Python for Visualization & EDA

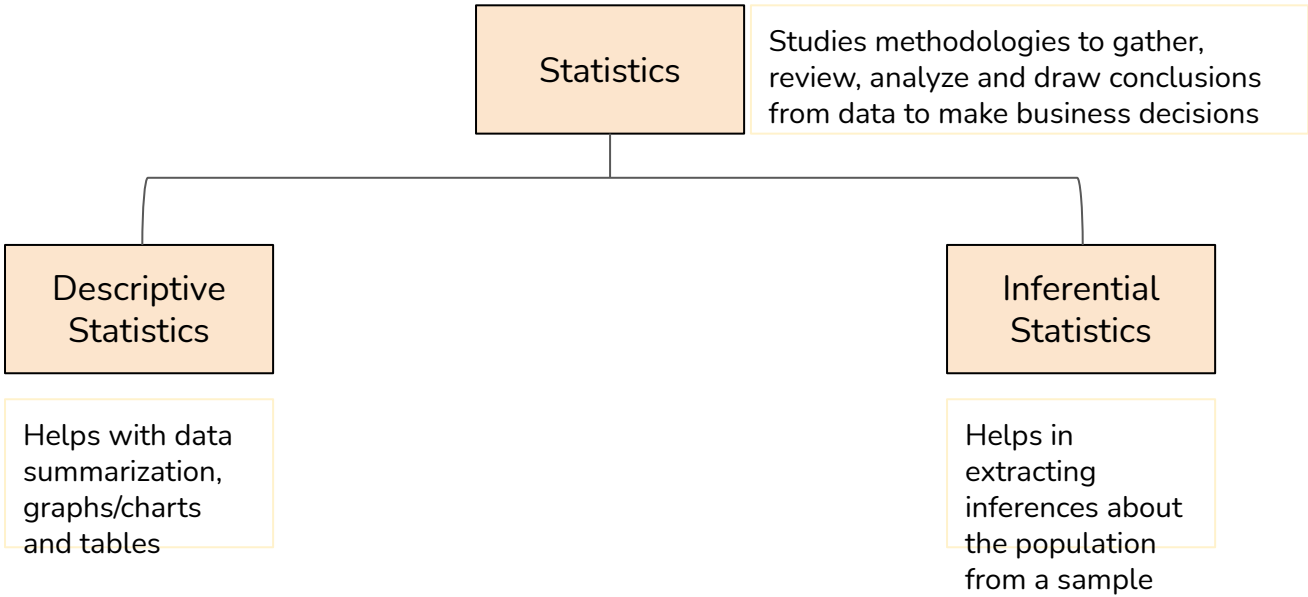
Agenda

1. Basic Statistics
2. Types of data
3. Central Tendency and 3Ms
4. Measure of dispersion, Range, IQR, Variance, Standard Deviation
5. Covariance & Correlation
6. Introduction to Visualization
7. Common libraries for Visualization

Pop Quiz

1. How does statistics help us with data analysis?
2. What do you understand by quantitative and qualitative data?
3. What is the difference between mean, median and mode?
4. What is the difference between Covariance and Correlation?
5. What is the importance of visualisation for data analysis?
6. What are some of the popular charts/graphs available in Python?
7. Which plot would be the best to visualise average yearly rainfall, over the last decade - scatter plot or bar plot?

Statistics



Importance of statistics for EDA:

- Statistics provides the means and tools to find structure in the data
- It also give a deeper insight into what truths the data is showing.
- It is mainly used for quantitative data analysis and helps in analytical decision making.

Terminologies in Statistics

Population, Parameter, Sample, Statistic

- A **population** is the universe of possible data for a specified object.
- A **parameter** is a numerical value associated with a population.
- A **sample** is a selection of observations from a population
- A **Statistic** is a numerical value associated with an observed sample.

Example: A marketing manager of an enterprise is facing a decision whether to introduce a new type of chair into the market or not. Consumer acceptance measured in a blind test is agreed upon as an appropriate basis for evaluation. Marketing of the new chair will be pursued only if the acceptance rate exceeds 30%. Otherwise, the new product will not be introduced in the market. A random sample of 200 consumers is collected in the blind test.

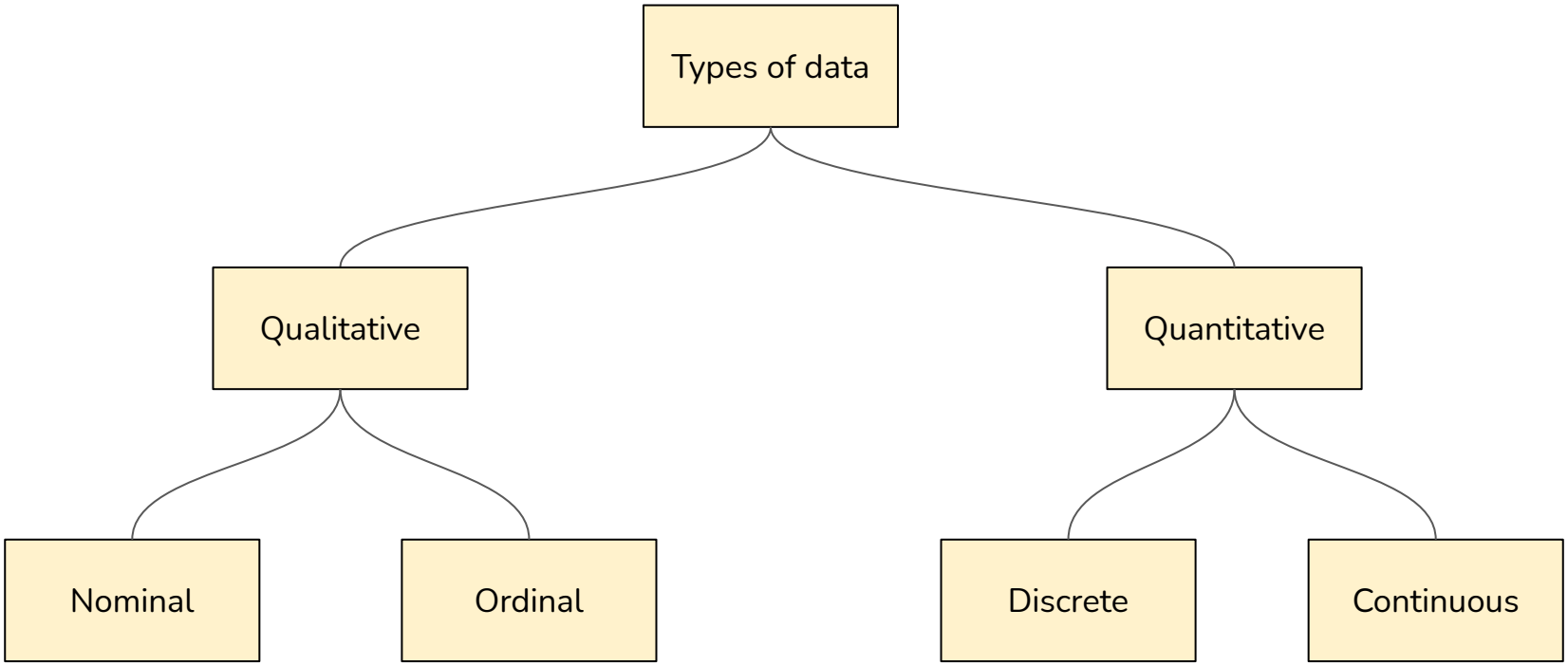
Population - all the target consumers

Sample - a random group of 200 people who have visited the store during the duration of the blind test

Parameter - the acceptance rate of the product

Statistic - the acceptance rate of the product from the blind test of 200 people

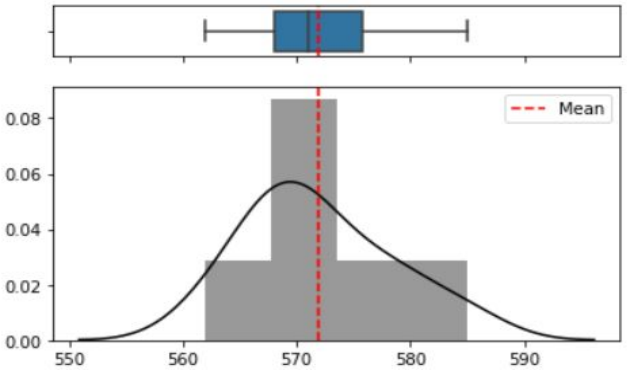
Types of Data



Mean

Mean is equal to the sum of all the values in the data set divided by the number of values in the data set.

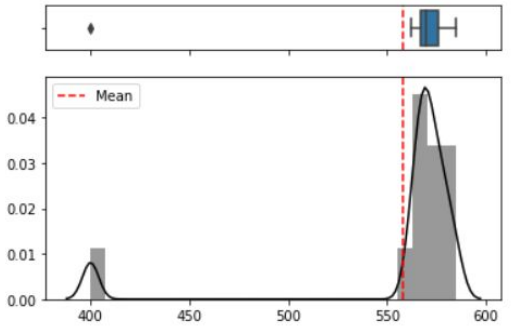
Example: Suppose over the last 12 days, a store sold 570, 568, 565, 572, 568, 585, 568, 578, 580, 575, 562, 572 litres of milk.



Mean = 571.92

But if store closed early on 1 day and sold only 400 litres of milk, the mean will be

Mean = 557.75

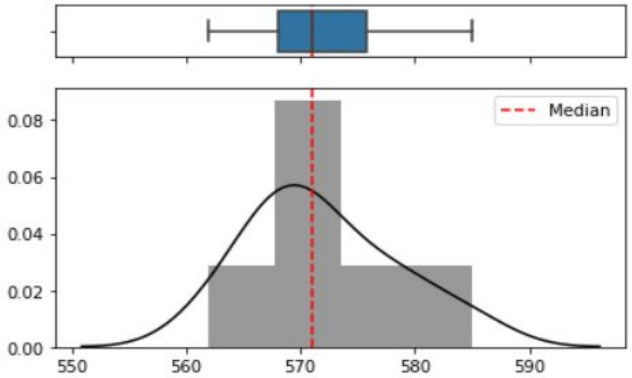


The mean has changed a lot. **Mean is affected by outliers.**

Median

The median is the middle score for a set of data that has been arranged in order of magnitude.

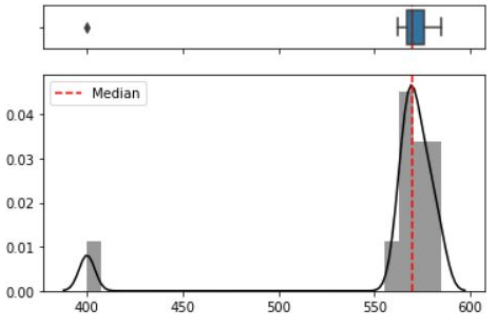
Example: Suppose over the last 12 days, a store sold 570, 568, 565, 572, 568, 585, 568, 578, 580, 575, 562, 572 litres of milk.



Median = 571

But if store closed early on 1 day and sold only 400 litres of milk, the median

Median = 570

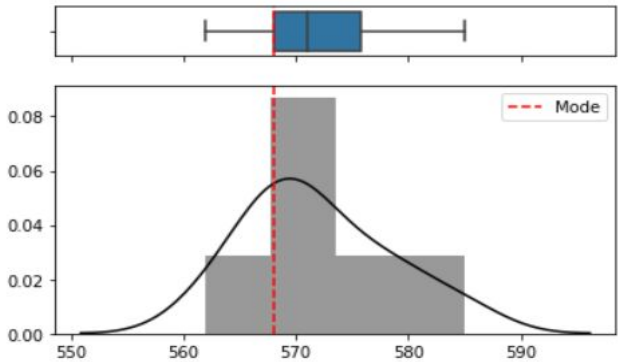


Hence median is less affected by outliers.

Mode

The mode is the most frequent score in our data set. This is the only central tendency measure that can be used with nominal data, which have purely qualitative category assignments.

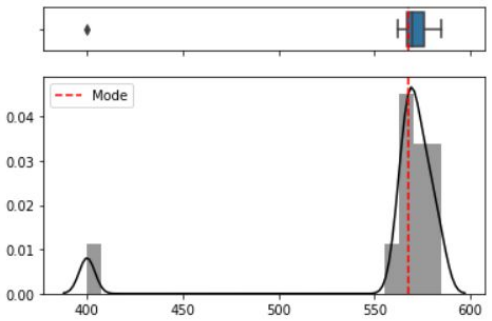
Example: Suppose over the last 12 days, a store sold 570, 568, 565, 572, 568, 585, 568, 578, 580, 575, 562, 572 litres of milk.



Mode = 568

But if store closed early on 1 day and sold only 400 litres of milk, the mode will be

Mode = 568



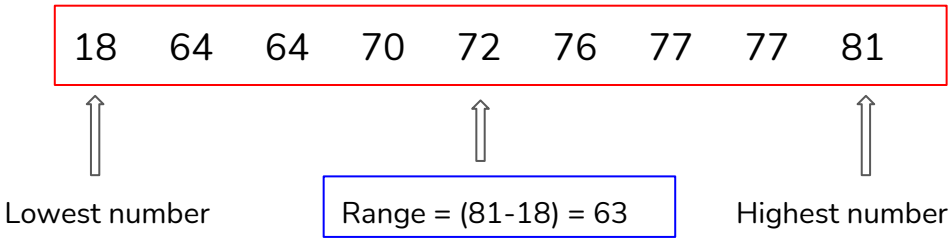
Hence mode is not affected by outliers.

Measure of dispersion, Range and IQR

Measures of dispersion: It indicates how large the spread of distribution in around the central tendency.

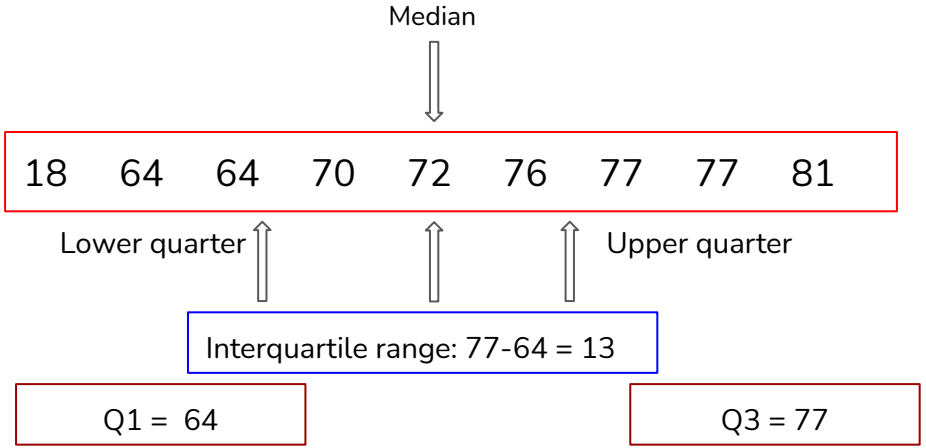
Range: Range is the simplest of all measures of dispersion. It is calculated as the difference between maximum and minimum value in dataset.

range = X(maximum) - X(minimum)



Interquartile range (IQR): It is a measure of variability, based on dividing a data set into quartiles i.e. into four parts represented by Q1,Q2,Q3 and Q4.

IQR = Q3 - Q1



Variance and Standard Deviation

Variance: It describes how far each value in the data set is from the mean.

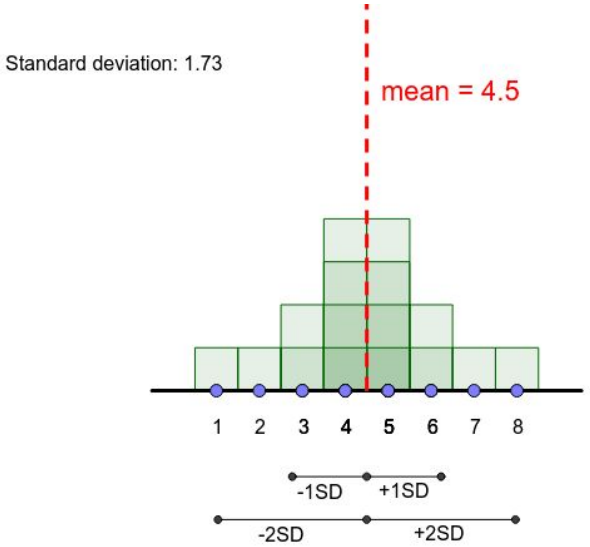
Standard Deviation: It is a measure of how spread out the numbers in a distribution are

$$Variance, \sigma^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}$$

$$Standard\ Deviation, \sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}}$$

Where x_i = *data set values*

$\bar{x}$ = *mean of the data set*



Covariance & Correlation

Covariance

- Covariance is a measure of association between two variables.
- It represents association in units of the two variables.

Correlation

- Correlation is also a measure of association between two variables.
- Moreover, it is a dimensionless quantity and thus enables comparison beyond units.

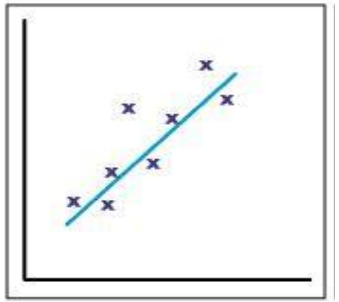
$$\text{Corr}(X,Y) = \frac{\text{Cov}(X,Y)}{\sigma_x \sigma_y}$$

Correlation between X and Y

Standard deviation of X

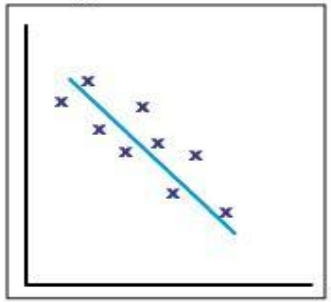
Standard deviation of Y

Positive correlation



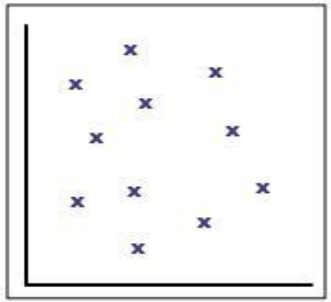
The points lie close to a straight line, which has a positive slope.
This shows that as one variable increases, the other increases.

Negative correlation



The points lie close to a straight line, which has a negative slope.
This shows that as one variable increases, the other decreases.

No correlation



There is no pattern to the points.

This shows that there is no connection between the two variables.

Introduction to Visualization

What is Data Visualization?

- Visual representation of data
- Helps to observe & communicate patterns and trends with naked eye

Why Data Visualization is important?

- Data visualization helps to communicate information in a manner that is universal, fast, and effective.
- Communicating insights to non-technical decision makers is one of the most critical phases in a data science project

Common Libraries for Visualization

Matplotlib

- Matplotlib is one of the most popular libraries for data visualizations.
- It provides high-quality graphics and a variety of plots such as histograms, bar charts, pie charts, etc.
- Some important functions - plot(), hist(), bar(), pie(), scatter(), text(), legend(), etc.

Seaborn

- Seaborn is complementary to Matplotlib and it specifically targets statistical data visualizations.
- A saying around matplotlib and seaborn is, “matplotlib tries to make easy things easy and hard things possible, seaborn tries to make a well-defined set of hard things easy too.”
- Some important functions - displot(), boxplot(), stripplot(), pairplot()

Which visualization to use (1/2)

There are numerous types of plots available in Matplotlib and Seaborn, each has its own usage with certain specific data. Choosing right visualization for right purpose is very important.

Type	X Variable	Y Variable	Purpose of analysis	Type of chart	Example
Univariate	Continuous	-	How the values of the X variable are distributed?	Histogram, Distribution plot	Distribution of cholesterol ranges Distribution of horsepower of cars
Univariate	Categorical	-	What is the count of observations in each category of X variable?	Count Plot	What is the count of employees for each type of degree in an organization?
Bivariate	Continuous	Continuous	How Y is correlated with X?	Scatter plot	How tip varies with the total bill?
Bivariate	Time Related (months, hours, etc.)	Continuous	How Y changes over time?	Line Plot	How sales varies on different days?
Bivariate	Continuous	Categorical	How range of X varies for various category levels?	Box plot, Swarm Plot	How tip varies at lunch and dinner? How tips varies with day of the week?
Bivariate	Categorical	Categorical	What is the number or % of records of X which falls under each category of Y?	Stacked Bar plot	What is the percentage of smokers and non-smokers across fitness levels.?

Note: Univariate plots can also be used to visualize relationships among two or more variables by using arguments like 'hue' in the plot.

Which visualization to use (2/2)

Multivariate analysis is used to study the interaction between more than two variables. Exploring more combination of variables helps to extract deeper insights which could not observed with univariate or bivariate analysis. Examples: Correlation, Regression analysis, etc.

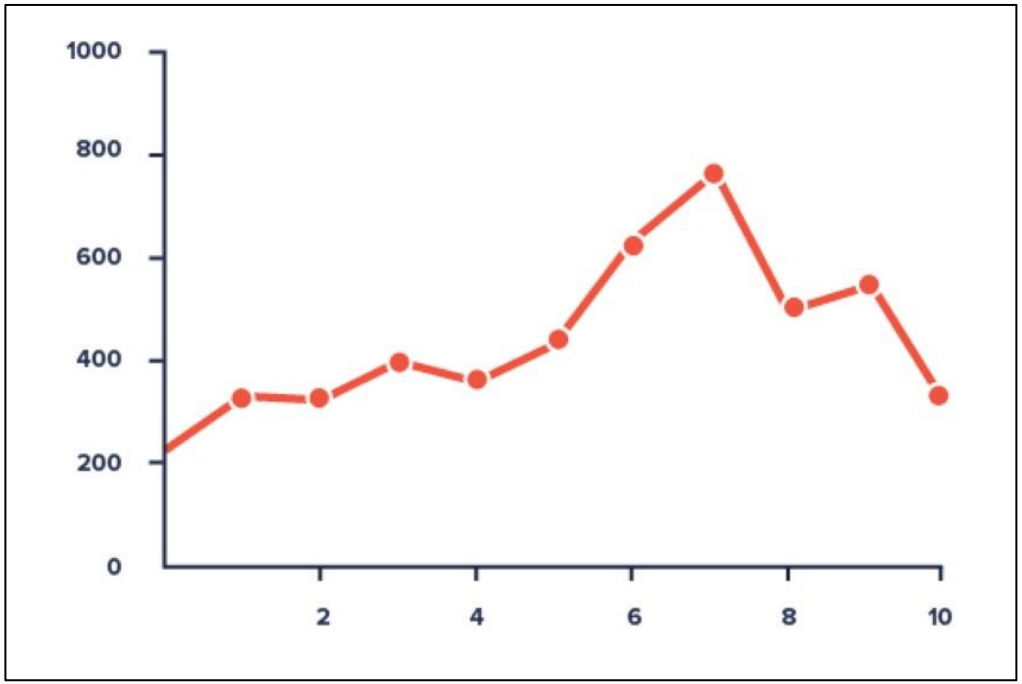
Type	Variables	Purpose of analysis	Type of chart	Example
Multivariate	Continuous (more than two)	How to visualize relationship across multiple combination of variables?	Pair Plot	Relation between three variables - horsepower, weight, and acceleration
Multivariate	Continuous (more than two)	How to visualize the spread of values in the data with color-encoding?	Heatmap	Correlation matrix for three variables horsepower, weight, and acceleration

Note: Pair plot and heatmap can also be used with only two variables but are generally preferred and more useful for visualizing more than two variables.

Appendix

Line Chart

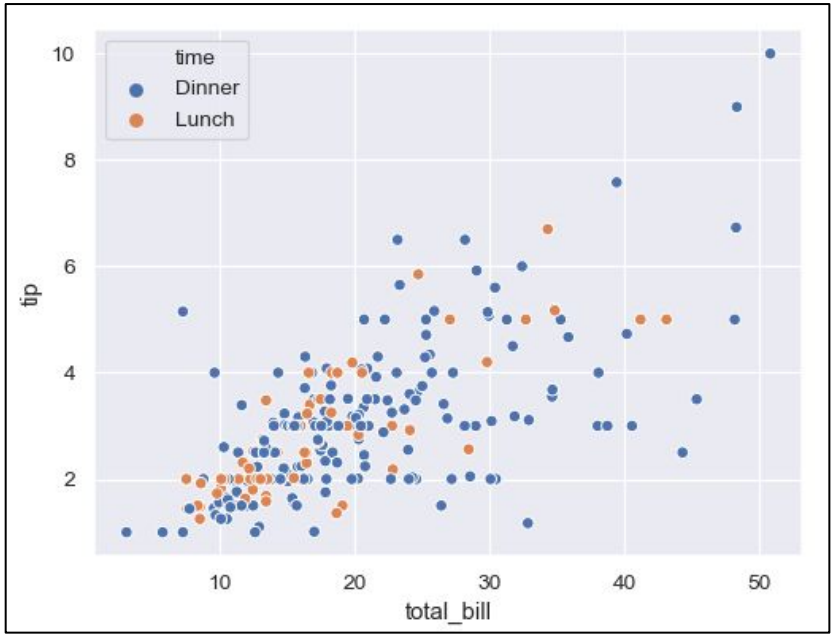
A **line graph** is a graphical display of information that changes continuously over time.



- This plot shows the relationship between the sales and the no. of days
- We can say that sales has been the highest on day 7

Scatter Plot

- A **scatter plot** uses dots to represent values for two different numeric variables.
- The position of each dot on the horizontal and vertical axis indicates values for an individual data point.
- Scatter plots are used to observe relationships between variables.



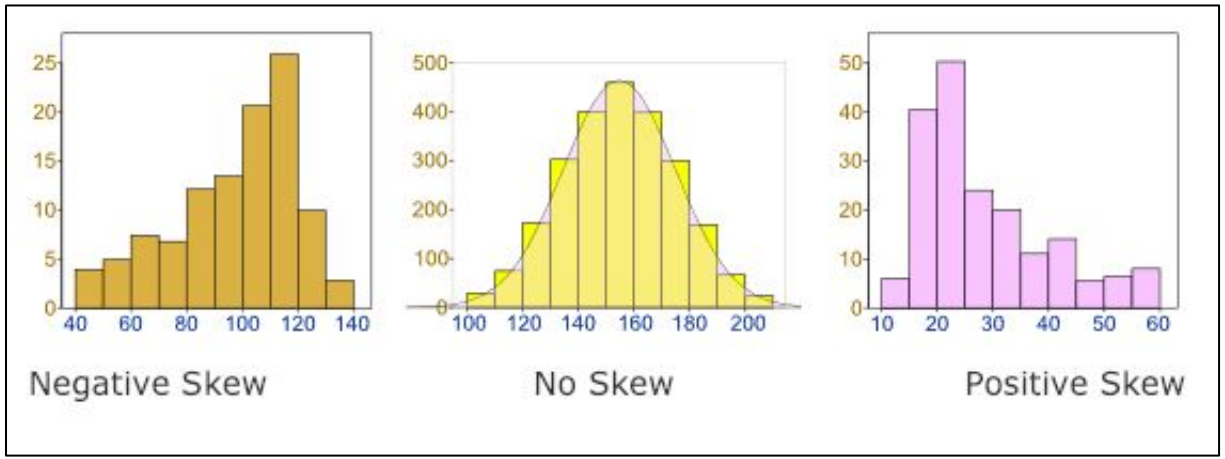
- This plot shows the relationship between the tip and the total bill at the time of lunch and dinner.
- We can say if the total bill is large, the tip can also be large

Histogram and skewness in data

- A **histogram** is a graphical display of data using bars of different heights.
- In a histogram, each bar groups numbers into ranges

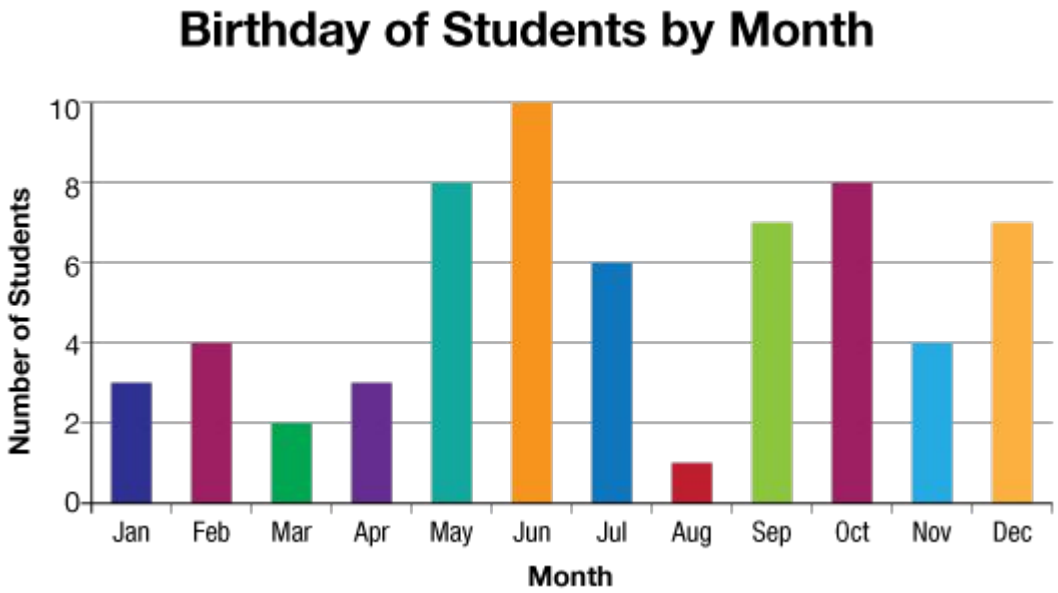
Skewness refers to distortion or asymmetry in a symmetrical bell curve in a set of data

- If the curve is shifted to the left, it is called left skewed. (leftmost curve in the below fig.)
- If the curve is shifted to the right, it is called right skewed. (rightmost curve in the below fig.)



Bar Plot

- A bar chart is a chart 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.



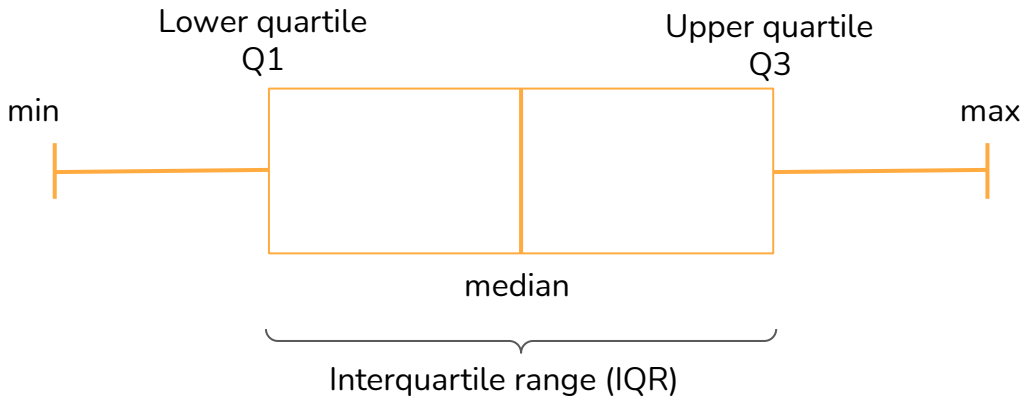
- Most of the students celebrated their birthday in June.
- In August, very less students celebrated their birthdays.

Five number summary and Box Plot

The five number summary gives you a rough idea about what your data set looks like. It includes five items:

- The minimum.
- Q1 (the first quartile, or the 25% mark)
- The median.
- Q3 (the third quartile, or the 75% mark)
- The maximum.

A box plot is a type of chart often used in exploratory data analysis to visually show the distribution of numerical data and skewness through displaying the data quartiles.



Great Learning

Happy Learning !