Python for scientific research

Plotting with `Matplotlib`

John Joseph Valletta

University of Exeter, Penryn Campus, UK

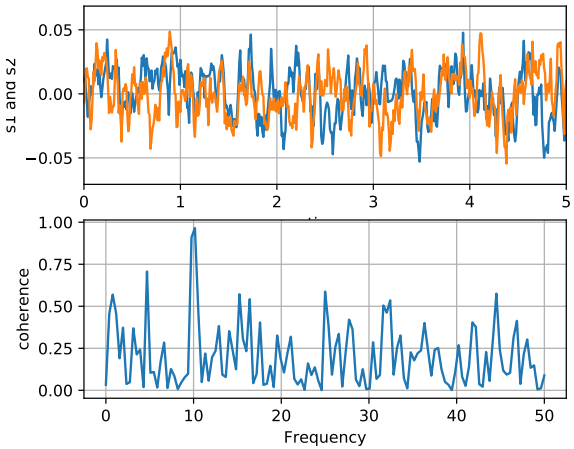
June 2017

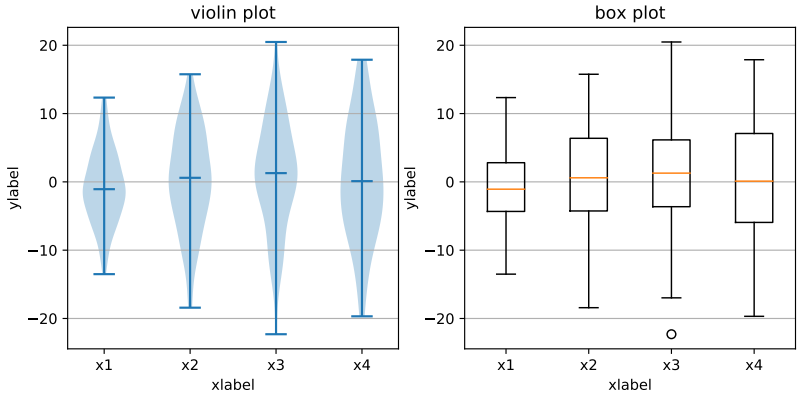
What we've done so far

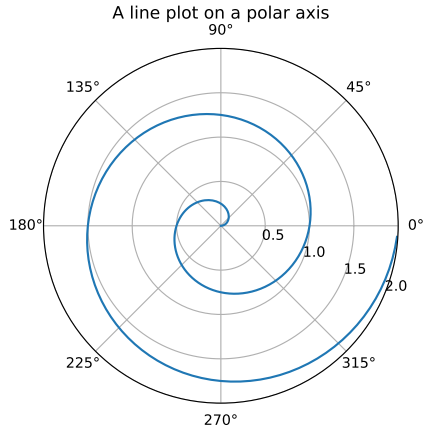
1. Declare variables using built-in data types and execute operations on them
2. Use flow control commands to dictate the order in which commands are run and when
3. Encapsulate programs into reusable functions, modules and packages
4. Using `NumPy` and `SciPy` for numerical computations
5. **Next**: Introducing `Matplotlib`, Python's plotting library

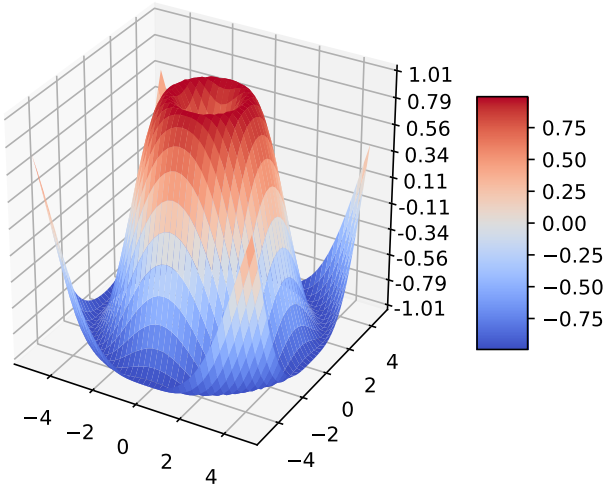
Introduction

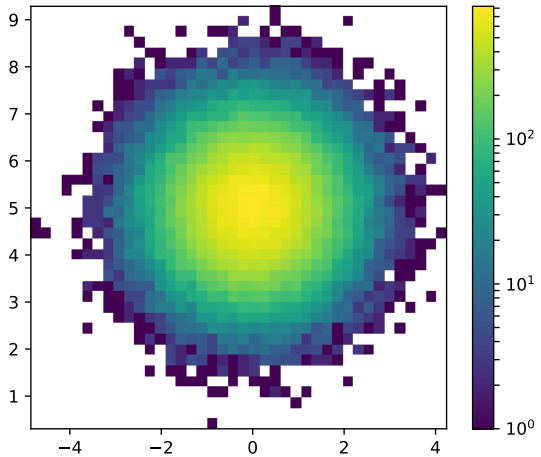
- `Matplotlib` is a 2D and 3D plotting library that produces publication-ready scientific figures in most formats (e.g PNG, EPS)

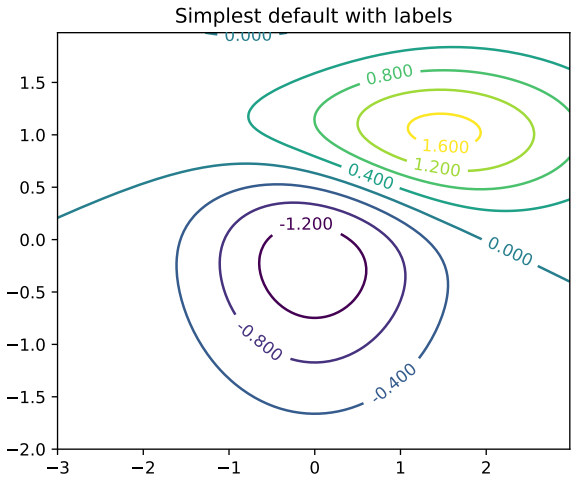




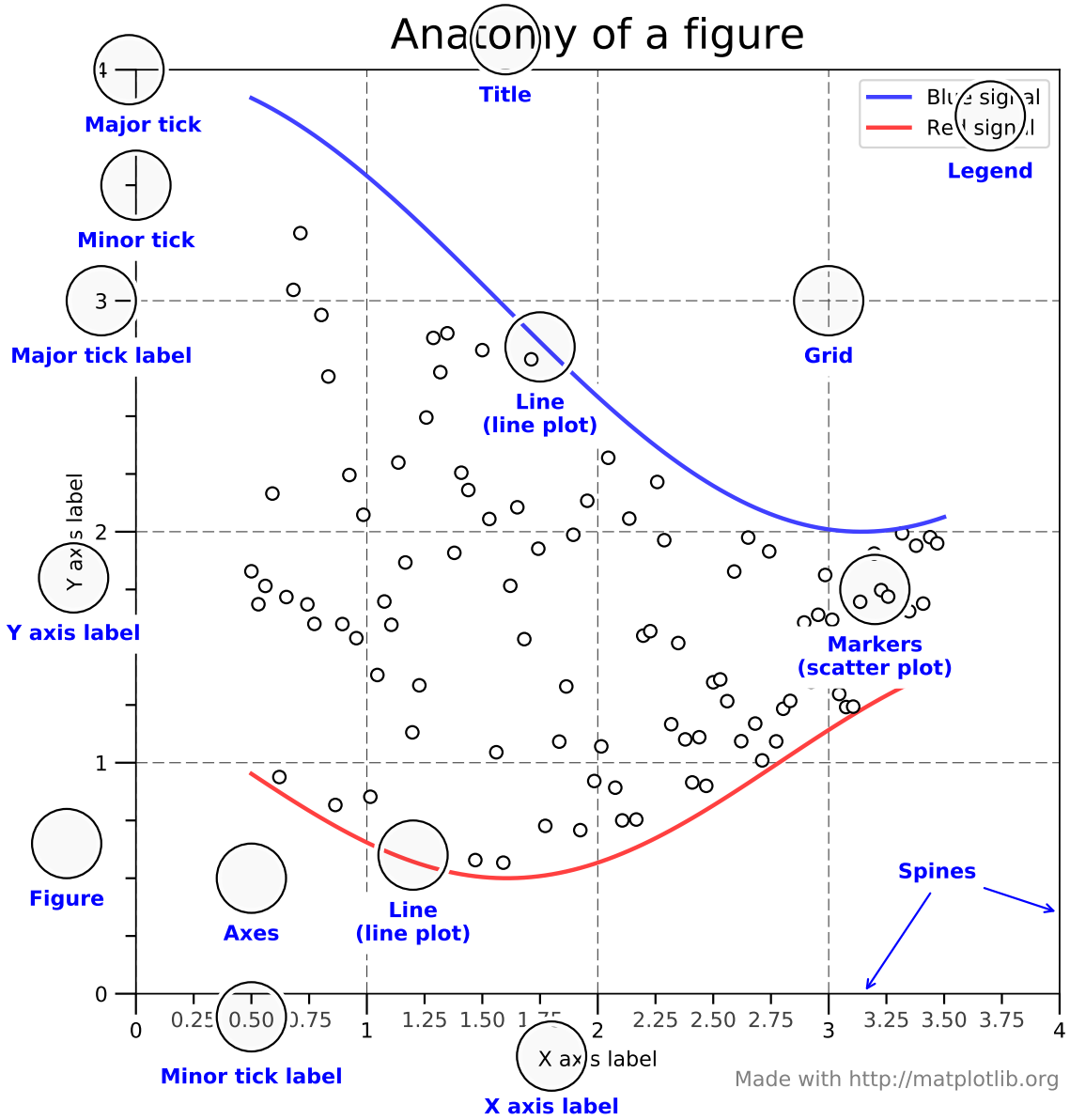






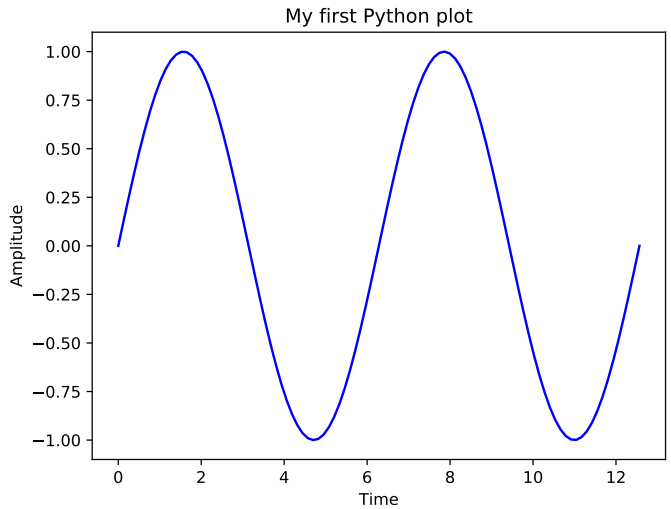


Anatomy of a figure



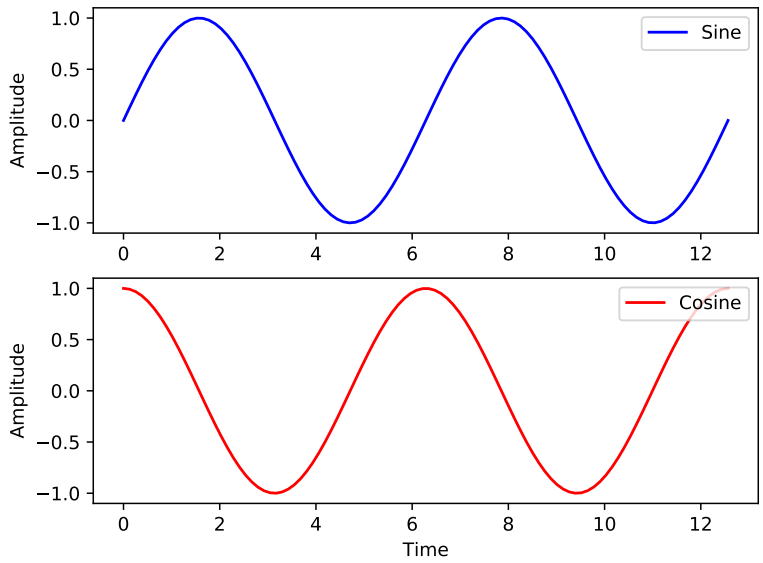
My first plot

```
import numpy as np
import matplotlib.pyplot as plt

# Generate a sinusoidal data
x = np.linspace(0, 4*np.pi, 100)
y = np.sin(x)

# Plot sinusoidal curve
plt.plot(x, y, color="blue")
plt.xlabel("Time")
plt.ylabel("Amplitude")
plt.title("My first Python plot")
```



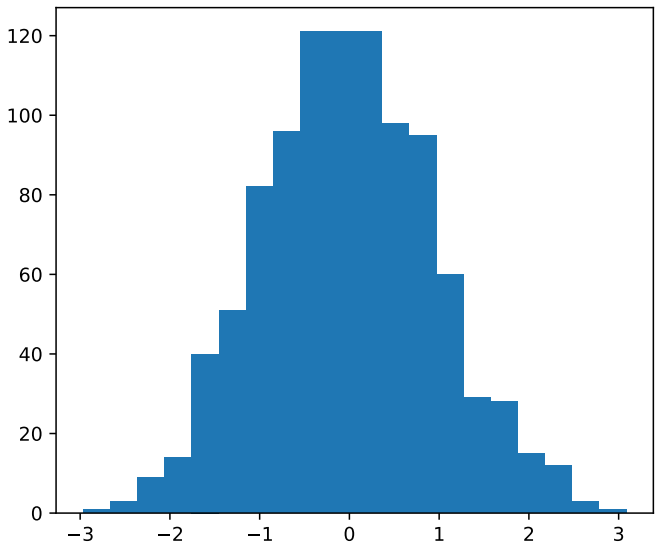
Subplots

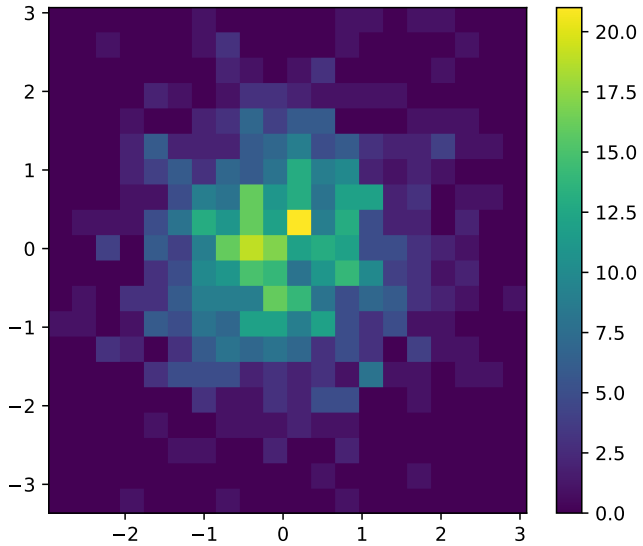
```
plt.subplot(2, 1, 1) # 2 rows, 1 column, first plot
plt.plot(x, np.sin(x), color="b", label="Sine")
plt.ylabel("Amplitude")
plt.legend(loc="upper right")

plt.subplot(2, 1, 2) # 2 rows, 1 column, second plot
plt.plot(x, np.cos(x), color="r", label="Cosine")
plt.xlabel("Time")
plt.ylabel("Amplitude")
plt.legend(loc="upper right")
```



Histograms

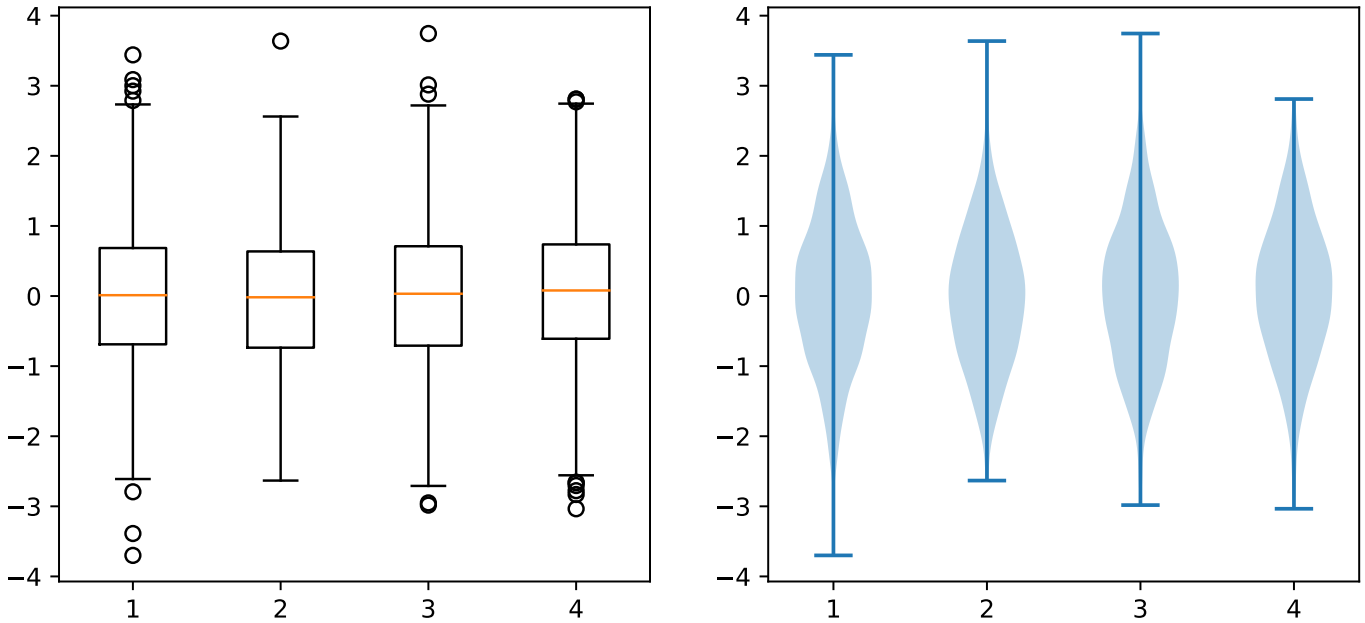
```
# Generate 1000 normally distributed numbers
x1 = np.random.randn(1000)
x2 = np.random.randn(1000)

# 1D histogram (x1)
plt.subplot(1, 2, 1)
plt.hist(x1, bins=20)

# 2D histogram (x1 vs x2)
plt.subplot(1, 2, 2)
plt.hist2d(x1, x2, bins=20)
plt.colorbar()
```





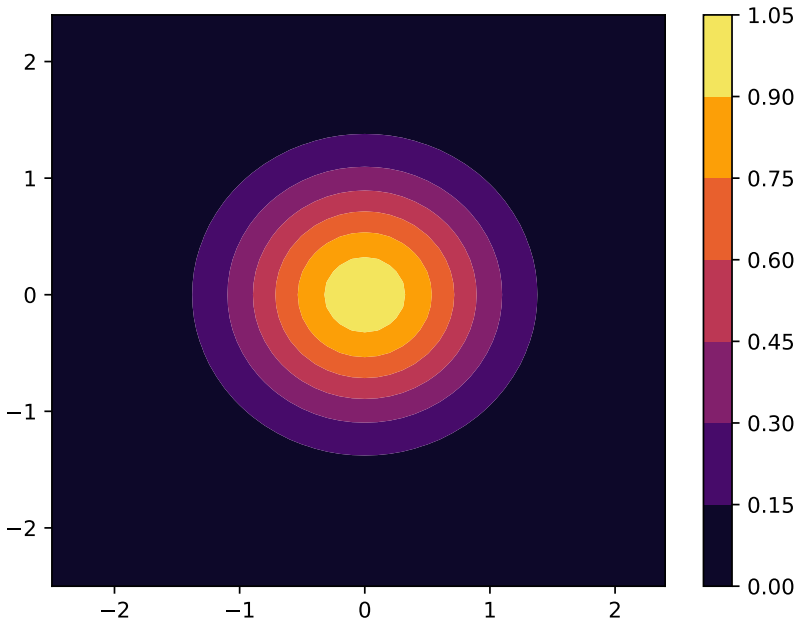
Boxplots and violin plots

```
# Generate four sets of random numbers
data = [np.random.randn(1000) for i in range(4)]

# Boxplot
plt.subplot(1, 2, 1)
plt.boxplot(data)

# Violin plot
plt.subplot(1, 2, 2)
plt.violinplot(data)
```



Contour plot

```
from matplotlib import cm

# Generate some x, y, z data
x = np.arange(-2.5, 2.5, 0.1)
y = np.arange(-2.5, 2.5, 0.1)
x, y = np.meshgrid(x, y)
z = np.exp(-x**2 - y**2)

# Contour plot
plt.contourf(x, y, z, cmap=cm.inferno)
plt.colorbar()
```



3D surface

```
from mpl_toolkits.mplot3d import Axes3D

# Create figure amenable for 3D plotting
hFig = plt.figure()
hAx = hFig.gca(projection="3d")

# Plot the surface
hSurf = hAx.plot_surface(x, y, z, cmap=cm.inferno)
plt.colorbar(hSurf, shrink=0.5)
```