# CMPE 257: Machine Learning

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## Bike Sharing Demand Prediction

### With Following Classifiers

- Random Forest
- Decision Tree
- RBF SVM
- Lineat SVM
- AdaBoost
- Neural Net

Bike sharing systems have gained immense popularity in urban settings, offering a convenient and eco-friendly transportation alternative. These modern bike rentals have automated the entire process—from membership and rental to return—allowing users to easily rent a bike from one location and return it to another.

Given the increasing role of bike-sharing systems in addressing traffic congestion, environmental concerns, and public health, predicting bike demand has become crucial for effective city planning. Each team member has performarmed multiple classifications to achieve the optimal amalgamation outcome.

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import csv
```

## Importing all dataasets

### Data Wrangling

```
datasetUrl1 = 'https://drive.google.com/file/d/10wKdg9HnqQ_o9UZatlAsTMfiIpg8NtMq'
datasetUrl1 ='https://drive.google.com/uc?id=' + datasetUrl1.split('/')[-1]
data1 = pd.read_csv(datasetUrl1)
data1.head(10)
```

| | instant | dteday | season | yr | mnth | hr | holiday | weekday | workingday | weathe |
|---|---|---|---|---|---|---|---|---|---|---|

```
datasetUrl2 = 'https://drive.google.com/file/d/1yVL1fUAfZ5ktpPbaAAF8zQrLlBAicgN7'
datasetUrl2 ='https://drive.google.com/uc?id=' + datasetUrl2.split('/')[-1]
data2 = pd.read_csv(datasetUrl2, encoding_errors='ignore')
data2.head(10)
```

| | Date | Rented Bike Count | Hour | Temperature(C) | Humidity(%) | Wind speed (m/s) | Visibility (10m) | te |
|---|---|---|---|---|---|---|---|---|
| **0** | 01/12/2017 | 254 | 0 | -5.2 | 37 | 2.2 | 2000 | |
| **1** | 01/12/2017 | 204 | 1 | -5.5 | 38 | 0.8 | 2000 | |
| **2** | 01/12/2017 | 173 | 2 | -6.0 | 39 | 1.0 | 2000 | |
| **3** | 01/12/2017 | 107 | 3 | -6.2 | 40 | 0.9 | 2000 | |
| **4** | 01/12/2017 | 78 | 4 | -6.0 | 36 | 2.3 | 2000 | |
| **5** | 01/12/2017 | 100 | 5 | -6.4 | 37 | 1.5 | 2000 | |
| **6** | 01/12/2017 | 181 | 6 | -6.6 | 35 | 1.3 | 2000 | |
| **7** | 01/12/2017 | 460 | 7 | -7.4 | 38 | 0.9 | 2000 | |
| **8** | 01/12/2017 | 930 | 8 | -7.6 | 37 | 1.1 | 2000 | |
| **9** | 01/12/2017 | 490 | 9 | -6.5 | 27 | 0.5 | 1928 | |

```
data2['year'] = data2['Date'].str.split('/').str[2]
```

```
data1['year'] = data1['dteday'].str.split('-').str[0]
```

```
data1.head(10)
```

| | instant | dteday | season | yr | mnth | hr | holiday | weekday | workingday | weathe |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1 | 2011-01-01 | 1 | 0 | 1 | 0 | 0 | 6 | 0 | |
| **1** | 2 | 2011-01-01 | 1 | 0 | 1 | 1 | 0 | 6 | 0 | |
| **2** | 3 | 2011-01-01 | 1 | 0 | 1 | 2 | 0 | 6 | 0 | |
| **3** | 4 | 2011-01-01 | 1 | 0 | 1 | 3 | 0 | 6 | 0 | |
| **4** | 5 | 2011-01-01 | 1 | 0 | 1 | 4 | 0 | 6 | 0 | |
| **5** | 6 | 2011-01-01 | 1 | 0 | 1 | 5 | 0 | 6 | 0 | |
| | | 2011- | | | | | | | | |

```
data2.head(10)
```

| | Date | Rented Bike Count | Hour | Temperature(C) | Humidity(%) | Wind speed (m/s) | Visibility (10m) | te |
|---|---|---|---|---|---|---|---|---|
| **0** | 01/12/2017 | 254 | 0 | -5.2 | 37 | 2.2 | 2000 | |
| **1** | 01/12/2017 | 204 | 1 | -5.5 | 38 | 0.8 | 2000 | |
| **2** | 01/12/2017 | 173 | 2 | -6.0 | 39 | 1.0 | 2000 | |
| **3** | 01/12/2017 | 107 | 3 | -6.2 | 40 | 0.9 | 2000 | |
| **4** | 01/12/2017 | 78 | 4 | -6.0 | 36 | 2.3 | 2000 | |
| **5** | 01/12/2017 | 100 | 5 | -6.4 | 37 | 1.5 | 2000 | |

```
data2 = data2.drop(['Date', 'Rainfall(mm)','Snowfall (cm)','Seasons','Holiday'], axis = 1)
```

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **6** | 01/12/2017 | 181 | 6 | -6.6 | 35 | 1.3 | 2000 | |

```
data1 = data1.drop(['workingday','holiday','weathersit','yr'], axis = 1)
```

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **7** | 01/12/2017 | 460 | 7 | -7.4 | 38 | 0.9 | 2000 | |

```
data1.head(10)
```

| | instant | dteday | season | mnth | hr | weekday | temp | atemp | hum | windspeed | ca |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1 | 2011-01-01 | 1 | 1 | 0 | 6 | 0.24 | 0.2879 | 0.81 | 0.0000 | |
| **1** | 2 | 2011-01-01 | 1 | 1 | 1 | 6 | 0.22 | 0.2727 | 0.80 | 0.0000 | |
| **2** | 3 | 2011-01-01 | 1 | 1 | 2 | 6 | 0.22 | 0.2727 | 0.80 | 0.0000 | |
| **3** | 4 | 2011-01-01 | 1 | 1 | 3 | 6 | 0.24 | 0.2879 | 0.75 | 0.0000 | |
| **4** | 5 | 2011-01-01 | 1 | 1 | 4 | 6 | 0.24 | 0.2879 | 0.75 | 0.0000 | |
| **5** | 6 | 2011-01-01 | 1 | 1 | 5 | 6 | 0.24 | 0.2576 | 0.75 | 0.0896 | |

```
data2.head(10)
```

| | Rented Bike Count | Hour | Temperature(C) | Humidity(%) | Wind speed (m/s) | Visibility (10m) | Dew poi temperature( |
|---|---|---|---|---|---|---|---|
| **0** | 254 | 0 | -5.2 | 37 | 2.2 | 2000 | -1 |
| **1** | 204 | 1 | -5.5 | 38 | 0.8 | 2000 | -1 |
| **2** | 173 | 2 | -6.0 | 39 | 1.0 | 2000 | -1 |
| **3** | 107 | 3 | -6.2 | 40 | 0.9 | 2000 | -1 |
| **4** | 78 | 4 | -6.0 | 36 | 2.3 | 2000 | -1 |
| **5** | 100 | 5 | -6.4 | 37 | 1.5 | 2000 | -1 |
| **6** | 181 | 6 | -6.6 | 35 | 1.3 | 2000 | -1 |
| **7** | 460 | 7 | -7.4 | 38 | 0.9 | 2000 | -1 |
| **8** | 930 | 8 | -7.6 | 37 | 1.1 | 2000 | -1 |

```
data1.rename(columns = {'hr':'Hour','windspeed':'Wind speed (m/s)','zip_code':'zipcode', 'num_bedrooms':'bedrooms','yr':'year'}, i
```

```
data1.head(10)
```

| | instant | dteday | season | mnth | Hour | weekday | temp | atemp | hum | Wind speed (m/s) | casu |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1 | 2011-01-01 | 1 | 1 | 0 | 6 | 0.24 | 0.2879 | 0.81 | 0.0000 | |
| **1** | 2 | 2011-01-01 | 1 | 1 | 1 | 6 | 0.22 | 0.2727 | 0.80 | 0.0000 | |
| **2** | 3 | 2011-01-01 | 1 | 1 | 2 | 6 | 0.22 | 0.2727 | 0.80 | 0.0000 | |
| **3** | 4 | 2011-01-01 | 1 | 1 | 3 | 6 | 0.24 | 0.2879 | 0.75 | 0.0000 | |

```
df = data1.merge(data2, on = ['Hour','Wind speed (m/s)'], how = 'outer')
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 31759 entries, 0 to 31758
Data columns (total 22 columns):
 #   Column                     Non-Null Count  Dtype  
---  ------                     --------------  -----  
 0   instant                    23073 non-null  float64
 1   dteday                     23073 non-null  object 
 2   season                     23073 non-null  float64
 3   mnth                       23073 non-null  float64
 4   Hour                       31759 non-null  int64  
 5   weekday                    23073 non-null  float64
 6   temp                       23073 non-null  float64
 7   atemp                      23073 non-null  float64
 8   hum                        23073 non-null  float64
 9   Wind speed (m/s)           31759 non-null  float64
 10  casual                     23073 non-null  float64
 11  registered                 23073 non-null  float64
 12  cnt                        23073 non-null  float64
 13  year_x                     23073 non-null  object 
 14  Rented Bike Count          16560 non-null  float64
 15  Temperature(C)             16560 non-null  float64
 16  Humidity(%)                16560 non-null  float64
 17  Visibility (10m)           16560 non-null  float64
 18  Dew point temperature(C)   16560 non-null  float64
 19  Solar Radiation (MJ/m2)    16560 non-null  float64
 20  Functioning Day            16560 non-null  object 
 21  year_y                     16560 non-null  object 
dtypes: float64(17), int64(1), object(4)
memory usage: 5.6+ MB
```

```
df.to_csv('updated_csv.csv')
```

```
df=df.drop(['atemp','Humidity(%)','year_y','Functioning Day','registered','casual','weekday','dteday'],axis=1)
```

```
df.head()
```

| | instant | season | mnth | Hour | temp | hum | Wind speed (m/s) | cnt | year_x | Rented Bike Count | Temperat |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1.0 | 1.0 | 1.0 | 0 | 0.24 | 0.81 | 0.0 | 16.0 | 2011 | 145.0 | |
| **1** | 1.0 | 1.0 | 1.0 | 0 | 0.24 | 0.81 | 0.0 | 16.0 | 2011 | 811.0 | |
| **2** | 1.0 | 1.0 | 1.0 | 0 | 0.24 | 0.81 | 0.0 | 16.0 | 2011 | 848.0 | |
| **3** | 1.0 | 1.0 | 1.0 | 0 | 0.24 | 0.81 | 0.0 | 16.0 | 2011 | 520.0 | |

```
df.info()
```

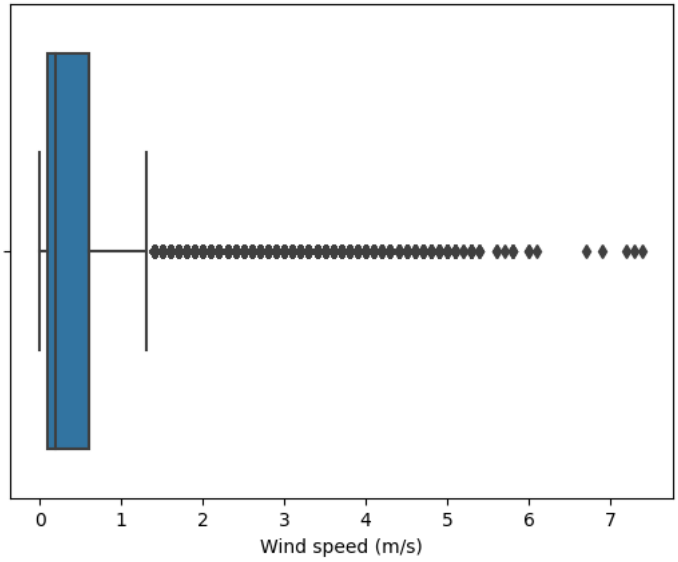
```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 31759 entries, 0 to 31758
Data columns (total 14 columns):
 #   Column                     Non-Null Count  Dtype  
---  ------                     --------------  -----  
 0   instant                    23073 non-null  float64
 1   season                     23073 non-null  float64
 2   mnth                       23073 non-null  float64
 3   Hour                       31759 non-null  int64  
```

```
 4   temp                       23073 non-null  float64
 5   hum                        23073 non-null  float64
 6   Wind speed (m/s)           31759 non-null  float64
 7   cnt                        23073 non-null  float64
 8   year_x                     23073 non-null  object
 9   Rented Bike Count          16560 non-null  float64
 10  Temperature(C)             16560 non-null  float64
 11  Visibility (10m)           16560 non-null  float64
 12  Dew point temperature(C)   16560 non-null  float64
 13  Solar Radiation (MJ/m2)    16560 non-null  float64
dtypes: float64(12), int64(1), object(1)
memory usage: 3.6+ MB
```

## Exploratory Data Analysis (EDA)

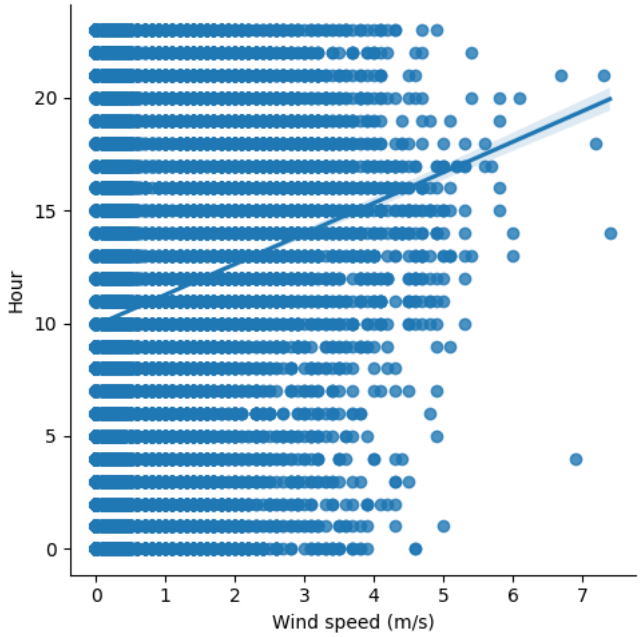
```
sns.boxplot(x=df['Wind speed (m/s)'])
```

```
<Axes: xlabel='Wind speed (m/s)'>
```



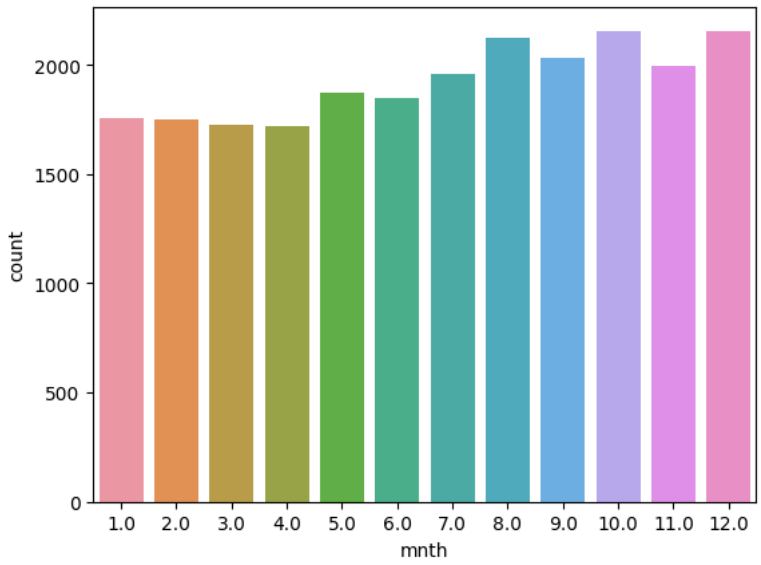

```
sns.lmplot(x='Wind speed (m/s)',y='Hour',data=df)
```

```
<seaborn.axisgrid.FacetGrid at 0x7f27ee88f970>
```



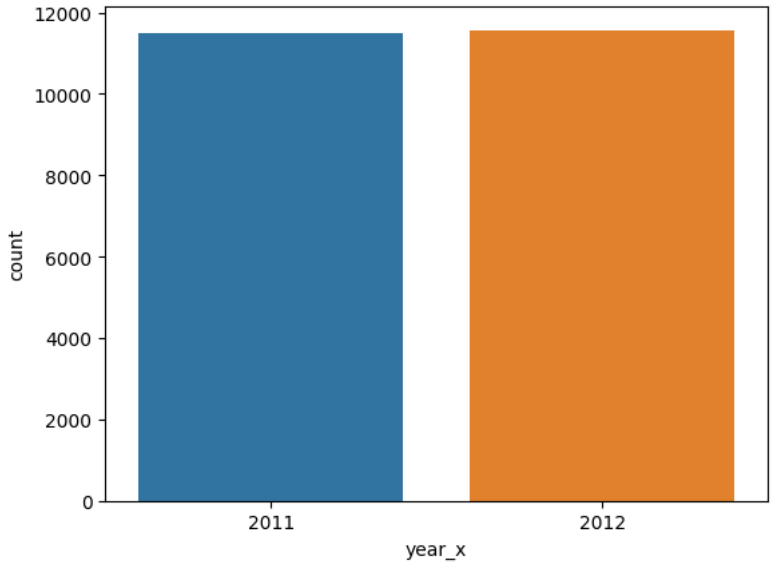

```
sns.countplot(x='mnth',data=df)
```

```
<Axes: xlabel='mnth', ylabel='count'>
```

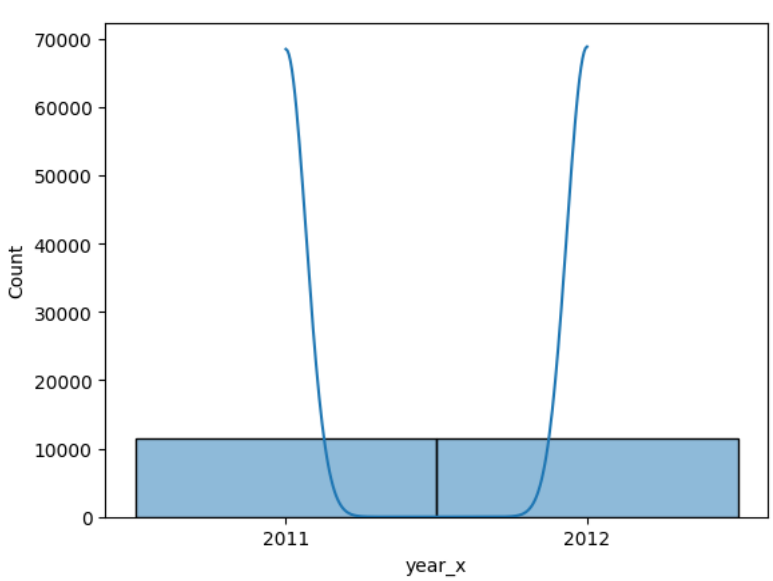


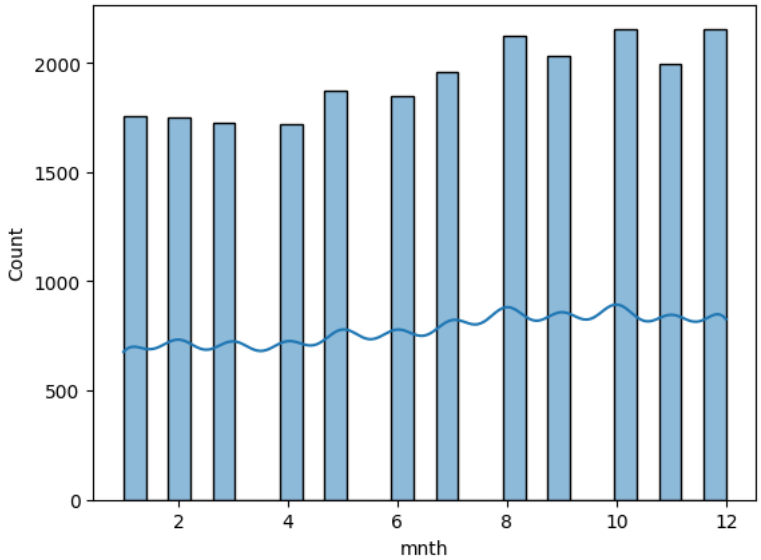

```
sns.countplot(x='year_x',data=df)
```

```
<Axes: xlabel='year_x', ylabel='count'>
```




```
num_cols = ['year_x',   'mnth', 'Wind speed (m/s)', 'Hour']
for col in num_cols:
    sns.histplot(df[col], kde = True)
    plt.show()
```

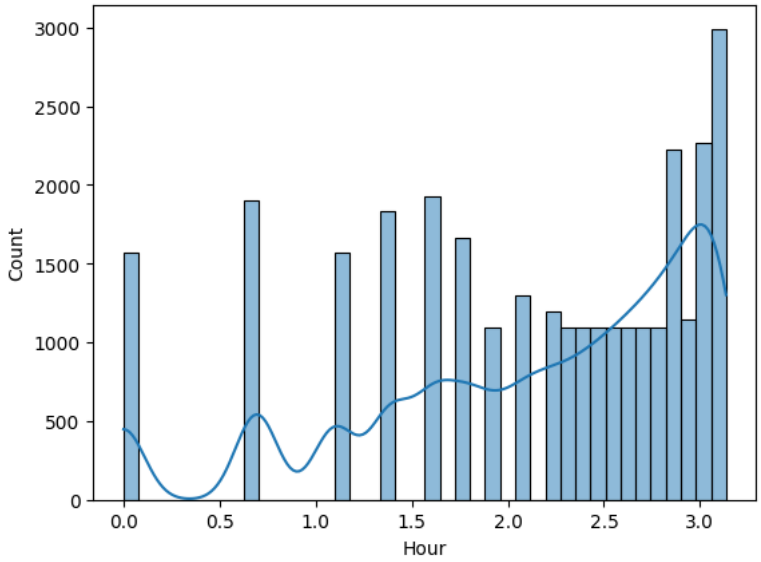


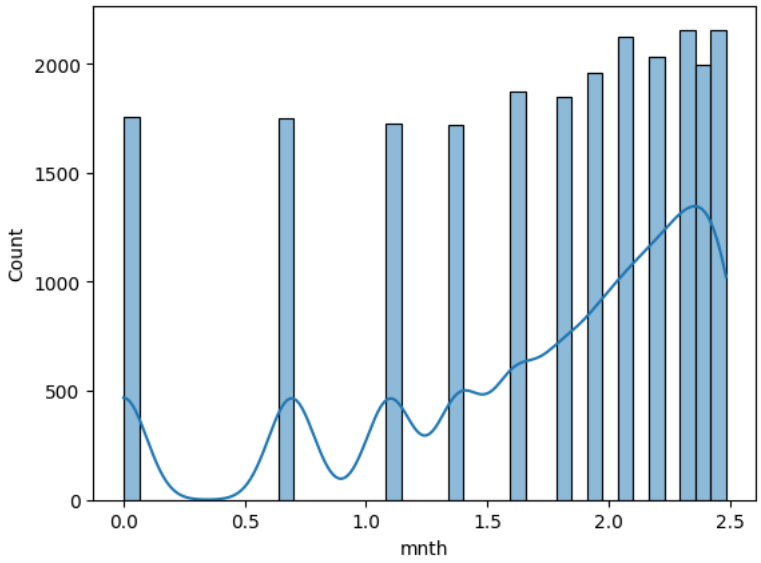





```
num_cols = ['Hour', 'mnth', 'Wind speed (m/s)']
for col in num_cols:
    sns.histplot(np.log(df[col]), kde = True)
    plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/pandas/core/arraylike.py:402: Run
  result = getattr(ufunc, method)(*inputs, **kwargs)
```

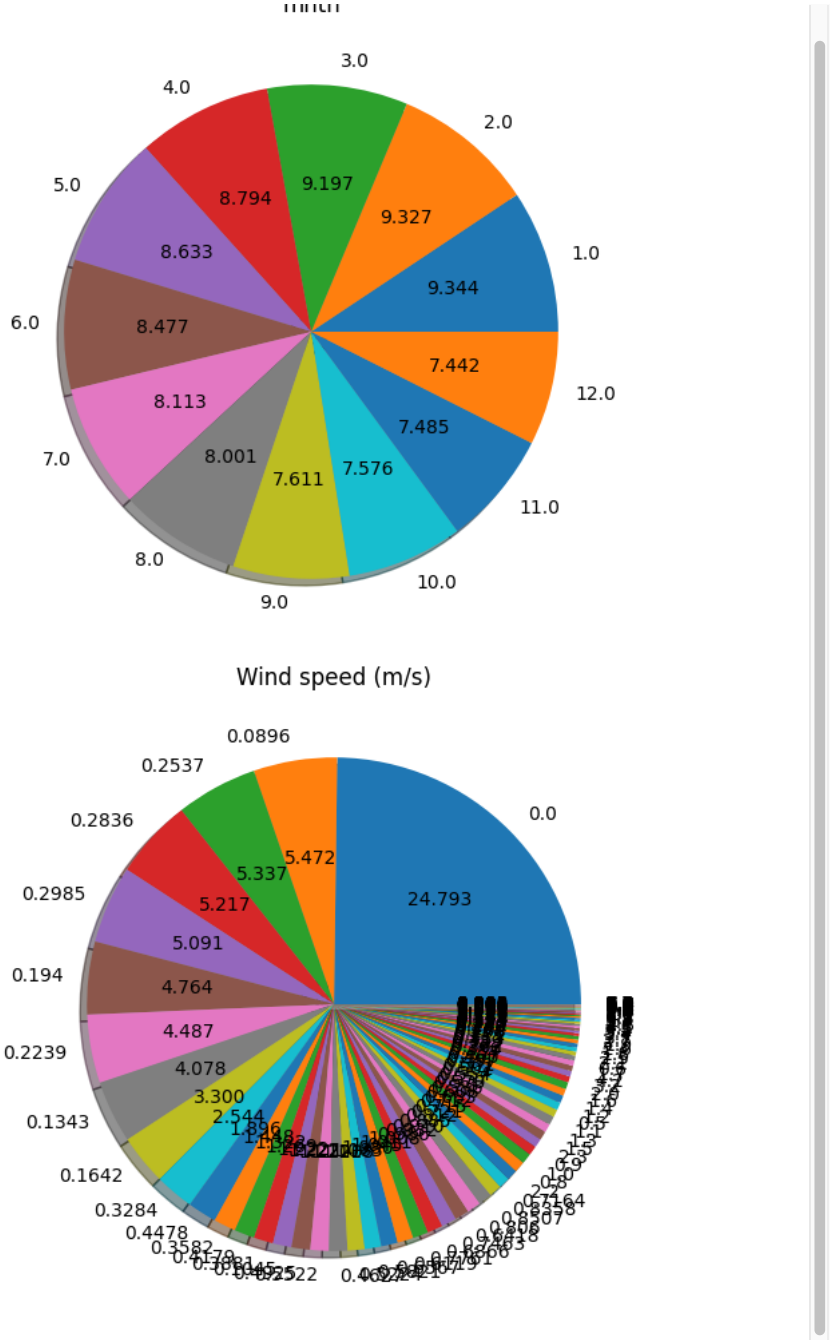



```
/usr/local/lib/python3.10/dist-packages/pandas/core/arraylike.py:402: Run
  result = getattr(ufunc, method)(*inputs, **kwargs)
```

```
cols = ['mnth', 'Wind speed (m/s)']
for col in cols:
    plt.figure(figsize=(6, 6))
    plt.title(col)
```

```
    unique_values = df[col].nunique()
    labels = df[col].unique()[:unique_values]
    plt.pie(df[col].value_counts().values[:unique_values], labels=labels, shadow=True, autopct='%.3f')
    plt.show()
```




```
cols = ['Hour', 'mnth', 'Wind speed (m/s)']
for col in cols:
    print(col + ':')
    print(df[col].value_counts())
    print()
```

```
Hour:
5     1928
2     1901
4     1831
6     1664
3     1573
1     1572
23    1496
22    1496
0     1432
8     1295
9     1193
```

```
21    1178
19    1144
18    1132
16    1094
17    1094
13    1093
14    1093
15    1093
20    1092
12    1092
10    1091
11    1091
7     1091
Name: Hour, dtype: int64

mnth:
12.0    2156
10.0    2152
8.0     2122
9.0     2029
11.0    1992
7.0     1956
5.0     1872
6.0     1846
1.0     1756
2.0     1748
3.0     1727
4.0     1717
Name: mnth, dtype: int64

Wind speed (m/s):
0.0000    7874
0.1343    1738
0.1642    1695
0.1940    1657
0.1045    1617
          ...
7.2000       1
6.1000       1
7.3000       1
6.9000       1
5.7000       1
Name: Wind speed (m/s), Length: 94, dtype: int64
```

**Applying Muller**

```
df = df.dropna()
df.isnull().any()
```

```
instant                    False
season                     False
mnth                       False
Hour                       False
temp                       False
hum                        False
Wind speed (m/s)           False
cnt                        False
year_x                     False
Rented Bike Count          False
Temperature(C)             False
Visibility (10m)           False
Dew point temperature(C)   False
Solar Radiation (MJ/m2)    False
dtype: bool
```

```
X=df.iloc[:4000,:].drop(['mnth','Hour','hum', 'Wind speed (m/s)','cnt'],axis=1)
y=df.iloc[:4000,:]['mnth']
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 7874 entries, 0 to 20893
Data columns (total 14 columns):
 #   Column                   Non-Null Count  Dtype
---  ------                   --------------  -----
 0   instant                  7874 non-null   float64
 1   season                   7874 non-null   float64
 2   mnth                     7874 non-null   float64
 3   Hour                     7874 non-null   int64
```

```
 4   temp                     7874 non-null   float64
 5   hum                      7874 non-null   float64
 6   Wind speed (m/s)         7874 non-null   float64
 7   cnt                      7874 non-null   float64
 8   year_x                   7874 non-null   object
 9   Rented Bike Count        7874 non-null   float64
 10  Temperature(C)           7874 non-null   float64
 11  Visibility (10m)         7874 non-null   float64
 12  Dew point temperature(C) 7874 non-null   float64
 13  Solar Radiation (MJ/m2)  7874 non-null   float64
dtypes: float64(12), int64(1), object(1)
memory usage: 922.7+ KB
```

```
X['Temperature(C)'].fillna(X['Temperature(C)'].mean(), inplace=True)
X['Rented Bike Count'].fillna(X['Rented Bike Count'].median(), inplace=True)
```

```
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y, test_size=0.10, random_state=2)
```

```
X_train.dropna(inplace=True)
y_train = y_train[X_train.index]

X_test.dropna(inplace=True)
y_test = y_test[X_test.index]
```

```
X_train.fillna(X_train.mean(), inplace=True)
X_test.fillna(X_train.mean(), inplace=True)
```

```
from scipy.stats.mstats import winsorize
X_train = X_train.round(2)
X_test = X_test.round(2)
# apply winsorize() function to each column individually
X_train = X_train.apply(lambda x: winsorize(x, limits=[None, 0.01]))
X_test = X_test.apply(lambda x: winsorize(x, limits=[None, 0.01]))
```

```
from sklearn.preprocessing import MinMaxScaler

scaler = MinMaxScaler()

scaler.fit(X_train)
X_train_scaled = scaler.transform(X_train)

X_test_scaled = scaler.transform(X_test)
```

## Best Classifier using Muller Loop

```
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.colors import ListedColormap
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.datasets import make_moons, make_circles, make_classification
from sklearn.neural_network import MLPClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.svm import SVC
from sklearn.gaussian_process import GaussianProcessClassifier
from sklearn.gaussian_process.kernels import RBF
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.discriminant_analysis import QuadraticDiscriminantAnalysis
```

```
names = [
    "Nearest Neighbors", "Linear SVM", "RBF SVM",
         "Decision Tree", "Random Forest", "Neural Net", "AdaBoost",
         "Naive Bayes"
         ]
```

```
classifiers = [
    KNeighborsClassifier(2),
    SVC(kernel="linear", C=0.025),
    SVC(gamma=2, C=1),
    DecisionTreeClassifier(max_depth=5),
    RandomForestClassifier(max_depth=5, n_estimators=10, max_features=1),
    MLPClassifier(alpha=1, max_iter=1000),
    AdaBoostClassifier(),
    GaussianNB()]


from sklearn import metrics
max_score = 0.0
max_class = ''
# iterate over classifiers
metrics_df = pd.DataFrame({
    'Classifier': [],
    'MSE' : [],
    'MAE': [],
    'RSquared': [],
    'Test Accuracy': [],
    'Recall':[],
    'Precision': []
    })
for name, clf in zip(names, classifiers):
    clf.fit(X_train_scaled, y_train)
    y_pred = clf.predict(X_test_scaled)
    score = 100.0 * clf.score(X_test_scaled, y_test)
    mean_absolute_error = np.round(metrics.mean_absolute_error(y_test, y_pred), 2)
    mean_squared_error = np.round(metrics.mean_squared_error(y_test, y_pred), 2)
    r_squared = np.round(metrics.r2_score(y_test, y_pred), 2)
    test_acc = metrics.accuracy_score(y_test, y_pred) * 100
    recall = metrics.recall_score(y_test, y_pred, average = 'weighted')
    precision = metrics.precision_score(y_test, y_pred, average = 'weighted')
    new_row = pd.DataFrame({
    'Classifier': name,
    'MSE' : mean_absolute_error,
    'MAE': mean_squared_error,
    'RSquared': r_squared,
    'Test Accuracy': test_acc,
    'Recall': recall,
    'Precision': precision}, index=[0])
    metrics_df = pd.concat([new_row,metrics_df.loc[:]]).reset_index(drop=True)

    print('Best Classifier -----> %s, Score (test, accuracy) -----> %.2f,' %(name, score))
    if score > max_score:
        clf_best = clf
        max_score = score
        max_class = name

print('Best Classifier -----> %s, Score (test, accuracy) -----> %.2f' %(max_class, max_score))
```

```
 Best Classifier -----> Nearest Neighbors, Score (test, accuracy) -----> 59.00,
 /usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344: UndefinedMetricWarning: Precision is ill-de
   _warn_prf(average, modifier, msg_start, len(result))
 Best Classifier -----> Linear SVM, Score (test, accuracy) -----> 37.75,
 Best Classifier -----> RBF SVM, Score (test, accuracy) -----> 64.00,
 Best Classifier -----> Decision Tree, Score (test, accuracy) -----> 77.00,
 Best Classifier -----> Random Forest, Score (test, accuracy) -----> 63.00,
 Best Classifier -----> Neural Net, Score (test, accuracy) -----> 63.00,
 Best Classifier -----> AdaBoost, Score (test, accuracy) -----> 21.25,
 Best Classifier -----> Naive Bayes, Score (test, accuracy) -----> 51.25,
 Best Classifier -----> Decision Tree, Score (test, accuracy) -----> 77.00
 /usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344: UndefinedMetricWarning: Precision is ill-de
   _warn_prf(average, modifier, msg_start, len(result))
 /usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1344: UndefinedMetricWarning: Precision is ill-de
   _warn_prf(average, modifier, msg_start, len(result))
```

```
metrics_df.head(7)
```

| | Classifier | MSE | MAE | RSquared | Test Accuracy | Recall | Precision |
|---|---|---|---|---|---|---|---|
| 0 | Naive Bayes | 0.68 | 2.38 | 0.79 | 51.25 | 0.5125 | 0.368132 |
| 1 | AdaBoost | 1.58 | 5.11 | 0.54 | 21.25 | 0.2125 | 0.063422 |
| 2 | Neural Net | 0.39 | 0.43 | 0.96 | 63.00 | 0.6300 | 0.663311 |

**Previously best performing algorithm KNN Classification**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | Decision Tree | 0.41 | 1.90 | 0.83 | 77.00 | 0.7700 | 0.855025 |
| 6 | Linear SVM | 0.95 | 2.93 | 0.74 | 37.75 | 0.3775 | 0.208823 |

```
X=df.iloc[:5000,:].drop(['mnth','Hour','hum', 'Wind speed (m/s)','cnt'],axis=1)
y=df.iloc[:5000,:]['mnth']
```

```
X['Temperature(C)'].fillna(X['Temperature(C)'].mean(), inplace=True)
X['Rented Bike Count'].fillna(X['Rented Bike Count'].median(), inplace=True)


X_train, X_test, y_train, y_test = train_test_split(X,y, test_size=0.10, random_state=2)

X_train.dropna(inplace=True)
y_train = y_train[X_train.index]

X_test.dropna(inplace=True)
y_test = y_test[X_test.index]

X_train.fillna(X_train.mean(), inplace=True)
X_test.fillna(X_train.mean(), inplace=True)


X_train = X_train.round(2)
X_test = X_test.round(2)


X_train = X_train.apply(lambda x: winsorize(x, limits=[None, 0.01]))
X_test = X_test.apply(lambda x: winsorize(x, limits=[None, 0.01]))


scaler.fit(X_train)

X_train_scaled = scaler.transform(X_train)

X_test_scaled = scaler.transform(X_test)


def get_metrics(y_test, y_pred):
  print("MSE : " , np.round(metrics.mean_squared_error(y_test, y_pred), 2))
  print("MAE : " , np.round(metrics.mean_absolute_error(y_test, y_pred), 2))
  print("RSquared : " , np.round(metrics.r2_score(y_test, y_pred), 2))
  print('Test Accuracy:', metrics.accuracy_score(y_test, y_pred) * 100)
  print('Recall:', metrics.recall_score(y_test, y_pred, average = 'weighted'))
  print('Precision:', metrics.precision_score(y_test, y_pred, average = 'weighted'))
  print('\n confussion matrix:\n',metrics.confusion_matrix(y_test, y_pred))
  clf_report = metrics.classification_report(y_test, y_pred, output_dict=True)
  sns.heatmap(pd.DataFrame(clf_report).iloc[:-1, :].T, annot=True)
  plt.show()


classifier = KNeighborsClassifier(2)
classifier.fit(X_train_scaled, y_train)
y_pred = classifier.predict(X_test_scaled)
get_metrics(y_test, y_pred)
```