Assignment-based Subjective Questions Answer

Question 1: From your analysis of the categorical variables from the dataset, what could you infer about their effect on the dependent variable?

Answer:

- Season:- Almost 32% of the bike booking were happening in season3 with a median of over 5000 booking (for the period of 2 years). This was followed by season2 & season4 with 27% & 25% of total booking. Fall is the Top season where the number of bikes rented is high.

- Weather:- Almost 67% of the bike booking were happening during 'weathersit1 with a median of close to 5000 booking (for the period of 2 years). This was followed by weathersit2 with 30% of total booking. The number of bikes rented is high when the weather is clear.

- Weekdays:-The number of bikes rented goes high during mid week. weekday variable shows very close trend (between 13.5%-14.8% of total booking on all days of the week) having their independent medians between 4000 to 5000 bookings.

- Month:-The number of bikes rented goes high during mid year. Almost 10% of the bike booking were happening in the months 5,6,7,8 & 9 with a median of over 4000 booking per month.

Observations from above boxplots for categorical variables:

- The year box plots indicates that more bikes are rent during 2019.
- The season box plots indicates that more bikes are rent during fall season.
- The working day and holiday box plots indicate that more bikes are rent during normal working days than on weekends or holidays.
- The month box plots indicates that more bikes are rent during september month.
- The weekday box plots indicates that more bikes are rent during saturday.
- The weathersit box plots indicates that more bikes are rent during Clear, Few clouds, Partly cloudy weather.

Question 2: Why is it important to use drop_first=True during dummy variable creation?

Answer: Its very indispensable for drop variables which may directly affect some models adversely moreover the effect is strong when the cardinality is small. Therefore first=True is important to use which will eventually help in reducing the extra column created during dummy variable creation. therefore, it reduces the

correlations created among dummy variables. dummy variables might be correlated because the first column becomes a reference group during dummy encoding.

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 furnished and semi furnished, then It is obvious unfurnished. So we do not need 3rd variable to identify the unfurnished.

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

Answer: The numerical variable 'registered' has the highest correlation with the target variable cnt', if we consider all the features. when we drop registered due to multicollinearity the numerical variable 'temp' has the highest correlation with the target variable 'cnt'.

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

Answer:

Validation of the model is done with the help of Residual analysis by plotting distribution plot. Residual Analysis shows that error terms for both the models gives almost a normal distribution, but the R squared value is better for the Second model compared to the seventh model. Also, normality of error distribution is slightly better for Second model compared to seventh model. Hence 4th model was taken into consideration for the prediction.

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

Answer:

- Temperature (temp) - People are less likely to use their service at low or extreme temperatures. So, either the company can function to half the capacity or minimum capacity to reduce operational costs for better profits and provide service for regular registered customers mostly. Similarly in days with increase in humidity and windspeed. Discounts or offers will not help as well since it is inconvenient to commute using bikes in such situations.

- **Weather Situation (weathersit)** - People are more likely to use their service in the best or the neutral weather environments i.e : Clear, Few clouds, Partly cloudy, Partly cloudy OR Mist + Cloudy, Mist + Broken clouds, Mist + Few clouds, Mist.

- Year (yr) - There will be increase in the number of users with increase in year since people will start adapting to renting bikes more often. There might be chances that because of covid just been around the corner, the

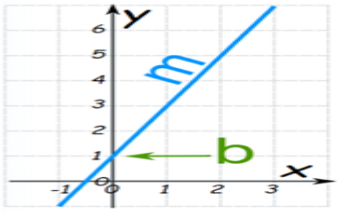
trend might not follow immediately but giving a year more will definitely see rise in number of users.

General Subjective Questions

1. Explain the linear regression algorithm in detail.

Answer:-

Linear Regression is a machine learning algorithm based on **supervised learning**. It performs a **regression task**. Regression models a target prediction value based on independent variables. It is mostly used for finding out the relationship between variables and forecasting. Different regression models differ based on – the kind of relationship between dependent and independent variables, they are considering and the number of independent variables being used.



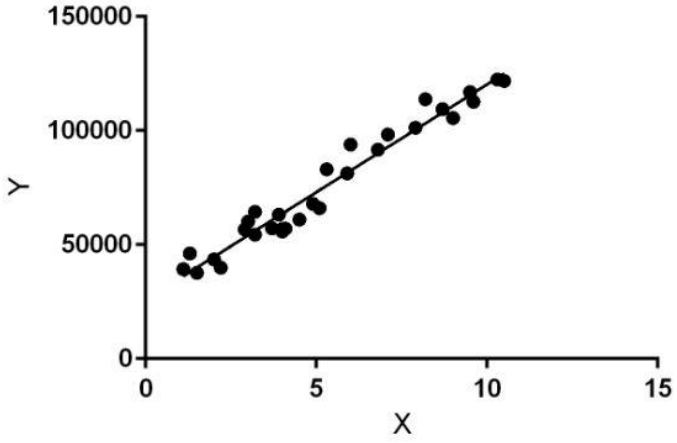
price = m * area + b

y = mx + b

Slope (or Gradient) Y Intercept

Reference: https://www.mathsisfun.com/algebra/linear-equations.html

Linear Equation y = mx + b, m is coefficient, x is an independent variable, and b is the intercept.



$$y = \theta_1 + \theta_2.x$$

Linear regression performs the task to predict a dependent variable value (y) based on a given independent variable (x). So, this regression technique finds out a linear relationship between x (input) and y(output). Hence, the name is Linear Regression. In the figure above, X (input) is the work experience and Y (output) is the salary of a person. The regression line is the best fit line for our model.

While training the model we are given :
x: input training data (univariate – one input variable(parameter))
y: labels to data (supervised learning)

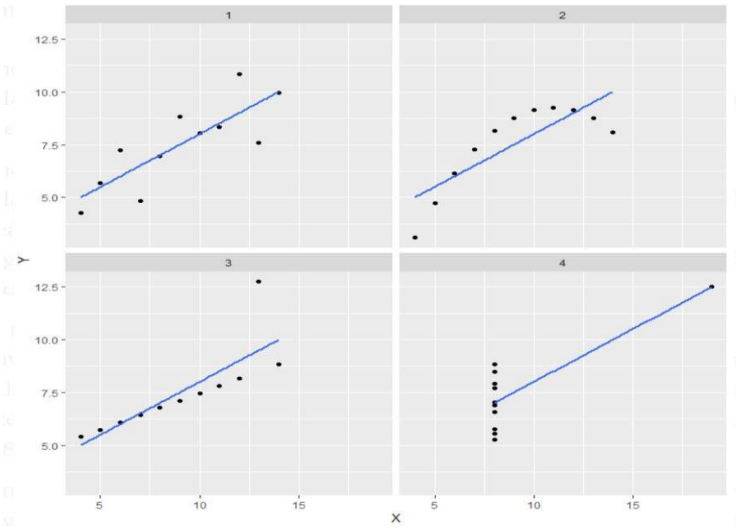
2. **Explain the Anscombe's quartet in details:**

Answer:

Anscombe's quartet comprises four datasets that have nearly identical simple statistical properties, yet appear very different when graphed. Each dataset consists of eleven (x,y) points. They were constructed in 1973 by the statistician Francis Anscombe to demonstrate both the importance of graphing data before analyzing it and the effect of outliers on statistical properties.

Simple understanding:
Once Francis John "Frank" Anscombe who was a statistician of great repute found 4 sets of 11 data-points in his dream and requested the council as his last wish to plot those points. Those 4 sets of 11 data-points are given below.

I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89



It is mentioned in the definition that Anscombe's quartet comprises four datasets that have nearly identical simple statistical properties, yet appear very different when graphed.

Explanation of this output:

- In the first one(top left) if you look at the scatter plot you will see that there seems to be a linear relationship between x and y.
- In the second one(top right) if you look at this figure you can conclude that there is a non-linear relationship between x and y.
- In the third one(bottom left) you can say when there is a perfect linear relationship for all the data points except one which seems to be an outlier which is indicated be far away from that line.
- Finally, the fourth one(bottom right) shows an example when one high-leverage point is enough to produce a high correlation coefficient.

3. **What is Pearson's R?**

Answer:-

Pearson's Correlation Coefficient

In Statistics, the Pearson's Correlation Coefficient is also referred to as **Pearson's r, the Pearson product-moment correlation coefficient (PPMCC), or bivariate correlation**. It is a statistic that measures the linear correlation between two variables. Like all correlations, it also has a numerical value that lies between -1.0 and +1.0.

Whenever we discuss correlation in statistics, it is generally Pearson's correlation coefficient. However, it cannot capture nonlinear relationships between two variables and cannot differentiate between dependent and independent variables.

Pearson's correlation coefficient is the covariance of the two variables divided by the product of their standard deviations. The form of the definition involves a "product moment", that is, the mean (the first moment about the origin) of the product of the mean-adjusted random variables; hence the modifier product-moment in the name.

Pearson's Correlation Coefficient is named after Karl Pearson. He formulated the correlation coefficient from a related idea by Francis Galton in the 1880s.

formula proposed by Karl Pearson, we can calculate a **linear relationship** between the two given variables. For example, a child's height increases with his increasing age (different factors affect this biological change). So, we can calculate the relationship between these two variables by obtaining the value of Pearson's Correlation Coefficient r. There are certain requirements for Pearson's Correlation Coefficient:

- Scale of measurement should be interval or ratio
- Variables should be approximately normally distributed
- The association should be linear
- There should be no outliers in the data

The formula given is:

$$r = \frac{N\Sigma xy-(\Sigma x)(\Sigma y)}{\sqrt{[N\Sigma x^2-(\Sigma x)^2][N\Sigma y^2-(\Sigma y)^2]}}$$

Where,

N = the number of pairs of scores

Σxy = the sum of the products of paired scores

Σx = the sum of x scores

Σy = the sum of y scores

Σx2 = the sum of squared x scores

Σy2 = the sum of squared y scores

4. **What is scaling? Why is scaling performed? What is the difference between normalized scaling and standardized scaling?**
   Answer:-

   Scaling

   It is a step of data Pre-Processing which is applied to independent variables to normalize the data within a particular range. It also helps in speeding up the calculations in an algorithm.

Why is scaling performed ?

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.

Difference between Normalisation and Standardisation

S.NO.	Normalisation	Standardisation
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.
6.	This transformation squishes the n-dimensional data into an n-dimensional unit hypercube.	It translates the data to the mean vector of original data to the origin and squishes or expands.
7.	It is useful when we don’t know about the distribution	It is useful when the feature distribution is Normal or Gaussian.
8.	It is a often called as Scaling Normalization	It is a often called as Z-Score Normalization.

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

Answer:-

If there is perfect correlation, then VIF = infinity. This shows a perfect correlation between two independent variables. In the case of perfect correlation, we get R2

=1, which lead to 1/(1-R2) infinity. To solve this problem we need to drop one of the variables from the dataset which is causing this perfect multicollinearity.

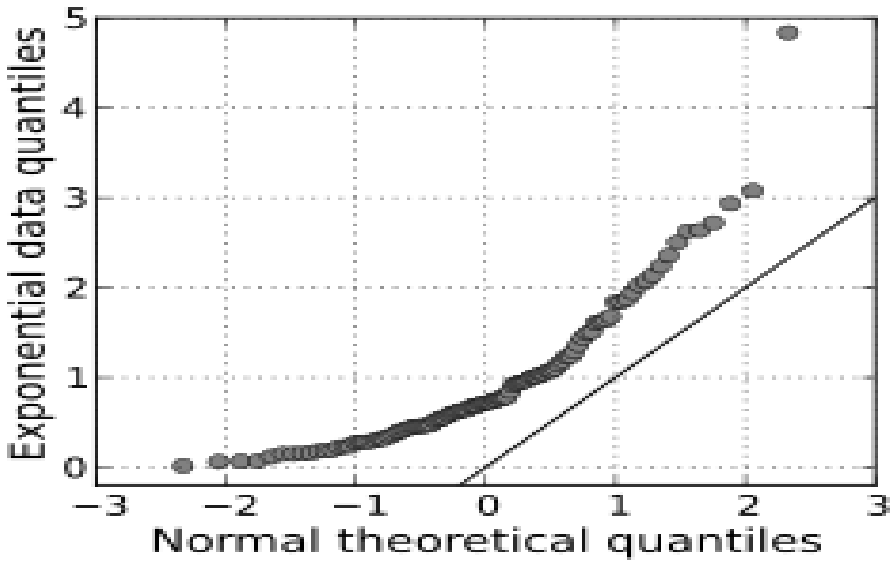
An infinite VIF value indicates that the corresponding variable may be expressed exactly by a linear combination of other variables (which show an infinite VIF as well).

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

Answer:-

Q-Q Plots (Quantile-Quantile plots) are plots of two quantiles against each other. A quantile is a fraction where certain values fall below that quantile. For example, the median is a quantile where 50% of the data fall below that point and 50% lie above it. The purpose of Q Q plots is to find out if two sets of data come from the same distribution. A 45 degree angle is plotted on the Q Q plot; if the two data sets come from a common distribution, the points will fall on that reference line.

A Q Q plot showing the 45 degree reference line:



If the two distributions being compared are similar, the points in the Q–Q plot will approximately lie on the line y = x. If the distributions are linearly related, the points in the Q–Q plot will approximately lie on a line, but not necessarily on the line y = x. Q–Q plots can also be used as a graphical means of estimating parameters in a location-scale family of distributions.

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.