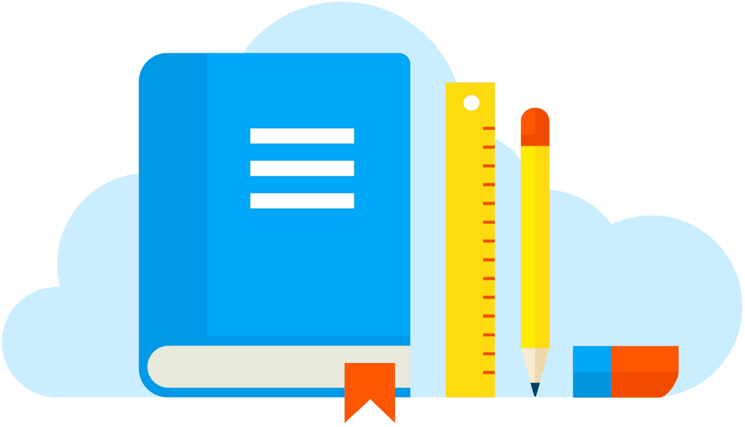


Python Programming

UNIT 1

Errors and Debugging

Syntax errors

Python will find these kinds of errors when it tries to parse your program, and exit with an error message without running anything. Syntax errors are mistakes in the use of the Python language. Common Python syntax errors include:

- leaving out a keyword
- putting a keyword in the wrong place
- leaving out a symbol, such as a colon, comma or brackets
- misspelling a keyword
- incorrect indentation
- empty block

Note it is illegal for any block (like an if body, or the body of a function) to be left completely empty. If you want a block to do nothing, you can use the pass statement inside the block.

Python will do its best to tell you where the error is located, but sometimes its messages can be misleading: for example, if you forget to escape a quotation mark inside a string you may get a syntax error referring to a place later in your code, even though that is not the real source of the problem. If you can't see anything wrong on the line specified in the error message, try backtracking through the previous few lines.

Here are some examples of syntax errors in Python: **<IDENTIFY ERRORS IN CODE>**

```
myfunction(x, y):
    return x + y

else:
    print("Hello!")

if mark >= 50
    print("You passed!")

if arriving:
    print("Hi!")
esle:
    print("Bye!")

if flag:
print("Flag is set!")
```

Runtime errors

If a program is syntactically correct – that is, free of syntax errors – it will be run by the Python interpreter. However, the program may exit unexpectedly during execution if it encounters a runtime error – a problem which was not detected when the program was parsed, but is only revealed when a particular line is executed. When a program comes to a halt because of a runtime error, we say that it has crashed.

Some examples of Python runtime errors:

- division by zero
- performing an operation on incompatible types
- using an identifier which has not been defined
- accessing a list element, dictionary value or object attribute which doesn't exist
- trying to access a file which doesn't exist

Runtime errors often creep in if you don't consider all possible values that a variable could contain, especially when you are processing user input. You should always try to add checks to your code to make sure that it can deal with bad input and edge cases gracefully.

Semantic / Logical errors

Logical errors are the most difficult to fix. They occur when the program runs without crashing, but produces an incorrect result. The error is caused by a mistake in the program's logic. You won't get an error message, because no syntax or runtime error has occurred. You will have to find the problem on your own by reviewing all the relevant parts of your code – although some tools can flag suspicious code which looks like it could cause unexpected behaviour.

Sometimes there can be absolutely nothing wrong with your Python implementation of an algorithm – the algorithm itself can be incorrect. However, more frequently these kinds of errors are caused by programmer carelessness. Here are some examples of mistakes which lead to logical errors:

- using the wrong variable name
- indenting a block to the wrong level
- using integer division instead of floating point division
- getting operator precedence wrong
- making a mistake in a boolean expression
- off-by-one, and other numerical errors

If you misspell an identifier name, you may get a runtime error or a logical error, depending on whether the misspelled name is defined.

A common source of variable name mix-ups and incorrect indentation is frequent copying and pasting of large blocks of code. If you have many duplicate lines with minor differences, it's very easy to miss a necessary change when you are editing your pasted lines.

Formal and Natural Languages

Natural languages are the languages that people speak, such as English, Spanish, and French. They were not designed by people (although people try to impose some order on them); they evolved naturally.

Formal languages are languages that are designed by people for specific applications. For example, the notation that mathematicians use is a formal language that is particularly good at denoting relationships among numbers and symbols. Chemists use a formal language to represent the chemical structure of molecules. And most importantly:

Programming languages are formal languages that have been designed to express computations.

Formal languages tend to have strict rules about syntax. For example, `3+3=6` *is a syntactically correct mathematical statement, but* `3=+6$` *is not.* H_2O *is a syntactically correct chemical name, but* $_2$*Zz is not.*

Difference Between Brackets, Braces, and Parentheses

There are three common parentheses in the Python language: parentheses (), brackets [], and curly braces {}; their roles are also different, representing different Python basic built-in data types.

Parentheses()

Parentheses () in Python: represents the tuple ancestor data type, and the ancestor is an immutable sequence.

Example

```
>>> a = (12,23)

>>> a

(12, 23)
```

Brackets[]

Brackets in Python[]: represents the list list data type, which is a variable sequence.

Example

```
>>> list('home')

 ['h', 'o', 'm', 'e']
```

curly braces{}

Braces in Python {}: represents the dict dictionary data type, which is the only built-in mapping type in Python. The values in the dictionary have no special order, but are stored under a specific key. Keys can be numbers, strings, and ancestors.

Example

```
>>> dic = {'jay':'boy','may"':'girl'}

>>> dic
{'jay': 'boy', 'may': 'girl'}
```

Python Comments

Comments can be used to explain Python code.
Comments can be used to make the code more readable.
Comments can be used to prevent execution when testing code.

Creating a Comment

Comments starts with a #, and Python will ignore them:

Example

```
#This is a comment
print("Hello, World!")
```

Comments can be placed at the end of a line, and Python will ignore the rest of the line:

Example

```
print("Hello, World!") #This is a comment
```

A comment does not have to be text that explains the code, it can also be used to prevent Python from executing code:

Example

```
#print("Hello, World!")
print("Cheers, Mate!")
```

Multi Line Comments

Python does not really have a syntax for multi line comments.
To add a multiline comment you could insert a # for each line:

Example

```
#This is a comment
#written in
#more than just one line

print("Hello, World!")
```

Or, not quite as intended, you can use a multiline string.

Since Python will ignore string literals that are not assigned to a variable, you can add a multiline string (triple quotes) in your code, and place your comment inside it:

Example

```
"""
This is a comment
written in
more than just one line
"""
print("Hello, World!")
```

As long as the string is not assigned to a variable, Python will read the code, but then ignore it, and you have made a multiline comment.

Variables

Variables are containers for storing data values.

Creating Variables

Python has no command for declaring a variable.

A variable is created the moment you first assign a value to it.

Example

```
x = 5
y = "John"
print(x)
print(y)
```

Variables do not need to be declared with any particular *type*, and can even change type after they have been set.

Example

```
x = 4       # x is of type int
x = "Sally" # x is now of type str
print(x)
```

Casting

If you want to specify the data type of a variable, this can be done with casting.

Example

```
x = str(3)    # x will be '3'
y = int(3)    # y will be 3
z = float(3)  # z will be 3.0
```

Get the Type

You can get the data type of a variable with the type() function.

Example

```
x = 5
y = "John"
print(type(x))
print(type(y))
```

Single or Double Quotes?

String variables can be declared either by using single or double quotes:

Example

```
x = "John"
# is the same as
x = 'John'
```

Case-Sensitive

Variable names are case-sensitive.

Example

This will create two variables:

```
a = 4
A = "Sally"
#A will not overwrite a
```

Variable Names

A variable can have a short name (like x and y) or a more descriptive name (age, carname, total_volume). Rules for Python variables:

- A variable name must start with a letter or the underscore character
- A variable name cannot start with a number
- A variable name can only contain alpha-numeric characters and underscores (A-z, 0-9, and _)
- Variable names are case-sensitive (age, Age and AGE are three different variables)

Many Values to Multiple Variables

Python allows you to assign values to multiple variables in one line:

Example

```
x, y, z = "Orange", "Banana", "Cherry"
```

```
print(x)
print(y)
print(z)
```

One Value to Multiple Variables

And you can assign the *same* value to multiple variables in one line:

Example

```
x = y = z = "Orange"
print(x)
print(y)
print(z)
```

Unpack a Collection

If you have a collection of values in a list, tuple etc. Python allows you extract the values into variables. This is called *unpacking*.

Example

Unpack a list:

```
fruits = ["apple", "banana", "cherry"]
x, y, z = fruits
print(x)
print(y)
print(z)
```

Global Variables

Variables that are created outside of a function (as in all of the examples above) are known as global variables.

Global variables can be used by everyone, both inside of functions and outside.

Example

Create a variable outside of a function, and use it inside the function

```
x = "awesome"

def myfunc():
  print("Python is " + x)

myfunc()
```

If you create a variable with the same name inside a function, this variable will be local, and can only be used inside the function. The global variable with the same name will remain as it was, global and with the original value.

Example

Create a variable inside a function, with the same name as the global variable

```
x = "awesome"
```

```
def myfunc():
  x = "fantastic"
  print("Python is " + x)

myfunc()

print("Python is " + x)
```

The global Keyword

Normally, when you create a variable inside a function, that variable is local, and can only be used inside that function.

To create a global variable inside a function, you can use the `global` keyword.

Example

If you use the `global` keyword, the variable belongs to the global scope:

```
def myfunc():
  global x
  x = "fantastic"

myfunc()

print("Python is " + x)
```

Also, use the `global` keyword if you want to change a global variable inside a function.

Example

To change the value of a global variable inside a function, refer to the variable by using the `global` keyword:

```
x = "awesome"

def myfunc():
  global x
  x = "fantastic"

myfunc()

print("Python is " + x)
```

Python Data Types

Data type defines the type of the variable, whether it is an integer variable, string variable, tuple, dictionary, list etc. In this guide, you will learn about the data types and their usage in Python.

Python data types

Python data types are divided in two categories, mutable data types and immutable data types.

Immutable Data types in Python

1. Numeric

2. String

3. Tuple

Mutable Data types in Python

1. List

2. Dictionary

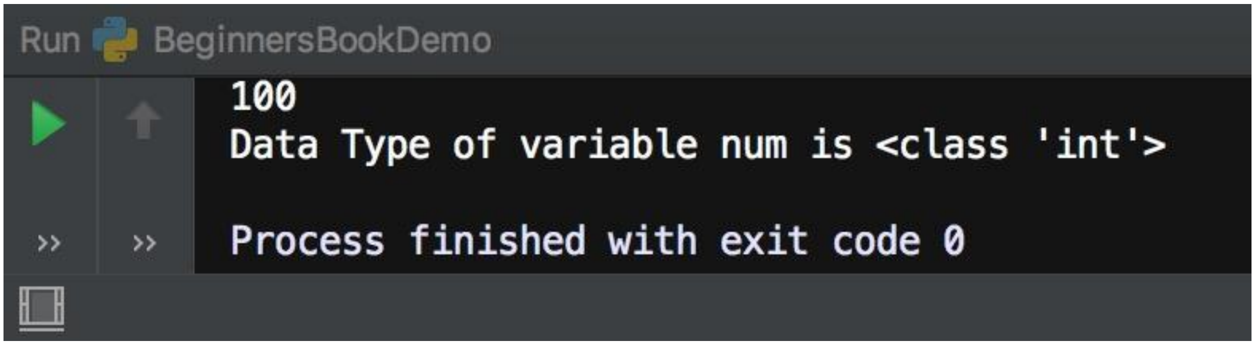
3. Set

1. Numeric Data Type in Python

Integer – In Python 3, there is no upper bound on the integer number which means we can have the value as large as our system memory allows.

```
# Integer number
num = 100
print(num)
print("Data Type of variable num is", type(num))
```

Output:



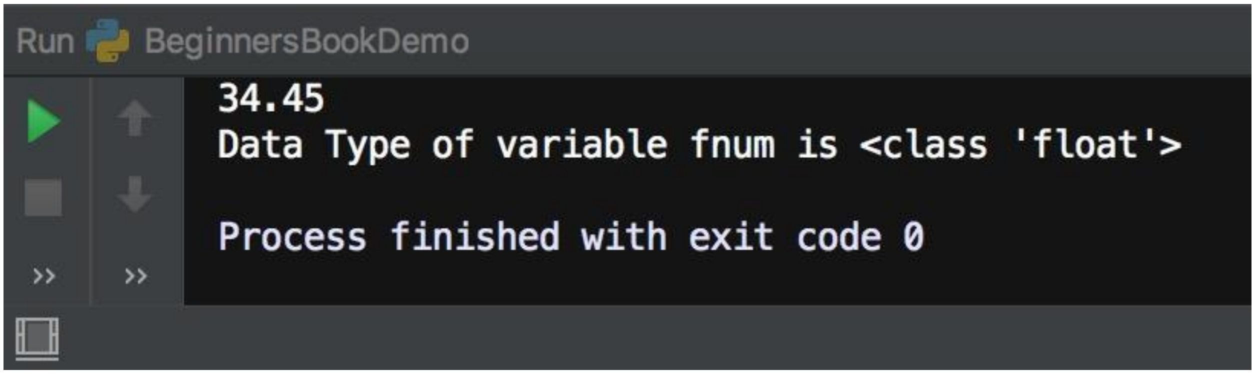
```
100
Data Type of variable num is <class 'int'>

Process finished with exit code 0
```

Long – Long data type is deprecated in Python 3 because there is no need for it, since the integer has no upper limit, there is no point in having a data type that allows larger upper limit than integers.

Float – Values with decimal points are the float values, there is no need to specify the data type in Python. It is automatically inferred based on the value we are assigning to a variable. For example here fnum is a float data type.

```
# float number
fnum = 34.45
print(fnum)
print("Data Type of variable fnum is", type(fnum))
```

Output:

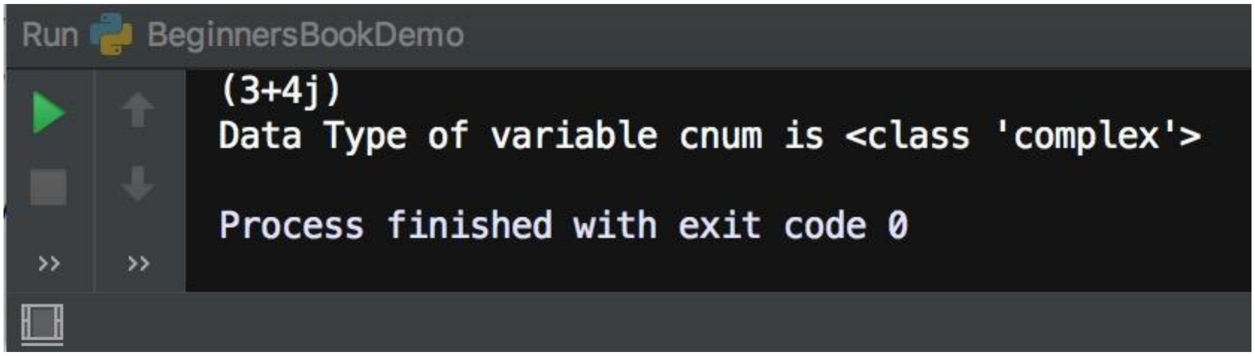


```
34.45
Data Type of variable fnum is <class 'float'>

Process finished with exit code 0
```

Complex Number – Numbers with real and imaginary parts are known as complex numbers. Unlike other programming language such as Java, Python is able to identify these complex numbers with the values. In the following example when we print the type of the variable cnum, it prints as complex number.

```
# complex number
cnum = 3 + 4j
print(cnum)
print("Data Type of variable cnum is", type(cnum))
```

Output:



```
(3+4j)
Data Type of variable cnum is <class 'complex'>

Process finished with exit code 0
```

Binary, Octal and Hexadecimal numbers

In Python we can print decimal equivalent of binary, octal and hexadecimal numbers using the prefixes.

0b(zero + ‘b’) and 0B(zero + ‘B’) – **Binary Number**

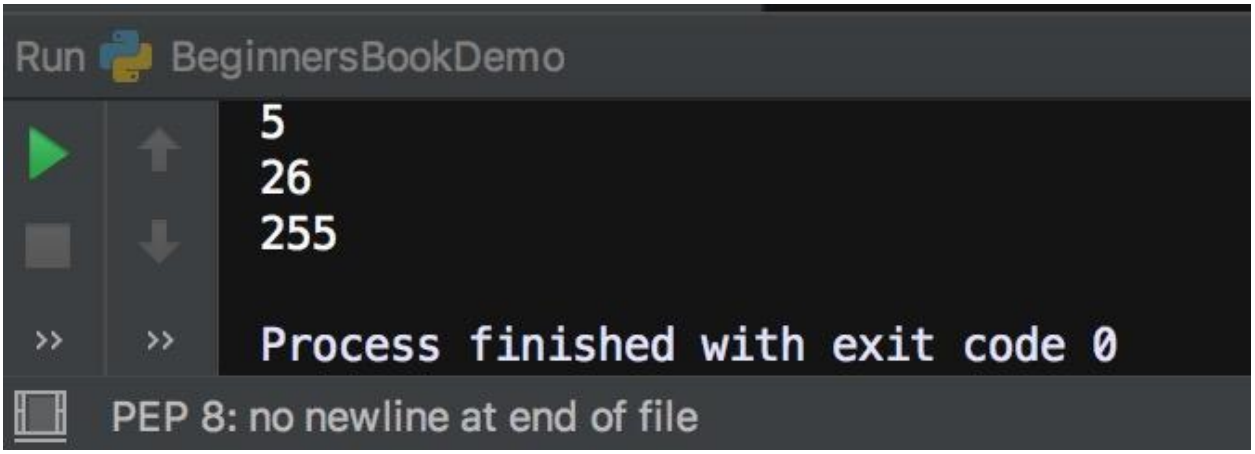
0o(zero + ‘o’) and 0O(zero + ‘O’) – **Octal Number**

0x(zero + ‘x’) and 0X(zero + ‘X’) – **Hexadecimal Number**

```
# integer equivalent of binary number 101
num = 0b101
print(num)

# integer equivalent of Octal number 32
num2 = 0o32
print(num2)
```

```
# integer equivalent of Hexadecimal number FF
num3 = 0xFF
print(num3)
```

Output:



```
5
26
255

Process finished with exit code 0
```

PEP 8: no newline at end of file

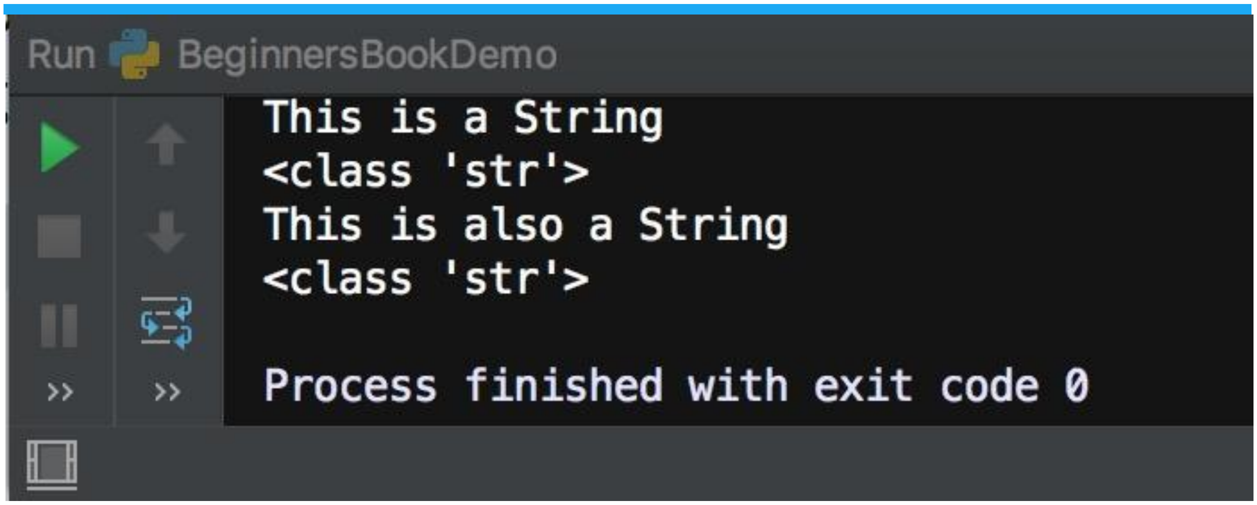
2. Python Data Type – String

String is a sequence of characters in Python. The data type of String in Python is called “str”.

Strings in Python are either enclosed with single quotes or double quotes. In the following example we have demonstrated two strings one with the double quotes and other string s2 with the single quotes.

```
# Python program to print strings and type

s = "This is a String"
s2 = 'This is also a String'

# displaying string s and its type
print(s)
print(type(s))

# displaying string s2 and its type
print(s2)
print(type(s2))
```

Output:



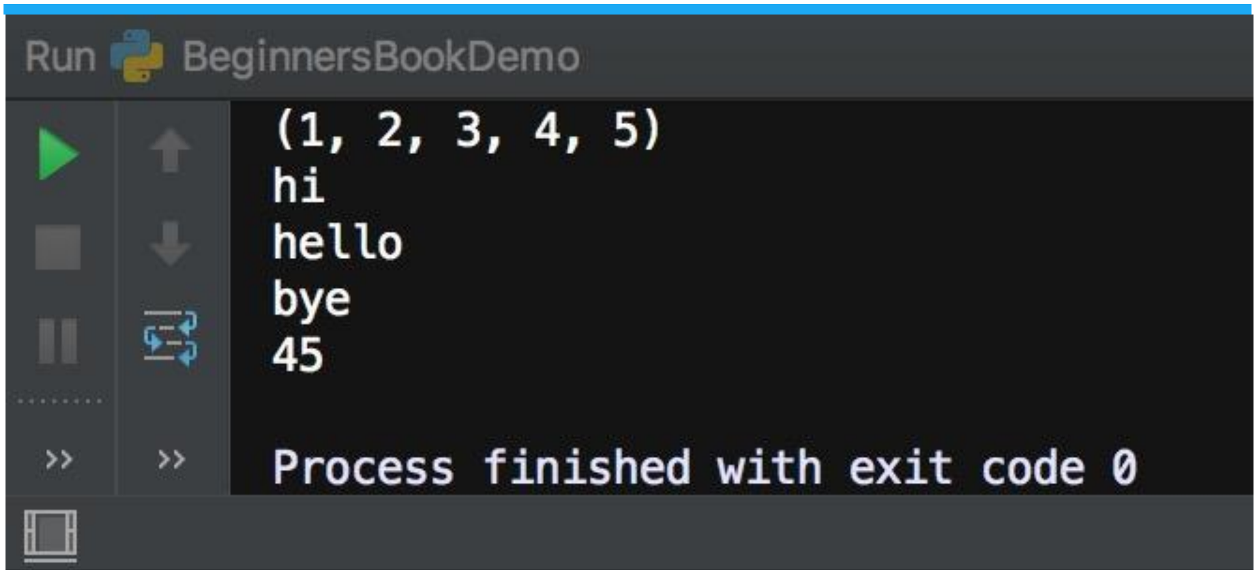
```
This is a String
<class 'str'>
This is also a String
<class 'str'>

Process finished with exit code 0
```

3. Python Data Type – Tuple

Tuple is an immutable data type in Python which means it cannot be changed. It is an ordered collection of elements enclosed in round brackets and separated by commas.

```
# tuple of integers
t1 = (1, 2, 3, 4, 5)
# prints entire tuple
print(t1)

# tuple of strings
t2 = ("hi", "hello", "bye")
# loop through tuple elements
for s in t2:
    print (s)

# tuple of mixed type elements
t3 = (2, "Lucy", 45, "Steve")
'''
Print a specific element
indexes start with zero
'''
print(t3[2])
```

Output:



```
(1, 2, 3, 4, 5)
hi
hello
bye
45

Process finished with exit code 0
```

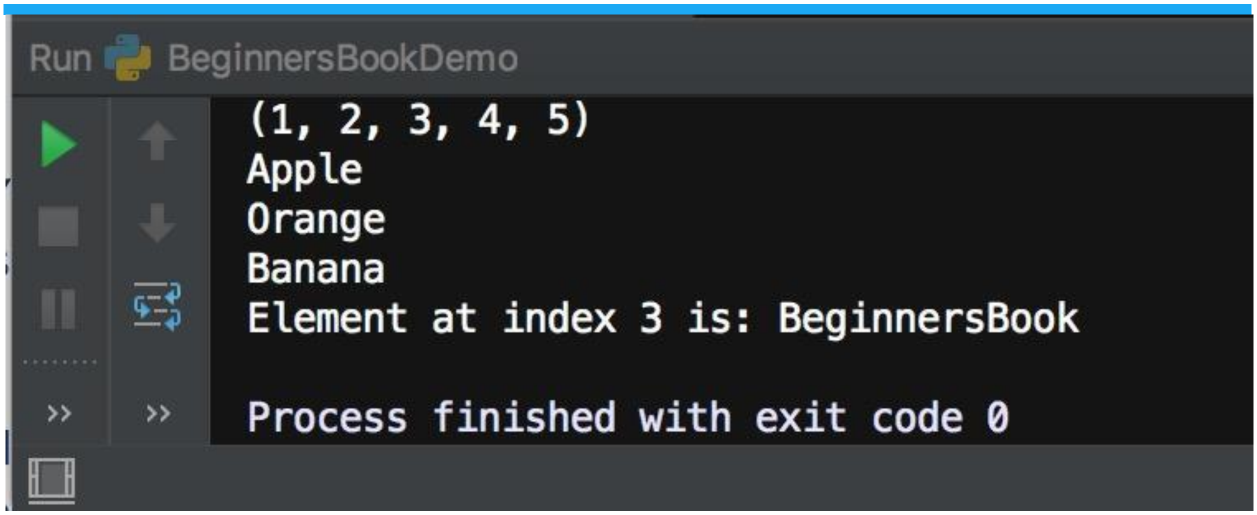
4. Python Data Type – List

List is similar to tuple, it is also an ordered collection of elements, however list is a mutable data type which means it can be changed unlike tuple which is an immutable data type.

A list is enclosed with square brackets and elements are separated by commas.

```
# list of integers
lis1 = [1, 2, 3, 4, 5]
# prints entire list
print(lis1)

# list of strings
lis2 = ["Apple", "Orange", "Banana"]
# loop through list elements
for x in lis2:
    print (x)

# List of mixed type elements
lis3 = [20, "Chaitanya", 15, "BeginnersBook"]
'''
Print a specific element in list
indexes start with zero
'''
print("Element at index 3 is:",lis3[3])
```

Output:



```
(1, 2, 3, 4, 5)
Apple
Orange
Banana
Element at index 3 is: BeginnersBook

Process finished with exit code 0
```

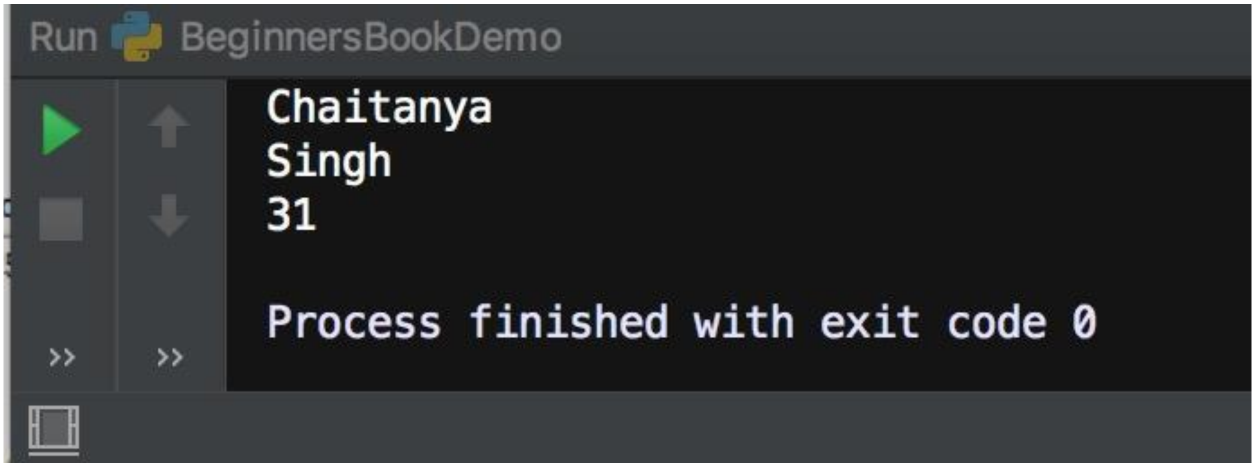
5. Python Data Type – Dictionary

Dictionary is a collection of key and value pairs. A dictionary doesn't allow duplicate keys but the values can be duplicated. It is an ordered, indexed and mutable collection of elements.

The keys in a dictionary don't necessarily have to be a single data type, as you can see in the following example that we have 1 integer key and two string keys.

```
# Dictionary example

dict = {1:"Chaitanya","lastname":"Singh", "age":31}

# prints the value where key value is 1
print(dict[1])
# prints the value where key value is "lastname"
print(dict["lastname"])
# prints the value where key value is "age"
print(dict["age"])
```

Output:



```
Chaitanya
Singh
31

Process finished with exit code 0
```

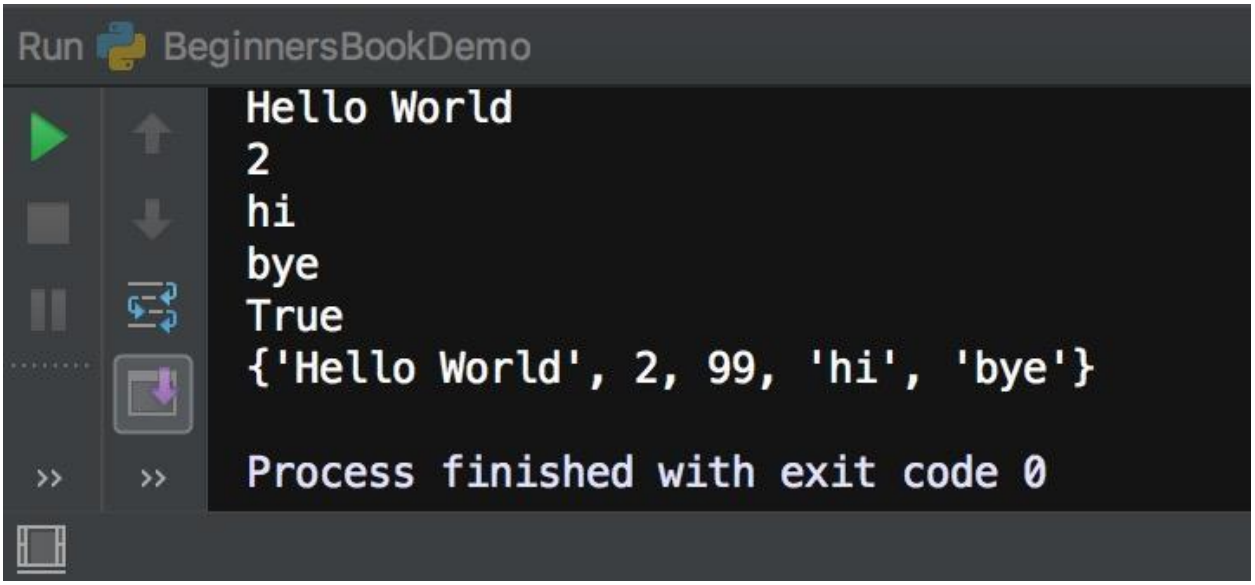
6. Python Data Type – Set

A set is an unordered and unindexed collection of items. This means when we print the elements of a set they will appear in the random order and we cannot access the elements of the set based on indexes because it is unindexed.

Elements of the set are separated by commas and enclosed in curly braces.

```
# Set Example
myset = {"hi", 2, "bye", "Hello World"}

# loop through set
for a in myset:
    print(a)

# checking whether 2 exists in myset
print(2 in myset)

# adding new element
myset.add(99)
print(myset)
```

Output:



```
Hello World
2
hi
bye
True
{'Hello World', 2, 99, 'hi', 'bye'}

Process finished with exit code 0
```

Python Casting

Specify a Variable Type

There may be times when you want to specify a type on to a variable. This can be done with casting. Python is an object-orientated language, and as such it uses classes to define data types, including its primitive types.

Casting in python is therefore done using constructor functions:

- `int()` - constructs an integer number from an integer literal, a float literal (by removing all decimals), or a string literal (providing the string represents a whole number)
- `float()` - constructs a float number from an integer literal, a float literal or a string literal (providing the string represents a float or an integer)
- `str()` - constructs a string from a wide variety of data types, including strings, integer literals and float literals

Example

Integers:

```
x = int(1)   # x will be 1
y = int(2.8) # y will be 2
z = int("3") # z will be 3
```

Example

Floats:

```
x = float(1)     # x will be 1.0
y = float(2.8)   # y will be 2.8
z = float("3")   # z will be 3.0
w = float("4.2") # w will be 4.2
```

Example

Strings:

```
x = str("s1") # x will be 's1'
y = str(2)    # y will be '2'
z = str(3.0)  # z will be '3.0'
```

Python Operators

Operators in general are used to perform operations on values and variables in Python. These are standard symbols used for the purpose of logical and arithmetic operations. In this article, we will look into different types of Python operators.

Arithmetic operators:

Arithmetic operators are used to perform mathematical operations like addition, subtraction, multiplication and division.

Operator	Description	Syntax
+	Addition: adds two operands	x + y
-	Subtraction: subtracts two operands	x - y
*	Multiplication: multiplies two operands	x * y
/	Division (float): divides the first operand by the second	x / y
//	Division (floor): divides the first operand by the second	x // y
%	Modulus: returns the remainder when first operand is divided by the second	x % y
**	Power : Returns first raised to power second	x ** y

```
# Examples of Arithmetic Operator
a = 9
b = 4

# Addition of numbers
add = a + b

# Subtraction of numbers
```

```
sub = a - b

# Multiplication of number
mul = a * b

# Division(float) of number
div1 = a / b

# Division(floor) of number
div2 = a // b

# Modulo of both number
mod = a % b

# Power
p = a ** b

# print results
print(add)
print(sub)
print(mul)
print(div1)
print(div2)
print(mod)
print(p)
```

OUTPUT

```
13
5
36
2.25
2
1
6561
```

Relational Operators:

Relational operators compares the values. It either returns **True** or **False** according to the condition.

Operator	Description	Syntax
>	Greater than: True if left operand is greater than the right	x > y
<	Less than: True if left operand is less than the right	x < y
==	Equal to: True if both operands are equal	x == y
!=	Not equal to - True if operands are not equal	x != y
>=	Greater than or equal to: True if left operand is greater than or equal to the right	x >= y
<=	Less than or equal to: True if left operand is less than or equal to the right	x <= y

```
# Examples of Relational Operators
a = 13
b = 33

# a > b is False
print(a > b)

# a < b is True
print(a < b)

# a == b is False
print(a == b)

# a != b is True
print(a != b)

# a >= b is False
print(a >= b)

# a <= b is True
print(a <= b)
```

Output:

```
False
True
False
True
False
True
```

Logical operators:

Logical operators perform **Logical AND**, **Logical OR** and **Logical NOT** operations.

Operator	Description	Syntax
and	Logical AND: True if both the operands are true	x and y

or	Logical OR: True if either of the operands is true	x or y
not	Logical NOT: True if operand is false	not x

```
# Examples of Logical
Operator
a = True
b = False

# Print a and b is False
print(a and b)

# Print a or b is True
print(a or b)

# Print not a is False
print(not a)
```

Output:

```
False
True
False
```

Bitwise operators:

Bitwise operators act on bits and perform bit by bit operation.

Operator	Description	Syntax
&	Bitwise AND	x & y
|	Bitwise OR	x | y
~	Bitwise NOT	~x
^	Bitwise XOR	x ^ y
>>	Bitwise right shift	x>>
<<	Bitwise left shift	x<<

```
# Examples of Bitwise operators
a = 10
b = 4

# Print bitwise AND operation
print(a & b)

# Print bitwise OR operation
print(a | b)

# Print bitwise NOT operation
print(~a)

# print bitwise XOR operation
print(a ^ b)

# print bitwise right shift
operation
print(a >> 2)

# print bitwise left shift operation
print(a << 2)
```

Output:

```
0
14
-11
14
2
40
```

Assignment operators:

Assignment operators are used to assign values to the variables.

Operato r	Description	Syntax
=	Assign value of right side of expression to left side operand	x = y + z
+=	Add AND: Add right side operand with left side operand and then assign to left operand	a+=b a=a+b
-=	Subtract AND: Subtract right operand from left operand and then assign to left operand	a-=b a=a-b
*=	Multiply AND: Multiply right operand with left operand and then assign to left operand	a*=b a=a*b
/=	Divide AND: Divide left operand with right operand and then assign to left operand	a/=b a=a/b
%=	Modulus AND: Takes modulus using left and right operands and assign result to left operand	a%=b a=a%b

//=	Divide(floor) AND: Divide left operand with right operand and then assign the value(floor) to left operand	a//=b a=a//b
**=	Exponent AND: Calculate exponent(raise power) value using operands and assign value to left operand	a**=b a=a**b
&=	Performs Bitwise AND on operands and assign value to left operand	a&=b a=a&b
|=	Performs Bitwise OR on operands and assign value to left operand	a|=b a=a|b
^=	Performs Bitwise xOR on operands and assign value to left operand	a^=b a=a^b
>>=	Performs Bitwise right shift on operands and assign value to left operand	a>>=b a=a>>b

<<=	Performs Bitwise left shift on operands and assign value to left operand	a <<= b a= a << b

Special operators:

There are some special type of operators like-

Identity operators-

is and **is not** are the identity operators both are used to check if two values are located on the same part of the memory. Two variables that are equal does not imply that they are identical.

is True if the operands are identical

- **is not** True if the operands are not identical

```
# Examples of Identity operators
a1 = 3
b1 = 3
a2 = 'GeeksforGeeks'
b2 = 'GeeksforGeeks'
a3 = [1,2,3]
b3 = [1,2,3]


print(a1 is not b1)


print(a2 is b2)

# Output is False, since lists are
mutable.
print(a3 is b3)
```

Output:

```
False
```

```
True
False
```

Membership operators-

in and **not in** are the membership operators; used to test whether a value or variable is in a sequence.

in True if value is found in the sequence

- **not in** True if value is not found in the sequence

```
# Examples of Membership
operator
x = 'Geeks for Geeks'
y = {3:'a',4:'b'}


print('G' in x)

print('geeks' not in x)

print('Geeks' not in x)

print(3 in y)

print('b' in y)
```

Output:

```
True
True
False
True
False
```

Operator Associativity:

If an expression contains two or more operators with the same precedence then Operator Associativity is used to determine. It can either be Left to Right or from Right to Left.

```
# Examples of Operator
Associativity

# Left-right associativity
# 100 / 10 * 10 is calculated as
# (100 / 10) * 10 and not
# as 100 / (10 * 10)
print(100 / 10 * 10)

# Left-right associativity
# 5 - 2 + 3 is calculated as
# (5 - 2) + 3 and not
# as 5 - (2 + 3)
print(5 - 2 + 3)

# left-right associativity
print(5 - (2 + 3))

# right-left associativity
# 2 ** 3 ** 2 is calculated as
# 2 ** (3 ** 2) and not
# as (2 ** 3) ** 2
print(2 ** 3 ** 2)
```

Output:

```
100.0
6
0
512
```

Operator	Description	Associativity
( )	Parentheses	left-to-right
**	Exponent	right-to-left
* / %	Multiplication/division/modulus	left-to-right
+ -	Addition/subtraction	left-to-right
<< >>	Bitwise shift left, Bitwise shift right	left-to-right
< <= > >=	Relational less than/less than or equal to Relational greater than/greater than or equal to	left-to-right
== !=	Relational is equal to/is not equal to	left-to-right

Python If ... Else

Python Conditions and If statements

Python supports the usual logical conditions from mathematics:

- Equals: `a == b`
- Not Equals: `a != b`
- Less than: `a < b`
- Less than or equal to: `a <= b`
- Greater than: `a > b`
- Greater than or equal to: `a >= b`

These conditions can be used in several ways, most commonly in "if statements" and loops.

An "if statement" is written by using the `if` keyword.

Example

If statement:

```
a = 33
b = 200
if b > a:
  print("b is greater than a")
```

In this example we use two variables, `a` and `b`, which are used as part of the if statement to test whether `b` is greater than `a`. As `a` is `33`, and `b` is `200`, we know that 200 is greater than 33, and so we print to screen that "b is greater than a".

Indentation

Python relies on indentation (whitespace at the beginning of a line) to define scope in the code. Other programming languages often use curly-brackets for this purpose.

Example

If statement, without indentation (will raise an error):

```
a = 33
b = 200
if b > a:
print("b is greater than a") # you will get an error
```

Elif

The `elif` keyword is pythons way of saying "if the previous conditions were not true, then try this condition".

Example

```
a = 33
b = 33
if b > a:
  print("b is greater than a")
elif a == b:
  print("a and b are equal")
```

In this example a is equal to b, so the first condition is not true, but the elif condition is true, so we print to screen that "a and b are equal".

Else

The else keyword catches anything which isn't caught by the preceding conditions.

Example

```
a = 200
b = 33
if b > a:
  print("b is greater than a")
elif a == b:
  print("a and b are equal")
else:
  print("a is greater than b")
```

In this example a is greater than b, so the first condition is not true, also the elif condition is not true, so we go to the else condition and print to screen that "a is greater than b".

You can also have an else without the elif:

Example

```
a = 200
b = 33
if b > a:
  print("b is greater than a")
else:
  print("b is not greater than a")
```

Short Hand If

If you have only one statement to execute, you can put it on the same line as the if statement.

Example

One line if statement:

```
if a > b: print("a is greater than b")
```

Short Hand If ... Else

If you have only one statement to execute, one for if, and one for else, you can put it all on the same line:

Example

One line if else statement:

```
a = 2
b = 330
print("A") if a > b else print("B")
```

This technique is known as Ternary Operators, or Conditional Expressions.

You can also have multiple else statements on the same line:

Example

One line if else statement, with 3 conditions:

```
a = 330
b = 330
print("A") if a > b else print("=") if a == b else print("B")
```

And

The and keyword is a logical operator, and is used to combine conditional statements:

Example

Test if a is greater than b, AND if c is greater than a:

```
a = 200
b = 33
c = 500
if a > b and c > a:
  print("Both conditions are True")
```

Or

The or keyword is a logical operator, and is used to combine conditional statements:

Example

Test if a is greater than b, OR if a is greater than c:

```
a = 200
b = 33
c = 500
if a > b or a > c:
  print("At least one of the conditions is True")
```

Nested If

You can have if statements inside if statements, this is called *nested* if statements.

Example

```
x = 41

if x > 10:
  print("Above ten,")
  if x > 20:
    print("and also above 20!")
  else:
    print("but not above 20.")
```

The pass Statement

if statements cannot be empty, but if you for some reason have an if statement with no content, put in the pass statement to avoid getting an error.

Example

```
a = 33
b = 200

if b > a:
  pass
```

Python While Loops

The while Loop

With the while loop we can execute a set of statements as long as a condition is true.

Example

Print i as long as i is less than 6:

```
i = 1
while i < 6:
  print(i)
  i += 1
```

Note: remember to increment i, or else the loop will continue forever.

The while loop requires relevant variables to be ready, in this example we need to define an indexing variable, i, which we set to 1.

The else Statement

With the else statement we can run a block of code once when the condition no longer is true:

Example

Print a message once the condition is false:

```
i = 1
while i < 6:
  print(i)
  i += 1
else:
  print("i is no longer less than 6")
```

The break Statement

With the `break` statement we can stop the loop even if the while condition is true:

Example

Exit the loop when i is 3:

```
i = 1
while i < 6:
  print(i)
  if i == 3:
    break
  i += 1
```

The continue Statement

With the `continue` statement we can stop the current iteration, and continue with the next:

Example

Continue to the next iteration if i is 3:

```
i = 0
while i < 6:
  i += 1
  if i == 3:
    continue
  print(i)
```

Python For Loops

A for loop is used for iterating over a sequence (that is either a list, a tuple, a dictionary, a set, or a string).

This is less like the for keyword in other programming languages, and works more like an iterator method as found in other object-orientated programming languages.

With the for loop we can execute a set of statements, once for each item in a list, tuple, set etc.

Example

Print each fruit in a fruit list:

```
fruits = ["apple", "banana", "cherry"]
for x in fruits:
  print(x)
```

The for loop does not require an indexing variable to set beforehand.

Looping Through a String

Even strings are iterable objects, they contain a sequence of characters:

Example

Loop through the letters in the word "banana":

```
for x in "banana":
  print(x)
```

The break Statement

With the break statement we can stop the loop before it has looped through all the items:

Example

Exit the loop when x is "banana":

```
fruits = ["apple", "banana", "cherry"]
for x in fruits:
  print(x)
  if x == "banana":
    break
```

Example

Exit the loop when x is "banana", but this time the break comes before the print:

```
fruits = ["apple", "banana", "cherry"]
for x in fruits:
  if x == "banana":
    break
  print(x)
```

The continue Statement

With the `continue` statement we can stop the current iteration of the loop, and continue with the next:

Example

Do not print banana:

```
fruits = ["apple", "banana", "cherry"]
for x in fruits:
  if x == "banana":
    continue
  print(x)
```

The range() Function

To loop through a set of code a specified number of times, we can use the `range()` function,

The `range()` function returns a sequence of numbers, starting from 0 by default, and increments by 1 (by default), and ends at a specified number.

Example

Using the range() function:

```
for x in range(6):
  print(x)
```

Note that `range(6)` is not the values of 0 to 6, but the values 0 to 5.

The `range()` function defaults to 0 as a starting value, however it is possible to specify the starting value by adding a parameter: `range(2, 6)`, which means values from 2 to 6 (but not including 6):

Example

Using the start parameter:

```
for x in range(2, 6):
  print(x)
```

The `range()` function defaults to increment the sequence by 1, however it is possible to specify the increment value by adding a third parameter: `range(2, 30, 3)`:

Example

Increment the sequence with 3 (default is 1):

```
for x in range(2, 30, 3):
  print(x)
```

Else in For Loop

The else keyword in a for loop specifies a block of code to be executed when the loop is finished:

Example

Print all numbers from 0 to 5, and print a message when the loop has ended:

```
for x in range(6):
  print(x)
else:
  print("Finally finished!")
```

Note: The else block will NOT be executed if the loop is stopped by a break statement.

Example

Break the loop when x is 3, and see what happens with the else block:

```
for x in range(6):
  if x == 3: break
  print(x)
else:
  print("Finally finished!")
```

Nested Loops

A nested loop is a loop inside a loop.

The "inner loop" will be executed one time for each iteration of the "outer loop":

Example

Print each adjective for every fruit:

```
adj = ["red", "big", "tasty"]
fruits = ["apple", "banana", "cherry"]

for x in adj:
  for y in fruits:
    print(x, y)
```

The pass Statement

for loops cannot be empty, but if you for some reason have a for loop with no content, put in the pass statement to avoid getting an error.

Example

```
for x in [0, 1, 2]:
  pass
```

Python Functions

A function is a block of code which only runs when it is called.
You can pass data, known as parameters, into a function.
A function can return data as a result.

Creating a Function

In Python a function is defined using the `def` keyword:

Example

```
def my_function():
  print("Hello from a function")
```

Calling a Function

To call a function, use the function name followed by parenthesis:

Example

```
def my_function():
  print("Hello from a function")

my_function()
```

Arguments

Information can be passed into functions as arguments.
Arguments are specified after the function name, inside the parentheses. You can add as many arguments as you want, just separate them with a comma.
The following example has a function with one argument (fname). When the function is called, we pass along a first name, which is used inside the function to print the full name:

Example

```
def my_function(fname):
  print(fname + " Refsnes")

my_function("Emil")
my_function("Tobias")
my_function("Linus")
```

Arguments are often shortened to *args* in Python documentations.

Parameters or Arguments?

The terms *parameter* and *argument* can be used for the same thing: information that are passed into a function.

From a function's perspective:

A parameter is the variable listed inside the parentheses in the function definition.
An argument is the value that is sent to the function when it is called.

Number of Arguments

By default, a function must be called with the correct number of arguments. Meaning that if your function expects 2 arguments, you have to call the function with 2 arguments, not more, and not less.

Example

This function expects 2 arguments, and gets 2 arguments:

```
def my_function(fname, lname):
  print(fname + " " + lname)

my_function("Emil", "Refsnes")
```

If you try to call the function with 1 or 3 arguments, you will get an error:

Example

This function expects 2 arguments, but gets only 1:

```
def my_function(fname, lname):
  print(fname + " " + lname)

my_function("Emil")
```

Arbitrary Arguments, *args

If you do not know how many arguments that will be passed into your function, add a * before the parameter name in the function definition.
This way the function will receive a *tuple* of arguments, and can access the items accordingly:

Example

If the number of arguments is unknown, add a * before the parameter name:

```
def my_function(*kids):
  print("The youngest child is " + kids[2])

my_function("Emil", "Tobias", "Linus")
```

Arbitrary Arguments are often shortened to **args* in Python documentations.

Keyword Arguments

You can also send arguments with the *key* = *value* syntax.
This way the order of the arguments does not matter.

Example

```
def my_function(child3, child2, child1):
  print("The youngest child is " + child3)

my_function(child1 = "Emil", child2 = "Tobias", child3 = "Linus")
```

The phrase *Keyword Arguments* are often shortened to *kwargs* in Python documentations.

Arbitrary Keyword Arguments, **kwargs

If you do not know how many keyword arguments that will be passed into your function, add two asterisk: ** before the parameter name in the function definition.
This way the function will receive a *dictionary* of arguments, and can access the items accordingly:

Example

If the number of keyword arguments is unknown, add a double ** before the parameter name:

```
def my_function(**kid):
  print("His last name is " + kid["lname"])

my_function(fname = "Tobias", lname = "Refsnes")
```

Arbitrary Kword Arguments are often shortened to ***kwargs* in Python documentations.

Default Parameter Value

The following example shows how to use a default parameter value.
If we call the function without argument, it uses the default value:

Example

```
def my_function(country = "Norway"):
  print("I am from " + country)

my_function("Sweden")
my_function("India")
my_function()
my_function("Brazil")
```

Passing a List as an Argument

You can send any data types of argument to a function (string, number, list, dictionary etc.), and it will be treated as the same data type inside the function.
E.g. if you send a List as an argument, it will still be a List when it reaches the function:

Example

```
def my_function(food):
  for x in food:
```

```
  print(x)

fruits = ["apple", "banana", "cherry"]

my_function(fruits)
```

Return Values

To let a function return a value, use the return statement:

Example

```
def my_function(x):
  return 5 * x

print(my_function(3))
print(my_function(5))
print(my_function(9))
```

The pass Statement

function definitions cannot be empty, but if you for some reason have a function definition with no content, put in the pass statement to avoid getting an error.

Example

```
def myfunction():
  pass
```

Recursion

Python also accepts function recursion, which means a defined function can call itself.

Recursion is a common mathematical and programming concept. It means that a function calls itself. This has the benefit of meaning that you can loop through data to reach a result.

The developer should be very careful with recursion as it can be quite easy to slip into writing a function which never terminates, or one that uses excess amounts of memory or processor power. However, when written correctly recursion can be a very efficient and mathematically-elegant approach to programming.

In this example, tri_recursion() is a function that we have defined to call itself ("recurse"). We use the k variable as the data, which decrements (-1) every time we recurse. The recursion ends when the condition is not greater than 0 (i.e. when it is 0).

Example

Recursion Example

```
def tri_recursion(k):
  if(k > 0):
      result = k + tri_recursion(k - 1)
      print(result)
  else:
      result = 0
  return result

print("\n\nRecursion Example Results")
tri_recursion(6)
```

OUTPUT

```
Recursion Example Results
1
3
6
10
15
21
```

Boolean Functions

Booleans represent one of two values: True or False.

Boolean Values

In programming you often need to know if an expression is True or False.
You can evaluate any expression in Python, and get one of two answers, True or False.
When you compare two values, the expression is evaluated and Python returns the Boolean answer:

Example

```
print(10 > 9)
print(10 == 9)
print(10 < 9)
```

When you run a condition in an if statement, Python returns True or False:

Example

Print a message based on whether the condition is True or False:

```
a = 200
b = 33

if b > a:
  print("b is greater than a")
else:
  print("b is not greater than a")
```

Evaluate Values and Variables

The bool() function allows you to evaluate any value, and give you True or False in return,

Example

Evaluate a string and a number:

```
print(bool("Hello"))
print(bool(15))
```

Example

Evaluate two variables:

```
x = "Hello"
y = 15

print(bool(x))
print(bool(y))
```

Most Values are True

Almost any value is evaluated to True if it has some sort of content.
Any string is True, except empty strings.

Any number is True, except 0.
Any list, tuple, set, and dictionary are True, except empty ones.

Example

The following will return True:

```
bool("abc")
bool(123)
bool(["apple", "cherry", "banana"])
```

Some Values are False

In fact, there are not many values that evaluate to False, except empty values, such as (), [], {}, "", the number 0, and the value None. And of course the value False evaluates to False.

Example

The following will return False:

```
bool(False)
bool(None)
bool(0)
bool("")
bool(())
bool([])
bool({})
```

One more value, or object in this case, evaluates to False, and that is if you have an object that is made from a class with a __len__ function that returns 0 or False:

Example

```
class myclass():
  def __len__(self):
    return 0

myobj = myclass()
print(bool(myobj))
```

Functions can Return a Boolean

You can create functions that returns a Boolean Value:

Example

Print the answer of a function:

```
def myFunction() :
  return True

print(myFunction())
```

You can execute code based on the Boolean answer of a function:

Example

Print "YES!" if the function returns True, otherwise print "NO!":

```
def myFunction() :
  return True

if myFunction():
  print("YES!")
else:
  print("NO!")
```

Python also has many built-in functions that return a boolean value, like the `isinstance()` function, which can be used to determine if an object is of a certain data type:

Example

Check if an object is an integer or not:

```
x = 200
print(isinstance(x, int))
```

Conversion Functions in Python

Few popular conversion functions in Python include the following

Sr.No.	Function & Description
1	**int(x [,base])** Converts x to an integer. base specifies the base if x is a string.
2	**long(x [,base])** Converts x to a long integer. base specifies the base if x is a string.
3	**float(x)** Converts x to a floating-point number.
4	**complex(real [,imag])** Creates a complex number.
5	**str(x)** Converts object x to a string representation.

6	**repr(x)** Converts object x to an expression string.
7	**eval(str)** Evaluates a string and returns an object.
8	**tuple(s)** Converts s to a tuple.
9	**list(s)** Converts s to a list.
10	**set(s)** Converts s to a set.
11	**dict(d)** Creates a dictionary. d must be a sequence of (key,value) tuples.
12	**frozenset(s)** Converts s to a frozen set.
13	**chr(x)** Converts an integer to a character.
14	**unichr(x)** Converts an integer to a Unicode character.
15	**ord(x)** Converts a single character to its integer value.
16	**hex(x)** Converts an integer to a hexadecimal string.

17	**oct(x)** Converts an integer to an octal string.

Math Functions in Python Math Module

Here is the list of all the functions and attributes defined in `math` module with a brief explanation of what they do.

Function	Description
ceil(x)	Returns the smallest integer greater than or equal to x.
copysign(x, y)	Returns x with the sign of y
fabs(x)	Returns the absolute value of x
factorial(x)	Returns the factorial of x
floor(x)	Returns the largest integer less than or equal to x
fmod(x, y)	Returns the remainder when x is divided by y
frexp(x)	Returns the mantissa and exponent of x as the pair (m, e)
fsum(iterable)	Returns an accurate floating point sum of values in the iterable
isfinite(x)	Returns True if x is neither an infinity nor a NaN (Not a Number)
isinf(x)	Returns True if x is a positive or negative infinity

isnan(x)	Returns True if x is a NaN
ldexp(x, i)	Returns x * (2**i)
modf(x)	Returns the fractional and integer parts of x
trunc(x)	Returns the truncated integer value of x
exp(x)	Returns e**x
expm1(x)	Returns e**x - 1
log(x[, b])	Returns the logarithm of x to the base b (defaults to e)
log1p(x)	Returns the natural logarithm of 1+x
log2(x)	Returns the base-2 logarithm of x
log10(x)	Returns the base-10 logarithm of x
pow(x, y)	Returns x raised to the power y
sqrt(x)	Returns the square root of x
acos(x)	Returns the arc cosine of x

asin(x)	Returns the arc sine of x
atan(x)	Returns the arc tangent of x
atan2(y, x)	Returns atan(y / x)
cos(x)	Returns the cosine of x
hypot(x, y)	Returns the Euclidean norm, sqrt(x*x + y*y)
sin(x)	Returns the sine of x
tan(x)	Returns the tangent of x
degrees(x)	Converts angle x from radians to degrees
radians(x)	Converts angle x from degrees to radians
acosh(x)	Returns the inverse hyperbolic cosine of x
asinh(x)	Returns the inverse hyperbolic sine of x
atanh(x)	Returns the inverse hyperbolic tangent of x
cosh(x)	Returns the hyperbolic cosine of x

sinh(x)	Returns the hyperbolic cosine of x
tanh(x)	Returns the hyperbolic tangent of x
erf(x)	Returns the error function at x
erfc(x)	Returns the complementary error function at x
gamma(x)	Returns the Gamma function at x
lgamma(x)	Returns the natural logarithm of the absolute value of the Gamma function at x
pi	Mathematical constant, the ratio of circumference of a circle to it's diameter (3.14159...)
e	mathematical constant e (2.71828...)