

Introduction to Python

Intensive Python

- ▶ Faced-paced coverage of core Python
- ▶ Assumes you know programming principles
 - ▶ Not necessarily in Python
- ▶ Goes deeper into the Python language than a Python-based CS1 course

Python gives you wings!

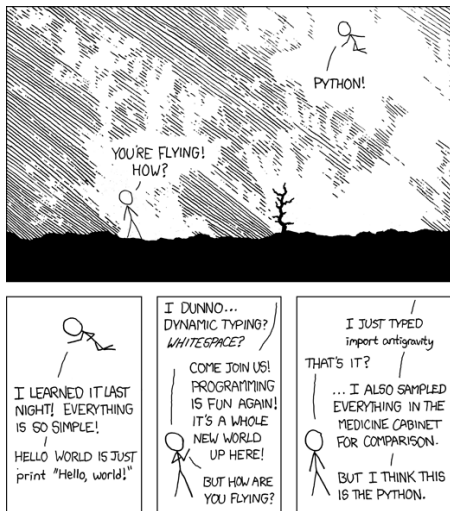


Figure 1: Python Wings

<http://xkcd.com/353/>

The Python Language

- ▶ Python is a general-purpose programming language, meaning you can write any kind of program in Python
 - ▶ A *domain-specific language* is designed for one application. E.g., SQL is just for manipulating relational databases.
- ▶ Python is interpreted, meaning you can run programs directly after you write them; you don't have to compile programs to some intermediate form for the operating system or a virtual machine to execute.
- ▶ Python is a great “glue” language; Python programs often bring together disparate components to do a coherent task.
 - ▶ One particular kind of glue is Python's killer feature for data science: easy to create Python bindings for libraries written in other languages
 - ▶ Data science libraries, e.g., NumPy, TensorFlow, are written high-performance languages like C and C++
 - ▶ Python provides a more comfortable way to use high-performance libraries

The coolest thing about Python ...

The Python Name



Figure 2: Flying Circus

<https://en.wikipedia.org/w/index.php?curid=6130072>

Python was named for Monty Python, of which Python's creator, Guido van Rossum, is a big fan.

The `python3` Program

Practically speaking, Python is a program on your computer that interprets Python programs and statements.

- ▶ You can ask `python3` a question without running any Python code. For example, this is how you ask which version of Python is installed (Note: the `$` character is the command prompt in the Unix Bash shell. The Windows command prompt is `C:\>`):

```
1 $ python3 --version
2 Python 3.8.10
```

If you get some other response, like command not found, then you haven't properly installed Python.

Executing Python Code

- ▶ You can run a Python program, which has a .py extension by convention:

```
1 $ python3 myprogram.py
```

- ▶ Or you can invoke the interactive Python shell (sometimes called REPL for “Read-Eval-Print Loop”):

```
1 $ python3
2 Python 3.8.10 (default, Jun  2 2021, 10:49:15)
3 [GCC 9.4.0] on linux
4 Type "help", "copyright", "credits" or "license" for more information.
5 >>>
```

To exit the Python shell type Ctrl-D on Linux/Unix, or Ctrl-Z on Windows.

Hello, Python

Since Kernighan and Ritchie's "The C Programming Language" it's customary for your first program in a new language to be "Hello, world!"

- ▶ Open your text editor, paste the following code into a buffer (or tab or window or whatever your editor calls it), and save it as `hello.py`:

```
1 print("Hello, world!")
```

- ▶ Then open your command shell (terminal on Unix or CMD.exe on Windows), go to the directory where you saved `hello.py` and enter:

```
1 $ python3 hello.py
```

Hello, world! will be printed to the console on the next line.

Interpreting Python Programs

What happens when we enter `python3 hello.py` at an operating system command shell prompt?

1. `python3` tells the OS to load the Python interpreter into memory and run it. `python` is the name of an executable file on your hard disk which your OS can find because its directory is on the `PATH`
2. We invoke `python` with a *command line argument*, which `python3` reads after it starts running
3. Since the command line argument was the name of a file (`hello.py`), the `python3` loads the file and executes the Python code in it.

A Python program, or script, is just a sequence of Python statements and expressions.

The Python REPL

Invoke the Python interactive shell by entering `python` at your command shell's prompt without any arguments and type in the same line we put in `hello.py`:

```
1 $ python3
2 Python 3.8.10 (default, Jun 2 2021, 10:49:15)
3 [GCC 9.4.0] on linux
4 Type "help", "copyright", "credits" or "license" for more information.
5 >>>
```

`>>>` is the command prompt for the Python REPL.

► REPL stands for *Read Eval Print Loop*:

1. *Read* an expression or statement at the command prompt,
2. *Evaluate* the expression or execute the statement,
3. *Print* the result to the console, and
4. *Loop* back to *Read* step

We'll spend a lot of time in the REPL, but since this course is intended as a fast-paced introduction to Python for data analytics, we'll use the `iPython` REPL.

iPython

Two modes:

- ▶ Interactive shell
 - ▶ Replacement for `python` REPL
- ▶ Jupyter notebook
 - ▶ Interactive web-based documents mixing text, executable code, graphics

Before we proceed, make sure your computer is ready (OS shell):

```
1 $ pip3 install ipython
```

iPython Shell History

```
1 In [1]: ['Sage', 'Thyme', 'Oragano', 'Posh']
2 Out[1]: ['Sage', 'Thyme', 'Oragano', 'Posh']
3
4 In [2]: type(In[1])
5 Out[2]: str
6
7 In [3]: type(Out[1])
8 Out[3]: list
9
10 In [4]: spices = Out[1]
11
12 In [5]: spices
13 Out[5]: ['Sage', 'Thyme', 'Oragano', 'Posh']
14
15 In [6]: spices is Out[1]
16 Out[6]: True
```

`In` is a list, `Out` is a dict.

iPython Help

Single ? gives abbreviated version of python's `help`

```
1 In [7]: def add(a, b):
2     ...:     """Return the result of + operation on a and b"""
3     ...:     return a + b
4     ...:
5 In [8]: add?
6 Signature: add(a, b)
7 Docstring: Return the result of + operation on a and b
8 File:      ~/cs2316/<ipython-input-7-af5293282e78>
9 Type:      function
```

Double ?? gives source code, if available.

```
1 In [9]: add??
2 Signature: add(a, b)
3 Source:
4 def add(a, b):
5     """Return the result of + operation on a and b"""
6     return a + b
7 File:      ~/cs2316/<ipython-input-7-af5293282e78>
8 Type:      function
```

iPython Magic Commands

Special commands provided by iPython, prepended by %.

- ▶ Run a Python script from within iPython:

```
1 In [35]: %run people.py
2 [<Stan, 2008-08-13, 150cm, 45kg>,
3  <Kyle, 2008-02-25, 160cm, 50kg>,
4  <Cartman, 2008-05-26, 140cm, 100kg>,
5  <Kenny, 2009-07-30, 130cm, 40kg>]
```

- ▶ Get help with a magic command with ?

```
1 In [2]: %cd?
2 Docstring:
3 Change the current working directory.
4
5 (content elided)
6
7 Usage:
8
9     cd 'dir': changes to directory 'dir'.
10 (additional output elided)
```

Get a list of all magic commands with %lsmagic

iPython Shell Commands

Run shell commands by prepending with a !

```
1 In [27]: !ls *.py
2 fun.py      grades.py    maths.py     people.py    pp.py
3
4 In [28]: pyscripts = !ls *.py
5
6 In [29]: pyscripts
7 Out[29]: ['fun.py', 'grades.py', 'maths.py', 'people.py', 'pp.py']
```

iPython provides magic commands for most common shell commands.

iPython Directory Bookmarking

Great time saving feature.

```
1 In [3]: %pwd
2 Out[3]: '/home/chris/vcs/github.com/cs2316/cs2316.github.io/code'
3
4 In [4]: %cd
5 /home/chris
6
7 In [5]: %bookmark cs2316code
8         ~/chris/vcs/github.com/cs2316/cs2316.github.io/code
9
10 In [6]: cd cs2316code
11 (bookmark:cs2316code) -> ~/chris/vcs/github.com/cs2316/cs2316.github.io/code
/home/chris/vcs/github.com/cs2316/cs2316.github.io/code
```


iPython Automagic commands

With `automagic` turned on, some shell commands can be run as if they were built into iPython:

```
1 In [22]: pwd
2 Out[22]: '/Users/chris/cs2316'
3
4 In [23]: ls *.py
5 fun.py      grades.py  maths.py   people.py  pp.py
```

- ▶ Toggle automagic on and off with `%automagic`.
- ▶ These commands work with automagic:
 - ▶ `%cd`, `%cat`, `%cp`, `%env`, `%ls`, `%man`, `%mkdir`, `%more`, `%mv`, `%pwd`, `%rm`, and `%rmdir`

`%doctest_mode`

iPython is superior to the Python.org REPL, but doctests use the Python.org REPL prompt. For writing doctest examples, iPython offers the `%doctest_mode` magic.

```
1  In [93]: def dubbel(x: int) -> int:
2           ...:     return x * 2
3           ...:
4
5  In [94]: %doctest_mode
6  Exception reporting mode: Plain
7  Doctest mode is: ON
8  >>> dubbel(3)
9  6
10 >>> %doctest_mode
11 Exception reporting mode: Context
12 Doctest mode is: OFF
13
14 In [97]:
```

Conclusion

- ▶ Python is an interpreted general purpose language
- ▶ Python code can be run as programs or interactively in a Python REPL
- ▶ Python is a great glue language
- ▶ Python is fun!