Bike Sharing Demand Prediction

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ABSTRACT:

A bike-sharing system is a service in which bikes are made available for shared use to individuals on a short term basis for a price or free. Many bike share systems allow people to borrow a bike from a "dock" which is usually computer-controlled wherein the user enters the payment information, and the system unlocks it. This bike can then be returned to another dock belonging to the same system. Rental Bike Sharing is the process by which bicycles are procured on several basis- hourly, weekly, membership-wise, etc. This phenomenon has seen its stock rise to considerable levels due to a global effort towards reducing the carbon footprint, leading to climate change, unprecedented natural disasters, ozone layer depletion, and other environmental anomalies. In our project, we chose to analyse a dataset pertaining to Rental Bike Demand from South Korean city of Seoul, comprising of climatic variables like Temperature, Humidity, Rainfall, Snowfall, Dew Point Temperature, and others. For the available raw data, firstly, a through pre-processing was done after which a Here, hourly rental bike count is the regress and. To an extent, our linear model was able to explain the factors orchestrating the hourly demand of rental bikes.

Keywords- Bike sharing demand prediction, exploratory data analysis, feature engineering, Retention, Higher Subscriber Base, Telecommunication, Data mining

INTRODUCTION:

According to recent studies, it is expected that more than 60% of the population in the world tends to dwell in cities, which is higher than 50% of the present scenario. Some countries around the world are practising righteous scenarios, renderings mobility at a fair cost and reduced carbon discharge. On the contrary other cities are far behind in the track. Urban mobility usually fills 64% of the entire kilometres travelled in the world. It ought to be modelled and taken over by inter-modality and networked self-driving vehicles which also provides a sustainable means of mobility. Systems called Mobility on Demand has a vital part in raising the vehicles' supply, increasing its idle time and numbers.

Bike-sharing MOD systems are already firmly holding the effective part in short commuting and as 'last mile' mobility resources on inter-modal trips in several cities. Certain issues prevail in the maintenance, design, and management of bike-sharing systems: layout of the station design; fleet size and capacity of the station; detecting broken, lost, or theft bikes; pricing; monitoring of traffic and customer activities to promote behaviour virtuously; and marketing using campaigns etc. System balancing is the hardest endeavour: In the daytime, some stations are likely to be crowded with bike flow, while leaving other stations empty, which hampers pick-up and drop-off, respectively. So, to restore the balance,

several manual techniques, like shifting bikes through trucks, cars and even by volunteers are employed. Data analysis techniques and studies focus on dynamic systems and optimisation methods are utilised for complementing the knowledge base of employing optimum rebalancing policies.

Today, bike-sharing systems are blooming across more cities around the world. To complete a short trip renting a bike is a faster way when compared to walking. Moreover, it is eco-friendly and comfortable too compared to driving.

PROBLEM STATEMENT:

Maximize: The availability of bikes to the customer.

Minimize: Minimise the time of waiting to get a bike on rent.

The main goal of the project is to:
Finding factors and cause those influence shortage of bike and time delay of availing bike on rent. Using the data provided, this paper aims to analyse the data to determine what variables are correlated with customer churn, if any. Hourly count of bike for rent will also be predicted.

DATA DESCRIPTION:

The data description phase starts with an initial data collection and proceeds with activities in order to get familiar with the data. Identifying data quality problems, discovering first insights into the data and detecting interesting subsets to form hypotheses from hidden information are activities of this step. Data which is collected from a rented bike provider company form Seoul to get analysed, involves usage details of customers from. The data was taken from rented bike Provider Company. It has 8760 rows and 14 columns. Most columns related to hourly bike count for rent. Other column was indicative of weather condition affecting bike count per hour.

DATASET PREPARATION:

The bike sharing demand prediction dataset from rented bike provider company from Seoul contains 14 features and 8760 observations of a complete year I.e. from 1.12.2017 to 31.11.2018. Below Table shows the data features.

Data-set description

Feature Name	Type
Date : year-month-day	Date
Rented Bike Count	Int64
Hour	Int64
Temperature(°C)	Float64
Humidity (%)	Int64
Wind speed (m/s)	Float64
Visibility (10m)	Int64
Dew Point temperature (°C)	Float64
Solar Radiation (MJ/m2)	Float64
Rainfall (mm)	Float64
Snowfall(cm)	Float64
Seasons	Object
Holiday	Object
Functioning day	Object

FEATURE BREAKDOWN:

Date: The date of the day, during 365 days from 01/12/2017 to 30/11/2018, formatting in DD/MM/YYYY, *we need to convert into date-time format.*

Rented Bike Count: Number of rented bikes per hour which our dependent variable and we need to predict that

Hour: The hour of the day, starting from 0-23 it's in a digital time format

Temperature (°C): Temperature of the weather in Celsius and it varies from -17°C to 39.4°C.

Humidity (%): Availability of Humidity in the air during the booking and ranges from 0 to 98%.

Wind speed (m/s): Speed of the wind while booking and ranges from 0 to 7.4m/s.

Visibility (10m): Visibility to the eyes during driving in "m" and ranges from 27m to 2000m.

Dew point temperature (°C):Temperature At the beginning of the day and it ranges from -30.6°C to 27.2°C.

Solar Radiation (MJ/m2): Sun contribution or solar radiation during ride booking which varies from 0 to 3.5 MJ/m2.

Rainfall (mm): The amount of rainfall during bike booking which ranges from 0 to 35mm.

Snowfall (cm): Amount of snowing in cm during the booking in cm and ranges from 0 to 8.8 cm.

Seasons: Seasons of the year and total there are 4 distinct seasons I.e. summer, autumn, spring and winter.

Holiday: If the day is holiday period or not and there are 2 types of data that is holiday and no holiday

Functioning Day: If the day is a Functioning Day or not and it contains object data type yes and no.

EXPLORATORY DATA ANALYSIS:

If we want to explain EDA in simple terms, it means trying to understand the given data much better, so that we can make some sense out of it. we using univariate frequency analysis was conducted to describe key characteristics of each feature including, minimum and maximum value, average, standard deviation and others. It was also used to produce a value distribution and identify missing values, and outliers.

EDA is a process of examining the available dataset to discover patterns, spot anomalies, test hypotheses, and check assumptions using statistical measures. In this chapter, we are going to discuss the steps involved in performing top notch exploratory data analysis

In statistics, A statistical model can be used or not, but primarily EDA is for seeing what the data can tell us beyond the formal modelling or hypothesis testing tasked in Python uses data visualization to draw meaningful patterns and insights

- **DATA ANALYSIS:**

This is one of the most crucial steps that deals with descriptive statistics and analysis of the data. The main tasks involve summarizing the data, finding the hidden correlation and relationships among the data, developing predictive models, evaluating the models, and calculating the accuracies. Some of the techniques used for data summarization are summary tables, graphs, descriptive statistics, inferential statistics, correlation statistics, searching, grouping, and mathematical models.

- **DATA SOURCING**

Data Sourcing is the process of finding and loading the data into our system. Broadly

there are two ways in which we can find data.

1. Private Data
2. Public Data

Data collected from several sources must be stored in the correct format and transferred to the right information technology personnel within a company. As mentioned previously, data can be collected from several objects on several events using different types of sensors and storage tools.

- **DATA PREPROCESSING:**

A dataset may contain noise, missing values, and inconsistent data, thus, pre-processing of data is essential to improve the quality of data and time required in the data mining.

- **DATA CLEANING**

After completing the Data Sourcing, the next step in the process of EDA is Data Cleaning. It is very important to get rid of the irregularities and clean the data after sourcing it into our system.

Irregularities are of different types of data.

- Missing Values
- Incorrect Format
- Incorrect Headers
- Anomalies/Outliers

- **DATA TRANSFORMATION:**

Data transformation is the process of normalizing and aggregating the data to further improve the efficiency and accuracy of data mining.

- **DATA DEDUPLICATION:**

It is very likely that your dataset contains duplicate rows. Removing them is essential to enhance the quality of the dataset.

- **MISSING VALUES:**

There is a representation of each service and product for each customer. Missing values may occur because not all customers have the same subscription. Some of them may have a number of service and others may have something different. In addition, there are some columns related to system configurations and these columns may have null values but in our orange telecom data set there are no null values present

If there are missing values in the Dataset before doing any statistical analysis, we need to handle those missing values.

There are mainly three types of missing values.

1. MCAR (Missing completely at random): These values do not depend on any other features.
2. MAR (Missing at random): These values may be dependent on some other features.

MNAR (Missing not at random): These missing values have some reason for why they are missing.

- **DROPPING MISSING VALUES:**

One of the ways to handle missing values is to simply remove them from our dataset. We have knew that we can use the isnull() and notnull() functions from the pandas library to determine null values

- **HANDLING OUTLIERS:**

Outliers are data points that diverge from other observations for several reasons. During the EDA phase, one of our common tasks is to detect and filter these outliers. The main reason for this detection and filtering of outliers is that the presence of

such outliers can cause serious issues in statistical analysis.

There are two types of outliers:

- **UNIVARIATE OUTLIERS:**

Univariate outliers are the data points whose values lie beyond the range of expected values based on one variable.

- **MULTIVARIATE OUTLIERS:**

While plotting data, some values of one variable may not lie beyond the expected range, but when you plot the data with some other variable, these values may lie far from the expected value.

- **MEASURES OF CENTRAL TENDENCY:**

The measure of central tendency tends to describe the average or mean value of datasets that is supposed to provide an optimal summarization of the entire set of measurements. This value is a number that is in some way central to the set. The most common measures for analysing the distribution frequency of data are the mean, median, and mode.

- **MEASURES OF DISPERSION**:

The second type of descriptive statistics is the measure of dispersion, also known as a measure of variability. If we are analyzing the dataset closely, sometimes, the mean/average might not be the best representation of the data because it will vary when there are large variations between the data. In such a case, a measure of dispersion will represent the variability in a dataset much more accurately.

Multiple techniques provide the measures of dispersion in our dataset. Some commonly used methods are standard deviation (or variance), the minimum and maximum values of the variables, range, kurtosis, and skewness.

- **STANDARDIZING VALUES:**

To perform data analysis on a set of values, we have to make sure the values in the same column should be on the same scale. For example, if the data contains the values of the top speed of different companies' cars, then the whole column should be either in meters/sec scale or miles/sec scale.

- **UNIVARIATE ANALYSIS:**

If we analyse data over a single variable/column from a dataset, it is known as Univariate Analysis. Univariate analysis looks at one feature at a time. When we analyse a feature independently, we are usually mostly interested in the distribution of its values and ignore other features in the dataset

Univariate analysis is the simplest form of analysing data. It means that our data has only one type of variable and that we perform analysis over it. The main purpose of univariate analysis is to take data, summarize that data, and find patterns among the values. It doesn't deal with causes or relationships between the values. Several techniques that describe the patterns found in univariate data include central tendency (that is the mean, mode, and median) and dispersion (that is, the range, variance, maximum and minimum quartiles (including the interquartile range), and standard deviation).

- **BIVARIATE ANALYSIS:**

If we analyse data by taking two variables/columns into consideration from a dataset, it is known as Bivariate Analysis.

- **a)Numeric-Numeric Analysis:**

Analysing the two numeric variables from a dataset is known as numeric-numeric analysis. We can analyse it in three different ways.

- Scatter Plot
- Pair Plot
- Correlation Matrix

- **b) Numeric - Categorical Analysis:**

Analysing the one numeric variable and one categorical variable from a dataset is known as numeric-categorical analysis. We analyse those mainly using mean, median, and box plots.

- **MULTIVARIATE ANALYSIS:**

Multivariate analysis is the analysis of three or more variables. This allows us to look at correlations (that is, how one variable changes with respect to another) and attempt to make predictions for future behaviour more accurately than with bivariate analysis.

One common way of plotting multivariate data is to make a matrix scatter plot, known as a pair plot. A matrix plot or pair plot shows each pair of variables plotted against each other. The pair plot allows us to see both the distribution of single variables and the relationships between two variables

- **CORRELATION AMONG VARIABLES**:

In words, the statistical technique that examines the relationship and explains whether, and how strongly, pairs of variables are related to one another is known as correlation. Correlation answers questions such as how one variable changes with respect to another. If it does change, then to what degree or strength? Additionally, if the relation between those variables is strong enough, then we can make predictions for future behaviour

- **GRAPHICAL REPRESENTATION OF THE RESULTS:**

This step involves presenting the dataset to the target audience in the form of graphs, summary tables, maps, and diagrams. This is also an essential step as the result analysed from the dataset should be interpretable by the business stakeholders, which is one of the major goals of EDA. Most of the graphical analysis techniques include Line chart, Bar chart, Scatter plot, Area plot, and stacked plot Pie chart, Table chart, Polar chart, Histogram, Lollipop chart etc.

ALGORITHMS:

1. LINEAR REGRESSION:

Linear regression is a supervised machine learning model majorly used in forecasting. Supervised machine learning models are those where we use the training data to build the model and then test the accuracy of the model using the loss function.

Linear regression is one of the most widely known time series forecasting techniques which is used for predictive modelling. As the name suggests, it assumes a linear relationship between a set of independent variables to that of the dependent variable (the variable of interest).

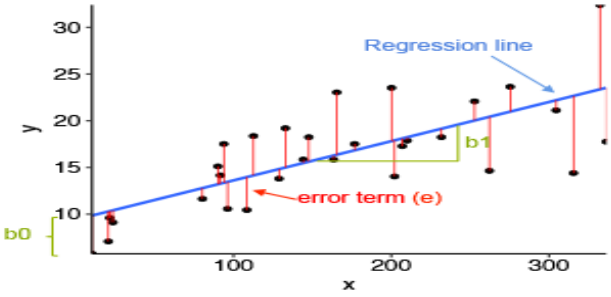
We're going to fit a line

$$y = \beta 0 + \beta 1 x$$

to our data. Here, x is called the independent variable or predictor variable, and y is called the dependent variable or response variable. Before we talk about how to do the fit, let's take a closer look at the important quantities from the fit:

• β1 is the slope of the line: this is one of the most important quantities in any linear regression analysis

• β0 is the intercept of the line.



2. RIDGE REGRESSION:

Ridge regression is a model tuning method that is used to analyse any data that suffers from multicollinearity. This method performs L2 regularization. When the issue of multicollinearity occurs, least-squares are unbiased, and variances are large, this results in predicted values to be far away from the actual values.

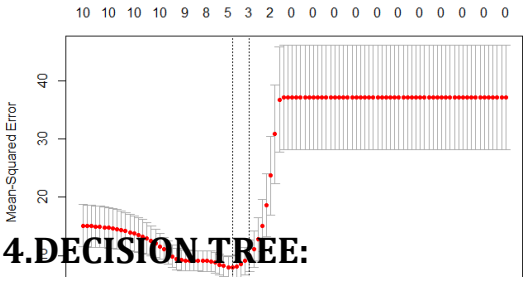
we have concluded that we would like to decrease the model complexity, that is the number of predictors. We could use the forward or backward selection for this, but that way we would not be able to tell anything about the removed variables' effect on the response. Removing predictors from the model can be seen as settings their coefficients to zero. Instead of forcing them to be exactly zero, let's penalize them if they are too far from zero, thus enforcing them to be small in a continuous way. This way, we decrease model complexity while keeping all variables in the model. This, basically, is what Ridge Regression does.

$$L_{ridge}(\hat{\beta}) = \sum_{i=1}^{n}(y_i - x_i'\hat{\beta})^2 + \lambda\sum_{j=1}^{m}\hat{\beta}_j^2 = ||y - X\hat{\beta}||^2 + \lambda||\hat{\beta}||^2.$$

3. LASSO REGRESSION:

Lasso, or Least Absolute Shrinkage and Selection Operator, is quite similar conceptually to ridge regression. It also adds a penalty for non-zero coefficients, but unlike ridge regression which penalizes sum of squared coefficients (the so-called L2 penalty), lasso penalizes the sum of their absolute values (L1 penalty). As a result, for high values of λ, many coefficients are exactly zeroed under lasso, which is never the case in ridge regression. The only difference in ridge and lasso loss functions is in the penalty terms. Under lasso, the loss is defined as:

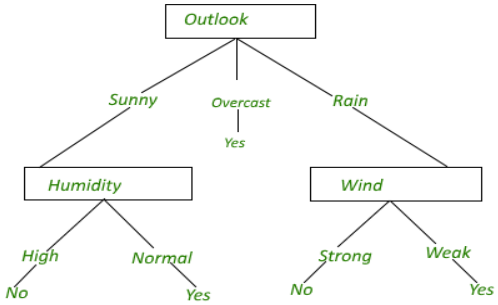
$$L_{lasso}(\hat{\beta}) = \sum_{i-1}^{n}(y_i - x_i'\hat{\beta})^2 + \lambda\sum_{j-1}^{m}|\hat{\beta}_j|.$$



4.DECISION TREE:

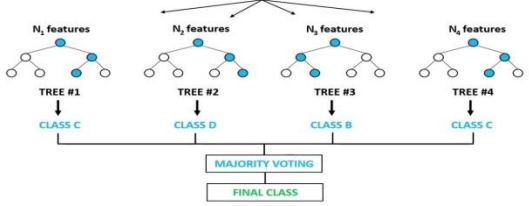
Decision tree is the most powerful and popular tool for classification and prediction. A Decision tree is a flowchart like tree structure, where each internal node denotes a test on an attribute, each branch represents an outcome of the test, and each leaf node (terminal node) holds a class label. A tree can be *"learned"* by

splitting the source set into subsets based on an attribute value test. This process is repeated on each derived subset in a recursive manner called *recursive partitioning*. Decision trees classify instances by sorting them down the tree from the root to some leaf node, which provides the classification of the instance. An instance is classified by starting at the root node of the tree, testing the attribute specified by this node, and then moving down the tree branch corresponding to the value of the attribute as shown in the above figure. This process is then repeated for the subtree rooted at the new node.



5. RANDOM FOREST:

Random Forest is a bagging type of Decision Tree Algorithm that creates a number of decision trees from a randomly selected subset of the training set, collects the labels from these subsets and then averages the final prediction depending on the most number of times a label has been predicted out of all.



6. GRADIENT BOOSTING:

The term gradient boosting consists of two sub-terms, gradient and boosting. We already know that gradient boosting is a boosting technique. Let us see how the term 'gradient' is related here.

Gradient boosting re-defines boosting as a numerical optimisation problem where the objective is to minimise the loss function of the model by adding weak learners using gradient descent. Gradient descent is a first-order iterative optimisation algorithm for finding a local minimum of a differentiable function. As gradient boosting is based on minimising a loss function, different types of loss functions can be used resulting in a flexible technique that can be applied to regression, multi-class classification, etc

CONCLUSIONS:

Bicycle sharing systems can be the new boom in India, with use of various prediction models the ease of operations will be increased. The four algorithms are applied on the bike share dataset for predicting the count of bicycles that will be rented per hour. We got some good results and accuracy with random forest. The accuracy and performance has been compared between the models using Root Mean Squared Error (RMSE), Mean Squared Error (MSE), Mean Absolute Error (MAE), R2 and Adjusted R2. If these systems include the use of analytics the probability of building a successful system will increase

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