Assignment-based Subjective Questions

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

Answer: As per my analysis of the categorical variables using the boxplot and barplot, below are the observations we could see from the visualization:

- It appears that Fall season has attracted highest number of bookings with a median of over 5000. Also, in each of the seasons, the number of bookings has increased considerably from 2018 to 2019.
- Fall is followed by Summer and Spring seasons attracting bookings for the period of 2 years. This indicates that, season can be a good predictor for the dependent variable.
- Majority of the bookings have been made in the month of June, July, August, September and October with a median of over 4000. The trend increased at the beginning of the year until the mid of the year and then it decreased continuously until the end of the year.
- This indicates that month has some trend for bookings and can be a good predictor for the dependent variable.
- Clear weather attracted more bookings with a median over close to 5000.
- This was followed by Misty season.
- And, in comparison to previous year, i.e. 2018, booking increased for each weather situation in 2019.
- This indicates, weather situation does show some trend towards the bike bookings and hence can be a good predictor for the dependent variable.
- Wednesday, Thursday, Friday, Saturday have more number of bookings.
- Bookings on Sunday is the least which implies that people like to spend time on Sundays with friends and family.
- It is to be also noted that, weekday variable shows very close trend having their independent medians between 4000 to 5000 bookings. This indicates, weekday variable can have some or no influence towards the predictor. The model would decide if this needs to be added or not.
- When it is not a holiday, booking seems to be more in number which seems reasonable as on holidays, people may want to spend time at home and enjoy with family.
- As we can see in the above bar plot, 97 percent of the bike bookings were happening when it is not a holiday which means this data is clearly biased. This indicates, holiday CANNOT be a good predictor for the dependent variable.
- Bookings seemed to be happening more in working day (almost two-thirds) with a median of close to 5000, which indicates, workingday can be a good predictor for the dependent variable.
- 2019 attracted more number of bookings from the previous year, which shows good progress in terms of business.

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

   Answer:

   drop_first = True is important to use, as it helps in reducing the extra column created during dummy variable creation. Hence it reduces the correlations created among dummy variables.
   Syntax -
   drop_first: bool, default False, which implies whether to get k-1 dummies out of k categorical levels by removing the first level.
   Let's say we have 3 types of values in Categorical column and we want to create dummy variable for that column. If one variable is not A and B, then It is obvious C. So we do not need 3rd variable to identify the C.

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

   Answer:

   'temp' variable 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:

I have validated the assumption of Linear Regression Model based on below assumptions:

- ➔ Error terms should be normally distributed.
- ➔ There should be insignificant multicollinearity among variables.
- ➔ Linearity should be visible among variables.
- ➔ Homoscedasticity - There should be no visible pattern in residual values

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:

- ➔ temp
- ➔ winter
- ➔ sep

General Subjective Questions

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

   Answer:

   Linear regression may be defined as the statistical model that analyses the linear relationship between a dependent variable with given set of independent variables. Linear relationship between variables means that when the value of one or more independent variables will change (increase or decrease), the value of dependent variable will also change accordingly (increase or decrease).

Mathematically the relationship can be represented with the help of following equation −

Y = mX + c

Here, Y is the dependent variable we are trying to predict.

X is the independent variable we are using to make predictions.

m is the slope of the regression line which represents the effect X has on Y

c is a constant, known as the Y-intercept. If X = 0, Y would be equal to c.

Furthermore, the linear relationship can be positive or negative in nature as explained below:

- ➔ Positive Linear Relationship:
  - A linear relationship will be called positive if both independent and dependent variable increases.
- ➔ Negative Linear relationship:
  - A linear relationship will be called positive if independent increases and dependent variable decreases.
- ➔ Linear regression is of the following two types:
  - ➢ Simple Linear Regression
  - ➢ Multiple Linear Regression

Assumptions -

The following are some assumptions about dataset that is made by Linear Regression model -

Multi-collinearity:

Linear regression model assumes that there is very little or no multi-collinearity in the data. Basically, multi-collinearity occurs when the independent variables or features have dependency in them.

Relationship between variables:

Linear regression model assumes that the relationship between response and feature variables must be linear.

Normality of error terms:

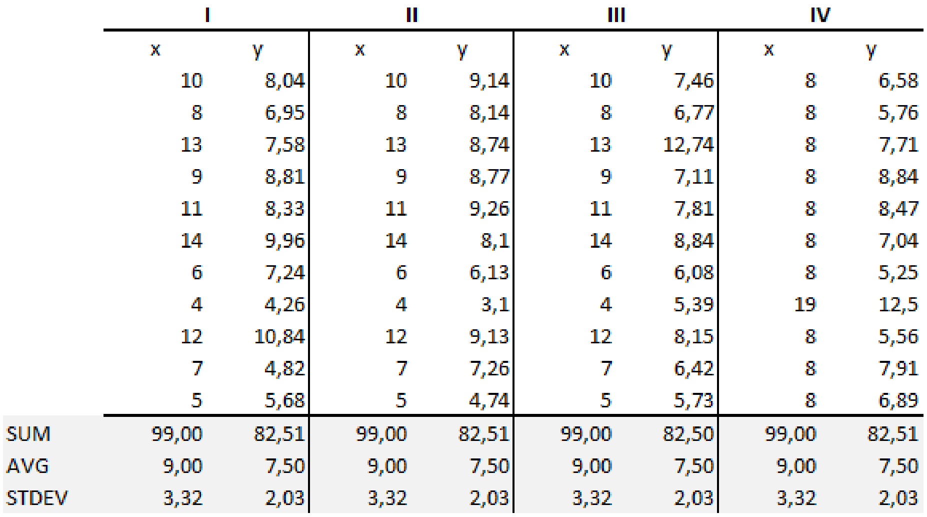
Error terms should be normally distributed

Homoscedasticity:

There should be no visible pattern in residual values.

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

Answer: Anscombe's Quartet was developed by statistician Francis Anscombe. It comprises four datasets, each containing eleven (x, y) pairs. The essential thing to note about these datasets is that they share the same descriptive statistics. But things change completely, and I must emphasize COMPLETELY, when they are graphed. Each graph tells a different story irrespective of their similar summary statistics.

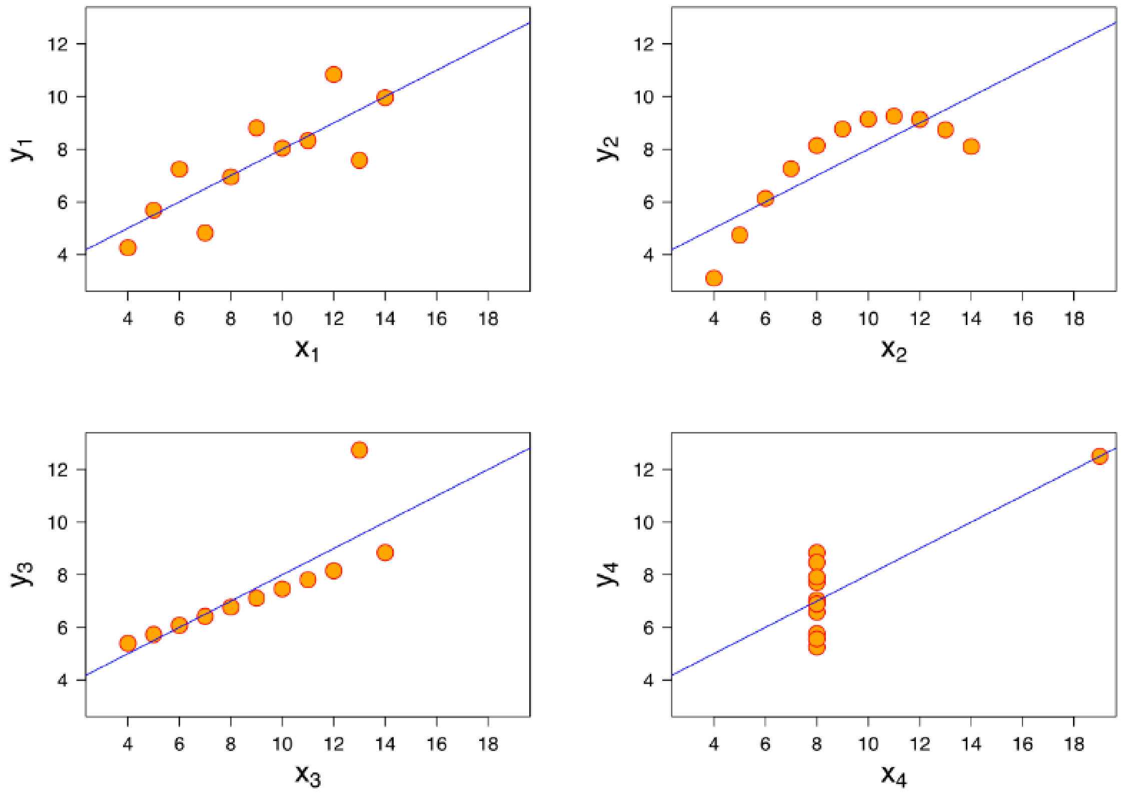


	I		II		III		IV	
	x	y	x	y	x	y	x	y
	10	8,04	10	9,14	10	7,46	8	6,58
	8	6,95	8	8,14	8	6,77	8	5,76
	13	7,58	13	8,74	13	12,74	8	7,71
	9	8,81	9	8,77	9	7,11	8	8,84
	11	8,33	11	9,26	11	7,81	8	8,47
	14	9,96	14	8,1	14	8,84	8	7,04
	6	7,24	6	6,13	6	6,08	8	5,25
	4	4,26	4	3,1	4	5,39	19	12,5
	12	10,84	12	9,13	12	8,15	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

The summary statistics show that the means and the variances were identical for x and y across the groups:

- Mean of x is 9 and mean of y is 7.50 for each dataset.
- Similarly, the variance of x is 11 and variance of y is 4.13 for each dataset
- The correlation coefficient (how strong a relationship is between two variables) between x and y is 0.816 for each dataset

When we plot these four datasets on an x/y coordinate plane, we can observe that they show the same regression lines as well but each dataset is telling a different story:



- Dataset I appears to have clean and well-fitting linear models.
- Dataset II is not distributed normally.
- In Dataset III the distribution is linear, but the calculated regression is thrown off by an outlier.
- Dataset IV shows that one outlier is enough to produce a high correlation coefficient.

This quartet emphasizes the importance of visualization in Data Analysis. Looking at the data reveals a lot of the structure and a clear picture of the dataset.

3. What is Pearson’s R? (3 marks)

Answer:

Pearson's r is a numerical summary of the strength of the linear association between the variables. If the variables tend to go up and down together, the correlation coefficient will be positive. If the variables tend to go up and down in opposition with low values of one variable associated with high values of the other, the correlation coefficient will be negative. The Pearson correlation coefficient, r, can take a range of values from +1 to -1. A value of 0 indicates that there is no association between the two variables. A value greater than 0 indicates a positive association; that is, as the value of one variable increases, so does the value of the other variable. A value less than 0 indicates a negative association; that is, as the value of one variable increases, the value of the other variable decreases.

4. What is scaling? Why is scaling performed? What is the difference between normalized scaling and 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.

S.NO.	Normalized scaling	Standardized scaling
1	Minimum and maximum value of features are used for scaling	Mean and standard deviation is used for scaling.
2	It is used when features are of different scales.	It is used when we want to ensure zero mean and unit standard deviation.
3	Scales values between [0, 1] or [-1, 1].	It is not bounded to a certain range.
4	It is really affected by outliers.	It is much less affected by outliers.
5	Scikit-Learn provides a transformer called MinMaxScaler for Normalization.	Scikit-Learn provides a transformer called StandardScaler for standardization.

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

(3 marks)

Answer:

If there is perfect correlation, then VIF = infinity. A large value of VIF indicates that there is a correlation between the variables. If the VIF is 4, this means that the variance of the model coefficient is inflated by a factor of 4 due to the presence of multicollinearity.

When the value of VIF is infinite it shows a perfect correlation between two independent variables. In the case of perfect correlation, we get R-squared (R2) =1, which lead to 1/ (1-R2) infinity. To solve this we need to drop one of the variables from the dataset which is causing this perfect multicollinearity.

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

(3 marks)

Answer:

The quantile-quantile (q-q) plot is a graphical technique for determining if two data sets come from populations with a common distribution.

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 that 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 of Q-Q plot:

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.