1 Lecture 1b: Introduction to Jupyter Notebooks, Google Colab and Matplotlib

Data Visualization · 1-DAV-105

1.1 Jupyter Notebook

- Jupyter Notebook is a web-based software for interactive work in Python.
- It is frequently used for data processing and visualization.
- A document called **notebook** consists of **cells**.
- Each cell contains either text or Python code.
- The text may include formatting in Markdown language.
- A cell with Python code can be executed and the results display below, including images.
- This presentation is a Jupyter notebook.
- Notebook files have extension `.ipynb`.

1.2 Google Colab and alternatives

- You can work with Jupyter notebooks on many platforms (both online and installed on your computer).
- In this course, we will primarily use Google Colaboratory (Colab).
- Colab stores your notebooks on Google drive, executes them on Google servers, you only need a web browser on your computer.
- You are free to use other options as long as the submitted notebooks can be executed in Colab.
- One popular option is VS Code. It requires Jupyter software to be installed as well, see documentation.

1.3 How to use Notebooks

- Notebooks have an intuitive interface with menus, toolbars, context menus (right-click) etc.
- It is useful to learn some keyboard shortcuts.

When you are not editting a cell:

- use Up and Down arrows to move between cells
- use **Enter** (or double-click) to start editing a cell
- use **Esc** to stop editing a cell
- use **Ctrl-Enter** to run a code in a cell, **Shift-Enter** to run the code and move to the next cell

1.3.1 An example of a code cell

- A cell can include imports, function definitions, commands.
- Variables will be visible in other cells.
- The results of `print` are shown below the cell when executed.
- The last expression is printed below the cell when executed.

[1]:

```
# create variable x with list of numbers 0,1,...,19
x = list(range(20))
```

```
# variable y will contain squares of values in x
y = [xval * xval for xval in x]
# print x and y
print(x)
print(y)
# the last value in the cell is also printed automatically
y[0:5]
```

```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19]
[0, 1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, 169, 196, 225, 256, 289,
324, 361]
```

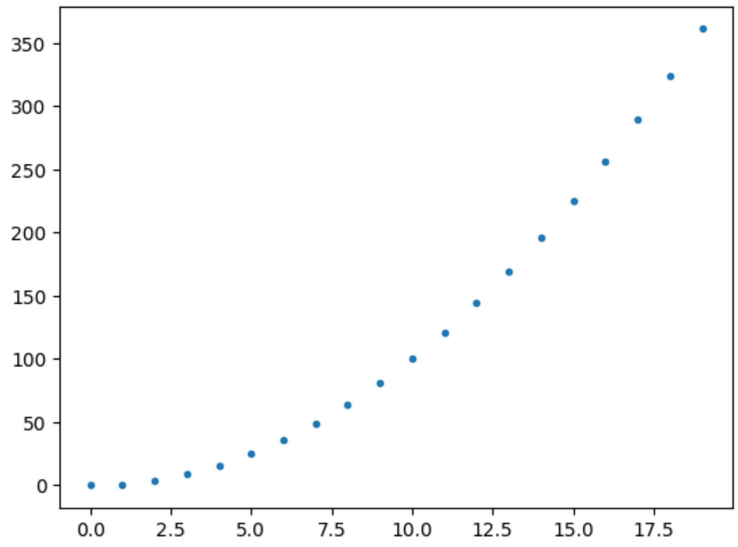
```
[1]: [0, 1, 4, 9, 16]
```

1.3.2 Example of a cell with a plot

The plot uses variables x and y from the previous cell to plot the quadratic function.

[2]:

```
import matplotlib.pyplot as plt
# create figure with a single plot (axes)
figure, axes = plt.subplots()
# plot x vs y
axes.plot(x, y, '.')
# command pass to suppress unwanted output from plot
pass
```



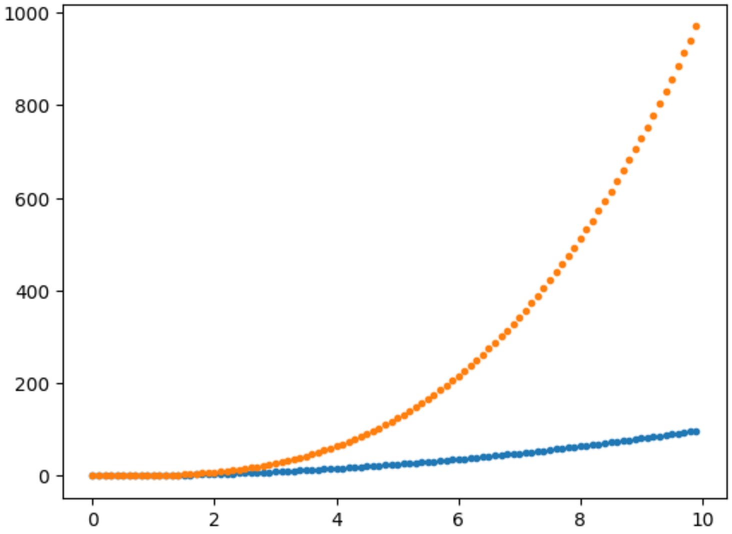
1.4 Matplotlib library

- Matplotlib is a Python library for creating plots.

- In the code above, axes is the Matplotlib name for a single plot.
- Let us now plot two functions: quadratic and cubic in the same plot.

[3]:

```
# x_dense is values from 0 to 10 with step 0.1
x_dense = [val / 10 for val in range(0, 100)]
# values in y2_dense are values from x_dense squared
y2_dense = [xval ** 2 for xval in x_dense]
# values in y3_dense are values from x_dense to the power of 3
y3_dense = [xval ** 3 for xval in x_dense]
# plot the quadratic and cubic function in a single plot
figure, axes = plt.subplots()
axes.plot(x_dense, y2_dense, '.')
axes.plot(x_dense, y3_dense, '.')
pass
```



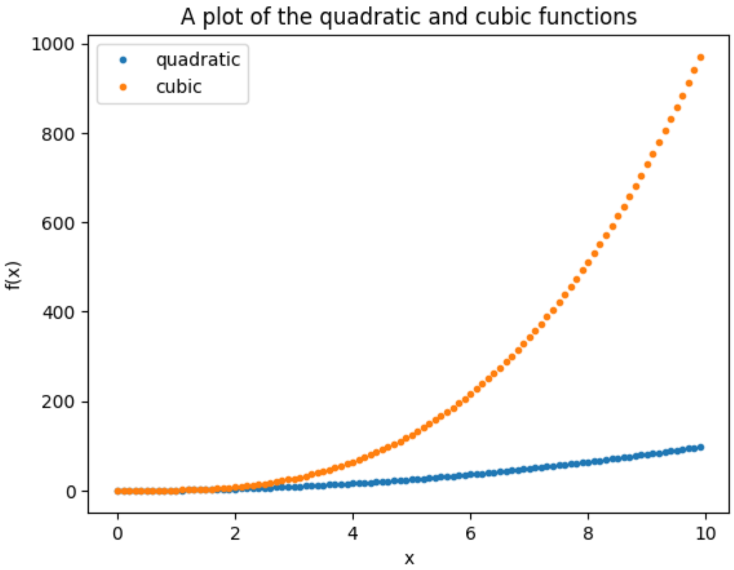
1.4.1 Setting labels and titles in Matplotlib

[4]:

```
# the same plot as before, but name the two sets of points by label
figure, axes = plt.subplots()
axes.plot(x_dense, y2_dense, '.', label="quadratic")
axes.plot(x_dense, y3_dense, '.', label="cubic")

# add titles for axes (usually use a more descriptive titles)
axes.set_xlabel("x")
axes.set_ylabel("f(x)")
# legend (which plot is which function), uses the labels set in axes.plot
axes.legend()
# a title of the whole plot
axes.set_title("A plot of the quadratic and cubic functions")
```

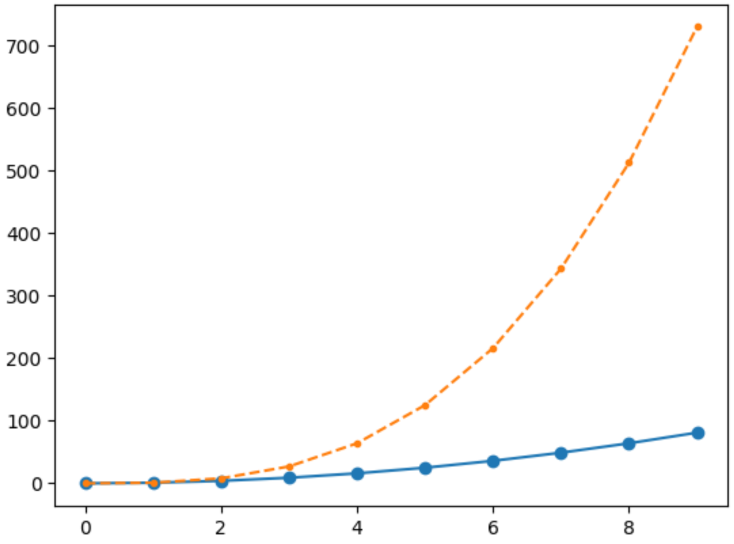
```
pass
```



1.4.2 Setting lines, markers and colors

- In the `axes.plot` command, `'.'` represents formatting, in this case a small dot.
- The formatting string has three optional parts: marker, line, color.
- Examples: `'or'` red circle, `'-g'` green solid line, `'--'` dashed line.
- See more in documentation.

[5]:
```
x_sparse = range(0, 10)
y2_sparse = [xval ** 2 for xval in x_sparse]
y3_sparse = [xval ** 3 for xval in x_sparse]
figure, axes = plt.subplots()
axes.plot(x_sparse, y2_sparse, 'o-')
axes.plot(x_sparse, y3_sparse, '.--')
pass
```

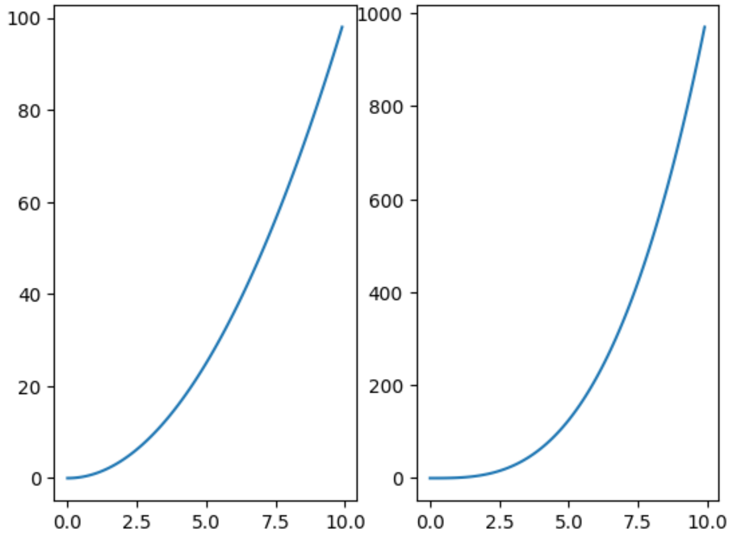


1.4.3 Multiple plots per image

- Function plt.subplots can take as arguments the number of rows and the number of columns and creates multiple subplots per image.
- Why is this figure not an ideal visual comparison of the quadratic and cubic function?

[6]:

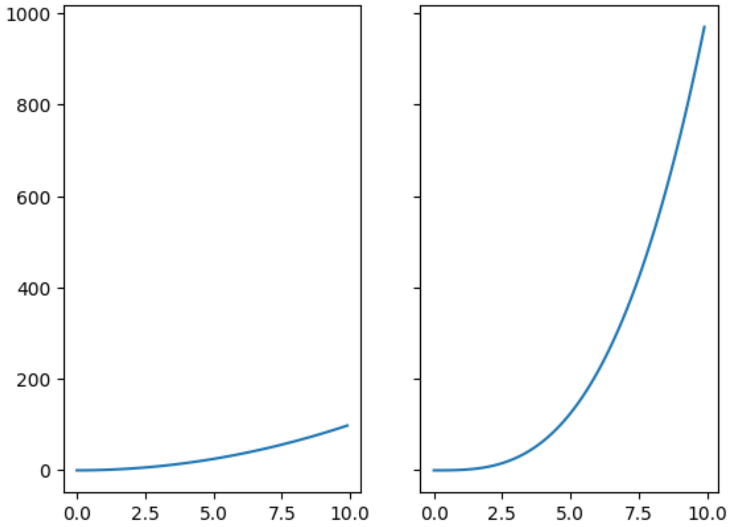
```
figure, axes = plt.subplots(1, 2)
axes[0].plot(x_dense, y2_dense)
axes[1].plot(x_dense, y3_dense)
pass
```



- Each plot has a different y-axis, which is not good, because we do not immediately see that the cubic function grows much faster than the quadratic.
- We will fix this in the next plot using `sharey=True` setting (`sharex=True` also exists but here it is not needed).

[7]:

```
# fixing the problem with different y-axis
figure, axes = plt.subplots(1, 2, sharey=True)
axes[0].plot(x_dense, y2_dense)
axes[1].plot(x_dense, y3_dense)
pass
```



1.5 Additional resources

- Python Data Science Handbook by Jake VanderPlas, O'Reilly 2016
- Jupyter Notebook documentation
- Google Colab website and introductory video
- Matplotlib tutorials