtracting 1 is called a *decrement*.



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

Trace the program by using a diagram. Predict the outcome with your partner.

Answers and Explanations for #3



The `while` statement

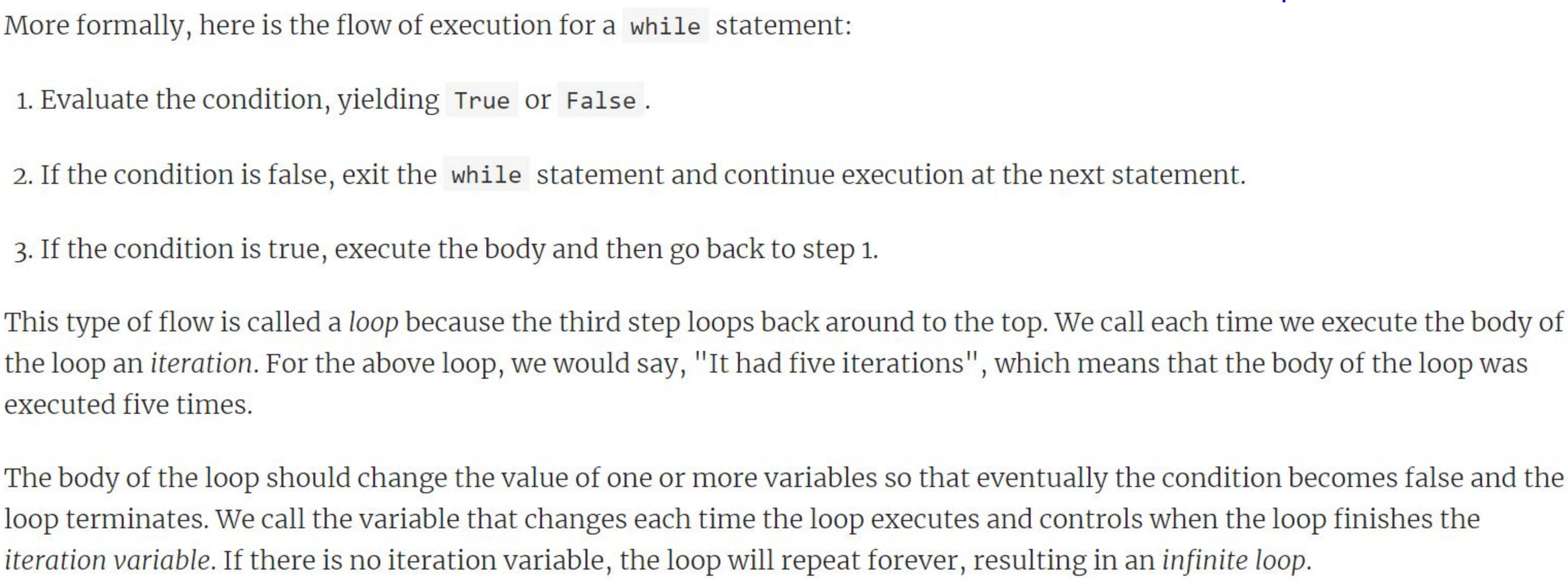
Computers are often used to automate repetitive tasks. Repeating identical or similar tasks without making errors is something that computers do well and people do poorly. Because iteration is so common, Python provides several language features to make it easier.

One form of iteration in Python is the `while` statement. Here is a simple program that counts down from five and then says "Blastoff!".

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

You can almost read the `while` statement as if it were English. It means, "While `n` is greater than 0, display the value of `n` and then reduce the value of `n` by 1. When you get to 0, exit the `while` statement and display the word `Blastoff!` "

Answers and Explanations for #3



More formally, here is the flow of execution for a `while` statement:

1. Evaluate the condition, yielding `True` or `False`.

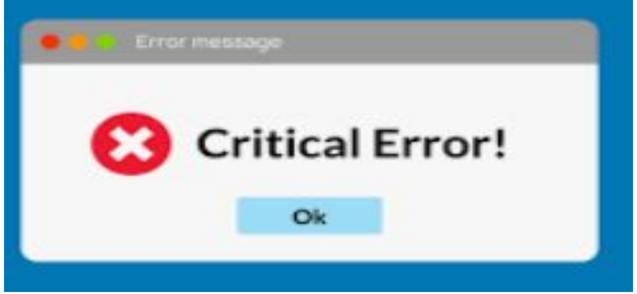
2. If the condition is false, exit the `while` statement and continue execution at the next statement.

3. If the condition is true, execute the body and then go back to step 1.

This type of flow is called a *loop* because the third step loops back around to the top. We call each time we execute the body of the loop an *iteration*. For the above loop, we would say, "It had five iterations", which means that the body of the loop was executed five times.

The body of the loop should change the value of one or more variables so that eventually the condition becomes false and the loop terminates. We call the variable that changes each time the loop executes and controls when the loop finishes the *iteration variable*. If there is no iteration variable, the loop will repeat forever, resulting in an *infinite loop*.

"Infinite loops" and `break`



Sometimes you don't know it's time to end a loop until you get half way through the body. In that case you can write an infinite loop on purpose and then use the `break` statement to jump out of the loop.

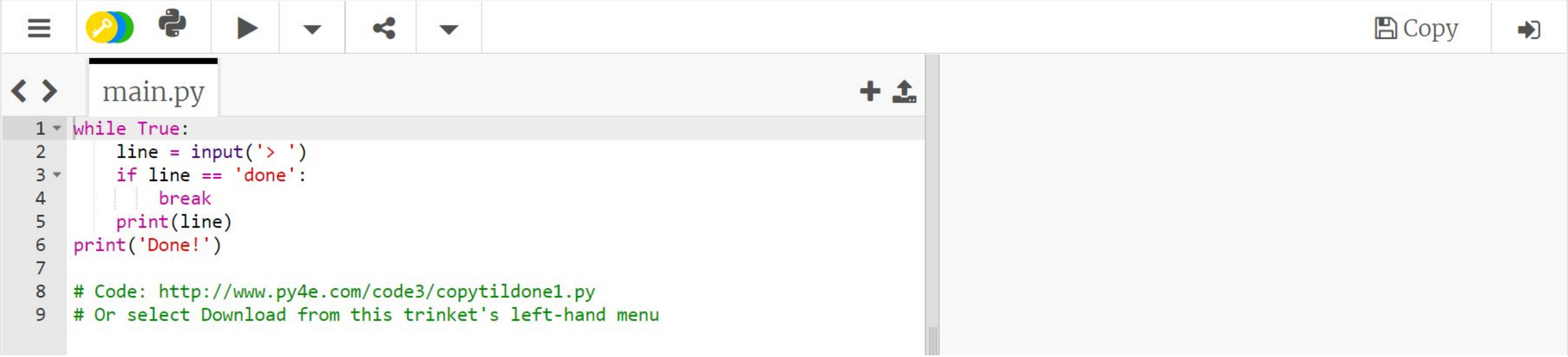
This loop is obviously an *infinite loop* because the logical expression on the `while` statement is simply the logical constant `True`:

```python
n = 10
while True:
    print(n, end=' ')
    n = n - 1
print('Done!')
```

If you make the mistake and run this code, you will learn quickly how to stop a runaway Python process on your system or find where the power-off button is on your computer. This program will run forever or until your battery runs out because the logical expression at the top of the loop is always true by virtue of the fact that the expression is the constant value `True`.

While this is a dysfunctional infinite loop, we can still use this pattern to build useful loops as long as we carefully add code to the body of the loop to explicitly exit the loop using `break` when we have reached the exit condition.

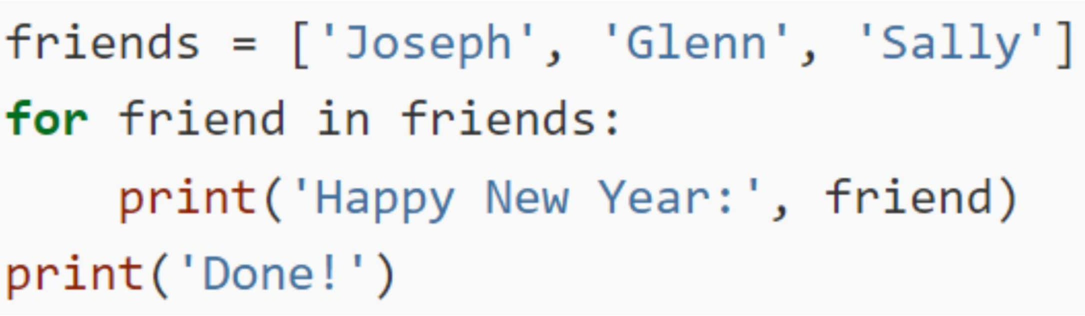
For example, suppose you want to take input from the user until they type `done`. You could write:



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

# Code: http://www.py4e.com/code3/copytildone1.py
# Or select Download from this trinket's left-hand menu
```

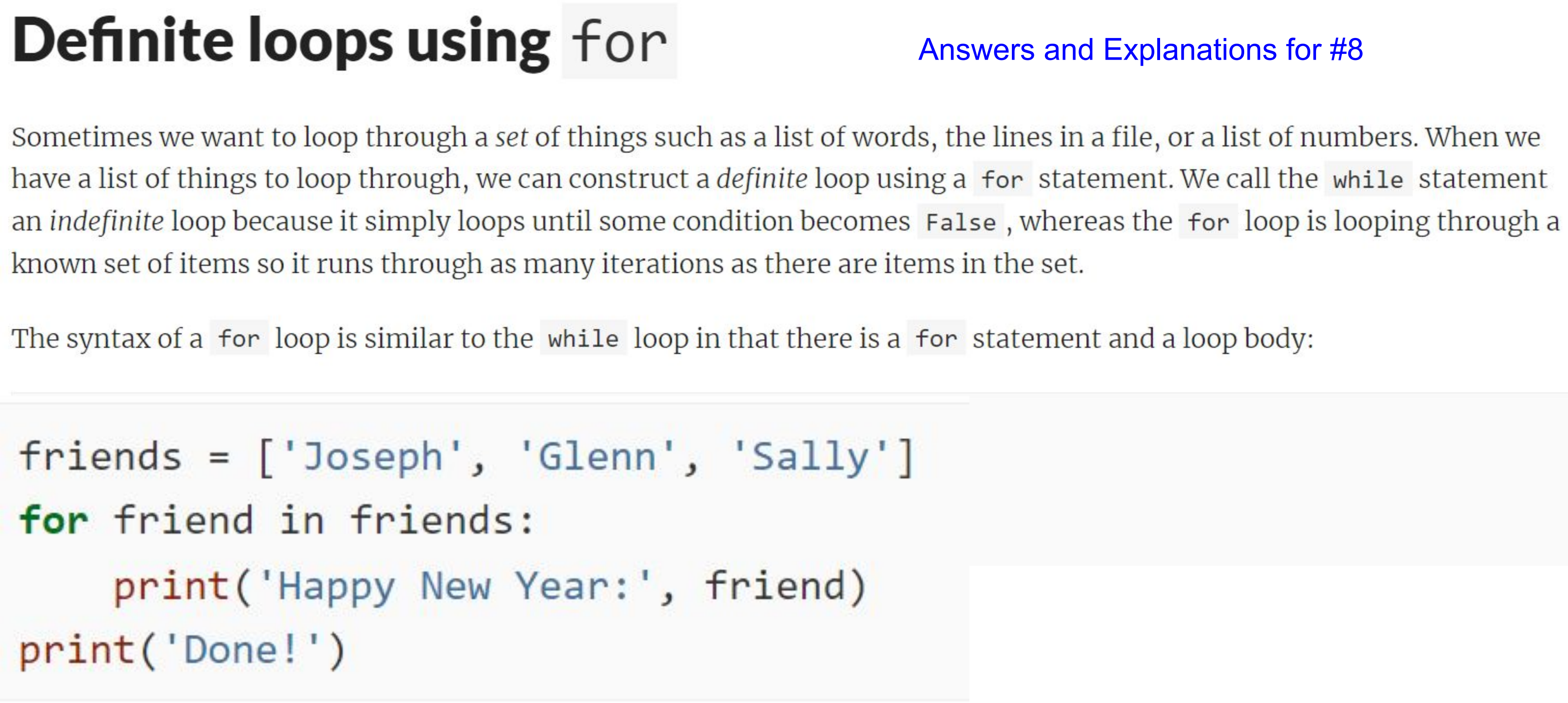
The loop condition is `True`, which is always true, so the loop runs repeatedly until it hits the break statement.



```python
friends = ['Joseph', 'Glenn', 'Sally']
for friend in friends:
    print('Happy New Year:', friend)
print('Done!')
```

Predict the output for this code segment with your partners. Then run the code to confirm.

Answers and Explanations for #8



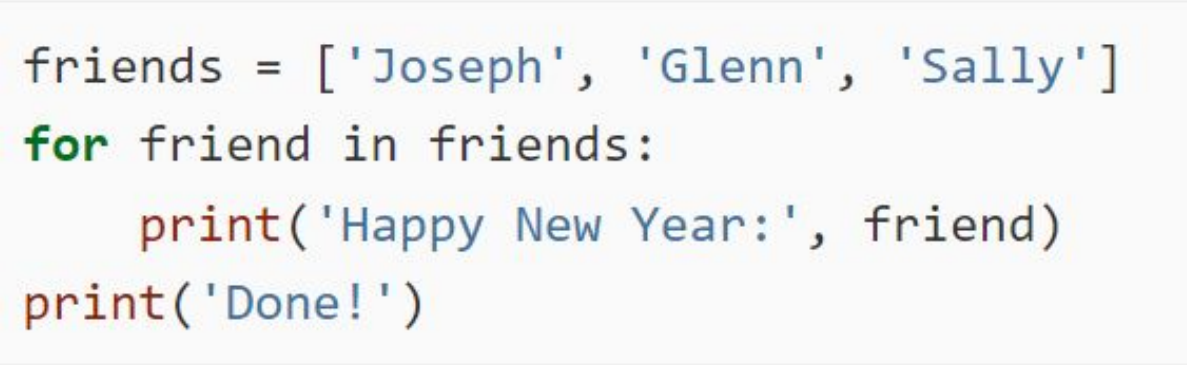
Definite loops using `for`

Sometimes we want to loop through a *set* of things such as a list of words, the lines in a file, or a list of numbers. When we have a list of things to loop through, we can construct a *definite* loop using a `for` statement. We call the `while` statement an *indefinite* loop because it simply loops until some condition becomes `False`, whereas the `for` loop is looping through a known set of items so it runs through as many iterations as there are items in the set.

The syntax of a `for` loop is similar to the `while` loop in that there is a `for` statement and a loop body:

```python
friends = ['Joseph', 'Glenn', 'Sally']
for friend in friends:
    print('Happy New Year:', friend)
print('Done!')
```

Answers and Explanations for #8



```python
friends = ['Joseph', 'Glenn', 'Sally']
for friend in friends:
    print('Happy New Year:', friend)
print('Done!')
```

Translating this `for` loop to English is not as direct as the `while`, but if you think of friends as a *set*, it goes like this: "Run the statements in the body of the for loop once for each friend *in* the set named friends."

Looking at the `for` loop, *for* and *in* are reserved Python keywords, and `friend` and `friends` are variables.

In particular, `friend` is the *iteration variable* for the for loop. The variable `friend` changes for each iteration of the loop and controls when the `for` loop completes. The *iteration variable* steps successively through the three strings stored in the `friends` variable.

Loop patterns

Often we use a `for` or `while` loop to go through a list of items or the contents of a file and we are looking for something such as the largest or smallest value of the data we scan through.

These loops are generally constructed by:

- Initializing one or more variables before the loop starts
- Performing some computation on each item in the loop body, possibly changing the variables in the body of the loop
- Looking at the resulting variables when the loop completes

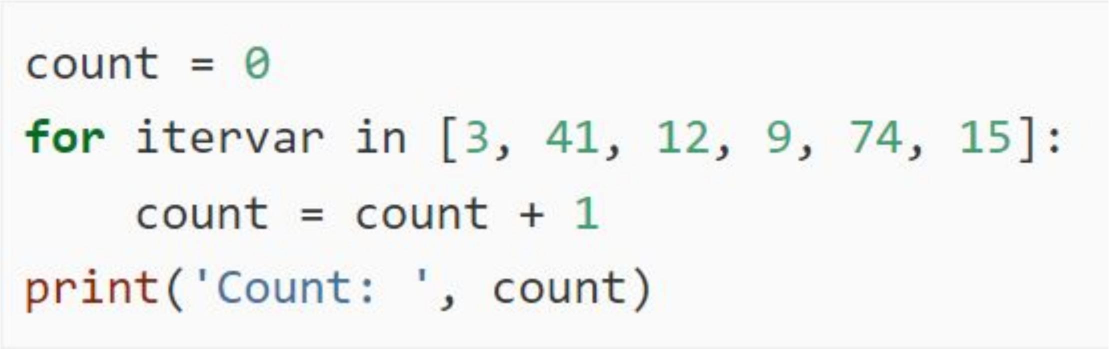
We will use a list of numbers to demonstrate the concepts and construction of these loop patterns.

Coding Practice: create a program that will count the total number of item in the list [3, 41, 12, 9, 74, 15]

pseudocode:

```
1. Create and initialize a counter
2. Use “for” to loop through each item in the list and increment the counter
3. Print the counter
```

For example, to count the number of items in a list, we would write the following `for` loop:



```
count = 0
for itervar in [3, 41, 12, 9, 74, 15]:
    count = count + 1
print('Count: ', count)
```

Answers and Explanations for #12

We set the variable `count` to zero before the loop starts, then we write a `for` loop to run through the list of numbers. Our *iteration* variable is named `itervar` and while we do not use `itervar` in the loop, it does control the loop and cause the loop body to be executed once for each of the values in the list.

In the body of the loop, we add 1 to the current value of `count` for each of the values in the list. While the loop is executing, the value of `count` is the number of values we have seen "so far".

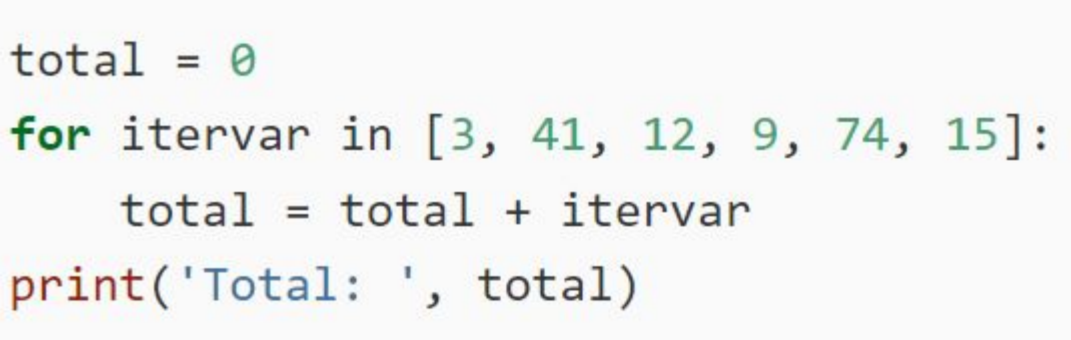
Once the loop completes, the value of `count` is the total number of items. The total number "falls in our lap" at the end of the loop. We construct the loop so that we have what we want when the loop finishes.

Coding Practice: create a program that will count the sum of the numbers in the list [3, 41, 12, 9, 74, 15]

pseudocode:

1.
2.
3.

Another similar loop that computes the total of a set of numbers is as follows:

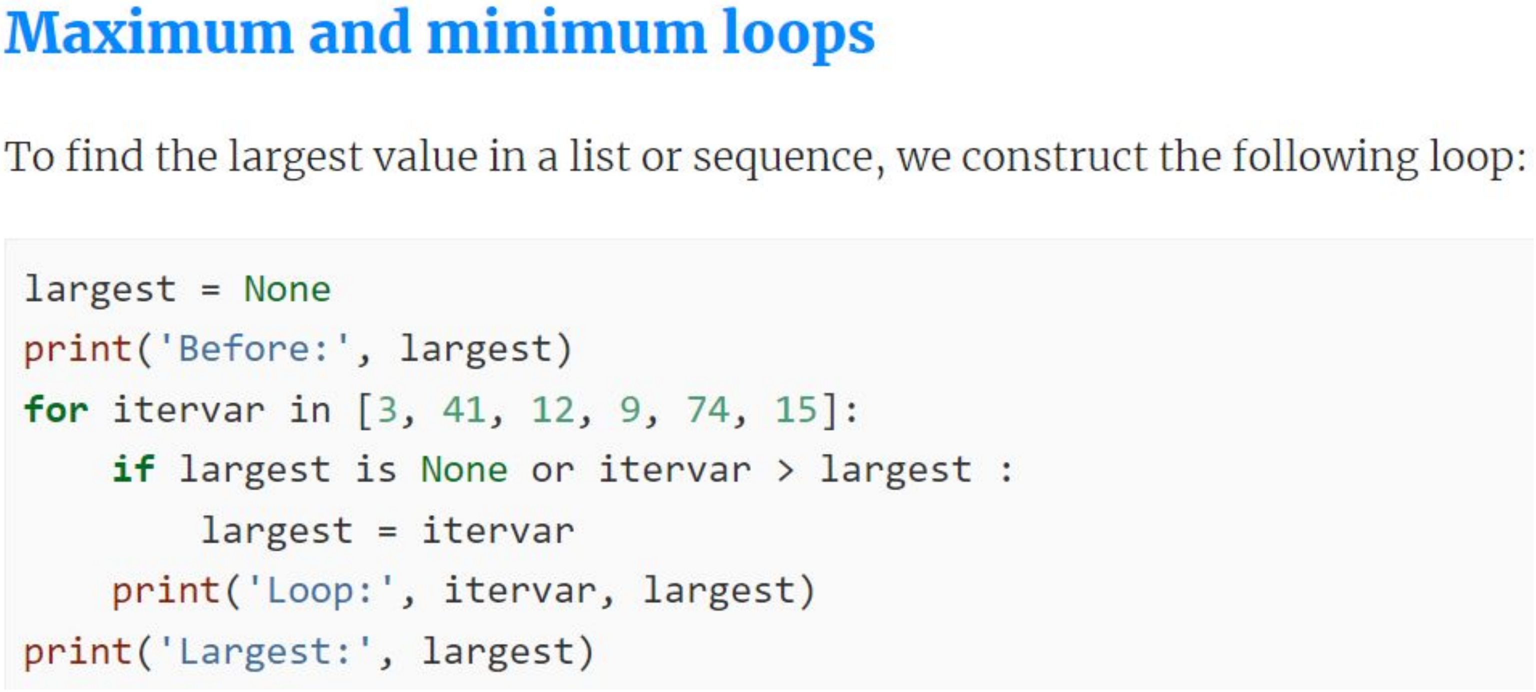


```
total = 0
for itervar in [3, 41, 12, 9, 74, 15]:
    total = total + itervar
print('Total: ', total)
```

Answers and Explanations for #14

In this loop we *do* use the *iteration variable*. Instead of simply adding one to the `count` as in the previous loop, we add the actual number (3, 41, 12, etc.) to the running total during each loop iteration. If you think about the variable `total`, it contains the "running total of the values so far". So before the loop starts `total` is zero because we have not yet seen any values, during the loop `total` is the running total, and at the end of the loop `total` is the overall total of all the values in the list.

As the loop executes, `total` accumulates the sum of the elements; a variable used this way is sometimes called an *accumulator*.



Maximum and minimum loops

To find the largest value in a list or sequence, we construct the following loop:

```
largest = None
print('Before:', largest)
for itervar in [3, 41, 12, 9, 74, 15]:
    if largest is None or itervar > largest :
        largest = itervar
    print('Loop:', itervar, largest)
print('Largest:', largest)
```

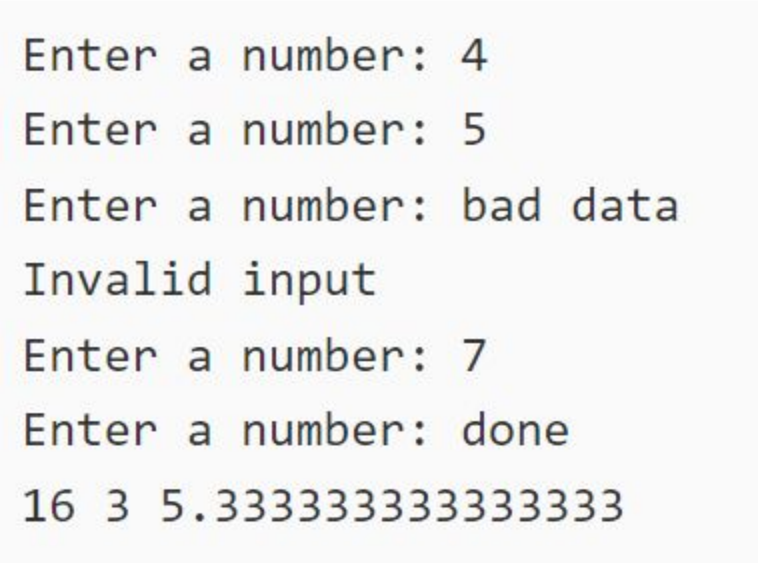
Run the code and use trace to explain what the program does.

You Try it !

Based on the previous slide, create the code for a minimum loop

Link of the code:

Exercise 1: Write a program which repeatedly reads numbers until the user enters "done". Once "done" is entered, print out the total, count, and average of the numbers. If the user enters anything other than a number, detect their mistake using `try` and `except` and print an error message and skip to the next number.



```
Enter a number: 4
Enter a number: 5
Enter a number: bad data
Invalid input
Enter a number: 7
Enter a number: done
16 3 5.333333333333333
```

Pseudocode here:

Shared the link on the next page

Link of the code for Exercise #1: