Python for you and me

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Contents

This is a simple book to learn Python programming language, it is for the programmers who are new to Python.

The Python 2.x version of the same book can be found here.

If you are new to command line in Linux, you can read lym.

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CHAPTER 1

Installation

In this chapter you will learn how to install Python 3, the latest version of the language.

1.1 On Windows

Download the latest Windows(TM) installer from the Python site, either x86_64 or i686. Install it just as any other Windows software.

1.2 On GNU/Linux

Install the latest Python from the distribution's repository.

For Fedora 23 and above Python3 is in the system by default.

For Fedora 22 and below.

```
[user@host]$ sudo yum install python3
```

From epel7 (RHEL7, CentOS7, SL7).

```
[user@host]$ sudo yum install python34
```

For Debian

```
[user@host]$ sudo apt-get install python3
```

CHAPTER 2

The Beginning

Let's look at our first code, hello world. Because Python is an interpreted language, you can write the code into the Python interpreter directly or you can write the code in a file and then run the file. In this topic, we will first write the code using the interpreter, after starting Python in the command prompt (shell or terminal). In case you are new to Linux command line, +then you can read learn about various command from this book

Note that the code samples that follow use the latest Python built from the source code, so the version number can be different.

```
Python 3.5.0a0 (default:d6ac4b6020b9+, Jun  9 2014, 12:15:05)
[GCC 4.8.2 20131212 (Red Hat 4.8.2-7)] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

2.1 Using the Python interpreter

In our first code we are going to print "Hello World!" using the interpreter. To generate the output, type the following:

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

2.2 Using a source file

As a serious programmer, you might want to write the above code into a source file. Use any text editor you like to create the file called helloworld.py. I used vi. You can even use GUI based tools like Kate or gedit. Enter the following text:

```
#!/usr/bin/env python3
print("Hello World!")
```

To run the code first you have to make the file executable. In GNU/Linux you can do this by typing the following command in a shell or terminal:

```
$ chmod +x helloworld.py
```

Now you can type the filename and it will run:

```
$ ./helloworld.py
Hello World!
```

On the first line you can *#!*, what we call it sha-bang. The sha-bang indicates that the Python interpreter should run this code. On the next line we are printing a text message. In Python we call all the lines of text "strings."

2.3 Whitespaces and indentation

In Python whitespace is an important thing. We divide different identifiers using spaces. Whitespace in the beginning of the line is known as indentation, but if you give wrong indentation it will throw an error. Below are some examples:

```
>>> a = 12
>>>  a = 12
File "<stdin>", line 1
a = 12
^
IndentationError: unexpected indent
```

Warning: Warning There is an extra space in the beginning of the second line which is causing the error, so always look for the proper indentation. You can even get into this indentation errors if you mix up tabs and spaces. Like if you use spaces and only use spaces for indentation, don't use tabs in that case. For you it may look same, but the code will give you error if you try to run it.

So we can have few basic rules ready for spaces and indentation.

- Use 4 spaces for indentation.
- Never mix tab and spaces.
- One blank line between functions.
- Two blank lines between classes.

There are more places where you should be following the same type of whitespace rules:

- Add a space after "," in dicts, lists, tuples, and argument lists and after ":" in dicts.
- Spaces around assignments and comparisons (except in argument list)
- No spaces just inside parentheses.

2.4 Comments

Comments are snippets of English text that explain what this code does. Write comments in the code so that is easier for others to understand. A comment line starts with *#*. Everything after that is ignored as a comment and does not affect the program.

```
>>> # This is a comment
>>> # The next line will add two numbers
>>> a = 12 + 34
>>> print(c) #this is a comment too :)
```

Comments are mainly for people who *develop* or *maintain* the codebase. So if you have any complex code, you should write enough comments inside so that anyone else can understand the code by reading the comments. Always give a space after # and then start writing the comment. You can also use some standard comments like:

```
# FIXME -- fix these code later
# TODO -- in future you have to do this
```

2.5 Modules

Modules are Python files that contain different function definitions or variables that can be reused. Module files should always end with a .py extension. Python itself has a vast module library with the default installation. We will use some of them later. To use a module you have to import it first.

```
>>> import math
>>> print(math.e)
2.71828182846
```

We will learn more about modules in the Modules chapter.

CHAPTER 3

Variables and Datatypes

Every programming language has its own grammar rules just like the languages we speak.

3.1 Keywords and Identifiers

The following identifiers are used as reserved words, or keywords of the language, and cannot be used as ordinary identifiers. They must be typed exactly as written here:

```
False      class      finally    is         return
None       continue   for        lambda     try
True       def        from       nonlocal   while
and        del        global     not        with
as         elif       if         or         yield
assert     else       import     pass
break      except     in         raise
```

In Python we don't specify what kind of data we are going to put in a variable. So you can directly write abc = 1 and abc will become an integer datatype. If you write abc = 1.0 abc will become of floating type. Here is a small program to add two given numbers

```
>>> a = 13
>>> b = 23
>>> a + b
36
```

From the above example you can understand that to declare a variable in Python , what you need is just to type the name and the value. Python can also manipulate strings They can be enclosed in single quotes or double quotes like

```
>>> 'India'
'India'
>>> 'India\'s best'
"India's best"
```

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```
>>> "Hello World!"
'Hello World!'
```

3.2 Reading input from the Keyboard

Generally the real life Python codes do not need to read input from the keyboard. In Python we use input function to do input. *input("String to show")* , this will return a string as output. Let us write a program to read a number from the keyboard and check if it is less than 100 or not. Name of the program is testhundred.py

```
#!/usr/bin/env python3
number = int(input("Enter an integer: "))
if number < 100:
    print("Your number is smaller than 100")
else:
    print("Your number is greater than 100")
```

The output

```
$ ./testhundred.py
Enter an integer: 13
Your number is smaller than 100
$ ./testhundred.py
Enter an integer: 123
Your number is greater than 100
```

In the next program we are going to calculate investments.

```
#!/usr/bin/env python3
amount = float(input("Enter amount: "))
inrate = float(input("Enter Interest rate: "))
period = int(input("Enter period: "))
value = 0
year = 1
while year <= period:
    value = amount + (inrate * amount)
    print("Year %d Rs. %.2f" % (year, value))
    amount = value
    year = year + 1
```

The output

```
$ ./investment.py
Enter amount: 10000
Enter Interest rate: 0.14
Enter period: 5
Year 1 Rs. 11400.00
Year 2 Rs. 12996.00
Year 3 Rs. 14815.44
Year 4 Rs. 16889.60
Year 5 Rs. 19254.15
```

3.3 Some Examples

Some examples of variables and datatypes:

3.3.1 Average of N numbers

In the next program we will do an average of N numbers.

```
#!/usr/bin/env python3
N = 10
sum = 0
count = 0
while count < N:
    number = float(input(""))
    sum = sum + number
    count = count + 1
average = float(sum)/N
print("N = %d , Sum = %f" % (N, sum))
print("Average = %f" % average)
```

The output

```
$ ./averagen.py
1
2.3
4.67
1.42
7
3.67
4.08
2.2
4.25
8.21
N = 10 , Sum = 38.800000
Average = 3.880000
```

3.3.2 Temperature conversion

In this program we will convert the given temperature to Celsius from Fahrenheit by using the formula C=(F-32)/1.8

```
#!/usr/bin/env python3
fahrenheit = 0.0
print("Fahrenheit Celsius")
while fahrenheit <= 250:
    celsius = ( fahrenheit - 32.0 ) / 1.8 # Here we calculate the Celsius value
    print("%5.1f %7.2f" % (fahrenheit , celsius))
    fahrenheit = fahrenheit + 25
```

The output

```
$ ./temperature.py
Fahrenheit Celsius
0.0  -17.78
25.0   -3.89
```

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```
50.0   10.00
75.0   23.89
100.0   37.78
125.0   51.67
150.0   65.56
175.0   79.44
200.0   93.33
225.0  107.22
250.0  121.11
```

3.4 Multiple assignments in a single line

You can even assign values to multiple variables in a single line, like

```
>>> a , b = 45, 54
>>> a
45
>>> b
54
```

Using this swapping two numbers becomes very easy

```
>>> a, b = b , a
>>> a
54
>>> b
45
```

To understand how this works, you will have to learn about a data type called *tuple*. We use *comma* to create tuple. In the right hand side we create the tuple (we call this as tuple packing) and in the left hand side we do tuple unpacking into a new tuple.

Below we have another example of tuple unpacking.

```
>>> data = ("Kushal Das", "India", "Python")
>>> name, country, language = data
>>> name
'Kushal Das'
>>> country
'India'
>>> language
'Python'
```

3.5 Formatting strings

In Python 3, there are a few different ways to format a string. We use these methods to format a text dynamically. I will go though a few examples below.

3.5.1 .format method

This is my preferable way to format strings. Example below:

```
>>> name = "Kushal"
>>> org = "dgplug"
>>> number_of_years = 10
>>> msg = "{0} is part of all {1} years of {2} summer training".format(name, number_
↪of_years, org)
>>> print(msg)
Kushal is part of all 10 years of dgplug summer training
```

From Python 3.6 we can also do like below:

```
>>> msg = f"{name} is part of all {number_of_years} years of {org} summer training"
>>> print(msg)
Kushal is part of all 10 years of dgplug summer training
```

CHAPTER 4

Operators and expressions

In Python most of the lines you will write will be expressions. Expressions are made of operators and operands. An expression is like *2 + 3* .

4.1 Operators

Operators are the symbols which tells the Python interpreter to do some mathematical or logical operation. Few basic examples of mathematical operators are given below:

```
>>> 2 + 3
5
>>> 23 - 3
20
>>> 22.0 / 12
1.8333333333333333
```

To get floating result you need to the division using any of operand as floating number. To do modulo operation use % operator

```
>>> 14 % 3
2
```

4.2 Example of integer arithmetic

The code

```
#!/usr/bin/env python3
days = int(input("Enter days: "))
months = days / 30
days = days % 30
print("Months = %d Days = %d" % (months, days))
```

The output

```
$ ./integer.py
Enter days: 265
Months = 8 Days = 25
```

In the first line I am taking the input of days, then getting the months and days and at last printing them. You can do it in a easy way

```
#!/usr/bin/env python3
days = int(input("Enter days: "))
print("Months = %d Days = %d" % (divmod(days, 30)))
```

The divmod(num1, num2) function returns two values , first is the division of num1 and num2 and in second the modulo of num1 and num2.

4.3 Relational Operators

You can use the following operators as relational operators

4.3.1 Relational Operators

Operator	Meaning
<	Is less than
<=	Is less than or equal to
>	Is greater than
>=	Is greater than or equal to
==	Is equal to
!=	Is not equal to

Some examples

```
>>> 1 < 2
True
>>> 3 > 34
False
>>> 23 == 45
False
>>> 34 != 323
True
```

// operator gives the floor division result

```
>>> 4.0 // 3
1.0
>>> 4.0 / 3
1.3333333333333333
```

4.4 Logical Operators

To do logical AND , OR we use *and* ,*or* keywords. *x and y* returns *False* if *x* is *False* else it returns evaluation of *y*. If *x* is *True*, it returns *True*.

```
>>> 1 and 4
4
>>> 1 or 4
1
>>> -1 or 4
-1
>>> 0 or 4
4
```

4.5 Shorthand Operator

x op = expression is the syntax for shorthand operators. It will be evaluated like *x = x op expression* , Few examples are

```
>>> a = 12
>>> a += 13
>>> a
25
>>> a /= 3
>>> a
8.333333333333334
>>> a += (26 * 32)
>>> a
840.3333333333334
```

shorthand.py example

```
#!/usr/bin/env python3
N = 100
a = 2
while a < N:
    print("%d" % a)
    a *= a
```

The output

```
$ ./shorthand.py
2
4
16
```

4.6 Expressions

Generally while writing expressions we put spaces before and after every operator so that the code becomes clearer to read, like

```
a = 234 * (45 - 56.0 / 34)
```

One example code used to show expressions

```
#!/usr/bin/env python3
a = 9
b = 12
c = 3
x = a - b / 3 + c * 2 - 1
y = a - b / (3 + c) * (2 - 1)
z = a - (b / (3 + c) * 2) - 1
print("X = ", x)
print("Y = ", y)
print("Z = ", z)
```

The output

```
$ ./evaluationexp.py
X =  10
Y =  7
Z =  4
```

At first *x* is being calculated. The steps are like this

```
9 - 12 / 3 + 3 * 2 -1
9 - 4 + 3 * 2 - 1
9 - 4 + 6 - 1
5 + 6 - 1
11 - 1
10
```

Now for *y* and *z* we have parentheses, so the expressions evaluated in different way. Do the calculation yourself to check them.

4.7 Type Conversions

We have to do the type conversions manually. Like

```
float(string) -> float value
int(string) -> integer value
str(integer) or str(float) -> string representation
>>> a = 8.126768
>>> str(a)
'8.126768'
```

4.8 evaluateequ.py

This is a program to evaluate 1/x+1/(x+1)+1/(x+2)+ . . . +1/n series upto n, in our case x = 1 and n =10

```
#!/usr/bin/env python3
sum = 0.0
for i in range(1, 11):
```

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```
    sum += 1.0 / i
    print("%2d %6.4f" % (i , sum))
```

The output

```
$ ./evaluateequ.py
1 1.0000
2 1.5000
3 1.8333
4 2.0833
5 2.2833
6 2.4500
7 2.5929
8 2.7179
9 2.8290
10 2.9290
```

In the line *sum += 1.0 / i* what is actually happening is *sum = sum + 1.0 / i*.

4.9 quadraticequation.py

This is a program to evaluate the quadratic equation

```
#!/usr/bin/env python3
import math
a = int(input("Enter value of a: "))
b = int(input("Enter value of b: "))
c = int(input("Enter value of c: "))
d = b * b - 4 * a * c
if d < 0:
    print("ROOTS are imaginary")
else:
    root1 = (-b + math.sqrt(d)) / (2.0 * a)
    root2 = (-b - math.sqrt(d)) / (2.0 * a)
    print("Root 1 = ", root1)
    print("Root 2 = ", root2)
```

4.10 salesmansalary.py

In this example we are going to calculate the salary of a camera salesman. His basic salary is 1500, for every camera he will sell he will get 200 and the commission on the month's sale is 2 %. The input will be number of cameras sold and total price of the cameras.

```
#!/usr/bin/env python3
basic_salary = 1500
bonus_rate = 200
commision_rate = 0.02
numberofcamera = int(input("Enter the number of inputs sold: "))
price = float(input("Enter the total prices: "))
bonus = (bonus_rate * numberofcamera)
commision = (commision_rate * numberofcamera * price)
print("Bonus        = %6.2f" % bonus)
```

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```
print("Commision    = %6.2f" % commision)
print("Gross salary = %6.2f" % (basic_salary + bonus + commision))
```

The output

```
$ ./salesmansalary.py
Enter the number of inputs sold: 5
Enter the total prices: 20450
Bonus        = 1000.00
Commision    = 2045.00
Gross salary = 4545.00
```

CHAPTER 5

If-else , the control flow

While working on real life of problems we have to make decisions. Decisions like which camera to buy or which cricket bat is better. At the time of writing a computer program we do the same. We make the decisions using if-else statements, we change the flow of control in the program by using them.

5.1 If statement

The syntax looks like

```
if expression:
    do this
```

If the value of *expression* is true (anything other than zero), do the what is written below under indentation. Please remember to give proper indentation, all the lines indented will be evaluated on the True value of the expression. One simple example is to take some number as input and check if the number is less than 100 or not.

```
#!/usr/bin/env python3
number = int(input("Enter a number: "))
if number < 100:
    print("The number is less than 100")
```

Then we execute the file.

```
$ ./number100.py
Enter a number: 12
The number is less than 100
```

5.2 Else statement

Now in the above example we want to print “Greater than” if the number is greater than 100. For that we have to use the *else* statement. This works when the *if*statement is not fulfilled.

```
#!/usr/bin/env python3
number = int(input("Enter a number: "))
if number < 100:
    print("The number is less than 100")
else:
    print("The number is greater than 100")
```

The output

```
$ ./number100.py
Enter a number: 345
The number is greater than 100
```

Another very basic example

```
>>> x = int(input("Please enter an integer: "))
>>> if x < 0:
...       x = 0
...       print('Negative changed to zero')
... elif x == 0:
...       print('Zero')
... elif x == 1:
...       print('Single')
... else:
...       print('More')
```

5.3 Truth value testing

The elegant way to test Truth values is like

```
if x:
    pass
```

Warning: Don't do this

```
if x == True:
    pass
```

CHAPTER 6

Looping

In the examples we used before , sometimes it was required to do the same work couple of times. We use a counter to check how many times the code needs to be executed. This technique is known as looping. First we are going to look into while statement for looping.

6.1 While loop

The syntax for *while* statement is like

```
while condition:
    statement1
    statement2
```

The code we want to reuse must be indented properly under the while statement. They will be executed if the *condition* is true. Again like in *if-else* statement any non zero value is true. Let us write a simple code to print numbers 0 to 10

```
>>> n = 0
>>> while n < 11:
...     print(n)
...     n += 1
...
0
1
2
3
4
5
6
7
8
9
10
```

In the first line we are setting *n = 0*, then in the while statement the condition is *n < 11*, that means what ever line indented below that will execute until n becomes same or greater than 11. Inside the loop we are just printing the value of n and then increasing it by one.

How is this code going to help us in any real life? Think about the situation where you have to turn on 10 light bulbs one by one. May be you can run a loop from 1 to 10 and for each value on n, turn on the nth bulb.

6.2 Fibonacci Series

Let us try to solve *Fibonacci* series. In this series we get the next number by adding the previous two numbers. So the series looks like *1,1,2,3,5,8,13 .....*

```
#!/usr/bin/env python3
a, b = 0, 1
while b < 100:
    print(b)
    a, b = b, a + b
```

The output

```
$ ./fibonacci1.py
1
1
2
3
5
8
13
21
34
55
89
```

In the first line of the code we are initializing *a* and *b*, then looping while b's value is less than 100. Inside the loop first we are printing the value of *b* and then in the next line putting the value of *b* to *a* and *a + b* to *b* in the same line.

In your print function call if you pass another argument called end and pass a space string, it will print in the same line with space delimiter. The default value for end is '\n'.

```
#!/usr/bin/env python3
a, b = 0, 1
while b < 100:
    print(b, end=' ')
    a, b = b, a + b
```

The output

```
$ ./fibonacci2.py
1 1 2 3 5 8 13 21 34 55 89
```

6.3 Power Series

Let us write a program to evaluate the power series. The series looks like e**x =1+x+x**2/2! +x**3/3! +....+ x**n/n! where 0 < x < 1

```
#!/usr/bin/env python3
x = float(input("Enter the value of x: "))
n = term = num = 1
sum = 1.0
while n <= 100:
    term *= x / n
    sum += term
    n += 1
    if term < 0.0001:
        break
print("No of Times= %d and Sum= %f" % (n, sum))
```

The output

```
$ ./powerseries.py
Enter the value of x: 0
No of Times= 2 and Sum= 1.000000
$ ./powerseries.py
Enter the value of x: 0.1
No of Times= 5 and Sum= 1.105171
$ ./powerseries.py
Enter the value of x: 0.5
No of Times= 7 and Sum= 1.648720
```

In this program we introduced a new keyword called *break*. What break does is stop the innermost loop. In this example we are using *break* under the *if* statement

```
if term < 0.0001:
    break
```

This means if the value of *term* is less than *0.0001* then get out of the loop.

6.4 Multiplication Table

In this example we are going to print the multiplication table up to 10.

```
#!/usr/bin/env python3
i = 1
print("-" * 50)
while i < 11:
    n = 1
    while n <= 10:
        print("%4d" % (i * n), end=' ')
        n += 1
    print()
    i += 1
print("-" * 50)
```

The output

```
$ ./multiplication.py
--------------------------------------------------
   1    2    3    4    5    6    7    8    9   10
   2    4    6    8   10   12   14   16   18   20
   3    6    9   12   15   18   21   24   27   30
```

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```
   4    8   12   16   20   24   28   32   36   40
   5   10   15   20   25   30   35   40   45   50
   6   12   18   24   30   36   42   48   54   60
   7   14   21   28   35   42   49   56   63   70
   8   16   24   32   40   48   56   64   72   80
   9   18   27   36   45   54   63   72   81   90
  10   20   30   40   50   60   70   80   90  100
--------------------------------------------------
```

Here we used one while loop inside another loop, this is known as nested looping. You can also see one interesting statement here

```
print("-" * 50)
```

In a *print* statement if we multiply the string with an integer *n* , the string will be printed *n* many times. Some examples

```
>>> print("*" * 10)
**********
>>> print("#" * 20)
####################
>>> print("--" * 20)
----------------------------------------
>>> print("-" * 40)
----------------------------------------
```

6.5 Some printing * examples

Here are some examples which you can find very often in college lab reports

Design 1

```
#!/usr/bin/env python3
row = int(input("Enter the number of rows: "))
n = row
while n >= 0:
    x =  "*" * n
    print(x)
    n -= 1
```

The output

```
$ ./design1.py
Enter the number of rows: 5
*****
****
***
**
*
```

Design 2

```
#!/usr/bin/env python3
n = int(input("Enter the number of rows: "))
i = 1
```

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```
while i <= n:
    print("*" * i)
    i += 1
```

The output

```
$ ./design2.py
Enter the number of rows: 5
*
**
***
****
*****
```

Design 3

```
#!/usr/bin/env python3
row = int(input("Enter the number of rows: "))
n = row
while n >= 0:
    x = "*" * n
    y = " " * (row - n)
    print(y + x)
    n -= 1
```

The output

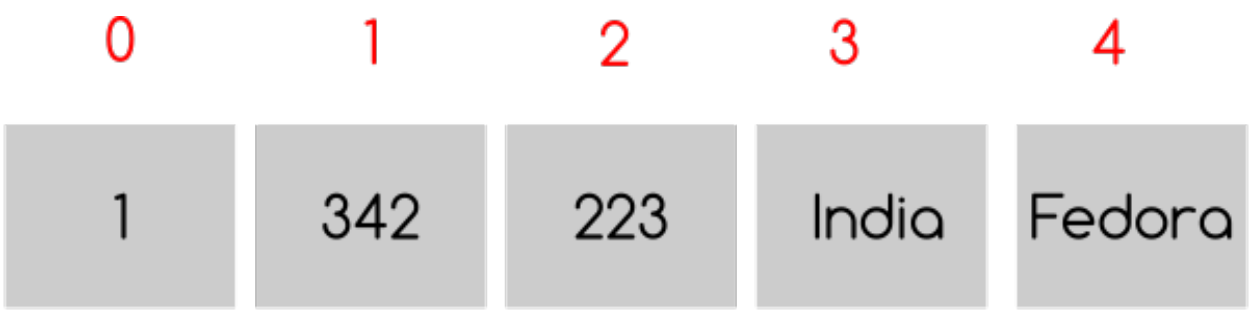
```
$ ./design3.py
Enter the number of rows: 5
*****
 ****
  ***
   **
    *
```

6.6 Lists

We are going to learn a data structure called list before we go ahead to learn more on looping. Lists can be written as a list of comma-separated values (items) between square brackets.

```
>>> a = [ 1, 342, 223, 'India', 'Fedora']
>>> a
[1, 342, 223, 'India', 'Fedora']
```

You can imagine the above as a list of boxes, each box contains the value mentioned. We can also access value of each box by using the index number (mentioned in red numbers). You can understand that the index starts with 0.



Now we can access the values of each box by using the index number.

```
>>> a[0]
1
>>> a[4]
'Fedora'
```

If we use a negative number as index, that means we are counting from the end of the list. Like

```
>>> a[-1]
'Fedora'
```

You can even slice it into different pieces, examples are given below

```
>>> a[4]
'Fedora'
>>> a[-1]
'Fedora'
>>> a[-2]
'India'
>>> a[0:-1]
[1, 342, 223, 'India']
>>> a[2:-2]
[223]
>>> a[:-2]
[1, 342, 223]
>>> a[0::2]
[1, 223, 'Fedora']
```

In the last example we used two :(s) , the last value inside the third brackets indicates step. *s[i:j:k]* means slice of *s* from *i* to *j* with step *k*.

To check if any value exists within the list or not you can do

```
>>> a = ['Fedora', 'is', 'cool']
>>> 'cool' in a
True
>>> 'Linux' in a
False
```

That means we can use the above statement as *if* clause expression. The built-in function *len()* can tell the length of a list.

```
>>> len(a)
3
```

Note: If you want to test if the list is empty or not, do it like this

```
if list_name: # This means the list is not empty
    pass
else: # This means the list is empty
    pass
```

6.7 For loop

There is another to loop by using *for* statement. In Python the *for* statement is different from the way it works in *C*. Here for statement iterates over the items of any sequence (a list or a string). Example given below

```
>>> a = ['Fedora', 'is', 'powerful']
>>> for x in a:
...     print(x)
...
Fedora
is
powerful
```

We can also do things like

```
>>> a = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
>>> for x in a[::2]:
...     print(x)
1
3
5
7
9
```

6.8 range() function

range() is a buitin class. From the help document

class range(object)

range(stop) -> range object
range(start, stop[, step]) -> range object

Return a virtual sequence of numbers from start to stop by step.

Methods defined here:

Now if you want to see this help message on your system type *help(range)* in the Python interpreter. *help(s)* will return help message on the object *s*. Examples of *range* function

```
>>> list(range(1, 5))
[1, 2, 3, 4]
>>> list(range(1, 15, 3))
[1, 4, 7, 10, 13]
>>> list(range(10))
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

6.9 Continue statement

Just like *break* we have another statement, *continue*, which skips the execution of the code after itself and goes back to the start of the loop. That means it will help you to skip a part of the loop. In the below example we will ask the user to input an integer, if the input is negative then we will ask again, if positive then we will square the number. To get out of the infinite loop user must input 0.

```
#!/usr/bin/env python3
while True:
    n = int(input("Please enter an Integer: "))
    if n < 0:
        continue # this will take the execution back to the starting of the loop
    elif n == 0:
        break
    print("Square is ", n ** 2)
print("Goodbye")
```

The output

```
$ ./continue.py
Please enter an Integer: 34
Square is 1156
Please enter an Integer: 4
Square is 16
Please enter an Integer: -9
Please enter an Integer: 0
Goodbye
```

6.10 Else statement in a loop

We can have an optional *else* statement after any loop. It will be executed after the loop unless a *break* statement stopped the loop.

```
>>> for i in range(0, 5):
...     print(i)
... else:
...     print("Bye bye")
...
0
1
2
3
4
Bye bye
```

We will see more example of *break* and *continue* later in the book.

6.11 Game of sticks

This is a very simple game of sticks. There are 21 sticks, first the user picks number of sticks between 1-4, then the computer picks sticks(1-4). Who ever will pick the last stick will loose. Can you find out the case when the user will win ?

```
#!/usr/bin/env python3
sticks = 21

print("There are 21 sticks, you can take 1-4 number of sticks at a time.")
print("Whoever will take the last stick will loose")

while True:
    print("Sticks left: " , sticks)
    sticks_taken = int(input("Take sticks(1-4):"))
    if sticks == 1:
        print("You took the last stick, you loose")
        break
    if sticks_taken >= 5 or sticks_taken <= 0:
        print("Wrong choice")
        continue
    print("Computer took: " , (5 - sticks_taken) , "\n")
    sticks -= 5
```

CHAPTER 7

Data Structures

Python has a few built-in data structures. If you are wondering what a data structure is, it is nothing but a way to store data and having particular methods to retrieve or manipulate it. We already encountered lists before; now we will go in some depth.

7.1 Lists

```
>>> a = [23, 45, 1, -3434, 43624356, 234]
>>> a.append(45)
>>> a
[23, 45, 1, -3434, 43624356, 234, 45]
```

At first we created a list *a*. Then to add *45* at the end of the list we call the *a.append(45)* method. You can see that *45* is added at the end of the list. Sometimes it is necessary to insert data at any place within the list, for that we have *insert()* method.

```
>>> a.insert(0, 1) # 1 added at the 0th position of the list
>>> a
[1, 23, 45, 1, -3434, 43624356, 234, 45]
>>> a.insert(0, 111)
>>> a
[111, 1, 23, 45, 1, -3434, 43624356, 234, 45]
```

count(s) will return you the number of times *s* is in the list. Here we are going to check how many times *45* is there in the list.

```
>>> a.count(45)
2
```

If you want to remove any particular value from the list you have to use the *remove()* method.

```
>>> a.remove(234)
>>> a
[111, 1, 23, 45, 1, -3434, 43624356, 45]
```

Now to reverse the whole list

```
>>> a.reverse()
>>> a
[45, 43624356, -3434, 1, 45, 23, 1, 111]
```

We can store anything in the list, so first we are going to add another list *b* in *a*; then we will learn how to add the values of *b* into *a*.

```
>>> b = [45, 56, 90]
>>> a.append(b)
>>> a
[45, 43624356, -3434, 1, 45, 23, 1, 111, [45, 56, 90]]
>>> a[-1]
[45, 56, 90]
>>> a.extend(b) #To add the values of b not the b itself
>>> a
[45, 43624356, -3434, 1, 45, 23, 1, 111, [45, 56, 90], 45, 56, 90]
>>> a[-1]
90
```

Above you can see how we used the *a.extend()* method to extend the list. To sort any list we have *sort()* method. The *sort()* method will only work if elements in the list are comparable. We will remove the list b from the list and then sort.

::

```
>>> a.remove(b)
>>> a
[45, 43624356, -3434, 1, 45, 23, 1, 111, 45, 56, 90]
>>> a.sort()
>>> a
[-3434, 1, 1, 23, 45, 45, 45, 56, 90, 111, 43624356]
```

You can also delete an element at any particular position of the list using the del keyword.

```
>>> del a[-1]
>>> a
[-3434, 1, 1, 23, 45, 45, 45, 56, 90, 111]
```

7.2 Using lists as stack and queue

Stacks are often known as LIFO (Last In First Out) structure. It means the data will enter into it at the end, and the last data will come out first. The easiest example can be of couple of marbles in an one side closed pipe. So if you want to take the marbles out of it you have to do that from the end where you inserted the last marble. To achieve the same in code

```
>>> a = [1, 2, 3, 4, 5, 6]
>>> a
[1, 2, 3, 4, 5, 6]
```

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```
>>> a.pop()
6
>>> a.pop()
5
>>> a.pop()
4
>>> a.pop()
3
>>> a
[1, 2]
>>> a.append(34)
>>> a
[1, 2, 34]
```

We learned a new method above *pop()*. *pop(i)* will take out the ith data from the list.

In our daily life we have to encounter queues many times, like at ticket counters or in the library or in the billing section of any supermarket. Queue is the data structure where you can append more data at the end and take out data from the beginning. That is why it is known as FIFO (First In First Out).

```
>>> a = [1, 2, 3, 4, 5]
>>> a.append(1)
>>> a
[1, 2, 3, 4, 5, 1]
>>> a.pop(0)
1
>>> a.pop(0)
2
>>> a
[3, 4, 5, 1]
```

To take out the first element of the list we are using *a.pop(0)*.

7.3 List Comprehensions

List comprehensions provide a concise way to create lists. Each list comprehension consists of an expression followed by a for clause, then zero or more for or if clauses. The result will be a list resulting from evaluating the expression in the context of the for and if clauses which follow it.

For example if we want to make a list out of the square values of another list, then

```
>>> a = [1, 2, 3]
>>> [x ** 2 for x in a]
[1, 4, 9]
>>> z = [x + 1 for x in [x ** 2 for x in a]]
>>> z
[2, 5, 10]
```

Above in the second case we used two list comprehensions in a same line.

7.4 Tuples

Tuples are data separated by commas.

```
>>> a = 'Fedora', 'Debian', 'Kubuntu', 'Pardus'
>>> a
('Fedora', 'Debian', 'Kubuntu', 'Pardus')
>>> a[1]
'Debian'
>>> for x in a:
...     print(x, end=' ')
...
Fedora Debian Kubuntu Pardus
```

You can also unpack values of any tuple into variables, like

```
>>> divmod(15,2)
(7, 1)
>>> x, y = divmod(15,2)
>>> x
7
>>> y
1
```

Tuples are immutable, meaning that you can not del/add/edit any value inside the tuple. Here is another example

```
>>> a = (1, 2, 3, 4)
>>> del a[0]
Traceback (most recent call last):
File "<stdin>", line 1, in <module>
TypeError: 'tuple' object doesn't support item deletion
```

As you can see above, Python gives an error when we try to delete a value in the tuple.

To create a tuple which contains only one value, type a trailing comma.

```
>>> a = (123)
>>> a
123
>>> type(a)
<class 'int'>
>>> a = (123, ) #Look at the trailing comma
>>> a
(123,)
>>> type(a)
<class 'tuple'>
```

Using the built-in function *type()* you can know the data type of any variable. Remember the *len()* function we used to find the length of any sequence?

```
>>> type(len)
<class 'builtin_function_or_method'>
```

7.5 Sets

Sets are another type of data structure with no duplicate items. We can apply mathematical set operations on sets.

```
>>> a = set('abcthabcjwethddda')
>>> a
{'a', 'c', 'b', 'e', 'd', 'h', 'j', 't', 'w'}
```

And some examples of the set operations

```
>>> a = set('abracadabra')
>>> b = set('alacazam')
>>> a                                  # unique letters in a
{'a', 'r', 'b', 'c', 'd'}
>>> a - b                              # letters in a but not in b
{'r', 'd', 'b'}
>>> a | b                              # letters in either a or b
{'a', 'c', 'r', 'd', 'b', 'm', 'z', 'l'}
>>> a & b                              # letters in both a and b
{'a', 'c'}
>>> a ^ b                              # letters in a or b but not both
{'r', 'd', 'b', 'm', 'z', 'l'}
```

To add or pop values from a set

```
>>> a
{'a', 'c', 'b', 'e', 'd', 'h', 'j', 'q', 't', 'w'}
>>> a.add('p')
>>> a
{'a', 'c', 'b', 'e', 'd', 'h', 'j', 'q', 'p', 't', 'w'}
```

7.6 Dictionaries

Dictionaries are unordered set of *key: value* pairs where keys are unique. We declare dictionaries using {} braces. We use dictionaries to store data for any particular key and then retrieve them.

```
>>> data = {'kushal':'Fedora', 'kart_':'Debian', 'Jace':'Mac'}
>>> data
{'kushal': 'Fedora', 'Jace': 'Mac', 'kart_': 'Debian'}
>>> data['kart_']
'Debian'
```

We can add more data to it by simply

```
>>> data['parthan'] = 'Ubuntu'
>>> data
{'kushal': 'Fedora', 'Jace': 'Mac', 'kart_': 'Debian', 'parthan': 'Ubuntu'}
```

To delete any particular *key:value* pair

```
>>> del data['kushal']
>>> data
{'Jace': 'Mac', 'kart_': 'Debian', 'parthan': 'Ubuntu'}
```

To check if any *key* is there in the dictionary or not you can use *in* keyword.

```
>>> 'Soumya' in data
False
```

You must remember that no mutable object can be a *key*, that means you can not use a *list* as a *key*.

dict() can create dictionaries from tuples of *key,value* pair.

```
>>> dict((('Indian','Delhi'),('Bangladesh','Dhaka')))
{'Indian': 'Delhi', 'Bangladesh': 'Dhaka'}
```

If you want to loop through a dict use *items()* method.

```
>>> data
{'Kushal': 'Fedora', 'Jace': 'Mac', 'kart_': 'Debian', 'parthan': 'Ubuntu'}
>>> for x, y in data.items():
...     print("%s uses %s" % (x, y))
...
Kushal uses Fedora
Jace uses Mac
kart_ uses Debian
parthan uses Ubuntu
```

Many times it happens that we want to add more data to a value in a dictionary and if the key does not exists then we add some default value. You can do this efficiently using *dict.setdefault(key, default)*.

```
>>> data = {}
>>> data.setdefault('names', []).append('Ruby')
>>> data
{'names': ['Ruby']}
>>> data.setdefault('names', []).append('Python')
>>> data
{'names': ['Ruby', 'Python']}
>>> data.setdefault('names', []).append('C')
>>> data
{'names': ['Ruby', 'Python', 'C']}
```

When we try to get value for a key which does not exists we get *KeyError*. We can use *dict.get(key, default)* to get a default value when they key does not exists before.

```
>>> data['foo']
Traceback (most recent call last):
File "<stdin>", line 1, in <module>
KeyError: 'foo'
>>> data.get('foo', 0)
0
```

If you want to loop through a list (or any sequence) and get iteration number at the same time you have to use *enumerate()*.

```
>>> for i, j in enumerate(['a', 'b', 'c']):
...     print(i, j)
...
0 a
1 b
2 c
```

You may also need to iterate through two sequences same time, for that use *zip()* function.

```
>>> a = ['Pradeepto', 'Kushal']
>>> b = ['OpenSUSE', 'Fedora']
>>> for x, y in zip(a, b):
```

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```
...     print("%s uses %s" % (x, y))
...
Pradeepto uses OpenSUSE
Kushal uses Fedora
```

7.7 students.py

In this example , you have to take number of students as input , then ask marks for three subjects as 'Physics', 'Maths', 'History', if the total marks for any student is less 120 then print he failed, or else say passed.

```
#!/usr/bin/env python3
n = int(input("Enter the number of students:"))
data = {} # here we will store the data
languages = ('Physics', 'Maths', 'History') #all languages
for i in range(0, n): #for the n number of students
    name = input('Enter the name of the student %d: ' % (i + 1)) #Get the name of the␣
↪student
    marks = []
    for x in languages:
        marks.append(int(input('Enter marks of %s: ' % x))) #Get the marks for ␣
↪languages
    data[name] = marks
for x, y in data.items():
    total =  sum(y)
    print("%s 's  total marks %d" % (x, total))
    if total < 120:
        print("%s failed :(" % x)
    else:
        print("%s passed :)" % x)
```

The output

```
$ ./students.py
Enter the number of students:2
Enter the name of the student 1: Babai
Enter marks of Physics: 12
Enter marks of Maths: 45
Enter marks of History: 40
Enter the name of the student 2: Tesla
Enter marks of Physics: 99
Enter marks of Maths: 98
Enter marks of History: 99
Babai 's  total marks 97
Babai failed :(
Tesla 's  total marks 296
Tesla passed :)
```

7.8 matrixmul.py

In this example we will multiply two matrices. First we will take input the number of rows/columns in the matrix (here we assume we are using n x n matrix). Then values of the matrices.

```
#!/usr/bin/env python3
n = int(input("Enter the value of n: "))
print("Enter values for the Matrix A")
a = []
for i in range(0, n):
    a.append([int(x) for x in input("").split(" ")])
print("Enter values for the Matrix B")
b = []
for i in range(0, n):
    b.append([int(x) for x in input("").split(" ")])
c = []
for i in range(0, n):
    c.append([a[i][j] * b[j][i] for j in range(0, n)])
print("After matrix multiplication")
print("-" * 10 * n)
for x in c:
    for y in x:
        print("%5d" % y, end=' ')
    print("")
print("-" * 10 * n)
```

The output

```
$ ./matrixmul.py
Enter the value of n: 3
Enter values for the Matrix A
1 2 3
4 5 6
7 8 9
Enter values for the Matrix B
9 8 7
6 5 4
3 2 1
After matrix multiplication
------------------------------
    9    12     9
   32    25    12
   49    32     9
------------------------------
```

Here we have used list comprehensions couple of times. *[int(x) for x in input("").split(" ")]* here first it takes the input as string by *input()*, then split the result by " ", then for each value create one int. We are also using *[a[i][j] * b[j][i] for j in range(0,n)]* to get the resultant row in a single line.

CHAPTER 8

Strings

Strings are nothing but simple text. In Python we declare strings in between “” or ‘’ or ‘” “” or “”” “””. The examples below will help you to understand string in a better way.

```
>>> s = "I am Indian"
>>> s
'I am Indian'
>>> s = 'I am Indian'
>>> s = "Here is a line \
... split in two lines"
>>> s
'Here is a line split in two lines'
>>> s = "Here is a line \n split in two lines"
>>> s
'Here is a line \n split in two lines'
>>> print(s)
Here is a line
 split in two lines
```

Now if you want to multiline strings you have to use triple single/double quotes.

```
>>> s = """ This is a
... multiline string, so you can
... write many lines"""
>>> print(s)
This is a
multiline string, so you can
write many lines
```

We can have two string literals side by side, and it will behave like a single string. For example

```
>>> s = "Hello " "World"
>>> print(s)
Hello World
```

This will help you to spilt a long string into smaller chunks in function calls.

You can find length of any string using the *len* function call.

```
>>> s = "Python"
>>> len(s)
6
```

8.1 Different methods available for Strings

Every string object is having couple of builtin methods available, we already saw some of them like *s.split(" ")*.

```
>>> s = "kushal das"
>>> s.title()
'Kushal Das'
```

title() method returns a titlecased version of the string, words start with uppercase characters, all remaining cased characters are lowercase.

```
>>> z = s.upper()
>>> z
'KUSHAL DAS'
>>> z.lower()
'kushal das'
```

upper() returns a total uppercase version whereas *lower()* returns a lower case version of the string.

```
>>> s = "I am A pRoGraMMer"
>> s.swapcase()
'i AM a PrOgRAmmER'
```

swapcase() returns the string with case swapped :)

```
>>> s = "jdwb 2323bjb"
>>> s.isalnum()
False
>>> s = "jdwb2323bjb"
>>> s.isalnum()
True
```

Because of the space in the first line *isalnum()* returned *False* , it checks for all characters are alpha numeric or not.

```
>>> s = "SankarshanSir"
>>> s.isalpha()
True
>>> s = "Sankarshan Sir"
>>> s.isalpha()
False
```

isalpha() checkes for only alphabets.

```
>>> s = "1234"
>>> s.isdigit() # To check if all the characters are digits or not
True
>>> s = "Fedora9 is coming"
>>> s.islower() # To check if all chracters are lower case or not
False
```

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```
>>> s = "Fedora9 Is Coming"
>>> s.istitle() # To check if it is a title or not
True
>>> s = "INDIA"
>>> s.isupper() # To check if characters are in upper case or not
True
```

To split any string we have *split()*. It takes a string as an argument , depending on that it will split the main string and returns a list containing splitted strings.

```
>>> s = "We all love Python"
>>> s.split(" ")
['We', 'all', 'love', 'Python']
>>> x = "Nishant:is:waiting"
>>> x.split(':')
['Nishant', 'is', 'waiting']
```

The opposite method for *split()* is *join()*. It takes a list contains strings as input and join them.

```
>>> "-".join("GNU/Linux is great".split(" "))
'GNU/Linux-is-great'
```

In the above example first we are splitting the string "GNU/Linux is great" based on the white space, then joining them with "-".

8.2 Strip the strings

Strings do have few methods to do striping. The simplest one is *strip(chars)*. If you provide the chars argument then it will strip any combination of them. By default it strips only whitespace or newline characters.

```
>>> s = "  abc\n "
>>> s.strip()
'abc'
```

You can particularly strip from the left hand or right hand side also using *lstrip(chars)* or *rstrip(chars)*.

```
>>> s = "www.foss.in"
>>> s.lstrip("cwsd.")
'foss.in'
>>> s.rstrip("cnwdi.")
'www.foss'
```

8.3 Finding text

Strings have some methods which will help you in finding text/substring in a string. Examples are given below:

```
>>> s = "faulty for a reason"
>>> s.find("for")
7
>>> s.find("fora")
-1
```

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```
>>> s.startswith("fa") #To check if the string startswith fa or not
True
>>> s.endswith("reason") #To check if the string endswith reason or not
True
```

find() helps to find the first occurrence of the substring given, if not found it returns -1.

8.4 Palindrome checking

Palindrome are the kind of strings which are same from left or right whichever way you read them. Example "madam". In this example we will take the word as input from the user and say if it is palindrome or not.

```
#!/usr/bin/env python3
s = input("Please enter a string: ")
z = s[::-1]
if s == z:
    print("The string is a palindrome")
else:
    print("The string is not a palindrome")
```

The output

```
$ ./palindrome.py
Please enter a string: madam1
The string is not a palindrome
$ ./palindrome.py
Please enter a string: madam
The string is a palindrome
```

8.5 Number of words

In this example we will count the number of words in a given line

```
#!/usr/bin/env python3
s = input("Enter a line: ")
print("The number of words in the line are %d" % (len(s.split(" "))))
```

The output

```
$ ./countwords.py
Enter a line: Sayamindu is a great programmer
The number of words in the line are 5
```

8.6 Iterating over all characters of a string

You can iterate over a string using simple *for* loop.

```
>>> for ch in "Python":
...     print(ch)
...
P
y
t
h
o
n
```

CHAPTER 9

Functions

Reusing the same code is required many times within a same program. Functions help us to do so. We write the things we have to do repeatedly in a function then call it where ever required. We already saw build in functions like *len()*, *divmod()*.

9.1 Defining a function

We use *def* keyword to define a function. General syntax is like

```
def functionname(params):
    statement1
    statement2
```

Let us write a function which will take two integers as input and then return the sum.

```
>>> def sum(a, b):
...     return a + b
```

In the second line with the *return* keyword, we are sending back the value of $a + b$ to the caller. You must call it like

```
>>> res = sum(234234, 34453546464)
>>> res
34453780698L
```

Remember the palindrome program we wrote in the last chapter. Let us write a function which will check if a given string is palindrome or not, then return *True* or *False*.

```
#!/usr/bin/env python3
def palindrome(s):
    return s == s[::-1]
if __name__ == '__main__':
    s = input("Enter a string: ")
    if palindrome(s):
```

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```
        print("Yay a palindrome")
    else:
        print("Oh no, not a palindrome")
```

Now run the code :)

9.2 Local and global variables

To understand local and global variables we will go through two examples.

```
#!/usr/bin/env python3
def change(b):
    a = 90
    print(a)
a = 9
print("Before the function call ", a)
print("inside change function", end=' ')
change(a)
print("After the function call ", a)
```

The output

```
$ ./local.py
Before the function call  9
inside change function 90
After the function call  9
```

First we are assigning *9* to *a*, then calling change function, inside of that we are assigning *90* to *a* and printing *a*. After the function call we are again printing the value of *a*. When we are writing *a = 90* inside the function, it is actually creating a new variable called *a*, which is only available inside the function and will be destroyed after the function finished. So though the name is same for the variable *a* but they are different in and out side of the function.

```
#!/usr/bin/env python3
def change(b):
    global a
    a = 90
    print(a)
a = 9
print("Before the function call ", a)
print("inside change function", end=' ')
change(a)
print("After the function call ", a)
```

Here by using global keyword we are telling that *a* is globally defined, so when we are changing a's value inside the function it is actually changing for the *a* outside of the function also.

The output

```
$ ./local.py
Before the function call  9
inside change function 90
After the function call  90
```

9.3 Default argument value

In a function variables may have default argument values, that means if we don't give any value for that particular variable it will be assigned automatically.

```
>>> def test(a , b=-99):
...     if a > b:
...         return True
...     else:
...         return False
```

In the above example we have written *b = -99* in the function parameter list. That means if no value for *b* is given then b's value is *-99*. This is a very simple example of default arguments. You can test the code by

```
>>> test(12, 23)
False
>>> test(12)
True
```

Important: Important

Remember that you can not have an argument without default argument if you already have one argument with default values before it. Like *f(a, b=90, c)* is illegal as *b* is having a default value but after that *c* is not having any default value.

Also remember that default value is evaluated only once, so if you have any mutable object like list it will make a difference. See the next example

```
>>> def f(a, data=[]):
...     data.append(a)
...     return data
...
>>> print(f(1))
[1]
>>> print(f(2))
[1, 2]
>>> print(f(3))
[1, 2, 3]
```

To avoid this you can write more idiomatic Python, like the following

```
>>> def f(a, data=None):
...     if data is None:
...         data = []
...     data.append(a)
...     return data
...
>>> print(f(1))
[1]
>>> print(f(2))
[2]
```

Note: To understand more read this link.

9.4 Keyword arguments

```
>>> def func(a, b=5, c=10):
...     print('a is', a, 'and b is', b, 'and c is', c)
...
>>> func(12, 24)
a is 12 and b is 24 and c is 10
>>> func(12, c = 24)
a is 12 and b is 5 and c is 24
>>> func(b=12, c = 24, a = -1)
a is -1 and b is 12 and c is 24
```

In the above example you can see we are calling the function with variable names, like *func(12, c = 24)*, by that we are assigning *24* to *c* and *b* is getting its default value. Also remember that you can not have without keyword based argument after a keyword based argument. like

```
>>> def func(a, b=13, v):
...     print(a, b, v)
...
File "<stdin>", line 1
SyntaxError: non-default argument follows default argument
```

9.5 Keyword only argument

We can also mark the arguments of function as keyword only. That way while calling the function, the user will be forced to use correct keyword for each parameter.

```
>>> def hello(*, name='User'):
...     print("Hello %s" % name)
...
>>> hello('Kushal')
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: hello() takes 0 positional arguments but 1 was given
>>> hello(name='Kushal')
Hello Kushal
```

Note: To learn more please read PEP-3102.

9.6 Docstrings

In Python we use docstrings to explain how to use the code, it will be useful in interactive mode and to create auto-documentation. Below we see an example of the docstring for a function called *longest_side*.

```
#!/usr/bin/env python3
import math

def longest_side(a, b):
    """
```

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```
    Function to find the length of the longest side of a right triangle.

    :arg a: Side a of the triangle
    :arg b: Side b of the triangle

    :return: Length of the longest side c as float
    """
    return math.sqrt(a*a + b*b)

if __name__ == '__main__':
    print(longest_side(4, 5))
```

We will learn more on docstrings in reStructuredText chapter.

9.7 Higher-order function

Higher-order function or a functor is a function which does at least one of the following step inside:

- Takes one or more functions as argument.
- Returns another function as output.

In Python any function can act as higher order function.

```
>>> def high(func, value):
...     return func(value)
...
>>> lst = high(dir, int)
>>> print(lst[-3:])
['imag', 'numerator', 'real']
>>> print(lst)
```

Note: To know more read this link.

9.8 map function

map is a very useful higher order function in Python. It takes one function and an iterator as input and then applies the function on each value of the iterator and returns a list of results.

Example:

```
>>> lst = [1, 2, 3, 4, 5]
>>> def square(num):
...     "Returns the square of a given number."
...     return num * num
...
>>> print(list(map(square, lst)))
[1, 4, 9, 16, 25]
```

CHAPTER 10

File handling

A file is some information or data which stays in the computer storage devices. You already know about different kinds of file , like your music files, video files, text files. Python gives you easy ways to manipulate these files. Generally we divide files in two categories, text file and binary file. Text files are simple text where as the binary files contain binary data which is only readable by computer.

10.1 File opening

To open a file we use *open()* function. It requires two arguments, first the file path or file name, second which mode it should open. Modes are like

- "r" -> open read only, you can read the file but can not edit / delete anything inside
- "w" -> open with write power, means if the file exists then delete all content and open it to write
- "a" -> open in append mode

The default mode is read only, ie if you do not provide any mode it will open the file as read only. Let us open a file

```
>>> fobj = open("love.txt")
>>> fobj
<_io.TextIOWrapper name='love.txt' mode='r' encoding='UTF-8'>
```

10.2 Closing a file

After opening a file one should always close the opened file. We use method *close()* for this.

```
>>> fobj = open("love.txt")
>>> fobj
<_io.TextIOWrapper name='love.txt' mode='r' encoding='UTF-8'>
>>> fobj.close()
```

Important: Important

Always make sure you *explicitly* close each open file, once its job is done and you have no reason to keep it open. Because - There is an upper limit to the number of files a program can open. If you exceed that limit, there is no reliable way of recovery, so the program could crash. - Each open file consumes some main-memory for the data-structures associated with it, like file descriptor/handle or file locks etc. So you could essentially end-up wasting lots of memory if you have more files open that are not useful or usable. - Open files always stand a chance of corruption and data loss.

10.3 Reading a file

To read the whole file at once use the *read()* method.

```
>>> fobj = open("sample.txt")
>>> fobj.read()
'I love Python\nPradeepto loves KDE\nSankarshan loves Openoffice\n'
```

If you call *read()* again it will return empty string as it already read the whole file. readline() can help you to read one line each time from the file.

```
>>> fobj = open("sample.txt")
>>> fobj.readline()
'I love Python\n'
>>> fobj.readline()
'Pradeepto loves KDE\n'
```

To read all the lines in a list we use *readlines()* method.

```
>>> fobj = open("sample.txt")
>>> fobj.readlines()
['I love Python\n', 'Pradeepto loves KDE\n', 'Sankarshan loves Openoffice\n']
```

You can even loop through the lines in a file object.

```
>>> fobj = open("sample.txt")
>>> for x in fobj:
...     print(x, end=' ')
...
I love Python
Pradeepto loves KDE
Sankarshan loves Openoffice
```

Let us write a program which will take the file name as the input from the user and show the content of the file in the console.

```
#!/usr/bin/env python3
name = input("Enter the file name: ")
fobj = open(name)
print(fobj.read())
fobj.close()
```

In the last line you can see that we closed the file object with the help of close() method.

The output

```
$ ./showfile.py
Enter the filename: sample.txt
I love Python
Pradeepto loves KDE
Sankarshan loves Openoffice
```

10.4 Using the with statement

In real life scenarios we should try to use *with* statement. It will take care of closing the file for you.

```
>>> with open('setup.py') as fobj:
...     for line in fobj:
...         print line,
...
#!/usr/bin/env python3
"""Factorial project"""
from setuptools import find_packages, setup

setup(name = 'factorial',
    version = '0.1',
    description = "Factorial module.",
    long_description = "A test module for our book.",
    platforms = ["Linux"],
    author="Kushal Das",
    author_email="kushaldas@gmail.com",
    url="https://pymbook.readthedocs.io/en/latest/",
    license = "http://www.gnu.org/copyleft/gpl.html",
    packages=find_packages()
    )
```

10.5 Writing in a file

Let us open a file then we will write some random text into it by using the write() method.

```
>>> fobj = open("ircnicks.txt", 'w')
>>> fobj.write('powerpork\n')
>>> fobj.write('indrag\n')
>>> fobj.write('mishti\n')
>>> fobj.write('sankarshan')
>>> fobj.close()
```

Now read the file we just created

```
>>> fobj = open('ircnicks.txt')
>>> s = fobj.read()
>>> print(s)
powerpork
indrag
mishti
sankarshan
```

10.6 copyfile.py

In this example we will copy a given text file to another file.

```
#!/usr/bin/env python3
import sys
if len(sys.argv) < 3:
    print("Wrong parameter")
    print("./copyfile.py file1 file2")
    sys.exit(1)
f1 = open(sys.argv[1])
s = f1.read()
f1.close()
f2 = open(sys.argv[2], 'w')
f2.write(s)
f2.close()
```

Note: This way of reading file is not always a good idea, a file can be very large to read and fit in the memory. It is always better to read a known size of the file and write that to the new file.

You can see we used a new module here *sys*. *sys.argv* contains all command line parameters. Remember *cp* command in shell, after *cp* we type first the file to be copied and then the new file name.

The first value in *sys.argv* is the name of the command itself.

```
#!/usr/bin/env python3
import sys
print("First value", sys.argv[0])
print("All values")
for i, x  in enumerate(sys.argv):
    print(i, x)
```

The output

```
$ ./argvtest.py Hi there
First value ./argvtest.py
All values
0 ./argvtest.py
1 Hi
2 there
```

Here we used a new function *enumerate(iterableobject)*, which returns the index number and the value from the iterable object.

10.7 Count spaces, tabs and new lines in a file

Let us try to write an application which will count the spaces, tabs, and lines in any given file.

```
#!/usr/bin/env python3

import os
import sys
```

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```
def parse_file(path):
    """
    Parses the text file in the given path and returns space, tab & new line
    details.

    :arg path: Path of the text file to parse

    :return: A tuple with count of spacaes, tabs and lines.
    """
    fd = open(path)
    i = 0
    spaces = 0
    tabs = 0
    for i,line in enumerate(fd):
        spaces += line.count(' ')
        tabs += line.count('\t')
    #Now close the open file
    fd.close()

    #Return the result as a tuple
    return spaces, tabs, i + 1

def main(path):
    """
    Function which prints counts of spaces, tabs and lines in a file.

    :arg path: Path of the text file to parse
    :return: True if the file exits or False.
    """
    if os.path.exists(path):
        spaces, tabs, lines = parse_file(path)
        print("Spaces %d. tabs %d. lines %d" % (spaces, tabs, lines))
        return True
    else:
        return False


if __name__ == '__main__':
    if len(sys.argv) > 1:
        main(sys.argv[1])
    else:
        sys.exit(-1)
    sys.exit(0)
```

You can see that we have two functions in the program , *main* and *parse_file* where the second one actually parses the file and returns the result and we print the result in *main* function. By splitting up the code in smaller units (functions) helps us to organize the codebase and also it will be easier to write test cases for the functions.

10.8 Let us write some real code

Do you know how many CPU(s) are there in your processor? or what is the model name? Let us write some code which can help us to know these things.

If you are in Linux, then you can actually view the output of the *lscpu* command first. You can actually find the

information in a file located at */proc/cpuinfo*.

Now try to write code which will open the file in read only mode and then read the file line by line and find out the number of CPU(s).

Tip: Always remember to read files line by line than reading them as a whole. Sometimes you may have to read files which are way bigger than your available RAM.

After you do this, try to write your own lscpu command in Python :)

CHAPTER 11

Exceptions

In this chapter we will learn about exceptions in Python and how to handle them in your code.

Any error which happens during the execution of the code is an exception. Each exception generally shows some error message.

11.1 NameError

When one starts writing code, this will be one of the most common exception he/she will find. This happens when someone tries to access a variable which is not defined.

```
>>> print(kushal)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'kushal' is not defined
```

The last line contains the details of the error message, the rest of the lines shows the details of how it happened (or what caused that exception).

11.2 TypeError

TypeError is also one of the most found exception. This happens when someone tries to do an operation with different kinds of incompatible data types. A common example is to do addition of Integers and a string.

```
>>> print(1 + "kushal")
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: unsupported operand type(s) for +: 'int' and 'str'
```

11.3 How to handle exceptions?

We use *try... except* blocks to handle any exception. The basic syntax looks like

```
try:
    statements to be inside try clause
    statement2
    statement3
    ...
except ExceptionName:
    statements to evaluated in case of ExceptionName happens
```

It works in the following way:

- First all lines between *try* and *except* statements.
- If *ExceptionName* happens during execution of the statements then *except* clause statements execute
- If no exception happens then the statements inside *except* clause does not execute.
- If the *Exception* is not handled in the *except* block then it goes out of *try* block.

The following examples showcase these scenarios.

```
>>> def get_number():
...     "Returns a float number"
...     number = float(input("Enter a float number: "))
...     return number
...
>>>
>>> while True:
...     try:
...         print(get_number())
...     except ValueError:
...         print("You entered a wrong value.")
...
Enter a float number: 45.0
45.0
Enter a float number: 24,0
You entered a wrong value.
Enter a float number: Traceback (most recent call last):
  File "<stdin>", line 3, in <module>
  File "<stdin>", line 3, in get_number
KeyboardInterrupt
```

As the first input I provided a proper float value and it printed it back, next I entered a value with a comma, so the *except* clause executed and the print statement executed.

In the third time I pressed *Ctrl+c* which caused a *KeyboardInterrupt*, which is not handled in the *except* block so the execution stopped with that exception.

An empty *except* statement can catch any exception. Read the following example:

```
>>> try:
...     input() # Press Ctrl+c for a KeyboardInterrupt
... except:
...     print("Unknown Exception")
...
Unknown Exception
```

11.4 Raising exceptions

One can raise an exception using *raise* statement.

```
>>> raise ValueError("A value error happened.")
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: A value error happened.
```

We can catch these exceptions like any other normal exceptions.

```
>>> try:
...     raise ValueError("A value error happened.")
... except ValueError:
...     print("ValueError in our code.")
...
ValueError in our code.
```

11.5 Using finally for cleanup

If we want to have some statements which must be executed under all circumstances, we can use *finally* clause, it will be always executed before finishing *try* statements.

```
>>> try:
...     fobj = open("hello.txt", "w")
...     res = 12 / 0
... except ZeroDivisionError:
...     print("We have an error in division")
... finally:
...     fobj.close()
...     print("Closing the file object.")
...
We have an error in division
Closing the file object.
```

In this example we are making sure that the file object we open, must get closed in the *finally* clause.

CHAPTER 12

Class

12.1 Your first class

Before writing your first class, you should know the syntax. We define a class in the following way.

```
class nameoftheclass(parent_class):
    statement1
    statement2
    statement3
```

In the statements you can write any Python statement, you can define functions (which we call methods of a class).

```
>>> class MyClass(object):
...     a = 90
...     b = 88
...
>>> p = MyClass()
>>> p
<__main__.MyClass instance at 0xb7c8aa6c>
```

In the above example you can see first we are declaring a class called MyClass, writing some random statements inside that class. After the class definition, we are creating an *object* p of the *class* MyClass. If you do a dir on that

```
>>> dir(p)
['__doc__', '__module__', 'a', 'b']
```

you can see the variables *a* and *b* inside it.

12.2 __init__ method

__init__ is a special method in Python classes, it is the constructor method for a class. In the following example you can see how to use it.

```
class Student(object):
    """
    Returns a ```Student``` object with the given name, branch and year.

    """
    def __init__(self, name, branch, year):
            self.name = name
            self.branch = branch
            self.year = year
            print("A student object is created.")

    def print_details(self):
        """
        Prints the details of the student.
        """
        print("Name:", self.name)
        print("Branch:", self.branch)
        print("Year:", self.year)
```

__init__ is called when ever an object of the class is constructed. That means when ever we will create a student object we will see the message "A student object is created" in the prompt. You can see the first argument to the method is *self*. It is a special variable which points to the current object (like *this* in C++). The object is passed implicitly to every method available in it, but we have to get it explicitly in every method while writing the methods. Example shown below. Remember to declare all the possible attributes in the *__init__* method itself. Even if you are not using them right away, you can always assign them as *None*.

```
>>> std1 = Student()
Traceback (most recent call last):
File "<stdin>", line 1, in <module>
TypeError: __init__() takes exactly 4 arguments (1 given)
>>> std1 = Student('Kushal','CSE','2005')
A student object is created
```

In this example at first we tried to create a Student object without passing any argument and Python interpreter complained that it takes exactly 4 arguments but received only one (self). Then we created an object with proper argument values and from the message printed, one can easily understand that *__init__* method was called as the constructor method.

Now we are going to call *print_details()* method.

```
>>> std1.print_details()
Name: Kushal
Branch: CSE
Year: 2005
```

12.3 Inheritance

In general we human beings always know about inheritance. In programming it is almost the same. When a class inherits another class it inherits all features (like variables and methods) of the parent class. This helps in reusing codes.

In the next example we first create a class called Person and create two sub-classes Student and Teacher. As both of the classes are inherited from Person class they will have all methods of Person and will have new methods and variables for their own purpose.

12.3.1 student_teacher.py

```
#!/usr/bin/env python3

class Person(object):
    """
    Returns a ```Person``` object with given name.

    """
    def __init__(self, name):
        self.name = name

    def get_details(self):
        "Returns a string containing name of the person"
        return self.name


class Student(Person):
    """
    Returns a ```Student``` object, takes 3 arguments, name, branch, year.

    """
    def __init__(self, name, branch, year):
        Person.__init__(self, name)
        self.branch = branch
        self.year = year

    def get_details(self):
        "Returns a string containing student's details."
        return "%s studies %s and is in %s year." % (self.name, self.branch, self.
↪year)


class Teacher(Person):
    """
    Returns a ```Teacher``` object, takes a list of strings (list of papers) as
    argument.
    """
    def __init__(self, name, papers):
        Person.__init__(self, name)
        self.papers = papers

    def get_details(self):
        return "%s teaches %s" % (self.name, ','.join(self.papers))


person1 = Person('Sachin')
student1 = Student('Kushal', 'CSE', 2005)
teacher1 = Teacher('Prashad', ['C', 'C++'])

print(person1.get_details())
print(student1.get_details())
print(teacher1.get_details())
```

The output:

```
$ ./student_teacher.py
```

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```
Sachin
Kushal studies CSE and is in 2005 year.
Prashad teaches C,C++
```

In this example you can see how we called the __init__ method of the class Person in both Student and Teacher classes' __init__ method. We also reimplemented *get_details()* method of Person class in both Student and Teacher class. So, when we are calling *get_details()* method on the teacher1 object it returns based on the object itself (which is of teacher class) and when we call *get_details()* on the student1 or person1 object it returns based on *get_details()* method implemented in it's own class.

12.4 Multiple Inheritance

One class can inherit more than one classes. It gets access to all methods and variables of the parent classes. The general syntax is:

```
class MyClass(Parentclass1, Parentclass2,...):
    def __init__(self):
        Parentclass1.__init__(self)
        Parentclass2.__init__(self)
        ...
        ...
```

12.5 Deleting an object

As we already know how to create an object, now we are going to see how to delete an Python object. We use *del* for this.

```
>>> s = "I love you"
>>> del s
>>> s
Traceback (most recent call last):
File "<stdin>", line 1, in <module>
NameError: name 's' is not defined
```

del actually decreases reference count by one. When the reference count of an object becomes zero the garbage collector will delete that object.

12.6 Getters and setters in Python

One simple answer, don't. If you are coming from other languages (read Java), you will be tempted to use getters or setters in all your classes. Please don't. Just use the attributes directly. The following shows a direct example.

```
>>> class Student(object):
...     def __init__(self, name):
...         self.name = name
...
>>> std = Student("Kushal Das")
>>> print(std.name)
Kushal Das
```

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```
>>> std.name = "Python"
>>> print(std.name)
Python
```

12.7 Properties

If you want more fine tuned control over data attribute access, then you can use properties. In the following example of a bank account, we will make sure that no one can set the money value to negative and also a property called *inr* will give us the INR values of the dollars in the account.

```
#!/usr/bin/env python3

class Account(object):
    """The Account class,
    The amount is in dollars.
    """
    def __init__(self, rate):
        self.__amt = 0
        self.rate = rate

    @property
    def amount(self):
        "The amount of money in the account"
        return self.__amt

    @property
    def inr(self):
        "Gives the money in INR value."
        return self.__amt * self.rate

    @amount.setter
    def amount(self, value):
        if value < 0:
            print("Sorry, no negative amount in the account.")
            return
        self.__amt = value

if __name__ == '__main__':
    acc = Account(rate=61) # Based on today's value of INR :(
    acc.amount = 20
    print("Dollar amount:", acc.amount)
    print("In INR:", acc.inr)
    acc.amount = -100
    print("Dollar amount:", acc.amount)
```

Output:

```
$ python property.py
Dollar amount: 20
In INR: 1220
Sorry, no negative amount in the account.
Dollar amount: 20
```

CHAPTER 13

Modules

In this chapter we are going to learn about Python modules.

13.1 Introduction

Up until now, all the code we wrote in the Python interpreter was lost when we exited the interpreter. But when people write large programs they tend to break their code into multiple different files for ease of use, debugging and readability. In Python we use *modules* to achieve such goals. Modules are nothing but files with Python definitions and statements. The module name, to import, has the same name of the Python file without the .py extension.

You can find the name of the module by accessing the *__name__* variable. It is a global variable.

Now we are going to see how modules work. Create a file called bars.py. Content of the file is given bellow.

```
"""
Bars Module
============
This is an example module with provide different ways to print bars.
"""
def starbar(num):
    """Prints a bar with *

    :arg num: Length of the bar
    """
    print('*' * num)

def hashbar(num):
    """Prints a bar with #

    :arg num: Length of the bar
    """
    print('#' * num)

def simplebar(num):
```

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```
    """Prints a bar with -

    :arg num: Length of the bar
    """
    print('-' * num)
```

Now we are going to start the Python interpreter and import our module.

```
>>> import bars
>>>
```

This will import the module bars. We have to use the module name to access functions inside the module.

```
>>> bars.hashbar(10)
##########
>>> bars.simplebar(10)
----------
>>> bars.starbar(10)
**********
```

13.2 Importing modules

There are different ways to import modules. We already saw one way to do this. You can even import selected functions from modules. To do so:

```
>>> from bars import simplebar, starbar
>>> simplebar(20)
--------------------
```

Warning: Never do *from module import* * Read this link for more information.

13.3 Submodules

We can have many submodules inside a module. A directory with a *__init__.py* can also be used as a module and all *.py* files inside it become submodules.

```
$ tree mymodule
mymodule
|-- bars.py
|-- __init__.py
`-- utils.py
```

In this example *mymodule* is the module name and *bars* and *utils* are two submodules in it. You can create an empty *__init__.py* using touch command.

```
$ touch mymodule/__init__.py
```

13.4 __all__ in __init__.py

If *__init__.py* file contains a list called *__all__*, then only the names listed there will be public. So if the mymodule's *__init__.py* file contains the following

```
from mymodule.bars import simplebar
__all__ = [simplebar, ]
```

Then from mymodule only *simplebar* will be available.

Note: *from mymodule import* * will only work for module level objects, trying to use it to import functions or classes will cause syntax error.

13.5 Default modules

Now your Python installation comes with different modules installed, you can use them as required and install new modules for any other special purposes. In the following few examples we are going to see many examples on the same.

```
>>> help()

Welcome to Python 3.5's help utility!

If this is your first time using Python, you should definitely check out
the tutorial on the Internet at http://docs.python.org/3.5/tutorial/.

Enter the name of any module, keyword, or topic to get help on writing
Python programs and using Python modules.  To quit this help utility and
return to the interpreter, just type "quit".

To get a list of available modules, keywords, symbols, or topics, type
"modules", "keywords", "symbols", or "topics".  Each module also comes
with a one-line summary of what it does; to list the modules whose name
or summary contain a given string such as "spam", type "modules spam".

help> modules
```

The above example shows how to get the list of all installed modules in your system. I am not pasting them here as it is a big list in my system :)

You can also use *help()* function in the interpeter to find documentation about any module/classes. Say you want to know all available methods in strings, you can use the following method

```
>>> help(str)
```

13.6 Module os

`os` module provides operating system dependent functionality. You can import it using the following import statement.

```
>>> import os
```

getuid() function returns the current process's effective user's id.

```
>>> os.getuid()
500
```

getpid() returns the current process's id. *getppid()* returns the parent process's id.

```
>>> os.getpid()
16150
>>> os.getppid()
14847
```

uname() returns different information identifying the operating system, in Linux it returns details you can get from the *uname* command. The returned object is a tuple, *(sysname, nodename, release, version, machine)*

```
>>> os.uname()
('Linux', 'd80', '2.6.34.7-56.fc13.i686.PAE', '#1 SMP Wed Sep 15 03:27:15 UTC 2010',
↪'i686')
```

*getcwd()*returns the current working directory. *chdir(path)* changes the current working directory to path. In the example we first see the current directory which is my home directory and change the current directory to */tmp* and then again checking the current directory.

```
>>> os.getcwd()
'/home/kushal'
>>> os.chdir('/tmp')
>>> os.getcwd()
'/tmp'
```

So let us use another function provided by the os module and create our own function to list all files and directories in any given directory.

```
def view_dir(path='.'):
    """
    This function prints all files and directories in the given directory.
    :args path: Path to the directory, default is current directory
    """
    names = os.listdir(path)
    names.sort()
    for name in names:
        print(name, end =' ')
```

Using the *view_dir* example.

```
>>> view_dir('/')
.readahead bin boot dev etc home junk lib lib64 lost+found media mnt opt
proc root run sbin srv sys tmp usr var
```

There are many other very useful functions available in the OS module, you can read about them here

13.7 Requests Module

requests is a Python module which changed the way people used to write code for many many projects. It helps you to do HTTP GET or POST calls in a very simple but elegant way. This is a third party module, that means you have to install it from your OS distribution packages, it does not come default.

```
# yum install python3-requests
```

The above command will install Python3 version of the requests module in your system.

13.7.1 Getting a simple web pages

You can use the *get* method to fetch any website.

```
>>> import requests
>>> req = requests.get('http://google.com')
>>> req.status_code
200
```

The *text* attribute holds the HTML returned by the server.

Using this knowledge, let us write a command which can download a given file (URL) from Internet.

```
#!/usr/bin/env python3
import os
import os.path
import requests

def download(url):
    '''Download the given url and saves it to the current directory.

    :arg url: URL of the file to be downloaded.
    '''
    req = requests.get(url)
    # First let us check non existing files.
    if req.status_code == 404:
        print('No such file found at %s' % url)
        return
    filename = url.split('/')[-1]
    with open(filename, 'wb') as fobj:
        fobj.write(req.content)
    print("Download over.")

if __name__ == '__main__':
    url = input('Enter a URL:')
    download(url)
```

Here we used something new, when the module name is *__main__*, then only ask for a user input and then download the given URL. This also prevents the same when some other Python code imports this file as a Python module.

To learn more about requests module, go to their wonderful documentation.

You can actually modify the above program to become more user friendly. For example, you can check if that given filename already exists in the current directory or not. Use `os.path` module for the name.

13.8 Command line arguments

Do you remember your *ls* command, you can pass different kind of options as command line arguments. You can do that too .. important:: your application. Read this how-to guide to learn about it.

13.9 TAB completion in your Python interpreter

First create a file as *~/.pythonrc* and include the following in that file

```
import rlcompleter, readline
readline.parse_and_bind('tab: complete')


history_file = os.path.expanduser('~/.python_history')
readline.read_history_file(history_file)

import atexit
atexit.register(readline.write_history_file, history_file)
```

Next, just export PYTHONSTARTUP variable pointing to this file from your *~/.bashrc* file.

```
export PYTHONSTARTUP=~/.pythonrc
```

Now from future whenever you open a bash shell, you will have TAB completion and history of code entered in your Python interpreter.

To use it in the current shell, source the bashrc file.

```
$ source ~/.bashrc
```

CHAPTER 14

Collections module

In this chapter we will learn about a module called *Collections*. This module implements some nice data structures which will help you to solve various real life problems.

```
>>> import collections
```

This is how you can import the module, now we will see the available classes which you can use.

14.1 Counter

Counter is a *dict* subclass which helps to count hashable objects. Inside it elements are stored as dictionary keys and counts are stored as values which can be zero or negative.

Below we will see one example where we will find occurrences of words in the Python LICENSE file.

14.1.1 Counter example

```
>>> from collections import Counter
>>> import re
>>> path = '/usr/share/doc/python-2.7.3/LICENSE'
>>> words = re.findall('\w+', open(path).read().lower())
>>> Counter(words).most_common(10)
[('2', 97), ('the', 80), ('or', 78), ('1', 76), ('of', 61), ('to', 50), ('and', 47), (
↪'python', 46), ('psf', 44), ('in', 38)]
```

Counter objects has a method called *elements* which returns an iterator over elements repeating each as many times as its count. Elements are returned in arbitrary order.

```
>>> c = Counter(a=4, b=2, c=0, d=-2)
>>> list(c.elements())
['a', 'a', 'a', 'a', 'b', 'b']
```

most_common is a method which returns most common elements and their counts from the most common to the least.

```
>>> Counter('abracadabra').most_common(3)
[('a', 5), ('r', 2), ('b', 2)]
```

14.2 defaultdict

defaultdict is a dictionary like object which provides all methods provided by dictionary but takes first argument (default_factory) as default data type for the dictionary. Using defaultdict is faster than doing the same using *dict.set_default* method.

14.2.1 defaultdict example

::

```
>>> from collections import defaultdict
>>> s = [('yellow', 1), ('blue', 2), ('yellow', 3), ('blue', 4), ('red', 1)]
>>> d = defaultdict(list)
>>> for k, v in s:
...     d[k].append(v)
...
>>> d.items()
dict_items([('blue', [2, 4]), ('red', [1]), ('yellow', [1, 3])])
```

In the example you can see even if the key is not there in the defaultdict object, it automatically creates an empty list. *list.append* then helps to append the value to the list.

14.3 namedtuple

Named tuples helps to have meaning of each position in a tuple and allow us to code with better readability and self-documenting code. You can use them in any place where you are using *tuples*. In the example we will create a namedtuple to show hold information for points.

14.3.1 Named tuple

```
>>> from collections import namedtuple
>>> Point = namedtuple('Point', ['x', 'y'])  # Defining the namedtuple
>>> p = Point(10, y=20)  # Creating an object
>>> p
Point(x=10, y=20)
>>> p.x + p.y
30
>>> p[0] + p[1]  # Accessing the values in normal way
30
>>> x, y = p     # Unpacking the tuple
>>> x
10
>>> y
20
```

CHAPTER 15

PEP8 Guidelines

15.1 Introduction

This document gives coding conventions for the Python code comprising the standard library in the main Python distribution. Please see the companion informational PEP describing style guidelines for the C code in the C implementation of Python[1].

This document and PEP 257 (Docstring Conventions) were adapted from Guido's original Python Style Guide essay, with some additions from Barry's style guide[2].

15.2 A Foolish Consistency is the Hobgoblin of Little Minds

One of Guido's key insights is that code is read much more often than it is written. The guidelines provided here are intended to improve the readability of code and make it consistent across the wide spectrum of Python code. As PEP 20 says, "Readability counts".

A style guide is about consistency. Consistency with this style guide is important. Consistency within a project is more important. Consistency within one module or function is the most important.

But most importantly: know when to be inconsistent – sometimes the style guide just doesn't apply. When in doubt, use your best judgment. Look at other examples and decide what looks best. And don't hesitate to ask!

Two good reasons to break a particular rule:

1. When applying the rule would make the code less readable, even for someone who is used to reading code that follows the rules.
2. To be consistent with surrounding code that also breaks it (maybe for historic reasons) – although this is also an opportunity to clean up someone else's mess (in true XP style).

[1] PEP 7, Style Guide for C Code, van Rossum
[2] Barry's GNU Mailman style guide http://barry.warsaw.us/software/STYLEGUIDE.txt

15.3 Code lay-out

15.3.1 Indentation

Use 4 spaces per indentation level.

For really old code that you don't want to mess up, you can continue to use 8-space tabs.

Continuation lines should align wrapped elements either vertically using Python's implicit line joining inside parentheses, brackets and braces, or using a hanging indent. When using a hanging indent the following considerations should be applied; there should be no arguments on the first line and further indentation should be used to clearly distinguish itself as a continuation line.

Yes:

```
# Aligned with opening delimiter
foo = long_function_name(var_one, var_two,
                         var_three, var_four)

# More indentation included to distinguish this from the rest.
def long_function_name(
        var_one, var_two, var_three,
        var_four):
    print(var_one)
```

No:

```
# Arguments on first line forbidden when not using vertical alignment
foo = long_function_name(var_one, var_two,
    var_three, var_four)

# Further indentation required as indentation is not distinguishable
def long_function_name(
    var_one, var_two, var_three,
    var_four):
    print(var_one)
```

Optional:

```
# Extra indentation is not necessary.
foo = long_function_name(
  var_one, var_two,
  var_three, var_four)
```

The closing brace/bracket/parenthesis on multi-line constructs may either line up under the first non-whitespace character of the last line of list, as in:

```
my_list = [
    1, 2, 3,
    4, 5, 6,
    ]
result = some_function_that_takes_arguments(
    'a', 'b', 'c',
    'd', 'e', 'f',
    )
```

or it may be lined up under the first character of the line that starts the multi-line construct, as in:

```
my_list = [
    1, 2, 3,
    4, 5, 6,
]
result = some_function_that_takes_arguments(
    'a', 'b', 'c',
    'd', 'e', 'f',
)
```

15.3.2 Tabs or Spaces?

Never mix tabs and spaces.

The most popular way of indenting Python is with spaces only. The second-most popular way is with tabs only. Code indented with a mixture of tabs and spaces should be converted to using spaces exclusively. When invoking the Python command line interpreter with the `-t` option, it issues warnings about code that illegally mixes tabs and spaces. When using `-tt` these warnings become errors. These options are highly recommended!

For new projects, spaces-only are strongly recommended over tabs. Most editors have features that make this easy to do.

15.3.3 Maximum Line Length

Limit all lines to a maximum of 79 characters.

There are still many devices around that are limited to 80 character lines; plus, limiting windows to 80 characters makes it possible to have several windows side-by-side. The default wrapping on such devices disrupts the visual structure of the code, making it more difficult to understand. Therefore, please limit all lines to a maximum of 79 characters. For flowing long blocks of text (docstrings or comments), limiting the length to 72 characters is recommended.

The preferred way of wrapping long lines is by using Python's implied line continuation inside parentheses, brackets and braces. Long lines can be broken over multiple lines by wrapping expressions in parentheses. These should be used in preference to using a backslash for line continuation.

Backslashes may still be appropriate at times. For example, long, multiple `with`-statements cannot use implicit continuation, so backslashes are acceptable:

```
with open('/path/to/some/file/you/want/to/read') as file_1, \
        open('/path/to/some/file/being/written', 'w') as file_2:
    file_2.write(file_1.read())
```

Another such case is with `assert` statements.

Make sure to indent the continued line appropriately. The preferred place to break around a binary operator is *after* the operator, not before it. Some examples:

```
class Rectangle(Blob):

    def __init__(self, width, height,
                 color='black', emphasis=None, highlight=0):
        if (width == 0 and height == 0 and
            color == 'red' and emphasis == 'strong' or
            highlight > 100):
            raise ValueError("sorry, you lose")
        if width == 0 and height == 0 and (color == 'red' or
```

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```
                                        emphasis is None):
            raise ValueError("I don't think so -- values are %s, %s" %
                             (width, height))
        Blob.__init__(self, width, height,
                      color, emphasis, highlight)
```

15.3.4 Blank Lines

Separate top-level function and class definitions with two blank lines.

Method definitions inside a class are separated by a single blank line.

Extra blank lines may be used (sparingly) to separate groups of related functions. Blank lines may be omitted between a bunch of related one-liners (e.g. a set of dummy implementations).

Use blank lines in functions, sparingly, to indicate logical sections.

Python accepts the control-L (i.e. ^L) form feed character as whitespace; Many tools treat these characters as page separators, so you may use them to separate pages of related sections of your file. Note, some editors and web-based code viewers may not recognize control-L as a form feed and will show another glyph in its place.

15.3.5 Encodings (PEP 263)

Code in the core Python distribution should always use the ASCII or Latin-1 encoding (a.k.a. ISO-8859-1). For Python 3.0 and beyond, UTF-8 is preferred over Latin-1, see PEP 3120.

Files using ASCII should not have a coding cookie. Latin-1 (or UTF-8) should only be used when a comment or docstring needs to mention an author name that requires Latin-1; otherwise, using `\x`, `\u` or `\U` escapes is the preferred way to include non-ASCII data in string literals.

For Python 3.0 and beyond, the following policy is prescribed for the standard library (see PEP 3131): All identifiers in the Python standard library MUST use ASCII-only identifiers, and SHOULD use English words wherever feasible (in many cases, abbreviations and technical terms are used which aren't English). In addition, string literals and comments must also be in ASCII. The only exceptions are (a) test cases testing the non-ASCII features, and (b) names of authors. Authors whose names are not based on the latin alphabet MUST provide a latin transliteration of their names.

Open source projects with a global audience are encouraged to adopt a similar policy.

15.3.6 Imports

- Imports should usually be on separate lines, e.g.:

```
Yes: import os
     import sys

No:  import sys, os
```

  It's okay to say this though:

```
from subprocess import Popen, PIPE
```

- Imports are always put at the top of the file, just after any module comments and docstrings, and before module globals and constants.

  Imports should be grouped in the following order:

1. standard library imports
2. related third party imports
3. local application/library specific imports

You should put a blank line between each group of imports.

Put any relevant `__all__` specification after the imports.

- Relative imports for intra-package imports are highly discouraged. Always use the absolute package path for all imports. Even now that PEP 328 is fully implemented in Python 2.5, its style of explicit relative imports is actively discouraged; absolute imports are more portable and usually more readable.
- When importing a class from a class-containing module, it's usually okay to spell this:

```
from myclass import MyClass
from foo.bar.yourclass import YourClass
```

If this spelling causes local name clashes, then spell them

```
import myclass
import foo.bar.yourclass
```

and use "myclass.MyClass" and "foo.bar.yourclass.YourClass".

15.4 Whitespace in Expressions and Statements

15.4.1 Pet Peeves

Avoid extraneous whitespace in the following situations:

- Immediately inside parentheses, brackets or braces.

```
Yes: spam(ham[1], {eggs: 2})
No:  spam( ham[ 1 ], { eggs: 2 } )
```

- Immediately before a comma, semicolon, or colon:

```
Yes: if x == 4: print x, y; x, y = y, x
No:  if x == 4 : print x , y ; x , y = y , x
```

- Immediately before the open parenthesis that starts the argument list of a function call:

```
Yes: spam(1)
No:  spam (1)
```

- Immediately before the open parenthesis that starts an indexing or slicing:

```
Yes: dict['key'] = list[index]
No:  dict ['key'] = list [index]
```

- More than one space around an assignment (or other) operator to align it with another.

  Yes:

```
x = 1
y = 2
long_variable = 3
```

No:

```
x             = 1
y             = 2
long_variable = 3
```

15.4.2 Other Recommendations

- Always surround these binary operators with a single space on either side: assignment (=), augmented assignment (+=, -= etc.), comparisons (==, <, >, !=, <>, <=, >=, `in`, `not in`, `is`, `is not`), Booleans (`and`, `or`, `not`).
- If operators with different priorities are used, consider adding whitespace around the operators with the lowest priority(ies). Use your own judgement; however, never use more than one space, and always have the same amount of whitespace on both sides of a binary operator.

  Yes:

```
i = i + 1
submitted += 1
x = x*2 - 1
hypot2 = x*x + y*y
c = (a+b) * (a-b)
```

  No:

```
i=i+1
submitted +=1
x = x * 2 - 1
hypot2 = x * x + y * y
c = (a + b) * (a - b)
```

- Don't use spaces around the = sign when used to indicate a keyword argument or a default parameter value.

  Yes:

```
def complex(real, imag=0.0):
    return magic(r=real, i=imag)
```

  No:

```
def complex(real, imag = 0.0):
    return magic(r = real, i = imag)
```

- Compound statements (multiple statements on the same line) are generally discouraged.

  Yes:

```
if foo == 'blah':
    do_blah_thing()
do_one()
do_two()
do_three()
```

Rather not:

```
if foo == 'blah': do_blah_thing()
do_one(); do_two(); do_three()
```

- While sometimes it's okay to put an if/for/while with a small body on the same line, never do this for multi-clause statements. Also avoid folding such long lines!

  Rather not:

```
if foo == 'blah': do_blah_thing()
for x in lst: total += x
while t < 10: t = delay()
```

  Definitely not:

```
if foo == 'blah': do_blah_thing()
else: do_non_blah_thing()

try: something()
finally: cleanup()

do_one(); do_two(); do_three(long, argument,
                             list, like, this)

if foo == 'blah': one(); two(); three()
```

15.5 Comments

Comments that contradict the code are worse than no comments. Always make a priority of keeping the comments up-to-date when the code changes!

Comments should be complete sentences. If a comment is a phrase or sentence, its first word should be capitalized, unless it is an identifier that begins with a lower case letter (never alter the case of identifiers!).

If a comment is short, the period at the end can be omitted. Block comments generally consist of one or more paragraphs built out of complete sentences, and each sentence should end in a period.

You should use two spaces after a sentence-ending period.

When writing English, Strunk and White apply.

Python coders from non-English speaking countries: please write your comments in English, unless you are 120% sure that the code will never be read by people who don't speak your language.

15.5.1 Block Comments

Block comments generally apply to some (or all) code that follows them, and are indented to the same level as that code. Each line of a block comment starts with a # and a single space (unless it is indented text inside the comment).

Paragraphs inside a block comment are separated by a line containing a single #.

15.5.2 Inline Comments

Use inline comments sparingly.

An inline comment is a comment on the same line as a statement. Inline comments should be separated by at least two spaces from the statement. They should start with a # and a single space.

Inline comments are unnecessary and in fact distracting if they state the obvious. Don't do this:

```
x = x + 1                 # Increment x
```

But sometimes, this is useful:

```
x = x + 1                 # Compensate for border
```

15.5.3 Documentation Strings

Conventions for writing good documentation strings (a.k.a. "docstrings") are immortalized in PEP 257.

- Write docstrings for all public modules, functions, classes, and methods. Docstrings are not necessary for non-public methods, but you should have a comment that describes what the method does. This comment should appear after the `def` line.
- PEP 257 describes good docstring conventions. Note that most importantly, the `"""` that ends a multiline docstring should be on a line by itself, and preferably preceded by a blank line, e.g.:

```
"""Return a foobang

Optional plotz says to frobnicate the bizbaz first.

"""
```

- For one liner docstrings, it's okay to keep the closing `"""` on the same line.

15.6 Version Bookkeeping

If you have to have Subversion, CVS, or RCS crud in your source file, do it as follows.

```
__version__ = "$Revision$"
# $Source$
```

These lines should be included after the module's docstring, before any other code, separated by a blank line above and below.

15.7 Naming Conventions

The naming conventions of Python's library are a bit of a mess, so we'll never get this completely consistent – nevertheless, here are the currently recommended naming standards. New modules and packages (including third party frameworks) should be written to these standards, but where an existing library has a different style, internal consistency is preferred.

15.7.1 Descriptive: Naming Styles

There are a lot of different naming styles. It helps to be able to recognize what naming style is being used, independently from what they are used for.

The following naming styles are commonly distinguished:

- `b` (single lowercase letter)
- `B` (single uppercase letter)
- `lowercase`
- `lower_case_with_underscores`
- `UPPERCASE`
- `UPPER_CASE_WITH_UNDERSCORES`
- `CapitalizedWords` (or CapWords, or CamelCase – so named because of the bumpy look of its letters[3]). This is also sometimes known as StudlyCaps.

  Note: When using abbreviations in CapWords, capitalize all the letters of the abbreviation. Thus HTTPServerError is better than HttpServerError.
- `mixedCase` (differs from CapitalizedWords by initial lowercase character!)
- `Capitalized_Words_With_Underscores` (ugly!)

There's also the style of using a short unique prefix to group related names together. This is not used much in Python, but it is mentioned for completeness. For example, the `os.stat()` function returns a tuple whose items traditionally have names like `st_mode`, `st_size`, `st_mtime` and so on. (This is done to emphasize the correspondence with the fields of the POSIX system call struct, which helps programmers familiar with that.)

The X11 library uses a leading X for all its public functions. In Python, this style is generally deemed unnecessary because attribute and method names are prefixed with an object, and function names are prefixed with a module name.

In addition, the following special forms using leading or trailing underscores are recognized (these can generally be combined with any case convention):

- `_single_leading_underscore`: weak "internal use" indicator. E.g. `from M import *` does not import objects whose name starts with an underscore.
- `single_trailing_underscore_`: used by convention to avoid conflicts with Python keyword, e.g.

```
Tkinter.Toplevel(master, class_='ClassName')
```

- `__double_leading_underscore`: when naming a class attribute, invokes name mangling (inside class FooBar, `__boo` becomes `_FooBar__boo`; see below).
- `__double_leading_and_trailing_underscore__`: "magic" objects or attributes that live in user-controlled namespaces. E.g. `__init__`, `__import__` or `__file__`. Never invent such names; only use them as documented.

15.7.2 Prescriptive: Naming Conventions

Names to Avoid

Never use the characters 'l' (lowercase letter el), 'O' (uppercase letter oh), or 'I' (uppercase letter eye) as single character variable names.

In some fonts, these characters are indistinguishable from the numerals one and zero. When tempted to use 'l', use 'L' instead.

[3] http://www.wikipedia.com/wiki/CamelCase

Package and Module Names

Modules should have short, all-lowercase names. Underscores can be used in the module name if it improves readability. Python packages should also have short, all-lowercase names, although the use of underscores is discouraged.

Since module names are mapped to file names, and some file systems are case insensitive and truncate long names, it is important that module names be chosen to be fairly short – this won't be a problem on Unix, but it may be a problem when the code is transported to older Mac or Windows versions, or DOS.

When an extension module written in C or C++ has an accompanying Python module that provides a higher level (e.g. more object oriented) interface, the C/C++ module has a leading underscore (e.g. `_socket`).

Class Names

Almost without exception, class names use the CapWords convention. Classes for internal use have a leading underscore in addition.

Exception Names

Because exceptions should be classes, the class naming convention applies here. However, you should use the suffix "Error" on your exception names (if the exception actually is an error).

Global Variable Names

(Let's hope that these variables are meant for use inside one module only.) The conventions are about the same as those for functions.

Modules that are designed for use via `from M import *` should use the `__all__` mechanism to prevent exporting globals, or use the older convention of prefixing such globals with an underscore (which you might want to do to indicate these globals are "module non-public").

Function Names

Function names should be lowercase, with words separated by underscores as necessary to improve readability.

mixedCase is allowed only in contexts where that's already the prevailing style (e.g. threading.py), to retain backwards compatibility.

Function and method arguments

Always use `self` for the first argument to instance methods.

Always use `cls` for the first argument to class methods.

If a function argument's name clashes with a reserved keyword, it is generally better to append a single trailing underscore rather than use an abbreviation or spelling corruption. Thus `class_` is better than `clss`. (Perhaps better is to avoid such clashes by using a synonym.)

Method Names and Instance Variables

Use the function naming rules: lowercase with words separated by underscores as necessary to improve readability.

Use one leading underscore only for non-public methods and instance variables.

To avoid name clashes with subclasses, use two leading underscores to invoke Python's name mangling rules.

Python mangles these names with the class name: if class Foo has an attribute named `__a`, it cannot be accessed by `Foo.__a`. (An insistent user could still gain access by calling `Foo._Foo__a`.) Generally, double leading underscores should be used only to avoid name conflicts with attributes in classes designed to be subclassed.

Note: there is some controversy about the use of __names (see below).

Constants

Constants are usually defined on a module level and written in all capital letters with underscores separating words. Examples include `MAX_OVERFLOW` and `TOTAL`.

Designing for inheritance

Always decide whether a class's methods and instance variables (collectively: "attributes") should be public or non-public. If in doubt, choose non-public; it's easier to make it public later than to make a public attribute non-public.

Public attributes are those that you expect unrelated clients of your class to use, with your commitment to avoid backward incompatible changes. Non-public attributes are those that are not intended to be used by third parties; you make no guarantees that non-public attributes won't change or even be removed.

We don't use the term "private" here, since no attribute is really private in Python (without a generally unnecessary amount of work).

Another category of attributes are those that are part of the "subclass API" (often called "protected" in other languages). Some classes are designed to be inherited from, either to extend or modify aspects of the class's behavior. When designing such a class, take care to make explicit decisions about which attributes are public, which are part of the subclass API, and which are truly only to be used by your base class.

With this in mind, here are the Pythonic guidelines:

- Public attributes should have no leading underscores.
- If your public attribute name collides with a reserved keyword, append a single trailing underscore to your attribute name. This is preferable to an abbreviation or corrupted spelling. (However, not withstanding this rule, 'cls' is the preferred spelling for any variable or argument which is known to be a class, especially the first argument to a class method.)

  Note 1: See the argument name recommendation above for class methods.
- For simple public data attributes, it is best to expose just the attribute name, without complicated accessor/mutator methods. Keep in mind that Python provides an easy path to future enhancement, should you find that a simple data attribute needs to grow functional behavior. In that case, use properties to hide functional implementation behind simple data attribute access syntax.

  Note 1: Properties only work on new-style classes.

  Note 2: Try to keep the functional behavior side-effect free, although side-effects such as caching are generally fine.

  Note 3: Avoid using properties for computationally expensive operations; the attribute notation makes the caller believe that access is (relatively) cheap.

- If your class is intended to be subclassed, and you have attributes that you do not want subclasses to use, consider naming them with double leading underscores and no trailing underscores. This invokes Python's name mangling algorithm, where the name of the class is mangled into the attribute name. This helps avoid attribute name collisions should subclasses inadvertently contain attributes with the same name.

  Note 1: Note that only the simple class name is used in the mangled name, so if a subclass chooses both the same class name and attribute name, you can still get name collisions.

  Note 2: Name mangling can make certain uses, such as debugging and `__getattr__()`, less convenient. However the name mangling algorithm is well documented and easy to perform manually.

  Note 3: Not everyone likes name mangling. Try to balance the need to avoid accidental name clashes with potential use by advanced callers.

15.8 References

15.9 Copyright

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CHAPTER 16

Iterators, generators and decorators

In this chapter we will learn about iterators, generators and decorators.

16.1 Iterators

Python iterator objects are required to support two methods while following the iterator protocol.

__iter__ returns the iterator object itself. This is used in *for* and *in* statements.

__next__ method returns the next value from the iterator. If there is no more items to return then it should raise *StopIteration* exception.

```
class Counter(object):
    def __init__(self, low, high):
        self.current = low
        self.high = high

    def __iter__(self):
        'Returns itself as an iterator object'
        return self

    def __next__(self):
        'Returns the next value till current is lower than high'
        if self.current > self.high:
            raise StopIteration
        else:
            self.current += 1
            return self.current - 1
```

Now we can use this iterator in our code.

```
>>> c = Counter(5,10)
>>> for i in c:
...   print(i, end=' ')
```

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```
...
5 6 7 8 9 10
```

Remember that an iterator object can be used only once. It means after it raises *StopIteration* once, it will keep raising the same exception.

```
>>> c = Counter(5,6)
>>> next(c)
5
>>> next(c)
6
>>> next(c)
Traceback (most recent call last):
File "<stdin>", line 1, in <module>
File "<stdin>", line 11, in next
StopIteration
>>> next(c)
Traceback (most recent call last):
File "<stdin>", line 1, in <module>
File "<stdin>", line 11, in next
StopIteration
```

Using the iterator in for loop example we saw, the following example tries to show the code behind the scenes.

```
>>> iterator = iter(c)
>>> while True:
...     try:
...         x = iterator.__next__()
...         print(x, end=' ')
...     except StopIteration as e:
...         break
...
5 6 7 8 9 10
```

16.2 Generators

In this section we learn about Python generators. They were introduced in Python 2.3. It is an easier way to create iterators using a keyword *yield* from a function.

```
>>> def my_generator():
...     print("Inside my generator")
...     yield 'a'
...     yield 'b'
...     yield 'c'
...
>>> my_generator()
<generator object my_generator at 0x7fbcfa0a6aa0>
```

In the above example we create a simple generator using the yield statements. We can use it in a for loop just like we use any other iterators.

```
>>> for char in my_generator():
...     print(char)
...
```

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```
Inside my generator
a
b
c
```

In the next example we will create the same Counter class using a generator function and use it in a for loop.

```
def counter_generator(low, high):
    while low <= high:
       yield low
       low += 1

>>> for i in counter_generator(5,10):
...     print(i, end=' ')
...
5 6 7 8 9 10
```

Inside the while loop when it reaches to the *yield* statement, the value of low is returned and the generator state is suspended. During the second *next* call the generator resumed where it freeze-ed before and then the value of *low* is increased by one. It continues with the while loop and comes to the *yield* statement again.

When you call an generator function it returns a *generator* object. If you call *dir* on this object you will find that it contains *__iter__* and *__next__* methods among the other methods.

```
   >>> c = counter_generator(5,10)
   >>> dir(c)
   ['__class__', '__delattr__', '__dir__', '__doc__', '__eq__', '__format__',
'__ge__', '__getattribute__', '__gt__', '__hash__', '__init__', '__iter__',
'__le__', '__lt__', '__name__', '__ne__', '__new__', '__next__', '__reduce__',
'__reduce_ex__', '__repr__', '__setattr__', '__sizeof__', '__str__', '__subclasshook__
↪',
'close', 'gi_code', 'gi_frame', 'gi_running', 'send', 'throw']
```

We mostly use generators for laze evaluations. This way generators become a good approach to work with lots of data. If you don't want to load all the data in the memory, you can use a generator which will pass you each piece of data at a time.

One of the biggest example of such example is *os.path.walk()* function which uses a callback function and current *os.walk* generator. Using the generator implementation saves memory.

We can have generators which produces infinite values. The following is a one such example.

```
>>> def infinite_generator(start=0):
...     while True:
...         yield start
...         start += 1
...
>>> for num in infinite_generator(4):
...     print(num, end=' ')
...     if num > 20:
...         break
...
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
```

If we go back to the example of *my_generator* we will find one feature of generators. They are not re-usable.

```
>>> g = my_generator()
>>> for c in g:
...     print(c)
...
Inside my generator
a
b
c
>>> for c in g:
...     print(c)
...
```

One way to create a reusable generator is Object based generators which does not hold any state. Any class with a *__iter__* method which yields data can be used as a object generator. In the following example we will recreate out counter generator.

```
>>> class Counter(object):
...     def __init__(self, low, high):
...         self.low = low
...         self.high = high
...     def __iter__(self):
...          counter = self.low
...          while self.high >= counter:
...              yield counter
...              counter += 1
...
>>> gobj = Counter(5, 10)
>>> for num in gobj:
...     print(num, end=' ')
...
5 6 7 8 9 10
>>> for num in gobj:
...     print(num, end=' ')
...
5 6 7 8 9 10
```

16.3 Generator expressions

In this section we will learn about generator expressions which is a high performance, memory efficient generalization of list comprehensions and generators.

For example we will try to sum the squares of all numbers from 1 to 9.

```
>>> sum([x*x for x in range(1,10)])
```

The example actually first creates a list of the square values in memory and then it iterates over it and finally after sum it frees the memory. You can understand the memory usage in case of a big list.

We can save memory usage by using a generator expression.

```
sum(x*x for x in range(1,10))
```

The syntax of generator expression says that always needs to be directly inside a set of parentheses and cannot have a comma on either side. Which basically means both the examples below are valid generator expression usage example.

```
>>> sum(x*x for x in range(1,10))
285
>>> g = (x*x for x in range(1,10))
>>> g
<generator object <genexpr> at 0x7fc559516b90>
```

We can have chaining of generators or generator expressions. In the following example we will read the file */var/log/cron* and will find if any particular job (in the example we are searching for anacron) is running successfully or not.

We can do the same using a shell command *tail -f /var/log/cron |grep anacron*

```
>>> jobtext = 'anacron'
>>> all_lines = (line for line in open('/var/log/cron', 'r') )
>>> job = ( line for line in all_lines if line.find(jobtext) != -1)
>>> text = next(job)
>>> text
"May  6 12:17:15 dhcp193-104 anacron[23052]: Job `cron.daily' terminated\n"
>>> text = next(job)
>>> text
'May  6 12:17:15 dhcp193-104 anacron[23052]: Normal exit (1 job run)\n'
>>> text = next(job)
>>> text
'May  6 13:01:01 dhcp193-104 run-parts(/etc/cron.hourly)[25907]: starting 0anacron\n'
```

You can write a for loop to the lines.

16.4 Closures

Closures are nothing but functions that are returned by another function. We use closures to remove code duplication. In the following example we create a simple closure for adding numbers.

```
>>> def add_number(num):
...     def adder(number):
...         'adder is a closure'
...         return num + number
...     return adder
...
>>> a_10 = add_number(10)
>>> a_10(21)
31
>>> a_10(34)
44
>>> a_5 = add_number(5)
>>> a_5(3)
8
```

adder is a closure which adds a given number to a pre-defined one.

16.5 Decorators

Decorator is way to dynamically add some new behavior to some objects. We achieve the same in Python by using closures.

In the example we will create a simple example which will print some statement before and after the execution of a function.

```
>>> def my_decorator(func):
...     def wrapper(*args, **kwargs):
...         print("Before call")
...         result = func(*args, **kwargs)
...         print("After call")
...         return result
...     return wrapper
...
>>> @my_decorator
... def add(a, b):
...     "Our add function"
...     return a + b
...
>>> add(1, 3)
Before call
After call
4
```

CHAPTER 17

Virtualenv

Virtual Python Environment or venv is a Python environment which will help you to install different versions of Python modules in a local directory using which you can develop and test your code without requiring to install everything systemwide.

17.1 Installation

In Python3 we can use the *venv* module to create virtual environments.

17.2 Usage

We will create a directory call *virtual* inside which we will have two different virtual environment.

The following commands will create an env called virt1.

```
$ cd virtual
$ python3 -m venv virt1
$
```

Now we can activate the virt1 environment.

```
$ source virt1/bin/activate
(virt1)[user@host]$
```

The first part of the prompt is now the name of the virtual environment, it will help you identify which environment you are in when you have multiple environments.

To deactivate the environment use *deactivate* command.

```
(virt1)$ deactivate
$
```

So, now we will install a Python module called redis.

```
(virt1)$ pip install redis
Collecting redis
  Downloading redis-2.10.5-py2.py3-none-any.whl (60kB)
    100% || 61kB 607kB/s
Installing collected packages: redis
Successfully installed redis-2.10.5
```

Now we will create another virtual environment *virt2* where we will install the same redis module but an old 2.4 version of it.

```
$ python3 -m venv virt2
$ source virt2/bin/activate
(virt2)$
(virt2)$ pip install redis==2.4
Downloading/unpacking redis
Downloading redis-2.4.0.tar.gz
Running setup.py egg_info for package redis
Installing collected packages: redis
Running setup.py install for redis
Successfully installed redis
Cleaning up...
```

This way you can have many different environments for all of your development needs.

Note: Always remember to create virtualenvs while developing new applications. This will help you keep the system modules clean.

CHAPTER 18

Type hinting and annotations

This is one of the new feature of the language. We can do the similar kind of work in Python2 also, but with different syntax. Please remember that Python will stay as a dynamically typed language, this type hinting does not effect your code anyway.

The major benefit of having type hints in your codebase is about future maintenance of the codebase. When a new developer will try to contribute to your project, having type hints will save a lot of time for that new person. It can also help to detect some of the runtime issues we see due to passing of wrong variable types in different function calls.

18.1 First example of type annotation

Let us start with a simple example, adding of two integers.

```
def add(a, b):
    return a + b
```

Now, the above example will work for any object which supports + operator. But, we want to specify that it is expecting only Integers as parameters, and the function call will return another Integer.

```
def add(a: int, b: int) -> int:
    return a + b
```

You can see that the return type of the function call is defined after ->. We can do the same in Python2 using a comment (before any docstring).

```
def add(a, b):
    # type: (int, int) -> int
    return a + b
```

18.2 Using mypy and more examples

Mypy is a static type checker written for Python. If we use the type annotations as explained above, mypy can help by finding common problems in our code. You can use mypy in various ways in your development workflow, may be in CI as a proper test.

18.2.1 Installing mypy

We can install mypy inside of a virtual environment.

```
$ python3 -m venv env
$ source env/bin/activate
(env) $ pip install mypy
Collecting mypy
Downloading mypy-0.511-py3-none-any.whl (1.0MB)
    100% |################################| 1.0MB 965kB/s
Collecting typed-ast<1.1.0,>=1.0.3 (from mypy)
Downloading typed_ast-1.0.3-cp36-cp36m-macosx_10_11_x86_64.whl (214kB)
    100% |################################| 215kB 682kB/s
Installing collected packages: typed-ast, mypy
Successfully installed mypy-0.511 typed-ast-1.0.3
```

18.2.2 Our example code

We wil working on the following example code. This does not do much useful things, but we can use this to learn about type annotations and mypy.

```
class Student:

    def __init__(self, name, batch, branch, roll):
        self.name = name
        self.batch = batch
        self.branch = branch
        self.roll = roll
        self.semester = None
        self.papers = {}

    def is_passed(self):
        "To find if the student has pass the exam in the current semester"
        for k, v in self.papers.items():
            if v < 34:
                return False

        return True


    def total_score(self):
        "Returns the total score of the student"
        total = 0
        for k, v in self.papers.items():
            total += v

        return total
```

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```
std1 = Student("Kushal", 2005, "cse", "123")
std2 = Student("Sayan", 2005, "cse", 121)
std3 = Student("Anwesha", 2005, "law", 122)

std1.papers = {"english": 78, "math": 82, "science": 77}
std2.papers = {"english": 80, "math": 92, "science": "78"}
std3.papers = {"english": 82, "math": 87, "science": 77}

for std in [std1, std2, std3]:
    print("Passed: {0}. The toral score of {1} is {2}".format(std.is_passed(), std.
↪name, std.total_score()))
```

You may find some errors in the code, but in case of a large codebase we can not detect the similar issues unless we see the runtime errors.

18.2.3 Using mypy

We can just call mypy on our source file, I named it as *students2.py*

```
$ mypy studets2.py
```

18.2.4 Enabling the first few type annotations

We will add some type annotations to the *__init__* method. For reducing the code length, I am only showing the changed code below.

```
class Student:

def __init__(self, name: str, batch: int, branch: str, roll: int) -> None:
    self.name = name
    self.batch = batch
    self.branch = branch
    self.roll = roll
    self.semester = None
    self.papers = {}
```

```
$ mypy students2.py
students2.py:11: error: Need type annotation for variable
students2.py:31: error: Argument 4 to "Student" has incompatible type "str"; expected
↪"int"
```

You can see mypy is complaing about variable which does not have type annotations, and also found that in line 31, as argument 4 we are passing *str*, where as we were supposed to send in an Integer for the rull number. Let us fix these.

```
from typing import Dict

class Student:

    def __init__(self, name: str, batch: int, branch: str, roll: int) -> None:
        self.name = name
        self.batch = batch
        self.branch = branch
```

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```
        self.roll = roll
        self.semester: str = None
        self.papers: Dict[str, int] = {}

    def is_passed(self) -> bool:
        "To find if the student has pass the exam in the current semester"
        for k, v in self.papers.items():
            if v < 34:
                return False

        return True


    def total_score(self) -> int:
        "Returns the total score of the student"
        total = 0
        for k, v in self.papers.items():
            total += v

        return total


std1: Student = Student("Kushal", 2005, "cse", 123)
std2: Student = Student("Sayan", 2005, "cse", 121)
std3: Student = Student("Anwesha", 2005, "law", 122)

std1.papers = {"english": 78, "math": 82, "science": 77}
std2: Student.papers = {"english": 80, "math": 92, "science": 78}
std3.papers = {"english": 82, "math": 87, "science": 77}

for std in [std1, std2, std3]:
    print("Passed: {0}. The toral score of {1} is {2}".format(std.is_passed(), std.
↪name, std.total_score()))
```

```
$ mypy students2.py
```

Now, it does not complain about any error. You can see that in line 1, we imported Dict from the typing module. And, then using the same we added the type annotation of the *self.paper* variable. We are saying that it is a dictionary which has string keys, and Integers as values. We also used our *Student* class as type of std1, std2, and std3 variables.

Now let us say we by mistake assign a new list to the papers variable.

```
std1.papers = ["English", "Math"]
```

Or maybe assigned a wrong kind of dictionary.

```
std2.papers = {1: "Engish", 2: "Math"}
```

We can see what mypy says in these cases

```
$ mypy students2.py
students2.py:35: error: Incompatible types in assignment (expression has type␣
↪List[str], variable has type Dict[str, int])
students2.py:36: error: Dict entry 0 has incompatible type "int": "str"
students2.py:36: error: Dict entry 1 has incompatible type "int": "str"
```

18.3 More examples of type annotations

```
from typing import List, Tuple, Sequence, Optional

values: List[int] = []
city: int = 350 # The city code, not a name


# This function returns a Tuple of two values, a str and an int
def get_details() -> Tuple[str, int]:
    return "Python", 5

# The following is an example of Tuple unpacking
name: str
marks: int
name, marks = get_details()


def print_all(values: Sequence) -> None:
    for v in values:
        print(v)


print_all([1,2,3])
print_all({"name": "kushal", "class": 5})
# alltypes.py:23: error: Argument 1 to "print_all" has incompatible type Dict[str,␣
↪object]; expected Sequence[Any]
# But running the code will give us no error with wrong output

def add_ten(number: Optional[int] = None) -> int:
    if number:
        return number + 10
    else:
        return 42

print(add_ten())
print(add_ten(12))
```

You can learn more about types from PEP 484.

CHAPTER 19

Simple testing in Python

19.1 What we should test ?

If possible everything in our codebase, each and every function. But it depends as a choice of the developers. You can skip it if it is not practical to write a robust test. As Nick Coghlan said in a guest session – . . . *with a solid test suite, you can make big changes, confident that the externally visible behavior will remain the same*

19.2 Unit testing

A method by which individual units of source code. Wikipedia says *In computer programming, unit testing is a method by which individual units of source code, sets of one or more computer program modules together with associated control data, usage procedures, and operating procedures, are tested to determine if they are fit for use.*

19.3 unittest module

In Python we have `unittest` module to help us.

19.4 Factorial code

In this example we will write a file *factorial.py*.

```
import sys

def fact(n):
    """
    Factorial function
```

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```
    :arg n: Number
    :returns: factorial of n

    """
    if n == 0:
        return 1
    return n * fact(n -1)

def div(n):
    """
    Just divide
    """
    res = 10 / n
    return res


def main(n):
    res = fact(n)
    print(res)

if __name__ == '__main__':
    if len(sys.argv) > 1:
        main(int(sys.argv[1]))
```

Output

```
$ python factorial.py 5
```

19.5 Which function to test ?

As you can see `fact(n)` is function which is doing all calculations, so we should test that at least.

19.6 Our first test case

Now we will write our first test case.

```
import unittest
from factorial import fact

class TestFactorial(unittest.TestCase):
    """
    Our basic test class
    """

    def test_fact(self):
        """
        The actual test.
        Any method which starts with ``test_`` will considered as a test case.
        """
        res = fact(5)
        self.assertEqual(res, 120)
```

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```
if __name__ == '__main__':
    unittest.main()
```

Running the test:

```
$ python factorial_test.py
.
----------------------------------------------------------------------
Ran 1 test in 0.000s

OK
```

19.7 Description

We are importing `unittest` module first and then the required functions which we want to test.

A testcase is created by subclassing `unittest.TestCase`.

Now open the test file and change *120* to *121* and see what happens :)

19.8 Different assert statements

Method	Checks that	New in
assertEqual(a, b)	`a == b`	
assertNotEqual(a, b)	`a != b`	
assertTrue(x)	`bool(x) is True`	
assertFalse(x)	`bool(x) is False`	
assertIs(a, b)	`a is b`	2.7
assertIsNot(a, b)	`a is not b`	2.7
assertIsNone(x)	`x is None`	2.7
assertIsNotNone(x)	`x is not None`	2.7
assertIn(a, b)	`a in b`	2.7
assertNotIn(a, b)	`a not in b`	2.7
assertIsInstance(a, b)	`isinstance(a, b)`	2.7
assertNotIsInstance(a, b)	`not isinstance(a, b)`	2.7

19.9 Testing exceptions

If we call `div(0)` in factorial.py , we can see if raises an exception.

We can also test these exceptions, like:

```
self.assertRaises(ZeroDivisionError, div, 0)
```

Full code

```
import unittest
from factorial import fact, div

class TestFactorial(unittest.TestCase):
    """
    Our basic test class
    """

    def test_fact(self):
        """
        The actual test.
        Any method which starts with ``test_`` will considered as a test case.
        """
        res = fact(5)
        self.assertEqual(res, 120)

    def test_error(self):
        """
        To test exception raise due to run time error
        """
        self.assertRaises(ZeroDivisionError, div, 0)



if __name__ == '__main__':
    unittest.main()
```

19.10 mounttab.py

Here we have only one function *mount_details()* doing the parsing and printing mount details.

```
import os


def mount_details():
    """
    Prints the mount details
    """
    if os.path.exists('/proc/mounts'):
        fd = open('/proc/mounts')
        for line in fd:
            line = line.strip()
            words = line.split()
            print()'%s on %s type %s' % (words[0],words[1],words[2]), end=' ')
            if len(words) > 5:
                print('(%s)' % ' '.join(words[3:-2]))
            else:
                print('')


if __name__ == '__main__':
    mount_details()
```

19.11 After refactoring

Now we refactored the code and have one new function *parse_mounts* which we can test easily.

```
import os

def parse_mounts():
    """
    It parses /proc/mounts and returns a list of tuples
    """
    result = []
    if os.path.exists('/proc/mounts'):
        fd = open('/proc/mounts')
        for line in fd:
            line = line.strip()
            words = line.split()
            if len(words) > 5:
                res = (words[0],words[1],words[2], '(%s)' % ' '.join(words[3:-2]))
            else:
               res = (words[0],words[1],words[2])
            result.append(res)
    return result

def mount_details():
    """
    Prints the mount details
    """
    result = parse_mounts()
    for line in result:
        if len(line) == 4:
            print('%s on %s type %s %s' % line)
        else:
            print('%s on %s type %s' % line)


if __name__ == '__main__':
    mount_details()
```

and the test code for the same.

```
#!/usr/bin/env python
import unittest
from mounttab2 import parse_mounts

class TestMount(unittest.TestCase):
    """
    Our basic test class
    """

    def test_parsemount(self):
        """
        The actual test.
        Any method which starts with ``test_`` will considered as a test case.
        """
        result = parse_mounts()
        self.assertIsInstance(result, list)
        self.assertIsInstance(result[0], tuple)
```

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```
    def test_rootext4(self):
        """
        Test to find root filesystem
        """
        result = parse_mounts()
        for line in result:
            if line[1] == '/' and line[2] != 'rootfs':
                self.assertEqual(line[2], 'ext4')


if __name__ == '__main__':
    unittest.main()
```

```
$ python mounttest.py
..
----------------------------------------------------------------------
Ran 2 tests in 0.001s

OK
```

19.12 Test coverage

Test coverage is a simple way to find untested parts of a codebase. It does not tell you how good your tests are.

In Python we already have a nice coverage tool to help us. You can install it in Fedora

```
# yum install python-coverage
```

Or using *pip*.

```
$ pip install coverage
```

19.13 Coverage Example

```
$ coverage -x mounttest.py
<OUTPUT snipped>

$ coverage -rm
Name         Stmts   Miss  Cover   Missing
----------------------------------------
mounttab2       21      7    67%   16, 24-29, 33
mounttest       14      0   100%
----------------------------------------
TOTAL           35      7    80%
```

CHAPTER 20

A project structure

This chapter explains a full Python project structure. What kind of directory layout you can use and how make release a software to the world.

We will call our example project *factorial*.

```
$ mkdir factorial
$ cd factorial/
```

20.1 Primary code

The name of the Python module will be *myfact*, so we will create the directory next.

```
$ mkdir myfact
```

The primary code will be in a file called *fact.py*

```
"myfact module"

def factorial(num):
    """
    Returns the factorial value of the given number.

    :arg num: Interger value of whose factorial we will calculate.

    :return: The value of the the factorial or -1 in case negative value passed.
    """
    if num >= 0:
        if num == 0:
            return 1
        return num * factorial(num -1)
    else:
        return -1
```

We also have a *__init__.py* file for the module.

```
from fact import factorial
__all__ = [factorial, ]
```

We also added a *README.rst* file. So, the directory structure looks like

```
$ ls
myfact  README.rst
$ ls myfact/
fact.py  __init__.py
```

20.2 MANIFEST.in

Now we have to write a *MANIFEST.in* file which will be used to find out which all files will be part of the source tar ball of the project at the time of using *sdist* command.

```
include *.py
include README.rst
```

If you want to exclude some file, you can use *exclude* statements in this file.

20.3 Installing python-setuptools package

You have to install *python-setuptools* package in your system. For this we are using a virtualenv (not showing the steps here)

```
$ pip install setuptools
```

20.4 setup.py

Finally we have to write a *setup.py* which then can be used to create a source tarball or installing the software.

```
#!/usr/bin/env python
"""Factorial project"""
from setuptools import find_packages, setup

setup(name = 'factorial',
    version = '0.1',
    description = "Factorial module.",
    long_description = "A test module for our book.",
    platforms = ["Linux"],
    author="Kushal Das",
    author_email="kushaldas@gmail.com",
    url="https://pymbook.readthedocs.io/en/latest/",
    license = "MIT",
    packages=find_packages()
    )
```

name is the name of the project, *version* is the release version. You can easily understand *description* and *long_description*. *platforms* is a list of the platforms this module can work on. *find_packages* is a special function which can find all modules under your source directory.

Note: To learn more you can read the packaging docs.

20.5 Usage of setup.py

To create a source release one execute the following command.

```
$ python setup.py sdist
running sdist
running egg_info
creating factorial.egg-info
writing factorial.egg-info/PKG-INFO
writing top-level names to factorial.egg-info/top_level.txt
writing dependency_links to factorial.egg-info/dependency_links.txt
writing manifest file 'factorial.egg-info/SOURCES.txt'
reading manifest file 'factorial.egg-info/SOURCES.txt'
reading manifest template 'MANIFEST.in'
writing manifest file 'factorial.egg-info/SOURCES.txt'
running check
creating factorial-0.1
creating factorial-0.1/factorial.egg-info
creating factorial-0.1/myfact
making hard links in factorial-0.1...
hard linking MANIFEST.in -> factorial-0.1
hard linking README.rst -> factorial-0.1
hard linking setup.py -> factorial-0.1
hard linking factorial.egg-info/PKG-INFO -> factorial-0.1/factorial.egg-info
hard linking factorial.egg-info/SOURCES.txt -> factorial-0.1/factorial.egg-info
hard linking factorial.egg-info/dependency_links.txt -> factorial-0.1/factorial.egg-
↪info
hard linking factorial.egg-info/top_level.txt -> factorial-0.1/factorial.egg-info
hard linking myfact/__init__.py -> factorial-0.1/myfact
hard linking myfact/fact.py -> factorial-0.1/myfact
Writing factorial-0.1/setup.cfg
creating dist
Creating tar archive
removing 'factorial-0.1' (and everything under it)
```

One can see the tarball under *dist* directory.

```
$ ls dist/
factorial-0.1.tar.gz
```

Note: Remember to use a virtualenv while trying to install the code :)

To install from the source use the following command.

```
$ python setup.py install
```

Note: To learn more, read from packaging.python.org.

20.6 Python Package Index (PyPI)

Do you remember the *pip* command we are using still now? Ever thought from where those packages are coming from? The answer is PyPI. It is a repository of software for the Python programming language.

For our example, we will use the test server of PyPI which is https://testpypi.python.org/pypi

20.6.1 Creating account

First register yourself in this link. You will receive an email with a link, go to that link and confirm your registration.

Your account details genrally stay inside a file called *.pypirc* under your home directory. The content of the file will look like

```
[distutils]
index-servers =
    pypi

[pypi]
repository: https://testpypi.python.org/pypi
username: <username>
password: <password>
```

Replace <username> and <password> with your newly created account details.

Note: Remember to change the name of the project to something else in the ‘setup.py‘to test following instructions.

20.6.2 Registering your project

Next we will register our project to the PyPI service. This is done using the *register* command. We will also use *-r* to point it to the test server.

```
$ python setup.py register -r https://testpypi.python.org/pypi
running register
running egg_info
writing factorial.egg-info/PKG-INFO
writing top-level names to factorial.egg-info/top_level.txt
writing dependency_links to factorial.egg-info/dependency_links.txt
reading manifest file 'factorial.egg-info/SOURCES.txt'
reading manifest template 'MANIFEST.in'
writing manifest file 'factorial.egg-info/SOURCES.txt'
running check
Registering factorial to https://testpypi.python.org/pypi
Server response (200): OK
```

20.6.3 Uploading your project

Now finally we can upload our project to the PyPI server using *upload* command. Remember that this command needs to be invoked immediately after you build the source/binary distribution files.

```
$ python setup.py sdist upload -r https://testpypi.python.org/pypi
running sdist
running egg_info
writing factorial.egg-info/PKG-INFO
writing top-level names to factorial.egg-info/top_level.txt
writing dependency_links to factorial.egg-info/dependency_links.txt
reading manifest file 'factorial.egg-info/SOURCES.txt'
reading manifest template 'MANIFEST.in'
writing manifest file 'factorial.egg-info/SOURCES.txt'
running check
creating factorial-0.1
creating factorial-0.1/factorial.egg-info
creating factorial-0.1/myfact
making hard links in factorial-0.1...
hard linking MANIFEST.in -> factorial-0.1
hard linking README.rst -> factorial-0.1
hard linking setup.py -> factorial-0.1
hard linking factorial.egg-info/PKG-INFO -> factorial-0.1/factorial.egg-info
hard linking factorial.egg-info/SOURCES.txt -> factorial-0.1/factorial.egg-info
hard linking factorial.egg-info/dependency_links.txt -> factorial-0.1/factorial.egg-
↪info
hard linking factorial.egg-info/top_level.txt -> factorial-0.1/factorial.egg-info
hard linking myfact/__init__.py -> factorial-0.1/myfact
hard linking myfact/fact.py -> factorial-0.1/myfact
Writing factorial-0.1/setup.cfg
Creating tar archive
removing 'factorial-0.1' (and everything under it)
running upload
Submitting dist/factorial-0.1.tar.gz to https://testpypi.python.org/pypi
Server response (200): OK
```

Now if you visit the site, you will find your project is ready to be used by others.

CHAPTER 21

Building command line applications with Click

I recommend click module to build command line applications. Like any other project from Armin Ronacher, it has great documentation. In this post, I am going to write a beginners tutorial, you should the read the documentation for any more details and examples.

21.1 Installation, and development tips

Using virtualenv is highly recommended for developing "click" applications. I am going to assume that we are in an empty directory and the continue from there. To start, we will have a simple hello.py file with the following content:

```
def cli():
    print("Hello World")
```

Now we will need a setup.py file. This will help us to use the python module we are writing as a command line tool. It is also the recommended way to write command line tools in python, then directly using shebang based scripts.

```
from setuptools import setup

setup(
    name="myhello",
    version='0.1',
    py_modules=['hello'],
    install_requires=[
        'Click',
    ],
    entry_points='''
        [console_scripts]
        myhello=hello:cli
    ''',
)
```

You can see that we mentioned the starting point of our tool in the entry_points, *hello:cli* points to the right function to start with. We can then install this on the virtualenv locally. I will also create the virtualenv below so that becomes

easier others. To learn more, read this chapter later.

```
$ python3 -m venv env
$ source env/bin/activate
$ pip install --editable .
Obtaining file:///home/kdas/code/practice/yoclick
Collecting Click (from myhello==0.1)
Using cached click-6.7-py2.py3-none-any.whl
Installing collected packages: Click, myhello
Running setup.py develop for myhello
Successfully installed Click-6.7 myhello

$ myhello
Hello World
```

Now to convert the same script into a click based tool, we will make the following modifications. Now when we execute the command again, we see nothing changed visually, but it magically has a *–help* command line argument (which is optional).

```
$ myhello
Hello World
$ myhello --help
Usage: myhello [OPTIONS]

Options:
--help  Show this message and exit.
```

Using echo for printing text

The click module suggests using *echo* function to print, rather than the standard print function. So, we will make the required change in our code.

```
import click

@click.command()
def cli():
    click.echo("Hello World")
```

21.2 Boolean flags

In a command line tool, we sometimes want to have a boolean option. If the option is provided then do something, if not provided, then do something else. In our example, we will call the flag as *–verbose*, it is provided, then we will print some extra text.

```
import click

@click.command()
@click.option('--verbose', is_flag=True, help="Will print verbose messages.")
def cli(verbose):
    if verbose:
        click.echo("We are in the verbose mode.")
    click.echo("Hello World")
```

We added another decorator to the cli function. In *click.option()* decorator, first we passed the flag using *–verbose*, then marked this option as a boolean flag, and then finally added the help text.

```
$ myhello --help
Usage: myhello [OPTIONS]

Options:
--verbose  Will print verbose messages.
--help     Show this message and exit.
$ myhello --verbose
We are in the verbose mode.
Hello World
```

By default, any boolean flag is treated as false.

Standard options in the command line

We can now add more options to our tool. For example, we will have a *–name* option which will take a string as input.

```
import click

@click.command()
@click.option('--verbose', is_flag=True, help="Will print verbose messages.")
@click.option('--name', default='', help='Who are you?')
def cli(verbose,name):
    if verbose:
        click.echo("We are in the verbose mode.")
    click.echo("Hello World")
    click.echo('Bye {0}'.format(name))
```

```
$ myhello --help
Usage: myhello [OPTIONS]

Options:
--verbose    Will print verbose messages.
--name TEXT  Who are you?
--help       Show this message and exit.
$ myhello
Hello World
Bye
$ myhello --name kushal
Hello World
Bye kushal
```

21.3 Same option multiple times

We may want to take the same option multiple times. Click has a very simple way to do so.

```
import click

@click.command()
@click.option('--verbose', is_flag=True, help="Will print verbose messages.")
@click.option('--name', '-n', multiple=True, default='', help='Who are you?')
def cli(verbose,name):
    if verbose:
        click.echo("We are in the verbose mode.")
    click.echo("Hello World")
    for n in name:
        click.echo('Bye {0}'.format(n))
```

In the above example, you can see that we specified the *–name* as a multiple options. It also means the name parameter in the *cli* function is now a tuple.

Help text for the script

We can add help text for the script using python docstrings. For example:

```
import click

@click.command()
@click.option('--verbose', is_flag=True, help="Will print verbose messages.")
@click.option('--name', '-n', multiple=True, default='', help='Who are you?')
def cli(verbose,name):
    """This is an example script to learn Click."""
    if verbose:
        click.echo("We are in the verbose mode.")
    click.echo("Hello World")
    for n in name:
        click.echo('Bye {0}'.format(n))
```

```
$ myhello --help
Usage: myhello [OPTIONS]

This is an example script to learn Click.

Options:
--verbose        Will print verbose messages.
-n, --name TEXT  Who are you?
--help           Show this message and exit.
```

21.4 Super fast way to accept password with confirmation

Click provides a *password_option()* decorator, which can be used to accept a password over hidden prompt and second confirmation prompt. Btw, I am printing the password here as an example, never print the password to stdout in any tool.

```
import click

@click.command()
@click.option('--verbose', is_flag=True, help="Will print verbose messages.")
@click.option('--name', '-n', multiple=True, default='', help='Who are you?')
@click.password_option()
def cli(verbose,name, password):
    """This is an example script to learn Click."""
    if verbose:
        click.echo("We are in the verbose mode.")
    click.echo("Hello World")
    for n in name:
        click.echo('Bye {0}'.format(n))
    click.echo('We received {0} as password.'.format(password))
```

The output looks like below:

```
$ myhello --help
Usage: myhello [OPTIONS]
```

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```
This is an example script to learn Click.

Options:
--verbose        Will print verbose messages.
-n, --name TEXT  Who are you?
--password TEXT
--help           Show this message and exit.
$ myhello
Password:
Repeat for confirmation:
Hello World
We received hello as password.
```

To learn the full usage of password prompts, read this section.

21.5 Must have arguments

You can also add arguments to your tool. These are must haves, and if no default value is provided, they are assumed to be strings. In the below example, the script is expecting a county name to be specified.

```
import click

@click.command()
@click.option('--verbose', is_flag=True, help="Will print verbose messages.")
@click.option('--name', '-n', multiple=True, default='', help='Who are you?')
@click.argument('country')
def cli(verbose,name, country):
    """This is an example script to learn Click."""
    if verbose:
        click.echo("We are in the verbose mode.")
    click.echo("Hello {0}".format(country))
    for n in name:
        click.echo('Bye {0}'.format(n))
```

The output looks like:

```
$ myhello
Usage: myhello [OPTIONS] COUNTRY

Error: Missing argument "country".
$ myhello India
Hello India
```

Click has many other useful features, like *yes parameter*, *file path input*. I am not going to write about all of those here, but you can always from the upstream documentation.

CHAPTER 22

Introduction to Flask

22.1 What is flask?

Flask is a web framework. This means flask provides you with tools, libraries and technologies that allow you to build a web application. This web application can be some web pages, a blog, a wiki or go as big as a web-based calendar application or a commercial website.

Flask is part of the categories of the micro-framework. Micro-framework are normally framework with little to no dependencies to external libraries. This has pros and cons. Pros would be that the framework is light, there are little dependency to update and watch for security bugs, cons is that some time you will have to do more work by yourself or increase yourself the list of dependencies by adding plugins. In the case of Flask, its dependencies are:

- Werkzeug a WSGI utility library
- jinja2 which is its template engine

Note: WSGI is basically a protocol defined so that Python application can communicate with a web-server and thus be used as web-application outside of CGI.

22.2 What are template engines?

Have you ever built a website? Did you face the problem that to keep the style of the website consistent, you have had to write multiple times the same text? Did you ever tried to change the style of such website?

If your website contains only few pages, changing its style will take you some time but is doable. However, if you have a lot of pages (for example the list of items you sell in your store), this task become overwhelming.

Using templates you are able to set a basic layout for your pages and mention which element will change. This way you can define your header once and keep it consistent over all the pages of your website, and if you need to change your header, you will only have to update it in one place.

Using a template engine will save you a lot of time when creating your application but also when updating and maintaining it.

22.3 A "Hello world" application in flask

We are going to perform a very basic application with flask.

- Create the structure of the project

```
mkdir -p hello_flask/{templates,static}
```

This is the basic structure of your web application:

```
$ tree hello_flask/
hello_flask/
|-- static
`-- templates
```

The `templates` folder is the place where the templates will be put. The `static` folder is the place where any files (images, css, javascript) needed by the web application will be put.

- Create the application file

```
cd hello_flask
vim hello_flask.py
```

Put the following code in this file:

```
#!/usr/bin/env python

import flask


# Create the application.
APP = flask.Flask(__name__)


@APP.route('/')
def index():
    """ Displays the index page accessible at '/'
    """
    return flask.render_template('index.html')


if __name__ == '__main__':
    APP.debug=True
    APP.run()
```

- Create the template `index.html`

```
vim templates/index.html
```

Put the following code in this file

```
<!DOCTYPE html>
<html lang='en'>
```

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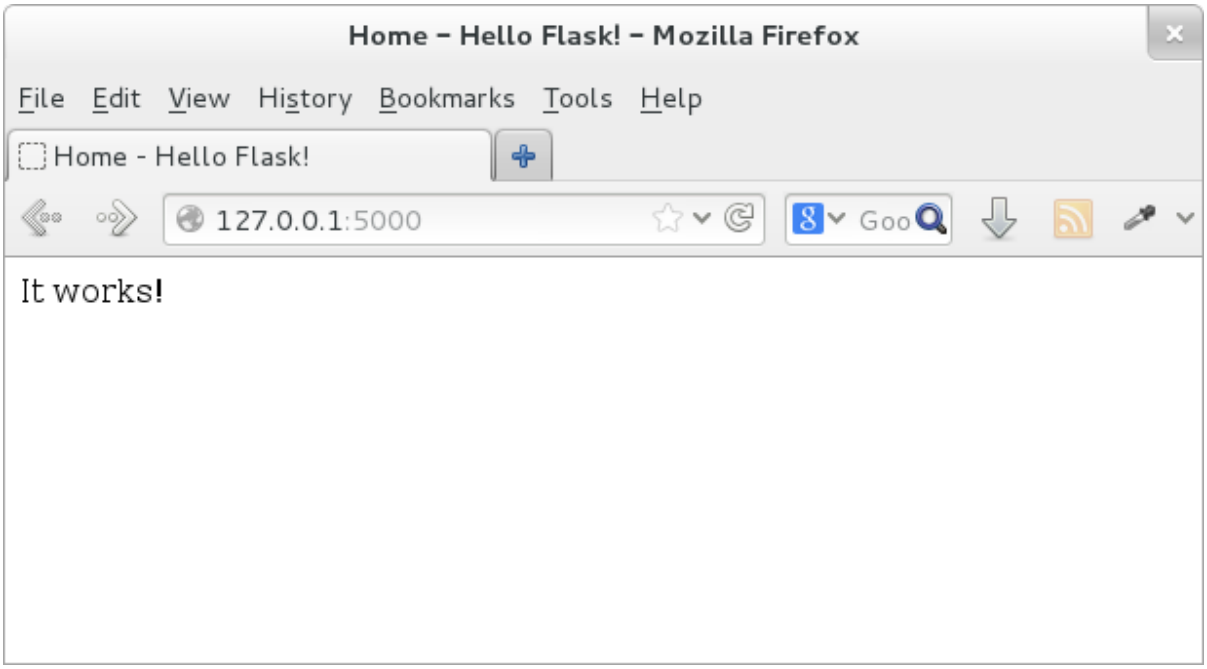
```
<head>
  <meta charset="utf-8" />
  <title>Hello world!</title>
  <link type="text/css" rel="stylesheet"
        href="{{ url_for('static',
              filename='hello.css')}}" />
</head>
<body>

It works!

</body>
</html>
```

- Run the flask application

```
python hello_flask.py
```

Access http://127.0.0.1:5000/ this should simply show you in black on white the text "It works!" (see Figure below).



22.4 Using arguments in Flask

In this section we are going to see how to use a page according to the URL used by the user.

For this we will update `hello_flask.py`.

- Add the following entry in `hello_flask.py`

```
@APP.route('/hello/<name>/')
def hello(name):
    """ Displays the page greats who ever comes to visit it.
```

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```
    """
    return flask.render_template('hello.html', name=name)
```

- Create the following template `hello.html`

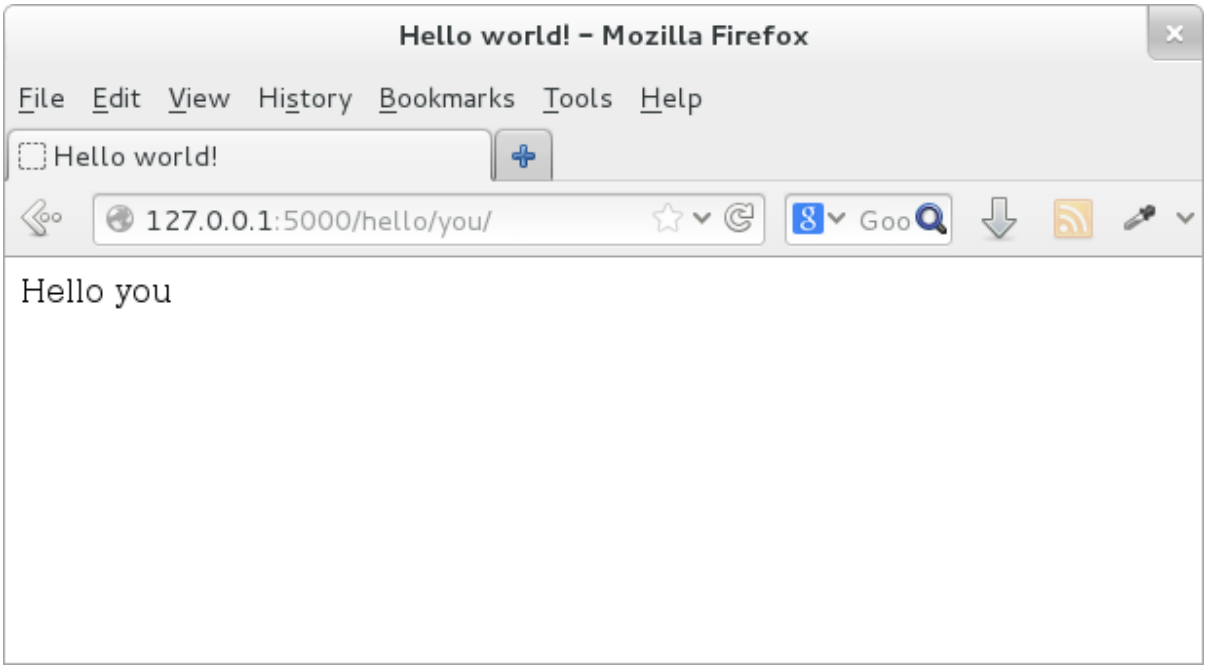
```
<!DOCTYPE html>
<html lang='en'>
<head>
    <meta charset="utf-8" />
    <title>Hello</title>
    <link type="text/css" rel="stylesheet"
          href="{{ url_for('static',
               filename='hello.css')}}" />
</head>
<body>

      Hello {{name}}

</body>
</html>
```

- Run the flask application

```
python hello_flask.py
```

Access http://127.0.0.1:5000/ this should simply show you in black on white the text “It works!”.

Access http://127.0.0.1:5000/hello/you this should return you the text “Hello you” (see Figure below).



Whatever you put behind `/hello/` in the URL will be returned to you in the page.

This is your first use of the template, we set up a variable `name` in `hello_flask.py` (see the return line of the function `hello`). This variable is then displayed in the page itself using the syntax `{{name}}`.

22.5 Additional work

Make use of the templates

At the moment for each page we have created a template, this is actually bad practice, what we should do is create a `master` template and have each page use it.

- Create the template `master.html`

```
<!DOCTYPE html>
<html lang='en'>
<head>
  <meta charset="utf-8" />
  <title>{% block title %}{% endblock %} - Hello Flask!</title>
  <link type="text/css" rel="stylesheet"
       href="{{ url_for('static',
                        filename='hello.css')}}" />
</head>
<body>

{% block body %}{% endblock %}

</body>
</html>
```

- Adjust the template `index.html`

```
{% extends "master.html" %}

{% block title %}Home{% endblock %}

{% block body %}
It works!
{% endblock %}
```

As you can see, in the `master.html` template we have defined two sections, blocks which are named `title` and `body`.

In the template `index.html` we say that this template relies on the template `master.html`, then we define the content to put in these two sections (blocks). In the first block `title` we say to put the word *Home*, In the second block we define what we want to have in the body of the page.

- As an exercise, transform the other template `hello.html` to use the `master.html` template as well.
- Add link to the front page from the hello page

Flask uses a specific syntax to create links from a page to another. This is fact generates the link dynamically according to the decorator set to the function linked to. In addition it takes care of where the application is deployed.

For example, if you website is deployed at: `/myapp/` flask will automatically happend `/myapp/` to all links without the need for you to specify it.

To create a link in a template, flask relies on the function `url_for()`. This function takes as first argument the function you want to call (link to). The following arguments are the arguments of function itself (for example the argument `name` of the function `hello`.

Adjust the template `hello.html` to add a link to the front page

```
<a href="{{ url_for('index') }}"><button>Home</button></a>
```

- As an assignment add a link in the front page to the hello page for *you*.

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