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: The analysis for the Categorical columns was done using box plot. Below are some of the observations based on data visualization are as below:

- The demand for the year 2019 is more than the year 2018. So, this indicates there is increase in demand from year 2018 to 2019.
- Bookings for the months May to October (month 5,6,7,8,9,10) is more compared to other months. So ***mnth*** column can be possible predictor of demand
- Season 3 (Fall) has higher booking, and there is no much significant difference between season 2(Summer), season 4(Winter), season 1 (Spring) has lowest demand. So possible ***season*** can be one of the predictors.
- The demand is more on a ***workingday*** (holiday = 0). So ***workingday*** might be a possible predictor.
- As per the plot there is very small / negligible difference on the ***cnt*** variable for all weekdays. So, ***weekday*** doesn't look to be a very good predictor of the bookings (cnt).
- When the weather is Clear (weathersit:1), the demand is more as compared to other weather conditions, which is indicating weather has significance in terms of predicting the model.

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

Ans: The **drop_first** parameter specifies whether or not we want to drop the first category of the categorical variable that we are encoding. It helps to avoid creating extra columns, while creating dummy variables.

Syntax of drop_first:

drop_first: ***bool, default False***

Whether to get k-1 dummies out of k categorical levels by removing the first level.

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

Ans: Based on pair plot 'temp' variable has highest correlation.

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

Ans: The assumptions of Linear Regression model are evaluated based on below aspects:

- **MultiCollinearity**:
  a. The multicollinearity between variables should be insignificant (VIF value of < 5)
- **Homoscedasticity**:
  a. No visible patterns on residuals
- **Normal Distribution of Error Terms**:
  a. Error Terms are normally distributed.
- **Linear relationship between variables**:
  a. Per the pair plot there was linear relationship observed with some of the variables for target variable.

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

Ans: As per final model, below are the top 3 features contributing significantly towards explaining the demand:

- **temp**: Temperature variable has highest coefficient value of *0.5480*. Which indicates a unit of increase in temperature increase the demand by *0.5480* units.
- **wheathersit 3** (Light Snow, Light Rain + Thunderstorm + Scattered clouds, Light Rain + Scattered clouds) : This has a coefficient value of *-0.2829* indicates that, a unit increase in Weathersit3 variable decreases the demand by *0.2829* units.
- **yr**: The coefficient of yr (year) is 0.2329. Which indicates there is increase the demand for bikes by *0.2329* for year **2019**.

General Subjective Questions:

1. Explain the linear regression algorithm in detail.

Ans: Linear Regression is a machine learning algorithm, which is based on supervised learning. Regression model predicts a dependent (output or target) variable based on independent variable(s).

Linear Regression is of 2 types:

- **Simple Linear Regression:** When we try to find the dependency between one dependent variable(Y), and one independent variable(predictive variable):

  Mathematical Equation: $Y = \beta_0+\beta_1*X$

  Where:

  β_0 = intercept, β_1 = coefficient

  X = independent (Predictive) variable, Y = dependent (target) variable

- **Multiple Linear Regression:** When we try to find the dependency between one dependent variable(Y), and more than one independent (predictive) variables

  Mathematical Equation: $Y = \beta_0+\beta_1*X_1+ \beta_2*X_2+ ..... + \beta_nX_n$

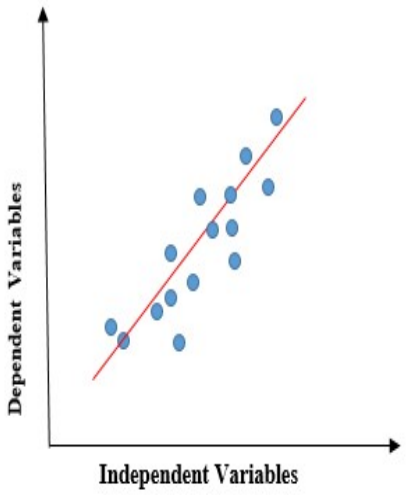
  Where:

  β_0 = intercept

  β_1 β_2 ... β_n = coefficients

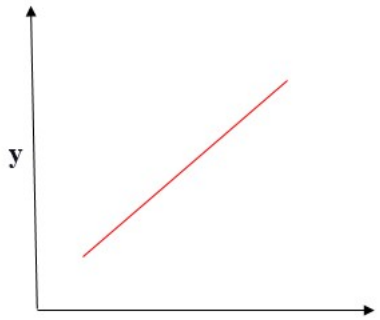
  X_1 X_2 .... X_n= independent (Predictive) variables

  Y = dependent (target) variable

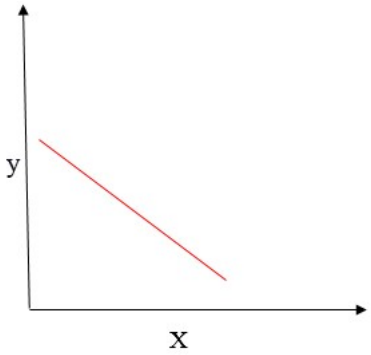


- Linear Relationship can be:

1. **Positive**: When the independent variable value increases, the dependent variable value also increases.



2. **Negative**: When the independent variable value increases, the dependent variable value decreases.



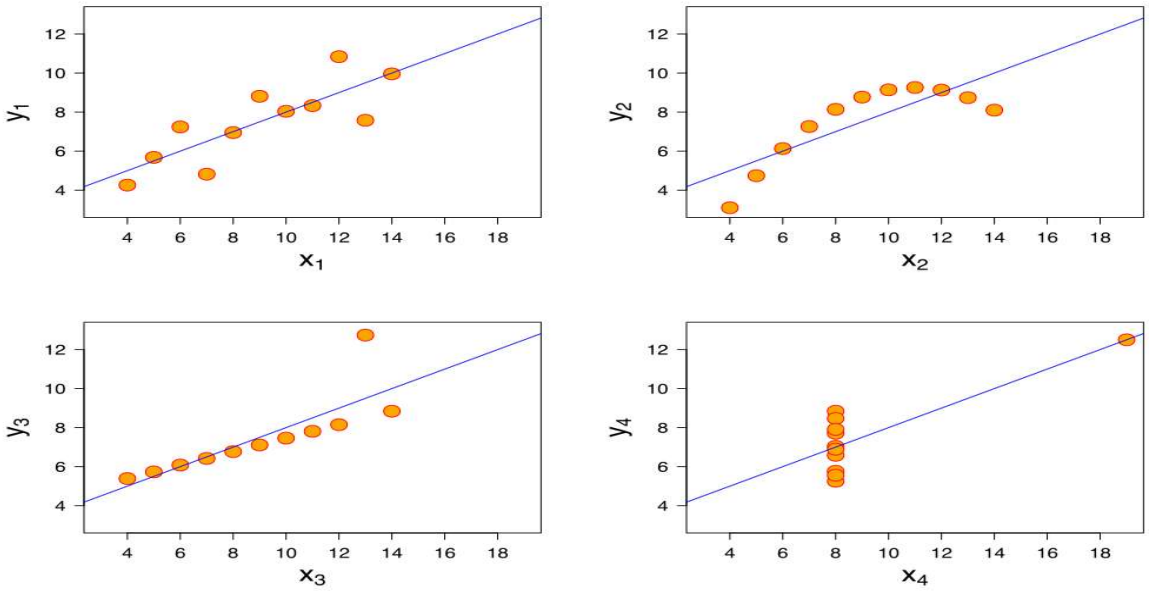
The goal of linear regression is to find the best values of $\beta_0, \beta_1, \beta_2, \ldots \beta_n$ to provide the best fit line for given datapoints. Cost function optimizes the regression coefficients or weights and measures how a linear regression model is performing. In linear Regression MSE (Mean Squared Error) cost function is used, which is the average of squared error.

2. Explain the Anscombe's quartet in detail

Ans: AnsCombe's Quartet was constructed by statistician Francis Anscombe in 1973, to demonstrate the importance of data the before analysing it. Anscombe's Quartet consists of four data sets that have nearly identical statistical observations yet have very different distributions and appear very different when graphed.

Anscombe's Data										
Observation	x1	y1		x2	y2		x3	y3		x4	y4
1	10	8.04		10	9.14		10	7.46		8	6.58
2	8	6.95		8	8.14		8	6.77		8	5.76
3	13	7.58		13	8.74		13	12.74		8	7.71
4	9	8.81		9	8.77		9	7.11		8	8.84
5	11	8.33		11	9.26		11	7.81		8	8.47
6	14	9.96		14	8.1		14	8.84		8	7.04
7	6	7.24		6	6.13		6	6.08		8	5.25
8	4	4.26		4	3.1		4	5.39		19	12.5
9	12	10.84		12	9.13		12	8.15		8	5.56
10	7	4.82		7	7.26		7	6.42		8	7.91
11	5	5.68		5	4.74		5	5.73		8	6.89
				Summary Statistics							
N	11	11		11	11		11	11		11	11
mean	9.00	7.50		9.00	7.500909		9.00	7.50		9.00	7.50
SD	3.16	1.94		3.16	1.94		3.16	1.94		3.16	1.94
r	0.82			0.82			0.82			0.82	

When the above data is plotted using a scatter plot, all datasets generate different kind of plot



1. **Dataset 1:** this **fits** the linear regression model.

2. **Dataset 2:** this **could not fit** linear regression model.

3. **Dataset 3: Though the model is linear,** there is an **outlier (one data point)** which exterts enough influence to lower correlation, involved in the dataset **which cannot be handled** by linear regression model

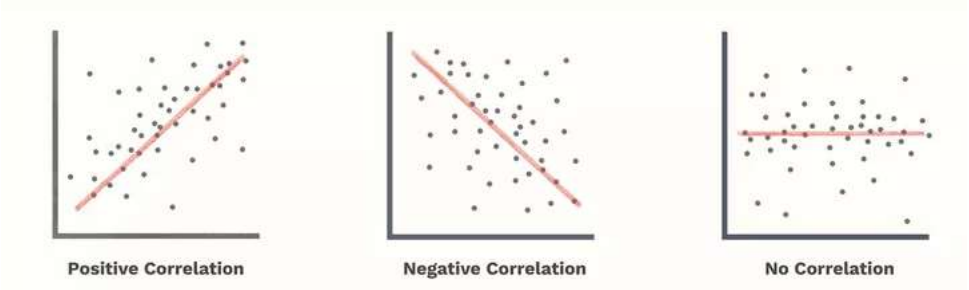
4. **Dataset 4:** shows the **outliers** involved in the dataset which **cannot be handled** by linear regression model

Summary: It's recommended to visualize important features in data set before implementing

3. What is Pearson's R?

Ans: Pearson Correlation Coefficient (PCC), which is also known as Pearson's R or Correlation coefficient is measure of linear relationship between 2 sets of Data. It is the ratio between covariance (joint variability of 2 variables), and product of standard deviations. If 2 variables tend to increase or decrease together then it shows positive correlation. If the variables tend to increase or decrease in opposite direction, then it shows negative correlation. The value of correlation coefficient or R lies between -1 and +1.

- ➔ A value of 0 indicates no correlation between variables.
- ➔ Value > 0 indicates positive correlation
- ➔ Value < 0 indicates negative correlation



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

Ans: Scaling is a technique used to standardize or normalize the range. This is performed during data pre-processing. As the data set might vary widely, if we take the exact or face value of data, then it might lead to algorithm considering the data with large values as higher, and small values as lower, irrespective of the unit of given data.

For example: Without feature scaling, algorithm might consider might be possible that 120 lbs might be considered as larger than 60 kgs, which might lead to wrong predictions.

Difference between normalized and standardised scaling.

S.No	Normalized Scaling (Min-Max Scaling)	Standardizes Scaling
1	Min, Max values of features are used for scaling	Mean and Standard Deviation are used for scaling
2	It is used when features are of different scales.	This is used when we want zero mean, and standard deviation of 1 unit.
3	Scales values between [0, 1] or [-1, 1].	It is not bounded to a certain range.
4	Affected by outliers	Not affected by outliers

5	Scikit-Learn provides a transformer (*MinMaxScaler*) for normalization	Scikit-Learn provides a transformer(*StandardScaler*) for standardisation
6	This is useful when we don't know the distribution.	This is useful, when the distribution is normal

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

Ans: A VIF value of infinite indicates that features have extremely strong relationship. In general, the larger value of VIF indicates that, there is correlation between variables. When there is a extremely strong or prefect correlation, then R-Squared value becomes 1, which leads VIF ($1/(1-R^2)$) to become infinity. In a way, this will cause multicollinearity, where variable with strong association will get dropped to bring down VIF values.

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

Ans: Q-Q (Quantile-Quantile) plot is a probability plot, a graphical technique, for determining if two data sets come from populations with a common distribution.

Uses:

q-q plot is a plot of the quantiles of the first data set against the quantiles of the second data set. A quantile, 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:

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.