

# About

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Basic cheatsheet for Python mostly based on the book writted by Al Sweigart, [Automate the Boring Stuff with Python](#) under the [Creative Commons](#) license and many other sources.

## Read It

- [Online](#)
- [Github](#)
- [PDF](#)

## Python Cheatsheet

- [Python Basics](#)
  - [Math Operators](#)
  - [Data Types](#)
  - [String Concatenation and Replication](#)
  - [Variables](#)
  - [Comments](#)
  - [The print\(\) Function](#)
  - [The input\(\) Function](#)
  - [The len\(\) Function](#)
  - [The str\(\), int\(\), and float\(\) Functions](#)
- [Flow Control](#)
  - [Comparison Operators](#)
  - [Boolean Operators](#)
  - [Mixing Boolean and Comparison Operators](#)
  - [if Statements](#)
  - [else Statements](#)
  - [elif Statements](#)
  - [while Loop Statements](#)
  - [break Statements](#)
  - [continue Statements](#)
  - [for Loops and the range\(\) Function](#)
  - [Importing Modules](#)
  - [Ending a Program Early with sys.exit\(\)](#)
- [Functions](#)
  - [Return Values and return Statements](#)
  - [The None Value](#)
  - [Keyword Arguments and print\(\)](#)
  - [Local and Global Scope](#)
  - [The global Statement](#)
- [Exception Handling](#)
- [Lists](#)

- Getting Individual Values in a List with Indexes
- Negative Indexes
- Getting Sublists with Slices
- Getting a List's Length with len()
- Changing Values in a List with Indexes
- List Concatenation and List Replication
- Removing Values from Lists with del Statements
- Using for Loops with Lists
- The in and not in Operators
- The Multiple Assignment Trick
- Augmented Assignment Operators
- Finding a Value in a List with the index() Method
- Adding Values to Lists with the append() and insert() Methods
- Removing Values from Lists with remove()
- Sorting the Values in a List with the sort() Method
- Tuple Data Type
- Converting Types with the list() and tuple() Functions
- Dictionaries and Structuring Data
  - The keys(), values(), and items() Methods
  - Checking Whether a Key or Value Exists in a Dictionary
  - The get() Method
  - The setdefault() Method
  - Pretty Printing
- Manipulating Strings
  - Escape Characters
  - Raw Strings
  - Multiline Strings with Triple Quotes
  - Indexing and Slicing Strings
  - The in and not in Operators with Strings
  - The upper(), lower(), isupper(), and islower() String Methods
  - The isX String Methods
  - The startswith() and endswith() String Methods
  - The join() and split() String Methods
  - Justifying Text with rjust(), ljust(), and center()
  - Removing Whitespace with strip(),rstrip(), and lstrip()
  - Copying and Pasting Strings with the pyperclip Module
- Regular Expressions
  - Matching Regex Objects
  - Grouping with Parentheses
  - Matching Multiple Groups with the Pipe
  - Optional Matching with the Question Mark
  - Matching Zero or More with the Star
  - Matching One or More with the Plus
  - Matching Specific Repetitions with Curly Brackets
  - Greedy and Nongreedy Matching

- The findall() Method
- Making Your Own Character Classes
- The Caret and Dollar Sign Characters
- The Wildcard Character
- Matching Everything with Dot-Star
- Matching Newlines with the Dot Character
- Review of Regex Symbols
- Case-Insensitive Matching
- Substituting Strings with the sub() Method
- Managing Complex Regexes
- Reading and Writing Files
  - Backslash on Windows and Forward Slash on OS X and Linux
  - The Current Working Directory
  - Absolute vs. Relative Paths
  - Creating New Folders with os.makedirs()
  - Handling Absolute and Relative Paths
  - Finding File Sizes and Folder Contents
  - Checking Path Validity
  - The File Reading/Writing Process
  - Opening Files with the open() Function
  - Reading the Contents of Files
  - Writing to Files
  - Saving Variables with the shelve Module
  - Saving Variables with the pprint.pformat() Function
  - Copying Files and Folders
  - Moving and Renaming Files and Folders
  - Permanently Deleting Files and Folders
  - Safe Deletes with the send2trash Module
  - Walking a Directory Tree
  - Reading ZIP Files
  - Extracting from ZIP Files
  - Creating and Adding to ZIP Files
- Debugging
  - Raising Exceptions
  - Getting the Traceback as a String
  - Assertions
  - Logging
  - Logging Levels
  - Disabling Logging
  - Logging to a File
- Virtual Environment
  - Windows
- Lambda Functions
- Ternary Conditional Operator

# Python Basics

## Math Operators

From **Highest** to **Lowest** precedence:

Operators	Operation	Example
**	Exponent	$2 ** 3 = 8$
%	Modulus/Remaider	$22 \% 8 = 6$
//	Integer division	$22 // 8 = 2$
/	Division	$22 / 8 = 2.75$
*	Multiplication	$3 * 3 = 9$
-	Subtraction	$5 - 2 = 3$
+	Addition	$2 + 2 = 4$

Examples of expressions in the interactive shell:

```
>>> 2 + 3 * 6
20

>>> (2 + 3) * 6
30

>>> 2 ** 8
256

>>> 23 // 7
3

>>> 23 % 7
2

>>> (5 - 1) * ((7 + 1) / (3 - 1))
16.0
```

[Return to the Top](#)

## Data Types

Data Type	Examples
Integers	-2, -1, 0, 1, 2, 3, 4, 5
Floating-point numbers	-1.25, -1.0, --0.5, 0.0, 0.5, 1.0, 1.25

Strings

'a', 'aa', 'aaa', 'Hello!', '11 cats'

[Return to the Top](#)

## String Concatenation and Replication

String concatenation:

```
>>> 'Alice' + 'Bob'
'AliceBob'
```

String Replication:

```
>>> 'Alice' * 5
'AliceAliceAliceAliceAlice'
```

[Return to the Top](#)

## Variables

You can name a variable anything as long as it obeys the following three rules:

1. It can be only one word.
2. It can use only letters, numbers, and the underscore (\_) character.
3. It can't begin with a number.

Example:

```
>>> spam = 'Hello'
>>> spam
'Hello'
```

[Return to the Top](#)

## Comments

Inline comment:

```
# This is a comment
```

Multiline comment:

```
# This is a
# multiline comment
```

Function docstring:

```
def foo():
    """
    This is a function docstring
    You can also use:
    ''' Function Docstring '''
    """
```

[Return to the Top](#)

## The print() Function

```
>>> print('Hello world!')
Hello world!
```

[Return to the Top](#)

## The input() Function

Example Code:

```
>>> print('What is your name?')    # ask for their name
>>> myName = input()
>>> print('It is good to meet you, ' + myName)
```

Output:

```
What is your name?
Al
It is good to meet you, Al
```

[Return to the Top](#)

## The len() Function

Evaluates to the integer value of the number of characters in a string:

```
>>> len('hello')
5
```

[Return to the Top](#)

## The str(), int(), and float() Functions

Convert Between Data Types:

Integer to String or Float:

```
>>> str(29)
'29'

>>> print('I am ' + str(29) + ' years old.')
I am 29 years old.

>>> str(-3.14)
'-3.14'
```

Float to Integer:

```
>>> int(7.7)
7

>>> int(7.7) + 1
8
```

[Return to the Top](#)

## Flow Control

### Comparison Operators

Operator	Meaning
==	Equal to
!=	Not equal to
<	Less than
>	Greater Than
<=	Less than or Equal to
>=	Greater than or Equal to

These operators evaluate to True or False depending on the values you give them:

Examples:

```
>>> 42 == 42
True

>>> 40 == 42
False

>>> 'hello' == 'hello'
True

>>> 'hello' == 'Hello'
False

>>> 'dog' != 'cat'
True

>>> True == True
True

>>> True != False
True

>>> 42 == 42.0
True

>>> 42 == '42'
False
```

[Return to the Top](#)

## Boolean Operators

There are three Boolean operators: and, or, and not.

The *and* Operator's *Truth* Table:

Expression	Evaluates to
True and True	True
True and False	False
False and True	False
False and False	False

The *or* Operator's *Truth* Table:



Expression	Evaluates to
True or True	True
True or False	True
False or True	True
False or False	False

The *not* Operator's *Truth* Table:

Expression	Evaluates to
not True	False
not False	True

[Return to the Top](#)

## Mixing Boolean and Comparison Operators

```
>>> (4 < 5) and (5 < 6)
True

>>> (4 < 5) and (9 < 6)
False

>>> (1 == 2) or (2 == 2)
True
```

You can also use multiple Boolean operators in an expression, along with the comparison operators:

```
>>> 2 + 2 == 4 and not 2 + 2 == 5 and 2 * 2 == 2 + 2
True
```

[Return to the Top](#)

## if Statements

```
if name == 'Alice':
    print('Hi, Alice.')
```

[Return to the Top](#)

## else Statements

```
name = 'Bob'
if name == 'Alice':
    print('Hi, Alice.')
else:
    print('Hello, stranger.')
```

[Return to the Top](#)

## elif Statements

```
name = 'Bob'
age = 5
if name == 'Alice':
    print('Hi, Alice.')
elif age < 12:
    print('You are not Alice, kiddo.')
```

```
name = 'Bob'
age = 30
if name == 'Alice':
    print('Hi, Alice.')
elif age < 12:
    print('You are not Alice, kiddo.')
else:
    print('You are neither Alice nor a little kid.')
```

[Return to the Top](#)

## while Loop Statements

```
spam = 0
while spam < 5:
    print('Hello, world.')
    spam = spam + 1
```

[Return to the Top](#)

## break Statements

If the execution reaches a break statement, it immediately exits the while loop's clause.

```
while True:
```

```
print('Please type your name.')
name = input()
if name == 'your name':
    break
print('Thank you!')
```

[Return to the Top](#)

## continue Statements

When the program execution reaches a continue statement, the program execution immediately jumps back to the start of the loop.

```
while True:
    print('Who are you?')
    name = input()
    if name != 'Joe':
        continue
    print('Hello, Joe. What is the password? (It is a fish.)')
    password = input()
    if password == 'swordfish':
        break
    print('Access granted.')
```

[Return to the Top](#)

## for Loops and the range() Function

```
print('My name is')
for i in range(5):
    print('Jimmy Five Times (' + str(i) + ')')
```

Output:

```
My name is
Jimmy Five Times (0)
Jimmy Five Times (1)
Jimmy Five Times (2)
Jimmy Five Times (3)
Jimmy Five Times (4)
```

The `range()` function can also be called with three arguments. The first two arguments will be the start and stop values, and the third will be the step argument. The step is the amount that the variable is increased by after each iteration.

```
for i in range(0, 10, 2):  
    print(i)
```

Output:

```
0  
2  
4  
6  
8
```

You can even use a negative number for the step argument to make the for loop count down instead of up.

```
for i in range(5, -1, -1):  
    print(i)
```

Output:

```
5  
4  
3  
2  
1  
0
```

[Return to the Top](#)

## Importing Modules

```
import random  
for i in range(5):  
    print(random.randint(1, 10))
```

```
import random, sys, os, math
```

```
from random import *.
```

[Return to the Top](#)

## Ending a Program Early with sys.exit()

```
import sys

while True:
    print('Type exit to exit.')
    response = input()
    if response == 'exit':
        sys.exit()
    print('You typed ' + response + '.')
```

[Return to the Top](#)

## Functions

```
def hello(name):
    print('Hello ' + name)

hello('Alice')
hello('Bob')
```

Output:

```
Hello Alice
Hello Bob
```

[Return to the Top](#)

## Return Values and return Statements

When creating a function using the def statement, you can specify what the return value should be with a return statement. A return statement consists of the following:

- The return keyword.
- The value or expression that the function should return.

```
import random

def getAnswer(answerNumber):
    if answerNumber == 1:
        return 'It is certain'
    elif answerNumber == 2:
```

```
        return 'It is decidedly so'
    elif answerNumber == 3:
        return 'Yes'
    elif answerNumber == 4:
        return 'Reply hazy try again'
    elif answerNumber == 5:
        return 'Ask again later'
    elif answerNumber == 6:
        return 'Concentrate and ask again'
    elif answerNumber == 7:
        return 'My reply is no'
    elif answerNumber == 8:
        return 'Outlook not so good'
    elif answerNumber == 9:
        return 'Very doubtful'

r = random.randint(1, 9)
fortune = getAnswer(r)
print(fortune)
```

[Return to the Top](#)

## The None Value

```
>>> spam = print('Hello!')
Hello!

>>> spam is None
True
```

[Return to the Top](#)

## Keyword Arguments and print()

```
print('Hello', end='')
print('World')
```

Output:

```
HelloWorld
```

```
>>> print('cats', 'dogs', 'mice')
cats dogs mice
```

```
>>> print('cats', 'dogs', 'mice', sep=',')
cats,dogs,mice
```

[Return to the Top](#)

## Local and Global Scope

- Code in the global scope cannot use any local variables.
- However, a local scope can access global variables.
- Code in a function's local scope cannot use variables in any other local scope.
- You can use the same name for different variables if they are in different scopes. That is, there can be a local variable named spam and a global variable also named spam.

[Return to the Top](#)

## The global Statement

If you need to modify a global variable from within a function, use the global statement:

```
def spam():
    global eggs
    eggs = 'spam'

eggs = 'global'
spam()
print(eggs)
```

Output:

```
spam
```

There are four rules to tell whether a variable is in a local scope or global scope:

1. If a variable is being used in the global scope (that is, outside of all functions), then it is always a global variable.
2. If there is a global statement for that variable in a function, it is a global variable.
3. Otherwise, if the variable is used in an assignment statement in the function, it is a local variable.
4. But if the variable is not used in an assignment statement, it is a global variable.

[Return to the Top](#)

## Exception Handling

```
def spam(divideBy):
    try:
        return 42 / divideBy
    except ZeroDivisionError:
        print('Error: Invalid argument.')

print(spam(2))
print(spam(12))
print(spam(0))
print(spam(1))
```

Output:

```
21.0
3.5
Error: Invalid argument.
None
42.0
```

[Return to the Top](#)

## Lists

```
>>> spam = ['cat', 'bat', 'rat', 'elephant']

>>> spam
['cat', 'bat', 'rat', 'elephant']
```

[Return to the Top](#)

### Getting Individual Values in a List with Indexes

```
>>> spam = ['cat', 'bat', 'rat', 'elephant']

>>> spam[0]
'cat'

>>> spam[1]
'bat'
```



```
>>> spam[2]
'rat'

>>> spam[3]
'elephant'
```

[Return to the Top](#)

## Negative Indexes

```
>>> spam = ['cat', 'bat', 'rat', 'elephant']
>>> spam[-1]
'elephant'

>>> spam[-3]
'bat'

>>> 'The ' + spam[-1] + ' is afraid of the ' + spam[-3] + '.'
'The elephant is afraid of the bat.'
```

[Return to the Top](#)

## Getting Sublists with Slices

```
>>> spam = ['cat', 'bat', 'rat', 'elephant']

>>> spam[0:4]
['cat', 'bat', 'rat', 'elephant']

>>> spam[1:3]
['bat', 'rat']

>>> spam[0:-1]
['cat', 'bat', 'rat']
```

```
>>> spam = ['cat', 'bat', 'rat', 'elephant']

>>> spam[:2]
['cat', 'bat']

>>> spam[1:]
['bat', 'rat', 'elephant']

>>> spam[:]
['cat', 'bat', 'rat', 'elephant']
```

[Return to the Top](#)

## Getting a List's Length with len()

```
>>> spam = ['cat', 'dog', 'moose']

>>> len(spam)
3
```

[Return to the Top](#)

## Changing Values in a List with Indexes

```
>>> spam = ['cat', 'bat', 'rat', 'elephant']

>>> spam[1] = 'aardvark'

>>> spam
['cat', 'aardvark', 'rat', 'elephant']

>>> spam[2] = spam[1]

>>> spam
['cat', 'aardvark', 'aardvark', 'elephant']

>>> spam[-1] = 12345

>>> spam
['cat', 'aardvark', 'aardvark', 12345]
```

[Return to the Top](#)

## List Concatenation and List Replication

```
>>> [1, 2, 3] + ['A', 'B', 'C']
[1, 2, 3, 'A', 'B', 'C']

>>> ['X', 'Y', 'Z'] * 3
['X', 'Y', 'Z', 'X', 'Y', 'Z', 'X', 'Y', 'Z']

>>> spam = [1, 2, 3]

>>> spam = spam + ['A', 'B', 'C']

>>> spam
```

```
[1, 2, 3, 'A', 'B', 'C']
```

[Return to the Top](#)

## Removing Values from Lists with del Statements

```
>>> spam = ['cat', 'bat', 'rat', 'elephant']

>>> del spam[2]

>>> spam
['cat', 'bat', 'elephant']

>>> del spam[2]

>>> spam
['cat', 'bat']
```

[Return to the Top](#)

## Using for Loops with Lists

```
>>> supplies = ['pens', 'staplers', 'flame-throwers', 'binders']

>>> for i, supply in enumerate(supplies):
    print('Index ' + str(i) + ' in supplies is: ' + supply)
```

Output:

```
Index 0 in supplies is: pens
Index 1 in supplies is: staplers
Index 2 in supplies is: flame-throwers
Index 3 in supplies is: binders
```

[Return to the Top](#)

## The in and not in Operators

```
>>> 'howdy' in ['hello', 'hi', 'howdy', 'heyas']
True

>>> spam = ['hello', 'hi', 'howdy', 'heyas']
```

```
>>> 'cat' in spam
False

>>> 'howdy' not in spam
False

>>> 'cat' not in spam
True
```

[Return to the Top](#)

## The Multiple Assignment Trick

The multiple assignment trick is a shortcut that lets you assign multiple variables with the values in a list in one line of code. So instead of doing this:

```
>>> cat = ['fat', 'orange', 'loud']

>>> size = cat[0]

>>> color = cat[1]

>>> disposition = cat[2]
```

you could type this line of code:

```
>>> cat = ['fat', 'orange', 'loud']

>>> size, color, disposition = cat
```

The multiple assignment trick can also be used to swap the values in two variables:

```
>>> a, b = 'Alice', 'Bob'

>>> a, b = b, a

>>> print(a)
'Bob'

>>> print(b)
'Alice'
```

[Return to the Top](#)

## Augmented Assignment Operators

Operator	Equivalent
spam += 1	spam = spam + 1
spam -= 1	spam = spam - 1
spam *= 1	spam = spam * 1
spam /= 1	spam = spam / 1
spam %= 1	spam = spam % 1

Examples:

```
>>> spam = 'Hello'
>>> spam += ' world!'
>>> spam
'Hello world!'

>>> bacon = ['Zophie']
>>> bacon *= 3
>>> bacon
['Zophie', 'Zophie', 'Zophie']
```

[Return to the Top](#)

## Finding a Value in a List with the index() Method

```
>>> spam = ['Zophie', 'Pooka', 'Fat-tail', 'Pooka']
>>> spam.index('Pooka')
1
```

[Return to the Top](#)

## Adding Values to Lists with the append() and insert() Methods

**append():**

```
>>> spam = ['cat', 'dog', 'bat']
>>> spam.append('moose')
>>> spam
['cat', 'dog', 'bat', 'moose']
```

## **insert():**

```
>>> spam = ['cat', 'dog', 'bat']

>>> spam.insert(1, 'chicken')

>>> spam
['cat', 'chicken', 'dog', 'bat']
```

[Return to the Top](#)

## Removing Values from Lists with remove()

```
>>> spam = ['cat', 'bat', 'rat', 'elephant']

>>> spam.remove('bat')

>>> spam
['cat', 'rat', 'elephant']
```

If the value appears multiple times in the list, only the first instance of the value will be removed.

[Return to the Top](#)

## Sorting the Values in a List with the sort() Method

```
>>> spam = [2, 5, 3.14, 1, -7]

>>> spam.sort()

>>> spam
[-7, 1, 2, 3.14, 5]

>>> spam = ['ants', 'cats', 'dogs', 'badgers', 'elephants']

>>> spam.sort()

>>> spam
['ants', 'badgers', 'cats', 'dogs', 'elephants']
```

You can also pass True for the reverse keyword argument to have sort() sort the values in reverse order:

```
>>> spam.sort(reverse=True)
```

```
>>> spam
['elephants', 'dogs', 'cats', 'badgers', 'ants']
```

If you need to sort the values in regular alphabetical order, pass `str.lower` for the `key` keyword argument in the `sort()` method call:

```
>>> spam = ['a', 'z', 'A', 'Z']

>>> spam.sort(key=str.lower)

>>> spam
['a', 'A', 'z', 'Z']
```

[Return to the Top](#)

## Tuple Data Type

```
>>> eggs = ('hello', 42, 0.5)

>>> eggs[0]
'hello'

>>> eggs[1:3]
(42, 0.5)

>>> len(eggs)
3
```

The main way that tuples are different from lists is that tuples, like strings, are immutable.

[Return to the Top](#)

## Converting Types with the `list()` and `tuple()` Functions

```
>>> tuple(['cat', 'dog', 5])
('cat', 'dog', 5)

>>> list(('cat', 'dog', 5))
['cat', 'dog', 5]

>>> list('hello')
['h', 'e', 'l', 'l', 'o']
```

[Return to the Top](#)

## Dictionaries and Structuring Data

Example Dictionary:

```
myCat = {'size': 'fat', 'color': 'gray', 'disposition': 'loud'}
```

[Return to the Top](#)

The keys(), values(), and items() Methods

**values():**

```
>>> spam = {'color': 'red', 'age': 42}

>>> for v in spam.values():
    print(v)
```

Output:

```
red
42
```

**keys():**

```
>>> for k in spam.keys():
    print(k)
```

Output:

```
color
age
```

**items():**

```
>>> for i in spam.items():
    print(i)
```



Output:

```
('color', 'red')  
( 'age', 42)
```

Using the `keys()`, `values()`, and `items()` methods, a for loop can iterate over the keys, values, or key-value pairs in a dictionary, respectively

```
>>> spam = {'color': 'red', 'age': 42}  
  
>>> for k, v in spam.items():  
    print('Key: ' + k + ' Value: ' + str(v))
```

Output:

```
Key: age Value: 42  
Key: color Value: red
```

[Return to the Top](#)

## Checking Whether a Key or Value Exists in a Dictionary

```
>>> spam = {'name': 'Zophie', 'age': 7}  
  
>>> 'name' in spam.keys()  
True  
  
>>> 'Zophie' in spam.values()  
True  
  
>>> # You can omit the call to keys() when checking for a key  
>>> 'color' in spam  
False  
  
>>> 'color' not in spam  
True  
  
>>> 'color' in spam  
False
```

[Return to the Top](#)

## The get() Method

```
>>> picnic_items = {'apples': 5, 'cups': 2}

>>> 'I am bringing ' + str(picnic_items.get('cups', 0)) + ' cups.'
'I am bringing 2 cups.'

>>> 'I am bringing ' + str(picnic_items.get('eggs', 0)) + ' eggs.'
'I am bringing 0 eggs.'
```

[Return to the Top](#)

## The setdefault() Method

```
spam = {'name': 'Pooka', 'age': 5}

if 'color' not in spam:
    spam['color'] = 'black'
```

The above code is equal to:

```
>>> spam = {'name': 'Pooka', 'age': 5}

>>> spam.setdefault('color', 'black')
'black'

>>> spam
{'color': 'black', 'age': 5, 'name': 'Pooka'}

>>> spam.setdefault('color', 'white')
'black'

>>> spam
{'color': 'black', 'age': 5, 'name': 'Pooka'}
```

[Return to the Top](#)

## Pretty Printing

```
import pprint

message = 'It was a bright cold day in April, and the clocks were striking
thirteen.'
count = {}
```

```
for character in message:
    count.setdefault(character, 0)
    count[character] = count[character] + 1

pprint.pprint(count)
```

Output:

```
{' ': 13,
 ',': 1,
 '.': 1,
 'A': 1,
 'I': 1,
 'a': 4,
 'b': 1,
 'c': 3,
 'd': 3,
 'e': 5,
 'g': 2,
 'h': 3,
 'i': 6,
 'k': 2,
 'l': 3,
 'n': 4,
 'o': 2,
 'p': 1,
 'r': 5,
 's': 3,
 't': 6,
 'w': 2,
 'y': 1}
```

[Return to the Top](#)

## Manipulating Strings

### Escape Characters

Escape character	Prints as
'	Single quote
"	Double quote
\t	Tab
\n	Newline (line break)
\	Backslash

Example:

```
>>> print("Hello there!\nHow are you?\nI\'m doing fine.")
```

Output:

```
Hello there!
How are you?
I\'m doing fine.
```

[Return to the Top](#)

## Raw Strings

A raw string completely ignores all escape characters and prints any backslash that appears in the string.

```
>>> print(r'That is Carol\'s cat.')
```

Output:

```
That is Carol\'s cat.
```

[Return to the Top](#)

## Multiline Strings with Triple Quotes

```
print('''Dear Alice,

Eve's cat has been arrested for catnapping, cat burglary, and extortion.

Sincerely,
Bob''')
```

Output:

```
Dear Alice,

Eve's cat has been arrested for catnapping, cat burglary, and extortion.
```

Sincerely,  
Bob

[Return to the Top](#)

## Indexing and Slicing Strings

H	e	l	l	o		w	o	r	l	d	!
0	1	2	3	4	5	6	7	8	9	10	11

```
>>> spam = 'Hello world!'

>>> spam[0]
'H'

>>> spam[4]
'o'

>>> spam[-1]
'!'

>>> spam[0:5]
'Hello'

>>> spam[:5]
'Hello'

>>> spam[6:]
'world!'
```

Slicing:

```
>>> spam = 'Hello world!'

>>> fizz = spam[0:5]

>>> fizz
'Hello'
```

[Return to the Top](#)

## The in and not in Operators with Strings

```
>>> 'Hello' in 'Hello World'
True

>>> 'Hello' in 'Hello'
True

>>> 'HELLO' in 'Hello World'
False

>>> '' in 'spam'
True

>>> 'cats' not in 'cats and dogs'
False
```

[Return to the Top](#)

## The upper(), lower(), isupper(), and islower() String Methods

upper() and lower():

```
>>> spam = 'Hello world!'

>>> spam = spam.upper()

>>> spam
'HELLO WORLD!'

>>> spam = spam.lower()

>>> spam
'hello world!'
```

isupper() and islower():

```
>>> spam = 'Hello world!'

>>> spam.islower()
False

>>> spam.isupper()
False

>>> 'HELLO'.isupper()
True
```

```
>>> 'abc12345'.islower()
True

>>> '12345'.islower()
False

>>> '12345'.isupper()
False
```

[Return to the Top](#)

## The isX String Methods

- **isalpha()** returns True if the string consists only of letters and is not blank.
- **isalnum()** returns True if the string consists only of letters and numbers and is not blank.
- **isdecimal()** returns True if the string consists only of numeric characters and is not blank.
- **isspace()** returns True if the string consists only of spaces, tabs, and new-lines and is not blank.
- **istitle()** returns True if the string consists only of words that begin with an uppercase letter followed by only lowercase letters.

[Return to the Top](#)

## The startswith() and endswith() String Methods

```
>>> 'Hello world!'.startswith('Hello')
True

>>> 'Hello world!'.endswith('world!')
True

>>> 'abc123'.startswith('abcdef')
False

>>> 'abc123'.endswith('12')
False

>>> 'Hello world!'.startswith('Hello world!')
True

>>> 'Hello world!'.endswith('Hello world!')
True
```

[Return to the Top](#)

## The join() and split() String Methods

join():

```
>>> ', '.join(['cats', 'rats', 'bats'])
'cats, rats, bats'

>>> ' '.join(['My', 'name', 'is', 'Simon'])
'My name is Simon'

>>> 'ABC'.join(['My', 'name', 'is', 'Simon'])
'MyABCnameABCisABCSimon'
```

split():

```
>>> 'My name is Simon'.split()
['My', 'name', 'is', 'Simon']

>>> 'MyABCnameABCisABCSimon'.split('ABC')
['My', 'name', 'is', 'Simon']

>>> 'My name is Simon'.split('m')
['My na', 'e is Si', 'on']
```

[Return to the Top](#)

Justifying Text with rjust(), ljust(), and center()

rjust() and ljust():

```
>>> 'Hello'.rjust(10)
'      Hello'

>>> 'Hello'.rjust(20)
'                Hello'

>>> 'Hello World'.rjust(20)
'                Hello World'

>>> 'Hello'.ljust(10)
'Hello          '
```

An optional second argument to rjust() and ljust() will specify a fill character other than a space character. Enter the following into the interactive shell:

```
>>> 'Hello'.rjust(20, '*')
'*****Hello'

>>> 'Hello'.ljust(20, '-')
'Hello          '
```



```
'Hello-----'
```

center():

```
>>> 'Hello'.center(20)
'      Hello      '

>>> 'Hello'.center(20, '=')
'====Hello===='
```

[Return to the Top](#)

Removing Whitespace with strip(), rstrip(), and lstrip()

```
>>> spam = '    Hello World    '

>>> spam.strip()
'Hello World'

>>> spam.lstrip()
'Hello World '

>>> spam.rstrip()
'    Hello World'
```

```
>>> spam = 'SpamSpamBaconSpamEggsSpamSpam'
>>> spam.strip('ampS')

'BaconSpamEggs'
```

[Return to the Top](#)

Copying and Pasting Strings with the pyperclip Module

```
>>> import pyperclip

>>> pyperclip.copy('Hello world!')

>>> pyperclip.paste()
'Hello world!'
```

[Return to the Top](#)

# Regular Expressions

1. Import the regex module with `import re`.
2. Create a Regex object with the `re.compile()` function. (Remember to use a raw string.)
3. Pass the string you want to search into the Regex object's `search()` method. This returns a Match object.
4. Call the Match object's `group()` method to return a string of the actual matched text.

All the regex functions in Python are in the `re` module:

```
>>> import re
```

[Return to the Top](#)

## Matching Regex Objects

```
>>> phone_num_regex = re.compile(r'\d\d\d-\d\d\d-\d\d\d\d')

>>> mo = phone_num_regex.search('My number is 415-555-4242.')

>>> print('Phone number found: ' + mo.group())
Phone number found: 415-555-4242
```

[Return to the Top](#)

## Grouping with Parentheses

```
>>> phone_num_regex = re.compile(r'(\d\d\d)-(\d\d\d-\d\d\d\d)')

>>> mo = phone_num_regex.search('My number is 415-555-4242.')

>>> mo.group(1)
'415'

>>> mo.group(2)
'555-4242'

>>> mo.group(0)
'415-555-4242'

>>> mo.group()
'415-555-4242'
```

To retrieve all the groups at once: `groups()` method—note the plural form for the name.

```
>>> mo.groups()
('415', '555-4242')

>>> area_code, main_number = mo.groups()

>>> print(area_code)
415

>>> print(main_number)
555-4242
```

[Return to the Top](#)

## Matching Multiple Groups with the Pipe

The `|` character is called a pipe. You can use it anywhere you want to match one of many expressions. For example, the regular expression `r'Batman|Tina Fey'` will match either 'Batman' or 'Tina Fey'.

```
>>> hero_regex = re.compile (r'Batman|Tina Fey')

>>> mo1 = hero_regex.search('Batman and Tina Fey.')

>>> mo1.group()
'Batman'

>>> mo2 = hero_regex.search('Tina Fey and Batman.')

>>> mo2.group()
'Tina Fey'
```

You can also use the pipe to match one of several patterns as part of your regex:

```
>>> bat_regex = re.compile(r'Bat(man|mobile|copter|bat)')

>>> mo = bat_regex.search('Batmobile lost a wheel')

>>> mo.group()
'Batmobile'

>>> mo.group(1)
'mobile'
```

[Return to the Top](#)

## Optional Matching with the Question Mark

The ? character flags the group that precedes it as an optional part of the pattern.

```
>>> bat_regex = re.compile(r'Bat(wo)?man')
>>> mo1 = bat_regex.search('The Adventures of Batman')
>>> mo1.group()
'Batman'

>>> mo2 = bat_regex.search('The Adventures of Batwoman')
>>> mo2.group()
'Batwoman'
```

[Return to the Top](#)

## Matching Zero or More with the Star

The \* (called the star or asterisk) means “match zero or more”—the group that precedes the star can occur any number of times in the text.

```
>>> bat_regex = re.compile(r'Bat(wo)*man')
>>> mo1 = bat_regex.search('The Adventures of Batman')
>>> mo1.group()
'Batman'

>>> mo2 = bat_regex.search('The Adventures of Batwoman')
>>> mo2.group()
'Batwoman'

>>> mo3 = bat_regex.search('The Adventures of Batwowowowoman')
>>> mo3.group()
'Batwowowowoman'
```

[Return to the Top](#)

## Matching One or More with the Plus

While \* means “match zero or more,” the + (or plus) means “match one or more”. The group preceding a plus must appear at least once. It is not optional:

```
>>> bat_regex = re.compile(r'Bat(wo)+man')
>>> mo1 = bat_regex.search('The Adventures of Batwoman')
>>> mo1.group()
'Batwoman'

>>> mo2 = bat_regex.search('The Adventures of Batwowowowoman')
>>> mo2.group()
'Batwowowowoman'
```

```
>>> mo3 = bat_regex.search('The Adventures of Batman')
>>> mo3 is None
True
```

[Return to the Top](#)

## Matching Specific Repetitions with Curly Brackets

If you have a group that you want to repeat a specific number of times, follow the group in your regex with a number in curly brackets. For example, the regex `(Ha){3}` will match the string `'HaHaHa'`, but it will not match `'HaHa'`, since the latter has only two repeats of the `(Ha)` group.

Instead of one number, you can specify a range by writing a minimum, a comma, and a maximum in between the curly brackets. For example, the regex `(Ha){3,5}` will match `'HaHaHa'`, `'HaHaHaHa'`, and `'HaHaHaHaHa'`.

```
>>> ha_regex = re.compile(r'(Ha){3}')
>>> mo1 = ha_regex.search('HaHaHa')
>>> mo1.group()
'HaHaHa'

>>> mo2 = ha_regex.search('Ha')
>>> mo2 is None
True
```

[Return to the Top](#)

## Greedy and Nongreedy Matching

Python's regular expressions are greedy by default, which means that in ambiguous situations they will match the longest string possible. The non-greedy version of the curly brackets, which matches the shortest string possible, has the closing curly bracket followed by a question mark.

```
>>> greedy_ha_regex = re.compile(r'(Ha){3,5}')
>>> mo1 = greedy_ha_regex.search('HaHaHaHaHa')
>>> mo1.group()
'HaHaHaHaHa'

>>> nongreedy_ha_regex = re.compile(r'(Ha){3,5}?')
>>> mo2 = nongreedy_ha_regex.search('HaHaHaHaHa')
>>> mo2.group()
'HaHaHa'
```

[Return to the Top](#)

## The `findall()` Method

In addition to the `search()` method, `Regex` objects also have a `findall()` method. While `search()` will return a `Match` object of the first matched text in the searched string, the `findall()` method will return the strings of every match in the searched string.

```
>>> phone_num_regex = re.compile(r'\d\d\d-\d\d\d-\d\d\d\d') # has no groups
>>> phone_num_regex.findall('Cell: 415-555-9999 Work: 212-555-0000')
['415-555-9999', '212-555-0000']
```

To summarize what the `findall()` method returns, remember the following:

- When called on a regex with no groups, such as `\d-\d\d\d-\d\d\d\d`, the method `findall()` returns a list of ng matches, such as `['415-555-9999', '212-555-0000']`.
- When called on a regex that has groups, such as `(\d\d\d)-d\d)-(\d\d\d\d)`, the method `findall()` returns a list of es of strings (one string for each group), such as `[('415', ' ', '9999'), ('212', '555', '0000')]`.

[Return to the Top](#)

## Making Your Own Character Classes

There are times when you want to match a set of characters but the shorthand character classes (`\d`, `\w`, `\s`, and so on) are too broad. You can define your own character class using square brackets. For example, the character class `[aeiouAEIOU]` will match any vowel, both lowercase and uppercase.

```
>>> vowel_regex = re.compile(r'[aeiouAEIOU]')
>>> vowel_regex.findall('Robocop eats baby food. BABY FOOD.')
['o', 'o', 'o', 'e', 'a', 'a', 'o', 'o', 'A', 'O', 'O']
```

You can also include ranges of letters or numbers by using a hyphen. For example, the character class `[a-zA-Z0-9]` will match all lowercase letters, uppercase letters, and numbers.

By placing a caret character (`^`) just after the character class's opening bracket, you can make a negative character class. A negative character class will match all the characters that are not in the character class. For example, enter the following into the interactive shell:

```
>>> consonant_regex = re.compile(r'^[aeiouAEIOU]')
>>> consonant_regex.findall('Robocop eats baby food. BABY FOOD.')
['R', 'b', 'c', 'p', ' ', 't', 's', ' ', 'b', 'b', 'y', ' ', 'f', 'd', '.', ' ', 'B', 'B', 'Y', ' ', 'F', 'D', '.']
```

[Return to the Top](#)

## The Caret and Dollar Sign Characters

- You can also use the caret symbol (^) at the start of a regex to indicate that a match must occur at the beginning of the searched text.
- Likewise, you can put a dollar sign (\$) at the end of the regex to indicate the string must end with this regex pattern.
- And you can use the ^ and \$ together to indicate that the entire string must match the regex—that is, it's not enough for a match to be made on some subset of the string.

The `r'^Hello'` regular expression string matches strings that begin with 'Hello':

```
>>> begins_with_hello = re.compile(r'^Hello')

>>> begins_with_hello.search('Hello world!')
<_sre.SRE_Match object; span=(0, 5), match='Hello'>

>>> begins_with_hello.search('He said hello.') is None
True
```

The `r'\d$'` regular expression string matches strings that end with a numeric character from 0 to 9:

```
>>> whole_string_is_num = re.compile(r'\d+$')

>>> whole_string_is_num.search('1234567890')
<_sre.SRE_Match object; span=(0, 10), match='1234567890'>

>>> whole_string_is_num.search('12345xyz67890') is None
True

>>> whole_string_is_num.search('12 34567890') is None
True
```

[Return to the Top](#)

## The Wildcard Character

The `.` (or dot) character in a regular expression is called a wildcard and will match any character except for a newline:

```
>>> at_regex = re.compile(r'.at')

>>> at_regex.findall('The cat in the hat sat on the flat mat.')
['cat', 'hat', 'sat', 'lat', 'mat']
```

[Return to the Top](#)

## Matching Everything with Dot-Star

```
>>> name_regex = re.compile(r'First Name: (.*) Last Name: (.*)')
>>> mo = name_regex.search('First Name: Al Last Name: Sweigart')
>>> mo.group(1)
'Al'
>>> mo.group(2)
'Sweigart'
```

The dot-star uses greedy mode: It will always try to match as much text as possible. To match any and all text in a nongreedy fashion, use the dot, star, and question mark (`.*?`). The question mark tells Python to match in a nongreedy way:

```
>>> nongreedy_regex = re.compile(r'<.*?>')
>>> mo = nongreedy_regex.search('<To serve man> for dinner.>')
>>> mo.group()
'<To serve man>'

>>> greedy_regex = re.compile(r'<.*>')
>>> mo = greedy_regex.search('<To serve man> for dinner.>')
>>> mo.group()
'<To serve man> for dinner.>'
```

[Return to the Top](#)

## Matching Newlines with the Dot Character

The dot-star will match everything except a newline. By passing `re.DOTALL` as the second argument to `re.compile()`, you can make the dot character match all characters, including the newline character:

```
>>> no_newline_regex = re.compile('.*')
>>> no_newline_regex.search('Serve the public trust.\nProtect the
innocent.\nUphold the law.').group()
'Serve the public trust.'

>>> newline_regex = re.compile('.*', re.DOTALL)
>>> newline_regex.search('Serve the public trust.\nProtect the
innocent.\nUphold the law.').group()
'Serve the public trust.\nProtect the innocent.\nUphold the law.'
```



[Return to the Top](#)

## Review of Regex Symbols

Symbol	Matches
?	zero or one of the preceding group.
*	zero or more of the preceding group.
+	one or more of the preceding group.
{n}	exactly n of the preceding group.
{n,}	n or more of the preceding group.
{,m}	0 to m of the preceding group.
{n,m}	at least n and at most m of the preceding p.
{n,m}? or *? or +?	performs a nongreedy match of the preceding p.
^spam	means the string must begin with spam.
spam\$	means the string must end with spam.
.	any character, except newline characters.
\d, \w, and \s	a digit, word, or space character, ectively.
\D, \W, and \S	anything except a digit, word, or space acter, respectively.
[abc]	any character between the brackets (such as a, b, ).
[^abc]	any character that isn't between the brackets.

[Return to the Top](#)

## Case-Insensitive Matching

To make your regex case-insensitive, you can pass `re.IGNORECASE` or `re.I` as a second argument to `re.compile()`:

```
>>> robocop = re.compile(r'robocop', re.I)

>>> robocop.search('Robocop is part man, part machine, all cop.').group()
'Robocop'

>>> robocop.search('ROBOCOP protects the innocent.').group()
'ROBOCOP'

>>> robocop.search('Al, why does your programming book talk about robocop so
much?').group()
'robocop'
```

[Return to the Top](#)

## Substituting Strings with the sub() Method

The sub() method for Regex objects is passed two arguments:

1. The first argument is a string to replace any matches.
2. The second is the string for the regular expression.

The sub() method returns a string with the substitutions applied:

```
>>> names_regex = re.compile(r'Agent \w+')

>>> names_regex.sub('CENSORED', 'Agent Alice gave the secret documents to
Agent Bob.')
'CENSORED gave the secret documents to CENSORED.'
```

Another example:

```
>>> agent_names_regex = re.compile(r'Agent (\w)\w*')

>>> agent_names_regex.sub(r'\1****', 'Agent Alice told Agent Carol that Agent
Eve knew Agent Bob was a double agent.')
A**** told C**** that E**** knew B**** was a double agent.'
```

[Return to the Top](#)

## Managing Complex Regexes

To tell the re.compile() function to ignore whitespace and comments inside the regular expression string, “verbose mode” can be enabled by passing the variable re.VERBOSE as the second argument to re.compile().

Now instead of a hard-to-read regular expression like this:

```
phone_regex = re.compile(r'((\d{3}|\(\d{3}\))?(s|-|\.)?\d{3}(s|-|\.)\d{4}
(s*(ext|x|ext.)s*\d{2,5})?)')
```

you can spread the regular expression over multiple lines with comments like this:

```
phone_regex = re.compile(r'''(
    (\d{3}|\(\d{3}\))?           # area code
    (s|-|\.)?                   # separator
    \d{3}                        # first 3 digits
    (s|-|\.)                     # separator
```

```
\d{4}                # last 4 digits
(\s*(ext|x|ext.)\s*\d{2,5})? # extension
)''' , re.VERBOSE)
```

[Return to the Top](#)

## Reading and Writing Files

### Backslash on Windows and Forward Slash on OS X and Linux

On Windows, paths are written using backslashes () as the separator between folder names. OS X and Linux, however, use the forward slash (/) as their path separator.

Fortunately, this is simple to do with the `os.path.join()` function. If you pass it the string values of individual file and folder names in your path, `os.path.join()` will return a string with a file path using the correct path separators.

```
>>> import os

>>> os.path.join('usr', 'bin', 'spam')
'usr\\bin\\spam'
```

The `os.path.join()` function is helpful if you need to create strings for filenames:

```
>>> myFiles = ['accounts.txt', 'details.csv', 'invite.docx']

>>> for filename in myFiles:
    print(os.path.join('C:\\Users\\asweigart', filename))
```

Output:

```
C:\Users\asweigart\accounts.txt
C:\Users\asweigart\details.csv
C:\Users\asweigart\invite.docx
```

[Return to the Top](#)

### The Current Working Directory

```
>>> import os

>>> os.getcwd()
'C:\\Python34'
```

```
>>> os.chdir('C:\\Windows\\System32')

>>> os.getcwd()
'C:\\Windows\\System32'
```

[Return to the Top](#)

## Absolute vs. Relative Paths

There are two ways to specify a file path.

- An absolute path, which always begins with the root folder
- A relative path, which is relative to the program's current working directory

There are also the dot (.) and dot-dot (..) folders. These are not real folders but special names that can be used in a path. A single period ("dot") for a folder name is shorthand for "this directory." Two periods ("dot-dot") means "the parent folder."

[Return to the Top](#)

## Creating New Folders with os.makedirs()

```
>>> import os
>>> os.makedirs('C:\\delicious\\walnut\\waffles')
```

[Return to the Top](#)

## Handling Absolute and Relative Paths

- Calling os.path.abspath(path) will return a string of the absolute path of the argument. This is an easy way to convert a relative path into an absolute one.
- Calling os.path.isabs(path) will return True if the argument is an absolute path and False if it is a relative path.
- Calling os.path.relpath(path, start) will return a string of a relative path from the start path to path. If start is not provided, the current working directory is used as the start path.

[Return to the Top](#)

## Finding File Sizes and Folder Contents

- Calling os.path.getsize(path) will return the size in bytes of the file in the path argument.
- Calling os.listdir(path) will return a list of filename strings for each file in the path argument. (Note that this function is in the os module, not os.path.)

```
>>> os.path.getsize('C:\\Windows\\System32\\calc.exe')
```

776192

```
>>> os.listdir('C:\\Windows\\System32')
['0409', '12520437.cpx', '12520850.cpx', '5U877.ax', 'aaclient.dll',
--snip--
'xwtpdui.dll', 'xwtpw32.dll', 'zh-CN', 'zh-HK', 'zh-TW', 'zipfldr.dll']
```

To find the total size of all the files in this directory, use `os.path.getsize()` and `os.listdir()` together:

```
>>> total_size = 0

>>> for filename in os.listdir('C:\\Windows\\System32'):
    total_size = total_size +
os.path.getsize(os.path.join('C:\\Windows\\System32', filename))

>>> print(total_size)
1117846456
```

[Return to the Top](#)

## Checking Path Validity

- Calling `os.path.exists(path)` will return `True` if the file or folder referred to in the argument exists and will return `False` if it does not exist.
- Calling `os.path.isfile(path)` will return `True` if the path mentioned exists and is a file and will return `False` otherwise.
- Calling `os.path.isdir(path)` will return `True` if the path mentioned exists and is a folder and will return `False` otherwise.

[Return to the Top](#)

## The File Reading/Writing Process

To read/write to a file in Python, you will want to use the `with` statement, which will close the file for you after you are done.

[Return to the Top](#)

## Opening and reading files with the `open()` function

```
>>> with open('C:\\Users\\your_home_folder\\hello.txt') as hello_file:
...     hello_content = hello_file.read()
>>> hello_content
'Hello World!'
```

```
>>> # Alternatively, you can use the *readlines()* method to get a list of
string values from the file, one string for each line of text:

>>> with open('sonnet29.txt') as sonnet_file:
...     sonnet_file.readlines()
[When, in disgrace with fortune and men's eyes,\n', ' I all alone beweeep my
outcast state,\n', And trouble deaf heaven with my bootless cries,\n', And
look upon myself and curse my fate,']

>>> # You can also iterate through the file line by line:
>>> with open('sonnet29.txt') as sonnet_file:
...     for line in sonnet_file: # note the new line character will be
included in the line
...         print(line, end='')

When, in disgrace with fortune and men's eyes,
I all alone beweeep my outcast state,
And trouble deaf heaven with my bootless cries,
And look upon myself and curse my fate,
```

[Return to the Top](#)

## Writing to Files

```
>>> with open('bacon.txt', 'w') as bacon_file:
...     bacon_file.write('Hello world!\n')
13

>>> with open('bacon.txt', 'a') as bacon_file:
...     bacon_file.write('Bacon is not a vegetable.')
25

>>> with open('bacon.txt') as bacon_file:
...     content = bacon_file.read()

>>> print(content)
Hello world!
Bacon is not a vegetable.
```

[Return to the Top](#)

## Saving Variables with the shelve Module

To save variables:

```
>>> import shelve
```

```
>>> cats = ['Zophie', 'Pooka', 'Simon']
>>> with shelve.open('mydata') as shelf_file:
...     shelf_file['cats'] = cats
```

To open and read variables:

```
>>> with shelve.open('mydata') as shelf_file:
...     print(type(shelf_file))
...     print(shelf_file['cats'])
<class 'shelve.DbfilenameShelf'>
['Zophie', 'Pooka', 'Simon']
```

Just like dictionaries, shelf values have `keys()` and `values()` methods that will return list-like values of the keys and values in the shelf. Since these methods return list-like values instead of true lists, you should pass them to the `list()` function to get them in list form.

```
>>> with shelve.open('mydata') as shelf_file:
...     print(list(shelf_file.keys()))
...     print(list(shelf_file.values()))
['cats']
[['Zophie', 'Pooka', 'Simon']]
```

[Return to the Top](#)

## Saving Variables with the `pprint.pformat()` Function

```
>>> import pprint

>>> cats = [{'name': 'Zophie', 'desc': 'chubby'}, {'name': 'Pooka', 'desc':
'fluffy'}]

>>> pprint.pformat(cats)
"[{'desc': 'chubby', 'name': 'Zophie'}, {'desc': 'fluffy', 'name': 'Pooka'}]"

>>> with open('myCats.py', 'w') as file_obj:
...     file_obj.write('cats = ' + pprint.pformat(cats) + '\n')
83
```

[Return to the Top](#)

## Copying Files and Folders

The `shutil` module provides functions for copying files, as well as entire folders.

```
>>> import shutil, os

>>> os.chdir('C:\\')

>>> shutil.copy('C:\\spam.txt', 'C:\\delicious')
'C:\\delicious\\spam.txt'

>>> shutil.copy('eggs.txt', 'C:\\delicious\\eggs2.txt')
'C:\\delicious\\eggs2.txt'
```

While `shutil.copy()` will copy a single file, `shutil.copytree()` will copy an entire folder and every folder and file contained in it:

```
>>> import shutil, os

>>> os.chdir('C:\\')

>>> shutil.copytree('C:\\bacon', 'C:\\bacon_backup')
'C:\\bacon_backup'
```

[Return to the Top](#)

## Moving and Renaming Files and Folders

```
>>> import shutil
>>> shutil.move('C:\\bacon.txt', 'C:\\eggs')
'C:\\eggs\\bacon.txt'
```

The destination path can also specify a filename. In the following example, the source file is moved and renamed:

```
>>> shutil.move('C:\\bacon.txt', 'C:\\eggs\\new_bacon.txt')
'C:\\eggs\\new_bacon.txt'
```

If there is no eggs folder, then `move()` will rename `bacon.txt` to a file named `eggs`.

```
>>> shutil.move('C:\\bacon.txt', 'C:\\eggs')
'C:\\eggs'
```

[Return to the Top](#)



## Permanently Deleting Files and Folders

- Calling `os.unlink(path)` will delete the file at path.
- Calling `os.rmdir(path)` will delete the folder at path. This folder must be empty of any files or folders.
- Calling `shutil.rmtree(path)` will remove the folder at path, and all files and folders it contains will also be deleted.

[Return to the Top](#)

## Safe Deletes with the send2trash Module

You can install this module by running `pip install send2trash` from a Terminal window.

```
>>> import send2trash

>>> with open('bacon.txt', 'a') as bacon_file: # creates the file
...     bacon_file.write('Bacon is not a vegetable.')
25

>>> send2trash.send2trash('bacon.txt')
```

[Return to the Top](#)

## Walking a Directory Tree

```
import os

for folder_name, subfolders, filenames in os.walk('C:\\delicious'):
    print('The current folder is ' + folder_name)

    for subfolder in subfolders:
        print('SUBFOLDER OF ' + folder_name + ': ' + subfolder)
    for filename in filenames:
        print('FILE INSIDE ' + folder_name + ': ' + filename)

    print('')
```

Output:

```
The current folder is C:\delicious
SUBFOLDER OF C:\delicious: cats
SUBFOLDER OF C:\delicious: walnut
FILE INSIDE C:\delicious: spam.txt
```

```
The current folder is C:\delicious\cats
FILE INSIDE C:\delicious\cats: catnames.txt
FILE INSIDE C:\delicious\cats: zophie.jpg

The current folder is C:\delicious\walnut
SUBFOLDER OF C:\delicious\walnut: waffles

The current folder is C:\delicious\walnut\waffles
FILE INSIDE C:\delicious\walnut\waffles: butter.txt
```

[Return to the Top](#)

## Reading ZIP Files

```
>>> import zipfile, os

>>> os.chdir('C:\\')      # move to the folder with example.zip
>>> with zipfile.ZipFile('example.zip') as example_zip:
...     print(example_zip.namelist())
...     spam_info = example_zip.getinfo('spam.txt')
...     print(spam_info.file_size)
...     print(spam_info.compress_size)
...     print('Compressed file is %sx smaller!' % (round(spam_info.file_size /
spam_info.compress_size, 2)))

['spam.txt', 'cats/', 'cats/catnames.txt', 'cats/zophie.jpg']
13908
3828
'Compressed file is 3.63x smaller!'
```

[Return to the Top](#)

## Extracting from ZIP Files

The `extractall()` method for `ZipFile` objects extracts all the files and folders from a ZIP file into the current working directory.

```
>>> import zipfile, os

>>> os.chdir('C:\\')      # move to the folder with example.zip

>>> with zipfile.ZipFile('example.zip') as example_zip:
...     example_zip.extractall()
```

The `extract()` method for `ZipFile` objects will extract a single file from the ZIP file. Continue the interactive shell example:

```
>>> with zipfile.ZipFile('example.zip') as example_zip:
...     print(example_zip.extract('spam.txt'))
...     print(example_zip.extract('spam.txt', 'C:\\some\\new\\folders'))
'C:\\spam.txt'
'C:\\some\\new\\folders\\spam.txt'
```

[Return to the Top](#)

## Creating and Adding to ZIP Files

```
>>> import zipfile

>>> with zipfile.ZipFile('new.zip', 'w') as new_zip:
...     new_zip.write('spam.txt', compress_type=zipfile.ZIP_DEFLATED)
```

This code will create a new ZIP file named new.zip that has the compressed contents of spam.txt.

[Return to the Top](#)

## Debugging

### Raising Exceptions

Exceptions are raised with a raise statement. In code, a raise statement consists of the following:

- The raise keyword
- A call to the Exception() function
- A string with a helpful error message passed to the Exception() function

```
>>> raise Exception('This is the error message.')
Traceback (most recent call last):
  File "<pyshell#191>", line 1, in <module>
    raise Exception('This is the error message.')
Exception: This is the error message.
```

Often it's the code that calls the function, not the function itself, that knows how to handle an exception. So you will commonly see a raise statement inside a function and the try and except statements in the code calling the function.

```
def box_print(symbol, width, height):
    if len(symbol) != 1:
        raise Exception('Symbol must be a single character string.')
    if width <= 2:
        raise Exception('Width must be greater than 2.')
```

```

if height <= 2:
    raise Exception('Height must be greater than 2.')
print(symbol * width)
for i in range(height - 2):
    print(symbol + (' ' * (width - 2)) + symbol)
print(symbol * width)
for sym, w, h in (('*', 4, 4), ('O', 20, 5), ('x', 1, 3), ('ZZ', 3, 3)):
    try:
        box_print(sym, w, h)
    except Exception as err:
        print('An exception happened: ' + str(err))

```

[Return to the Top](#)

## Getting the Traceback as a String

The traceback is displayed by Python whenever a raised exception goes unhandled. But can also obtain it as a string by calling `traceback.format_exc()`. This function is useful if you want the information from an exception's traceback but also want an except statement to gracefully handle the exception. You will need to import Python's `traceback` module before calling this function.

```

>>> import traceback

>>> try:
    raise Exception('This is the error message.')
except:
    with open('errorInfo.txt', 'w') as error_file:
        error_file.write(traceback.format_exc())
    print('The traceback info was written to errorInfo.txt.')

```

Output:

```

116
The traceback info was written to errorInfo.txt.

```

The 116 is the return value from the `write()` method, since 116 characters were written to the file. The traceback text was written to `errorInfo.txt`.

```

Traceback (most recent call last):
  File "<pyshell#28>", line 2, in <module>
Exception: This is the error message.

```

[Return to the Top](#)

## Assertions

An assertion is a sanity check to make sure your code isn't doing something obviously wrong. These sanity checks are performed by assert statements. If the sanity check fails, then an AssertionError exception is raised. In code, an assert statement consists of the following:

- The assert keyword
- A condition (that is, an expression that evaluates to True or False)
- A comma
- A string to display when the condition is False

```
>>> pod_bay_door_status = 'open'

>>> assert pod_bay_door_status == 'open', 'The pod bay doors need to be
"open".'

>>> pod_bay_door_status = 'I\'m sorry, Dave. I\'m afraid I can\'t do that.'

>>> assert pod_bay_door_status == 'open', 'The pod bay doors need to be
"open".'

Traceback (most recent call last):
  File "<pyshell#10>", line 1, in <module>
    assert pod_bay_door_status == 'open', 'The pod bay doors need to be
"open".'
AssertionError: The pod bay doors need to be "open".
```

In plain English, an assert statement says, "I assert that this condition holds true, and if not, there is a bug somewhere in the program." Unlike exceptions, your code should not handle assert statements with try and except; if an assert fails, your program should crash. By failing fast like this, you shorten the time between the original cause of the bug and when you first notice the bug. This will reduce the amount of code you will have to check before finding the code that's causing the bug.

### Disabling Assertions

Assertions can be disabled by passing the -O option when running Python.

[Return to the Top](#)

## Logging

To enable the logging module to display log messages on your screen as your program runs, copy the following to the top of your program (but under the #! python shebang line):

```
import logging

logging.basicConfig(level=logging.DEBUG, format=' %(asctime)s - %(levelname)s -
```

```
%(message)s')
```

Say you wrote a function to calculate the factorial of a number. In mathematics, factorial 4 is  $1 \times 2 \times 3 \times 4$ , or 24. Factorial 7 is  $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7$ , or 5,040. Open a new file editor window and enter the following code. It has a bug in it, but you will also enter several log messages to help yourself figure out what is going wrong. Save the program as factorialLog.py.

```
import logging

logging.basicConfig(level=logging.DEBUG, format=' %(asctime)s - %(levelname)s-
%(message)s')

logging.debug('Start of program')

def factorial(n):

    logging.debug('Start of factorial(%s)' % (n))
    total = 1

    for i in range(n + 1):
        total *= i
        logging.debug('i is ' + str(i) + ', total is ' + str(total))

    logging.debug('End of factorial(%s)' % (n))

    return total

print(factorial(5))
logging.debug('End of program')
```

Output:

```
2015-05-23 16:20:12,664 - DEBUG - Start of program
2015-05-23 16:20:12,664 - DEBUG - Start of factorial(5)
2015-05-23 16:20:12,665 - DEBUG - i is 0, total is 0
2015-05-23 16:20:12,668 - DEBUG - i is 1, total is 0
2015-05-23 16:20:12,670 - DEBUG - i is 2, total is 0
2015-05-23 16:20:12,673 - DEBUG - i is 3, total is 0
2015-05-23 16:20:12,675 - DEBUG - i is 4, total is 0
2015-05-23 16:20:12,678 - DEBUG - i is 5, total is 0
2015-05-23 16:20:12,680 - DEBUG - End of factorial(5)
0
2015-05-23 16:20:12,684 - DEBUG - End of program
```

[Return to the Top](#)

## Logging Levels

Logging levels provide a way to categorize your log messages by importance. There are five logging levels, described in Table 10-1 from least to most important. Messages can be logged at each level using a different logging function.

Level	Logging Function	Description
DEBUG	logging.debug()	The lowest level. Used for small details. Usually you care about these messages only when diagnosing problems.
INFO	logging.info()	Used to record information on general events in your program or confirm that things are working at their point in the program.
WARNING	logging.warning()	Used to indicate a potential problem that doesn't prevent the program from working but might do so in the future.
ERROR	logging.error()	Used to record an error that caused the program to fail to do something.
CRITICAL	logging.critical()	The highest level. Used to indicate a fatal error that has caused or is about to cause the program to stop running entirely.

[Return to the Top](#)

## Disabling Logging

After you've debugged your program, you probably don't want all these log messages cluttering the screen. The `logging.disable()` function disables these so that you don't have to go into your program and remove all the logging calls by hand.

```
>>> import logging

>>> logging.basicConfig(level=logging.INFO, format=' %(asctime)s -%(
levelname)s - %(message)s')

>>> logging.critical('Critical error! Critical error!')
2015-05-22 11:10:48,054 - CRITICAL - Critical error! Critical error!

>>> logging.disable(logging.CRITICAL)

>>> logging.critical('Critical error! Critical error!')

>>> logging.error('Error! Error!')
```

[Return to the Top](#)

## Logging to a File

Instead of displaying the log messages to the screen, you can write them to a text file. The `logging.basicConfig()` function takes a `filename` keyword argument, like so:

```
import logging

logging.basicConfig(filename='myProgramLog.txt', level=logging.DEBUG,
format='%(asctime)s - %(levelname)s - %(message)s')
```

[Return to the Top](#)

## Virtual Environment

The use of a Virtual Environment is to test python code in encapsulated environments and to also avoid filling the base Python installation with libraries we might use for only one project.

[Return to the Top](#)

### Windows

1. Install virtualenv:

```
pip install virtualenv
```

2. Install virtualenvwrapper-win:

```
pip install virtualenvwrapper-win
```

Usage:

1. Make a Virtual Environment:

```
mkvirtualenv HelloWorld
```

Anything we install now will be specific to this project. And available to the projects we connect to this environment.

2. Set Project Directory:

To bind our virtualenv with our current working directory we simply enter:

```
setprojectdir .
```



### 3. Deactivate:

To move onto something else in the command line type 'deactivate' to deactivate your environment.

```
deactivate
```

Notice how the parenthesis disappear.

### 4. Workon:

Open up the command prompt and type 'workon HelloWorld' to activate the environment and move into your root project folder:

```
workon HelloWorld
```

[Return to the Top](#)

## Lambda Functions

This function:

```
>>> def add(x, y):  
    return x + y  
  
>>> add(5, 3)  
8
```

Is equivalent to the *lambda* function:

```
>>> add = lambda x, y: x + y  
>>> add(5, 3)  
8
```

It's not even need to bind it to a name like add before:

```
>>> (lambda x, y: x + y)(5, 3)  
8
```

Like regular nested functions, lambdas also work as lexical closures:

```
>>> def make_adder(n):  
    return lambda x: x + n  
  
>>> plus_3 = make_adder(3)  
>>> plus_5 = make_adder(5)  
  
>>> plus_3(4)  
7  
>>> plus_5(4)  
9
```

[Return to the Top](#)

## Ternary Conditional Operator

Many programming languages have a ternary operator, which define a conditional expression. The most common usage is to make a terse simple conditional assignment statement. In other words, it offers one-line code to evaluate the first expression if the condition is true, otherwise it evaluates the second expression.

```
<expression1> if <condition> else <expression2>
```

Example:

```
>>> age = 15  
  
>>> print('kid' if age < 18 else 'adult')  
kid
```

Ternary operators can be changed:

```
>>> age = 15  
  
>>> print('kid' if age < 13 else 'teenager' if age < 18 else 'adult')  
teenager
```

The code above is equivalent to:

```
if age < 18:  
    if age < 12:  
        print('kid')  
    else:  
        print('teenager')
```

```
else:  
    print('adult')
```

[Return to the Top](#)