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)**

Answer: **Number of bikes rented is high:**

1.Season- Fall is the Top season where the number of bikes rented is high

2-Weather- The number of bikes rented is high when the weather is clear , few clouds

3.Weekdays-The number of bikes rented goes high during mid week.

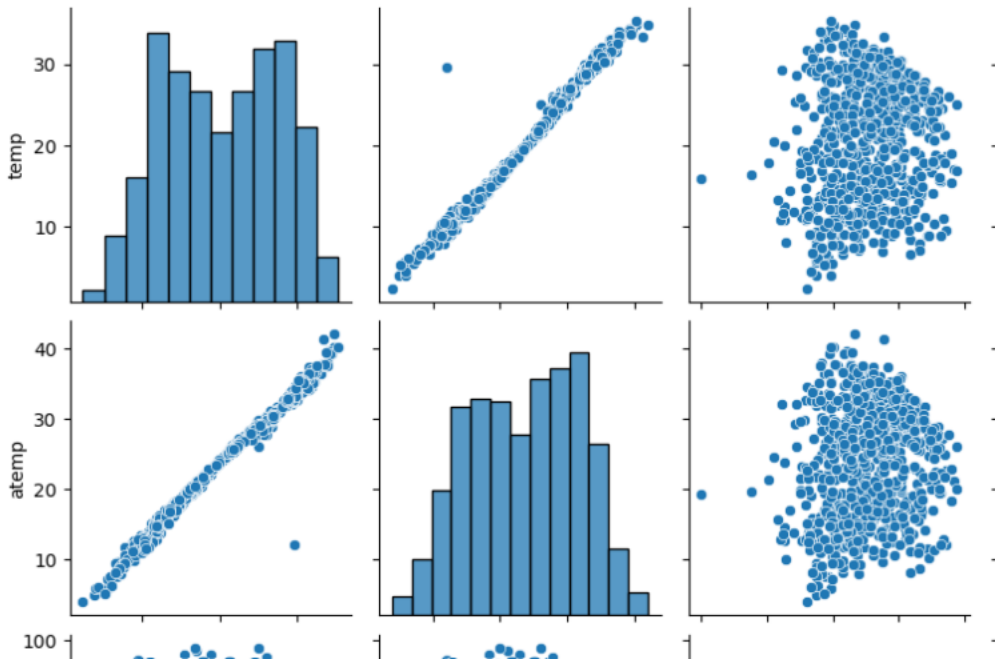
4. Month--The number of bikes rented goes high during mid year.

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. This may affect some modelsadversely and the effect is stronger when the cardinality is smaller. Hence,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.
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

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

from above graphs we can say that temp and atemp have a relationship.



4. **How did you validate the assumptions of Linear Regression after building the model on**

the training set? (3 marks)

We can validate the assumptions of Linear Regression after building the model on the following training set by below method:

1)Fitted regression line is linear.

2)Error terms came out normally distributed with mean as 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 changes of increasing the number of bikes being rented increases during the working day.
The demand for bikes on rent if negatively affected by windspeed
The demand for bikes on rent is high in Fall season
The demand of bikes on rent is high in clear weather.

General Subjective Questions

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

In simple terms, linear regression is a method of finding the best straight line fitting to the given data, i.e., finding the best linear relationship between the independent and dependent variables. In technical terms, linear regression is a machine learning algorithm that finds the best linear-fit relationship on any given data, between independent and dependent variables. It is mostly done by the Residual Sum of Squares Method. Linear Regression is a supervised machine learning algorithm where the predicted output is continuous and has a constant slope. It's used to predict values within a continuous range, (e.g. sales, price) rather than trying to classify them into categories (e.g. cat, dog). There are two main types: Simple regression: - Simple linear regression uses traditional slope-intercept form, where m and b are the variables our algorithm will try to "learn" to produce the most accurate predictions. x represents our input data and y represents our prediction. y=mx+by=mx+b Multivariable regression: - A more complex, multi-variable linear equation might look like this, where w represents the coefficients, or weights, our model will try to learn. f (x, y, z) =w1x+w2y+w3z The variables x,y,z represent the attributes, or distinct pieces of information, we have about each observation. For sales predictions, these attributes might include a company's advertising spend on radio, TV, and newspapers. Sales=w1Radio+w2TV+w3News

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

Answer: Anscombe's Quartet was developed by statistician **Francis Anscombe**. This is a method which keeps four datasets, each containing eleven (x, y) pairs. The important thing to note about these datasets is that they share the same descriptive statistics. Each graph tells a different story irrespective of their similar summary statistics. Below is the glimpse of the statistics of the 4 datasets:

	I		II		III		IV	
	x	y	x	y	x	y	x	y
	10	8,04	10	9,14	10	7,46	8	6,58
	8	6,95	8	8,14	8	6,77	8	5,76
	13	7,58	13	8,74	13	12,74	8	7,71
	9	8,81	9	8,77	9	7,11	8	8,84
	11	8,33	11	9,26	11	7,81	8	8,47
	14	9,96	14	8,1	14	8,84	8	7,04
	6	7,24	6	6,13	6	6,08	8	5,25
	4	4,26	4	3,1	4	5,39	19	12,5
	12	10,84	12	9,13	12	8,15	8	5,56
	7	4,82	7	7,26	7	6,42	8	7,91
	5	5,68	5	4,74	5	5,73	8	6,89
SUM	99,00	82,51	99,00	82,51	99,00	82,50	99,00	82,51
AVG	9,00	7,50	9,00	7,50	9,00	7,50	9,00	7,50
STDEV	3,32	2,03	3,32	2,03	3,32	2,03	3,32	2,03

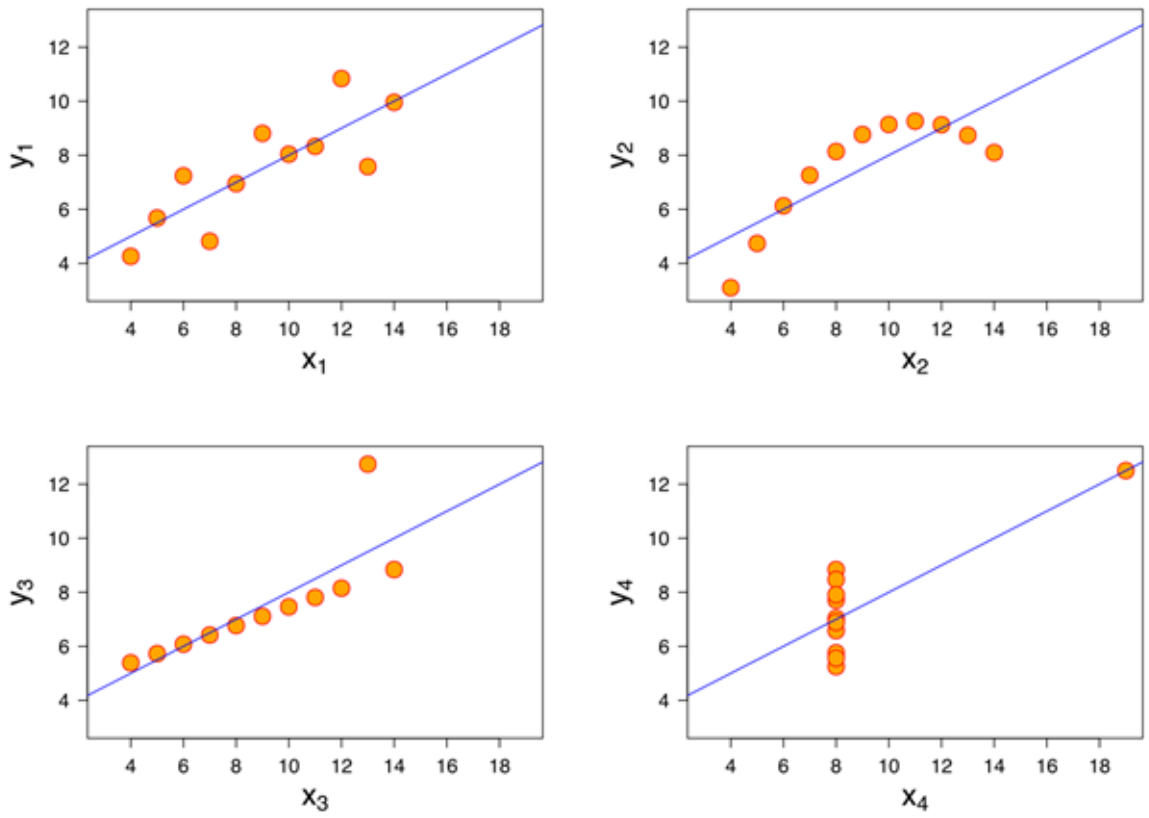
The summary statistics show that the means and the variances were identical for x and y across the groups:

Mean of x is 9 and mean of y is 7.50 for each dataset.

Similarly, the variance of x is 11 and variance of y is 4.13 for each dataset

The correlation coefficient (how strong a relationship is between two variables) between x and y is 0.816 for each dataset

When we plot these four datasets on an x/y coordinate plane, we can observe that they show the same regression lines as well but each dataset is telling a different story:



Dataset I appears to have clean and well-fitting linear models.

Dataset II is not distributed normally.

· In Dataset III the distribution is linear, but the calculated regression is thrown off by an outlier.

Dataset IV shows that one outlier is enough to produce a high correlation coefficient.

This quartet emphasizes the importance of visualization in Data Analysis. Looking at the data reveals a lot of the structure and a clear picture of the dataset.

Additionally, Anscombe's Quartet warns of the dangers of outliers in data sets.

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

Pearson's R was developed by **Karl Pearson** and it is a correlation coefficient which is a measure of the strength of a linear association between two variables and it is denoted by 'r'. it has a value between +1 and −1, where 1 is total positive linear correlation, 0 is no linear correlation, and −1 is total negative linear correlation.

Mathematically, Pearson's correlation coefficient is denoted as the covariance of the two variables divided by the product of their standard deviations. The form of the definition involves a "product moment", that is, the mean (the first moment about the origin) of the product of the mean-adjusted random variables; hence the modifier product-moment in the name.

Formula:

$$r = \frac{N\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{[N\Sigma x^2 - (\Sigma x)^2][N\Sigma y^2 - (\Sigma y)^2]}}$$

Where:

- N = number of pairs of scores
- Σxy = sum of the products of paired scores
- Σx = sum of x scores
- Σy = sum of y scores
- Σx^2 = sum of squared x scores
- Σy^2 = sum of squared y scores

Example:

· Statistically significant relationship between age and height.

· Relationship between temperature and ice cream sales.

· Relationship among job satisfaction, productivity, and income.

· Which two variables have the strongest co-relation between age, height, weight, size of family and family income.

4. **What is scaling? Why is scaling performed? What is the difference between normalized scalingand standardized scaling? (3 marks)**

Scaling is the process to normalize the data within a particular range. Many times, in our dataset we see that multiple variables are in different ranges. So, scaling is required to bring them all in a single range.

The two most discussed scaling methods are **Normalization** and **Standardization**. Normalization typically scales the values into a range of [0,1]. Standardization typically scales data to have a mean of 0 and a standard deviation of 1 (unit variance).

Formula of Normalized scaling:

$$x = \frac{x - min(x)}{max(x) - min(x)}$$

Formula of Standardized scaling:

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

Question 7: You might have observed that sometimes the value of VIF is infinite. Why does this happen?

Answer: The value of VIF is calculated by the below formula:

$$VIF_i = \frac{1}{1 - {R_i}^2}$$

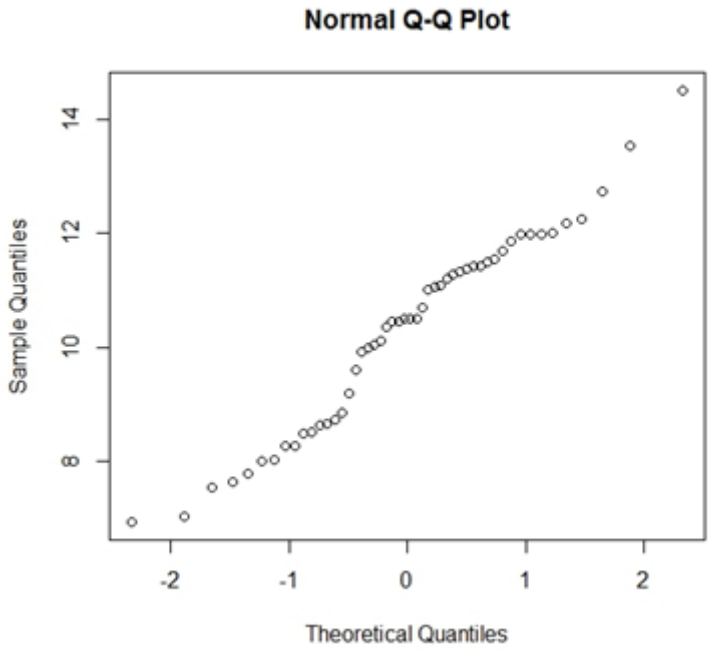
Where, 'i' refers to the ith variable.

If R-squared value is equal to 1 then the denominator of the above formula become 0 and the overall value become infinite. It denotes perfect correlation in variables.

5. **You might have observed that sometimes the value of VIF is infinite. Why does this happen? (3 marks)**
6. **What is a Q-Q plot? Explain the use and importance of a Q-Q plot in linear regression. (3 marks)**

The Q-Q plot or quantile-quantile plot is a graphical technique for determining if two data sets come from populations with a common distribution.

A Q-Q plot is a scatterplot created by plotting two sets of quantiles against one another. If both sets of quantiles came from the same distribution, we should see the points forming a line that's roughly straight. Here's an example of a Normal Q-Q plot when both sets of quantiles truly come from Normal distributions.



Use of Q-Q plot in Linear Regression: The Q-Q plot is used to see if the points lie approximately on the line. If they don't, it means, our residuals aren't Gaussian (Normal) and thus, our errors are also not Gaussian.

Importance of Q-Q plot: Below are the points:

I. The sample sizes do not need to be equal.

II. Many distributional aspects can be simultaneously tested. For example, shifts in location, shifts in scale, changes in symmetry, and the presence of outliers.

III. The q-q plot can provide more insight into the nature of the difference than analytical methods.