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)**

Answer: I have plotted the categorical variables with the target variables on boxplot and has inferred following effect on target:

- Season: 3:fall has highest demand for rental bikes.
- There is an increase in demand for next year.
- Each month, the demand has grown until June. September month has highest demand. After September,demand is decreasing.
- Demand decreases during holidays.
- Weekday is not giving clear picture abount demand.
- The clear weathershit has highest demand.
- During September, bike sharing is more. During the year end and beginning, it is less could be due to extereme weather conditions.

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

Answer: drop_first=True is important to use, as it helps in reducing the extra column created during dummy variable creation. Hence it reduces the correlations created among dummy variables.

If we do not drop one of the dummy variables created from a categorical variable then it becomes redundant with dataset as we will have constant variable(intercept) which will create multicollinearity issue.

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

Answer: The feature “temp” has highest correlation. It is very well linearly related with target “cnt”

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

Answer: I have checked the following assumptions:

- Error terms are normally distributed with mean 0.
- Error Terms do not follow any pattern.
- Multicollinearity check using VIF(s).
- Linearity Check.
- Ensured the overfitting by looking the R2 value and Adjusted R2.

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

Answer:
Features “holiday”, “temp” and season “hum” are highly related with target column, so these are top contributing features in model building.

General Subjective Questions:

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

Answer:

- Linear Regression Algorithm is a machine learning algorithm based on supervised learning. Linear regression is a part of regression analysis. Regression analysis is a technique of predictive modelling that helps you to find out the relationship between Input and the target variable.
- 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.
- For example, suppose you`re selling and you expect a certain number of customers to grow now. What you can do is look at the previous promotion, plot it on a chart at run time, evaluate the promotion and use the previous historical data to see if the number of customers has increased. You are trying to estimate what the count is, or what the estimated count for my current action is. This will give you a better idea of how many booths you need and how many staff you

need to serve your customers. The idea here is to estimate future value based on historical data by learning behaviors and patterns from historical data.

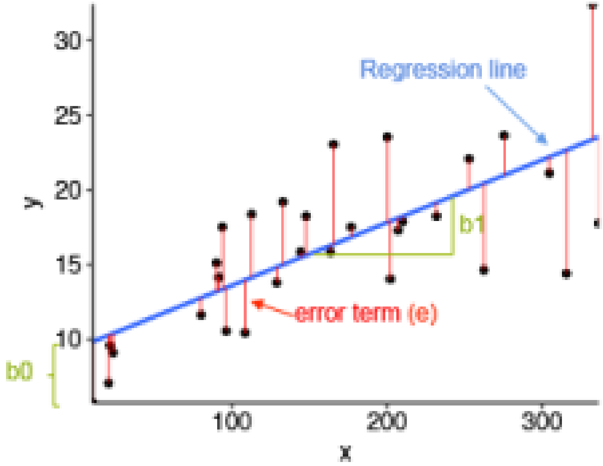
- In some cases, the value will be linearly upward that means whenever X is increasing Y is also increasing or vice versa that means they have a correlation or there will be a linear downward relationship.
- One example for that could be that the police department is running a campaign to reduce the 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 simple linear regression equation as follow

y ~ b0 + b1*x

Where y is the predicted variable (dependent variable), b1 is slope of the line,

x is independent variable, b0 is intercept(constant).

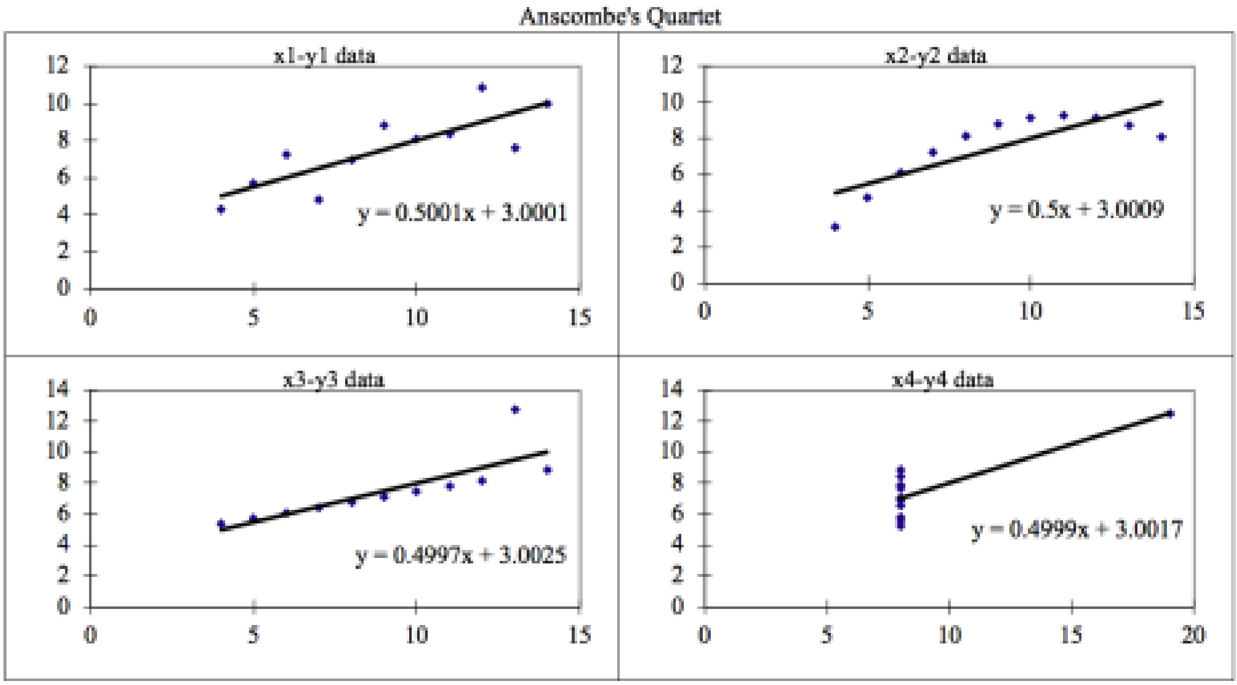
It is cost function which helps to find the best possible value for m and c which in turn provide the best fit line for the data points.



Here, x and y are two variables on the regression line.
b1 = Slope of the line.
b0 = y-intercept of the line.
x = Independent variable from dataset
y = Dependent variable from dataset

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

Answer: Anscombe's quartet can be defined as a set of four datasets that are nearly identical in simple descriptive statistics, but datasets have some peculiarities that trick regression models at build time. They have very different distributions and look different when plotted on a scatter plot. Each dataset consists of 11 (x, y) points.



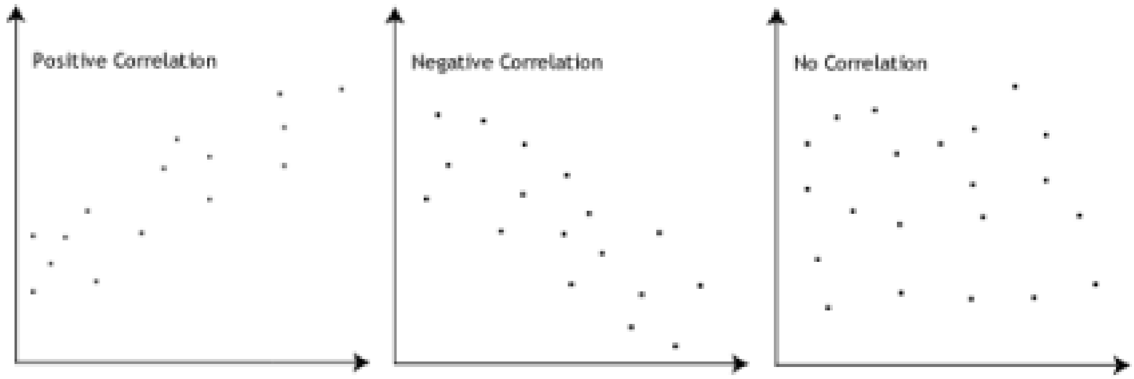
The four datasets can be described as:

- 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

8. What is Pearson’s R? (3 marks)

Answer:

- The Pearson's R referred to as Pearson's Correlation Coefficient in statistics. It is a statistic that measures the linear correlation between two variables.
- Pearson's r is a numerical summary of the strength of the linear association between the variables. If the variables tend to go up and down together, the correlation coefficient will be positive.

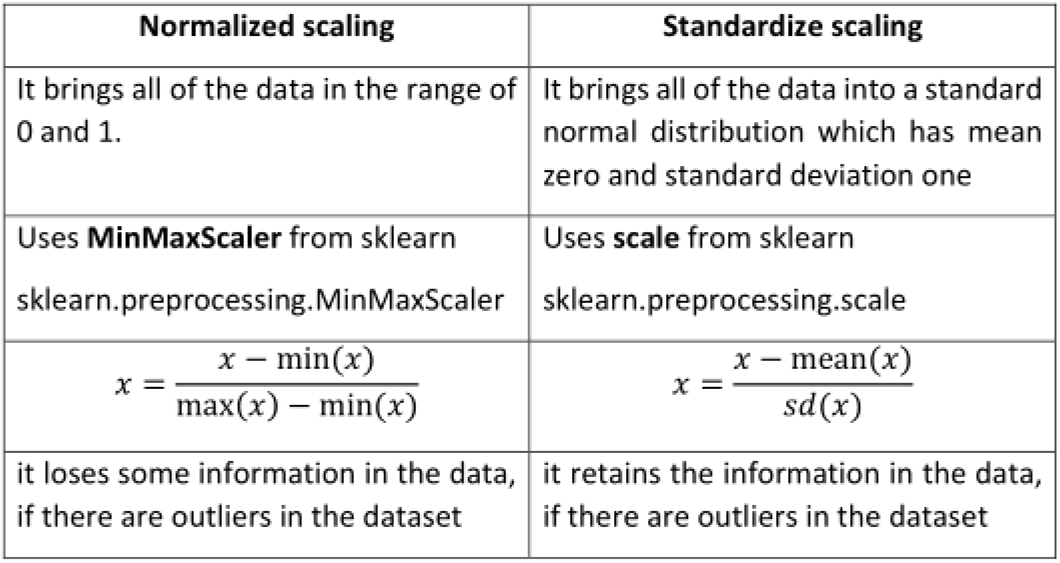
- Pearson's r measures the strength of the linear relationship between two variables. Pearson's r always between -1 and 1.
- If data lie on a perfect straight line with negative slope, then r = -1.
- 

  Positive correlation indicates the both the variable increase and decrease together. Negative correlation indicates the one the variable increase and the other variable decrease and vice versa.

9. What is scaling? Why is scaling performed? What is the difference between normalized scaling and standardized scaling? (3 marks)

Answer:

- Scaling is a method of normalizing the range of independent variables. This is done to place all independent variables in the regression on the same scale. If no scaling is performed, the regression algorithm considers large values to be high and small values to be low.
- 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.
- Example Weight of a device = 500 grams, and weight of another device is 5 kg. In this example machine learning algorithm will consider 500 as greater value which is not the case. And it will do wrong prediction.
- Machine Learning algorithm works on numbers not units. So, before regression on a dataset it is a necessary step to perform.
- Scaling can be performed in two ways: Normalization: It scale a variable in range 0 and 1. Standardization: It transforms data to have a mean of 0 and standard deviation of 1



Normalized scaling	Standardize scaling
It brings all of the data in the range of 0 and 1.	It brings all of the data into a standard normal distribution which has mean zero and standard deviation one
Uses **MinMaxScaler** from sklearn sklearn.preprocessing.MinMaxScaler	Uses **scale** from sklearn sklearn.preprocessing.scale
$x = \frac{x - \min(x)}{\max(x) - \min(x)}$	$x = \frac{x - \mathrm{mean}(x)}{sd(x)}$
it loses some information in the data, if there are outliers in the dataset	it retains the information in the data, if there are outliers in the dataset

10.You might have observed that sometimes the value of VIF is infinite. Why does this happen? (3 marks)

Answer:

- VIF is an index that provides a measure of how much the variance of an estimated regression coefficient increases due to collinearity.
- A large value of VIF indicates that there is a correlation between the variables.
- When there is a perfect relationship then VIF = Infinity whereas if all the independent variables are orthogonal then to each other then VIF = 1.0.
- Means if a variable is expressed exactly by a linear combination of other variable then it is said that VIF is infinite.

11.What is a Q-Q plot? Explain the use and importance of a Q-Q plot in linear regression. (3 marks)

Answer: Quantile-Quantile (Q-Q) plot, is a graphical tool to help us assess if a set of data plausibly came from some theoretical distribution such as a Normal, exponential or Uniform distribution. Also, it helps to determine if two data sets come from populations with a common distribution
It is used for determining if two data sets come from populations with a common distribution. A q-q plot is a plot of the quantiles of the first data set against the quantiles of the second data set. Whether the Distributions is Gaussian, Uniform, Exponential or even Pareto distribution, it can be found out.

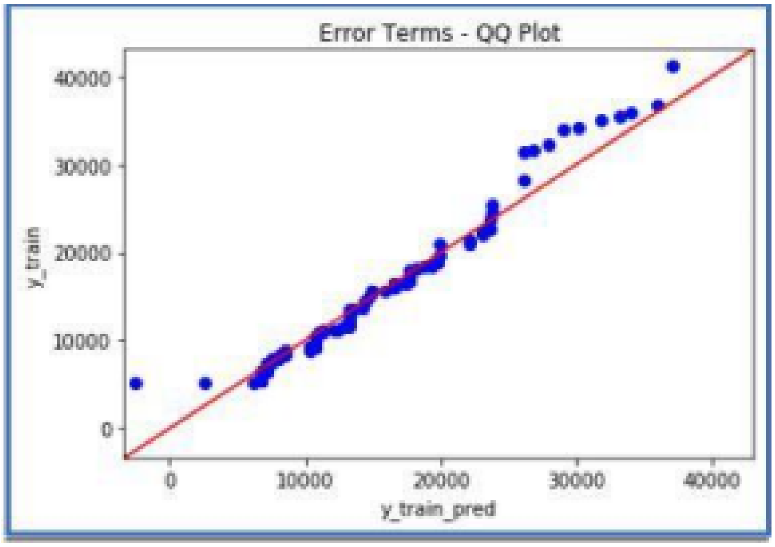
Few advantages:

a) It can be used with sample sizes also
b) Many distributional aspects like shifts in location, shifts in scale, changes in symmetry, and the presence of outliers can all be detected from this plot.

It is used to check following scenarios:

If two data sets —
i. come from populations with a common distribution
ii. have common location and scale
iii. have similar distributional shapes
iv. have similar tail behavior

Interpretation:
A q-q plot is a plot of the quantiles of the first data set against the quantiles of the second data set.
Below are the possible interpretations for two data sets.
a) Similar distribution: If all point of quantiles lies on or close to straight line at an angle of 45 degree from x -axis
b) Y-values < X-values: If y-quantiles are lower than the x-quantiles.
c) X-values < Y-values: If x-quantiles are lower than the y-quantiles.



d) Different distribution: If all point of quantiles lies away from the straight line at an angle of 45 degree from x -axis