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?**

   Ans: Analysis on categorical columns done using the boxplot.

   Inference from the visualization:

   - **Fall season seems to have attracted more booking**. And, in each season the booking count has increased drastically from 2018 to 2019
   - **Most of the bookings** has been done during the month of **May, June, Aug, Sept** and **Oct**. Trend increased starting of the year till mid of the year and then it started decreasing as we approached the end of year.
   - **Clear weather** attracted **more booking** which seems obvious. **Sat, Wed, Thu** have **more number of bookings** as compared to the start of the week.
   - **Booking** seemed to be **almost equal** either on **working day and holiday**.
   - **2019** attracted **more number of booking** 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)**

   Ans: Setting drop_first=True while creating dummy variables is important:

   - To **prevent multicollinearity and maintain independence among features**. This avoid perfect correlation between the dummy variables, as dropping the first category **removes redundancy**.
   - Hence, **ensures the model stability and interpretability**.

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

   Ans: **'Temp'** has highest correlation with target variable.

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

   Ans: Validating assumption in linear regression involves various steps:
   - Normality of error: Error terms should be normally distributed.
   - Multicollinearity check: There should be insignificant multicollinearity among variables.
   - Linear relationship validation: 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)**

Ans: On the basis of final model the top 3 features that contribute significantly are as follows:

- year
- temp
- winter

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.

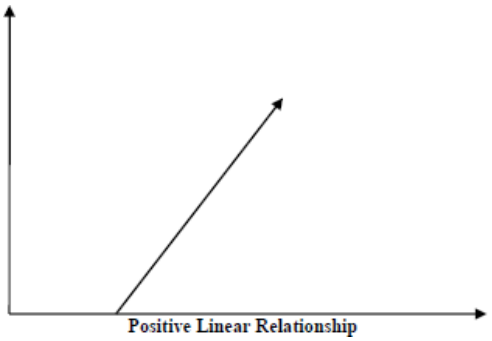
X is the independent variable we are using to make predictions.

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.

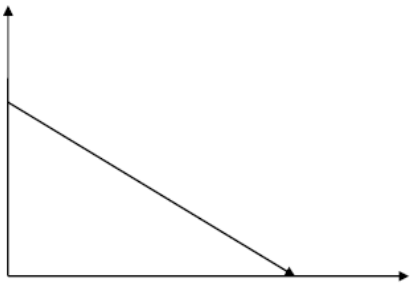
Furthermore, the linear relationship can be positive or negative in nature as explained below–

- Positive Linear Relationship:
  - A linear relationship will be called positive if both independent and dependent variable increases. It can be understood with the help of following graph:



Positive Linear Relationship

- Negative Linear relationship:
    - A linear relationship will be called positive if independent increases and dependent variable decreases. It can be understood with the help of following graph −



Negative Linear Relationship

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 −

- Multicollinearity -Linear regression model assumes that there is very little or no multicollinearity in the data. Basically, multicollinearity occurs when the independent variables or features have dependency in them.
- Auto-correlation- Another assumption Linear regression model assumes is that there is very little or no auto-correlation in the data. Basically, auto-correlation occurs when there is dependency between residual errors.
- 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:

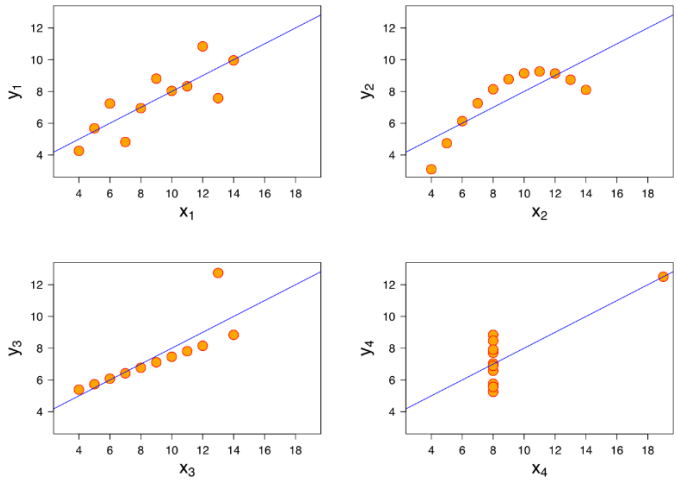
Anscombe's Quartet was developed by statistician Francis Anscombe. It comprises four datasets, each containing eleven (x, y) pairs. The essential thing to note about these datasets is that they share the same descriptive statistics. But things change completely, and I must emphasize COMPLETELY, when 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.

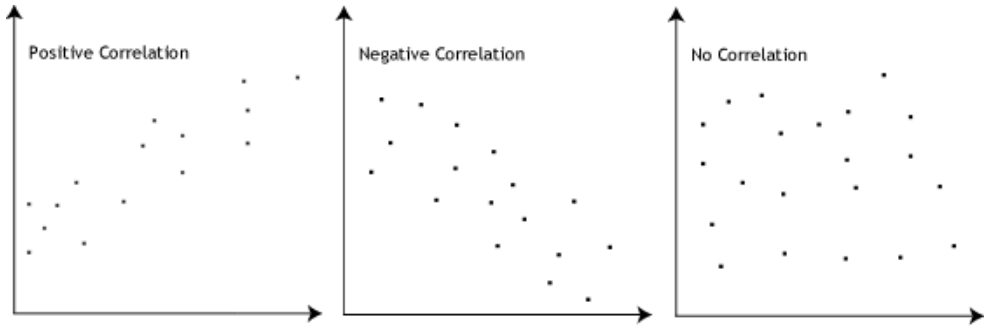
This quartet emphasizes the importance of visualization in Data Analysis. Looking at the data reveals a lot of the structure and a clear picture of the dataset.

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. This is shown in the diagram below:



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

Ans: Scaling in machine learning is one of the most critical steps during the pre-processing of data before creating a machine learning model. Scaling can make a difference between a weak machine learning model and a better one.

- The most common techniques of feature scaling are Normalization and Standardization. Scaling is performed because Most of the times, collected data set contains features highly varying in magnitudes, units and range.
- If scaling is not done then algorithm only takes magnitude in account and not units hence incorrect modelling. To solve this issue, we have to do scaling to bring all the variables to the same level of magnitude. It is important to note that scaling just affects the coefficients and none of the other parameters like t-statistic, F-statistic, p-values, R-squared, etc.

- Below are the few ways we can do feature scaling: MinMaxScaling: It brings all of the data in the range of 0 and 1. sklearn.preprocessing.MinMaxScaler helps to implement normalization in python.
- MinMax Scaling: x= x-min(x)/max(x) – min(x)
- Standardization Scaling: Standardization replaces the values by their Z scores. It brings all of the data into a standard normal distribution which has mean (μ) zero and standard deviation one (σ). Standardization: x= x-mean(x)/sd(x)
- The difference between two most discussed scaling methods are: Normalization and Standardization. Normalization typically means rescales the values into a range of [0,1]. Standardization typically means rescales data to have a mean of 0 and a standard deviation of 1 (unit variance)

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)

Ans: VIF(Variance Inflation Factor)- VIF is an index that provides a measure of how much the variance of an estimated regression coefficient increases due to collinearity. In order to determine VIF, we fit a regression model between the independent variables.

- 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)

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

A q-q plot is a plot of the quantile's of the first data set against the quantile's of the second data set.

- The Q-Q plot use in linear regression in a scenario when we have training and test data set received separately and then we can confirm using Q-Q plot that both the data sets are from populations with same distributions.
- Some other uses and importance of a Q-Q plot in Linear Regression are:
  a) It can be used with sample sizes
  b) Many distributional aspects like shifts in location, shifts in scale, changes in symmetry, and the presence of outliers can all be detected from this plot.
  It is used to check following scenarios: If two data sets —
  I. Come from populations with a common distribution
  II. Have common location and scale
  III. Have similar distributional shapes
  IV. Have similar tail behavior