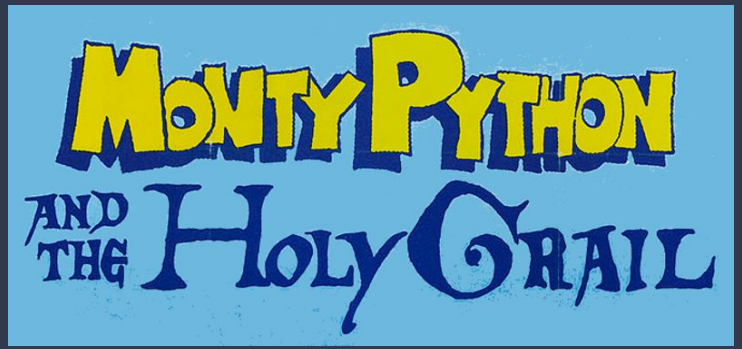
# Programming in Python

An introduction
by William Grimes

# Overview

- History of Python programming
- Why use Python?
- How to install Python
- Where to run Python?
- Course contents:
  - Data types
  - Boolean conditionals (if/else)
  - Loops
  - Dictionaries
  - Functions
  - Classes and OOP
  - Useful libraries (numpy, matplotlib)

# History of Python

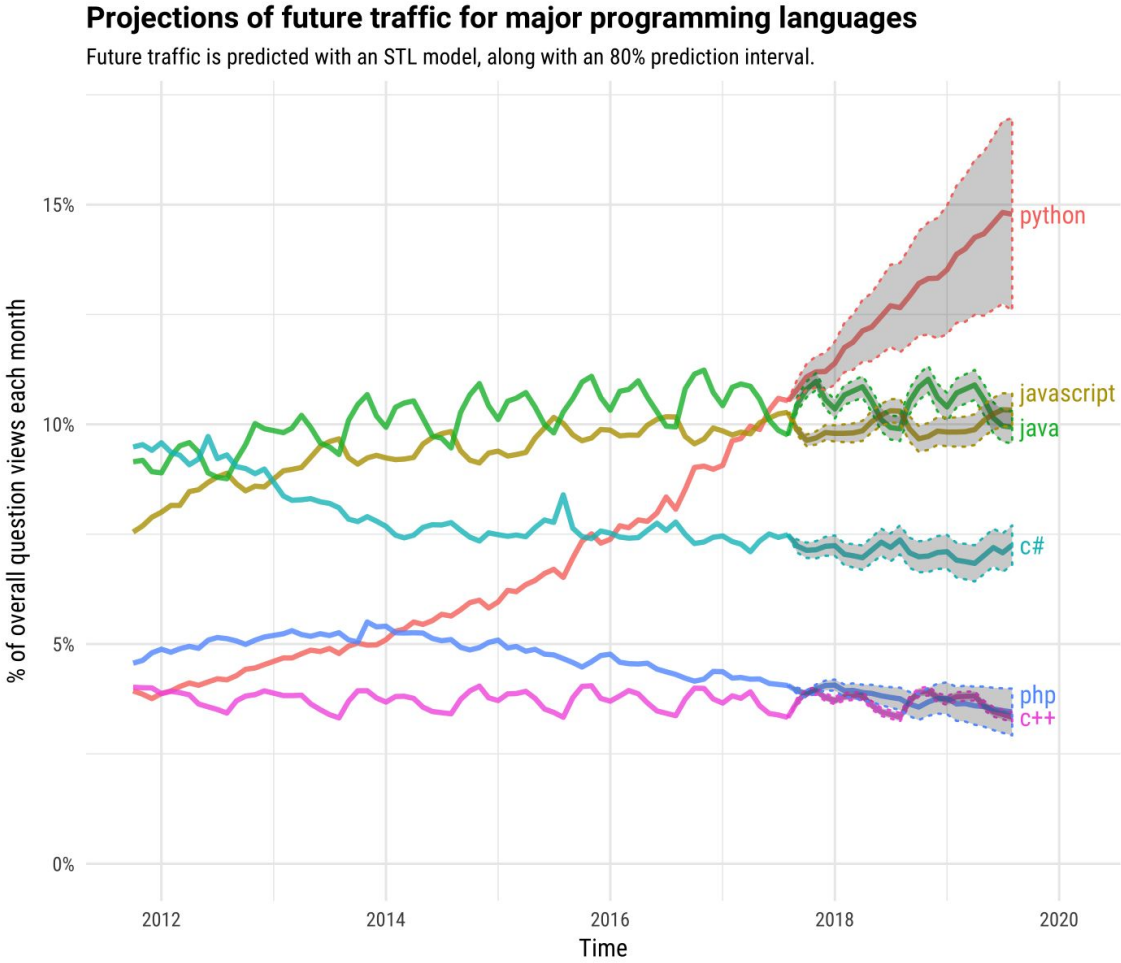



- Conceptualised in 1980s by a Dutch programmer Guido van Rossum
- Named after Monty Python, the British TV show
- Python versions:
  - 1990: Python
  - 2000: Python 2.0
  - 2008: Python 3.0

# Python is popular

- Python was the most visited tag on Stack Overflow within high-income nations

- Very versatile uses:
  - Finance
  - Sciences
  - Web and internet development
  - Desktop applications
  - Business



# Why Python?


- Powerful, open-source, and free
- Efficient high level data structures, allowing you to do more in fewer lines of code.
- Both object-oriented and imperative
- It is an interpreted language, rather than compiled, so easier to write code, but execution is slower.
- Fun and easy to be productive


# Python installation

- Python 2 vs Python 3
  - Different syntax
    - print ‘hello’
    - print(‘hello’)
  - Not backwards compatible
  - Python 3 is supported now

- Anaconda is a Python distribution
  - Bundled with useful packages
  - Includes a package manager
  - Includes Jupyter Notebooks

- Download Anaconda Python 3.6

https://www.anaconda.com/download

```
>>> x = {'a': 1, 'b': 2}
>>> y = {'b': 3, 'c': 4}

>>> z = {**x, **y}

>>> z
{'c': 4, 'a': 1, 'b': 3}
```

# Where to run Python?


```
>>> x = {'a': 1, 'b': 2}
>>> y = {'b': 3, 'c': 4}

>>> z = {**x, **y}

>>> z
{'c': 4, 'a': 1, 'b': 3}
```


- Main ways to access python:

1. **Python Shell**
   - terminal/command prompt

2. **Jupyter Notebooks**
   - Graphical procedural approach, useful for experimenting

3. **IDE :** Integrated Development Environment
   - A software that helps you build code

# 1) Python Shell

```
~ python
Python 3.5.3 | packaged by conda-forge | (default, May 12 2017, 15:07:14)
[GCC 4.8.2 20140120 (Red Hat 4.8.2-15)] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> print("this is the python shell")
this is the python shell
>>>
```

- Also called: shell, terminal, command prompt, interpreter, console
- A basic python interface, without the bells and whistles
- Activate in a terminal window by typing: ***python***
- Or try it here: [https://www.python.org/shell/](https://www.python.org/shell/)

# 2) IPython and Jupyter Notebooks

jupyter 0_topic_extraction_trials Last Checkpoint: 03/05/2017 (unsaved changes)

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Python [conda root]

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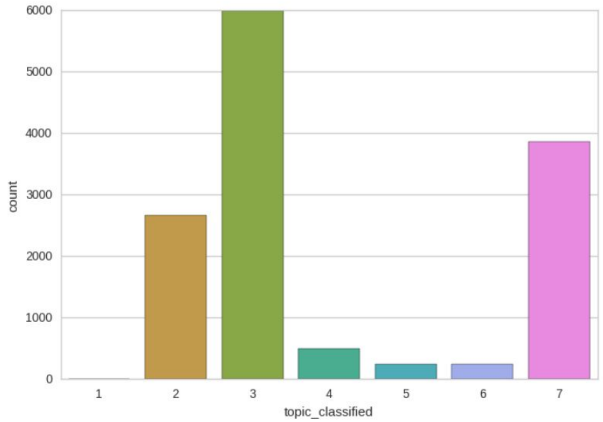
```
lfb_with_free_text['year'] = lfb_with_free_text.DDDateTimeOfCall.dt.year
```

In [17]:
```
lfb_with_free_text.topic_classified.value_counts()
```

Out[17]:
```
3    5982
7    3860
2    2663
4     494
6     249
5     239
1       3
Name: topic_classified, dtype: int64
```

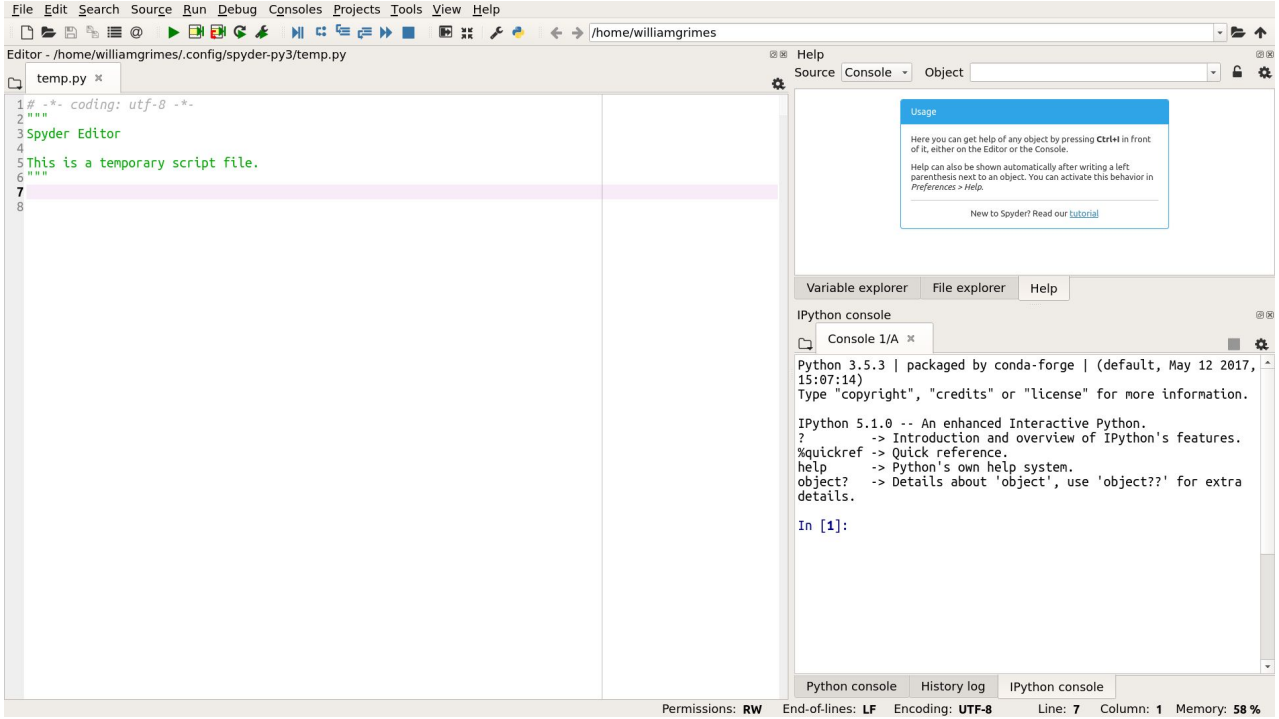
In [18]:
```
a = CorpusExtractor.extract_entire_corpus(lfb_with_free_text[lfb_with_free_text.topic_classified==4], free_text_columns)
a.to_csv('../topics_5.csv', index=False)
```

In [19]:
```
sns.set_style("whitegrid")
ax = sns.countplot(x="topic_classified", data=lfb_with_free_text)
```




- Shell for interactive Python
- Like a scientific laboratory notebook, useful for learning and experimenting
- Jupyter Notebook:
  - Browser based
  - Data visualisation
  - Markdown
  - Live code
- Jupyter comes with Anaconda

# 3) Integrated Development Environment (IDE)




- Includes:
  - Area to edit code
  - Python console
  - Functions to run, debug, and highlight errors
- IDEs:
  - Spyder
  - PyCharm
  - Rodeo
  - …
- Spyder comes with Anaconda

# Course overview

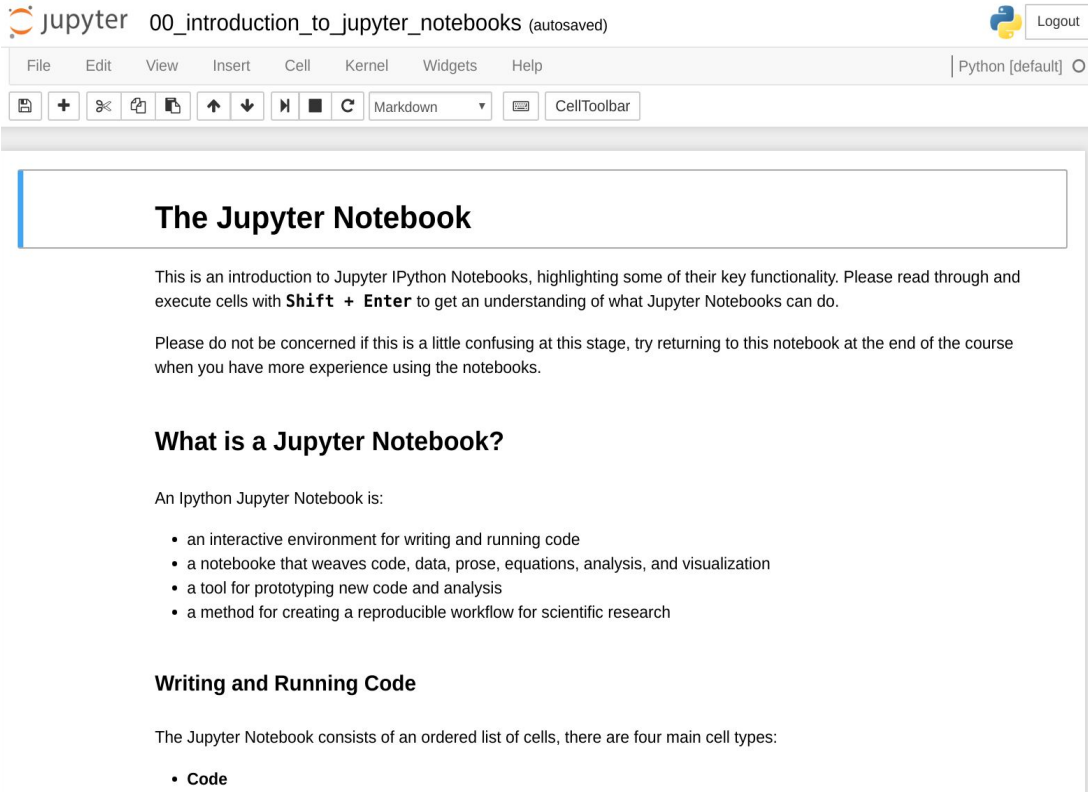
- Contents
  - Programming principles:
    - Data types
    - Boolean conditionals (if/else)
    - Loops
    - Dictionaries
    - Functions
    - Classes and OOP
  - Useful libraries
    - Numpy
    - matplotlib

- 14 Jupyter notebooks
- Extra notebooks for more detail
- Walkthroughs with examples

https://github.com/williamgrimes/python_in_a_notebook

# Lesson 0:

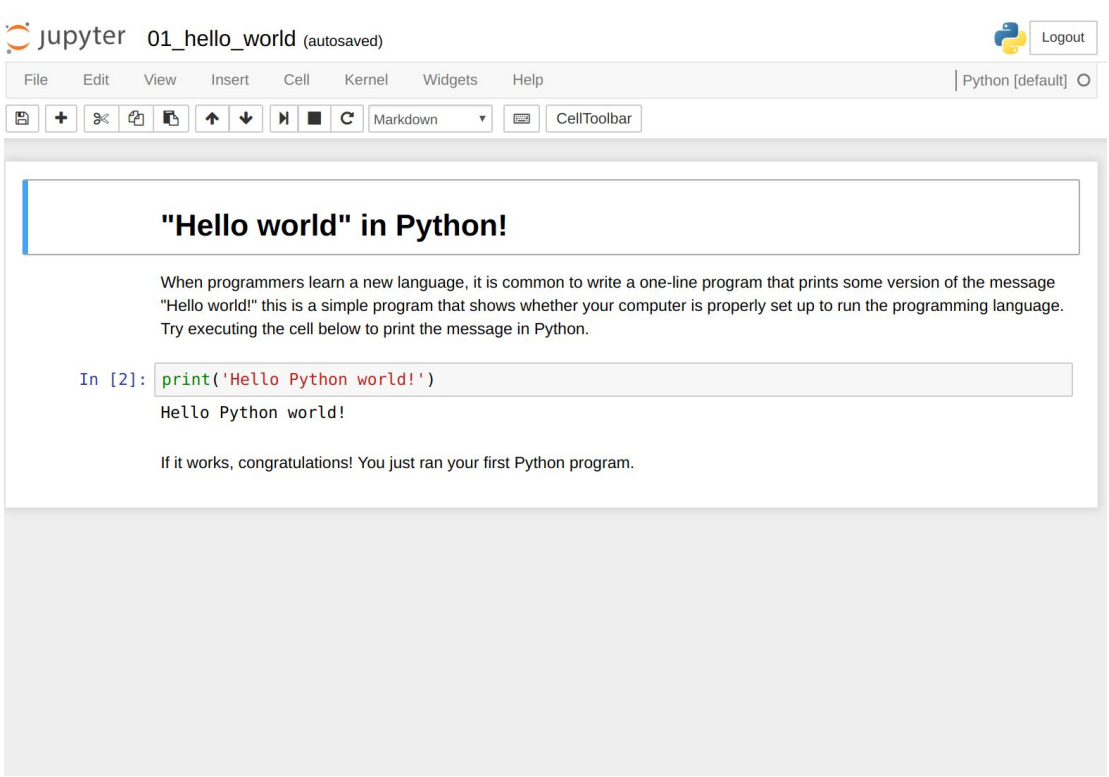
## Jupyter.ipynb




- How to work in Jupyter notebooks
- Demonstrates notebook functionality

# Lesson 1:

## “Hello World”




- Simple program to demonstrate basic syntax
- Customary when learning a new language

# Lesson 2:

## Data types and variables

jupyter 02_datatypes_strings_numbers_and_variables (autosaved) Logout

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### Variables, Strings, and Numbers

In this section, you will learn to store information in variables.

You will learn about two types of data: strings, which are sets of characters, and numerical data types.

### Contents



- Variables hold a value
  - Can be of multiple data types
  - string = “this is a string”
  - integer = 20395

# Lesson 3:

## Lists, tuples, and sets

- `a_list = ['item_0', 'item_1', 2]`
  - Creation
  - Sorting
  - Looping
  - Slicing
  - List comprehension
- `a_tuple = (0, 'item_1', 12.34)`
  - fixed length
- `a_set = {0, 1, 2, 3}`
  - Membership checking
  - Intersection and union

# Lesson 4:

## If statements and conditional logic

```
dogs = []

if len(dogs) >= 5:
    print("Lets start a dog hostel!")
elif len(dogs) >= 3:
    print("Wow, we have a lot of dogs here!")
elif len(dogs) >= 1:
    print("Okay, some dogs.")
else:
    print("I wish we had a dog here.")
```

- If, else, else if
- Boolean conditionals
- Test for a condition, and perform action
- N.B. indentation matters in Python

# Lesson 5:

## Loops
- for
- While
- infinite

```
edibles = ["ham", "spam", "eggs","nuts"]
for food in edibles:
    if food == "spam":
        print("No more spam please!")
        continue
    print("Great, delicious " + food)
else:
    print("I am so glad: No spam!")
print("Finally, I finished stuffing myself")
```

**Output:**
Great, delicious ham
No more spam please!
Great, delicious eggs
Great, delicious nuts
I am so glad: No spam!
Finally, I finished stuffing myself

# Lesson 6:

## Dictionaries

- Unordered sets
- Key-value pairs
- Implemented as hash tables

```
city_population = {"New York City":8550405,
                   "Los Angeles":3971883,
                   "Toronto":2731571,
                   "Vancouver":631486,
                   "Boston":667137}
```

**Output:**

```
>>> city_population["New York City"]
8550405
```

# Lesson 7:

## Functions

- Functions are code that is grouped together
  - Subroutines
  - Routines
  - Procedures
  - Methods
  - Subprograms
  - …

- Allows code to be reused

```
def return_sum(x,y):
    c = x + y
    return c

res = return_sum(4,5)
```

**Output:**

```
>>> print(res)
9
```

# Lesson 8:

## More functions

*Advanced topic*

- The return statement
- If this is too complex return to it later
- Function arguments
  - *args
  - **kwargs

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### More Functions

Earlier we learned the most bare-boned versions of functions. In this section we will learn more general concepts about functions, such as how to use functions to return values, and how to pass different kinds of data structures between functions.

### Contents

# Lesson 9:

## Classes and Object-Oriented Programming (OOP)

*Advanced topic*

- Classes combine information and behaviour in objects, aka variables and methods

- A very powerful tool in Python (and other languages e.g. C++. C#, Java, …)

- Four major principles of OOP:L
  - Encapsulation
  - Data Abstraction
  - Polymorphism
  - Inheritance

- Don’t worry if this seems abstract at the moment read the notebook anyway. You may not need to use OOP programming, but should be aware of what it is.

# Lesson 10:

## Exceptions

- Exception is an error during execution
- Modify flow through a program
- Python has built-in support for exception handling
- You may not need this in your code yet but good to be aware how to handle errors.

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### Exceptions

Exceptions which are events that can modify the *flow* of control through a program.

In Python, exceptions are triggered automatically on errors, and they can be triggered and intercepted by your code.

They are processed by **four** statements we'll study in this notebook, the first of which has two variations (listed separately here) and the last of which was an optional extension until Python 2.6 and 3.0:

- `try/except`:
  - Catch and recover from exceptions raised by Python, or by you
- `try/finally`:
  - Perform cleanup actions, whether exceptions occur or not

# Lesson 11:

## External files

- How to read files in and out
- Handling data
- Also look at Numpy and Pandas libraries

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### Text Files

Data is often stored in formats that are not easy to read unless you have some specialised software. Excel spreadsheets are one example; how do you read an Excel spreadsheet if you don't have Excel? This reliance on particular software is not very useful for programmatic analysis of data. Instead if we're going to use a programming language to analyse or process our data we would prefer some "easy to deal with" format. Text files or flatfiles provide just the sort of format we need (there are other choices). You can think of these as a single sheet from a spreadsheet with the data arranged in rows (separated by our old friend the `\n` character) and columns (separated by some other character).

Slide Type Sub-Slide

There are two common characters used to separate the data in text files into columns. The `\t`, or tab stop character and the humble comma (,). In both cases fields in our input file are separated by a single tab stop or a single comma.

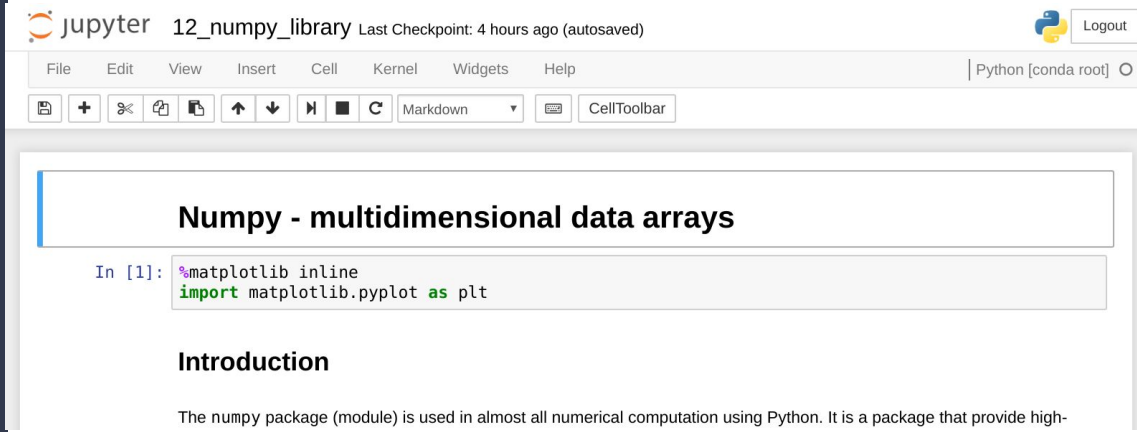
This gives rise to two commonly used file extensions (the bit after the dot in file names e.g. in `myfile.docx` the 'docx' is the file extension.). These file extensions are `.tsv` for 'tab separated file' and `.csv` for 'comma separated file'. Other separators in text files of data may be little used characters such as '|', ':' or spaces. As a quick aside separating fields in data files by spaces is tricky because an individual value might also contain spaces and therefore be inappropriately divided over more than one column.

As an illustration if you were to print a couple of lines from a `.tsv` file out it would look something like this:

# Lesson 12:

## Numpy library

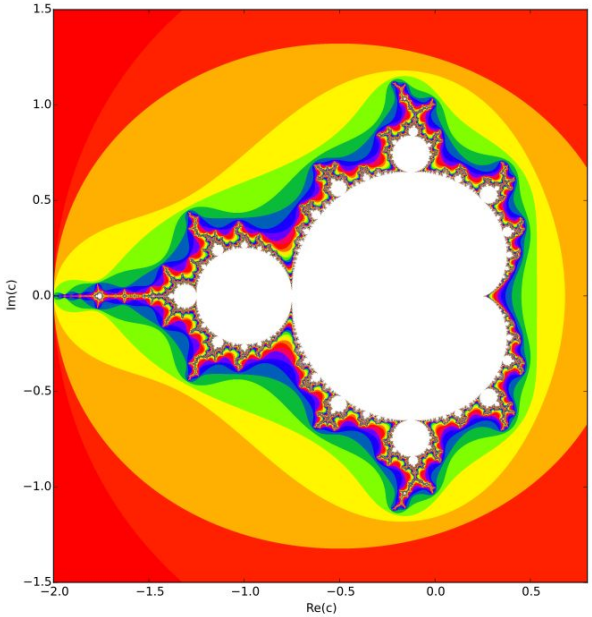
- Libraries extend core python functionality
  - see bonus_importing_modules.ipynb
- `import numpy as np`
- Numeric Python
  - Matrices/arrays
  - Vectorised
  - Implemented in C for performance



# Lesson 13:

## Matplotlib library

- `Primary python plotting library`
- Various other plotting libraries
  - Bokeh
  - Plotly
  - Seaborn
  - ggplot
  - ...



# Bonus lessons:

Coding Style

Databases and persistence

Importing modules

The Zen of Python

- Recommended bonus lessons:
  - Style guide for python
  - Importing modules

- Bonus lessons for fun:
  - Databases and persistence
  - The Zen of Python

- Other libraries to explore:
  - SciPy
  - Pandas

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  - Useful libraries (numpy, matplotlib)

# Links and Resources:

## https://github.com/williamgrimes/python_in_a_notebook

- Anaconda Install
  - https://www.anaconda.com/download
- Online interactive python shell:
  - https://www.python.org/shell/
- Extra learning resources:
  - https://www.learnpython.org/
  - https://www.python-course.eu/
  - https://wiki.python.org/moin/BeginnersGuide/NonProgrammers
  - http://pythontutor.com/
- Python documentation:
  - https://docs.python.org/3/
- Python style guide:
  - https://www.python.org/dev/peps/pep-0008/
- Google python class videos:
  - https://www.youtube.com/watch?v=tKTZoB2Vjuk