Assignment-based Subjective Questions

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

Answer::

- Observations from above boxplots for categorical variables:The year box plots indicate that more bikes are rented during 2019.
- The season box plots indicate that more bikes are rented during the fall season.
- The working day and holiday box plots indicate that more bikes are rented during normal working days than on weekends or holidays.
- The month box plots indicate that more bikes are rented during the September month.
- The weekday box plots indicate that more bikes are rented during saturday.
- The weathersit box plots indicate that more bikes are rented during Clear, Few clouds, Partly cloudy weather.

Q) Why is it important to use drop_first=True during dummy variable creation?

Answer: Drop_first = True, it helps to reduce extra created columns during dummy variable creation, which will help in reducing correlations (redundancy) among dummy variables.

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

Answer: As from the pair plot we can clearly see that temp and realfeeltemp (atemp) is highly correlated, almost linear with the target variable count.

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

Answer:

1. A Linear Relationship between the dependent variable and their predictors can be justified using pair plots
2. If error termsform a normal distribution, it validates the training model
3. VIF (Variance Inflation Factor) value for all the feature should not be greater than 5
4. P-values should for all the features should be less than 0.05(assumed) significance level
5. Error terms should be independent of each other
6.

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

Answer:

As per the model, top 3 features are,

1. Temperature
2. Weather
3. Year

General Subjective Questions

Q1. Explain the linear regression algorithm in detail.

Answer: Linear regression is one of the very basic forms of machine learning where we train a model to predict the behavior of your data based on some variables. In the case of linear regression as you can see the name suggests linear, that means the two variables which are on the x-axis and y-axis should be linearly correlated.

Mathematically, we can write a linear regression equation as:

$$y = a + bx$$

Where a and b given by the formulas:

$$b(slobe) = \frac{n\sum xy - (\sum x)(\sum y)}{n\sum x^2 - (\sum x)^2}$$

$$a(intercept) = \frac{n\sum y - b(\sum x)}{n}$$

Here, x and y are two variables on the regression line.

b = Slope of the line

a = y-intercept of the line

x = Independent variable from dataset

y = Dependent variable from dataset

Q2. Explain the Anscombe's quartet in detail.

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

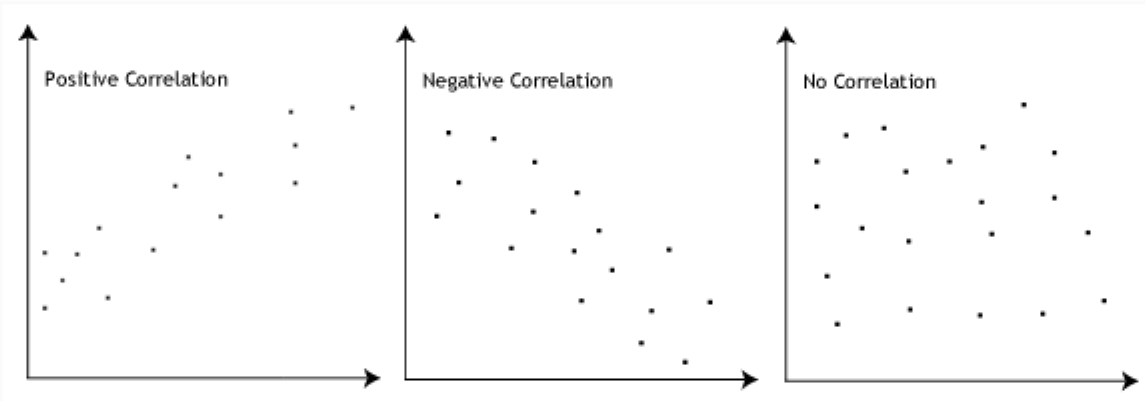
After that, the council analyzed them using only descriptive statistics and found the mean, standard deviation, and correlation between x and y.

Q3. What is Pearson's R?

Answer: In statistics, the Pearson correlation coefficient (PCC), also referred to as Pearson's r, the Pearson product-moment correlation coefficient (PPMCC), or the bivariate correlation, is a measure of linear correlation between two sets of data. It is the covariance of two variables, divided by the product of their standard deviations; thus it is essentially a normalised measurement of the covariance, such that the result always has a value between −1 and 1.

The Pearson's correlation coefficient varies between -1 and +1 where:

- r = 1 means the data is perfectly linear with a positive slope (i.e., both variables tend to change in the same direction)
- r = -1 means the data is perfectly linear with a negative slope (i.e., both variables tend to change in different directions)
- r = 0 means there is no linear association
- $r > 0 < 5$ means there is a weak association
- $r > 5 < 8$ means there is a moderate association
- $r > 8$ means there is a strong association



Pearson r Formula

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

Here,

- r=correlation coefficient
- x_i=values of the x-variable in a sample
- $\bar{x}$=mean of the values of the x-variable
- y_i=values of the y-variable in a sample
- $\bar{y}$=mean of the values of the y-variable

Q4. What is scaling? Why is scaling performed? What is the difference between normalized scaling and standardized scaling?

Answer: 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.

Most of the time, the collected data set contains features highly varying in magnitudes, units and range. If scaling is not done then the algorithm only takes magnitude in account and not units hence incorrect modeling. 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.

Feature scaling is one of the most important data preprocessing step in machine learning. Algorithms that compute the distance between the features are biased towards numerically larger values if the data is not scaled.

Tree-based algorithms are fairly insensitive to the scale of the features. Also, feature scaling helps machine learning, and deep learning algorithms train and converge faster.

There are some feature scaling techniques such as Normalization and Standardization that are the most popular and at the same time, the most confusing ones.

Let’s resolve that confusion.

Normalization or Min-Max Scaling is used to transform features to be on a similar scale. The new point is calculated as:

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X_new = (X - X_min)/(X_max - X_min)
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This scales the range to [0, 1] or sometimes [-1, 1]. Geometrically speaking, transformation squishes the n-dimensional data into an n-dimensional unit hypercube. Normalization is useful when there are no outliers as it cannot cope up with them. Usually, we would scale age and not incomes because only a few people have high incomes but the age is close to uniform.

Standardization or Z-Score Normalization is the transformation of features by subtracting from mean and dividing by standard deviation. This is often called as Z-score.

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X_new = (X - mean)/Std
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Standardization can be helpful in cases where the data follows a Gaussian distribution. However, this does not have to be necessarily true. Geometrically speaking, it translates the data to the mean vector of original data to the origin and squishes or expands the points if std is 1 respectively. We can see that we are just changing mean and standard deviation to a standard normal distribution which is still normal thus the shape of the distribution is not affected.

Standardization does not get affected by outliers because there is no predefined range of transformed features.

Difference between Normalization and Standardization

S.No	Normalization	Standardization
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	It translates the data to the mean vector of original data to the origin

	an n-dimensional unit hypercube.	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 often called Z-Score Normalization.

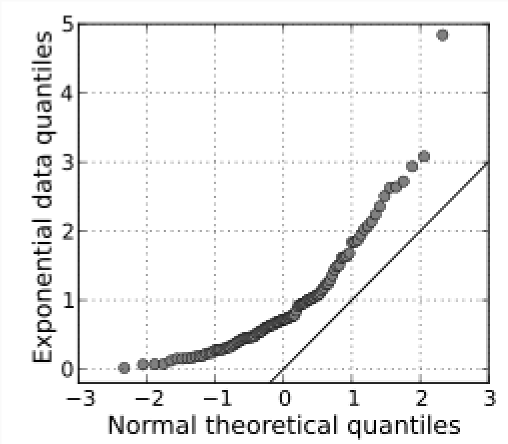
Q5. You might have observed that sometimes the value of VIF is infinite. Why does this happen?

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.

Q6. 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.