Data Visualization

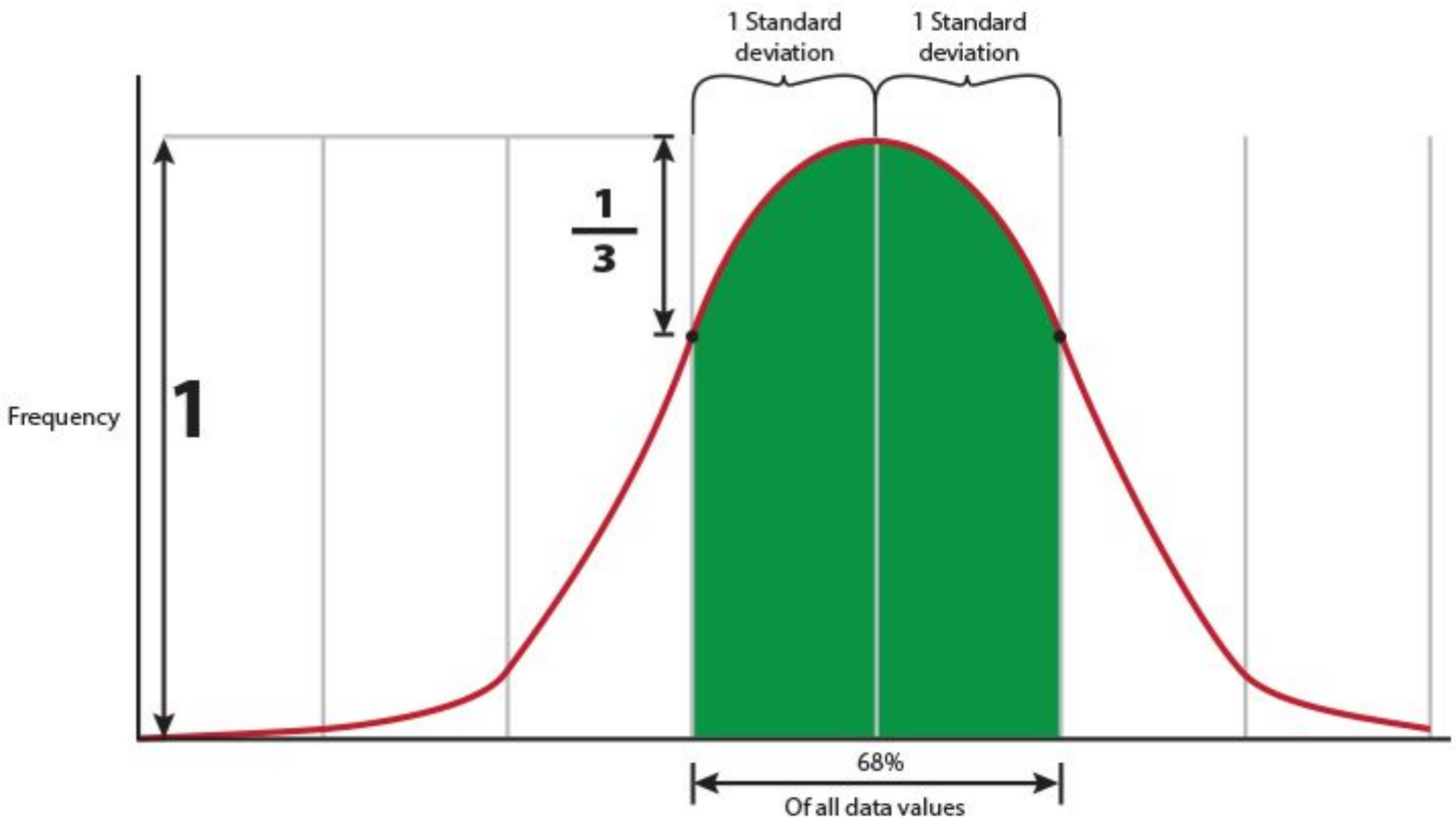
Agenda

1. Normal Distributions Intro
2. Histogram
3. Matplotlib Artist Layer Examples
4. Questions

Normal Distributions Intro

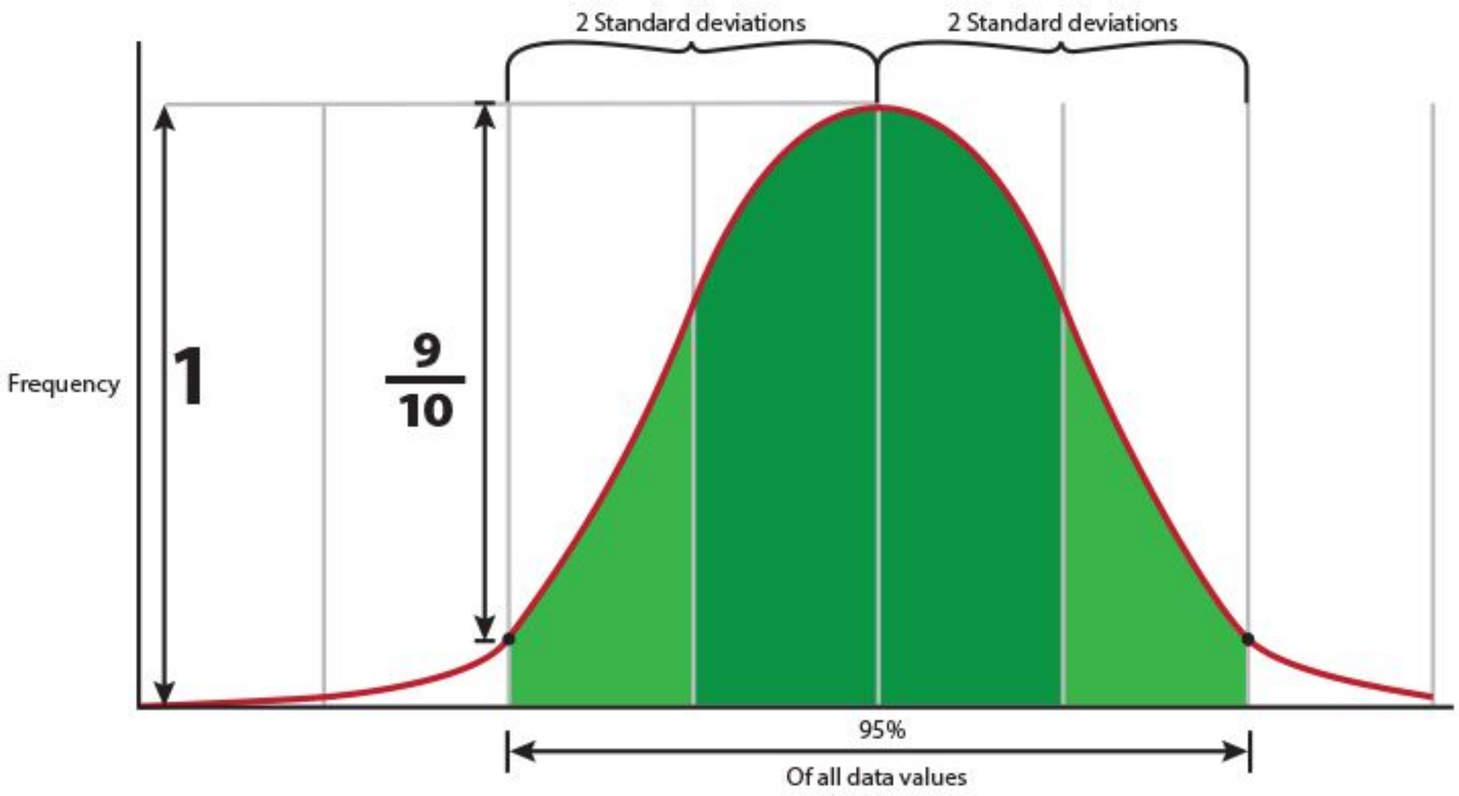
Normal Distributions (1 Standard Deviation)

68% of data is **< 1** standard deviation away from the mean



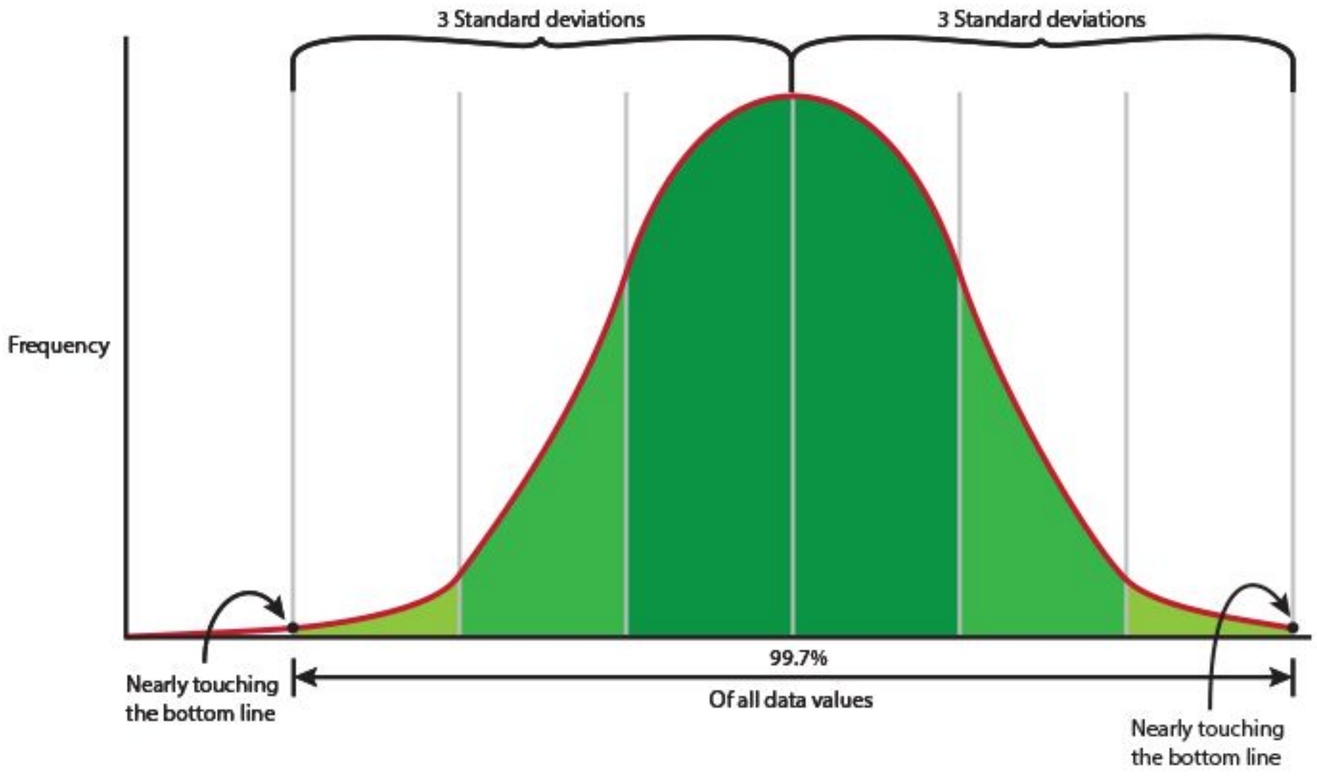
Normal Distributions (2 Standard Deviation)

95% of data is **< 2** standard deviations away from the mean

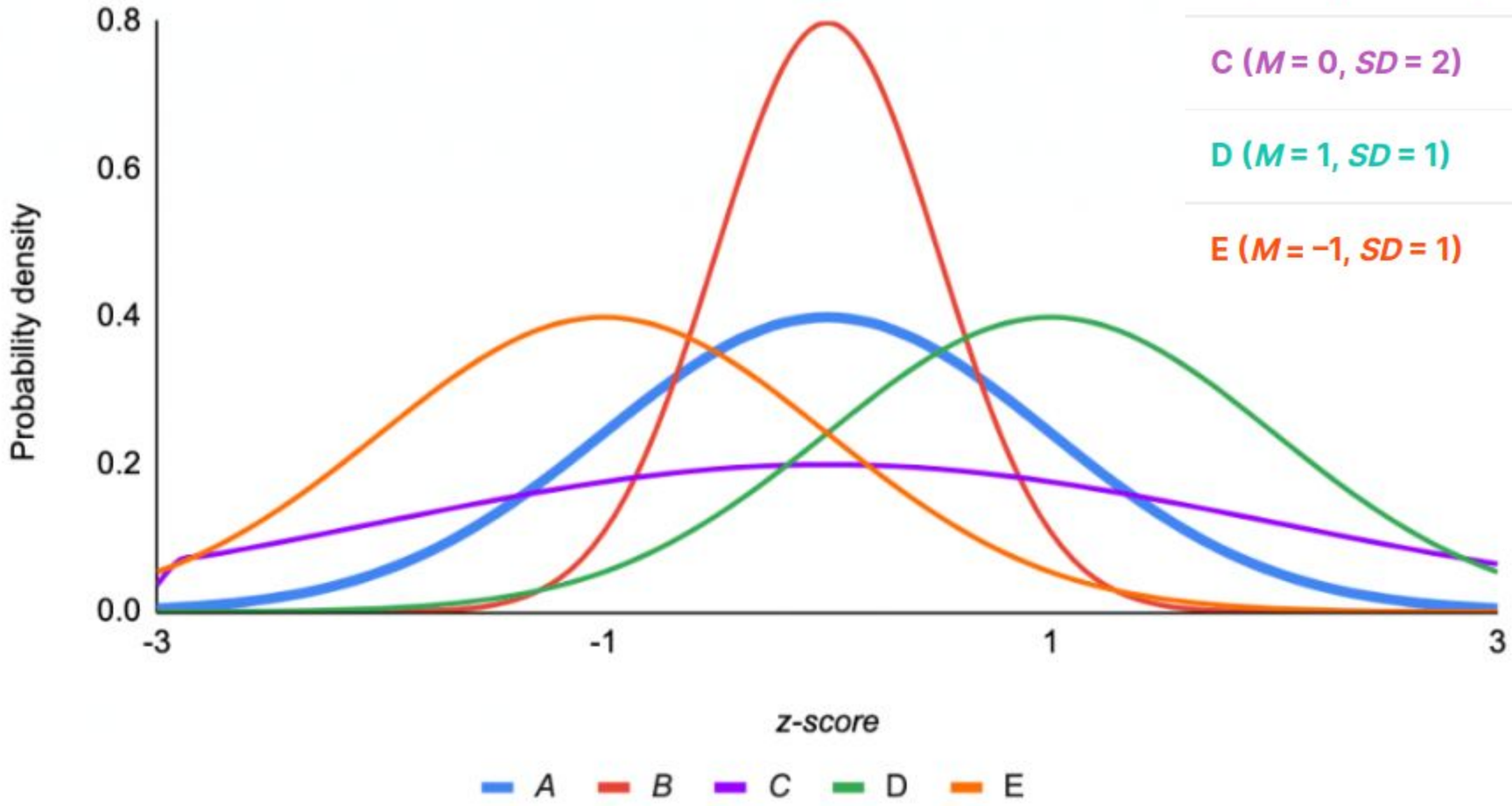


Normal Distributions (3 Standard Deviation)

99.7% of data is **< 3** standard deviations away from the mean



Standard Normal Distribution



A ($M = 0$, $SD = 1$)	Standard normal distribution
B ($M = 0$, $SD = 0.5$)	Squeezed, because $SD < 1$
C ($M = 0$, $SD = 2$)	Stretched, because $SD > 1$
D ($M = 1$, $SD = 1$)	Shifted right, because $M > 0$
E ($M = -1$, $SD = 1$)	Shifted left, because $M < 0$

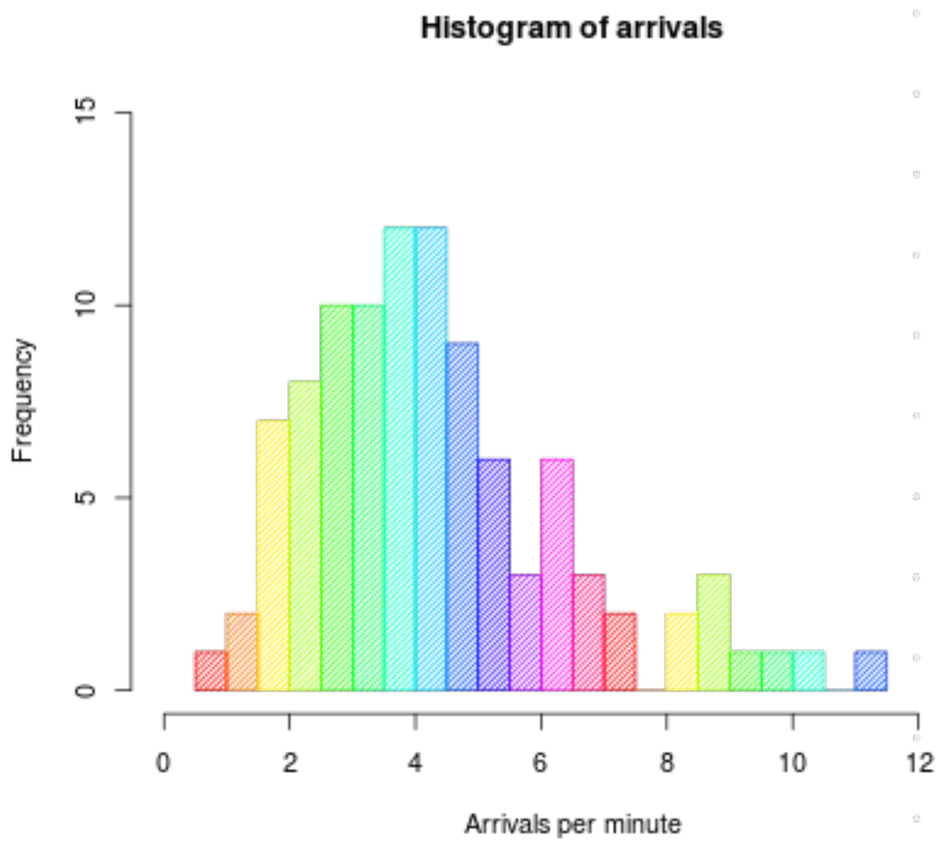
Histogram

Histogram

- approximate representation of **numerical data distribution**

- **Construct Histogram**
  - bin (bucket) the range of values
  - count how many values fall into each interval

- The **Bins** are usually specified as
  - consecutive
  - non-overlapping intervals



Histogram vs Column Chart

- **`Histogram`**
  - used for **continuous data**, where the bins represent ranges of data

- **`Column Chart`**
  - plot of **categorical variables**

- **`Recommendation`**
  - **Histogram** rectangles touch each other to indicate: original variable is **continuous**
  - **Column Chart** has gaps between the rectangles to clarify the distinction

Matplotlib Artist Layer Examples

NumPy Example

localhost:8888/notebooks/dv-0.ipynb

jupyter dv-0 Last Checkpoint: 21 hours ago (unsaved changes)

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Run Code

In [1]:
```
import numpy as np

np.random.randn(10) #Return 10 samples from the Standard Normal Distribution
```

Out[1]:
```
array([-0.64393041,  0.0329367 , -0.16840147,  0.88846809,  0.76751103,
        0.18852699, -1.30213432,  0.58043701,  1.80149475, -0.18262329])
```

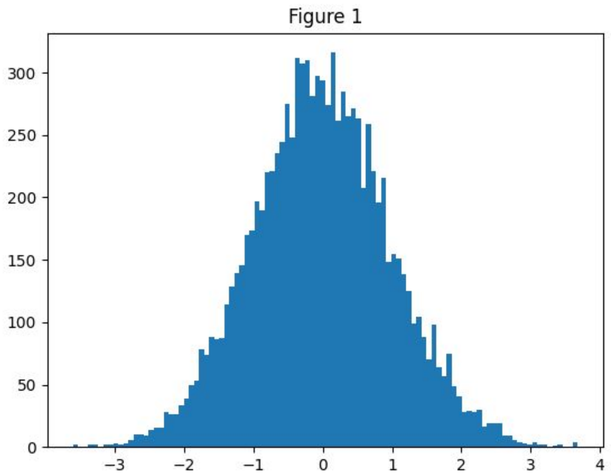
NumPy: Numerical Python library for **Scientific Computing**

https://github.dev/numpy/numpy/blob/main/numpy/random/__init__.py

https://github.dev/numpy/numpy/blob/main/numpy/matlib.py

Artist Layer Example 1

In [2]:
```
from matplotlib.backends.backend_agg import FigureCanvasAgg as FigureCanvas
from matplotlib.figure import Figure
import numpy as np

x = np.random.randn(10000)

fig = Figure()                    #Create an Artist (the Figure Artist)
canvas = FigureCanvas(fig)        #Create a Canvas and attach the Artist to it
ax = fig.add_subplot(111)         #Create a second Artist (the Axes Artist)
ax.hist(x, 100)                   #Call hist method to generate the histogram with 100 bins
ax.set_title('Figure 1')          #We should write an appropriate title
fig.savefig('hist1.png')          #Save the figure
```



Artist Layer Example 1 - Notes

- Use **Artist Layer** to generate histogram of 10000 random numbers

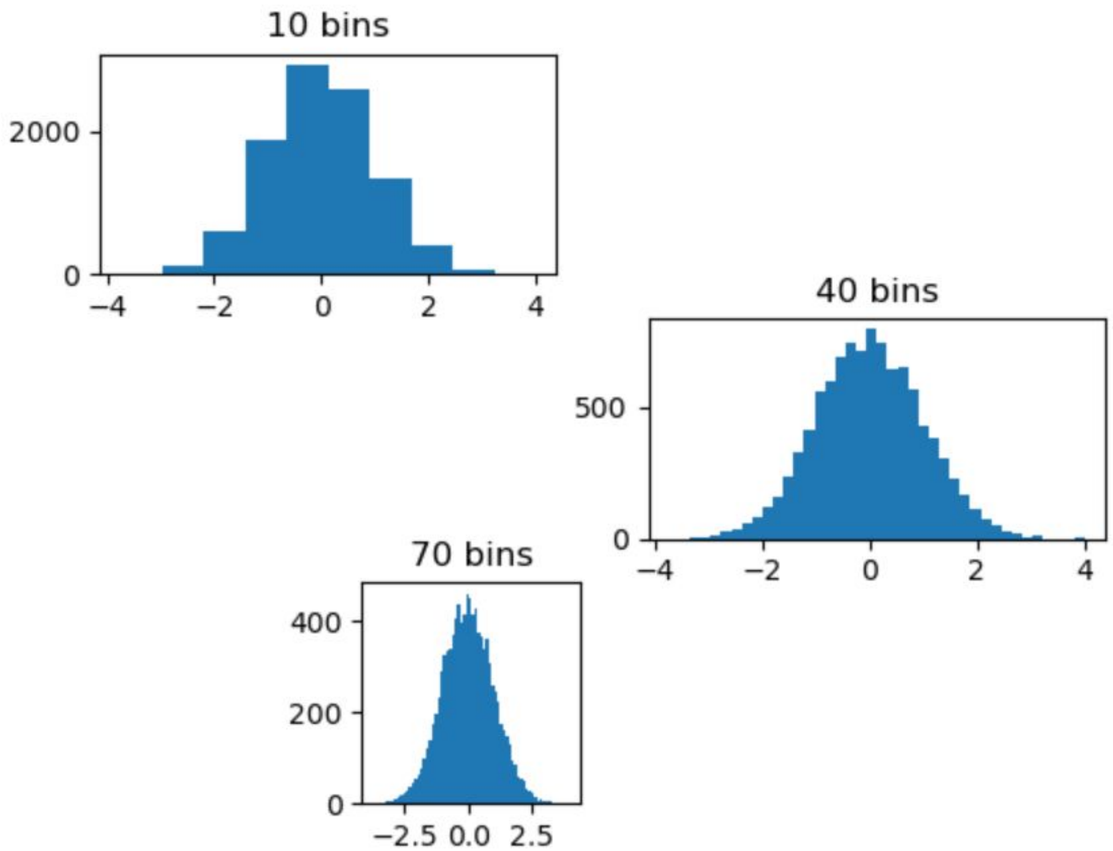
- **Anti Grain Geometry (AGG)**
  - a high-performance library that produces attractive images

- use **111** (from MATLAB convention)
  - creates a grid with 1 row and 1 column
  - uses the first cell in that grid for the location of the new **Axes Artist**

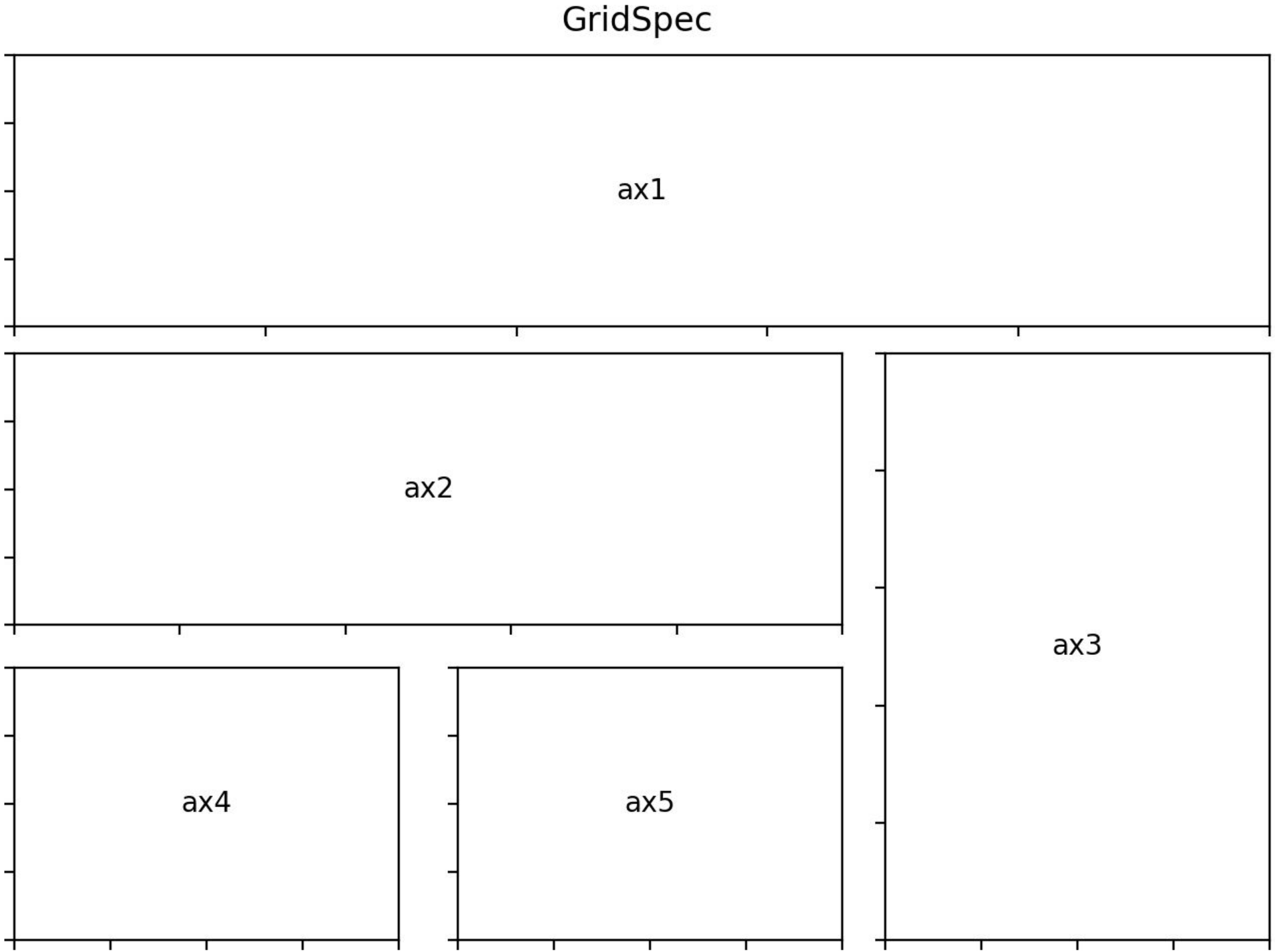
- **hist method**
  - creates a sequence of **Rectangle Artists**

Artist Layer Example 2

```
import numpy as np
x = np.random.randn(10000)

from matplotlib.backends.backend_agg import FigureCanvasAgg as FigureCanvas
from matplotlib.figure import Figure
fig = Figure()
canvas = FigureCanvas(fig)

ax1 = fig.add_subplot(321)
ax1.hist(x, 10)
ax1.set_title('10 bins')

ax2 = fig.add_subplot(324)
ax2.hist(x, 40)
ax2.set_title('40 bins')

ax3 = fig.add_subplot(3,4,10)
ax3.hist(x, 70)
ax3.set_title('70 bins')

fig.savefig('fig4.png')
```

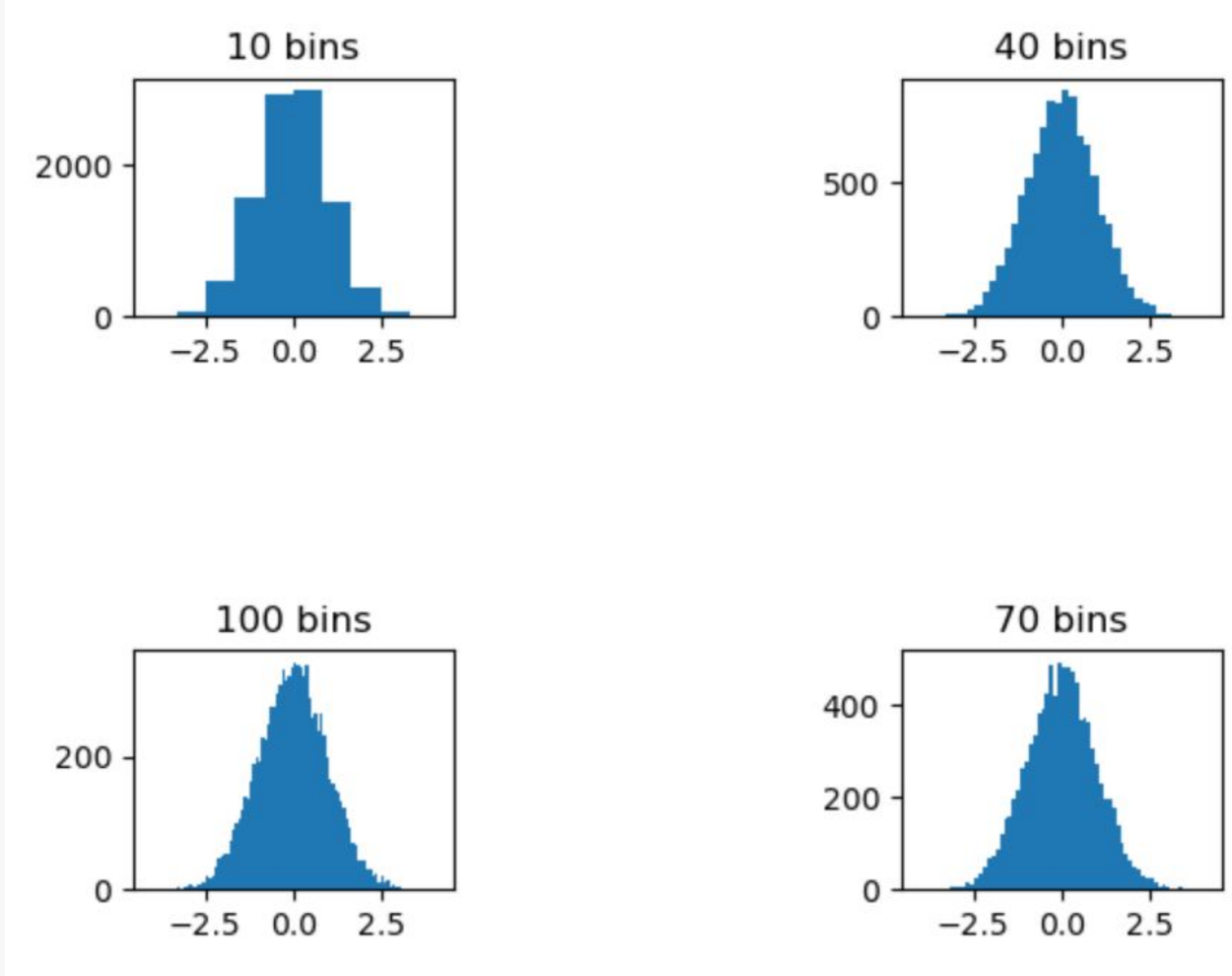


GridSpec



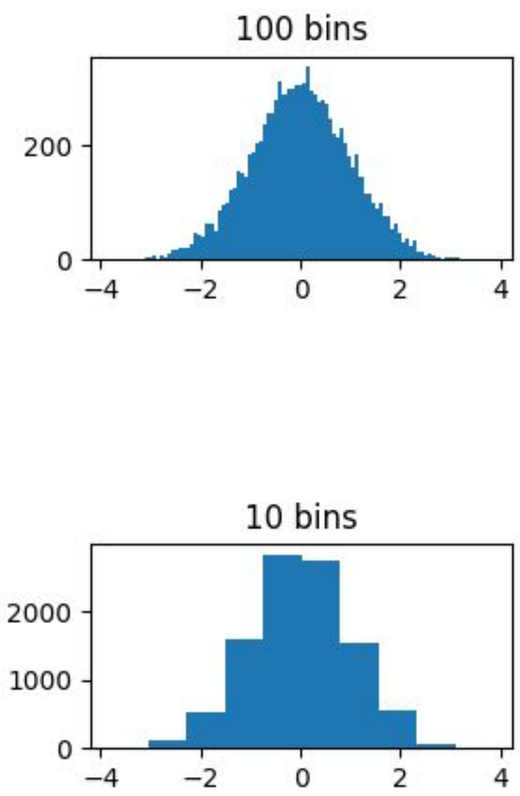
Artist Layer (Using GridSpec) Example 1

```
import numpy as np
x = np.random.randn(10000)

from matplotlib.backends.backend_agg import FigureCanvasAgg as FigureCanvas
from matplotlib.figure import Figure
fig = Figure()
canvas = FigureCanvas(fig)
gs = fig.add_gridspec(3, 3)

ax1 = fig.add_subplot(gs[0, 0])
ax1.hist(x, 10)
ax1.set_title('10 bins')

ax2 = fig.add_subplot(gs[0, 2])
ax2.hist(x, 40)
ax2.set_title('40 bins')

ax3 = fig.add_subplot(gs[2, 2])
ax3.hist(x, 70)
ax3.set_title('70 bins')

ax4 = fig.add_subplot(gs[2, 0])
ax4.hist(x, 100)
ax4.set_title('100 bins')

fig.savefig('fig5.png')
```



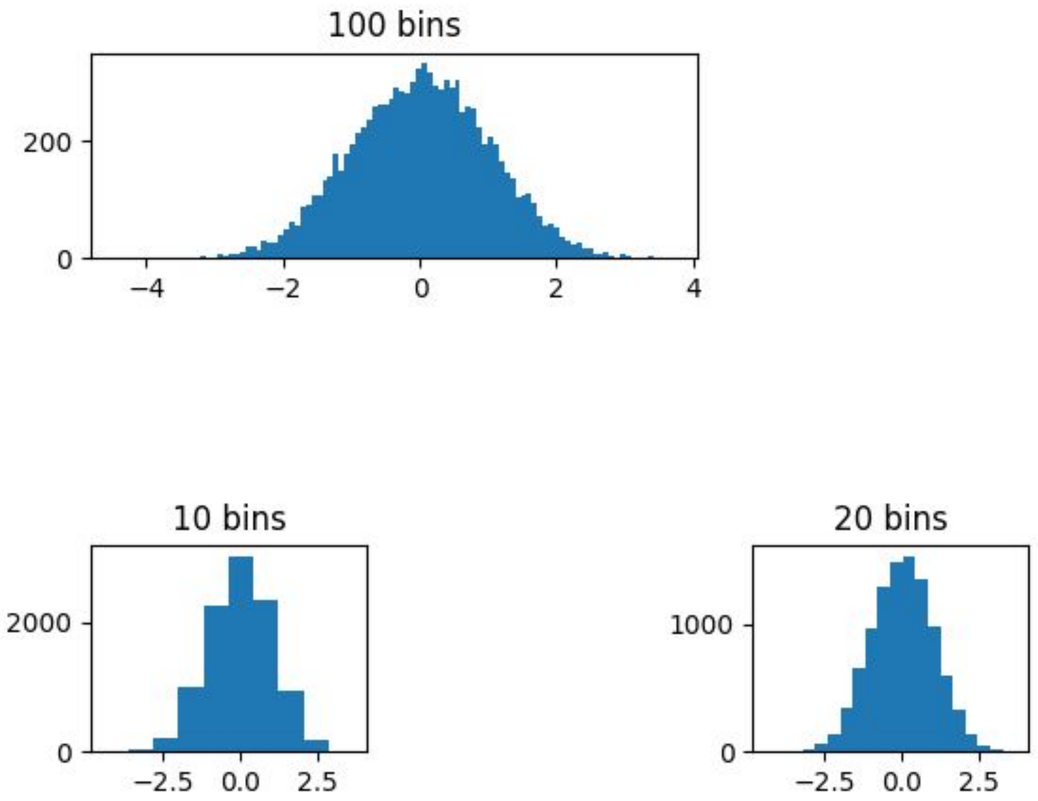
Artist Layer (Using GridSpec) Example 2

```
import numpy as np
x = np.random.randn(10000)

from matplotlib.backends.backend_agg import FigureCanvasAgg as FigureCanvas
from matplotlib.figure import Figure
fig = Figure()
canvas = FigureCanvas(fig)
gs = fig.add_gridspec(3, 2)

ax1 = fig.add_subplot(gs[0, 0])
ax1.hist(x, 100)
ax1.set_title('100 bins')

ax2 = fig.add_subplot(gs[2, 0])
ax2.hist(x, 10)
ax2.set_title('10 bins')

fig.savefig('2-axes.png')
```

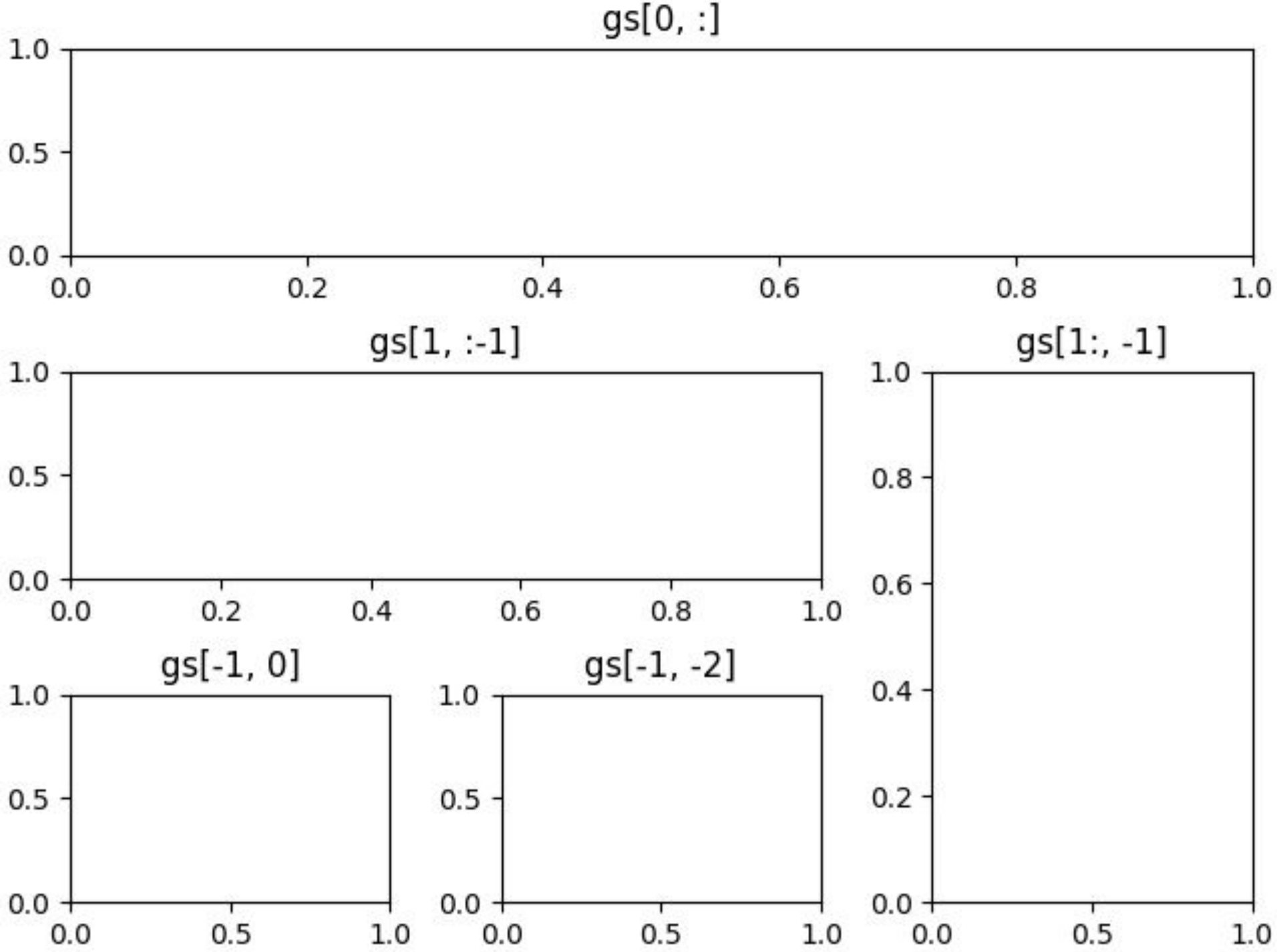


Artist Layer (Using GridSpec) Example 3

```
import numpy as np
x = np.random.randn(10000)

from matplotlib.backends.backend_agg import FigureCanvasAgg as FigureCanvas
from matplotlib.figure import Figure
fig = Figure()
canvas = FigureCanvas(fig)
gs = fig.add_gridspec(3, 3)

ax1 = fig.add_subplot(gs[0, 0:2])
ax1.hist(x, 100)
ax1.set_title('100 bins')

ax2 = fig.add_subplot(gs[2, 0])
ax2.hist(x, 10)
ax2.set_title('10 bins')

ax2 = fig.add_subplot(gs[2, -1])
ax2.hist(x, 20)
ax2.set_title('20 bins')

fig.savefig('span.png')
```



GridSpec



Questions

Links

https://github.com/fcai-b/dv

References

1. https://www.coursera.org/learn/python-for-data-visualization