Assignment-based Subjective Questions

1. From your analysis of the categorical variables from the dataset, what could you infer abouttheir effect on the dependent variable? (3 marks)

Answer:

Analysis based on Boxplot and Bar chart following are the point inferred:

1. Fall season has more bookings than any other season and has increased with increase in year as well.
2. Most of the bookings gradually starts rising from the beginning of the year, highest bookings are observed **in May, June, July, August, and September** and then gradually starts to decline.
3. **Clear** weather attracts more booking than any other weather.
4. For **holiday** demand seems to drop, which seems reasonable, people might want to spend some time with family.
5. **Year 2019** has more numbers of booking from the previous year, which shows good progress in terms of business with increase in year.

2. Why is it important to use drop_first = True during dummy variable creation? (2 mark)

Answer :

1. Drop_first = True is important to use as it helps in reducing the extra column created during dummy variable creation.
2. Hence it reduces the correlations created among dummy variables.
3. Dummy variables should always be created for feature whose level is greater than 2, no binary nature variables should be considered for dummy creation.

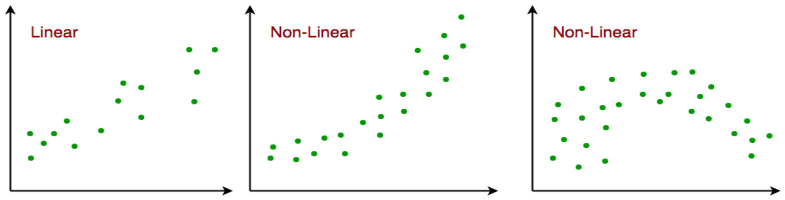
3. Looking at the pair-plot among the numerical variables, which one has the highest correlationwith the target variable? (1 mark)

Answer : Temp has the highest correlation with the target variable.

4. How did you validate the assumptions of Linear Regression after building the model on the training set? (3 marks)

Answer : Assumptions:

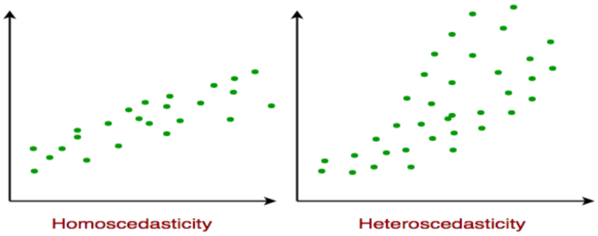
1. Linearity: Assumes that the relationship between the independent and dependent variables is linear.

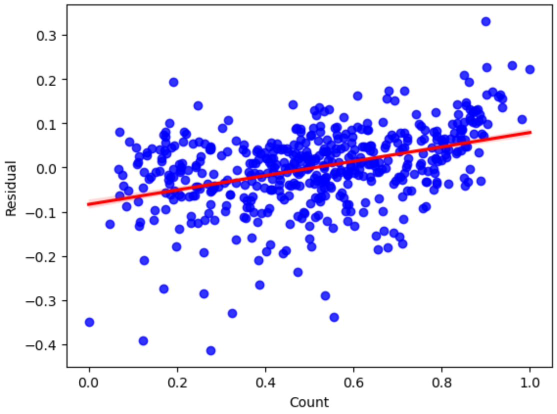


2. Independence: Assumes that the observations are independent of each other. No auto-

correlation

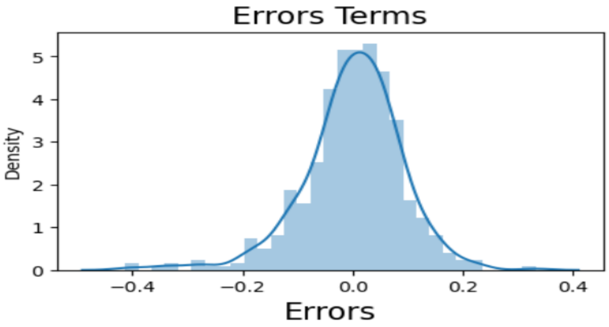
3. Homoscedasticity: Assumes that the variance of the errors is constant across all levels of the independent variable.





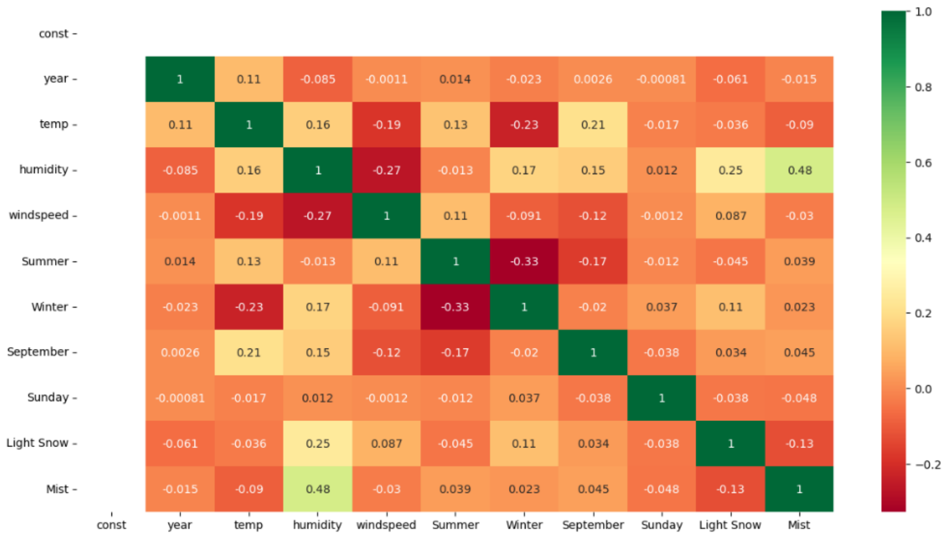
There should be no visible pattern in residual values as shown in above figure.

4. Normality: Assumes that the errors are normally distributed and centered around zero.



Distribution is centered around 0 and normal in nature

5. No multicollinearity: There is no high correlation between the independent variables. This indicates that there is little or no correlation between the independent variables. Multicollinearity occurs when two or more independent variables are highly correlated with each other, which can make it difficult to determine the individual effect of each variable on the dependent variable.



5. **Based on the final model, which are the top 3 features contributing significantly towards explaining the demand of the shared bikes? (2 marks)**

Answer: Below are the top 3 features contributing significantly towards explaining the demand of the shared bikes

1. **Temp** : Increase in temp will increase the demand. **(positive correlation)**
2. **Year :** with increase in consecutive year demand for bike sharing is rising. **(positive correlation)**
3. **Light snow :** decrease in light snow will increase in demand for shared bikes **(negative correlation)**

General Subjective Questions

1. **Explain the linear regression algorithm in detail. (4 marks)**

Answer : Linear regression is a supervised machine learning method that is used to train a model and find a linear equation that best describes the correlation of the explanatory variables with the dependent variable. This is achieved by fitting a line to the data using least squares. The line tries to minimize the sum of the squares of the residuals. The residual is the distance between the line and the actual value of the explanatory variable. Finding the line of best fit is an iterative process.

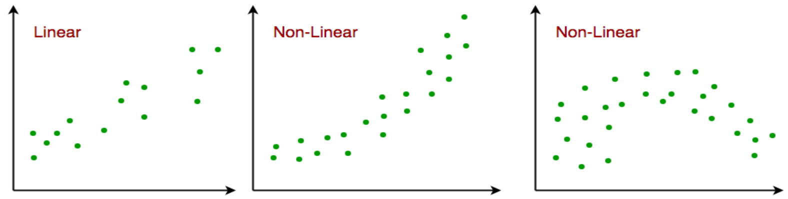
The following is an example of a resulting linear regression equation:

$$y = b_0 + b_1x_1 + b_2x_2 + \ldots$$

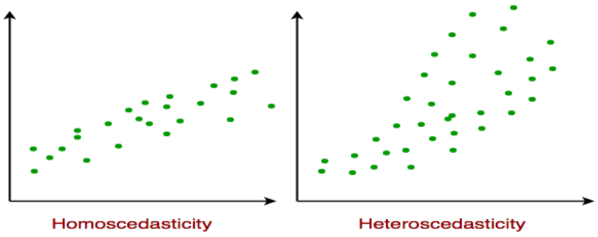
In the example above, y is the dependent variable, and x1, x2, and so on, are the explanatory variables. The coefficients (b1, b2, and so on) explain the correlation of the explanatory variables with the dependent variable. The sign of the coefficients (+/-) designates whether the variable is positively or negatively correlated. b0 is the intercept that indicates the value of the dependent variable assuming all explanatory variables are 0.

Assumptions:

1. Linearity: Assumes that the relationship between the independent and dependent variables is linear.



2. Independence: Assumes that the observations are independent of each other. No auto-correlation
3. Homoscedasticity: Assumes that the variance of the errors is constant across all levels of the independent variable. There should be no visible pattern in residual values



4. Normality: Assumes that the errors are normally distributed and centered around zero.
5. No multicollinearity: There is no high correlation between the independent variables. This indicates that there is little or no correlation between the independent variables. Multicollinearity occurs when two or more independent variables are highly correlated with each other, which can make it difficult to determine the individual effect of each variable on the dependent variable.

There are two types of Linear regression:

1 Simple Linear Regression : Simple linear regression is a regression model that estimates the relationship between one independent variable and one dependent variable using a straight line.

2 Multiple Linear Regression : Multiple linear regression is a regression model that estimates the relationship between a quantitative dependent variable and two or more independent variables using a straight line

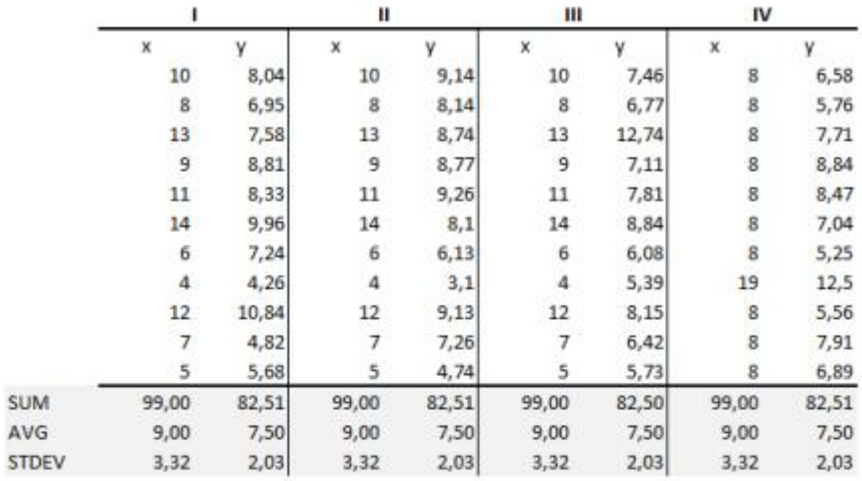
2. Explain the Anscombe's quartet in detail. (3 marks)

Answer :

Anscombe's quartet comprises a set of four dataset, having identical descriptive statistical properties in terms of means, variance, R-Squared, correlations, and linear regression lines but having different representations when we scatter plot on graph. The datasets were created by the statistician Francis Anscombe in 1973 to demonstrate the importance of visualizing data and to show that summary statistics alone can be misleading.

The four datasets that make up Anscombe's quartet each include 11 x-y pairs of data. When plotted, each dataset seems to have a unique connection between x and y, with unique variability patterns and distinctive correlation strengths. Despite these variations, each dataset has the same summary statistics, such as the same x and y mean and variance, x and y correlation coefficient, and linear regression line.

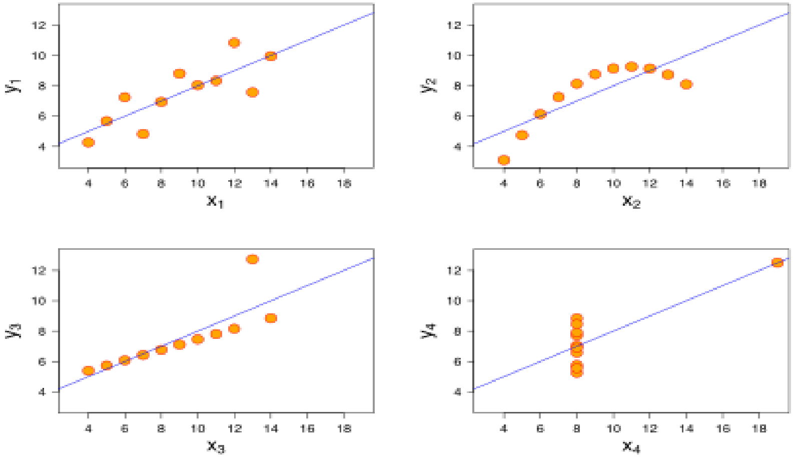
All four sets are identical when examined using simple summary statistics, but vary considerably when graphed



	I		II		III		IV	
	x	y	x	y	x	y	x	y
	10	8,04	10	9,14	10	7,46	8	6,58
	8	6,95	8	8,14	8	6,77	8	5,76
	13	7,58	13	8,74	13	12,74	8	7,71
	9	8,81	9	8,77	9	7,11	8	8,84
	11	8,33	11	9,26	11	7,81	8	8,47
	14	9,96	14	8,1	14	8,84	8	7,04
	6	7,24	6	6,13	6	6,08	8	5,25
	4	4,26	4	3,1	4	5,39	19	12,5
	12	10,84	12	9,13	12	8,15	8	5,56
	7	4,82	7	7,26	7	6,42	8	7,91
	5	5,68	5	4,74	5	5,73	8	6,89
SUM	99,00	82,51	99,00	82,51	99,00	82,50	99,00	82,51
AVG	9,00	7,50	9,00	7,50	9,00	7,50	9,00	7,50
STDEV	3,32	2,03	3,32	2,03	3,32	2,03	3,32	2,03

Mean for x = 9
Mean for y = 7.50
Standard Deviation for x = 3.32
Standard Deviation for y = 2.03

Even if the Statistical data is same for all data set the graph representation is different for all.

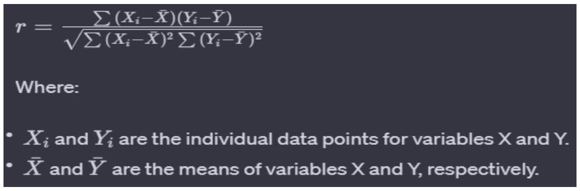


3. What is Pearson's R? (3 marks)

Answer :

Pearson's correlation coefficient, often denoted as "r" or Pearson's "r," is a statistical measure that quantifies the strength and direction of a linear relationship between two continuous variables. It ranges from -1 to 1, where:

1 indicates a perfect positive linear relationship: as one variable increases, the other variable also increases proportionally.
0 indicates no linear relationship: the variables are not correlated.
-1 indicates a perfect negative linear relationship: as one variable increases, the other variable decreases proportionally.
The formula for Pearson's correlation coefficient (r) is:



$$r = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum(X_i - \bar{X})^2 \sum(Y_i - \bar{Y})^2}}$$

Where:

- X_i and Y_i are the individual data points for variables X and Y.
- $\bar{X}$ and $\bar{Y}$ are the means of variables X and Y, respectively.

4. What is scaling? Why is scaling performed? What is the difference between normalized scalingand standardized scaling? (3 marks)

Answer :

Feature Scaling is a technique to standardize the independent features present in the data in a fixed range. It is performed during the data pre-processing to handle highly varying magnitudes or values or units. If feature scaling is not done, then a machine learning algorithm tends to weigh greater values, higher and consider smaller values as the lower values, regardless of the unit of the values.

Example: If an algorithm is not using feature scaling method then it can consider the value 3000 meter to be greater than 5 km but that’s actually not true and in this case, the algorithm will give wrong predictions. So, we use Feature Scaling to bring all values to same magnitudes and thus, tackle this issue.

Standard Scaling :

Standard Scaler is a fast and specialized algorithm for scaling data. It calculates the mean and standard deviation of the data set and normalizes it by subtracting the mean and dividing by standard deviation. Using Standard Scaler is a common practice in ML projects if the data set follows a normal distribution.

Also known as z-score normalization, standardized scaling transforms the features to have a mean of 0 and a standard deviation of 1.

$$z = \frac{x - \mu}{\sigma}$$

Min-Max Scaling:

MinMax Scaler is a simple and effective linear scaling function. It scales the data set between 0 and 1. In other words, the minimum and maximum values in the scaled data set are 0 and 1 respectively. MinMax Scaler is often used as an alternative to Standard Scaler if zero mean and unit variance want to be avoided.

$$x_{scaled} = \frac{x - x_{min}}{x_{max} - x_{min}}$$

5. You might have observed that sometimes the value of VIF is infinite. Why does this happen? (3 marks)

Answer:

The Variance Inflation Factor (VIF) is a measure used in regression analysis to assess the extent of multicollinearity among predictor variables. Multicollinearity occurs when two or more independent variables in a regression model are highly correlated, which can lead to issues in estimating the individual contribution of each variable to the dependent variable.

The formula for VIF is:
ViF = 1 / 1 – Ri^2

If the Ri^2 value is very close to 1, it means that the ith variable can be almost perfectly predicted by the other variables in the model, indicating high multicollinearity. In such cases, the denominator in the VIF formula becomes very close to zero, and therefore, the VIF can become very large or, in theory, infinite.

6. What is a Q-Q plot? Explain the use and importance of a Q-Q plot in linear regression.

(3 marks)

Answer:

A QQ plot is a scatterplot created by plotting two sets of quantiles against one another. If both sets of quantiles came from the same distribution, we should see the points forming a line that's roughly straight.

A Q–Q plot is used to compare the shapes of distributions, providing a graphical view of how properties such as location, scale, and skewness are similar or different in the two distributions.

Use of Q-Q plot:

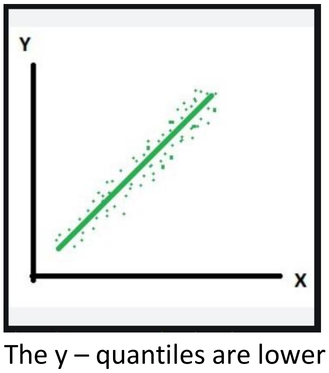
A q-q plot is a plot of the quantiles of the first data set against the quantiles of the second dataset. By a quantile, we mean the fraction (or percent) of points below the given value. That is, the 0.3 (or 30%) quantile is the point at which 30% percent of the data fall below and 70% fall above value. A 45-degree reference line is also plotted. If the two sets come from a population with the same distribution, the points should fall approximately along this reference line. The greater the departure from this reference line, the greater the evidence for the conclusion that the two data sets have come from populations with different distributions.

Importance :

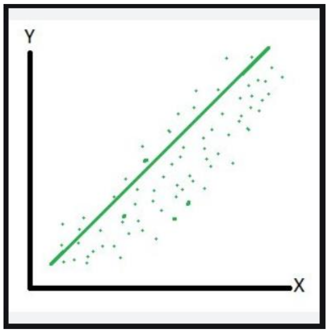
When there are two data samples, it is often desirable to know if the assumption of a common distribution is justified. If so, then location and scale estimators can pool both data sets to obtain estimates of the common location and scale. If two samples do differ, it is also useful to gain some understanding of the differences. The q-q plot can provide more insight into the nature of the difference than analytical methods such as the chi-square and Kolmogorov-Smirnov 2-sample tests.

Interpretation :

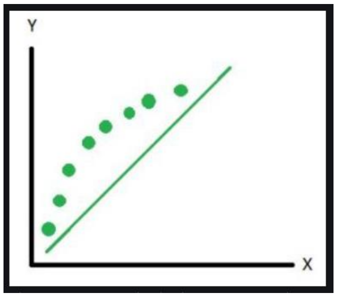
1. All point of quantiles lie on or close to straight line at an angle of 45 degree from x – axis. It indicates that two samples have similar distributions.



2. The y – quantiles are lower than the x – quantiles. It indicates y values have a tendency to be lower than x values.



3. The x – quantiles are lower than the y – quantiles. It indicates x values have a tendency to be lower than the y values.



4. Indicates that there is a breakpoint up to which the y – quantiles are lower than the x – quantiles and after that point the y – quantiles are higher than the x – quantiles.