DWDM PROJECT

*Importing required modules*

```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from xgboost import XGBRegressor
from sklearn.ensemble import VotingRegressor, RandomForestRegressor,
GradientBoostingRegressor,StackingRegressor
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import mean_squared_error,
r2_score ,accuracy_score, classification_report
from sklearn.preprocessing import StandardScaler, LabelEncoder
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.linear_model import LinearRegression
import warnings
warnings.filterwarnings("ignore")
```

*A small subset of data-set*

```
df = pd.read_csv(r"D:\3-1\Theory\F2 DWDM\project\data.csv")
df.head(10)
```

| | mandal | date | rainfall | temp_min | temp_max | humidity_min | \ |
|---|---|---|---|---|---|---|---|
| 0 | Shaikpet | 01-01-2018 | 0.0 | 17.4 | 30.30 | 40.6 | |
| 1 | Shaikpet | 02-01-2018 | 0.0 | 19.4 | 31.60 | 37.5 | |
| 2 | Shaikpet | 03-01-2018 | 0.0 | 19.3 | 29.90 | 43.8 | |
| 3 | Shaikpet | 04-01-2018 | 0.0 | 18.2 | 29.30 | 41.6 | |
| 4 | Shaikpet | 05-01-2018 | 0.0 | 17.1 | 28.00 | 42.9 | |
| 5 | Shaikpet | 06-01-2018 | 0.0 | 15.9 | 29.30 | 37.5 | |
| 6 | Shaikpet | 07-01-2018 | 0.0 | 17.2 | 29.90 | 35.5 | |
| 7 | Shaikpet | 08-01-2018 | 0.0 | 16.9 | 27.89 | 40.9 | |
| 8 | Shaikpet | 09-01-2018 | 0.0 | 17.3 | 26.70 | 42.7 | |
| 9 | Shaikpet | 10-01-2018 | 0.0 | 17.4 | 26.40 | 51.2 | |

| | humidity_max | wind_speed_min | wind_speed_max |
|---|---|---|---|
| 0 | 85.0 | 0.0 | 4.8 |
| 1 | 74.9 | 0.0 | 8.5 |
| 2 | 86.4 | 0.0 | 8.0 |
| 3 | 80.9 | 0.0 | 7.0 |
| 4 | 71.2 | 0.0 | 11.2 |
| 5 | 76.8 | 0.0 | 7.3 |
| 6 | 74.4 | 0.0 | 7.1 |
| 7 | 74.6 | 0.0 | 10.3 |
| 8 | 81.6 | 0.0 | 9.8 |
| 9 | 77.8 | 0.0 | 13.2 |

*Statistics of the data-set*

```
df.info()
df.describe()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 35042 entries, 0 to 35041
Data columns (total 9 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   mandal          35042 non-null  object
 1   date            35042 non-null  object
 2   rainfall        35042 non-null  float64
 3   temp_min        35042 non-null  float64
 4   temp_max        35042 non-null  float64
 5   humidity_min    35042 non-null  float64
 6   humidity_max    35042 non-null  float64
 7   wind_speed_min  34001 non-null  float64
 8   wind_speed_max  34977 non-null  float64
dtypes: float64(7), object(2)
memory usage: 2.4+ MB

           rainfall      temp_min      temp_max  humidity_min
humidity_max  \
count  35042.000000  35042.000000  35042.000000  35042.000000
35042.000000
mean       2.736562     23.189849     33.593165     42.558944
80.437477
std        9.082997      3.474841      3.941404     18.773714
16.168133
min        0.000000      6.000000     19.500000      0.000000
0.000000
25%        0.000000     21.500000     30.900000     27.300000
71.200000
50%        0.000000     23.500000     33.000000     42.000000
83.700000
75%        0.100000     25.200000     36.400000     56.000000
92.400000
max      149.700000     33.300000     44.800000     99.300000
100.000000

       wind_speed_min  wind_speed_max
count    34001.000000    34977.000000
mean         0.385418       10.433857
std          1.056075       11.976747
min          0.000000        0.000000
25%          0.000000        4.400000
50%          0.000000        7.900000
75%          0.100000       11.800000
max         15.500000      234.400000
```

*Removing duplicate records*

AS there are no null values we are skiping the step which fills the null values

```
df = df.drop_duplicates()
```

*Counting null values of each attribute in the data-set*

```
df.isnull().sum()
```

```
mandal                0
date                  0
rainfall              0
temp_min              0
temp_max              0
humidity_min          0
humidity_max          0
wind_speed_min     1041
wind_speed_max       65
dtype: int64
```

*Replacing the null values with the mean*

```
df["wind_speed_max"]=df["wind_speed_max"].fillna(df["wind_speed_max"].
mean())
df["wind_speed_min"]=df["wind_speed_min"].fillna(df["wind_speed_min"].
mean())
# df = df.drop(columns=['wind_speed_min'])
```

*Statistics of data-set*

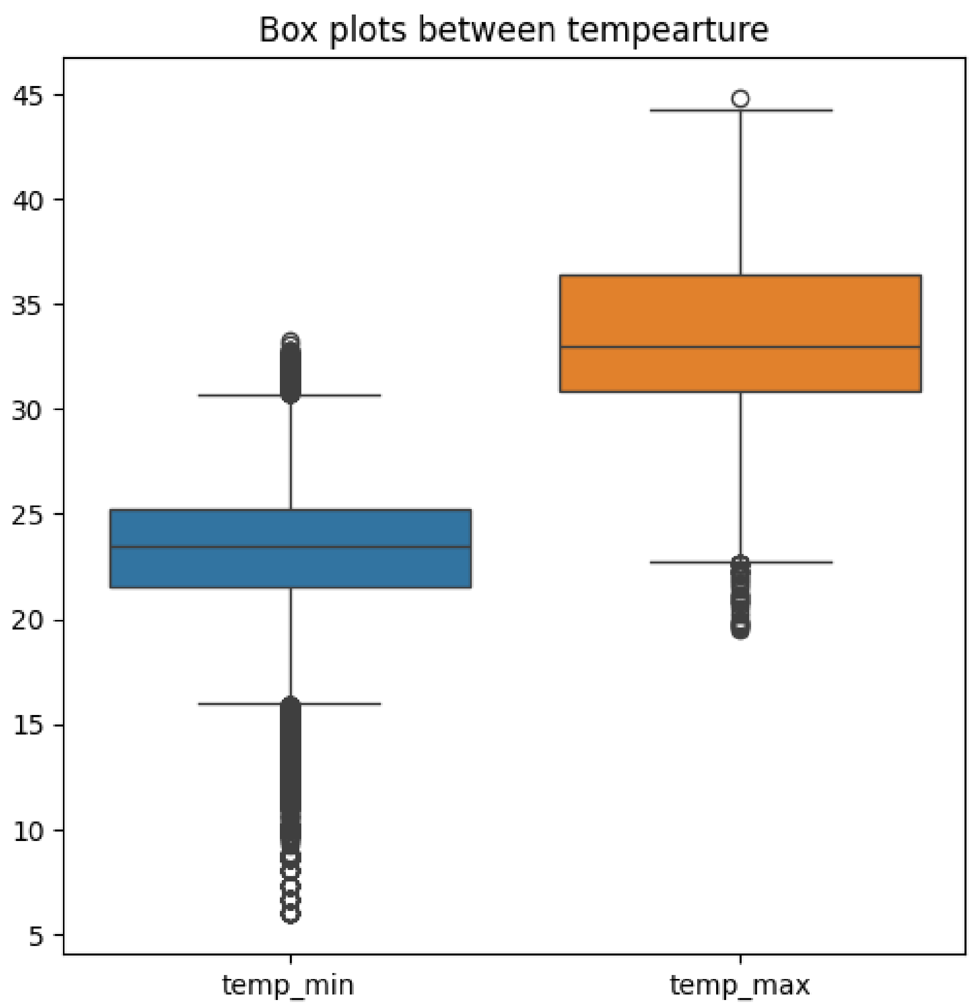
```
df.describe()
```

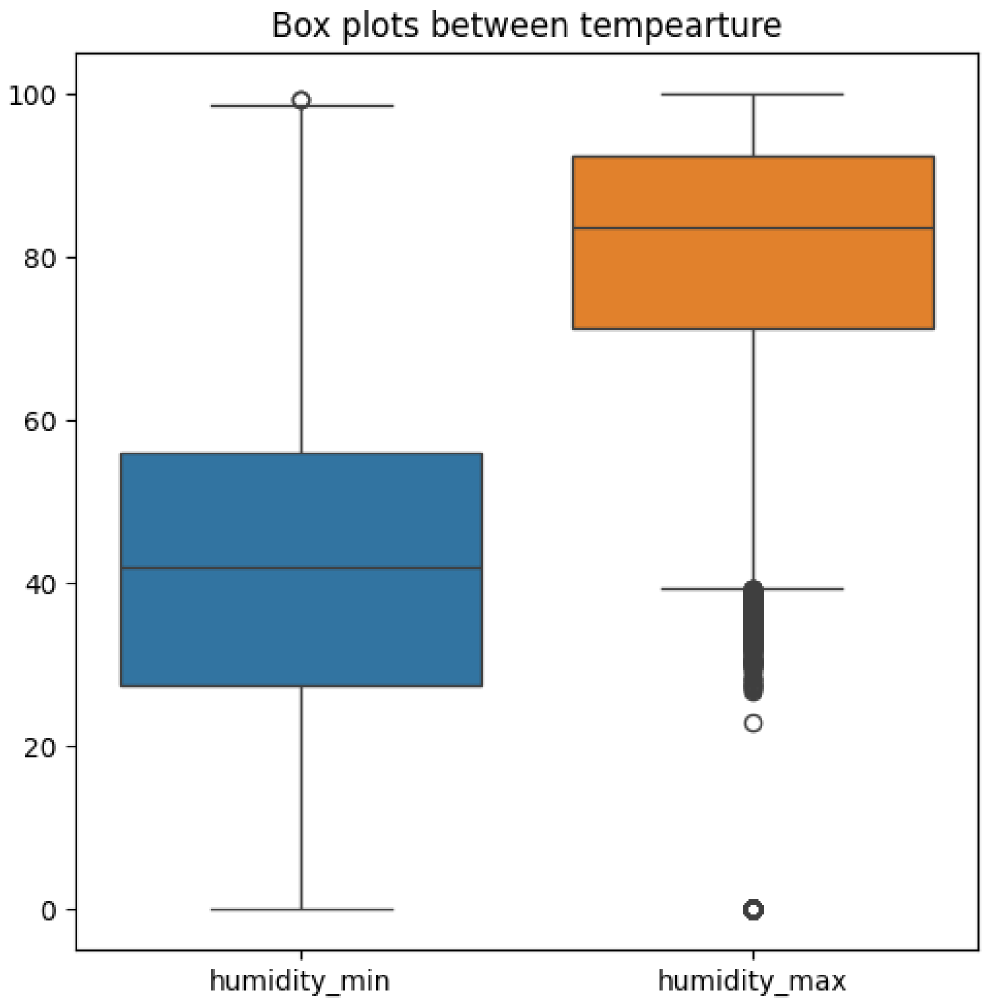
```
           rainfall      temp_min      temp_max   humidity_min
humidity_max  \
count  35042.000000  35042.000000  35042.000000  35042.000000
35042.000000
mean       2.736562     23.189849     33.593165     42.558944
80.437477
std        9.082997      3.474841      3.941404     18.773714
16.168133
min        0.000000      6.000000     19.500000      0.000000
0.000000
25%        0.000000     21.500000     30.900000     27.300000
71.200000
50%        0.000000     23.500000     33.000000     42.000000
83.700000
75%        0.100000     25.200000     36.400000     56.000000
92.400000
```

```
max      149.700000     33.300000     44.800000     99.300000
100.000000

       wind_speed_min  wind_speed_max
count    35042.000000    35042.000000
mean         0.385418       10.433857
std          1.040270       11.965633
min          0.000000        0.000000
25%          0.000000        4.400000
50%          0.000000        7.900000
75%          0.200000       11.800000
max         15.500000      234.400000
```

*Box plot of temp_min vs temp_max*

```
plt.figure(figsize=(6, 6))
sns.boxplot(data=df[['temp_min','temp_max']])
plt.title("Box plots between tempearture")
plt.show()
plt.figure(figsize=(6, 6))
sns.boxplot(data=df[['humidity_min','humidity_max']])
plt.title("Box plots between tempearture")
plt.show()
```


Box plots between tempearture
45
40
35
30
25
20
15
10
5
temp_min
temp_max



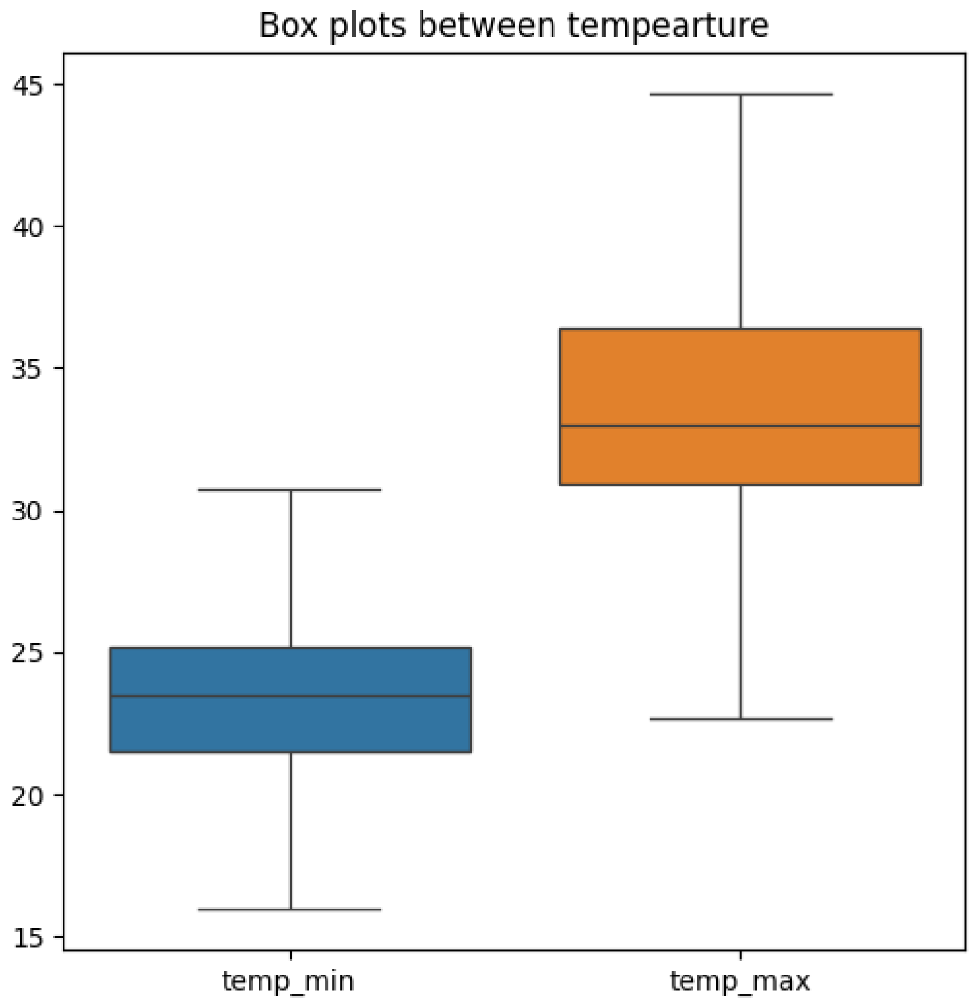

*Removing the outliers*

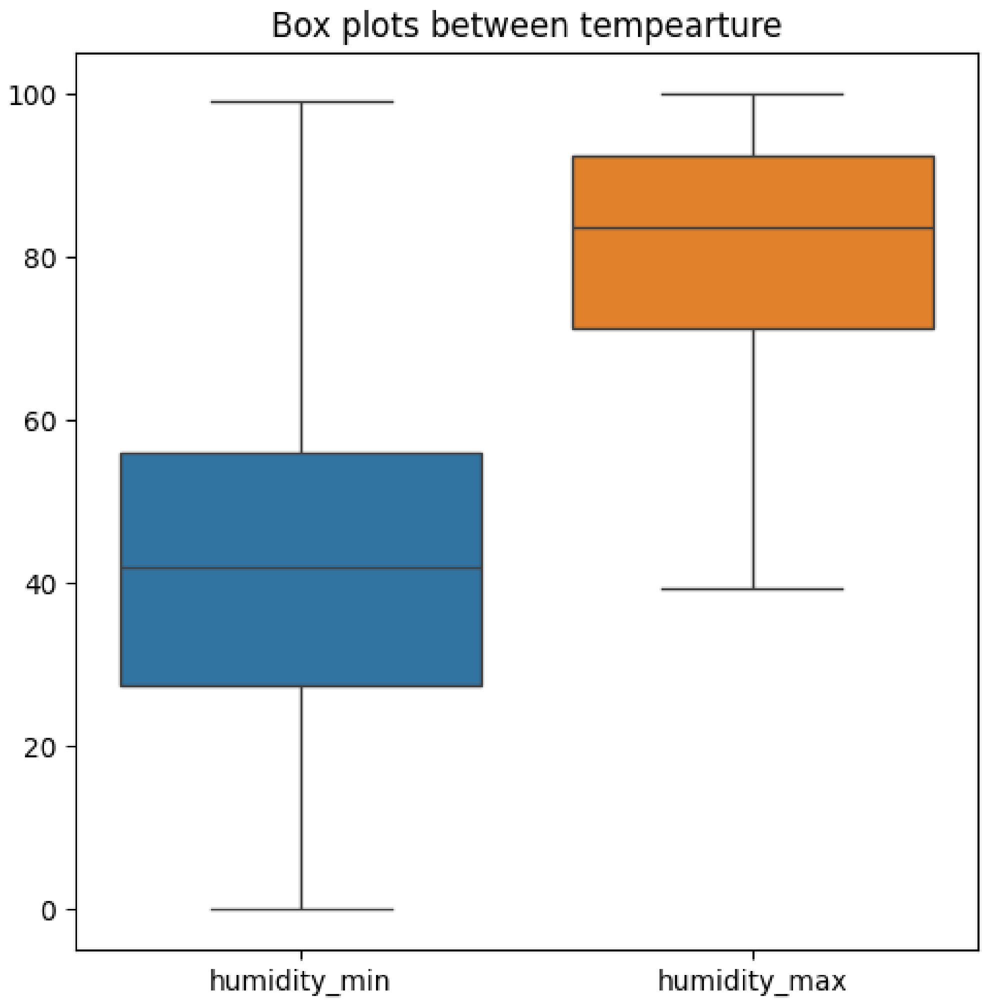
```
# def winsorize_outliers(df, columns, lower_quantile=0.05, 
upper_quantile=0.95):
#     for column in columns:
#         lower_bound = df[column].quantile(lower_quantile)
#         upper_bound = df[column].quantile(upper_quantile)
#         df[column] = np.where(df[column] < lower_bound, lower_bound, 
df[column])
#         df[column] = np.where(df[column] > upper_bound, upper_bound, 
df[column])
#     return df


# columns_to_clean = ["rainfall", "temp_min", "temp_max", 
"humidity_min", "humidity_max", "wind_speed_min", "wind_speed_max"]
# df= winsorize_outliers(df, columns_to_clean)
```

```python
def iqr_outlier_handling(df, columns):
    for column in columns:
        Q1 = df[column].quantile(0.25)
        Q3 = df[column].quantile(0.75)
        IQR = Q3 - Q1
        lower_bound = Q1 - 1.5 * IQR
        upper_bound = Q3 + 1.5 * IQR
        df[column] = np.where(df[column] < lower_bound, lower_bound, 
df[column])
        df[column] = np.where(df[column] > upper_bound, upper_bound, 
df[column])
    return df

columns_to_clean = ["rainfall", "temp_min", "temp_max", 
"humidity_min", "humidity_max", "wind_speed_min", "wind_speed_max"]
df = iqr_outlier_handling(df, columns_to_clean)
```

*Box plot after the removal of outliers*

```python
plt.figure(figsize=(6, 6))
sns.boxplot(data=df[['temp_min','temp_max']])
plt.title("Box plots between tempearture")
plt.show()
plt.figure(figsize=(6, 6))
sns.boxplot(data=df[['humidity_min','humidity_max']])
plt.title("Box plots between tempearture")
plt.show()
```


Box plots between tempearture
45
40
35
30
25
20
15
temp_min
temp_max




*Predicting the type of weather*

```
def categorize_weather(row):
    rainfall = row['rainfall']
    humidity_min = row['humidity_min']
    wind_speed_max = row['wind_speed_max']

    if rainfall == 0 and humidity_min < 50:
        return 'Sunny'
    elif rainfall == 0 and 50 <= humidity_min < 70:
        return 'Partly Sunny'
    elif rainfall == 0 and humidity_min >= 70:
        return 'Partly Cloudy'
    elif 0 < rainfall <= 10 and humidity_min > 60:
        return 'Sun and Rain'
    elif rainfall > 10 and humidity_min > 70:
        return 'Heavy Raining'
    elif 1 <= rainfall <= 10 and humidity_min > 60:
        return 'Light Raining'
```

```
    elif rainfall > 10 and humidity_min > 80 and wind_speed_max > 15:
        return 'Thunderstorms'
    elif rainfall == 0 and humidity_min > 60:
        return 'Cloudy'
    elif wind_speed_max > 15:
        return 'Windy'
    elif rainfall <= 1 and 50 <= humidity_min < 70:
        return 'Rainbow'
    else:
        return 'Clear'


df['weather_type'] = df.apply(categorize_weather, axis=1)


print(df[['rainfall', 'humidity_min', 'temp_min', 'wind_speed_max',
'weather_type']].head())
```

```
   rainfall  humidity_min  temp_min  wind_speed_max weather_type
0       0.0          40.6      17.4             4.8        Sunny
1       0.0          37.5      19.4             8.5        Sunny
2       0.0          43.8      19.3             8.0        Sunny
3       0.0          41.6      18.2             7.0        Sunny
4       0.0          42.9      17.1            11.2        Sunny
```

*Summarization of the data-set*

```
df.describe()
```

```
           rainfall      temp_min      temp_max  humidity_min
humidity_max  \
count  35042.000000  35042.000000  35042.000000  35042.000000
35042.000000
mean       0.063146     23.274716     33.594616     42.558933
80.756842
std        0.107586      3.189836      3.936952     18.773680
14.949620
min        0.000000     15.950000     22.650000      0.000000
39.400000
25%        0.000000     21.500000     30.900000     27.300000
71.200000
50%        0.000000     23.500000     33.000000     42.000000
83.700000
75%        0.100000     25.200000     36.400000     56.000000
92.400000
max        0.250000     30.750000     44.650000     99.050000
100.000000

       wind_speed_min  wind_speed_max
count    35042.000000    35042.000000
```

```
mean           0.118944         8.746330
std            0.196009         5.735108
min            0.000000         0.000000
25%            0.000000         4.400000
50%            0.000000         7.900000
75%            0.200000        11.800000
max            0.500000        22.900000
```

*Finding the Accuracy of Rainfall using Stacking, Random forest, XG Boost and GradientBoost Models*

RAINFALL(Stacking,Random forest,XGboost,GradientBoost)

```
X = df.drop(columns=['rainfall', 'mandal', 'date', 'weather_type'])
y = df['rainfall']

scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

X_train, X_test, y_train, y_test = train_test_split(X_scaled, y,
test_size=0.25, random_state=42)

rf = RandomForestRegressor(n_estimators=100, random_state=42)
xgb = XGBRegressor(n_estimators=100, random_state=42)
gb = GradientBoostingRegressor(n_estimators=100, random_state=42)

estimators = [
    ('rf', rf),
    ('xgb', xgb),
    ('gb', gb)
]

stacking_regressor = StackingRegressor(estimators=estimators,
final_estimator=LinearRegression())
stacking_regressor.fit(X_train, y_train)

y_pred_stacking = stacking_regressor.predict(X_test)

rmse_stacking = np.sqrt(mean_squared_error(y_test, y_pred_stacking))
accuracy_stacking = r2_score(y_test, y_pred_stacking) * 100

print(f'Accuracy (R^2 Score) for Stacking rainfall prediction:
{accuracy_stacking:.2f}%')

Accuracy (R^2 Score) for Stacking rainfall prediction: 50.33%
```

*Finding the Accuracy of temp_max using Random forest Model*

temp_max(Random forest)

```
X = df.drop(columns=['temp_max', 'mandal', 'date', 'weather_type'])
y = df['temp_max']

scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

X_train, X_test, y_train, y_test = train_test_split(X_scaled, y,
test_size=0.2, random_state=42)

model = RandomForestRegressor(n_estimators=100, random_state=42,
max_depth=15)
model.fit(X_train, y_train)

y_pred = model.predict(X_test)

rmse = np.sqrt(mean_squared_error(y_test, y_pred))
accuracy_temp_max = r2_score(y_test, y_pred) * 100

print(f'Accuracy (R^2 Score) for temp_max prediction:
{accuracy_temp_max:.2f}%')
```

```
Accuracy (R^2 Score) for temp_max prediction: 87.29%
```

*Finding the Accuracy of temp_min using Random forest Model*

temp_min(Random forest)

```
X = df.drop(columns=['temp_min', 'mandal', 'date', 'weather_type'])
y = df['temp_min']

scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

X_train, X_test, y_train, y_test = train_test_split(X_scaled, y,
test_size=0.2, random_state=42)

model = RandomForestRegressor(n_estimators=100, random_state=42,
max_depth=15)
model.fit(X_train, y_train)

y_pred = model.predict(X_test)

rmse = np.sqrt(mean_squared_error(y_test, y_pred))
accuracy_temp_min = r2_score(y_test, y_pred) * 100

print(f'Accuracy (R^2 Score) for temp_min prediction:
{accuracy_temp_min:.2f}%')
```

```
Accuracy (R^2 Score) for temp_min prediction: 79.54%
```

*Finding the Accuracy of humidity_min using GradientBoostingRegressor Model* humidity_min (GradientBoostingRegressor)

```
X = df.drop(columns=['humidity_min', 'mandal', 'date',
'weather_type'])
y = df['humidity_min']

scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

X_train, X_test, y_train, y_test = train_test_split(X_scaled, y,
test_size=0.2, random_state=42)

model = GradientBoostingRegressor(n_estimators=100, learning_rate=0.1,
max_depth=3, random_state=42)
model.fit(X_train, y_train)

y_pred = model.predict(X_test)

rmse = np.sqrt(mean_squared_error(y_test, y_pred))
accuracy_humidity_min = r2_score(y_test, y_pred) * 100

print(f'Accuracy (R^2 Score) for humidity_min prediction:
{accuracy_humidity_min:.2f}%')

Accuracy (R^2 Score) for humidity_min prediction: 87.70%
```

*Finding the Accuracy of humidity_max using GradientBoostingRegressor Model*

```
X = df.drop(columns=['humidity_max', 'mandal', 'date',
'weather_type'])
y = df['humidity_max']

scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

X_train, X_test, y_train, y_test = train_test_split(X_scaled, y,
test_size=0.25, random_state=42)

model = RandomForestRegressor(n_estimators=100, random_state=42,
max_depth=15)
model.fit(X_train, y_train)

y_pred = model.predict(X_test)

rmse = np.sqrt(mean_squared_error(y_test, y_pred))
accuracy_humidity_max = r2_score(y_test, y_pred) * 100

print(f'Accuracy (R^2 Score) for humidity_max prediction:
{accuracy_humidity_max:.2f}%')

Accuracy (R^2 Score) for humidity_max prediction: 71.46%
```

*Finding the Accuracy of wind_speed_max using Voting, Random forest, XGboost and GradientBoost Models*

Wind_speed_max(Voting,Random forest,XGboost,GradientBoost)

```
X = df.drop(columns=['rainfall', 'mandal', 'date', 'weather_type'])
y = df['wind_speed_max']

scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

X_train, X_test, y_train, y_test = train_test_split(X_scaled, y,
test_size=0.25, random_state=42)

rf = RandomForestRegressor(n_estimators=100, random_state=42,
max_depth=15)
xgb = XGBRegressor(n_estimators=100, random_state=42, max_depth=5)
gb = GradientBoostingRegressor(n_estimators=100, random_state=42,
max_depth=5)

voting_regressor = VotingRegressor(estimators=[('rf', rf), ('xgb',
xgb), ('gb', gb)])
voting_regressor.fit(X_train, y_train)

y_pred = voting_regressor.predict(X_test)

rmse = np.sqrt(mean_squared_error(y_test, y_pred))
accuracy_wind_max = r2_score(y_test, y_pred) * 100

print(f'Accuracy (R^2 Score) for predicting wind_speed_max:
{accuracy_wind_max:.2f}%')

Accuracy (R^2 Score) for predicting wind_speed_max: 100.00%
```

*Finding the Accuracy of wind_speed_min using Voting, Random forest, XGboost and GradientBoost Models*

Wind_speed_min(Voting,Random forest,XGboost,GradientBoost)

```
X = df.drop(columns=['rainfall', 'mandal', 'date', 'weather_type'])
y = df['wind_speed_min']

scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

X_train, X_test, y_train, y_test = train_test_split(X_scaled, y,
test_size=0.25, random_state=42)

rf = RandomForestRegressor(n_estimators=100, random_state=42,
max_depth=15)
xgb = XGBRegressor(n_estimators=100, random_state=42, max_depth=5)
```

```
gb = GradientBoostingRegressor(n_estimators=100, random_state=42,
max_depth=5)

voting_regressor = VotingRegressor(estimators=[('rf', rf), ('xgb',
xgb), ('gb', gb)])
voting_regressor.fit(X_train, y_train)

y_pred = voting_regressor.predict(X_test)

rmse = np.sqrt(mean_squared_error(y_test, y_pred))
accuracy_wind_min = r2_score(y_test, y_pred) * 100

print(f'Accuracy (R^2 Score) for predicting wind_speed_min:
{accuracy_wind_min:.2f}%')
```

```
Accuracy (R^2 Score) for predicting wind_speed_min: 100.00%
```

*Finding the Accuracy of weather_type using DecisionTreeClassifier Model*

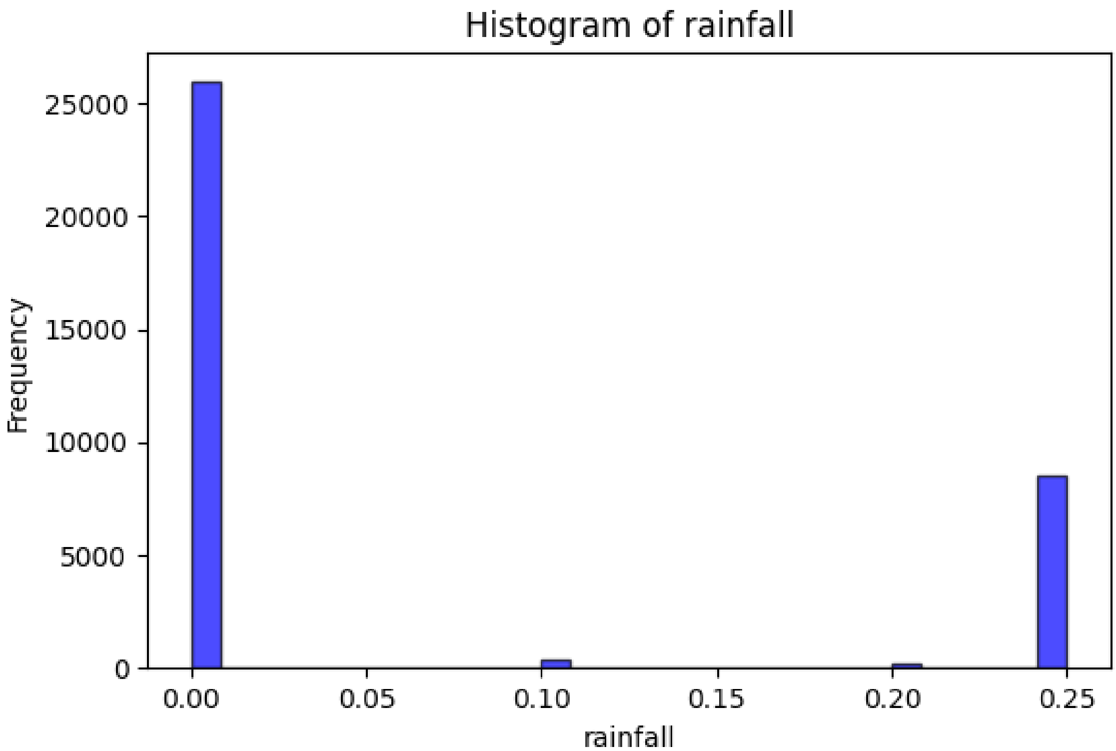
```
X = df.drop(columns=['rainfall', 'mandal', 'date', 'weather_type'])
y = df['weather_type']

label_encoder = LabelEncoder()
y_encoded = label_encoder.fit_transform(y)


scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

X_train, X_test, y_train, y_test = train_test_split(X_scaled,
y_encoded, test_size=0.25, random_state=42)

dt = DecisionTreeClassifier(random_state=42, max_depth=5)

dt.fit(X_train, y_train)

y_pred = dt.predict(X_test)

accuracy = accuracy_score(y_test, y_pred) * 100
report = classification_report(y_test, y_pred,
target_names=label_encoder.classes_)

print(f'Accuracy for predicting weather_type: {accuracy:.2f}%')
```

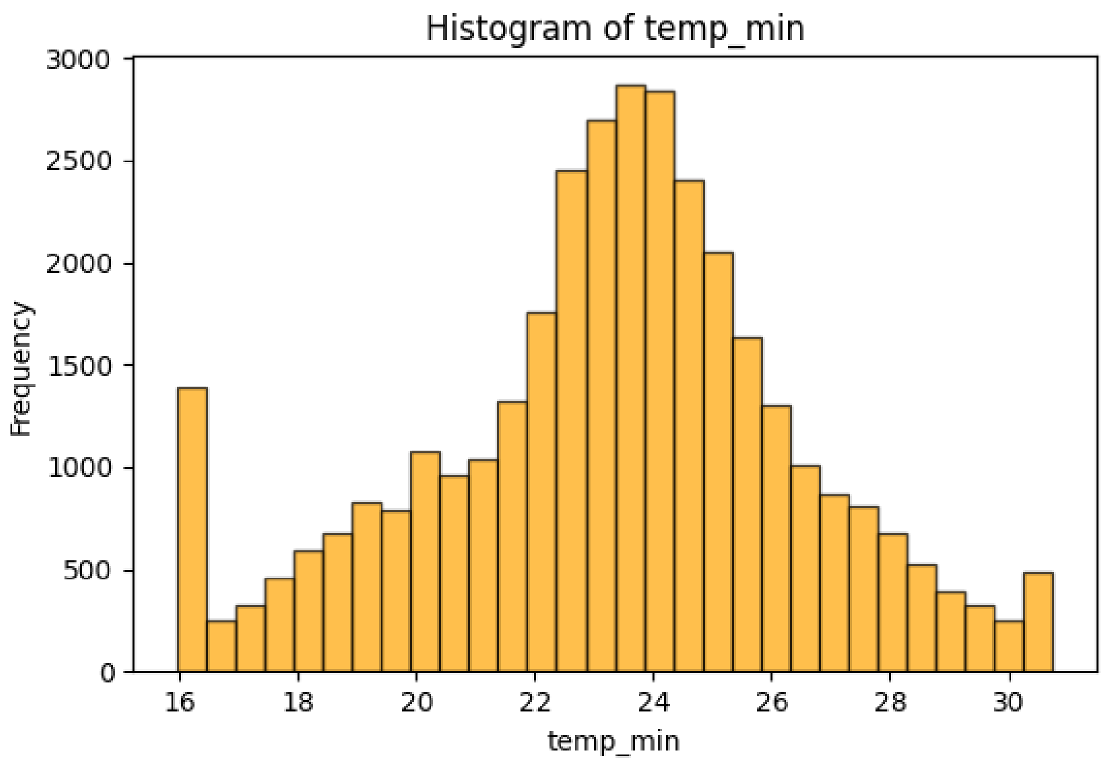
```
Accuracy for predicting weather_type: 84.37%
```

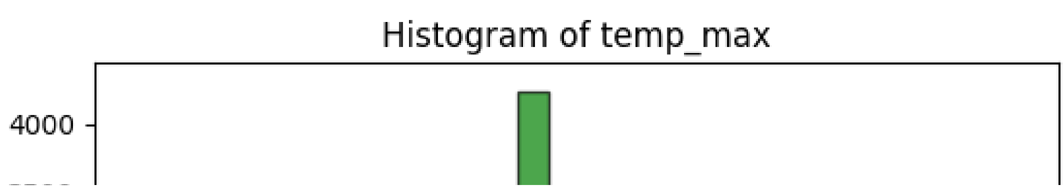
*Histogram representation of each and every attribute*

```
columns_to_plot = ['rainfall', 'temp_min', 'temp_max', 'humidity_min',
'humidity_max', 'wind_speed_min', 'wind_speed_max']
```

```
colors = ['blue', 'orange', 'green', 'red', 'purple', 'brown', 'pink']



n = len(columns_to_plot)
plt.figure(figsize=(6, 4 * n))

for i, (column, color) in enumerate(zip(columns_to_plot, colors),
start=1):
    plt.subplot(n, 1, i)
    plt.hist(df[column], bins=30, color=color, alpha=0.7,
edgecolor='black')
    plt.title(f'Histogram of {column}')
    plt.xlabel(column)
    plt.ylabel('Frequency')
    # plt.grid(axis='y', alpha=0.75)

plt.tight_layout()
plt.show()
```

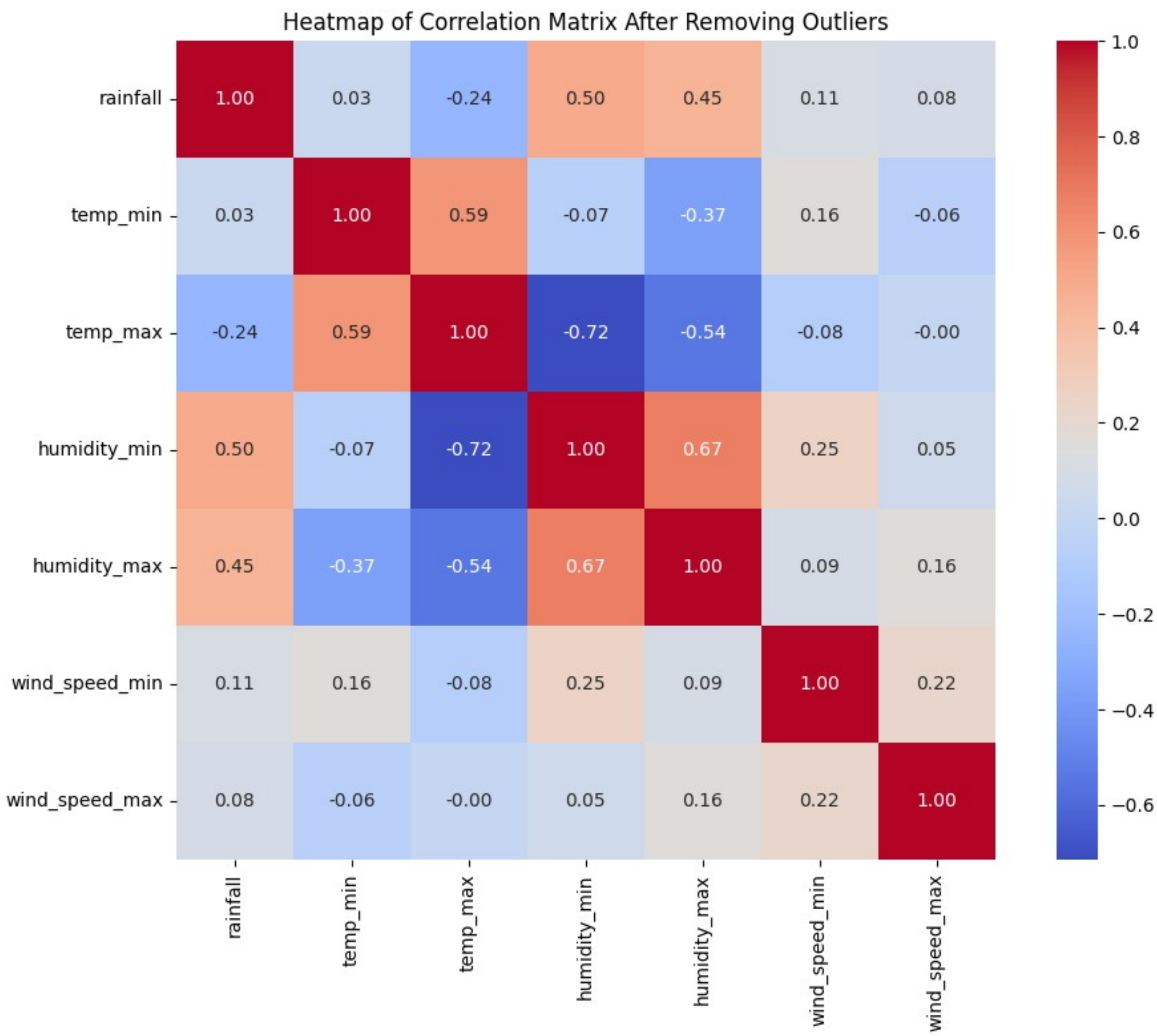

Histogram of rainfall
Frequency
rainfall
25000
20000
15000
10000
5000
0
0.00
0.05
0.10
0.15
0.20
0.25


Histogram of temp_min
Frequency
temp_min
3000
2500
2000
1500
1000
500
0
16
18
20
22
24
26
28
30


Histogram of temp_max
4000

*Heatmap of Correlation Matrix After Removing Outliers*

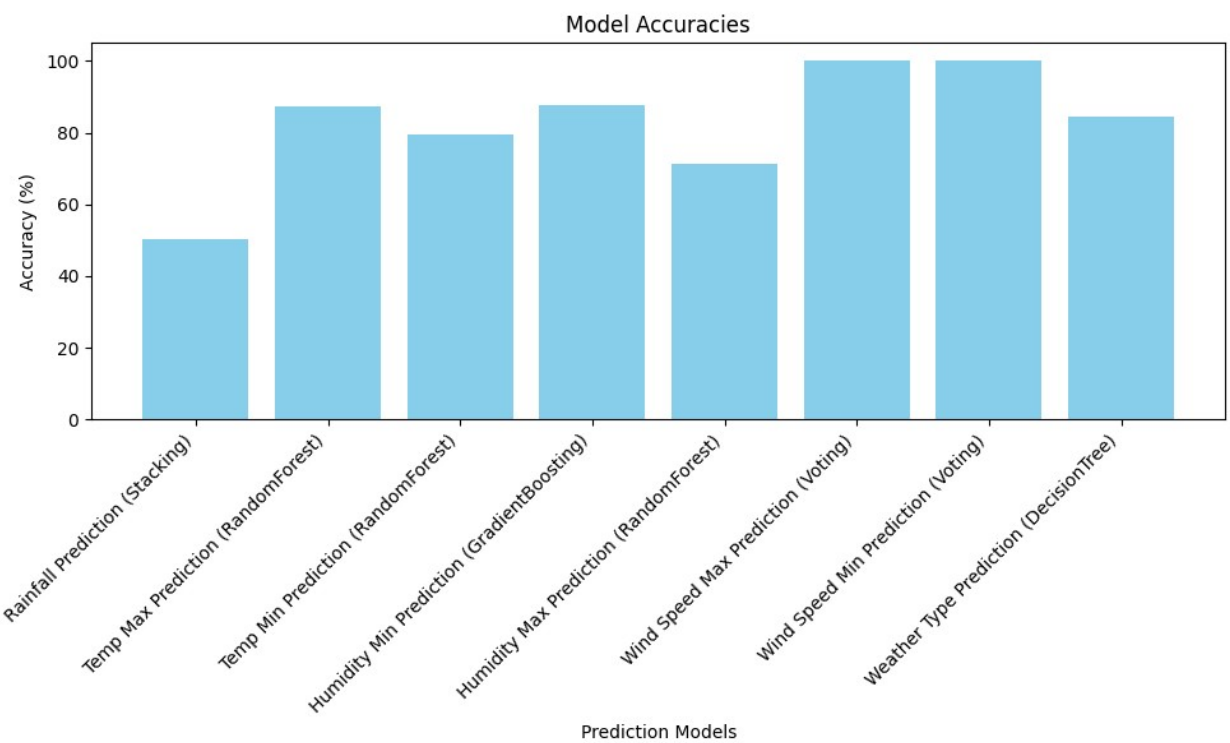
```
numeric_df = df.select_dtypes(include=['int64','float64'])

correlation_matrix = numeric_df.corr()

plt.figure(figsize=(12, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm',
fmt=".2f", square=True)
plt.title('Heatmap of Correlation Matrix After Removing Outliers')
plt.show()
```




*Representation of each and every attribute's Accuracy and the model used for it*

```
accuracies = {
    'Rainfall Prediction (Stacking)': accuracy_stacking,
```

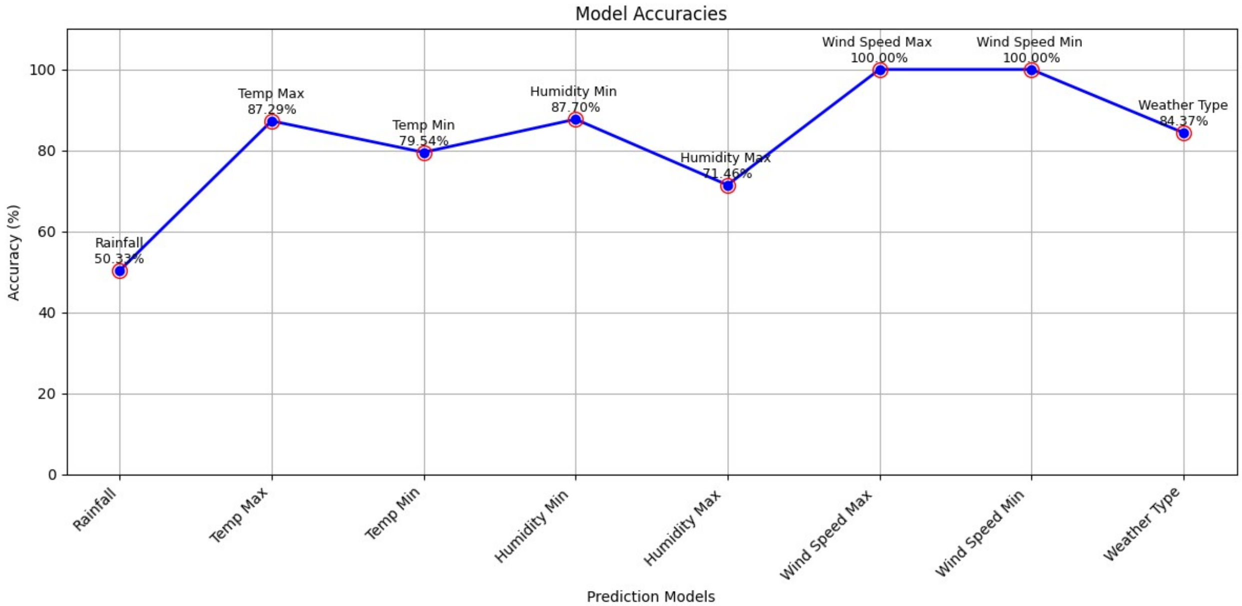
```
    'Temp Max Prediction (RandomForest)': accuracy_temp_max,
    'Temp Min Prediction (RandomForest)': accuracy_temp_min,
    'Humidity Min Prediction (GradientBoosting)':
accuracy_humidity_min,
    'Humidity Max Prediction (RandomForest)': accuracy_humidity_max,
    'Wind Speed Max Prediction (Voting)': accuracy_wind_max,
    'Wind Speed Min Prediction (Voting)': accuracy_wind_min,
    'Weather Type Prediction (DecisionTree)': accuracy
}


fig, ax = plt.subplots(figsize=(10, 6))
ax.bar(accuracies.keys(), accuracies.values(), color='skyblue')
ax.set_title('Model Accuracies')
ax.set_xlabel('Prediction Models')
ax.set_ylabel('Accuracy (%)')
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()
```




*Plot of all attribute's accuracies together*

```
model_names = [
    'Rainfall',
    'Temp Max',
    'Temp Min',
```

```
    'Humidity Min ',
    'Humidity Max ',
    'Wind Speed Max ',
    'Wind Speed Min ',
    'Weather Type'
]
accuracies = [
    accuracy_stacking,
    accuracy_temp_max,
    accuracy_temp_min,
    accuracy_humidity_min,
    accuracy_humidity_max,
    accuracy_wind_max,
    accuracy_wind_min,
    accuracy
]


plt.figure(figsize=(12, 6))
plt.plot(model_names, accuracies, marker='o', color='b',
linestyle='-', linewidth=2, markersize=6)

for i, (model, acc) in enumerate(zip(model_names, accuracies)):
    plt.text(i, acc + 1, f'{model}\n{acc:.2f}%', ha='center',
va='bottom', fontsize=9)
    plt.plot(i, acc, marker='o', markersize=10,
markerfacecolor='none', markeredgecolor='red')

plt.title('Model Accuracies')
plt.xlabel('Prediction Models')
plt.ylabel('Accuracy (%)')
plt.xticks(rotation=45, ha='right')
plt.ylim(0, 110)
plt.grid(True)
plt.tight_layout()
plt.show()
```



Model Accuracies
Accuracy (%)
0
20
40
60
80
100
Rainfall
50.33%
Temp Max
87.29%
Temp Min
79.54%
Humidity Min
87.70%
Humidity Max
71.46%
Wind Speed Max
100.00%
Wind Speed Min
100.00%
Weather Type
84.37%
Rainfall
Temp Max
Temp Min
Humidity Min
Humidity Max
Wind Speed Max
Wind Speed Min
Weather Type
Prediction Models