Assignment-based Subjective Questions

1. **From your analysis of the categorical variables from the dataset, what could you infer abouttheir effect on the dependent variable? (3 marks)**

Ans. Observations

1.In season 3 the demand is at the highest

2.As compare to year 2018 in 2019 the demand for the bike is increasing

3.On holidays the demand is less

4.when the weather is clear the demand is high.

5.working day is not giving some useful insights.

6. most demanded month is 9 which is Sep.

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

Ans 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.

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

Ans. temp is showing positive correlation with cnt.

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

Ans. The multiple regression model is based on the following assumptions:

1. **Linearity**: There is a linear relationship between the dependent variables and the independent variables.

This has been checked by plotting the scatter plot between the dependent variable (cnt) and the independent variables. The par plots between the cnt and other variables indicate a linear relation, so by this we checked the linearity assumption of the Linear Regression model

2. **Correlation**: The independent variables are not too highly correlated with each other.

While building the model we have checked the variables for their VIF value and p values and the predictor variables that are highly collinear with each other have beendropped while making various models.

3. **yi observations** are selected independently and randomly from the population.

   This is done by splitting the data in train and test set and using Rfe.

4. **Normal Distribution**: Residuals should be normally distributed with a mean of 0 and variance σ.

   This has been checked by plotting a distplot of the residuals/error terms

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

Ans. We can see that the equation of our best fitted line is:

cnt=0.239×yr−0.0845×$holiday$+0.5039×$temp$−0.1773×$windspeed$−0.0597×$spring$+0.0483×$summer$+0.0733×$winter$−0.055×$july$+0.0671×sep−0.0682×$mist$+0.1872

The top three features that are contributing significantly towards explaining the demand of the shared bikes are:

a. Temp (0.5039)
b. yr (0.239)
c. windspeed (0.1773)

General Subjective Questions

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

Ans. 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.

Regression analysis is used for three types of applications:

1. Finding out the effect of Input variables on Target variable.
2. Finding out the change in Target variable with respect to one or more input variable.
3. To find out upcoming trends.

Here are the types of regressions:

1. Linear Regression
2. Multiple Linear Regression
3. Logistic Regression
4. Polynomial Regression

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

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

Ans. Anscombe's quartet tells us about the importance of visualizing data before applying various algorithms to build models. This suggests the data features must be plotted to see the distribution of the samples that can help you identify the various anomalies present in the data (outliers, diversity of the data, linear separability of the data, etc.). Moreover, the linear

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

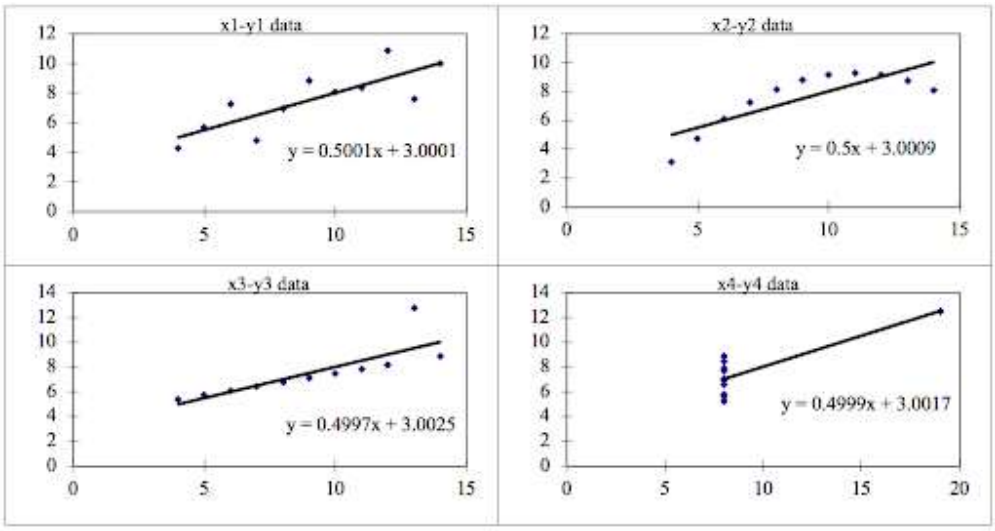
We can define these four plots as follows:

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 these four data sets is approximately similar. We can compute them 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	

However, when these models are plotted on a scatter plot, each data set generates a different kind of plot that isn't interpretable by any regression algorithm, as you can see below:



We can describe the four data sets as:

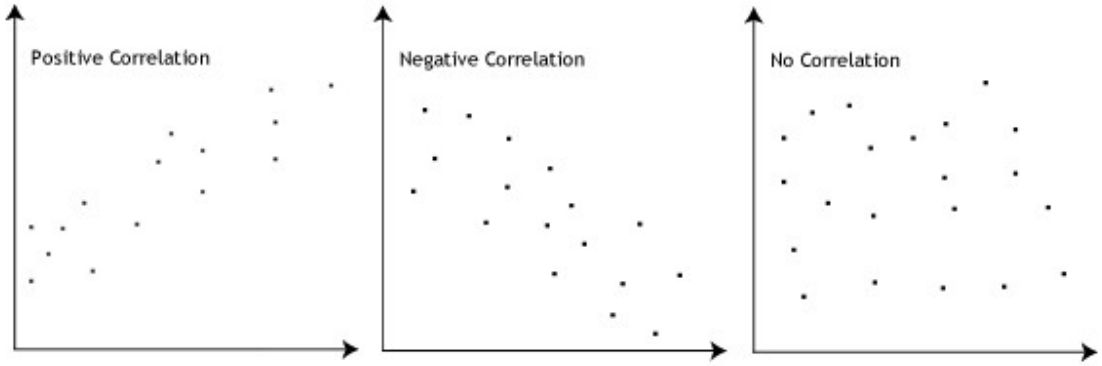
- Data Set 1: fits the linear regression model pretty well
- Data Set 2: cannot fit the linear regression model because the data is non-linear
- Data Set 3: shows the outliers involved in the data set, which cannot be handled by the linear regression model
- Data Set 4: shows the outliers involved in the data set, which also cannot be handled by the linear regression model

3. What is Pearson's R? (3 marks)

Ans. 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,

- =correlation coefficient
- =values of the x-variable in a sample
- =mean of the values of the x-variable
- =values of the y-variable in a sample
- =mean of the values of the y-variable

4. What is scaling? Why is scaling performed? What is the difference between normalized scalingand 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/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.

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

(3 marks)

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.

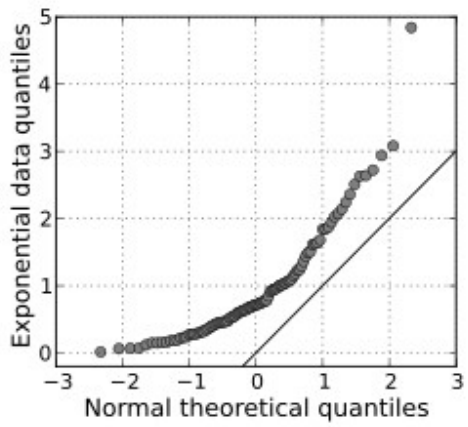
An infinite VIF value indicates that the corresponding variable may be expressed exactly by a linear combination of other variables (which show an infinite VIF as well).

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

(3 marks)

Ans. 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.