Ques 1:

From your analysis of the categorical variables from the dataset, what could you infer about their effect on the dependent variable? (3 marks)

Answer:

Here are some of the inferences I made from my analysis of categorical variables from the dataset on the dependent variable (Count)

1. Fall has the highest median, which is expected as weather conditions are most optimal to ride bike followed by summer.
2. Median bike rents are increasing year on as year 2019 has a higher median then 2018, it might be due the fact that bike rentals are getting popular and people are becoming more aware about environment.
3. Overall spread in the month plot is reflection of season plot as fall months have higher median.
4. People rent more on non - holidays compared to holidays, so reason might be they prefer to spend time with family and use personal vehicle instead of bike rentals.
5. Overall median across all days is same but spread for Saturday and Wednesday is bigger may be evident that those who have plans for Saturday might not rent bikes as it a non-working day.
6. Working and non-working days have almost the same median although spread is bigger for non-working days as people might have plans and do not want to rent bikes because of that
7.

Clear weather is most optimal for bike renting, as temperate is optimal, humidity is less, and temperature is less.

Ques 2:

Why is it important to use **drop first=True** during dummy variable creation? (2 mark)

Answer: A variable with n levels can be represented by n-1 dummy variables. So, if we remove the first column then also, we can represent the data. If the value of variable from 2 to n is 0, it means that the value of 1st variable is 1.

Example: 'Relationship' with three levels, namely, 'Single', 'In a Relationship', and 'Married'

Ques 3:

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

Ans:

Seeing the correlation among the numerical variables, temp, atemp and days old have the highest correlation.

Ques 4:

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

Ans:

Here VIF seems to be almost accepted. P-value for all the features is almost 0.0 and R2 is 0.821 Let us select Model 11 as our final as it has all important statistics high (R-square, Adjusted R-squared and F-statistic), along with no insignificant variables and no multi coliinear (high VIF) variables. Difference between R-squared and Adjusted R-squared values for this model is veryless, which also means that there are no additional parameters that can be removed from this model.

R2 value for predictions on test data (0.815) is almost same as R2 value of train data(0.818). This is a good R-squared value, hence we can see our model is performing good even on unseen data (test data)

As we can see the error terms are randomly distributed and there is no pattern which means the output is explained well by the model and there are no other parameters that can explain the model better.

Ques 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:

Three variables contributing significantly towards explaining the demand of the shared bikes are:

- holiday
- temp
- hum

General Subjective Questions

Ques 1:

Explain the linear regression algorithm in detail. (4 marks)

Ans:

Linear regression is one of the very basic forms of machine learning where we train a model to predict the behaviour 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.

An example is let's say you are running a sales promotion and expecting a certain number of count of customers to be increased now what you can do is you can look the previous promotions and plot if over on the chart when you run it and then try to see whether there is an increment into the number of customers whenever you rate the promotions and with the help of the previous historical data you try to figure it out or you try to estimate what will be the count or what will be the estimated count for my current promotion this will give you an idea to do the planning in a much better way about how many numbers of stalls maybe you need or how many increase number of employees you need to serve the customer. Here the idea is to estimate the future value based on the historical data by learning the behaviour or patterns from the historical data.

In some cases, the value will be linearly upward that means whenever X is increasing Y is also increasing or vice versa that means they have a correlation or there will be a linear downward relationship.

One example for that could be that the police department is running a campaign to reduce the number of robberies, in this case, the graph will be linearly downward.

Linear regression is used to predict a quantitative response Y from the predictor variable X.

Mathematically, we can write a linear regression equation as:

$$y = a + bx$$

Where a and b given by the formulas:

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

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

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

Use Cases of Linear Regression:

Prediction of trends and Sales targets – To predict how industry is performing or how many sales targets industry may achieve in the future.

Price Prediction – Using regression to predict the change in price of stock or product.

Risk Management- Using regression to the analysis of Risk Management in the financial and insurance sector.

Ques 2:

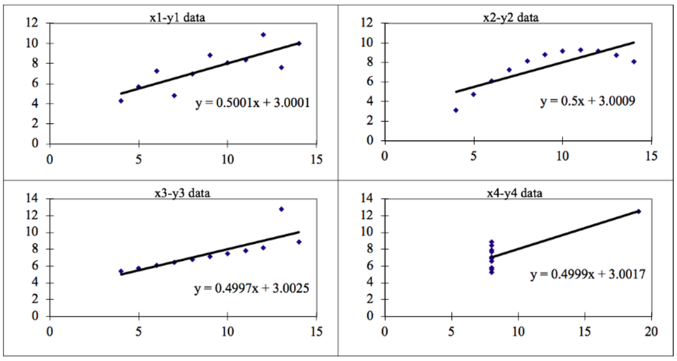
Explain the Anscombe's quartet in detail. (3 marks)

Ans:

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.

It was constructed in 1973 by statistician Francis Anscombe to illustrate the importance of plotting the graphs before analyzing and model building, and the effect of other observations on statistical properties.There are these four data set plots which have nearly same statistical observations, which provides same statistical information that involves variance, and mean of all x,y points in all four datasets.

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 be only be considered a fit for the data with linear relationships and is incapable of handling any other kind of datasets.



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

Ques 3:

What is Pearson's R? (3 marks)

Ans:

The Pearson correlation coefficient (r) is the most widely used correlation coefficient and is known by many names:

- Pearson's r
- Bivariate correlation

- Pearson product-moment correlation coefficient (PPMCC)
- The correlation coefficient

The Pearson correlation coefficient is a descriptive statistic, meaning that it summarizes the characteristics of a dataset. Specifically, it describes the strength and direction of the linear relationship between two quantitative variables.
Although interpretations of the relationship strength (also known as effect size) vary between disciplines, the table below gives general rules of thumb:

Pearson correlation coefficient (*r*) value	**Strength**	**Direction**
Greater than .5	Strong	Positive
Between .3 and .5	Moderate	Positive
Between 0 and .3	Weak	Positive
0	None	None
Between 0 and –.3	Weak	Negative
Between –.3 and –.5	Moderate	Negative
Less than –.5	Strong	Negative

The Pearson correlation coefficient is also an inferential statistic, meaning that it can be used to test statistical hypotheses. Specifically, we can test whether there is a significant relationship between two variables.
Visualizing the Pearson correlation coefficient
Another way to think of the Pearson correlation coefficient (r) is as a measure of how close the observations are to a line of best fit.
The Pearson correlation coefficient also tells you whether the slope of the line of best fit is negative or positive. When the slope is negative, r is negative. When the slope is positive, r is positive.
When r is 1 or –1, all the points fall exactly on the line of best fit:

Ques 4:
What is scaling? Why is scaling performed? What is the difference between normalized scaling and standardized scaling? (3 marks)
Ans:
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 is good to use when you know that the distribution of your data does not follow a Gaussian distribution. This can be useful in algorithms that do not assume any distribution of the data like K-Nearest Neighbors and Neural Networks.
- Standardization, on the other hand, can be helpful in cases where the data follows a Gaussian distribution. However, this does not have to be necessarily true. Also, unlike normalization, standardization does not have a bounding range. So, even if you have outliers in your data, they will not be affected by standardization.

Ques 5:

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

Ans:

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).

Ques 6:

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

Ans:

Q-Q plots are also known as Quantile-Quantile plots. As the name suggests, they plot the quantiles of a sample distribution against quantiles of a theoretical distribution. Doing this helps us determine if a dataset follows any particular type of probability distribution like normal, uniform, exponential.

QQ plots is very useful to determine If two populations are of the same distribution

- If residuals follow a normal distribution. Having a normal error term is an assumption in regression and we can verify if it’s met using this.
- Skewness of distribution

In Q-Q plots, we plot the theoretical Quantile values with the sample Quantile values. Quantiles are obtained by sorting the data. It determines how many values in a distribution are above or below a certain limit.

If the datasets we are comparing are of the same type of distribution type, we would get a roughly straight line.