Data Visualizations using Matplotlib #445

SHUBHAM PATEL

BATCH – 03

SERIAL NO. 104

What is Data Visualization

Data visualization refers to the representation of data or information in charts, graphs, maps or other visual formats. The resulting visual representation of data makes it easier to identify and share real-time trends, outliers, and new insights about the information represented in the data. Here, I am attempting to make sure that you understand the most basic and simple library used for data visualization - Matplotlib.

Contents

What is Matplotlib

Matplotlib is a low level graph plotting library in python that serves as a visualization utility.

Matplotlib was created by John D. Hunter.

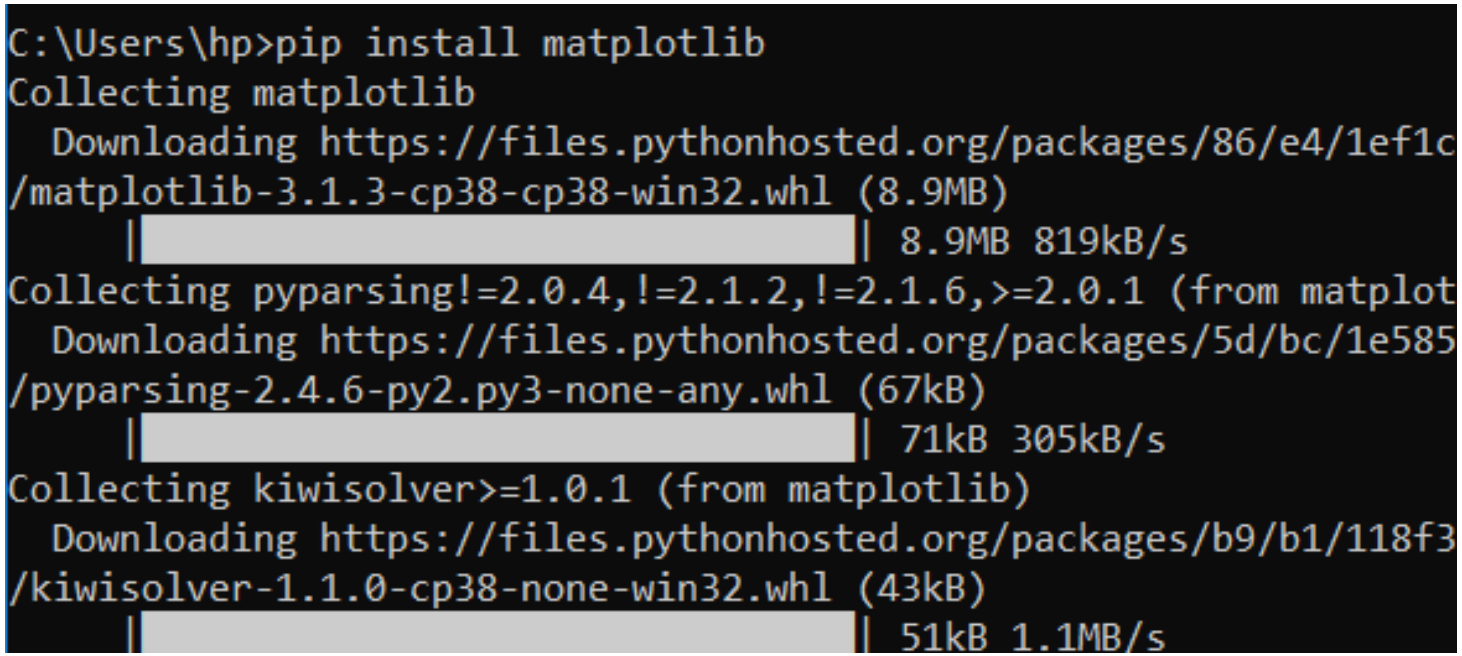
Matplotlib is open source and we can use it freely.

To see source code: https://github.com/matplotlib/matplotlib

Matplotlib is mostly written in python, a few segments are written in C, Objective-C and Javascript for Platform compatibility.

Original website: Matplotlib: Python plotting — Matplotlib 3.4.3 documentation

Installing Matplotlib



Import statement:

From matplotlib import pyplot as plt

Or

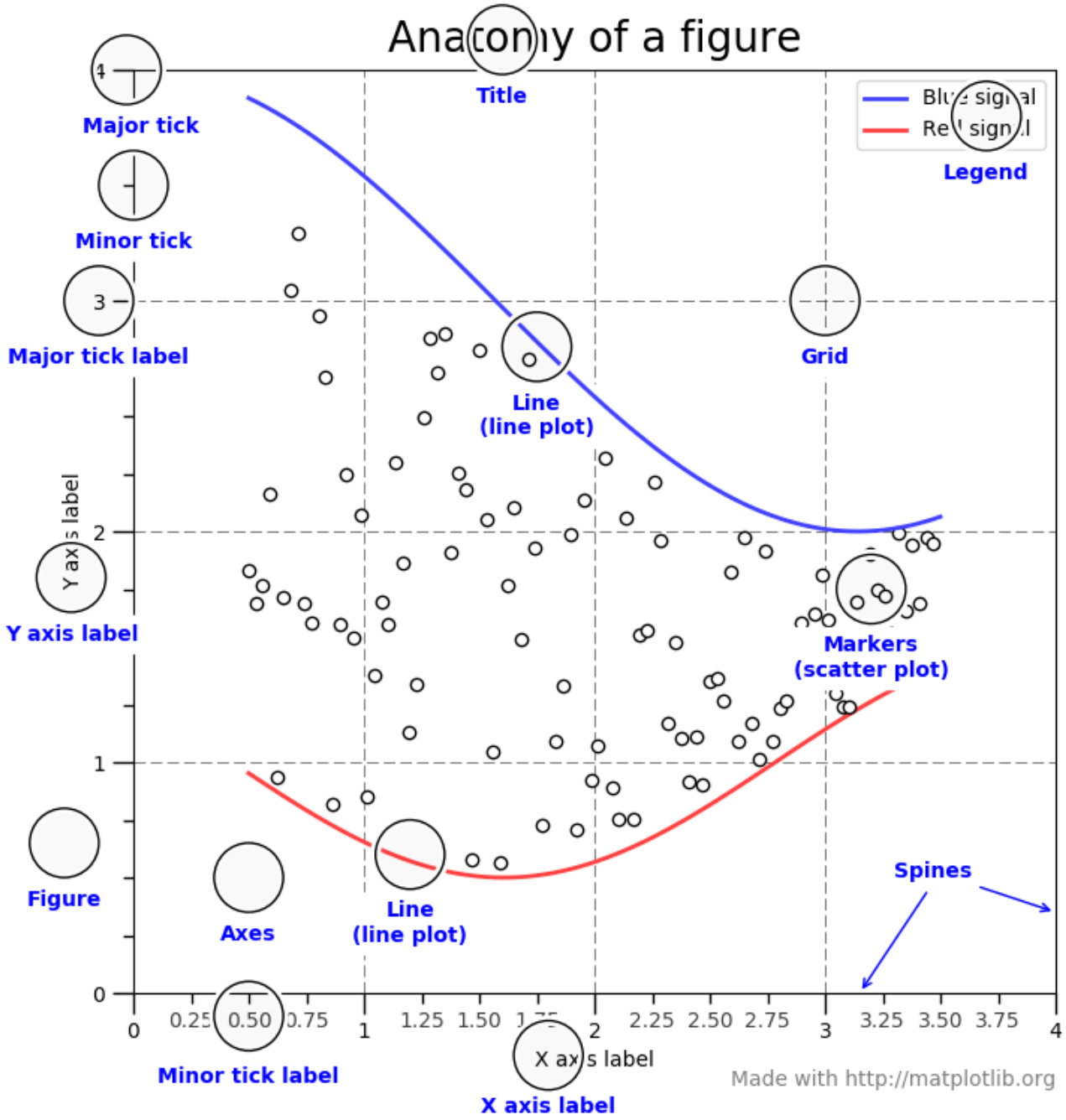
Import matplotlib.pyplot as plt

Parts of a Matplotlib Figure

Figure – The whole figure or complete image which is shown is called Figure. It keeps track of axes, special artists(labels, legends, ticks, etc)

Axes – This is what you think as a single plot. There can be many axes in 1 figure, but a given axes can be present in only 1 figure. The Axes contains two (or three in the case of 3D) Axis objects which take care of the data limits.

Artist - Basically, everything you can see on the figure is an artist. This includes text object, collection object, patch objects, everything.



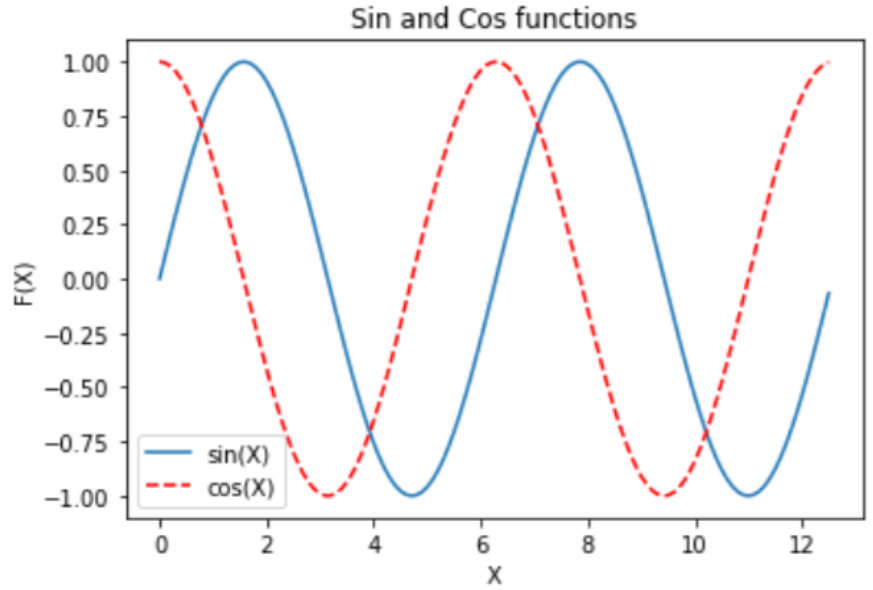
- Several graphs which will be covered by me:

    1. Line plot
    2. Bar Graph
    3. Scatter Plot
    4. Area Plot
    5. Pie Chart
    6. Histogram
    7. Bubble Plot
    8. Box Plot
    9. Violin Plot
    10. Plotting Subplots(Not Exactly a graph, but important thing)

Line Plot

A line chart or line plot is a type of chart which displays information as a series of data points called 'markers' connected by straight line. It is a basic type of chart common in many fields.

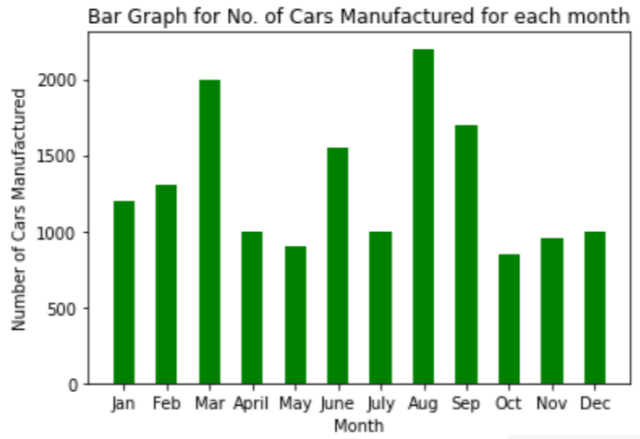
```
#Line Plot
x=np.arange(0,np.pi*4,0.1)
y1=np.sin(x)
y2=np.cos(x)
plt.plot(x,y1,label="sin(X)")
plt.plot(x,y2,color="red",linestyle="--",label="cos(X)")
plt.xlabel("X")
plt.ylabel("F(X)")
plt.title("Sin and Cos functions")
plt.legend()
plt.show()
```



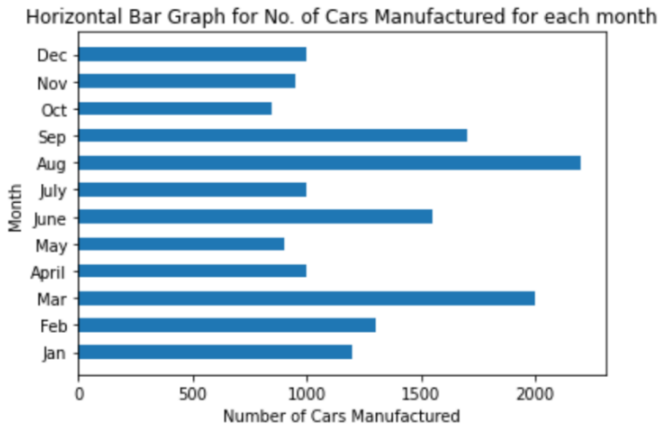
Bar Chart – Vertical and Horizontal

A bar chart or bar graph is a chart or graph that presents categorical data with rectangular bars with heights or lengths proportional to the values that they represent. The bars can be plotted vertically or horizontally. A vertical bar chart is sometimes called a column chart.

```
#Bar Graph
months=['Jan','Feb','Mar','April','May','June','July','Aug','Sep','Oct','Nov','Dec']
manufac=[1200,1300,2000,1000,900,1550,1000,2200,1700,850,950,1000]
plt.bar(months, manufac, width=0.5, color='green')
plt.xlabel("Month")
plt.ylabel("Number of Cars Manufactured")
plt.title("Bar Graph for No. of Cars Manufactured for each month")
plt.show()
```



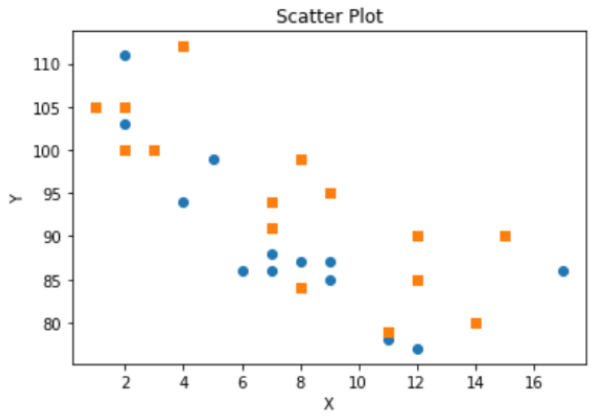

```
#Horizontal bar graph
plt.barh(months, manufac, height=0.5)
plt.ylabel("Month")
plt.xlabel("Number of Cars Manufactured")
plt.title("Horizontal Bar Graph for No. of Cars Manufactured for each month")
plt.show()
```



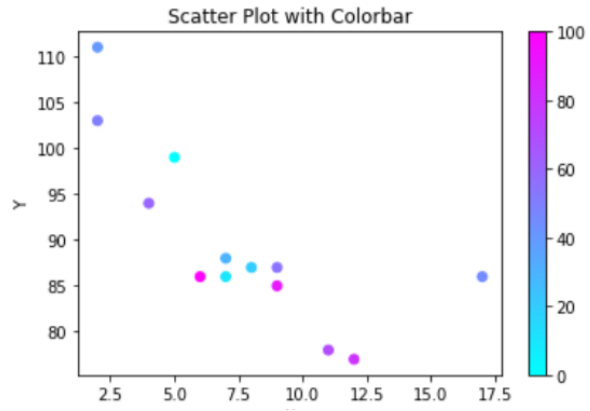
Scatter Plot

A scatter plot is a type of plot or mathematical diagram using Cartesian coordinates to display values for typically two variables for a set of data.

```
#Scatter Plot
x = np.array([5,7,8,7,2,17,2,9,4,11,12,9,6])
y = np.array([99,86,87,88,111,86,103,87,94,78,77,85,86])
plt.scatter(x, y)
#day two, the age and speed of 15 cars:
x = np.array([2,2,8,1,15,8,12,9,7,3,11,4,7,14,12])
y = np.array([100,105,84,105,90,99,90,95,94,100,79,112,91,80,85])
plt.scatter(x, y, marker="s")
plt.xlabel("X")
plt.ylabel("Y")
plt.title("Scatter Plot")
plt.show()
```



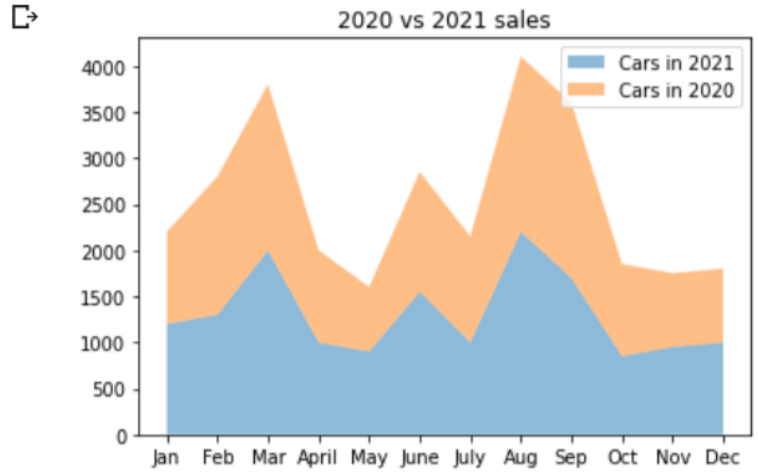

```
#Scatter Plot with Colorbar
x = np.array([5,7,8,7,2,17,2,9,4,11,12,9,6])
y = np.array([99,86,87,88,111,86,103,87,94,78,77,85,86])
colors = np.array([0, 10, 20, 30, 40, 45, 50, 55, 60, 70, 80, 90, 100])
plt.scatter(x, y, c=colors, cmap='cool')
plt.colorbar()
plt.xlabel("X")
plt.ylabel("Y")
plt.title("Scatter Plot with Colorbar")
plt.show()
```



Area Plot

An area chart or area graph displays graphically quantitative data. It is based on the line chart. The area between axis and line are commonly emphasized with colors, textures and hatchings. Commonly one compares two or more quantities with an area chart.

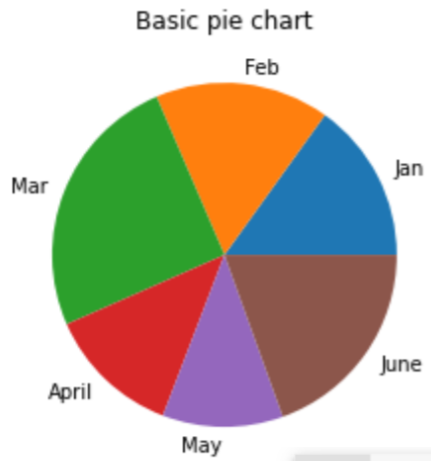
```
#Area Plot
months=['Jan','Feb','Mar','April','May','June','July','Aug','Sep','Oct','Nov','Dec']
manufac21=[1200,1300,2000,1000,900,1550,1000,2200,1700,850,950,1000]
manufac20=[1000,1500,1800,1000,700,1300,1150,1900,1900,1000,800,800]
plt.stackplot(months,manufac21,manufac20,labels=['Cars in 2021','Cars in 2020'],alpha=0.5)
plt.title("2020 vs 2021 sales")
plt.legend()
plt.show()
```



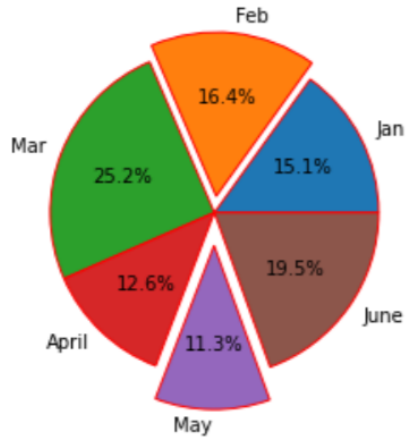
Pie Chart

A pie chart is a circular statistical graphic, which is divided into slices to illustrate numerical proportion. In a pie chart, the arc length of each slice, is proportional to the quantity it represents.

```
#Pie chart
months=['Jan','Feb','Mar','April','May','June']
manufac=[1200,1300,2000,1000,900,1550]
plt.pie(manufac,labels=months)
plt.title("Basic pie chart")
plt.show()
```



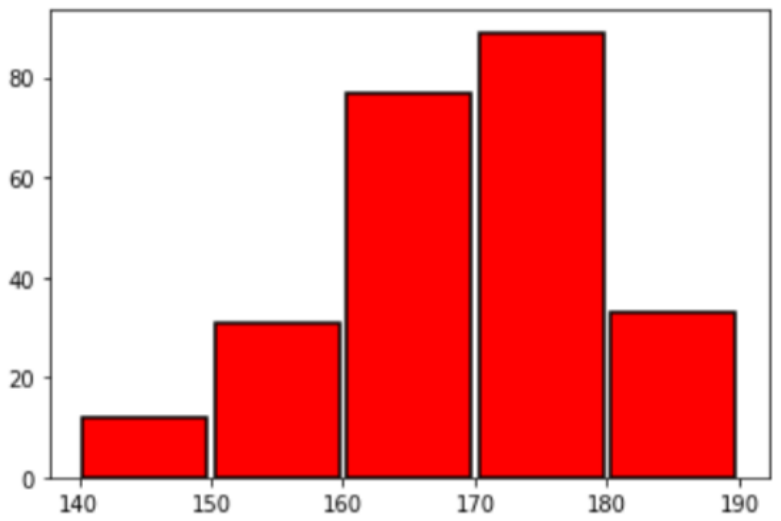

```
#Advanced pie chart
plt.pie(manufac,labels=months,wedgeprops={'edgecolor':'red','linewidth':1}\
        ,explode=[0,0.1,0,0,0.2,0],autopct="%1.1f%%")
plt.show()
```



Histogram

A histogram is a graphical display of data with bars of different heights, where each bar groups numbers into ranges. The taller the bars, the more the data falls in that range. It displays the shape as well as the spread of continuous sample data.

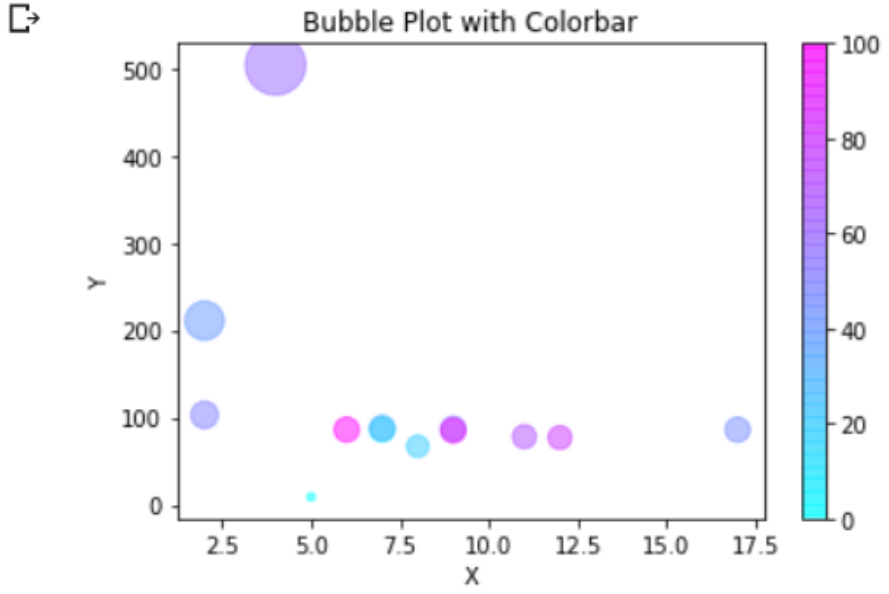
```
#Histogram using bins
x = np.random.normal(170, 10, 250)
bin=np.arange(140,200,10)
plt.hist(x,bins=bin,color='red',edgecolor='black',linewidth=1.5,rwidth=0.95)
plt.show()
```



Bubble Plot

A bubble chart (aka bubble plot) is an extension of the scatter plot used to look at relationships between three numeric variables. Each dot in a bubble chart corresponds with a single data point, and the variables' values for each point are indicated by horizontal position, vertical position, and dot size.

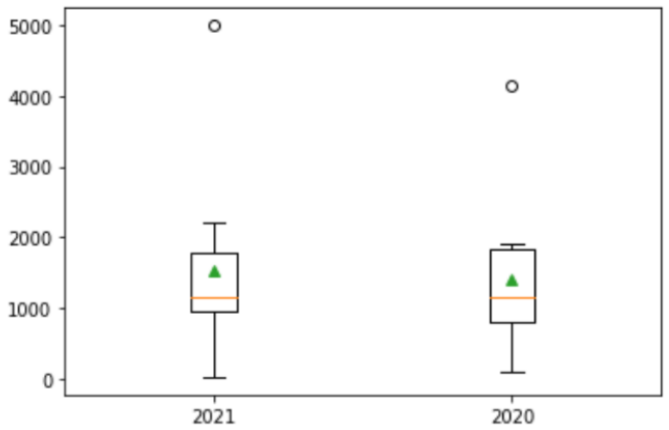
```
#Bubble Plot
x = np.array([5,7,8,7,2,17,2,9,4,11,12,9,6])
y = np.array([9,86,67,88,211,86,103,87,504,78,77,85,86])
colors = np.array([0, 10, 20, 30, 40, 45, 50, 55, 60, 70, 80, 90, 100])
plt.scatter(x, y, c=colors, cmap='cool',s=y*1.5,alpha=0.5)
plt.colorbar()
plt.xlabel("X")
plt.ylabel("Y")
plt.title("Bubble Plot with Colorbar")
plt.show()
```



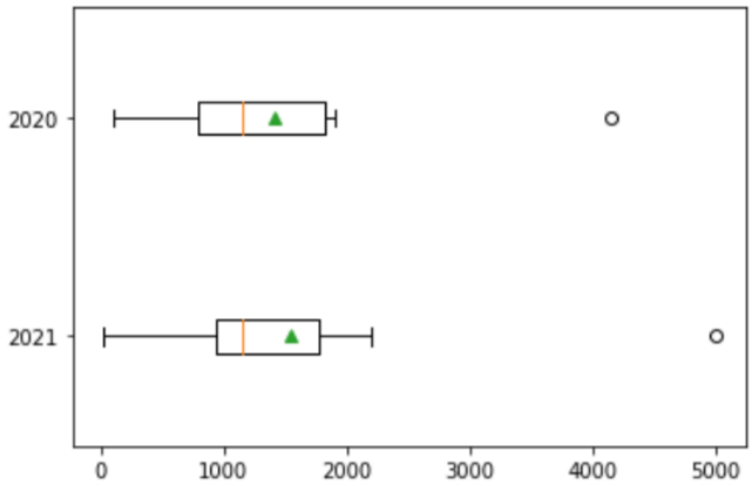
Box Plot

A box plot (or box-and-whisker plot) shows the distribution of quantitative data in a way that facilitates comparisons between variables or across levels of a categorical variable. The box shows the quartiles of the dataset while the whiskers extend to show the rest of the distribution, except for points that are determined to be “outliers” using a method that is a function of the inter-quartile range.

```
#Box plot
manufac21=[20,1300,2000,1000,900,1550,1000,2200,1700,850,950,5000]
manufac20=[100,1500,1800,1000,700,1300,4150,1900,1900,1000,800,800]
data=[manufac21,manufac20]
plt.boxplot(data,labels=['2021','2020'],showmeans=True)
plt.show()
```



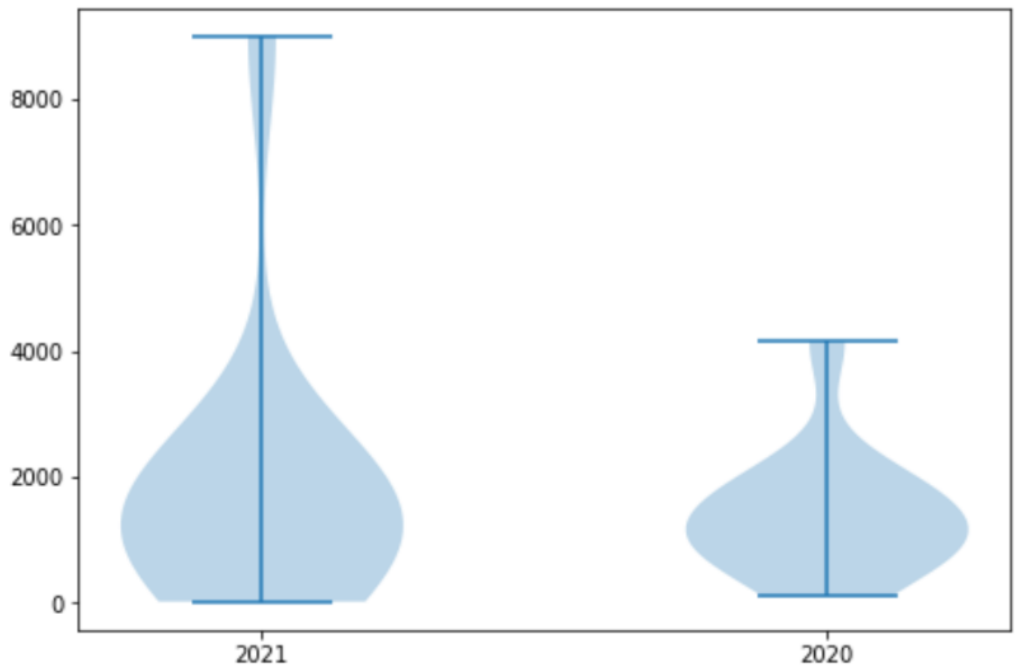

```
#Horizontal boxplot
data=[manufac21,manufac20]
plt.boxplot(data,labels=['2021','2020'],showmeans=True,vert=0)
plt.show()
```

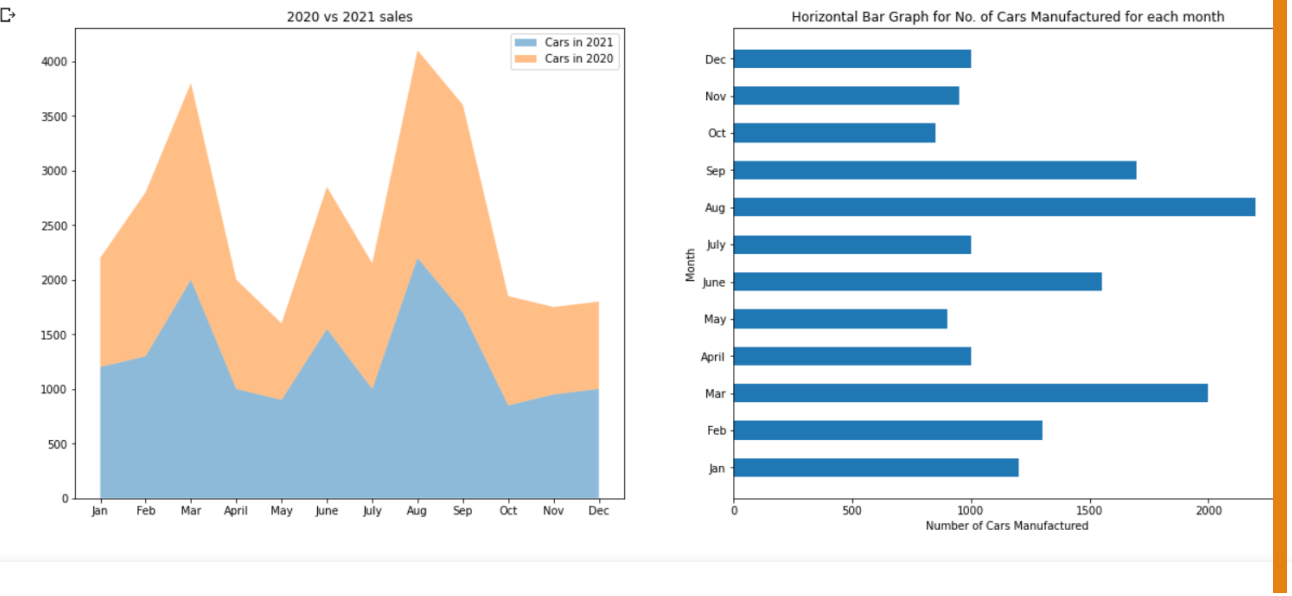


Violin Plot

A violin plot plays a similar role as a box and whisker plot. It shows the distribution of quantitative data across several levels of one (or more) categorical variables such that those distributions can be compared. Unlike a box plot, in which all of the plot components correspond to actual datapoints, the violin plot features a kernel density estimation of the underlying distribution.

```
#Violin plot
manufac21=[20,1300,2000,1000,900,1550,1000,2200,1700,850,950,9000]
manufac20=[100,1500,1800,1000,700,1300,4150,1900,1900,1000,800,800]
data=[manufac21,manufac20]
fig=plt.figure()
ax=fig.add_axes([0,0,1,1])
ax.violinplot(data)
ax.set_xticks([1,2])
ax.set_xticklabels(['2021','2020'])
plt.show()
```






```python
#Plotting Subplots
months=['Jan','Feb','Mar','April','May','June','July','Aug','Sep','Oct','Nov','Dec']
manufac21=[1200,1300,2000,1000,900,1550,1000,2200,1700,850,950,1000]
manufac20=[1000,1500,1800,1000,700,1300,1150,1900,1900,1000,800,800]
fig=plt.figure(figsize=(20,8))
plt.subplot(1,2,1)
plt.stackplot(months,manufac21,manufac20,labels=['Cars in 2021','Cars in 2020'],alpha=0.5)
plt.title("2020 vs 2021 sales")
plt.legend()

plt.subplot(1,2,2)
plt.barh(months, manufac21, height=0.5)
plt.ylabel("Month")
plt.xlabel("Number of Cars Manufactured")
plt.title("Horizontal Bar Graph for No. of Cars Manufactured for each month")


plt.show()
```

Plotting Subplots

Alternatives to Matplotlib

Seaborn – This is built on top of Matplotlib. Seaborn harnesses the power of matplotlib to create beautiful charts in a few lines of code. The key difference is Seaborn's default styles and color palettes, which are designed to be more aesthetically pleasing and modern.

Plotly - Plotly Library is an open-source library that can be used for data visualization and understanding data simply and easily Plotly has hover tool capabilities that allow us to detect any outliers or anomalies in a large number of data points. Also, it is visually attractive.

ggplot - ggplot is based on ggplot2, an R plotting system. ggplot operates differently than matplotlib: it lets you layer components to create a complete plot. For instance, you can start with axes, then add points, then a line, a trendline, etc. This concept is referred to as Grammar of Library.

Bokeh - Bokeh is a Python library for interactive visualization that targets web browsers for representation. This is the core difference between Bokeh and other visualization libraries. This is also based on concept of Grammar of Library.

Of course, there are many more which you can discover.

Thankyou

TO LEARN MORE, YOU CAN ALWAYS CHECK MATPLOTLIB'S ORIGINAL DOCUMENTATION FOR MORE KNOWLEDGE