COMPASS

Community Platform for Agricultural Sciences

Introduction to python

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Structure

- Divided into two 1h sessions.
- 10-minute break in between.

- Try to follow within your notebook and run all examples shown on the slides.

Ask!

The art and science of asking questions is the source of all knowledge.

- Thomas Berger

- Do not hesitate to ask!
- If something is not clear, stop me and ask.
- During exercises (you can also ask others).

Image by mohamed Hassan from Pixabay

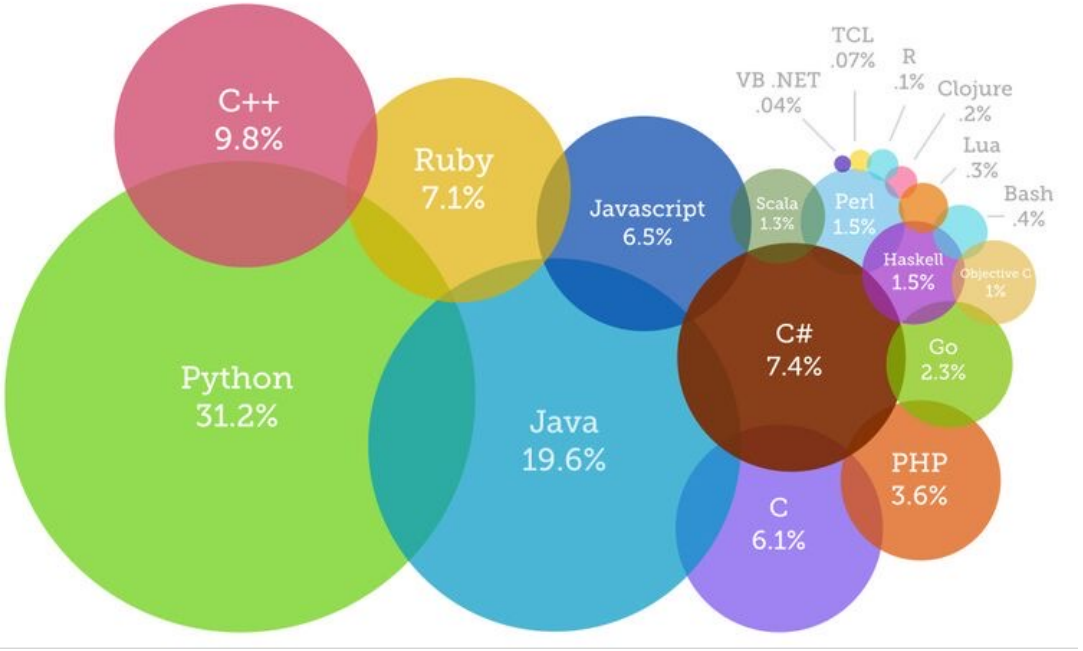
Python natalensis by A. Smith on Wikimedia Commons

History

- Started by Guido Van Rossum as a hobby
- Now widely spread
- Open Source! Free!
- Versatile

Guido Van Rossum by Doc Searls on Flickr CC-BY-SA

Most popular coding languages 2020



Python today

- Developed a large and active scientific computing and data analysis community
- Now one of the most important languages for
  - Data science
  - Machine learning
  - General software development
- Packages: NumPy, pandas, matplotlib, SciPy, scikit-learn, statsmodels

2 Modes

1. **IPython**

Python can be run interactively

Used extensively in research

2. **Python scripts**

What if we want to run more than a few lines of code?

Then we must write text files in .py

The Anaconda Ecosystem

ANACONDA.NAVIGATOR

Sign in

Home

Environments

Learning

Community

Applications on base (root) Channels Refresh

Datalore
Online Data Analysis Tool with smart coding assistance by JetBrains. Edit and run your Python notebooks in the cloud and share them with your team.
Launch

IBM Watson Studio Cloud
IBM Watson Studio Cloud provides you the tools to analyze and visualize data, to cleanse and shape data, to create and train machine learning models. Prepare data and build models, using open source data science tools or visual modeling.
Launch

JupyterLab
3.0.14
An extensible environment for interactive and reproducible computing, based on the Jupyter Notebook and Architecture.
Launch

Notebook
6.3.0
Web-based, interactive computing notebook environment. Edit and run human-readable docs while describing the data analysis.
Launch

Qt Console
5.0.3
PyQt GUI that supports inline figures, proper multiline editing with syntax highlighting, graphical calltips, and more.
Launch

Spyder
4.2.5
Scientific PYthon Development EnviRonment. Powerful Python IDE with advanced editing, interactive testing, debugging and introspection features
Launch

Glueviz
1.0.0
Multidimensional data visualization across files. Explore relationships within and among related datasets.
Install

Orange 3
3.26.0
Component based data mining framework. Data visualization and data analysis for novice and expert. Interactive workflows with a large toolbox.
Install

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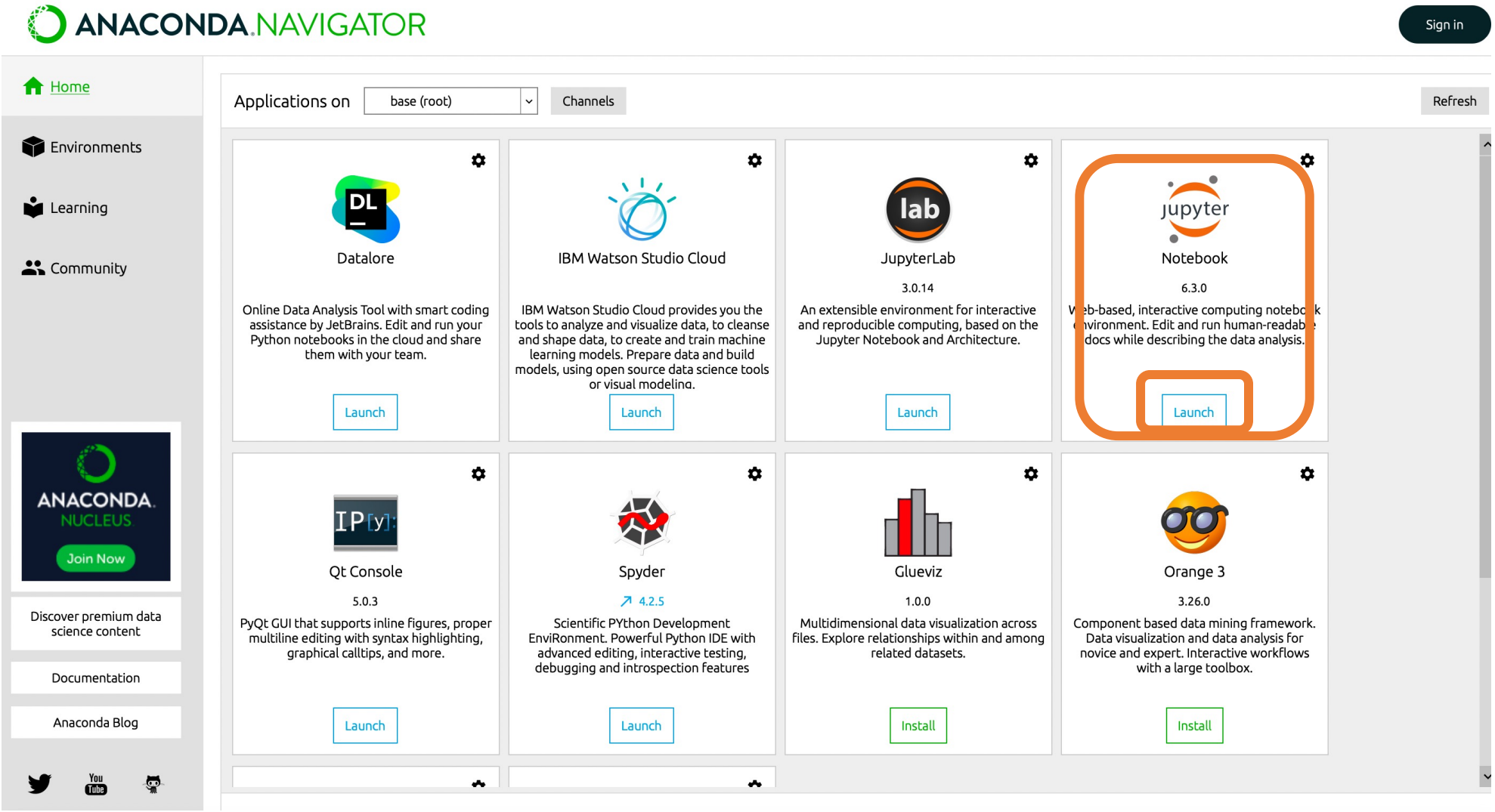
Documentation

Anaconda Blog

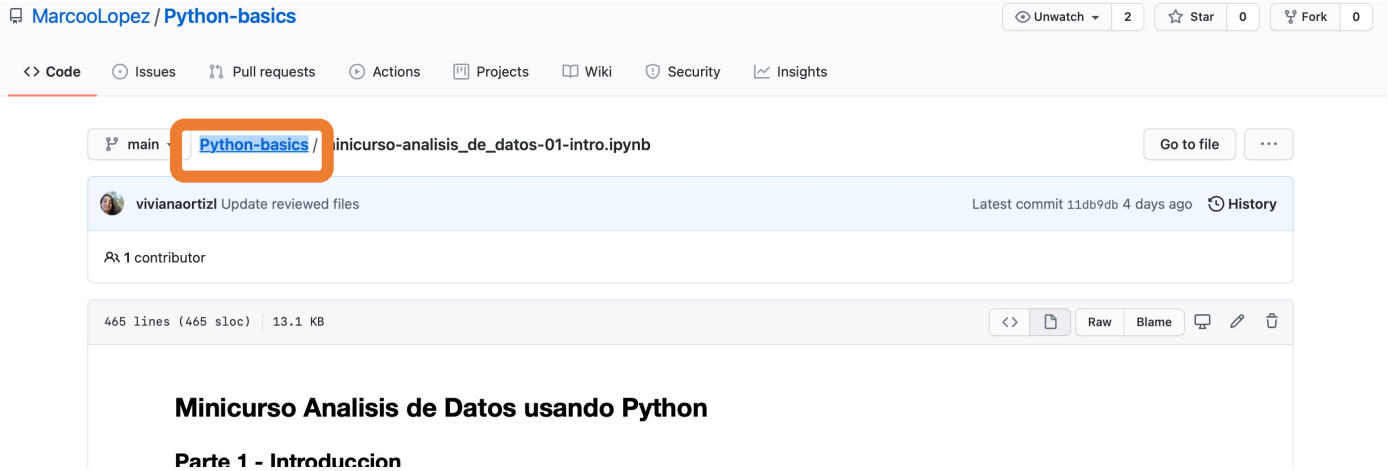
Jupyter notebooks

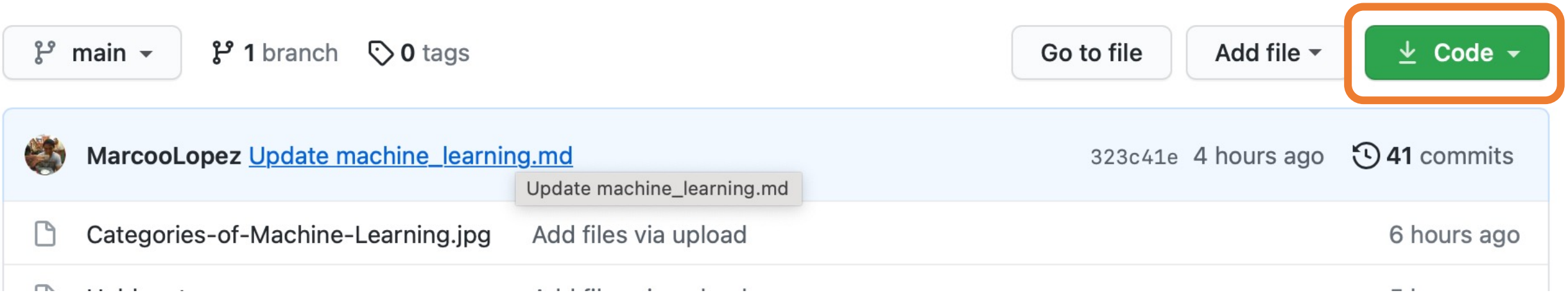
- Easy to use environment
- Web-based
- Combines both text and code into one
- Come with a great number of useful packages

1. Start Anaconda

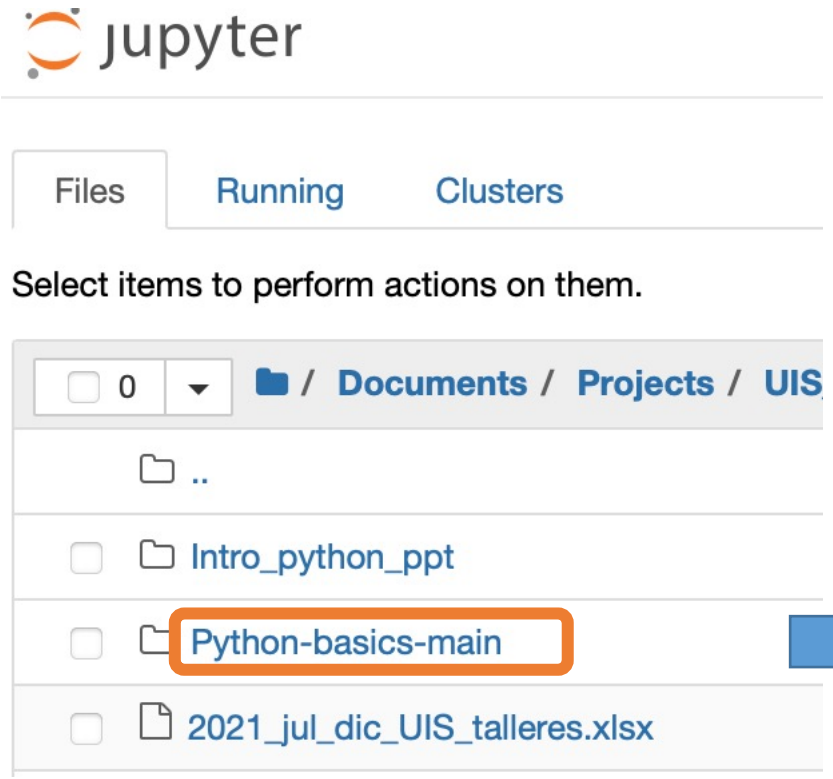


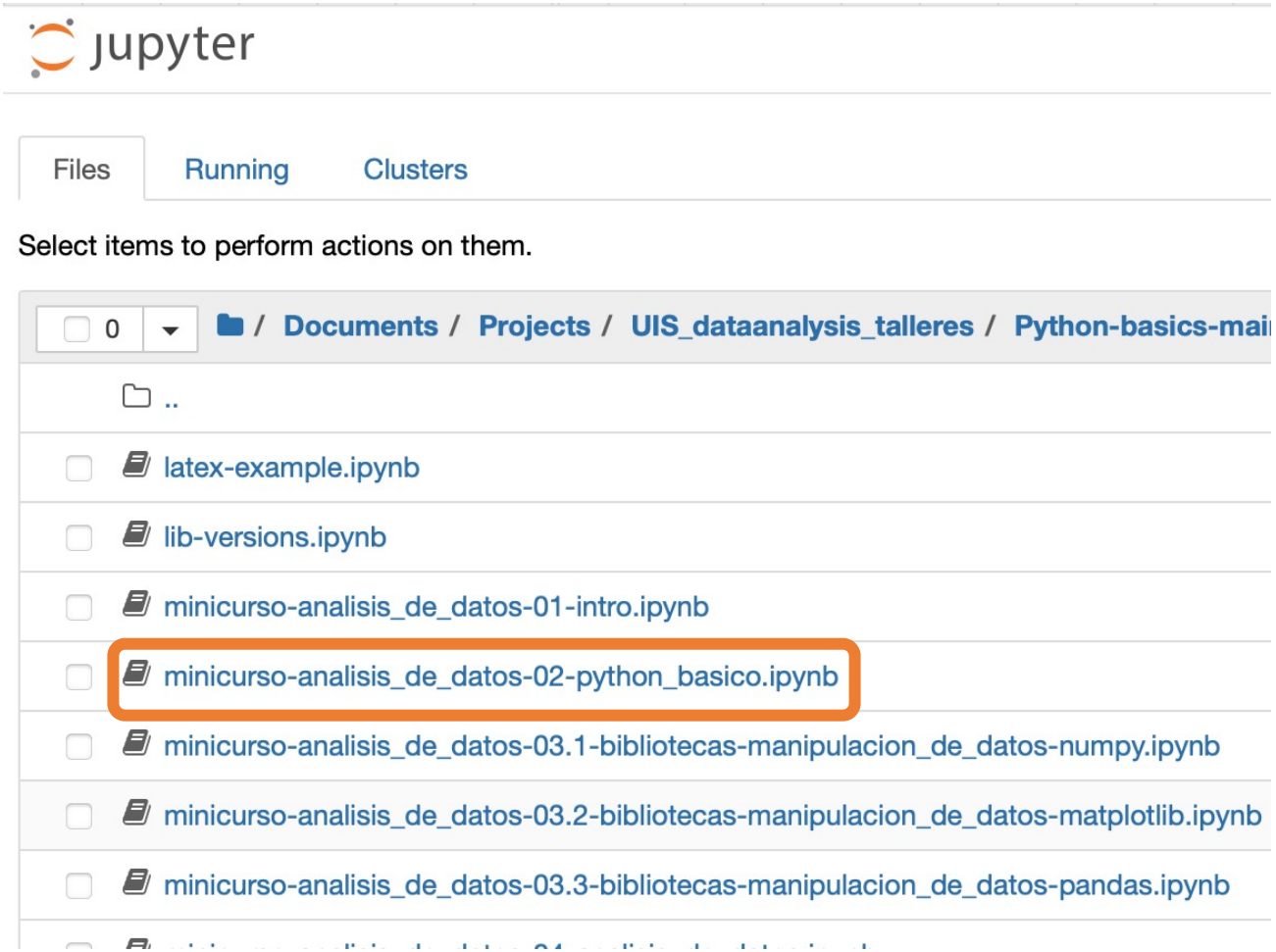
2. Download GitRepo



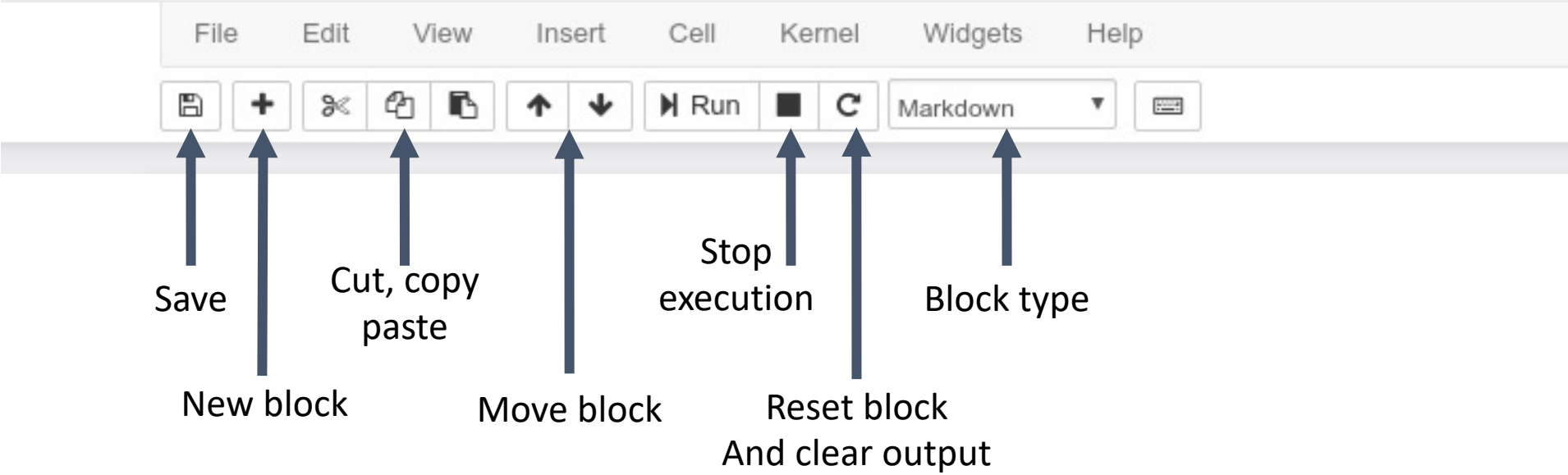


3. Starting a notebook

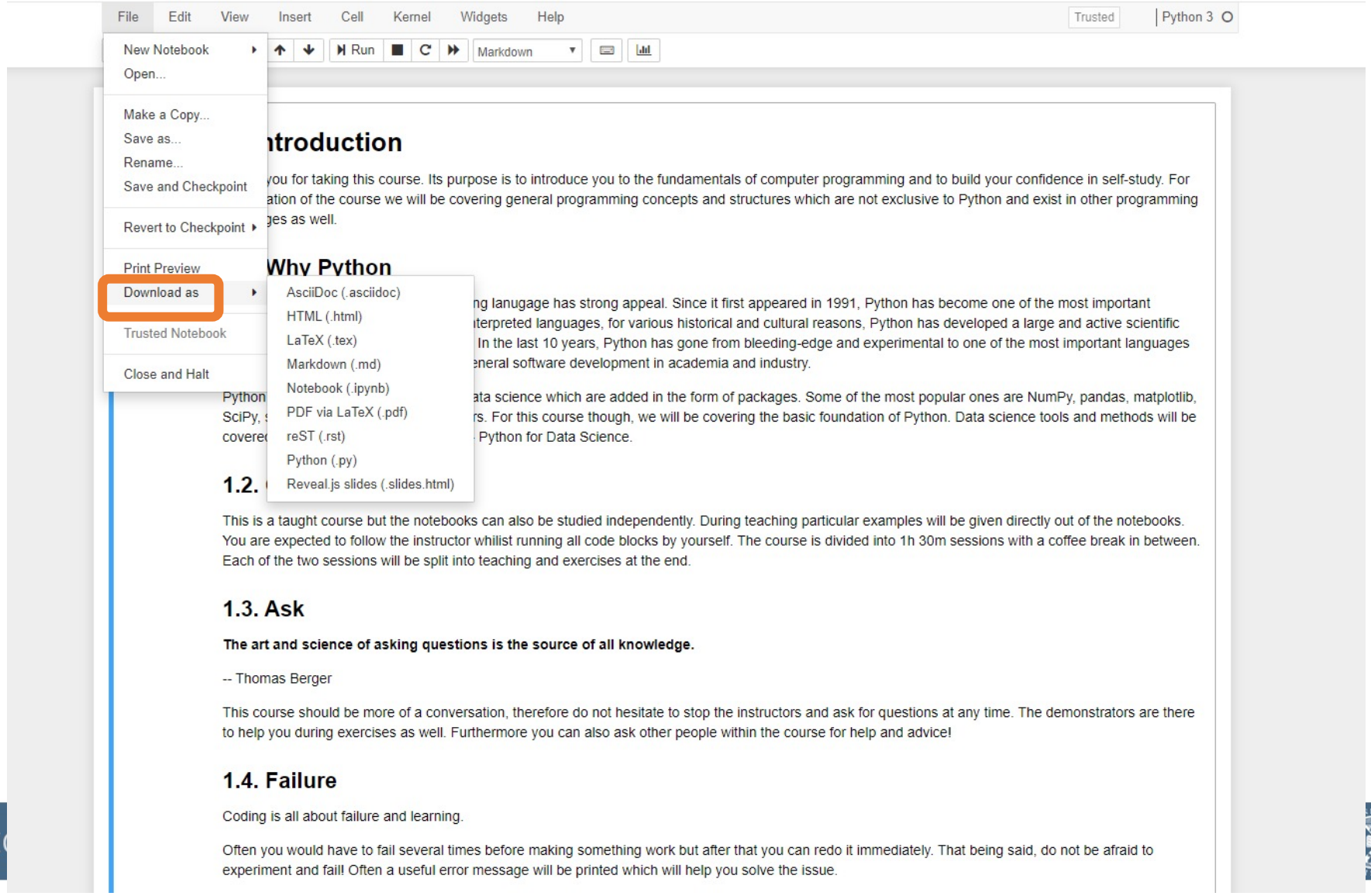




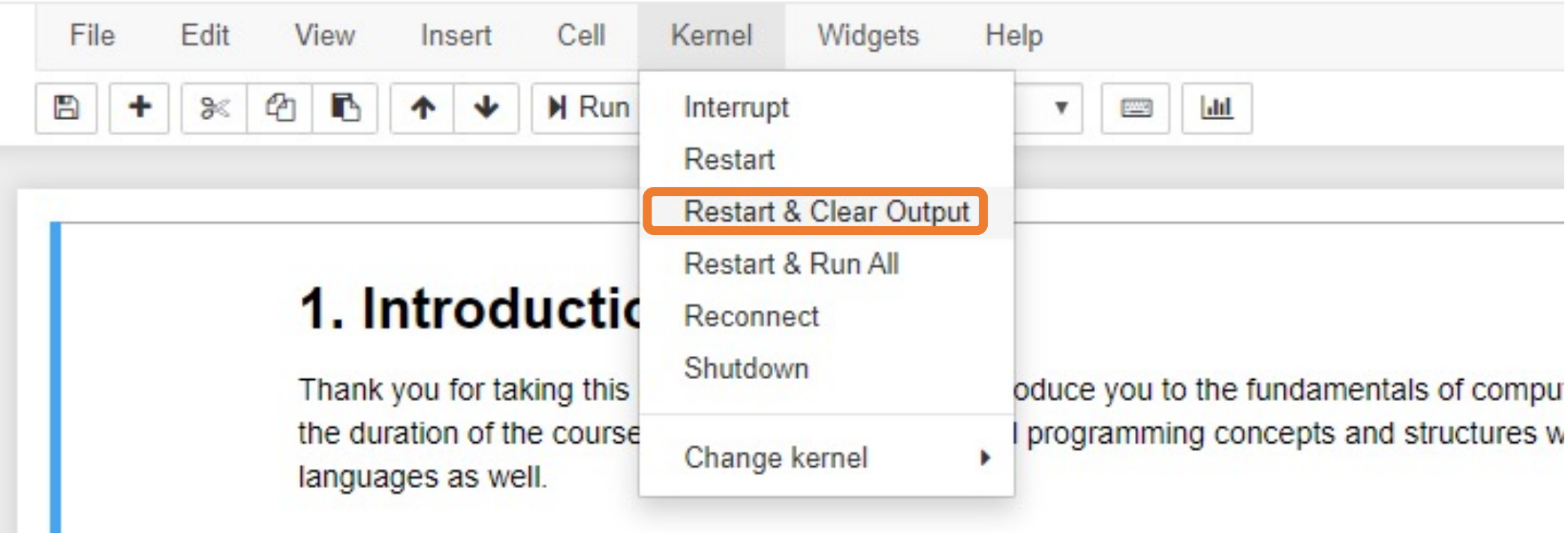
4. Toolbar


File
Edit
View
Insert
Cell
Kernel
Widgets
Help
Run
Markdown
Save
New block
Cut, copy
paste
Move block
Stop
execution
Reset block
And clear output
Block type

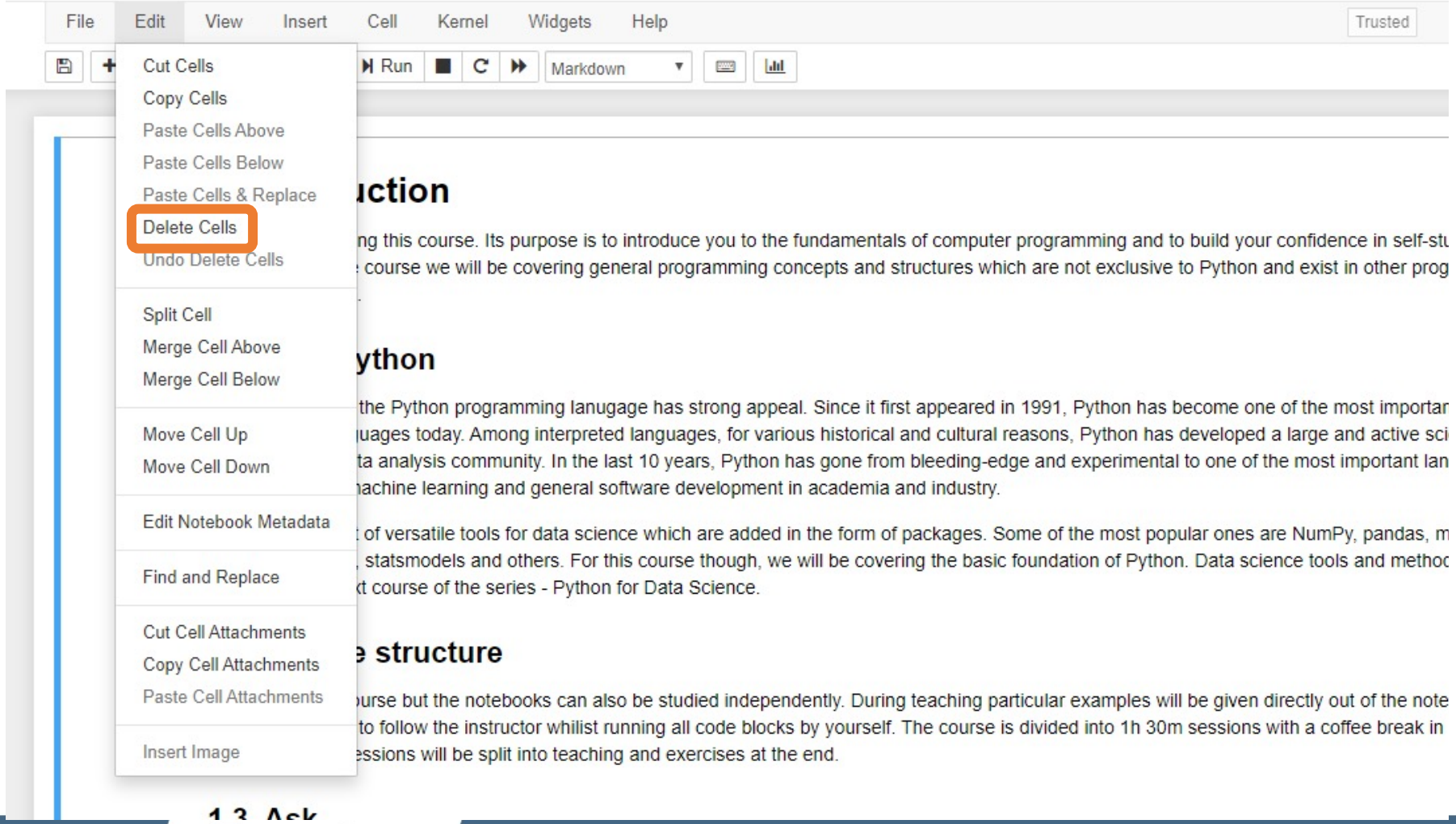
5. Download files



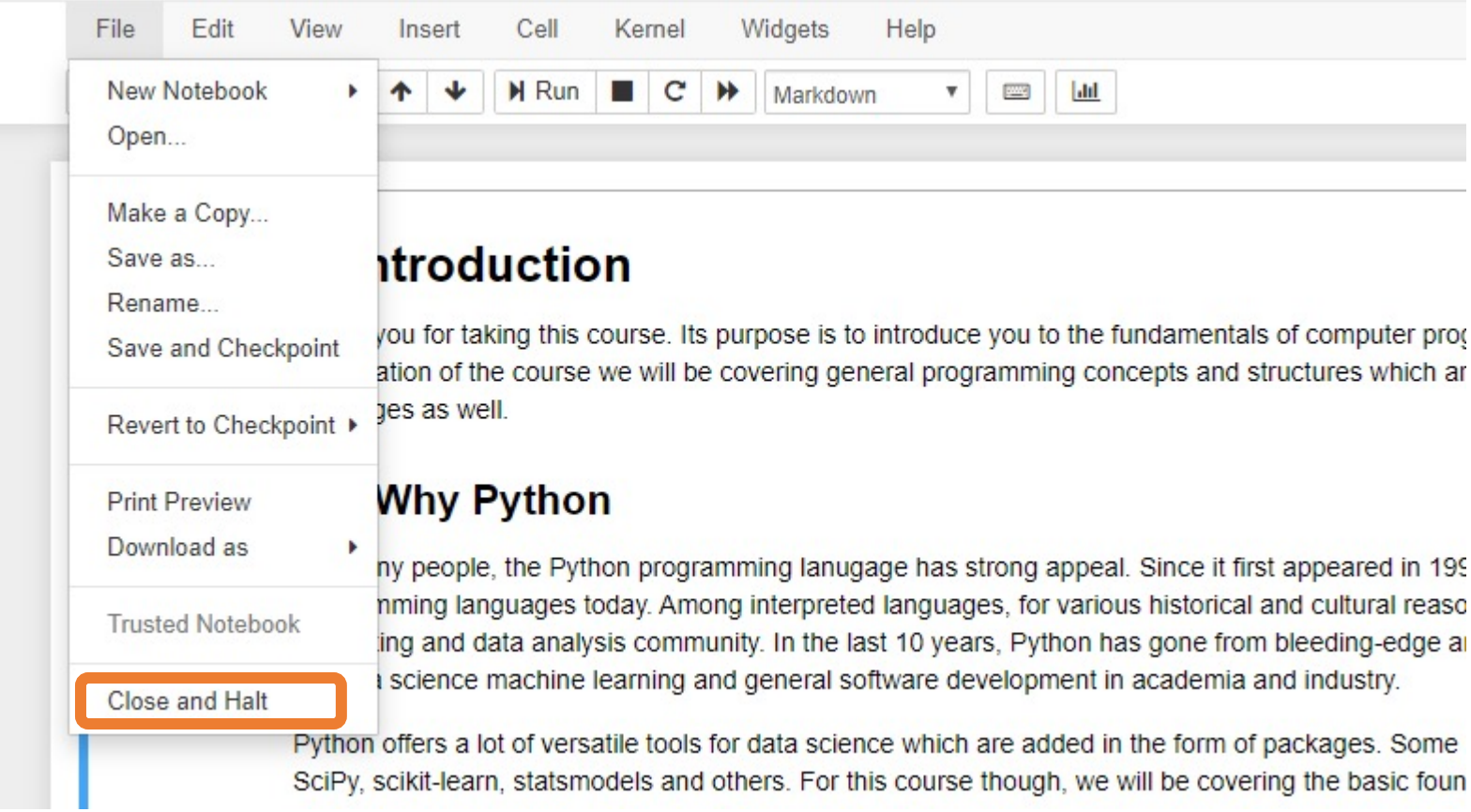
6. Kernel/Restart & Clear output



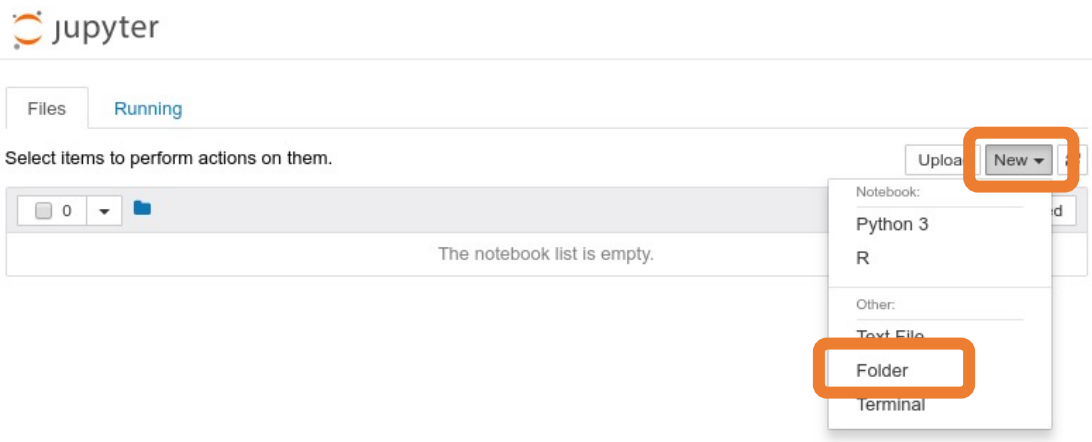
7. Edit/Delete Cell



8. File/ Close & Halt

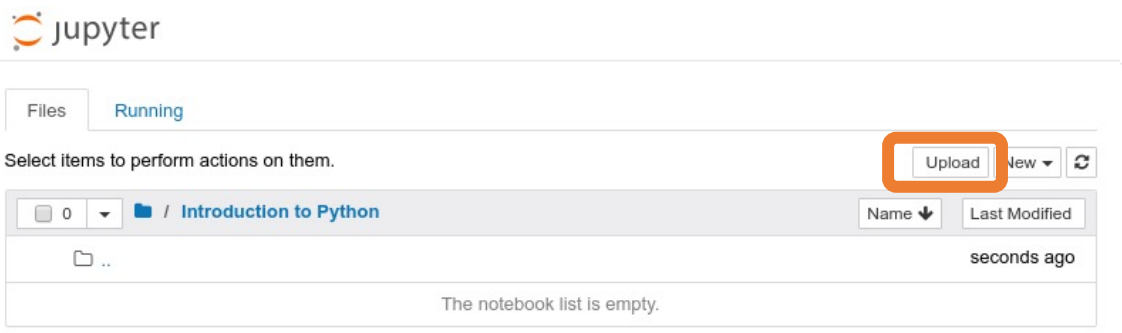


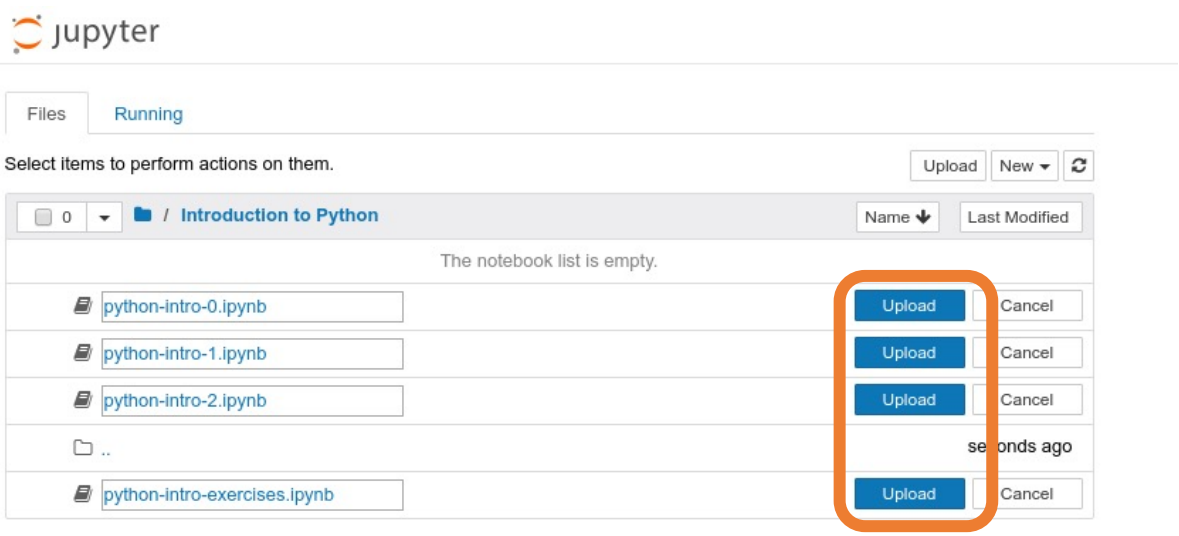
9. Create a folder



10.Rename

11. Upload files





Running blocks

- By pressing the Run button
- Shift + Enter – runs block
- Alt + Enter – creates a new block

Other operations

- File/Save and Checkpoint
- File/Revert to Checkpoint
- Tab completion
- Introspection

Let us start

If you like to follow along, you can open your own notebook. But please try to keep up with my presentation, as you still have time for exercises after the teaching.

Agenda

- Variables
- Types
- Arithmetic operators
- Boolean logic
- Strings
- Printing
- Exercises

Python as a calculator

- Let us calculate the distance between Edinburgh and London in km

```
403 * 1.60934
```

```
648.56402
```

Variables

- Great calculator but how can we make it store values?
- Do this by defining variables
- Can later be called by the variable name
- Variable names are case sensitive and unique

```
distanceToLondonMiles = 403
mileToKm = 1.60934
distanceToLondonKm = distanceToLondonMiles * mileToKm
distanceToLondonKm
```

```
648.56402
```

We can now reuse the variable mileToKm in the next block without having to define it again!

```
marathonDistanceMiles = 26.219
marathonDistanceKm = marathonDistanceMiles * mileToKm
print(marathonDistanceKm)
```

```
42.19528546
```

Types

Variables actually have a type, which defines the way it is stored.

The basic types are:

Type	Declaration	Example	Usage
Integer	int	`x = 124`	Numbers without decimal point
Float	float	`x = 124.56`	Numbers with decimcal point
String	str	`x = "Hello world"`	Used for text
Boolean	bool	`x = True` or `x = False`	Used for conditional statements
NoneType	None	`x = None`	Whenever you want an empty variable

Why should we care?

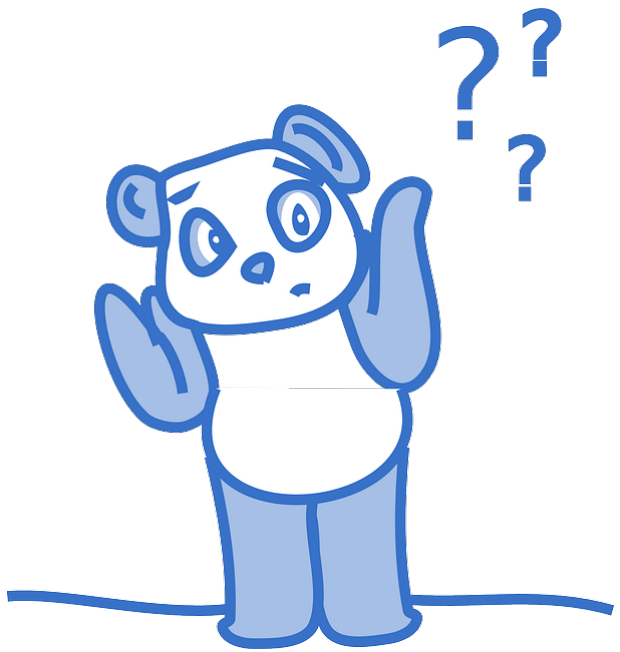


Image by Clker-Free-Vector-Images on Pixabay

```
In [4]: x = 10    # This is an integer
        y = "20"  # This is a string
        x + y
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
<ipython-input-4-f1463b8b4c2e> in <module>()
      1 x = 10    # This is an integer
      2 y = "20"  # This is a string
----> 3 x + y

TypeError: unsupported operand type(s) for +: 'int' and 'str'
```

Important lesson to remember!
We can't do arithmetic operations on variables of different types. Therefore make sure that you are always aware of your variables types!

You can find the type of a variable using **type()**. For example type **type(x)**.

Casting types

Luckily Python offers us a way of converting variables to different types!

Casting – the operation of converting a variable to a different type

```
x = 10     # This is an integer
y = "20"   # This is a string
x + int(y)
```

```
30
```

Similar methods exist for other data types: **int()**, **float()**, **str()**

Quick quiz

```
x = "10"
y = "20"
x + y
```

What will be the result?

```
'1020'
```

Arithmetic operations

Similar to actual Mathematics.

Order of precedence is the same as in Mathematics.

We can also use parenthesis ()

Symbol	Task Performed	Example	Result
+	Addition	4 + 3	7
-	Subtraction	4 - 3	1
/	Division	7 / 2	3.5
%	Mod	7 % 2	1
*	Multiplication	4 * 3	12
//	Floor division	7 // 2	3
**	Power of	7 ** 2	49

Order precedence example

```
16 ** 2 / 4
```

```
64.0
```

Quick quiz

```
4 + 3 ** 2
```

13

vs

```
(4 + 3) ** 2
```

49

Comparison operators

- I.e. comparison operators
- Return Boolean values

(i.e. True or False)

- Used extensively for conditional statements

Operator	Output
x == y	True if x and y have the same value
x != y	True if x and y don't have the same value
x < y	True if x is less than y
x > y	True if x is more than y
x <= y	True if x is less than or equal to y
x >= y	True if x is more than or equal to y

Comparison examples

```
x = 5        # assign 5 to the variable x
x == 5       # check if value of x is 5
```

```
True
```

Note that `==` *is not the same as* `=`

```
x > 7
```

```
False
```

Logical operators

- Allows us to extend the conditional logic
- Will become essential later on

Operation	Result
x or y	True if at least on is True
x and y	True only if both are True
not x	True only if x is False

a	not a
False	True
True	False

a	b	a and b	a or b
False	False	False	False
False	True	False	True
True	False	False	True
True	True	True	True

Truth-table definitions of `bool` *operations*

Combining both

```
x = 14
# check if x is within the range 10..20
True and True
```

```
True
```

Strings

- Powerful and flexible in Python
- Can be added
- Can be multiplied
- Can be multiple lines

Strings

```
x = "Python"
y = "rocks"
x + " " + y
```

```
'Python rocks'
```

```
x = "This can be"
y = "repeated "
x + " " + y * 3
```

```
'This can be repeated repeated repeated '
```

Strings

```
x = "Edinburgh"
x = x.upper()

y = "University Of "
y = y.lower()

y + x
```

```
'university of EDINBURGH'
```

These are called methods and add extra functionality to the String.
If you want to see more methods that can be applied to a string simply type in **dir('str')**

Mixing up strings and numbers

Often we would need to mix up numbers and strings.
It is best to keep numbers as numbers (i.e. int or float)
and cast them to strings whenever we need them as a string.

```
x = 6
x = ( x * 5345 ) // 63
"The answer to Life, the Universe and Everything is " + str(x)
```

```
'The answer to Life, the Universe and Everything is 42'
```

Multiline strings

```
x = """To include
multiple lines
you have to do this"""
y ="or you can also\ninclude the special\ncharacter `\\n` between lines"
print(x)
print(y)
```

```
To include
multiple lines
you have to do this
or you can also
include the special
character `\n` between lines
```

Printing

- When writing scripts, your outcomes aren't printed on the terminal.
- Thus, you must print them yourself with the print() function.
- Beware to not mix up the different type of variables!

```
print("Python is powerful!")
```

```
Python is powerful!
```

```
x = "Python is powerful"
y = " and versatile!"
print(x + y)
```

```
Python is powerful and versatile!
```

Quick quiz

Do you see anything wrong with this block?

```
str1 = "which means it has even more than"
str2 = 76
str3 = "quirks"
print(str1 + str2 + str3)
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
<ipython-input-2-3be15a6244a4> in <module>()
      2 str2 = 76
      3 str3 = " quirks"
----> 4 print(str1 + str2 + str3)

TypeError: must be str, not int
```

Another more generic way to fix it

```
str1 = "It has"
str2 = 76
str3 = "methods!"
print(str1, str2, str3)
```

```
It has 76 methods!
```

If we comma separate statements in a print function we can have different variables printing!

Placeholders

- A way to interleave numbers is

```
pi = 3.14159 # Pi
d = 12756 # Diameter of eath at equator (in km)
c = pi*d # Circumference of equator

#Print using +, and casting
print("Earth's diameter at equator: " + str(d) + "km. Equator's circumference:" + str(c) + "km.")
#Print using several arguments
print("Earth's diameter at equator:", d, "km. Equator's circumference:", c, "km.")
#Print using .format
print("Earth's diameter at equator: {:.1f} km. Equator's circumference: {:.1f} km.".format(d, c))
```

```
Earth's diameter at equator: 12756km. Equator's circumference:40074.12204km.
Earth's diameter at equator: 12756 km. Equator's circumference: 40074.12204 km.
Earth's diameter at equator: 12756.0 km. Equator's circumference: 40074.1 km.
```

- Elegant and easy
- more in your notes

Commenting

- Useful when your code needs further explanation. Either for your future self and anybody else.
- Useful when you want to remove the code from execution but not permanently
- Comments in Python are done with #

- `print(totalCost)` is ambiguous and we can't exactly be sure what `totalCost` is.
- `print(totalCost)  # Prints the total cost for renovating the Main Library` is more informative

Exercise time

Simple exercises (notebooks minicurso 02 and 03)

10-minute break afterwards.

Failure is progress!

Ask us anything. Ask among yourselves as well.