Subjective Questions

Assignment-based Subjective Questions

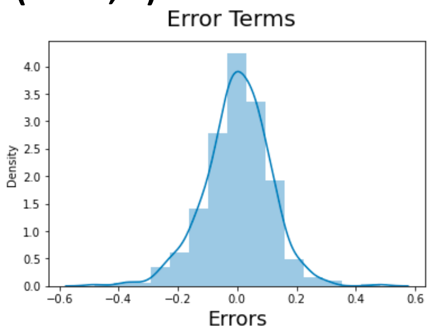
1. From your analysis of the categorical variables from the dataset, what could you infer about their effect on the dependent variable? (3 marks)
    - ‘**season**’ is a **strong driver variable** – maximum bikes are rented in the season 3(fall), followed by 2(summer), 4(winter), 1(spring)
    - ‘**weathersit**’ is a **strong driver variable** – more bikes are rented in weathersit 1(Clear, Few clouds, Partly cloudy, Partly cloudy), followed by 2(Mist + Cloudy, Mist + Broken clouds, Mist + Few clouds, Mist) and 3(Light Snow, Light Rain + Thunderstorm + Scattered clouds, Light Rain + Scattered clouds)
    - People rented more bikes on an average in the **year 1(2019) than year 0(2018)**
    - People rented more bikes during the **months 7,9,6,8 than the other months**
    - People rented more bikes on **non-holidays than holidays**
    - ‘**weekday**’ has little to no effect on the target variable
    - ‘**workingday**’ has little to no effect on the target variable

2. Why is it important to use drop_first=True during dummy variable creation? (2 mark)
    - When we have a **categorical variable** with say '**n**' levels, the idea of dummy variable creation is to build '**n-1**' variables, indicating the levels
    - We can drop one of the levels as all the **information** can still be **retained**
    - In **pandas**, using “drop_first=True”, informs the library to **drop the first level**

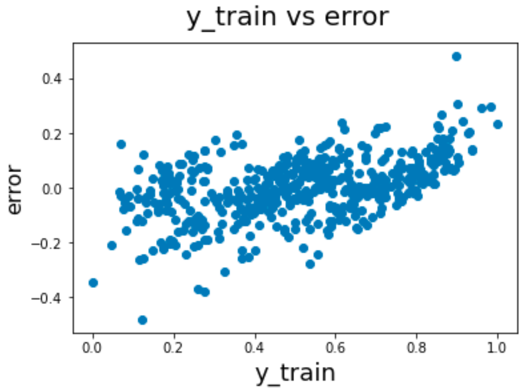
3. Looking at the pair-plot among the numerical variables, which one has the highest correlation with the target variable? (1 mark)
    - **atemp (0.65)**

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

- Assumption 1: **There is a *linear relationship* between X and Y:**
  i. By looking at the correlation values between feature variables, X and target Y
  ii. By making sure the p-values of the features are not significantly high in the linear models
- Assumption 2: **Error terms are *normally distributed* with mean zero(not X, Y):**
  I. By plotting the distribution of the errors



- Assumption 3: **Error terms are *independent* of each other:**
  i. By Plotting y_train vs error



- Assumption 4: **Error terms have *constant variance* (homoscedasticity):**
  - By plotting X vs y with the regression line
  - Not possible since the model is multi-linear and the regression line is a hyperplane
- Assumption 5: No assumptions on the distribution of X or y
  - No assumptions of X or y were considered in model building

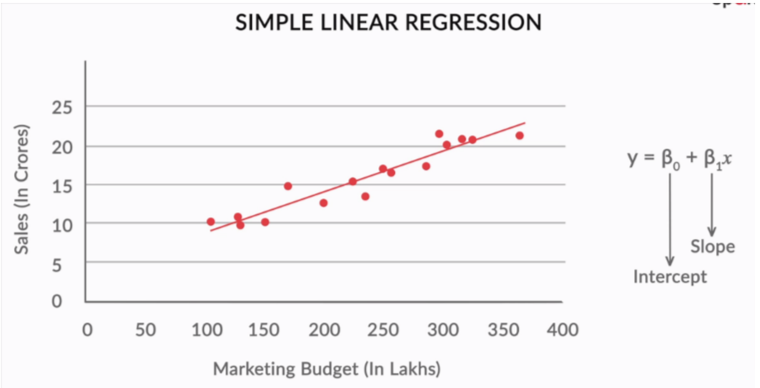
5. Based on the final model, which are the top 3 features contributing significantly towards explaining the demand of the shared bikes?

- **season_3 (fall) : (0.31)**
- **weathersit_3 (Light snow, …) : (-0.29)**
- **season_2 (summer) : (0.25)**

General Subjective Questions

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

- Belongs to **Supervised** learning technique
- As the name says, the output/target variable is **continuous** in nature
- A linear regression model attempts to explain the relationship between one or more dependent variables and an independent variable using a **regression line**
- The regression line or the best-fit line is a **straight line** in case of Simple Linear Regression and a **hyperplane** in case of Multiple Linear Regression.
- The best-fit line is found by **minimising the cost function, expression of RSS** (Residual Sum of Squares) which is equal to the sum of squares of the residual for each data point.
- A simple Linear Regression is given by the equation:



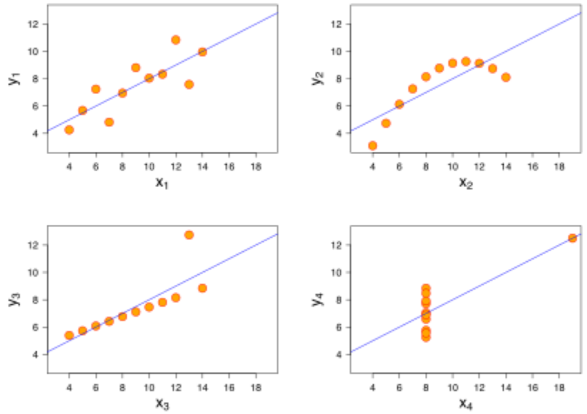
- A Multiple linear Regression is given by the equation:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p + \epsilon$$

- The strength of the linear regression model can be measured using 2 metrics:
  1. **R^2** or Coefficient of Determination
  2. **Residual Standard Error (RSE)**
- Linear Regression models can be **interpreted** using the coefficients
  - Ex: If X increases by a unit of 1, y increases by a unit of B(beta) 1

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

- **Anscombe's quartet** comprises four data sets that have nearly identical simple descriptive statistics, yet have very **different distributions** and **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** when analyzing it, and **the effect of outliers** and other influential observations on statistical properties.



- The first scatter plot (top left) appears to be a **simple linear relationship**, corresponding to two variables correlated where y could be modelled as gaussian with mean linearly dependent on *x*.
- The second graph (top right); while a relationship between the two variables is obvious, it is **not linear**, and the Pearson correlation coefficient is not relevant. A more general regression and the corresponding coefficient of determination would be more appropriate.
- In the third graph (bottom left), the modelled relationship is **linear**, but should have a different regression line (a robust regression would have been called for). The calculated regression is **offset by the one outlier** which exerts enough influence to lower the correlation coefficient from 1 to 0.816.
- Finally, the fourth graph (bottom right) shows an example when **one high-leverage point is enough to produce a high correlation coefficient**, even though the other data points do not indicate any relationship between the variables.

3. What is Pearson’s R? (3 marks)

- In statistics, Pearson's *r*, or the correlation coefficient is a **measure of linear correlation** between two sets of data.
- It is the ratio between the covariance of two variables and the product of their standard deviations; thus, it is essentially a normalized measurement of the covariance, such that the result always has a value between **−1 and 1**.
- As with covariance itself, the measure can only reflect a **linear correlation** of variables, and ignores many other types of relationships or correlations.

$$\rho_{X,Y} = \frac{\operatorname{cov}(X,Y)}{\sigma_X \sigma_Y}$$

- A **positive value** means the two variables are **directly proportional** and a **negative value** means that they are **inversely proportional** to each other

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

- Scaling is a technique to **standardize** the independent features present in the data to a **fixed range**. It is performed during the data pre-processing to handle **highly varying** magnitudes or values or units.
- If feature scaling is not done, then a machine learning algorithm tends to weigh greater values, higher and consider smaller values as the lower values, regardless of the unit of the values.
- Also, in cases like MLR, **without scaling, it is impossible to understand & interpret multiple coefficients**
- Difference: In **normalized scaling**, the feature values are rescaled to **range between 0 and 1**, whereas in **standardized scaling**, the values are rescaled such that they are **centered around the mean with a unit standard deviation**, i.e., mean = 0 and standard deviation = 1.

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

- VIF calculates how well **one independent variable is explained by all the other independent variables combined**, excluding the target variable
- A large value of VIF indicates that there is a **strong correlation** between the variables (multi-collinearity)
- If there is **perfect correlation**, then VIF = infinity.
- It means the **variances of the feature are perfectly explained** by a combination of other independent features
- i.e., the feature under consideration is not an independent variable and can be derived perfectly from other features

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

- In statistics, a **Q–Q plot** (**quantile-quantile plot**) is a probability plot,
- a graphical method for **comparing two probability distributions by plotting their *quantiles* against each other**.
- A point (x, y) on the plot corresponds to one of the quantiles of the second distribution (y-coordinate) plotted against the same quantile of the first distribution (x-coordinate). This defines a parametric curve where the parameter is the index of the quantile interval.
- If the two distributions being compared are **similar**, the points in the Q–Q plot will approximately lie on the identity 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 $y = x$.
- **Importance**: As the Q-Q plot answers if two distributed are linearly related, it can be used in **feature selection** of building linear regression models. If Q-Q plot of a feature with the target variable is linearly related, then the feature is good candidate for model.
- Example of two linearly related distributions