

A Byte of Python

Table of Contents

Introduction	1.1
Dedication	1.2
Preface	1.3
About Python	1.4
Installation	1.5
First Steps	1.6
Basics	1.7
Operators and Expressions	1.8
Control flow	1.9
Functions	1.10
Modules	1.11
Data Structures	1.12
Problem Solving	1.13
Object Oriented Programming	1.14
Input and Output	1.15
Exceptions	1.16
Standard Library	1.17
More	1.18
What Next	1.19
Appendix: FLOSS	1.20
Appendix: About	1.21
Appendix: Revision History	1.22
Appendix: Translations	1.23
Appendix: Translation How-to	1.24
Feedback	1.25

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Visit <https://github.com/swaroopch/byte-of-python> for the raw content (for suggesting corrections, changes, translating, etc.)

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If you are interested in reading or contributing translations of this book to other human languages, please see [Translations](#).

Dedication

To [Kalyan Varma](#) and many other seniors at [PESIT](#) who introduced us to GNU/Linux and the world of open source.

To the memory of [Atul Chitnis](#), a friend and guide who shall be missed greatly.

To the [pioneers who made the Internet happen](#). This book was first written in 2003. It still remains popular, thanks to the nature of sharing knowledge on the Internet as envisioned by the pioneers.

Preface

Python is probably one of the few programming languages which is both simple and powerful. This is good for beginners as well as for experts, and more importantly, is fun to program with. This book aims to help you learn this wonderful language and show how to get things done quickly and painlessly - in effect 'The Anti-venom to your programming problems'.

Who This Book Is For

This book serves as a guide or tutorial to the Python programming language. It is mainly targeted at newbies. It is useful for experienced programmers as well.

The aim is that if all you know about computers is how to save text files, then you can learn Python from this book. If you have previous programming experience, then you can also learn Python from this book.

If you do have previous programming experience, you will be interested in the differences between Python and your favorite programming language - I have highlighted many such differences. A little warning though, Python is soon going to become your favorite programming language!

Official Website

The official website of the book is <https://python.swaroopch.com/> where you can read the whole book online, download the latest versions of the book, [buy a printed hard copy](#) and also send me feedback.

Something To Think About

There are two ways of constructing a software design: one way is to make it so simple that there are obviously no deficiencies; the other is to make it so complicated that there are no obvious deficiencies. -- C. A. R. Hoare

Success in life is a matter not so much of talent and opportunity as of concentration and perseverance. -- C. W. Wendte

About Python

Python is one of those rare languages which can claim to be both *simple* and *powerful*. You will find yourself pleasantly surprised to see how easy it is to concentrate on the solution to the problem rather than the syntax and structure of the language you are programming in.

The official introduction to Python is:

Python is an easy to learn, powerful programming language. It has efficient high-level data structures and a simple but effective approach to object-oriented programming. Python's elegant syntax and dynamic typing, together with its interpreted nature, make it an ideal language for scripting and rapid application development in many areas on most platforms.

I will discuss most of these features in more detail in the next section.

Story behind the name

Guido van Rossum, the creator of the Python language, named the language after the BBC show "Monty Python's Flying Circus". He doesn't particularly like snakes that kill animals for food by winding their long bodies around them and crushing them.

Features of Python

Simple

Python is a simple and minimalistic language. Reading a good Python program feels almost like reading English, although very strict English! This pseudo-code nature of Python is one of its greatest strengths. It allows you to concentrate on the solution to the problem rather than the language itself.

Easy to Learn

As you will see, Python is extremely easy to get started with. Python has an extraordinarily simple syntax, as already mentioned.

Free and Open Source

Python is an example of a *FLOSS* (Free/Libré and Open Source Software). In simple terms, you can freely distribute copies of this software, read its source code, make changes to it, and use pieces of it in new free programs. FLOSS is based on the concept of a community which shares knowledge. This is one of the reasons why Python is so good - it has been created and is constantly improved by a community who just want to see a better Python.

High-level Language

When you write programs in Python, you never need to bother about the low-level details such as managing the memory used by your program, etc.

Portable

Due to its open-source nature, Python has been ported to (i.e. changed to make it work on) many platforms. All your Python programs can work on any of these platforms without requiring any changes at all if you are careful enough to avoid any system-dependent features.

You can use Python on GNU/Linux, Windows, FreeBSD, Macintosh, Solaris, OS/2, Amiga, AROS, AS/400, BeOS, OS/390, z/OS, Palm OS, QNX, VMS, Psion, Acorn RISC OS, VxWorks, PlayStation, Sharp Zaurus, Windows CE and PocketPC!

You can even use a platform like [Kivy](#) to create games for your computer *and* for iPhone, iPad, and Android.

Interpreted

This requires a bit of explanation.

A program written in a compiled language like C or C++ is converted from the source language i.e. C or C++ into a language that is spoken by your computer (binary code i.e. 0s and 1s) using a compiler with various flags and options. When you run the program, the linker/loader software copies the program from hard disk to memory and starts running it.

Python, on the other hand, does not need compilation to binary. You just *run* the program directly from the source code. Internally, Python converts the source code into an intermediate form called bytecodes and then translates this into the native language of your computer and then runs it. All this, actually, makes using Python much easier since you don't have to worry about compiling the program, making sure that the proper libraries are linked and loaded, etc. This also makes your Python programs much more portable, since you can just copy your Python program onto another computer and it just works!

Object Oriented

Python supports procedure-oriented programming as well as object-oriented programming. In *procedure-oriented* languages, the program is built around procedures or functions which are nothing but reusable pieces of programs. In *object-oriented* languages, the program is built around objects which combine data and functionality. Python has a very powerful but simplistic way of doing OOP, especially when compared to big languages like C++ or Java.

Extensible

If you need a critical piece of code to run very fast or want to have some piece of algorithm not to be open, you can code that part of your program in C or C++ and then use it from your Python program.

Embeddable

You can embed Python within your C/C++ programs to give *scripting* capabilities for your program's users.

Extensive Libraries

The Python Standard Library is huge indeed. It can help you do various things involving regular expressions, documentation generation, unit testing, threading, databases, web browsers, CGI, FTP, email, XML, XML-RPC, HTML, WAV files, cryptography, GUI (graphical user interfaces), and other system-dependent stuff. Remember, all this is always available wherever Python is installed. This is called the *Batteries Included* philosophy of Python.

Besides the standard library, there are various other high-quality libraries which you can find at the [Python Package Index](#).

Summary

Python is indeed an exciting and powerful language. It has the right combination of performance and features that make writing programs in Python both fun and easy.

Python 3 versus 2

You can ignore this section if you're not interested in the difference between "Python version 2" and "Python version 3". But please do be aware of which version you are using. This book is written for Python version 3.

Remember that once you have properly understood and learn to use one version, you can easily learn the differences and use the other one. The hard part is learning programming and understanding the basics of Python language itself. That is our goal in this book, and once you have achieved that goal, you can easily use Python 2 or Python 3 depending on your situation.

For details on differences between Python 2 and Python 3, see:

- [The future of Python 2](#)
- [Porting Python 2 Code to Python 3](#)
- [Writing code that runs under both Python2 and 3](#)
- [Supporting Python 3: An in-depth guide](#)

What Programmers Say

You may find it interesting to read what great hackers like ESR have to say about Python:

- *Eric S. Raymond* is the author of "The Cathedral and the Bazaar" and is also the person who coined the term *Open Source*. He says that [Python has become his favorite programming language](#). This article was the real inspiration for my first brush with Python.
- *Bruce Eckel* is the author of the famous 'Thinking in Java' and 'Thinking in C++' books. He says that no language has made him more productive than Python. He says that Python is perhaps the only language that focuses on making things easier for the programmer. Read the [complete interview](#) for more details.
- *Peter Norvig* is a well-known Lisp author and Director of Search Quality at Google (thanks to Guido van Rossum for pointing that out). He says that [writing Python is like writing in pseudocode](#). He says that Python has always been an integral part of Google. You can actually verify this statement by looking at the [Google Jobs](#) page which lists Python knowledge as a requirement for software engineers.

Installation

When we refer to "Python 3" in this book, we will be referring to any version of Python equal to or greater than version [Python 3.6.0](#).

Installation on Windows

Visit <https://www.python.org/downloads/> and download the latest version. At the time of this writing, it was Python 3.5.1 The installation is just like any other Windows-based software.

Note that if your Windows version is pre-Vista, you should [download Python 3.4 only](#) as later versions require newer versions of Windows.

CAUTION: Make sure you check option `Add Python 3.5 to PATH`.

To change install location, click on `Customize installation`, then `Next` and enter `C:\python35` (or another appropriate location) as the install location.

If you didn't check the `Add Python 3.5 PATH` option earlier, check `Add Python to environment variables`. This does the same thing as `Add Python 3.5 to PATH` on the first install screen.

You can choose to install Launcher for all users or not, it does not matter much. Launcher is used to switch between different versions of Python installed.

If your path was not set correctly (by checking the `Add Python 3.5 Path` OR `Add Python to environment variables` options), then follow the steps in the next section (`DOS Prompt`) to fix it. Otherwise, go to the `Running Python prompt on Windows` section in this document.

NOTE: For people who already know programming, if you are familiar with Docker, check out [Python in Docker](#) and [Docker on Windows](#).

DOS Prompt

If you want to be able to use Python from the Windows command line i.e. the DOS prompt, then you need to set the PATH variable appropriately.

For Windows 2000, XP, 2003, click on `Control Panel` -> `System` -> `Advanced` -> `Environment Variables`. Click on the variable named `PATH` in the *System Variables* section, then select `Edit` and add `;C:\Python35` (please verify that this folder exists, it will be

different for newer versions of Python) to the end of what is already there. Of course, use the appropriate directory name.

For older versions of Windows, open the file `C:\AUTOEXEC.BAT` and add the line

`PATH=%PATH%;C:\Python35` and restart the system. For Windows NT, use the `AUTOEXEC.NT` file.

For Windows Vista:

- Click Start and choose `Control Panel`
- Click System, on the right you'll see "View basic information about your computer"
- On the left is a list of tasks, the last of which is `Advanced system settings`. Click that.
- The `Advanced` tab of the `System Properties` dialog box is shown. Click the `Environment Variables` button on the bottom right.
- In the lower box titled `System Variables` scroll down to Path and click the `Edit` button.
- Change your path as need be.
- Restart your system. Vista didn't pick up the system path environment variable change until I restarted.

For Windows 7 and 8:

- Right click on Computer from your desktop and select `Properties` or click `Start` and choose `Control Panel -> System and Security -> System`. Click on `Advanced system settings` on the left and then click on the `Advanced` tab. At the bottom click on `Environment Variables` and under `System variables`, look for the `PATH` variable, select and then press `Edit`.
- Go to the end of the line under Variable value and append `;C:\Python35` (please verify that this folder exists, it will be different for newer versions of Python) to the end of what is already there. Of course, use the appropriate folder name.
- If the value was `%SystemRoot%\system32;` It will now become `%SystemRoot%\system32;C:\Python36`
- Click `OK` and you are done. No restart is required, however you may have to close and reopen the command line.

For Windows 10:

Windows Start Menu > `Settings` > `About` > `System Info` (this is all the way over to the right) > `Advanced System Settings` > `Environment Variables` (this is towards the bottom) > (then highlight `Path` variable and click `Edit`) > `New` > (type in whatever your python location is. For example, `C:\Python35\`)

Running Python prompt on Windows

For Windows users, you can run the interpreter in the command line if you have [set the PATH variable appropriately](#).

To open the terminal in Windows, click the start button and click `Run`. In the dialog box, type `cmd` and press `[enter]` key.

Then, type `python` and ensure there are no errors.

Installation on Mac OS X

For Mac OS X users, use [Homebrew](#): `brew install python3`.

To verify, open the terminal by pressing `[Command + Space]` keys (to open Spotlight search), type `Terminal` and press `[enter]` key. Now, run `python3` and ensure there are no errors.

Installation on GNU/Linux

For GNU/Linux users, use your distribution's package manager to install Python 3, e.g. on Debian & Ubuntu: `sudo apt-get update && sudo apt-get install python3`.

To verify, open the terminal by opening the `Terminal` application or by pressing `Alt + F2` and entering `gnome-terminal`. If that doesn't work, please refer the documentation of your particular GNU/Linux distribution. Now, run `python3` and ensure there are no errors.

You can see the version of Python on the screen by running:

```
$ python3 -V
Python 3.6.0
```

NOTE: `$` is the prompt of the shell. It will be different for you depending on the settings of the operating system on your computer, hence I will indicate the prompt by just the `$` symbol.

CAUTION: Output may be different on your computer, depending on the version of Python software installed on your computer.

Summary

From now on, we will assume that you have Python installed on your system.

Next, we will write our first Python program.

First Steps

We will now see how to run a traditional 'Hello World' program in Python. This will teach you how to write, save and run Python programs.

There are two ways of using Python to run your program - using the interactive interpreter prompt or using a source file. We will now see how to use both of these methods.

Using The Interpreter Prompt

Open the terminal in your operating system (as discussed previously in the [Installation](#) chapter) and then open the Python prompt by typing `python3` and pressing `[enter]` key.

Once you have started Python, you should see `>>>` where you can start typing stuff. This is called the *Python interpreter prompt*.

At the Python interpreter prompt, type:

```
print("Hello World")
```

followed by the `[enter]` key. You should see the words `Hello World` printed to the screen.

Here is an example of what you should be seeing, when using a Mac OS X computer. The details about the Python software will differ based on your computer, but the part from the prompt (i.e. from `>>>` onwards) should be the same regardless of the operating system.

```
$ python3
Python 3.6.0 (default, Jan 12 2017, 11:26:36)
[GCC 4.2.1 Compatible Apple LLVM 8.0.0 (clang-800.0.38)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> print("Hello World")
Hello World
```

Notice that Python gives you the output of the line immediately! What you just entered is a single Python *statement*. We use `print` to (unsurprisingly) print any value that you supply to it. Here, we are supplying the text `Hello World` and this is promptly printed to the screen.

How to Quit the Interpreter Prompt

If you are using a GNU/Linux or OS X shell, you can exit the interpreter prompt by pressing `[ctrl + d]` or entering `exit()` (note: remember to include the parentheses, `()`) followed by the `[enter]` key.

If you are using the Windows command prompt, press `[ctrl + z]` followed by the `[enter]` key.

Choosing An Editor

We cannot type out our program at the interpreter prompt every time we want to run something, so we have to save them in files and can run our programs any number of times.

To create our Python source files, we need an editor software where you can type and save. A good programmer's editor will make your life easier in writing the source files. Hence, the choice of an editor is crucial indeed. You have to choose an editor as you would choose a car you would buy. A good editor will help you write Python programs easily, making your journey more comfortable and helps you reach your destination (achieve your goal) in a much faster and safer way.

One of the very basic requirements is *syntax highlighting* where all the different parts of your Python program are colorized so that you can see your program and visualize its running.

If you have no idea where to start, I would recommend using [PyCharm Educational Edition](#) software which is available on Windows, Mac OS X and GNU/Linux. Details in the next section.

If you are using Windows, *do not use Notepad* - it is a bad choice because it does not do syntax highlighting and also importantly it does not support indentation of the text which is very important in our case as we will see later. Good editors will automatically do this.

If you are an experienced programmer, then you must be already using [Vim](#) or [Emacs](#). Needless to say, these are two of the most powerful editors and you will benefit from using them to write your Python programs. I personally use both for most of my programs, and have even written an [entire book on Vim](#).

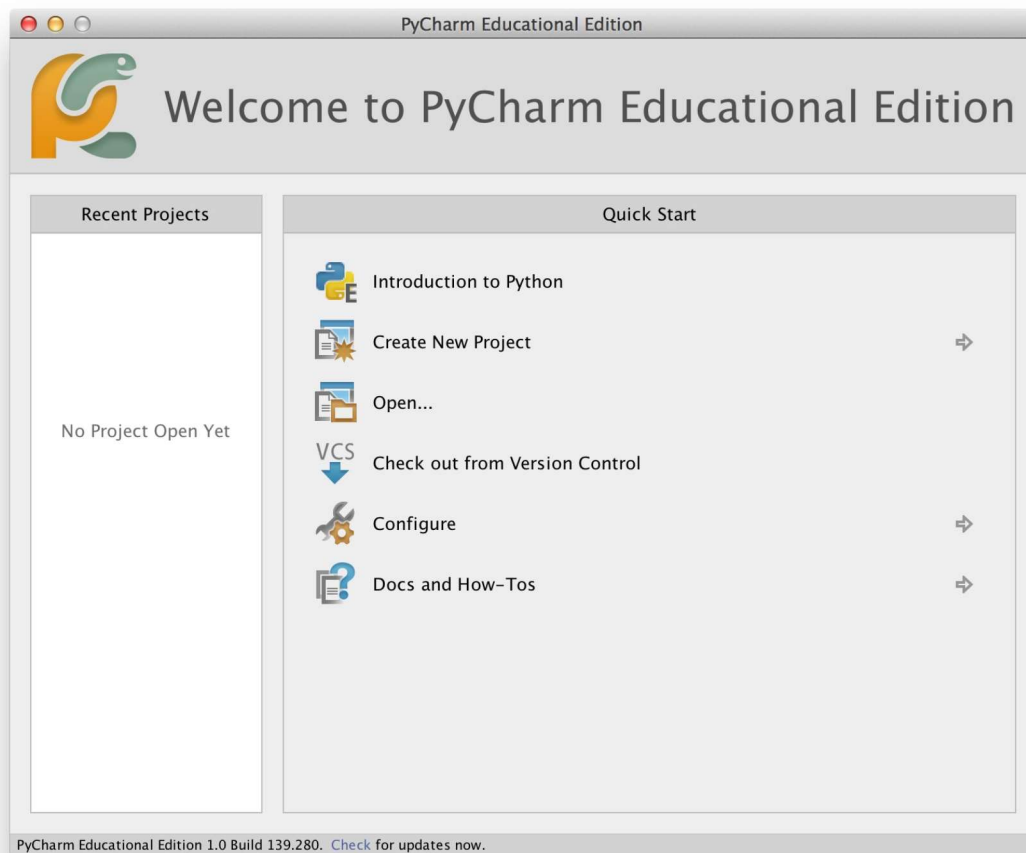
In case you are willing to take the time to learn Vim or Emacs, then I highly recommend that you do learn to use either of them as it will be very useful for you in the long run. However, as I mentioned before, beginners can start with PyCharm and focus the learning on Python rather than the editor at this moment.

To reiterate, please choose a proper editor - it can make writing Python programs more fun and easy.

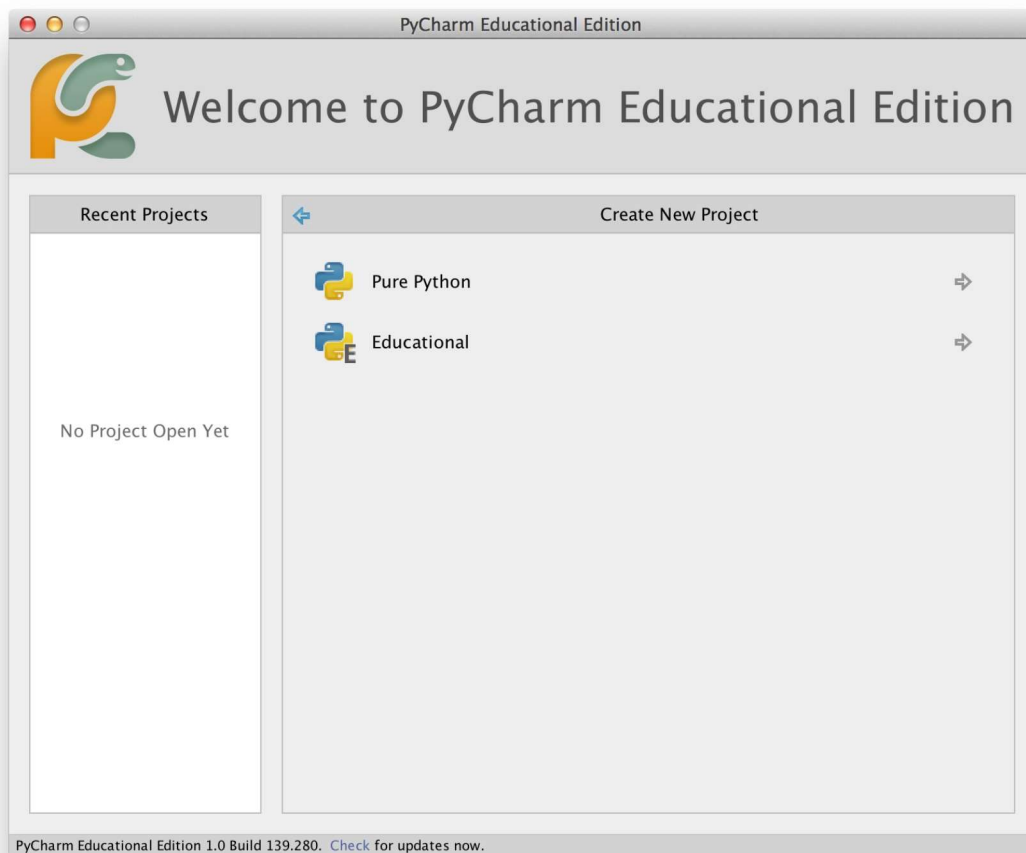
PyCharm

[PyCharm Educational Edition](#) is a free editor which you can use for writing Python programs.

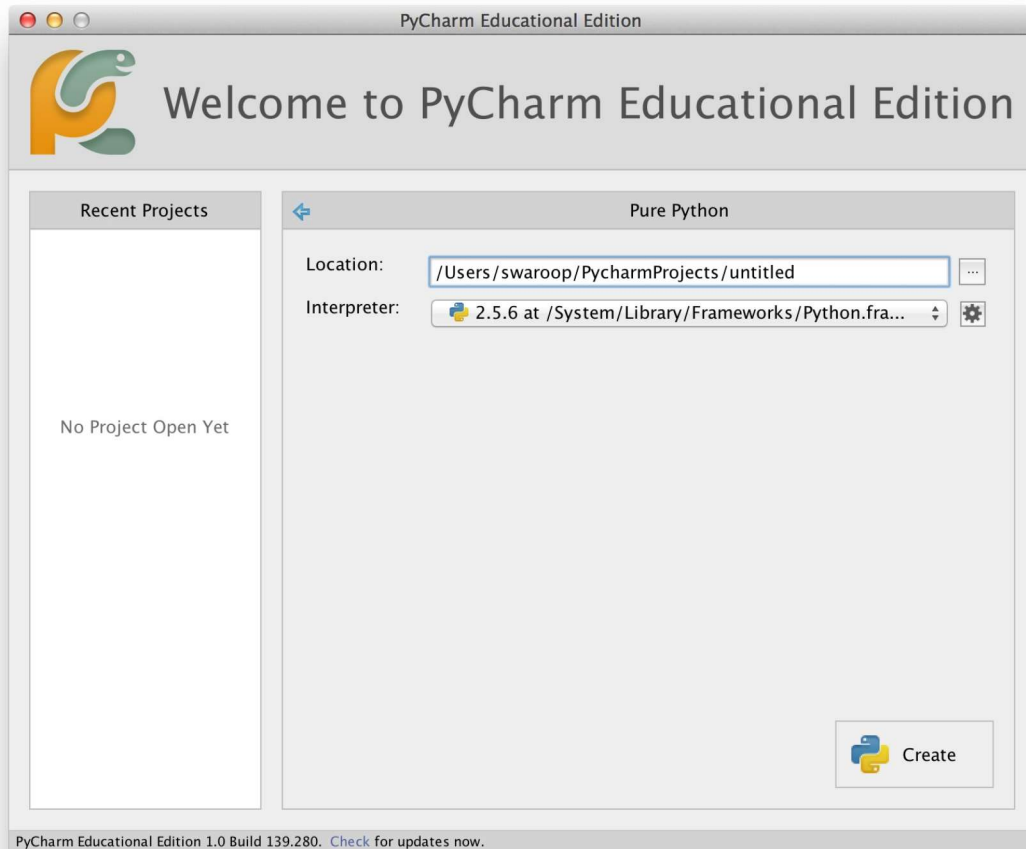
When you open PyCharm, you'll see this, click on `Create New Project` :



Select `Pure Python` :

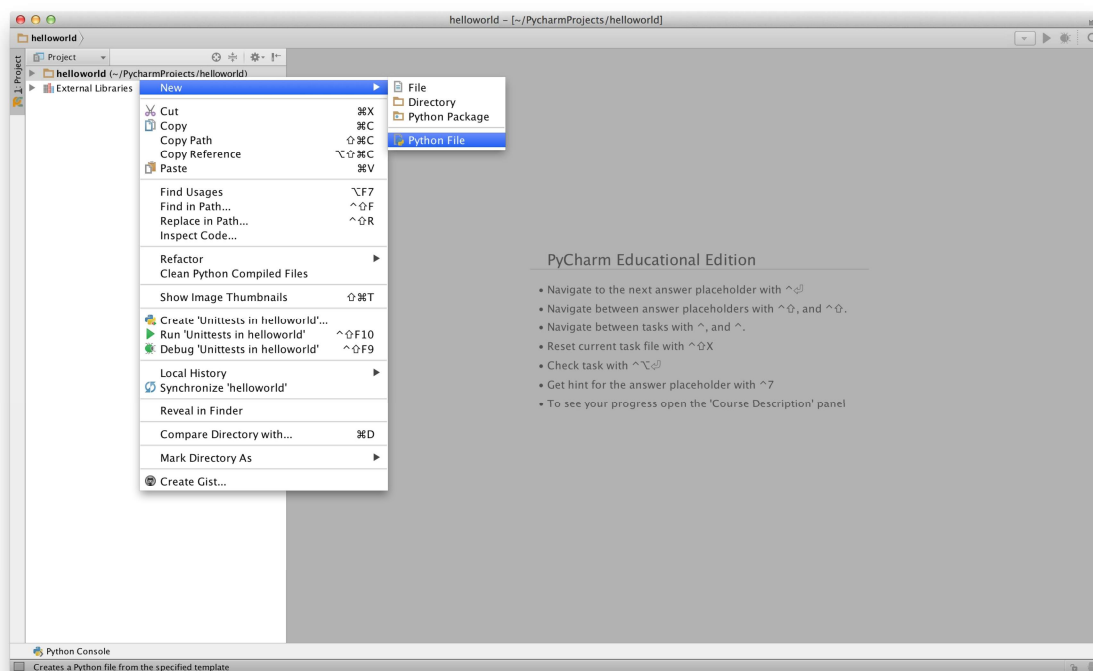


Change `untitled` to `helloworld` as the location of the project, you should see details similar to this:

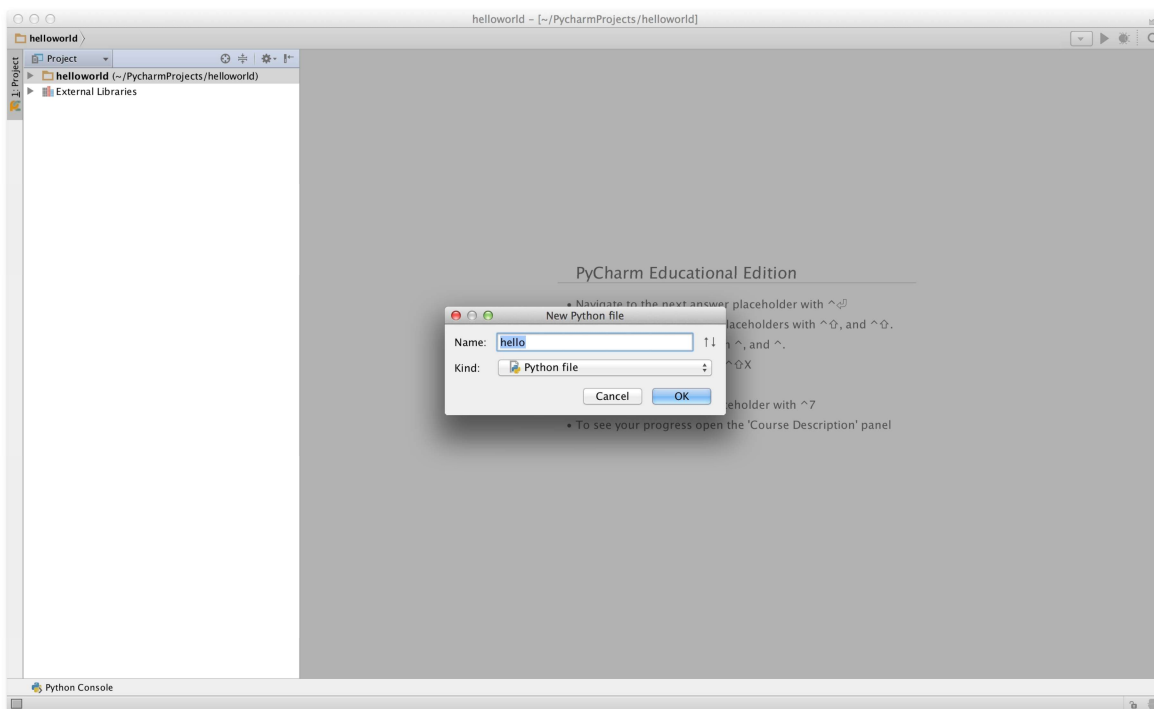


Click the `create` button.

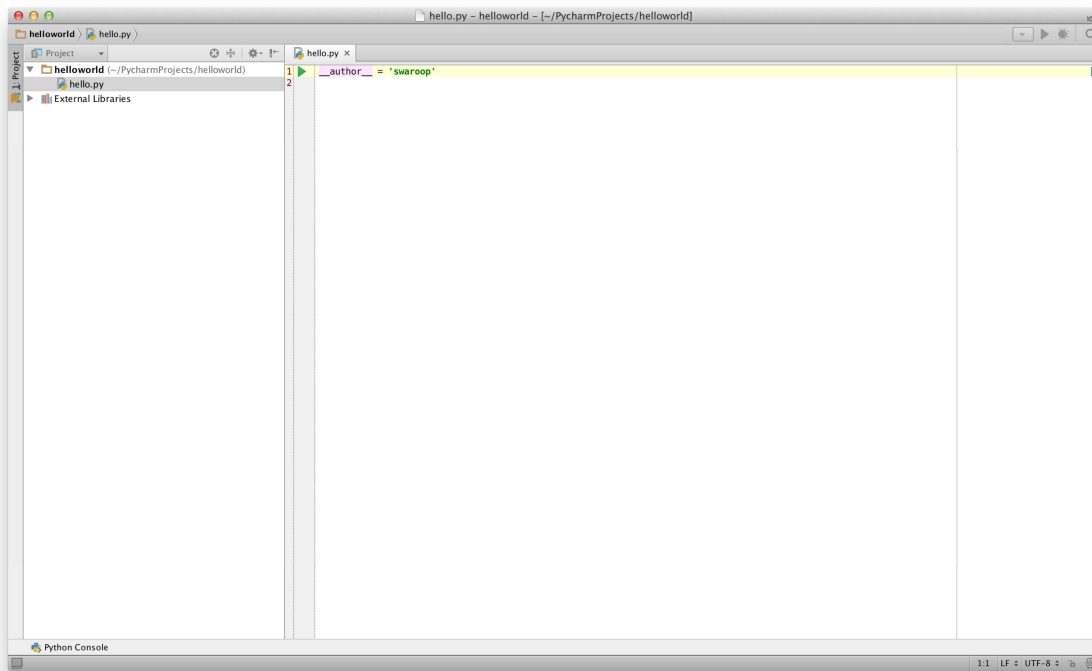
Right-click on the `helloworld` in the sidebar and select `New` -> `Python File` :



You will be asked to type the name, type `hello` :



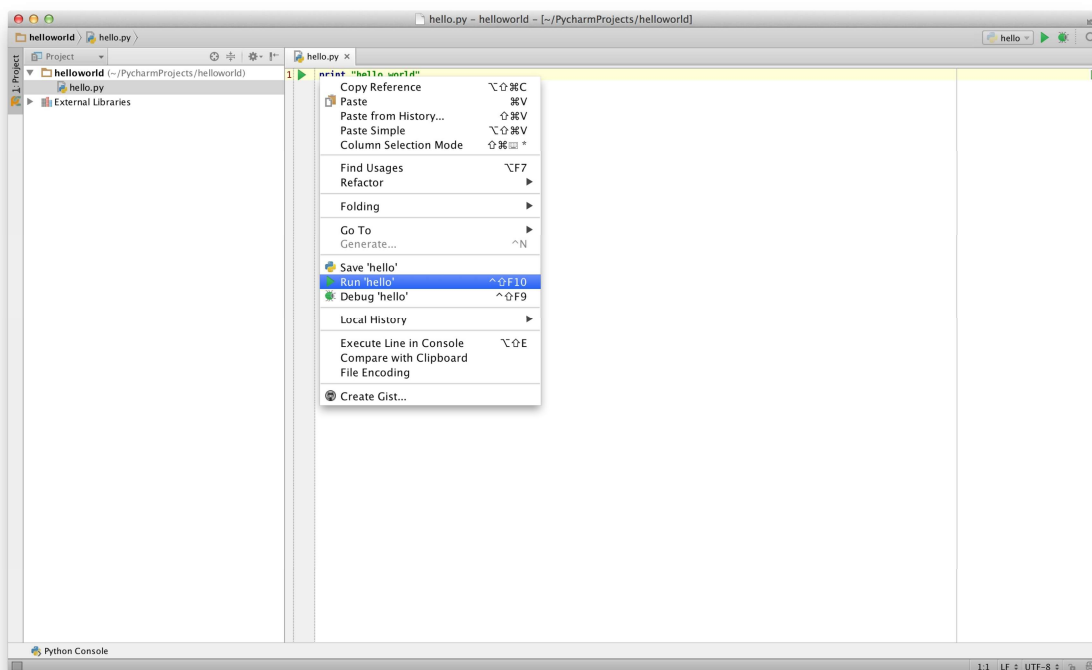
You can now see a file opened for you:



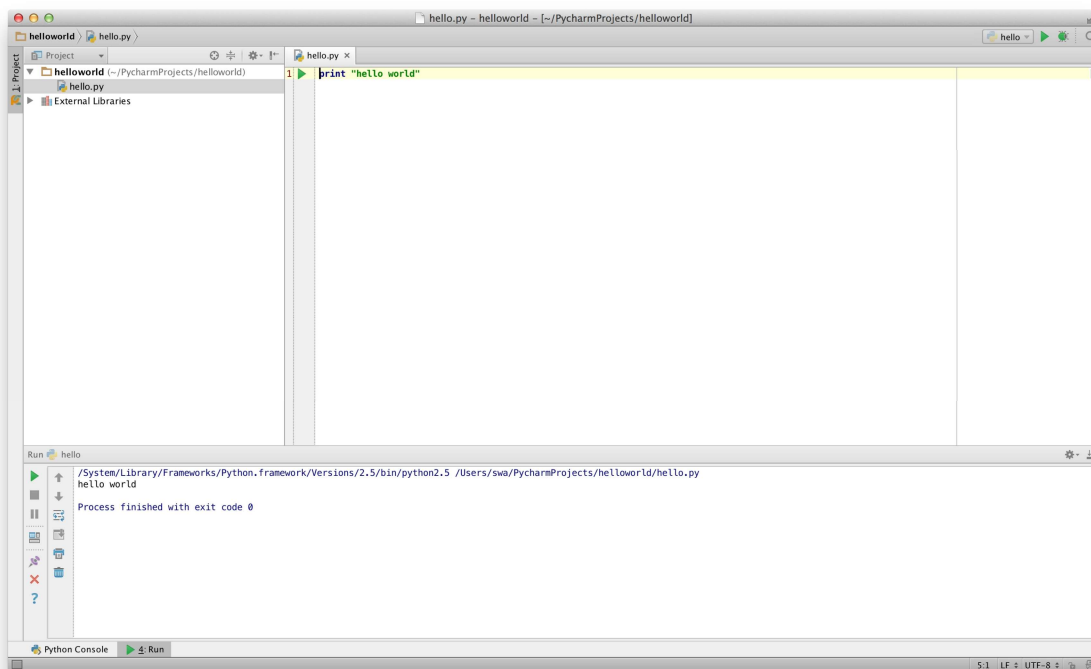
Delete the lines that are already present, and now type the following:

```
print("hello world")
```

Now right-click on what you typed (without selecting the text), and click on `Run 'hello'`.



You should now see the output (what it prints) of your program:



Phew! That was quite a few steps to get started, but henceforth, every time we ask you to create a new file, remember to just right-click on `helloworld` on the left -> `New` -> `Python File` and continue the same steps to type and run as shown above.

You can find more information about PyCharm in the [PyCharm Quickstart](#) page.

Vim

1. Install [Vim](#)
 - Mac OS X users should install `macvim` package via [HomeBrew](#)
 - Windows users should download the "self-installing executable" from [Vim website](#)
 - GNU/Linux users should get Vim from their distribution's software repositories, e.g. Debian and Ubuntu users can install the `vim` package.
2. Install [jedi-vim](#) plugin for autocompletion.
3. Install corresponding `jedi` python package : `pip install -U jedi`

Emacs

1. Install [Emacs 24+](#).
 - Mac OS X users should get Emacs from <http://emacsformacosx.com>
 - Windows users should get Emacs from <http://ftp.gnu.org/gnu/emacs/windows/>

- GNU/Linux users should get Emacs from their distribution's software repositories, e.g. Debian and Ubuntu users can install the `emacs24` package.

2. Install [ELPY](#)

Using A Source File

Now let's get back to programming. There is a tradition that whenever you learn a new programming language, the first program that you write and run is the 'Hello World' program - all it does is just say 'Hello World' when you run it. As Simon Cozens¹ says, it is the "traditional incantation to the programming gods to help you learn the language better."

Start your choice of editor, enter the following program and save it as `hello.py`.

If you are using PyCharm, we have already [discussed how to run from a source file](#).

For other editors, open a new file `hello.py` and type this:

```
print("hello world")
```

Where should you save the file? To any folder for which you know the location of the folder. If you don't understand what that means, create a new folder and use that location to save and run all your Python programs:

- `/tmp/py` on Mac OS X
- `/tmp/py` on GNU/Linux
- `C:\py` on Windows

To create the above folder (for the operating system you are using), use the `mkdir` command in the terminal, for example, `mkdir /tmp/py`.

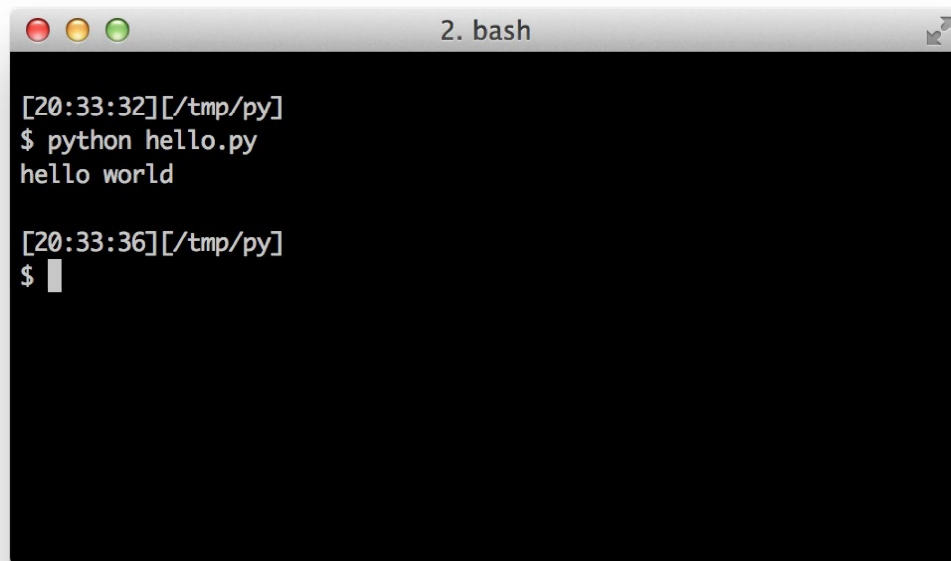
IMPORTANT: Always ensure that you give it the file extension of `.py`, for example,

```
foo.py
```

To run your Python program:

1. Open a terminal window (see the previous [Installation](#) chapter on how to do that)
2. **Change directory** to where you saved the file, for example, `cd /tmp/py`
3. Run the program by entering the command `python hello.py`. The output is as shown below.

```
$ python hello.py
hello world
```

A terminal window titled "2. bash" with a dark background and light-colored text. The window shows the execution of a Python program. The first prompt is "[20:33:32][~/tmp/py]" followed by "\$ python hello.py" and the output "hello world". The second prompt is "[20:33:36][~/tmp/py]" followed by "\$" and a cursor.

```
[20:33:32][~/tmp/py]
$ python hello.py
hello world

[20:33:36][~/tmp/py]
$
```

If you got the output as shown above, congratulations! - you have successfully run your first Python program. You have successfully crossed the hardest part of learning programming, which is, getting started with your first program!

In case you got an error, please type the above program *exactly* as shown above and run the program again. Note that Python is case-sensitive i.e. `print` is not the same as `Print` - note the lowercase `p` in the former and the uppercase `P` in the latter. Also, ensure there are no spaces or tabs before the first character in each line - we will see [why this is important](#) later.

How It Works

A Python program is composed of *statements*. In our first program, we have only one statement. In this statement, we call the `print` *statement* to which we supply the text "hello world".

Getting Help

If you need quick information about any function or statement in Python, then you can use the built-in `help` functionality. This is very useful especially when using the interpreter prompt. For example, run `help('len')` - this displays the help for the `len` function which is used to count number of items.

TIP: Press `q` to exit the help.

Similarly, you can obtain information about almost anything in Python. Use `help()` to learn more about using `help` itself!

In case you need to get help for operators like `return`, then you need to put those inside quotes such as `help('return')` so that Python doesn't get confused on what we're trying to do.

Summary

You should now be able to write, save and run Python programs at ease.

Now that you are a Python user, let's learn some more Python concepts.

¹. the author of the amazing 'Beginning Perl' book [↩](#)