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Plotting packages

- Until now, we were just able to return results via `print()` command.
- However, as humans depend very much on vision, data visualization is urgently needed.

Matplotlib

- Very common and widely used is the matplotlib (https://matplotlib.org/) package.
- Matplotlib provides with `pyplot` module very similar plotting commands as Matlab.
- Matplotlib is packaged and available through pip and conda.
- Let's create our first plot.

In [16]:

```
from matplotlib import pyplot as plt
%matplotlib inline
```

- The first line of code imports the pyplot module, which is very convenient for most simple plots.
- The second line is a special Jupyter magic command to present the plots instantly.

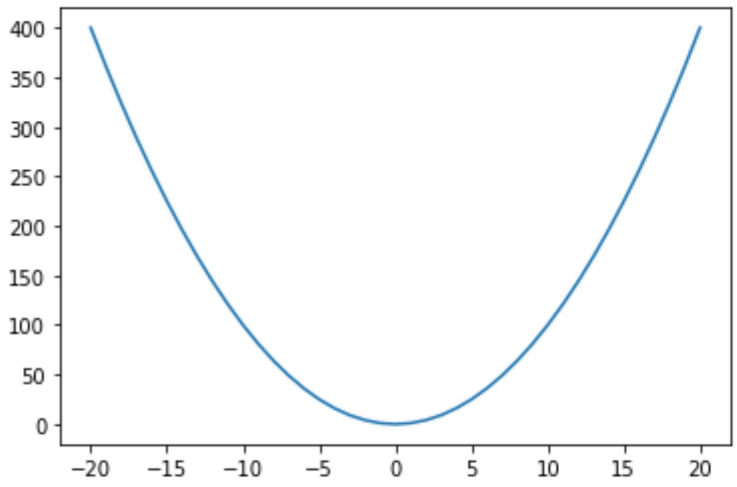
Basic plotting

In [17]:

```
# First, we create some data to plot, which is not that handy with lists.
x = [i for i in range(-20, 21)]
y = [x_i**2 for x_i in x]
```

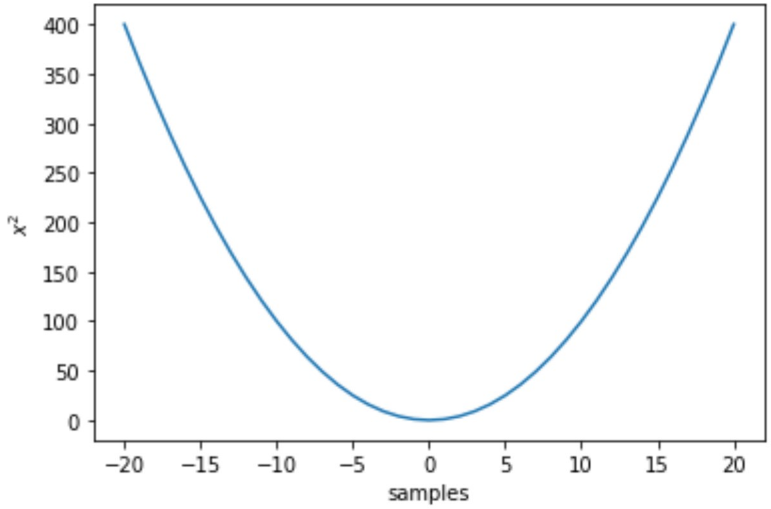
In [18]:

```
# Now the plot command
plt.plot(x, y)

plt.show()
```



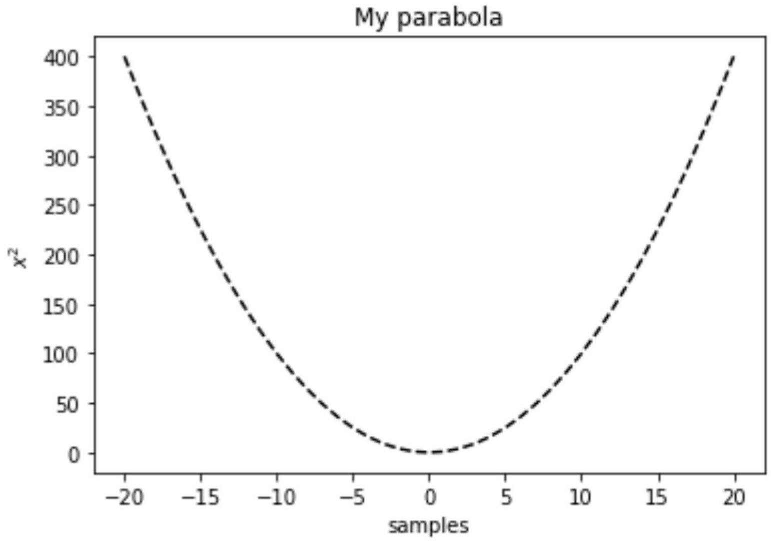
In [19]:

```
# Here the same plot with axis labels
plt.plot(x, y)
plt.xlabel("samples")
plt.ylabel("$x^2$") # You can use LaTeX's math support

plt.show()
```



In [20]:

```
# Some line style arguments and a title
plt.plot(x, y, "k--")
plt.xlabel("samples")
plt.ylabel("$x^2$") # You can use LaTeX's math support
plt.title("My parabola")

plt.show()
```



Multiple plots in one figure

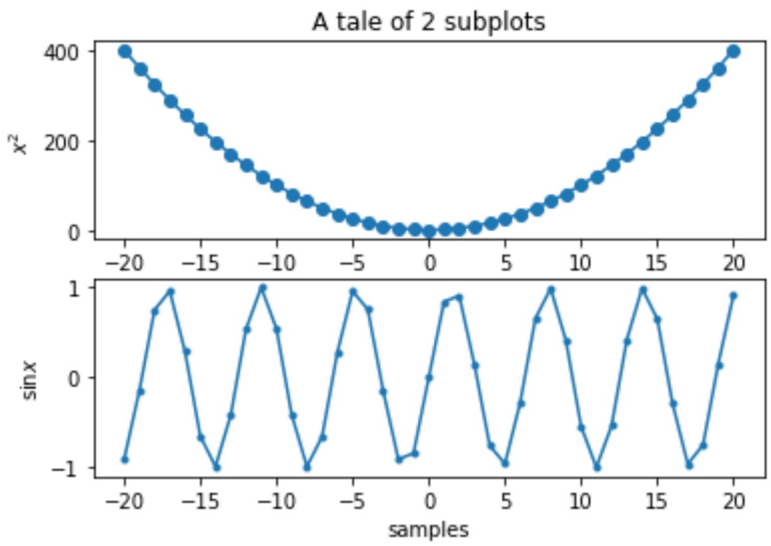
To present two time series, we will create an additional list of values.

In [21]:

```
import math
y2 = [math.sin(x_i) for x_i in x]
```

In [22]:

```
plt.subplot(2, 1, 1)
plt.plot(x, y, 'o-')
plt.title('A tale of 2 subplots')
plt.ylabel('$x^2$')

plt.subplot(2, 1, 2)
plt.plot(x, y2, '.-')
plt.xlabel('samples')
plt.ylabel('$\sin{x}$')

plt.show()
```



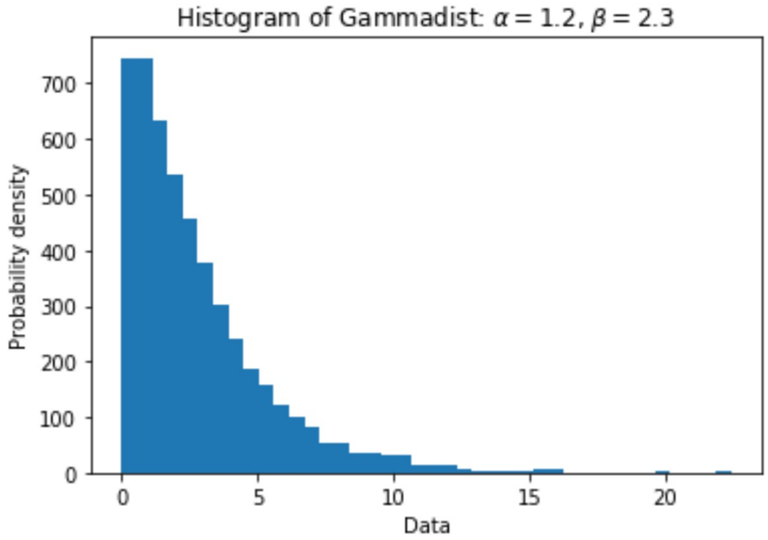
- I guess you got the concept here.
- Also basic statistical plots are simple to generate.

In [23]:

```
# Generate random numbers in a list
import random

y3 = [random.gammavariate(alpha=1.2, beta=2.3) for i in range(0, 5000)]
```

In [24]:

```
plt.hist(y3, bins=40)
plt.xlabel('Data')
plt.ylabel('Probability density')
plt.title(r'Histogram of Gammadist: $\alpha=1.2$, $\beta=2.3$')

plt.show()
```



Exercise: Matplotlib (10 minutes)

Here the task:

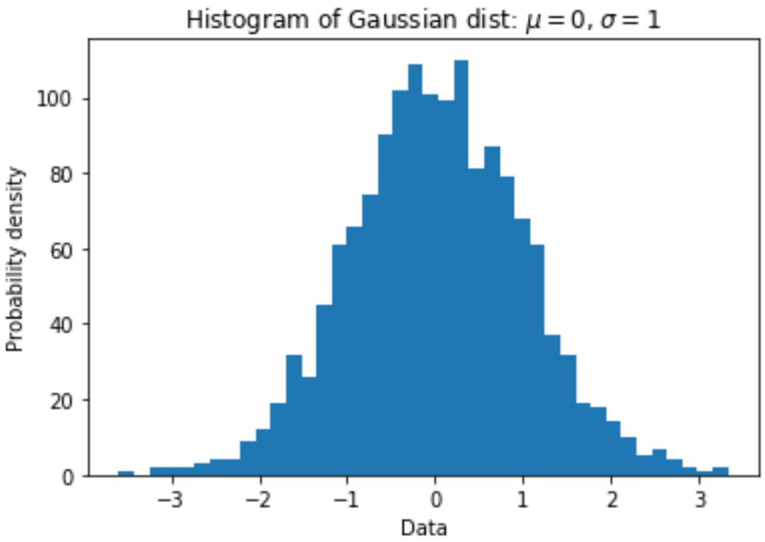
- Activate your local Python environment and install matplotlib with `conda install matplotlib`.
- Either work in Jupyter notebook, in Ipython shell, or Pycharm.
- Create a list of 1500 data points.
- Add a second list of 1500 data points with Gaussian distribution $\mathcal{N} \sim (0, 1)$.
- Create a figure with a histogram of the data.

Solution

Please find one possible solution in `solution_plotting.py` (solution_plotting.py) file.

In [25]:

```
%run solution_plotting.py
plt.show()
```



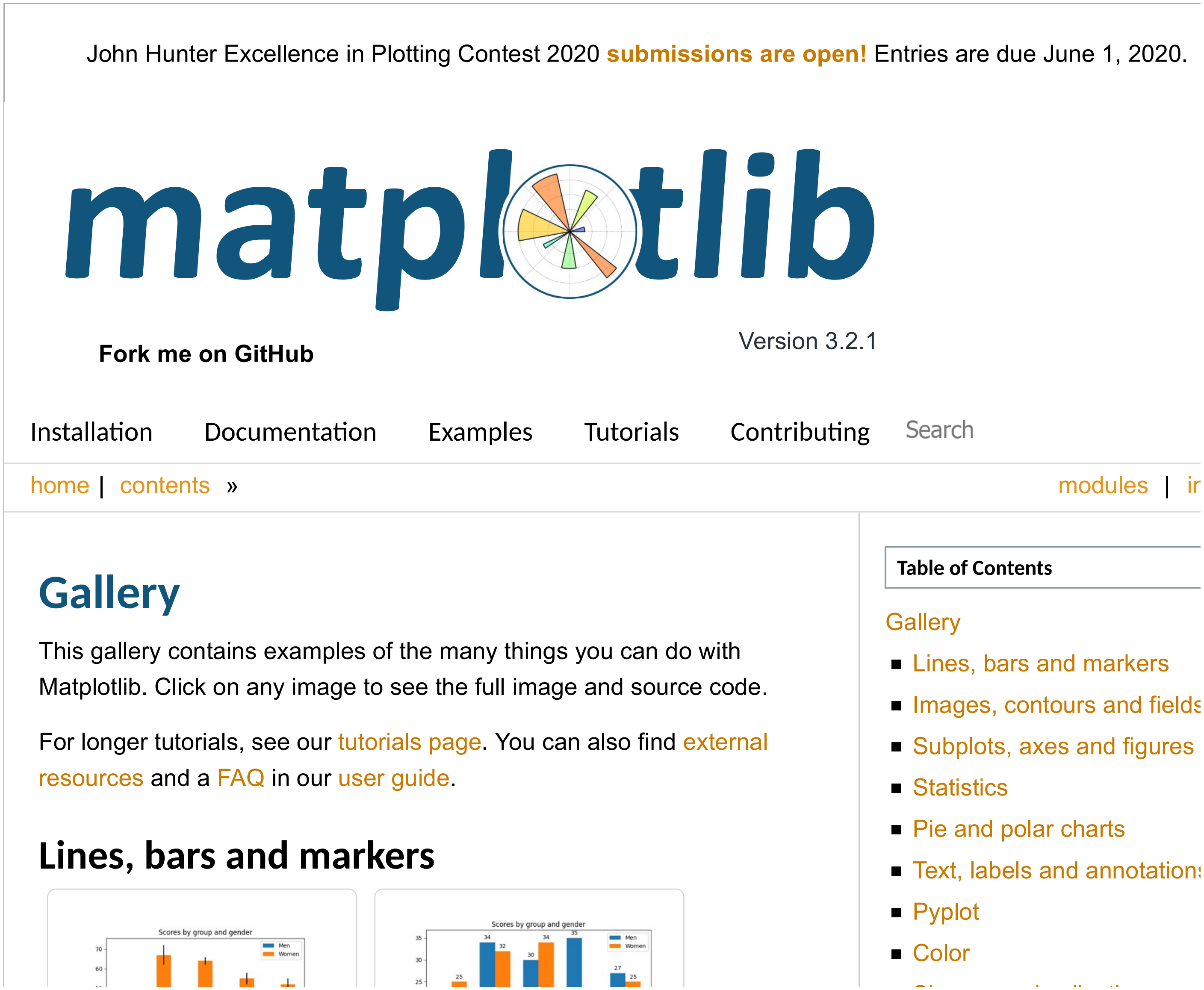
```
<Figure size 432x288 with 0 Axes>
```

More plot types

- Many other plots are as simple as the examples above.
- Other typical plots are
  - Bar plots
  - 3D plots
  - Pie charts
  - Scatter plots
  - ...
- You can find many more plot examples in the Matlotlib gallery (https://matplotlib.org/gallery/index.html)

```
In [26]: IFrame(src='https://matplotlib.org/gallery/index.html', width=700, height=600)
```

Out[26]:



John Hunter Excellence in Plotting Contest 2020 **submissions are open!** Entries are due June 1, 2020.

matplotlib

Version 3.2.1

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Gallery

This gallery contains examples of the many things you can do with Matplotlib. Click on any image to see the full image and source code.

For longer tutorials, see our tutorials page. You can also find external resources and a FAQ in our user guide.

Lines, bars and markers

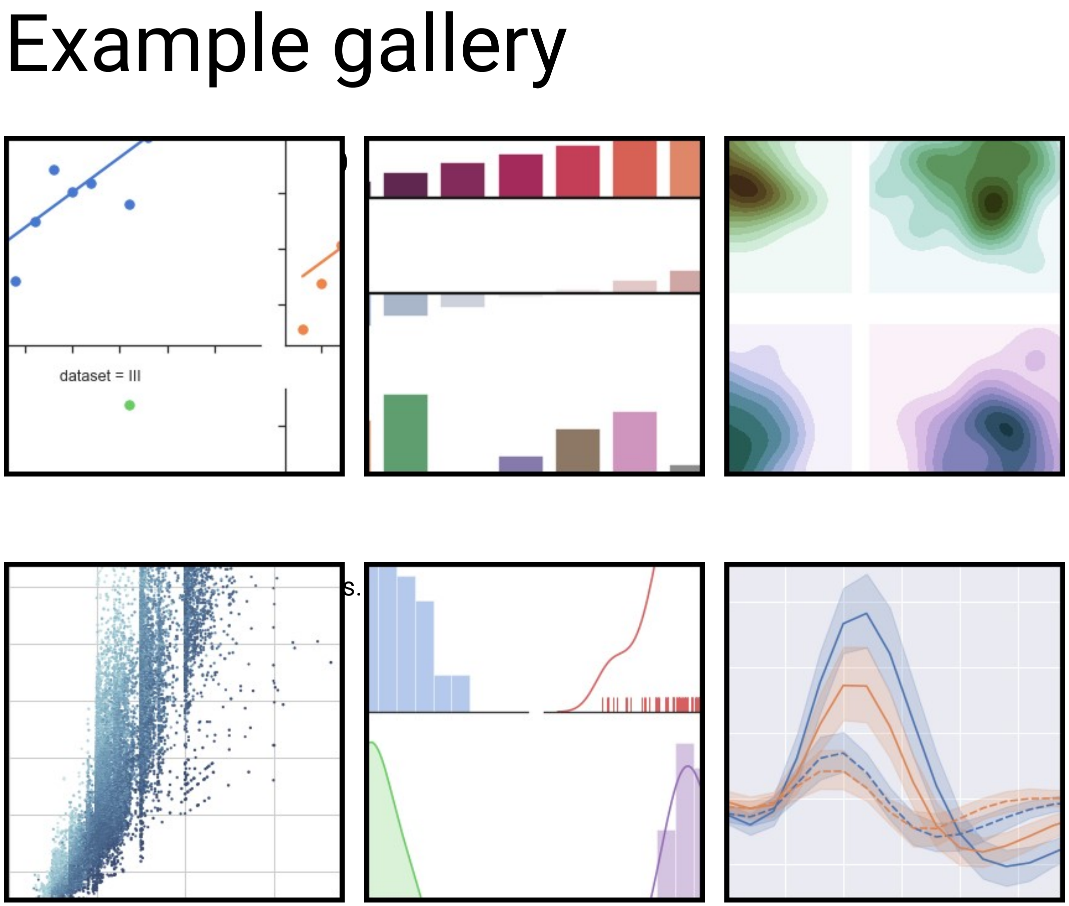
Table of Contents

Seaborn

- Seaborn is a statistical plot library for Python.
- It is based on matplotlib.
- Please find it's documentation here https://seaborn.pydata.org/ (https://seaborn.pydata.org/).
- You can install it with `conda install seaborn`.
- Next comes a snapshot of seaborn's example gallery https://seaborn.pydata.org/examples/index.html (https://seaborn.pydata.org/examples/index.html).

```
In [27]: IFrame(src='https://seaborn.pydata.org/examples/index.html', width=700, height=600)
```

Out[27]:



Example gallery

Bokeh

- Add to "static" plots, interactive plots and dashboards can be build with Bokeh library.
- Interactive plots are ideal if you want to visualize large data sets.
- Real time information is visible like server load,...
- Boekh is easy to install via conda and pip.
- Please find here the Bokeh gallery https://docs.bokeh.org/en/latest/docs/gallery.html (https://docs.bokeh.org/en/latest/docs/gallery.html).
- And in next cell, an interactive plot of bokeh website is presented.

In [28]:

```
IFrame(src='https://demo.bokeh.org/crossfilter', width=700, height=600)
```

Out[28]:

X-Axis

mpg

Y-Axis

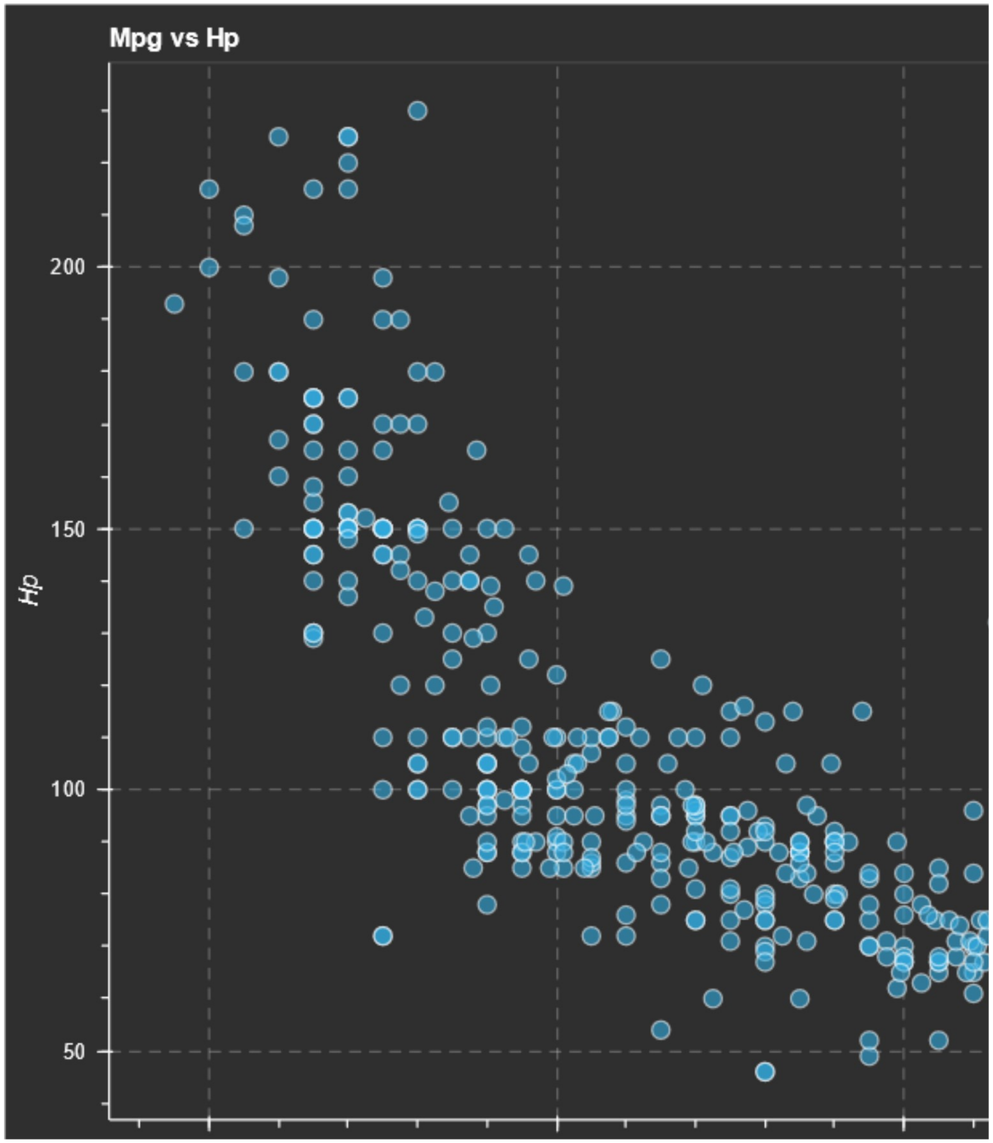
hp

Color

None

Size

None

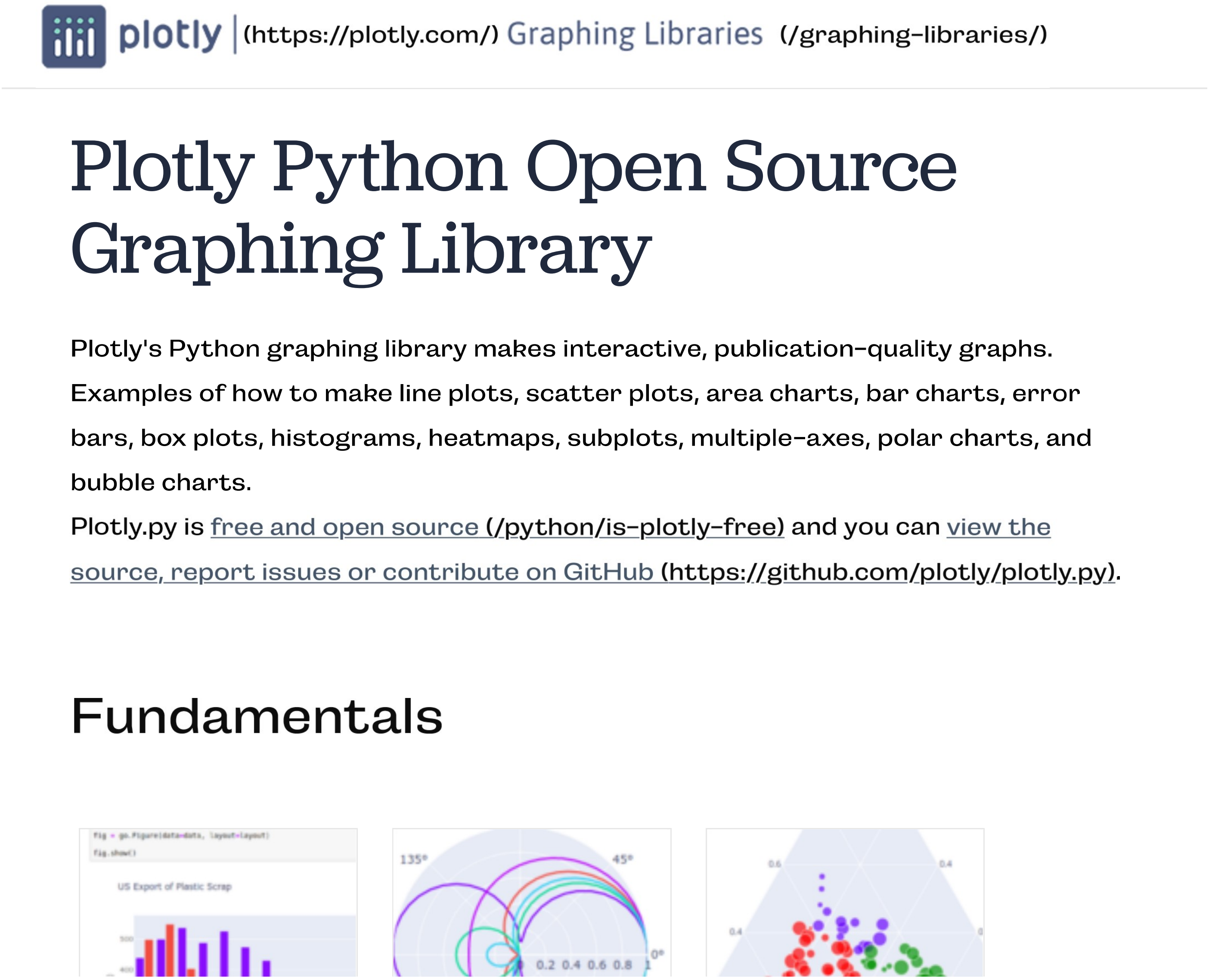


Plotly

- Plotly is another very simple to use interactive plot library.
- You can find more detail in https://plot.ly/python/ (https://plot.ly/python/).
- Next, some examples from plotly gallery are presented.

```
In [29]: IFrame(src='https://plot.ly/python/', width=700, height=600)
```

```
Out[29]:
```



plotly (https://plotly.com/) Graphing Libraries (/graphing-libraries/)

Plotly Python Open Source Graphing Library

Plotly's Python graphing library makes interactive, publication-quality graphs. Examples of how to make line plots, scatter plots, area charts, bar charts, error bars, box plots, histograms, heatmaps, subplots, multiple-axes, polar charts, and bubble charts.

Plotly.py is free and open source (/python/is-plotly-free) and you can view the source, report issues or contribute on GitHub (https://github.com/plotly/plotly.py).

Fundamentals

fig = go.Figure(data=data, layout=layout)
fig.show()
US Export of Plastic Scrap
135°
45°
0.2 0.4 0.6 0.8 1
0°
0.6
0.4
0.4

In a nutshell

- There are many very powerful plot libraries available for Python.
- The chance that someone wrote a template for your plotting task is very high.
- Just look in the galleries and you will find a great starting point.