Assignment-based Subjective Questions

Q1. From your analysis of the categorical variables from the dataset, what could you infer about their effect on the dependent variable?

Answer: The demad of bike is less in the month of spring when compared with other seasons.

- Bike demand in the fall is the highest.
- Bike demand takes a dip in spring.
- Bike demand in year 2019 is higher as compared to 2018.
- Bike demand is high in the months from May to October.
- Bike demand is high if weather is clear or with mist cloudy while it is low whenthere is light rain or light snow.
- The demand of bike is almost similar throughout the weekdays.
- Bike demand doesn't change whether day is working day or not.

Q2. Why is it important to use drop_first=True during dummy variable creation?

Answer: Drop_first=True is important to use, as it helps in reducing the extracolumn created during dummy variable creation. Hence it reduces thecorrelations created among dummy variables.

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.

drop_first=True drops the first column during dummy variable creation. Suppose, you have a column for gender that contains 4 variables- "Male", "Female", "Other", "Unknown". So a person is either "Male", or "Female", or "Other". If they are not either of these 3, their gender is "Unknown".

It can be necessary for some situations, while not applicable for others. The goal is to reduce the number of columns by dropping the column that is not necessary. However, it is not always true. For some situations, we need to keep the first column.

Example: Suppose, we have 5 unique values in a column called "Fav_genre"- "Rock", "Hip hop", "Pop", "Metal", "Country" This column contains value While dummy variable creation, we usually generate 5 columns. In this case, drop_first=True is not applicable. A person may have more than one favorite genres. So dropping any of the columns would not be right. Hence, drop_first=False is the default parameter.

Q3. Looking at the pair-plot among the numerical variables, which one has the highest correlation with the target variable?

Answer: atemp and temp both have same correlation with target variable of 0.63 which isthe highest among all numerical variables.

Q4. How did you validate the assumptions of Linear Regression after building the model on the training set?

Answer: The simple way to determine if this assumption is met or not is by creating a scatter plot x vs y. If the data points fall on a straight line in the graph, there is a linear relationship between the dependent and the independent variables, and the assumption holds.

If a linear relationship doesn't exist between the dependent and the independent variables, then apply a non-linear transformation such as logarithmic, exponential, square root, or reciprocal either to the dependent variable, independent variable, or both.

The residuals (error terms) are independent of each other. In other words, there is no correlation between the consecutive error terms of the time series data. The presence of correlation in the error terms drastically reduces the accuracy of the model. If the error terms are correlated, the estimated standard error tries to deflate the true standard error.

Conduct a Durbin-Watson (DW) statistic test. The values should fall between 0-4. If DW=2, no auto-correlation; if DW lies between 0 and 2, it means that there exists a positive correlation. If DW lies between 2 and 4, it means there is a negative correlation. Another method is to plot a graph against residuals vs time and see patterns in residual values.

Q5. Based on the final model, which are the top 3 features contributing significantly towards explaining the demand of the shared bikes?

Answer: Based on final model top three features contributing significantly towards explaining the demand are:

1. Temperature (0.552)
2. weathersit : Light Snow, Light Rain + Thunderstorm + Scattered clouds, Light Rain + Scattered clouds (-0.264)
3. year (0.256)

- So it recomended to give these variables utmost importance while planning to achieve maximum demand.

General Subjective Questions

Q1. 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

1. Simple regression: Simple linear regression uses traditional slope-intercept form to produce the most accurate predictions. x represents our input data and y represents our prediction. The motive of the linear regression algorithm is to find the best values for m and c in the equation y = mx + c.
2. Multiple linear regression: Multiple linear regression has one dependent variable and two or more independent variables.

   Assumptions in linear regression

   There are a few assumptions we make when using linear regression:
   - The relationship between the dependent and independent variables should be almost linear.
   - The data is homoscedastic.

- The results obtained from observation should not be influenced by the results obtained from the previous observation.
- The residuals should be normally distributed. This assumption means that the probability density function of the residual values is normally distributed at each independent value.

Uses of linear regression

Linear regression can be used for:

- determining the strength of predictors
- forecasting an effect
- trend forecasting

Q2. Explain the Anscombe's quartet in detail.

Answer: Anscombe's Quartet can be defined as a group of four data sets which are nearly identical in simple descriptive statistics, but there are some peculiarities in the dataset that fools the regression model if built. They have very different distributions and appear differently when plotted on scatter plots.

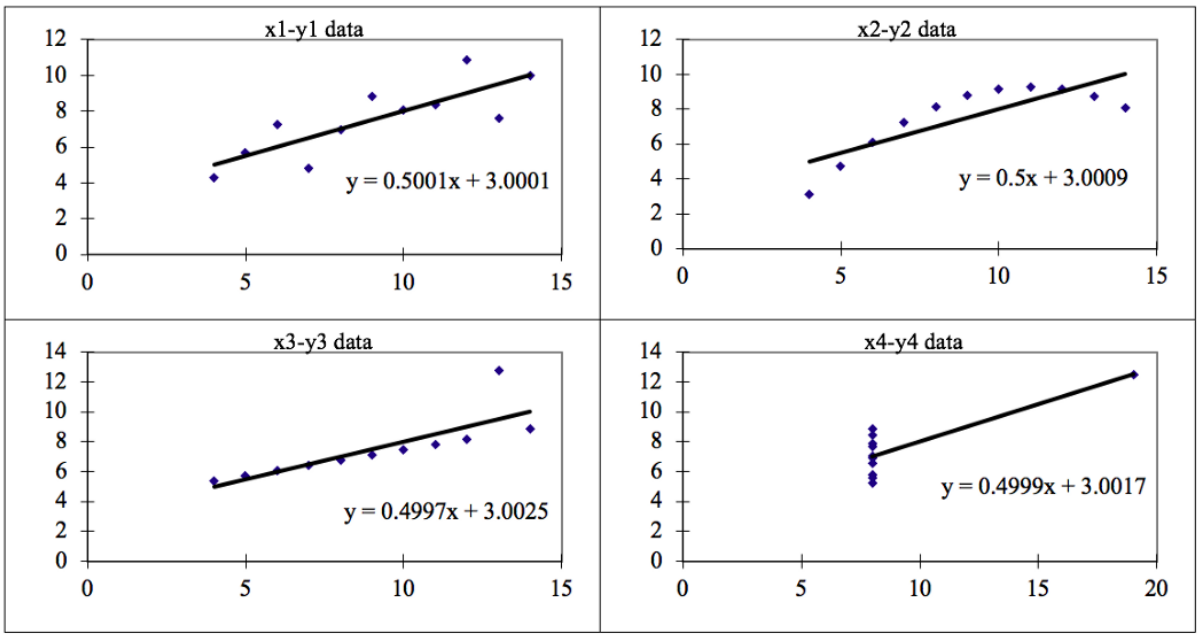
This tells us about the importance of visualising the data before applying various algorithms out there to build models out of them which suggests that the data features must be plotted in order to see the distribution of the samples that can help you identify the various anomalies present in the data like outliers, diversity of the data, linear separability of the data, etc. Also, the Linear Regression can only be considered a fit for the data with linear relationships and is incapable of handling any other kind of datasets. These four plots can be defined as follows:

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

The statistical information for all these four datasets are approximately similar and can be computed as follows:

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 these models are plotted on a scatter plot, all datasets generate a different kind of plot that is not interpretable by any regression algorithm which is fooled by these peculiarities and can be seen as follows:



The four datasets can be described as:

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

Dataset 2: this **could not fit** linear regression model on the data quite well as the data is non-linear.

Dataset 3: shows the **outliers** involved in the dataset which **cannot be handled** by linear regression model

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

Q3. What is Pearson's R?

Answer: In statistics, the Pearson correlation coefficient (PCC, pronounced /ˈpɪərsən/) — also known as Pearson's r, the Pearson product-moment correlation coefficient (PPMCC), the bivariate correlation,[1] or colloquially simply as the correlation coefficient [2] — is a measure of linear correlation between two sets of data. It is the ratio between the covariance of two variables and the product of their standard deviations; thus, it is essentially a normalized measurement of the covariance, such that the result always has a value between −1 and 1. As with covariance itself, the measure can only reflect a linear correlation of variables and ignores many other types of relationships or correlations. As a simple example, one would expect the age and height of a sample of teenagers from a high school to have a Pearson correlation coefficient significantly greater than 0, but less than 1 (as 1 would represent an unrealistically perfect correlation).

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 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.

Normalization/Min-Max Scaling:

- It brings all of the data in the range of 0 and 1. sklearn.preprocessing.MinMaxScaler helps to implement normalization in python.

$$\text{MinMax Scaling: } x = \frac{x - min(x)}{max(x) - min(x)}$$

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).

$$\text{Standardisation: } x = \frac{x - mean(x)}{sd(x)}$$

- sklearn.preprocessing.scale helps to implement standardization in python.

- One disadvantage of normalization over standardization is that it loses some information in the data, especially about outliers

Q4. You might have observed that sometimes the value of VIF is infinite. Why does this happen?

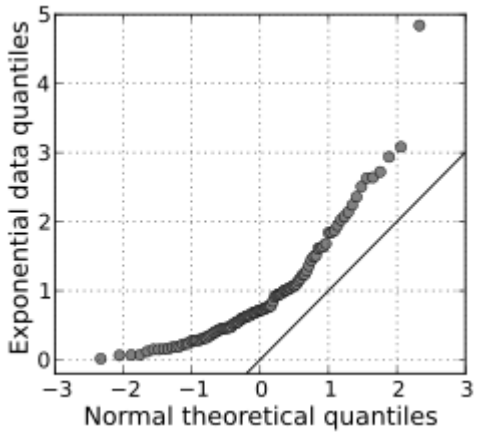
Answer: If there is perfect correlation, then VIF = infinity. This shows a perfect correlation between two independent variables. In the case of perfect correlation, we get R2 =1, which lead to 1/(1-R2) infinity. To solve this problem, we need to drop one of the variables from the dataset which is causing 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).

Q5. 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.