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? (3 marks)**

There were 6 categorical variables in the dataset.

We used Box plot to study their effect on the dependent variable ('cnt') .

The inference that We could derive were:

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. This indicates, season can be a good predictor for the dependent variable.

mnth: 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. This indicates, mnth has some trend for bookings and can be a good predictor for the dependent variable.

weathersit: 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. This indicates, weathersit does show some trend towards the bike bookings can be a good predictor for the dependent variable. holiday: Almost 97.6% of the bike booking were happening when it is not a holiday which means this data is clearly biased. This indicates, holiday CANNOT be a good predictor for the dependent variable.

weekday: 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. This variable can have some or no influence towards the predictor. I will let the model decide if this needs to be added or not.

workingday: Almost 69% of the bike booking were happening in 'workingday' with a median of close to 5000 booking (for the period of 2 years). This indicates, workingday can be a good predictor for the dependent variable Correlation Matrix

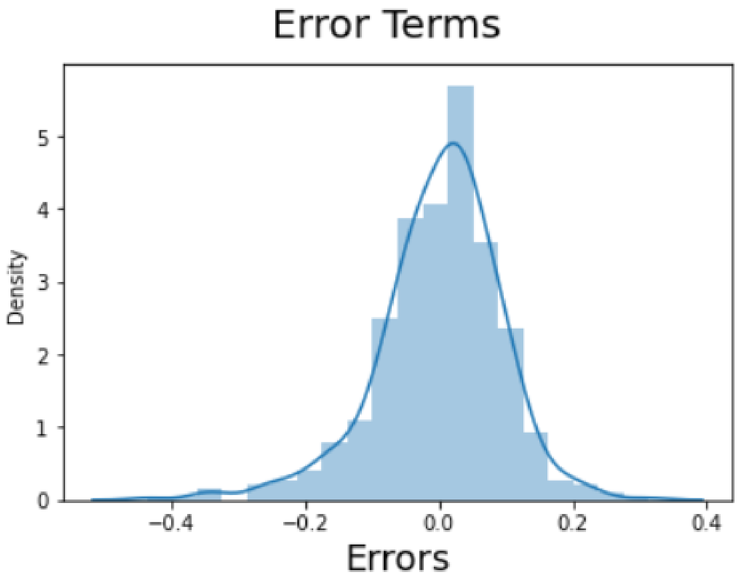
2**). Why is it important to use drop_first=True during dummy variable creation? (2 mark)**

If you don't drop the first column then your dummy variables will be correlated (redundant). This may effect some models adversely and the effect is stronger when the cardinality is smaller. For example iteratie models may have trouble converging and lists of variable importances may be distorted. Another reason is if we have all dummy variables it leads to multicollinearitybetween the dummy variables.

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

'temp' and 'atemp' are two numerical variables which are highly corelated with target variable 'cnt'.

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



Residuals distribution should flow normal distribution and centered around 0 (mean =0).The above diagram shows that the residuals are distributed about mean = 0.

5). Based on the final model, which are the top 3 features contributing significantly towards explaining the demand of the shared bikes? (2 marks)

the top 3 predictor variables that influences the bike booking are:

Temperature (temp) - A coefficient value of ‘0.5636’ indicated that a unit increase in temp variable increases the bike hire numbers by 0.5636 units.

Weather Situation 3 (weathersit_3) - A coefficient value of ‘-0.3070’ indicated that, w.r.t Weathersit1, a unit increase in Weathersit3 variable decreases the bike hire numbers by 0.3070 units.

Year (yr) - A coefficient value of ‘0.2308’ indicated that a unit increase in yr variable increases the bike hire numbers by 0.2308 units.

So, it's suggested to consider these variables utmost importance while planning, to achive maximum Booking The next best features that can also be considered are

season_4: - A coefficient value of ‘0.128744’ indicated that w.r.t season_1, a unit increase in season_4 variable increases the bike hire numbers by 0.128744 units.

windspeed: - A coefficient value of ‘-0.155191’ indicated that, a unit increase in windspeed variable decreases the bike hire numbers by 0.155191 units.

General Subjective Questions:

1) **Explain the linear regression algorithm in detail.**

Linear regression may be defined as the statistical model that analyzes the linear relationship between a dependent variable with given set of independent variables. Linear relationship between variables means that when the value of one or more independent variables will change (increase or decrease), the value of dependent variable will also change accordingly (increase or decrease).

Mathematically the relationship can be represented with the help of following equation −

$Y=mX+c$

Here, Y is the dependent variable we are trying to predict.

X is the independent variable we are using to make predictions.

m is the slop of the regression line which represents the effect X has on Y

c is a constant, known as the YY-intercept. If X = 0,Y would be equal to bb.

Regression is performed when the dependent variables of continuous data type and Predictors or independent variables could be of any data type like continuous, nominal/categorical etc.

Regression method tries to find the best fit line which shows the relationship between the dependent variable and predictors with least error.

Regression is broadly divided into two:

1) **Simple Linear Regression:** SLR is used when the dependent variable is predicted using only one independent variable.
2) **Multiple Linear Regression: MLR** is used when the dependent variable is predicted using multiple independent variables.

The equation for MLR will be:

$$Y=\beta_0+\beta_1X_1+\beta_2X_2+\ldots+\beta_pX_p+\epsilon$$

$\beta1$ = coefficient of X1 variable

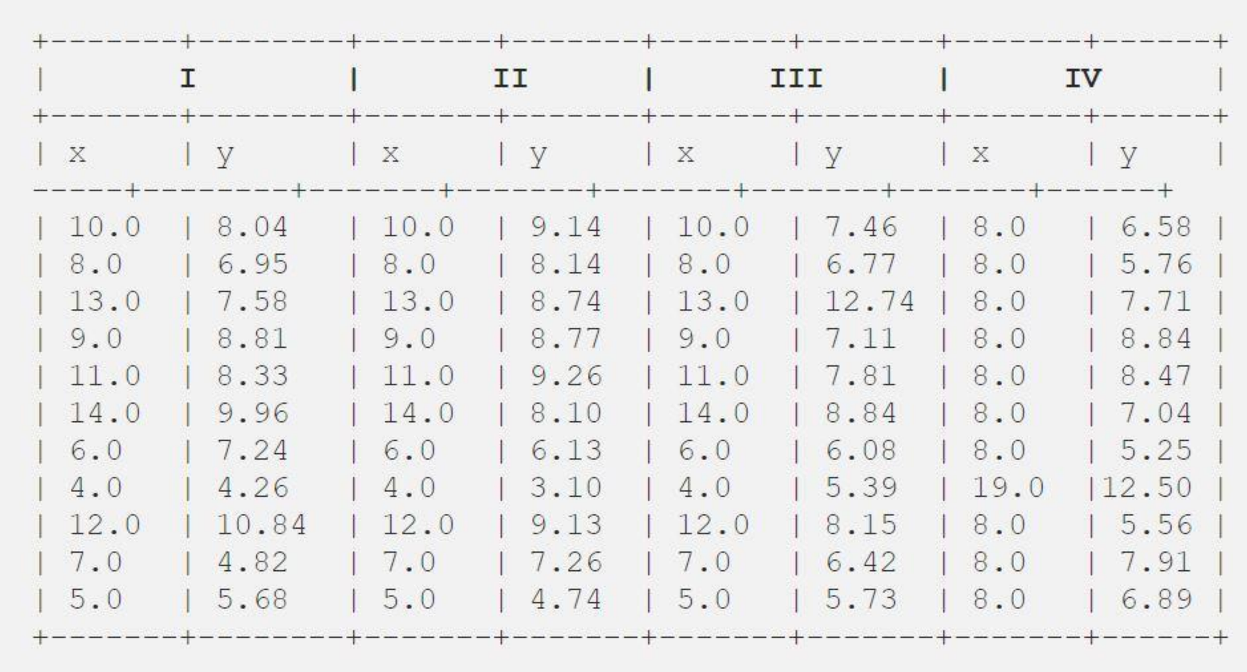
$\beta2$ = coefficient of X2 variable and so on..

2) **Explain the Anscombe’s quartet in detail.**

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.

3) **What is Pearson’s R?**

Pearson’s r is a numerical summary of the strength of the linear association between the variables. It value ranges between -1 to +1. It shows the linear relationship between two sets of data. In simple terms, it tells uscan we draw a line graph to represent the data.
r =1 mean the data is perfectly linear with a positive slope
r = -1 means the data is perfectly linear with negative slope
r = 0 means there is no linear association.

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

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 it 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.

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.

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).

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.

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

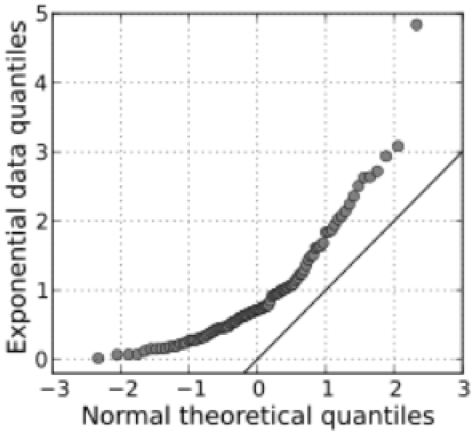
If there is perfect correlation, then VIF = infinity. This shows a perfect correlation between two independent variables. In the case of perfect correlation, we get R2 =1, which lead to 1/(1-R2) infinity. To solve this problem we need to drop one of the variables from the dataset which is causing this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

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.