main

May 16, 2023

1 Assignment

1.1 Problem

The objective of this project is develop a predictive classifier to predict the next-day rain on the target variable RainTomorrow

1.2 Group Members

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1.3 Library used

pandas

numpy

matplotlib

seaborn

plotly

sklearn

1.3.1 Link for DataSet & Source & Acknowledgements

Observations were drawn from numerous weather stations

The daily observations are available from http://www.bom.gov.au/climate/data

`<li>Definitions adapted from <a href="http://www.bom.gov.au/climate/dwo/IDCJDW0000.shtml">http`

Data source

http://www.bom.gov.au/climate/data

`<li><a href="https://www.kaggle.com/datasets/arunavakrchakraborty/australia-weather-data">https`

1.4 Importing packages

We will import all the required packages and define our dataset

[ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.impute import SimpleImputer
from sklearn.compose import ColumnTransformer, make_column_selector
from sklearn.preprocessing import LabelEncoder
from sklearn.utils import resample
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier, GradientBoostingClassifier
from sklearn.metrics import confusion_matrix
```

1.5 Dataset

In this step we will describe the data in the dataset

This dataset contains about 10 years of daily weather observations from many locations across Australia.

1.5.1 Data Description

Location - Name of the city from Australia. . MinTemp - The Minimum temperature during a particular day. (degree Celsius) MaxTemp - The maximum temperature during a particular day. (degree Celsius) MeanTemp - The mean temperature during a particular day. (degree Celsius) Rainfall - Rainfall during a particular day. (millimeters) Evaporation - Evaporation during a particular day. (millimeters) Sunshine - Bright sunshine during a particular day. (hours) WindGusDir - The direction of the strongest gust during a particular day. (16 compass points) WindGuSpeed - Speed of strongest gust during a particular day. (kilometers per hour) WindDir9am - The direction of the wind for 10 min prior to 9 am. (compass points) WindDir3pm - The direction of the wind for 10 min prior to 3 pm. (compass points) WindSpeed9am - Speed of the wind for 10 min prior to 9 am. (kilometers per hour) WindSpeed3pm - Speed of the wind for 10 min prior to 3 pm. (kilometers per hour) Humidity9am - The humidity of the wind at 9 am. (percent) Humidity3pm - The humidity of the wind at 3 pm. (percent) AvgHumidity - The average of humidity of the wind. (percent) Pressure9am - Atmospheric pressure at 9 am. (hectopascals) Pressure3pm - Atmospheric pressure at 3 pm. (hectopascals) AvgPressure - The average Atmospheric pressure. (hectopascals) Cloud9am - Cloud-obscured portions of the sky at 9 am. (eighths) Cloud3pm - Cloud-obscured portions of the sky at 3 pm. (eighths) Temp9am - The temperature at 9 am. (degree Celsius) Temp3pm - The temperature at 3 pm. (degree Celsius) RainToday - If today is rainy then 'Yes'. If today is not rainy then 'No'. RainTomorrow - This is will be the variable containing value of "if tomorrow is rainy then 1 (Yes) or if tomorrow is not rainy then 0 (No)"

[ ]:
```
df_train = pd.read_csv('WeatherTrainingData.csv')
df_test = pd.read_csv('WeatherTestData.csv')
```

[ ]:
```
print(df_train.shape)
print(df_test.shape)
```

```
(99516, 26)
(42677, 25)
```

[ ]:
```
df_train
```

[ ]:
```
       row ID Location  MinTemp  MaxTemp  MeanTemp  Rainfall  Evaporation  \
0           0   Albury     13.4     22.9     18.20       0.6          NaN
1           1   Albury      7.4     25.1     16.30       0.0          NaN
2           2   Albury     17.5     32.3     24.90       1.0          NaN
3           3   Albury     14.6     29.7     22.20       0.2          NaN
4           4   Albury      7.7     26.7     17.20       0.0          NaN
…         …      …       …        …        …         …           …
99511   99511    Uluru      8.0     20.7     14.35       0.0          NaN
99512   99512    Uluru      3.5     21.8     12.70       0.0          NaN
99513   99513    Uluru      2.8     23.4     13.10       0.0          NaN
99514   99514    Uluru      3.6     25.3     14.50       0.0          NaN
99515   99515    Uluru      5.4     26.9     16.20       0.0          NaN

       Sunshine WindGustDir  WindGustSpeed  … AvgHumidity Pressure9am  \
0           NaN           W           44.0  …        46.5      1007.7
1           NaN         WNW           44.0  …        34.5      1010.6
2           NaN           W           41.0  …        57.5      1010.8
3           NaN         WNW           56.0  …        39.0      1009.2
4           NaN           W           35.0  …        33.5      1013.4
…           …           …             …  …           …           …
99511       NaN         ESE           41.0  …        44.0      1028.1
99512       NaN           E           31.0  …        43.0      1024.7
99513       NaN           E           31.0  …        37.5      1024.6
99514       NaN         NNW           22.0  …        38.5      1023.5
99515       NaN           N           37.0  …        38.5      1021.0

       Pressure3pm  AvgPressure  Cloud9am  Cloud3pm  Temp9am  Temp3pm  \
0           1007.1       1007.4       8.0       NaN     16.9     21.8
1           1007.8       1009.2       NaN       NaN     17.2     24.3
2           1006.0       1008.4       7.0       8.0     17.8     29.7
3           1005.4       1007.3       NaN       NaN     20.6     28.9
4           1010.1       1011.8       NaN       NaN     16.3     25.5
…              …            …       …         …        …
99511       1024.3       1026.2       NaN       7.0     11.6     20.0
99512       1021.2       1023.0       NaN       NaN      9.4     20.9
99513       1020.3       1022.5       NaN       NaN     10.1     22.4
99514       1019.1       1021.3       NaN       NaN     10.9     24.5
99515       1016.8       1018.9       NaN       NaN     12.5     26.1

       RainToday  RainTomorrow
```

```
0             No            0
1             No            0
2             No            0
3             No            0
4             No            0
…           …           …
99511         No            0
99512         No            0
99513         No            0
99514         No            0
99515         No            0

[99516 rows x 26 columns]
```

1.6 Data Cleaning

Now in order to use this data, we need to clean the data and remove all the empty cells from the dataset. So we will use dropna( )

[ ]:
```
data_test=df_test
data_train=df_train
data_test['RainToday'] = data_test['RainToday'].map({'Yes': 1, 'No': 0})
```

[ ]:
```
data_test
```

[ ]:
```
       row ID Location  MinTemp  MaxTemp  MeanTemp  Rainfall  Evaporation  \
0           0   Albury     12.9     25.7     19.30       0.0          NaN
1           1   Albury      9.2     28.0     18.60       0.0          NaN
2           2   Albury     14.3     25.0     19.65       0.0          NaN
3           3   Albury      9.7     31.9     20.80       0.0          NaN
4           4   Albury     15.9     18.6     17.30      15.6          NaN
…       …      …      …      …       …       …       …
42672   42672    Uluru      2.4     19.1     10.80       0.0          NaN
42673   42673    Uluru      2.3     21.4     11.90       0.0          NaN
42674   42674    Uluru      2.6     22.5     12.60       0.0          NaN
42675   42675    Uluru      7.4     20.6     14.00       0.0          NaN
42676   42676    Uluru      7.8     27.0     17.40       0.0          NaN

       Sunshine WindGustDir  WindGustSpeed  … Humidity3pm AvgHumidity  \
0           NaN         WSW           46.0  …        30.0        34.0
1           NaN          NE           24.0  …        16.0        30.5
2           NaN           W           50.0  …        19.0        34.0
3           NaN         NNW           80.0  …         9.0        25.5
4           NaN           W           61.0  …        93.0        84.5
…         …           …             …   …         …         …
42672       NaN           E           33.0  …        24.0        41.5
42673       NaN          SE           22.0  …        28.0        44.0
42674       NaN           S           19.0  …        24.0        41.5
```

```
42675       NaN            E           35.0  …        33.0        48.0
42676       NaN           SE           28.0  …        24.0        37.5

       Pressure9am  Pressure3pm  AvgPressure  Cloud9am  Cloud3pm  Temp9am  \
0           1007.6       1008.7      1008.20       NaN       2.0     21.0
1           1017.6       1012.8      1015.20       NaN       NaN     18.1
2           1009.6       1008.2      1008.90       1.0       NaN     18.1
3           1008.9       1003.6      1006.30       NaN       NaN     18.3
4            994.3        993.0       993.65       8.0       8.0     17.4
…              …           …           …          …         …       …
42672       1030.0       1026.2      1028.10       NaN       NaN      8.0
42673       1026.9       1022.8      1024.90       NaN       NaN      8.9
42674       1025.0       1021.4      1023.20       NaN       NaN      8.8
42675       1027.2       1023.3      1025.30       NaN       NaN     11.0
42676       1019.4       1016.5      1018.00       3.0       2.0     15.1

       Temp3pm  RainToday
0         23.2        0.0
1         26.5        0.0
2         24.6        0.0
3         30.2        0.0
4         15.8        1.0
…          …          …
42672     18.8        0.0
42673     20.3        0.0
42674     22.1        0.0
42675     20.3        0.0
42676     26.0        0.0

[42677 rows x 25 columns]
```

[ ]:
```python
data_test.drop(columns=['Sunshine', 'Evaporation'], inplace=True)
categorical = data_test.select_dtypes(include = "object").columns
cleaner = ColumnTransformer([
    ('categorical_transformer', SimpleImputer(strategy='most_frequent'),␣
 ↪categorical)
])
data_test[categorical] = cleaner.fit_transform(data_test[categorical])
null_columns=data_test.columns[data_test.isnull().any()]
data_test[null_columns].isnull().sum()
```

[ ]:
```
MinTemp           194
MaxTemp            92
Rainfall          427
WindGustSpeed    2790
WindSpeed9am      413
WindSpeed3pm      795
```

```
Humidity9am        541
Humidity3pm       1104
Pressure9am       4266
Pressure3pm       4245
Cloud9am         16085
Cloud3pm         17092
Temp9am            290
Temp3pm            822
RainToday          427
dtype: int64
```

2 Data Analysis

Now we will plot graphs comparing diffrent characteristics of our dataset

2.1 1. Feature Distribution

[ ]:
```
X = df_train.drop(columns=['RainTomorrow'])
y = df_train['RainTomorrow']
df = pd.concat([X, df_test], axis=0)
```

[ ]:
```
df.describe().T
```

[ ]:
```
                  count          mean           std    min      25%       50%  \
row ID         142193.0  41227.832566  28156.744372    0.0  17774.0  35548.00
MinTemp        141556.0     12.186400      6.403283   -8.5      7.6     12.00
MaxTemp        141871.0     23.226784      7.117618   -4.8     17.9     22.60
MeanTemp       142193.0     17.672565      6.328795   -6.2     12.9     17.35
Rainfall       140787.0      2.349974      8.465173    0.0      0.0      0.00
Evaporation     56985.0      5.461320      4.162490    0.0      2.6      4.80
Sunshine        52199.0      7.615090      3.783008    0.0      4.8      8.40
WindGustSpeed  132923.0     39.984292     13.588801    6.0     31.0     39.00
WindSpeed9am   140845.0     14.001988      8.893337    0.0      7.0     13.00
WindSpeed3pm   139563.0     18.637576      8.803345    0.0     13.0     19.00
Humidity9am    140419.0     68.843810     19.051293    0.0     57.0     70.00
Humidity3pm    138583.0     51.482606     20.797772    0.0     37.0     52.00
AvgHumidity    142193.0     59.080240     19.084638    0.0     47.0     60.50
Pressure9am    128179.0   1017.653758      7.105476  980.5   1012.9   1017.60
Pressure3pm    128212.0   1015.258204      7.036677  977.1   1010.4   1015.20
AvgPressure    142193.0    916.413905    301.650595    0.0   1009.8   1015.50
Cloud9am        88536.0      4.437189      2.887016    0.0      1.0      5.00
Cloud3pm        85099.0      4.503167      2.720633    0.0      2.0      5.00
Temp9am        141289.0     16.987509      6.492838   -7.2     12.3     16.70
Temp3pm        139467.0     21.687235      6.937594   -5.4     16.6     21.10

                   75%      max
row ID         63967.0  99515.0
```

MinTemp	16.8	33.9
MaxTemp	28.2	48.1
MeanTemp	22.3	38.8
Rainfall	0.8	371.0
Evaporation	7.4	86.2
Sunshine	10.6	14.5
WindGustSpeed	48.0	135.0
WindSpeed9am	19.0	130.0
WindSpeed3pm	24.0	87.0
Humidity9am	83.0	100.0
Humidity3pm	66.0	100.0
AvgHumidity	72.5	100.0
Pressure9am	1022.4	1041.0
Pressure3pm	1020.0	1039.6
AvgPressure	1020.6	1040.1
Cloud9am	7.0	9.0
Cloud3pm	7.0	9.0
Temp9am	21.6	40.2
Temp3pm	26.4	46.7

[ ]:
```
df.drop(columns='row ID', inplace=True)
total = df.isnull().sum().sort_values(ascending=False)
percent = (df.isnull().sum() / df.isnull().count()).sort_values(ascending=False)
missing_data = pd.concat([total, percent], axis=1, keys=['Total', 'Percent'])
missing_data
```

[ ]:

	Total	Percent
Sunshine	89994	0.632900
Evaporation	85208	0.599242
Cloud3pm	57094	0.401525
Cloud9am	53657	0.377353
Pressure9am	14014	0.098556
Pressure3pm	13981	0.098324
WindGustSpeed	9270	0.065193
WindDir9am	7006	0.049271
WindGustDir	6521	0.045860
Humidity3pm	3610	0.025388
Temp3pm	2726	0.019171
WindDir3pm	2648	0.018623
WindSpeed3pm	2630	0.018496
Humidity9am	1774	0.012476
RainToday	1406	0.009888
Rainfall	1406	0.009888
WindSpeed9am	1348	0.009480
Temp9am	904	0.006358
MinTemp	637	0.004480
MaxTemp	322	0.002265

```
AvgHumidity        0   0.000000
AvgPressure        0   0.000000
MeanTemp           0   0.000000
Location           0   0.000000
```

[ ]:
```
df.drop(columns=['Sunshine', 'Evaporation'], inplace=True)
df.dtypes
```

[ ]:
```
Location          object
MinTemp          float64
MaxTemp          float64
MeanTemp         float64
Rainfall         float64
WindGustDir       object
WindGustSpeed    float64
WindDir9am        object
WindDir3pm        object
WindSpeed9am     float64
WindSpeed3pm     float64
Humidity9am      float64
Humidity3pm      float64
AvgHumidity      float64
Pressure9am      float64
Pressure3pm      float64
AvgPressure      float64
Cloud9am         float64
Cloud3pm         float64
Temp9am          float64
Temp3pm          float64
RainToday         object
dtype: object
```

[ ]:
```
categorical = df.select_dtypes(include = "object").columns
cleaner = ColumnTransformer([
    ('categorical_transformer', SimpleImputer(strategy='most_frequent'),␣
 ↪categorical)
])
df[categorical] = cleaner.fit_transform(df[categorical])

null_columns=df.columns[df.isnull().any()]
df[null_columns].isnull().sum()
```

[ ]:
```
MinTemp            637
MaxTemp            322
Rainfall          1406
WindGustSpeed     9270
WindSpeed9am      1348
```

```
WindSpeed3pm      2630
Humidity9am       1774
Humidity3pm       3610
Pressure9am      14014
Pressure3pm      13981
Cloud9am         53657
Cloud3pm         57094
Temp9am            904
Temp3pm           2726
dtype: int64
```

[ ]:
```
df = df.fillna(df.median())
df.isnull().sum()
```

```
/var/folders/df/npmhf4fs0qb8cnwm2kmptxk00000gn/T/ipykernel_94084/1273592041.py:1
: FutureWarning:

The default value of numeric_only in DataFrame.median is deprecated. In a future
version, it will default to False. In addition, specifying 'numeric_only=None'
is deprecated. Select only valid columns or specify the value of numeric_only to
silence this warning.
```

[ ]:
```
Location         0
MinTemp          0
MaxTemp          0
MeanTemp         0
Rainfall         0
WindGustDir      0
WindGustSpeed    0
WindDir9am       0
WindDir3pm       0
WindSpeed9am     0
WindSpeed3pm     0
Humidity9am      0
Humidity3pm      0
AvgHumidity      0
Pressure9am      0
Pressure3pm      0
AvgPressure      0
Cloud9am         0
Cloud3pm         0
Temp9am          0
Temp3pm          0
RainToday        0
dtype: int64
```

[ ]:
```python
categorical = df.select_dtypes(include = "object").columns
for i in range(len(categorical)):
    print(df[categorical[i]].value_counts())
    print('************************************\n')
```

```
Canberra            3418
Sydney              3337
Perth               3193
Darwin              3192
Hobart              3188
Brisbane            3161
Adelaide            3090
Bendigo             3034
Townsville          3033
AliceSprings        3031
MountGambier        3030
Launceston          3028
Ballarat            3028
Albany              3016
Albury              3011
PerthAirport        3009
MelbourneAirport    3009
Mildura             3007
SydneyAirport       3005
Nuriootpa           3002
Sale                3000
Watsonia            2999
Tuggeranong         2998
Portland            2996
Woomera             2990
Cairns              2988
Cobar               2988
Wollongong          2983
GoldCoast           2980
WaggaWagga          2976
Penrith             2964
NorfolkIsland       2964
SalmonGums          2955
Newcastle           2955
CoffsHarbour        2953
Witchcliffe         2952
Richmond            2951
Dartmoor            2943
NorahHead           2929
BadgerysCreek       2928
MountGinini         2907
Moree               2854
Walpole             2819
```

```
PearceRAAF          2762
Williamtown         2553
Melbourne           2435
Nhil                1569
Katherine           1559
Uluru               1521
Name: Location, dtype: int64
************************************

W      19110
SE      9309
E       9071
N       9033
SSE     8993
S       8949
WSW     8901
SW      8797
SSW     8610
WNW     8066
NW      8003
ENE     7992
ESE     7305
NE      7060
NNW     6561
NNE     6433
Name: WindGustDir, dtype: int64
************************************

N      21406
SE      9162
E       9024
SSE     8966
NW      8552
S       8493
W       8260
SW      8237
NNE     7948
NNW     7840
ENE     7735
ESE     7558
NE      7527
SSW     7448
WNW     7194
WSW     6843
Name: WindDir9am, dtype: int64
************************************

SE     14441
```

```
W      9911
S      9598
WSW    9329
SW     9182
SSE    9142
N      8667
WNW    8656
NW     8468
ESE    8382
E      8342
NE     8164
SSW    8010
NNW    7733
ENE    7724
NNE    6444
Name: WindDir3pm, dtype: int64
************************************

No     77887
0.0    32851
Yes    22056
1.0     9399
Name: RainToday, dtype: int64
************************************
```

[ ]:
```
from sklearn.preprocessing import LabelEncoder

for col in df.columns:
    if df[col].dtype == 'object':
        df[col] = df[col].astype(str)
        df[col] = LabelEncoder().fit_transform(df[col])

df
```

[ ]:
```
       Location  MinTemp  MaxTemp  MeanTemp  Rainfall  WindGustDir  \
0             2     13.4     22.9      18.2       0.6           13
1             2      7.4     25.1      16.3       0.0           14
2             2     17.5     32.3      24.9       1.0           13
3             2     14.6     29.7      22.2       0.2           14
4             2      7.7     26.7      17.2       0.0           13
…           …       …       …        …        …          …
42672        41      2.4     19.1      10.8       0.0            0
42673        41      2.3     21.4      11.9       0.0            9
42674        41      2.6     22.5      12.6       0.0            8
42675        41      7.4     20.6      14.0       0.0            0
42676        41      7.8     27.0      17.4       0.0            9
```

```
       WindGustSpeed  WindDir9am  WindDir3pm  WindSpeed9am  …  Humidity3pm  \
0               44.0          13          14          20.0  …         22.0
1               44.0           6          15           4.0  …         25.0
2               41.0           1           7           7.0  …         33.0
3               56.0          13          13          19.0  …         23.0
4               35.0          10          13           6.0  …         19.0
…                …           …           …             …  …          …
42672           33.0           9           0          17.0  …         24.0
42673           22.0           9          10          11.0  …         28.0
42674           19.0           8           0           9.0  …         24.0
42675           35.0           2           0          15.0  …         33.0
42676           28.0          10           3          13.0  …         24.0

       AvgHumidity  Pressure9am  Pressure3pm  AvgPressure  Cloud9am  Cloud3pm  \
0             46.5       1007.7       1007.1       1007.4       8.0       5.0
1             34.5       1010.6       1007.8       1009.2       5.0       5.0
2             57.5       1010.8       1006.0       1008.4       7.0       8.0
3             39.0       1009.2       1005.4       1007.3       5.0       5.0
4             33.5       1013.4       1010.1       1011.8       5.0       5.0
…              …           …           …           …         …       …
42672         41.5       1030.0       1026.2       1028.1       5.0       5.0
42673         44.0       1026.9       1022.8       1024.9       5.0       5.0
42674         41.5       1025.0       1021.4       1023.2       5.0       5.0
42675         48.0       1027.2       1023.3       1025.3       5.0       5.0
42676         37.5       1019.4       1016.5       1018.0       3.0       2.0

       Temp9am  Temp3pm  RainToday
0         16.9     21.8          2
1         17.2     24.3          2
2         17.8     29.7          2
3         20.6     28.9          2
4         16.3     25.5          2
…           …        …          …
42672      8.0     18.8          0
42673      8.9     20.3          0
42674      8.8     22.1          0
42675     11.0     20.3          0
42676     15.1     26.0          0

[142193 rows x 22 columns]
```

[ ]:

```
'''objects = df.select_dtypes(include = "object").columns
for i in range(len(objects)):
    df[objects[i]] = LabelEncoder().fit_transform(df[objects[i]])

df'''
```

[ ]:
```
'objects = df.select_dtypes(include = "object").columns\nfor i in
range(len(objects)):\n    df[objects[i]] =
LabelEncoder().fit_transform(df[objects[i]])\n\ndf'
```

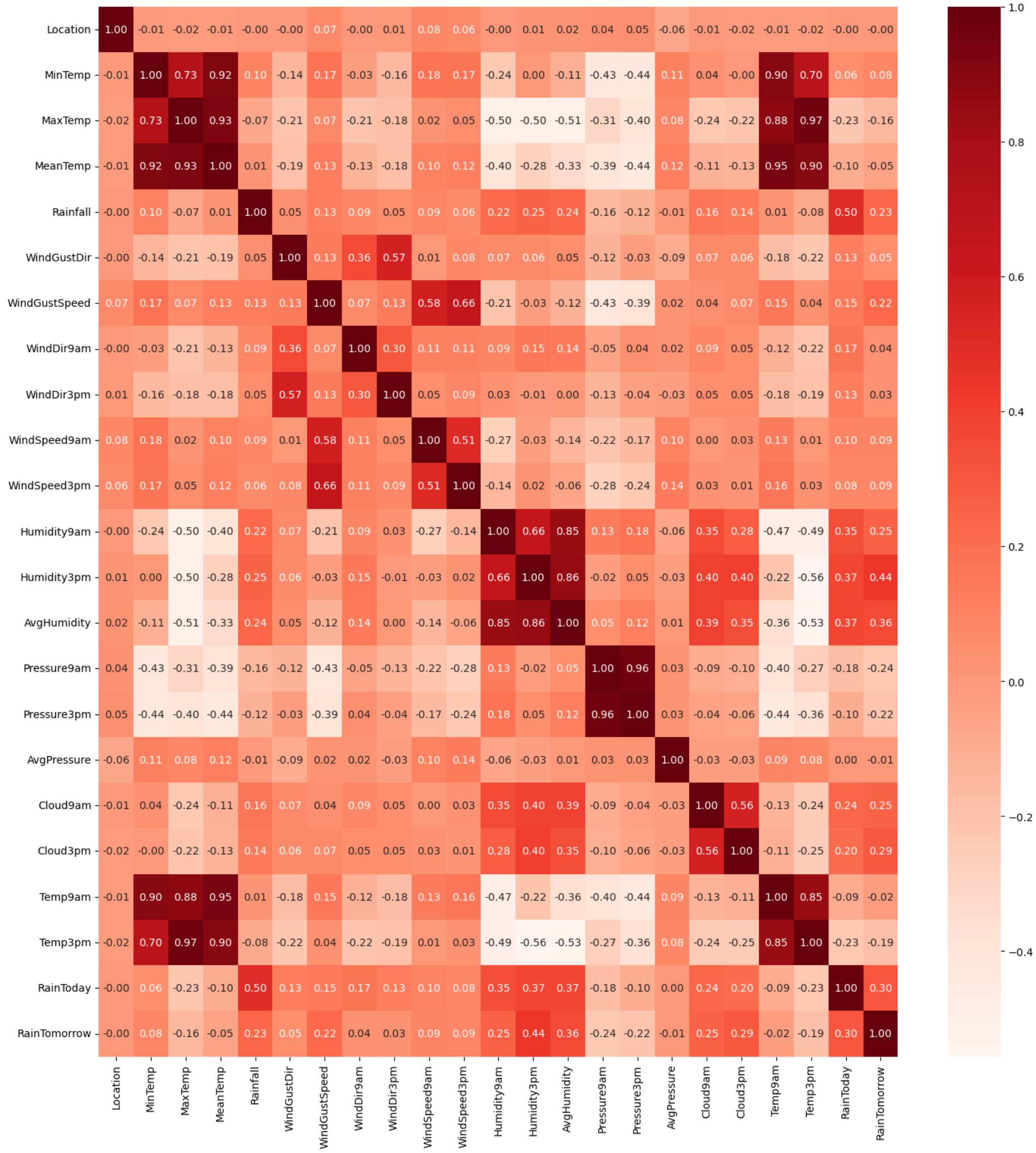
[ ]:
```
train = df.iloc[:99516,:]
new_train = pd.concat([train, y], axis=1)
test = df.iloc[99516:, :]
new_train
```

[ ]:
```
       Location  MinTemp  MaxTemp  MeanTemp  Rainfall  WindGustDir  \
0             2     13.4     22.9     18.20       0.6           13
1             2      7.4     25.1     16.30       0.0           14
2             2     17.5     32.3     24.90       1.0           13
3             2     14.6     29.7     22.20       0.2           14
4             2      7.7     26.7     17.20       0.0           13
…           …      …      …      …       …       …
99511        41      8.0     20.7     14.35       0.0            2
99512        41      3.5     21.8     12.70       0.0            0
99513        41      2.8     23.4     13.10       0.0            0
99514        41      3.6     25.3     14.50       0.0            6
99515        41      5.4     26.9     16.20       0.0            3

       WindGustSpeed  WindDir9am  WindDir3pm  WindSpeed9am  …  AvgHumidity  \
0               44.0          13          14          20.0  …         46.5
1               44.0           6          15           4.0  …         34.5
2               41.0           1           7           7.0  …         57.5
3               56.0          13          13          19.0  …         39.0
4               35.0          10          13           6.0  …         33.5
…                …         …         …          …  …          …
99511           41.0           9           0          19.0  …         44.0
99512           31.0           2           0          15.0  …         43.0
99513           31.0           9           1          13.0  …         37.5
99514           22.0           9           3          13.0  …         38.5
99515           37.0           9          14           9.0  …         38.5

       Pressure9am  Pressure3pm  AvgPressure  Cloud9am  Cloud3pm  Temp9am  \
0           1007.7       1007.1       1007.4       8.0       5.0     16.9
1           1010.6       1007.8       1009.2       5.0       5.0     17.2
2           1010.8       1006.0       1008.4       7.0       8.0     17.8
3           1009.2       1005.4       1007.3       5.0       5.0     20.6
4           1013.4       1010.1       1011.8       5.0       5.0     16.3
…              …          …          …          …       …       …
99511       1028.1       1024.3       1026.2       5.0       7.0     11.6
99512       1024.7       1021.2       1023.0       5.0       5.0      9.4
99513       1024.6       1020.3       1022.5       5.0       5.0     10.1
99514       1023.5       1019.1       1021.3       5.0       5.0     10.9
99515       1021.0       1016.8       1018.9       5.0       5.0     12.5
```

```
       Temp3pm  RainToday  RainTomorrow
0         21.8          2             0
1         24.3          2             0
2         29.7          2             0
3         28.9          2             0
4         25.5          2             0
…          …          …            …
99511     20.0          2             0
99512     20.9          2             0
99513     22.4          2             0
99514     24.5          2             0
99515     26.1          2             0

[99516 rows x 23 columns]
```

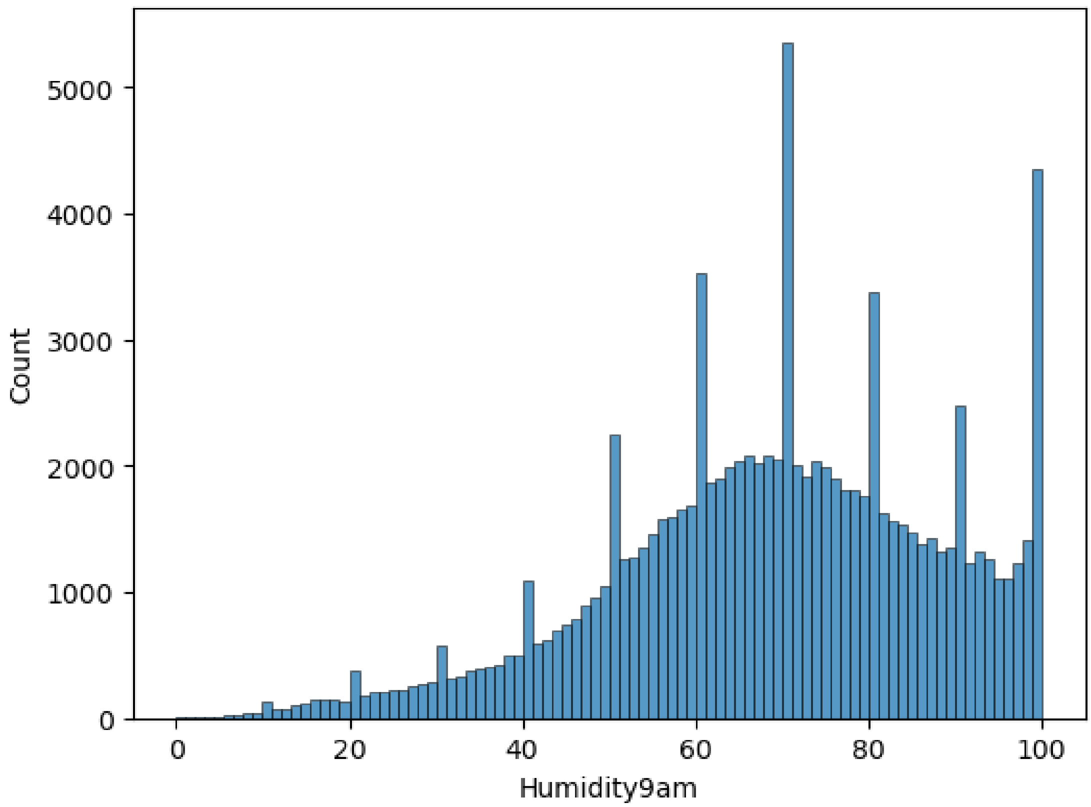
[ ]:
```
plt.figure(figsize=(17,18))
cor = new_train.corr()
sns.heatmap(cor, annot=True, cmap=plt.cm.Reds,fmt='.2f')
```

[ ]:
```
<Axes: >
```



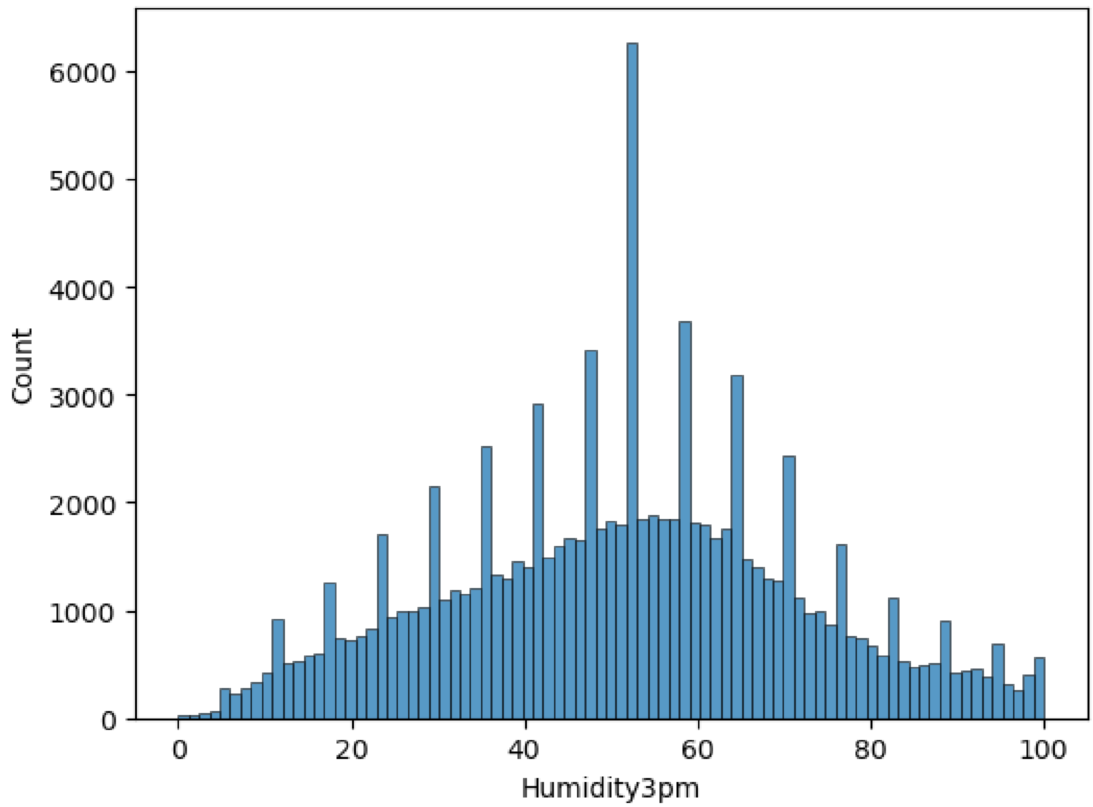
[ ]:
```
sns.histplot(new_train['Humidity9am'])
```

[ ]: <Axes: xlabel='Humidity9am', ylabel='Count'>



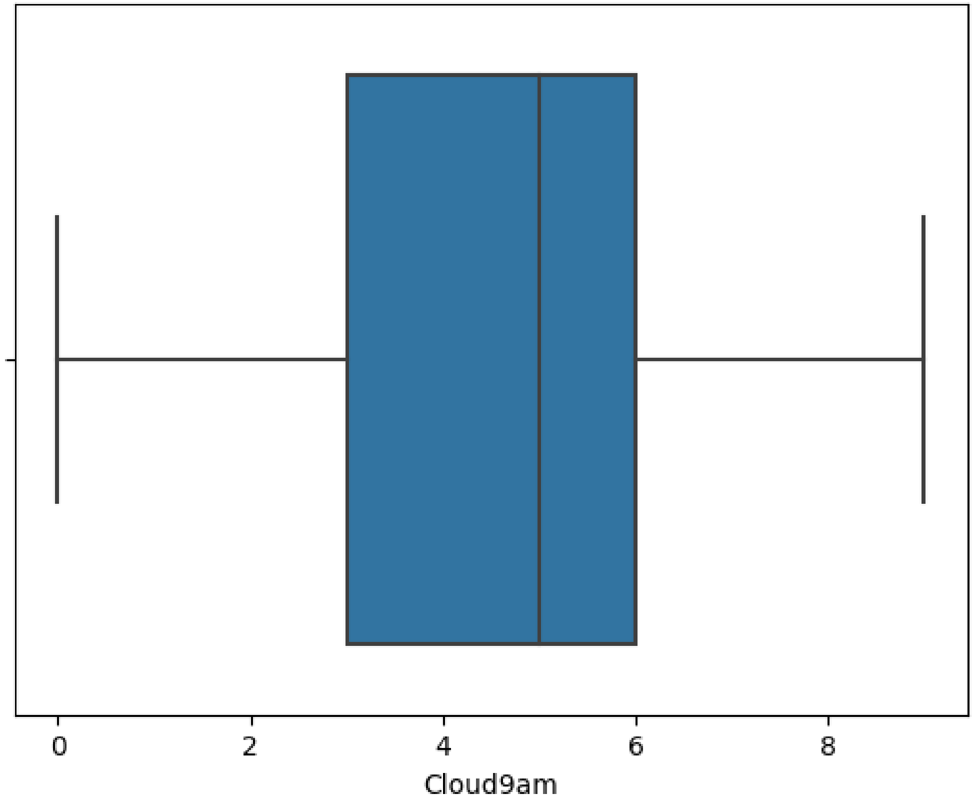
[ ]:
```
sns.histplot(new_train['Humidity3pm'])
```

[ ]: <Axes: xlabel='Humidity3pm', ylabel='Count'>



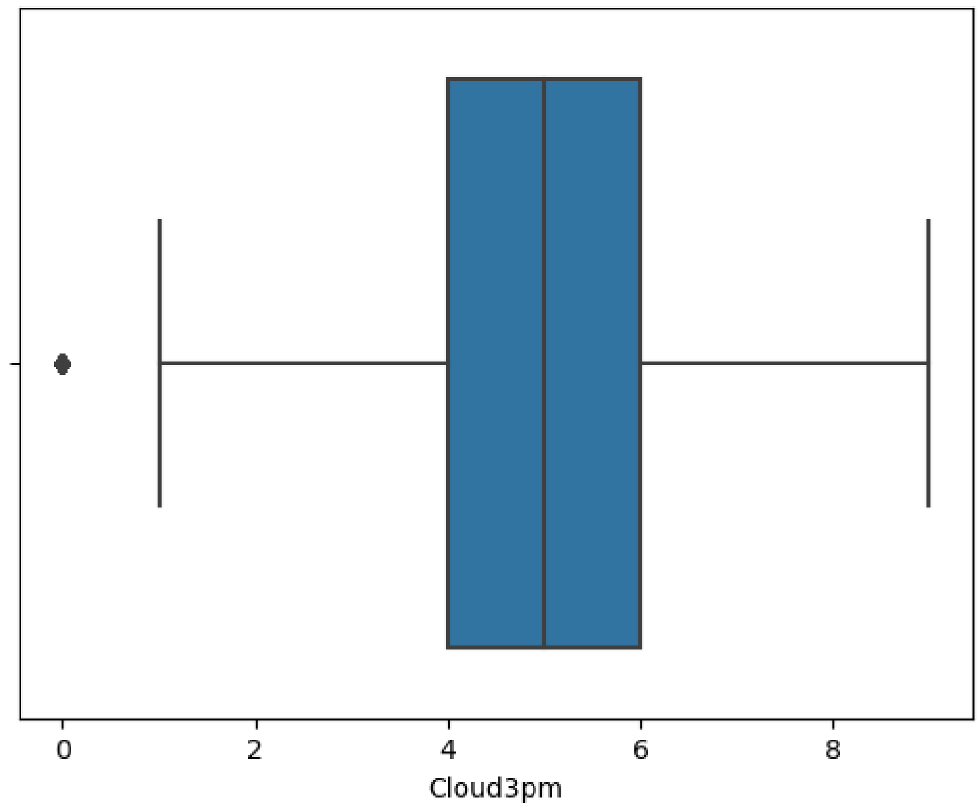
[ ]:
```
sns.boxplot(x=new_train['Cloud9am'])
```

[ ]: <Axes: xlabel='Cloud9am'>



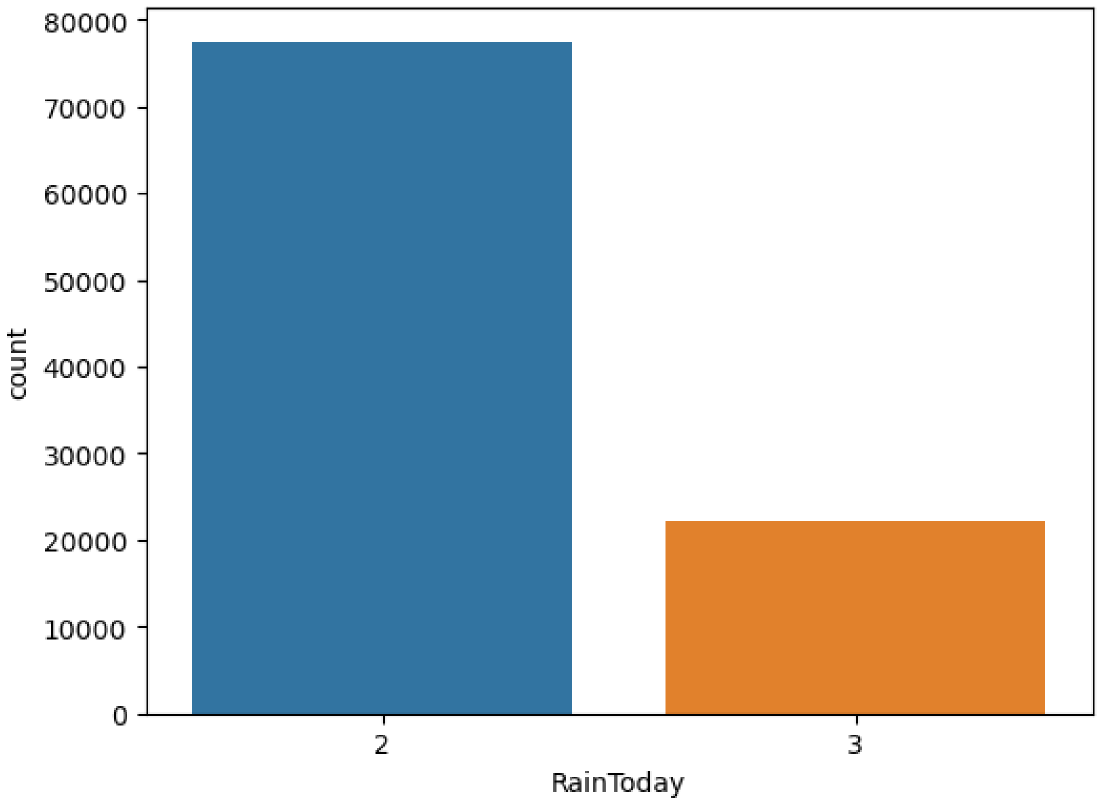
[ ]:
```
sns.boxplot(x=new_train['Cloud3pm'])
```

[ ]: <Axes: xlabel='Cloud3pm'>



[ ]:
```
sns.countplot(x=new_train['RainToday'])
```

[ ]: <Axes: xlabel='RainToday', ylabel='count'>

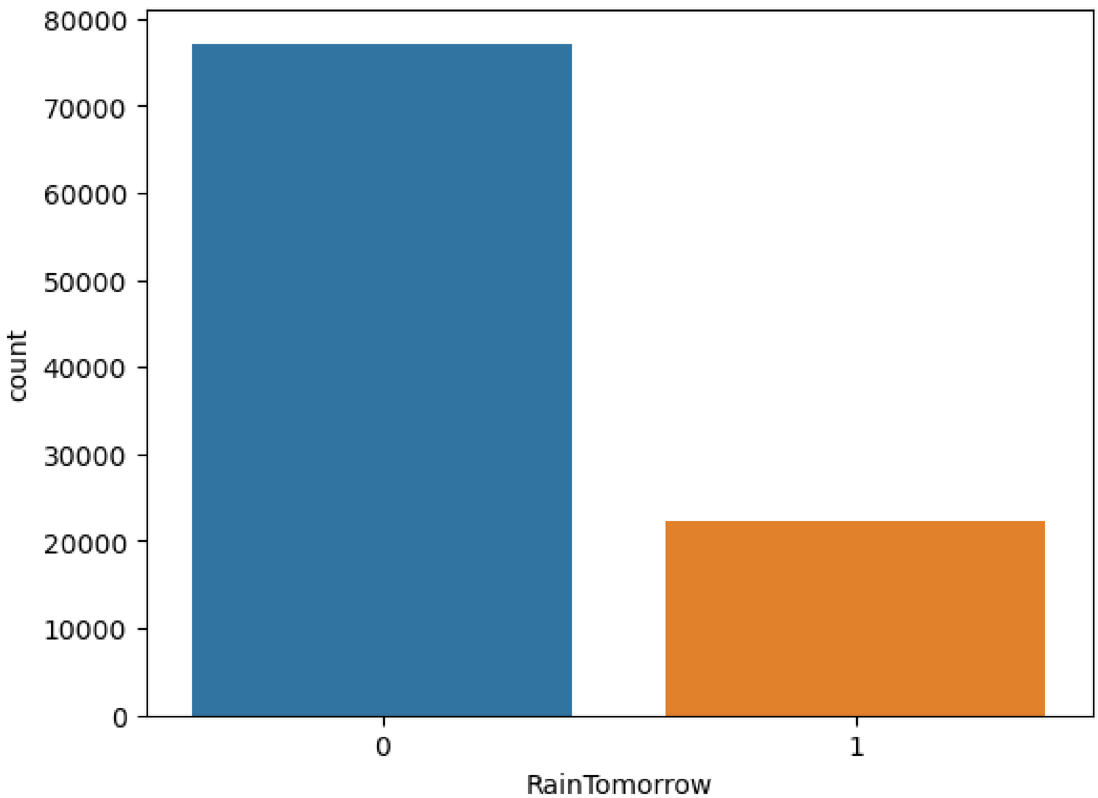


[ ]:
```
new_train['RainTomorrow'].value_counts()
```

[ ]:
```
0    77157
1    22359
Name: RainTomorrow, dtype: int64
```

[ ]:
```
sns.countplot(x=new_train['RainTomorrow'])
```

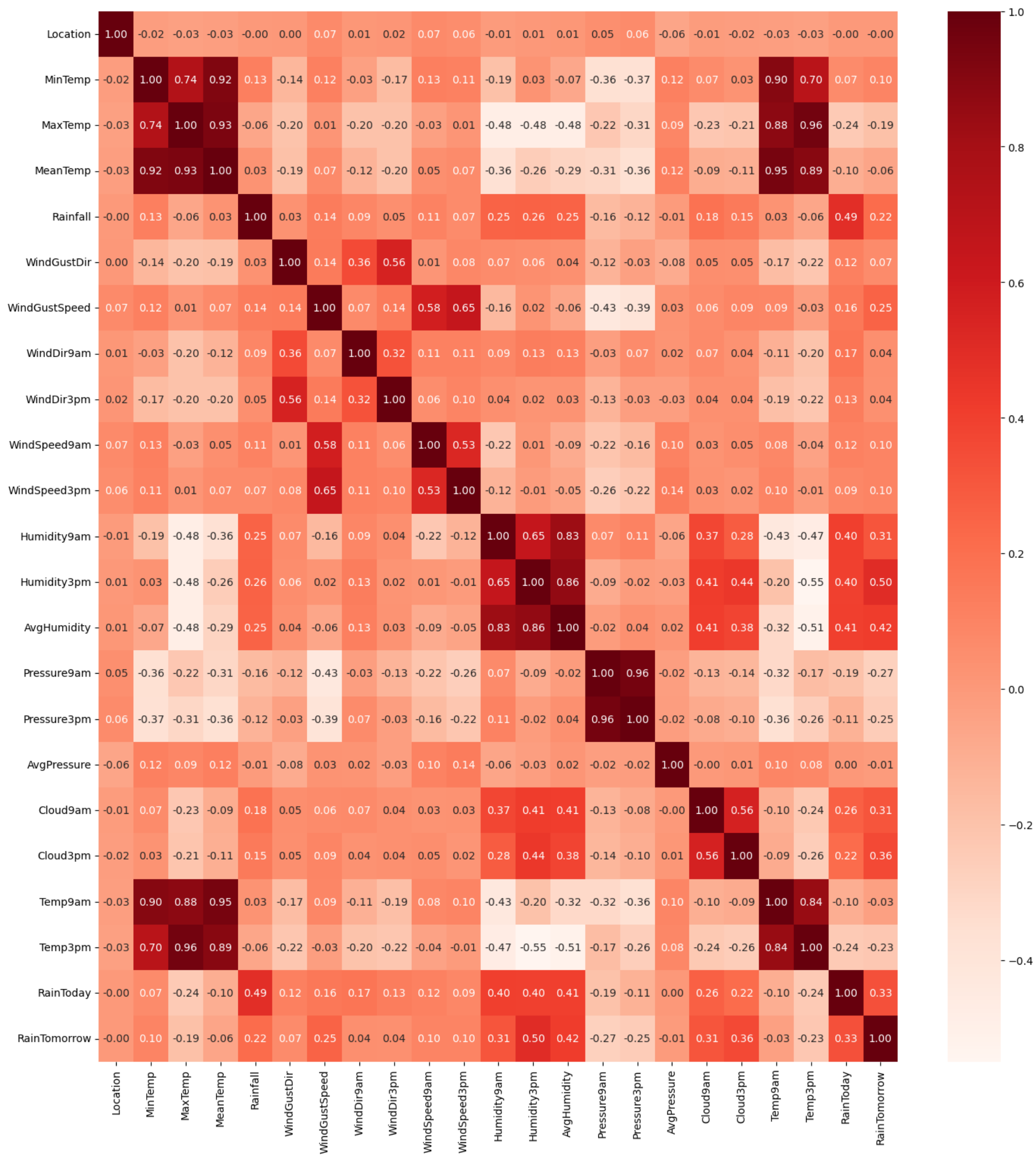
[ ]:
```
<Axes: xlabel='RainTomorrow', ylabel='count'>
```



[ ]:
```
df_majority_0 = new_train[(new_train['RainTomorrow']==0)]
df_minority_1 = new_train[(new_train['RainTomorrow']==1)]

df_minority_upsampled = resample(df_minority_1,
                                 replace=True,
                                 n_samples= 77157,
                                 random_state=42)

df_upsampled = pd.concat([df_minority_upsampled, df_majority_0])
```

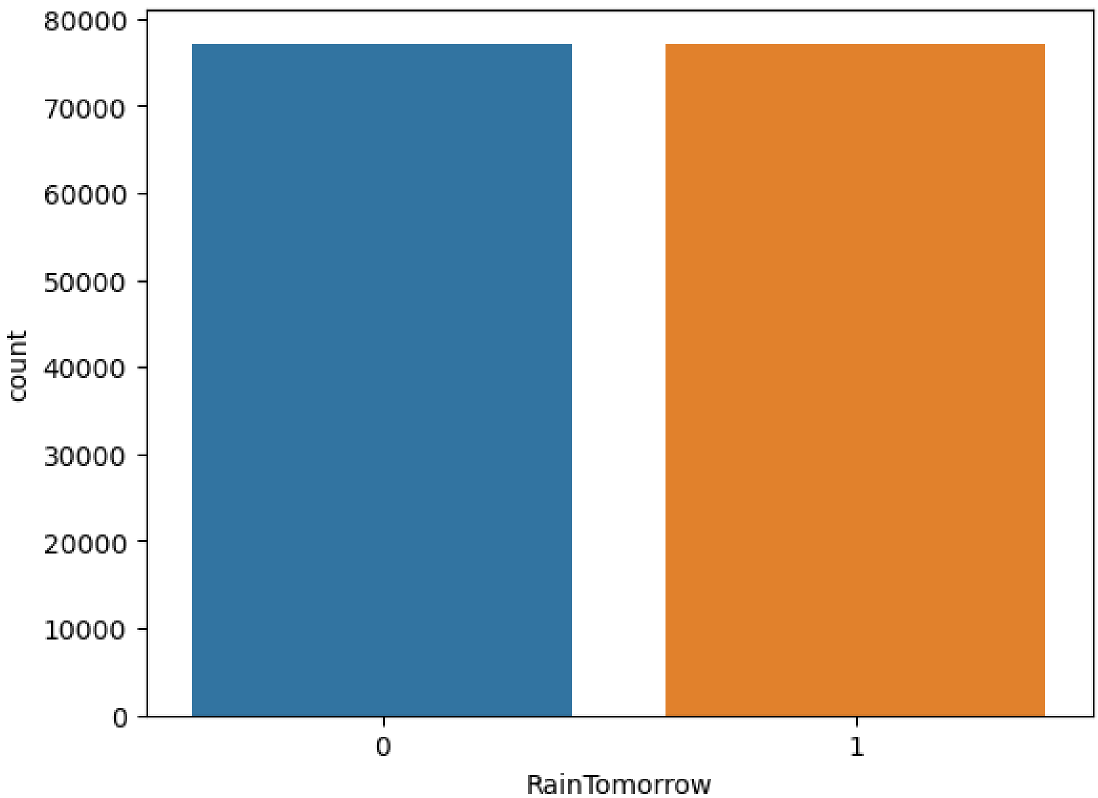
[ ]:
```
plt.figure(figsize=(17,18))
cor = df_upsampled.corr()
sns.heatmap(cor, annot=True, cmap=plt.cm.Reds,fmt='.2f')
```

[ ]: <Axes: >

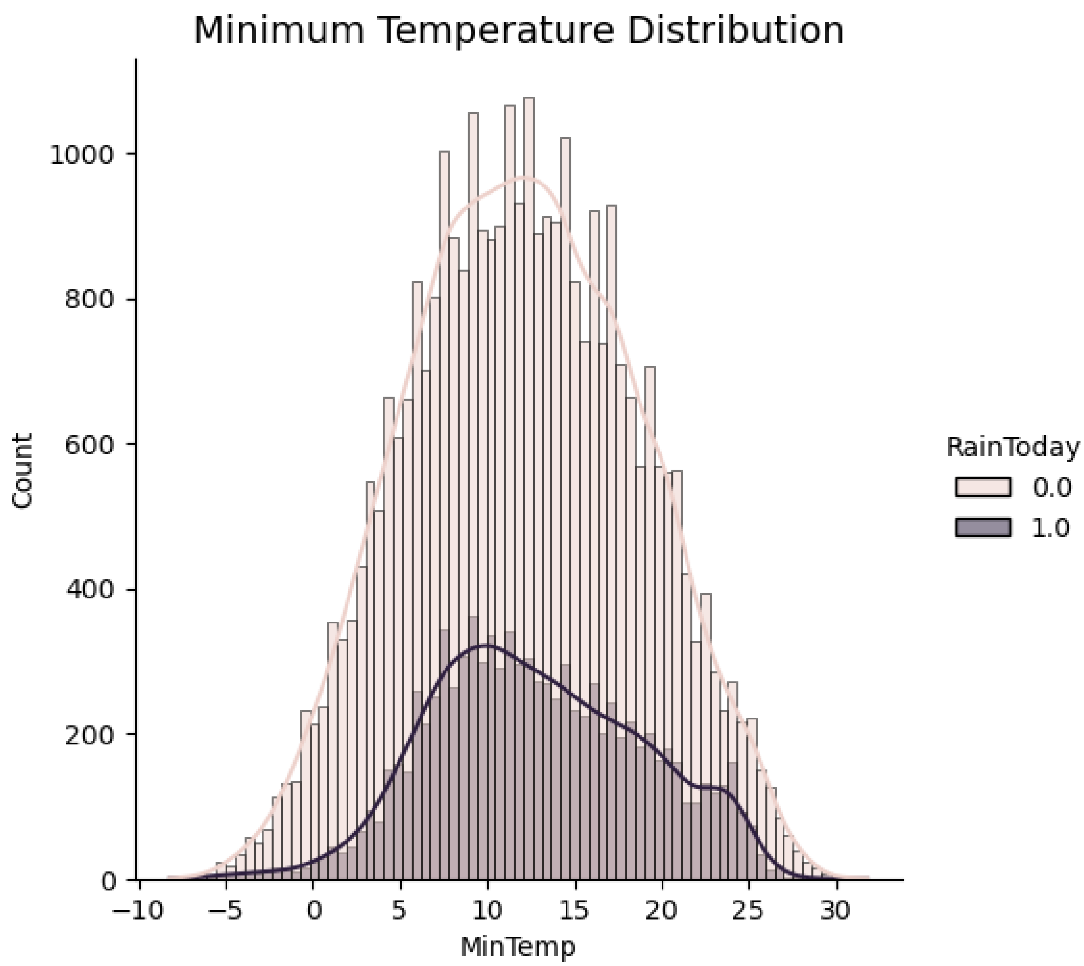


```
[ ]: sns.countplot(x=df_upsampled['RainTomorrow'])
```

```
[ ]: <Axes: xlabel='RainTomorrow', ylabel='count'>
```

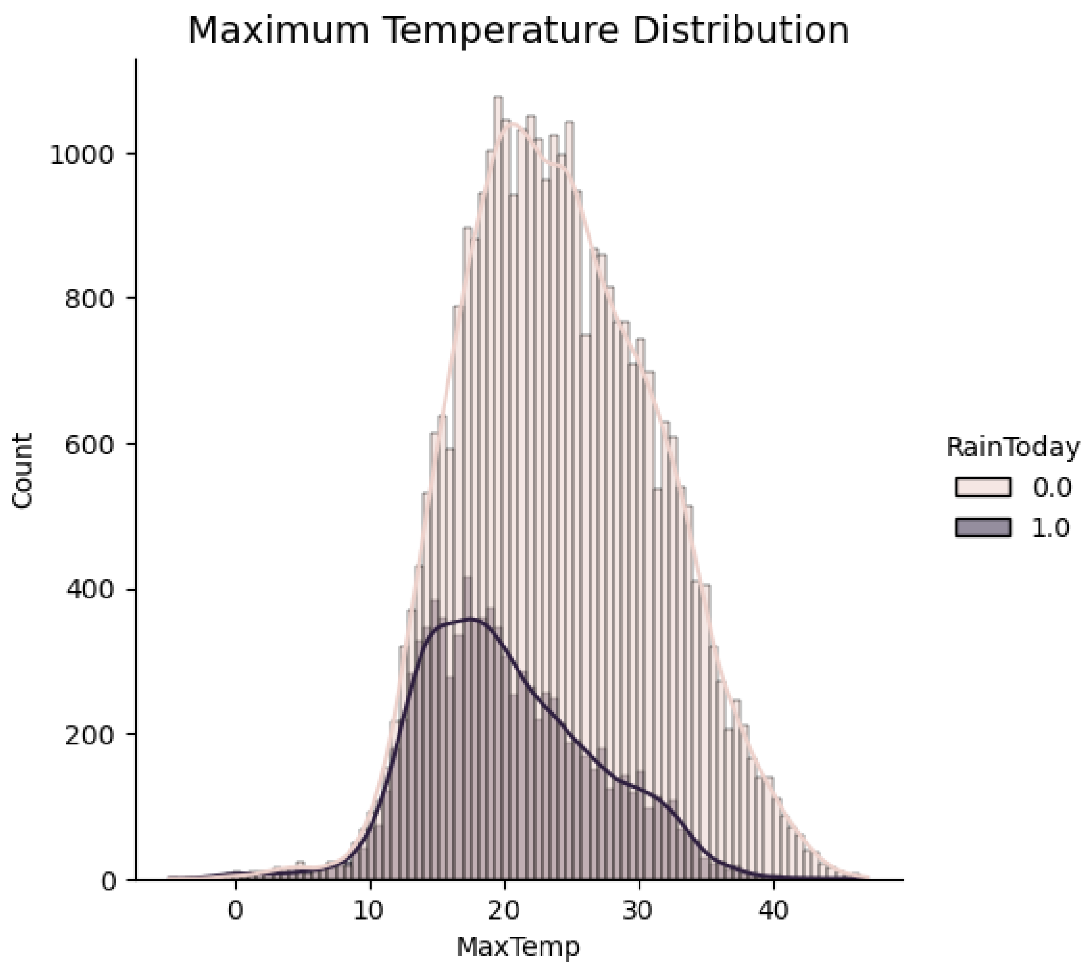


[ ]:
```
sns.displot(data_test, x="MinTemp", hue='RainToday', kde=True)
plt.title("Minimum Temperature Distribution", fontsize = 14)
plt.show()
```



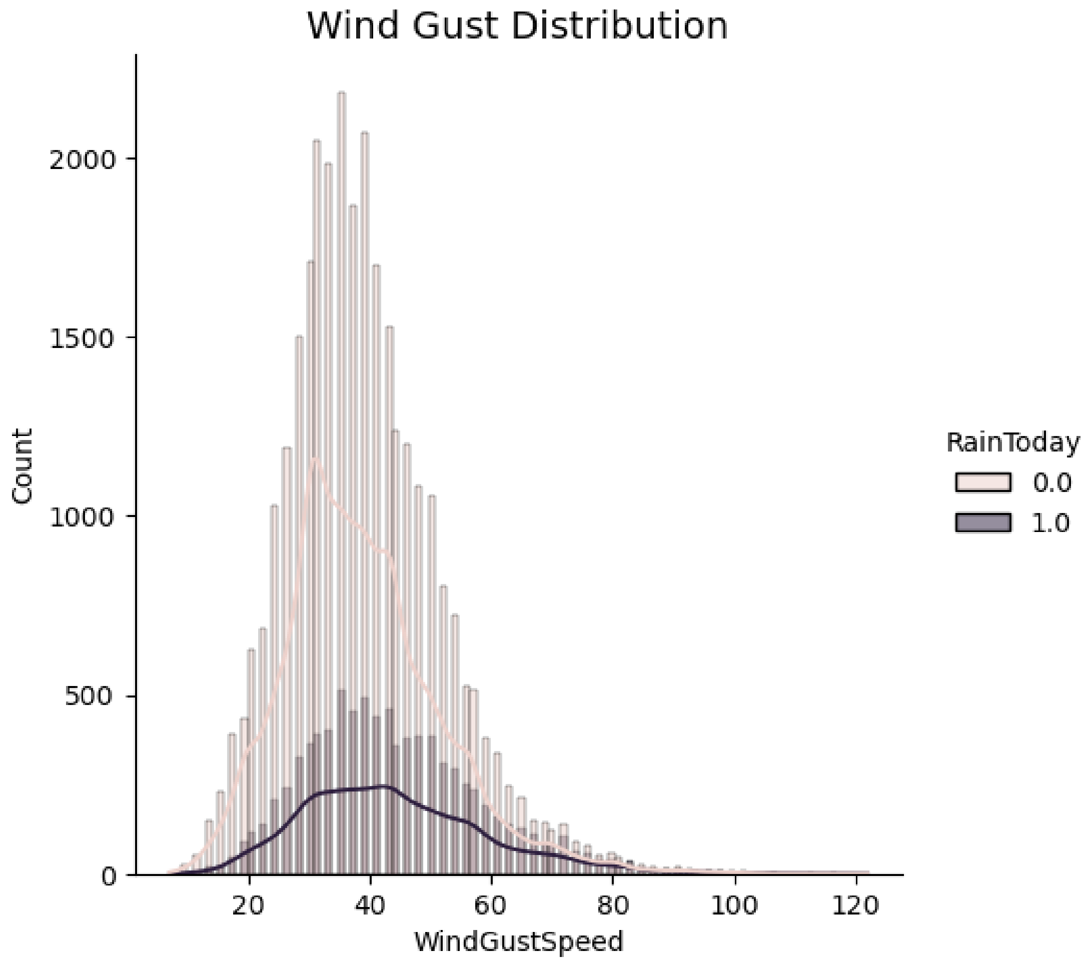
The analysis revealed that the minimum temperature range from -8.5 ℃ to 33.9 ℃ and the minimum temperature of 11 ℃ had the highest frequency in the data set.

[ ]:
```
sns.displot(data_test, x="MaxTemp", hue='RainToday', kde=True)
plt.title("Maximum Temperature Distribution", fontsize = 14)
plt.show()
```



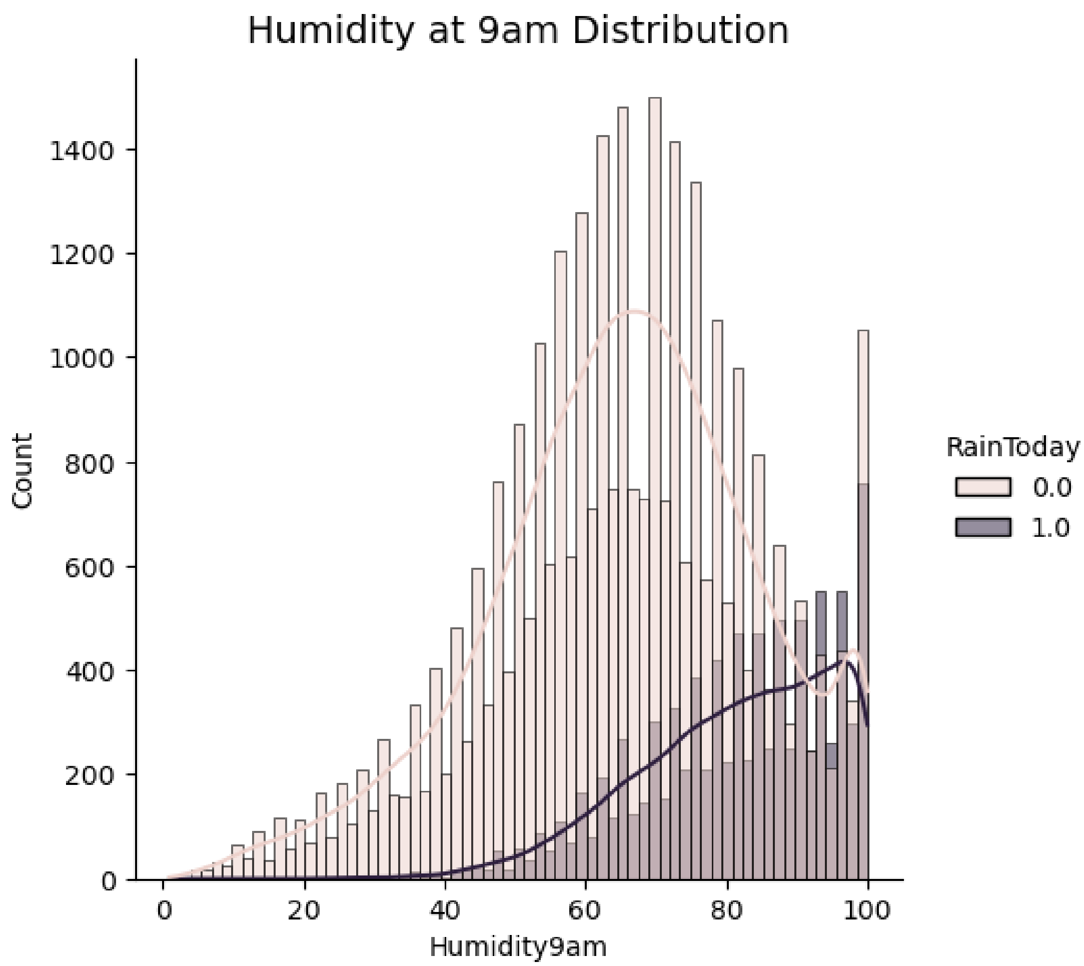
On the other hand, the maximum temperature range from -4.1 ℃ to 48.1 ℃ and the maximum temperature of 20 ℃ has the highest frequency in the data set.

[ ]:
```
sns.displot(data_test, x="WindGustSpeed", hue='RainToday', kde=True)
plt.title("Wind Gust Distribution", fontsize = 14)
plt.show()
```



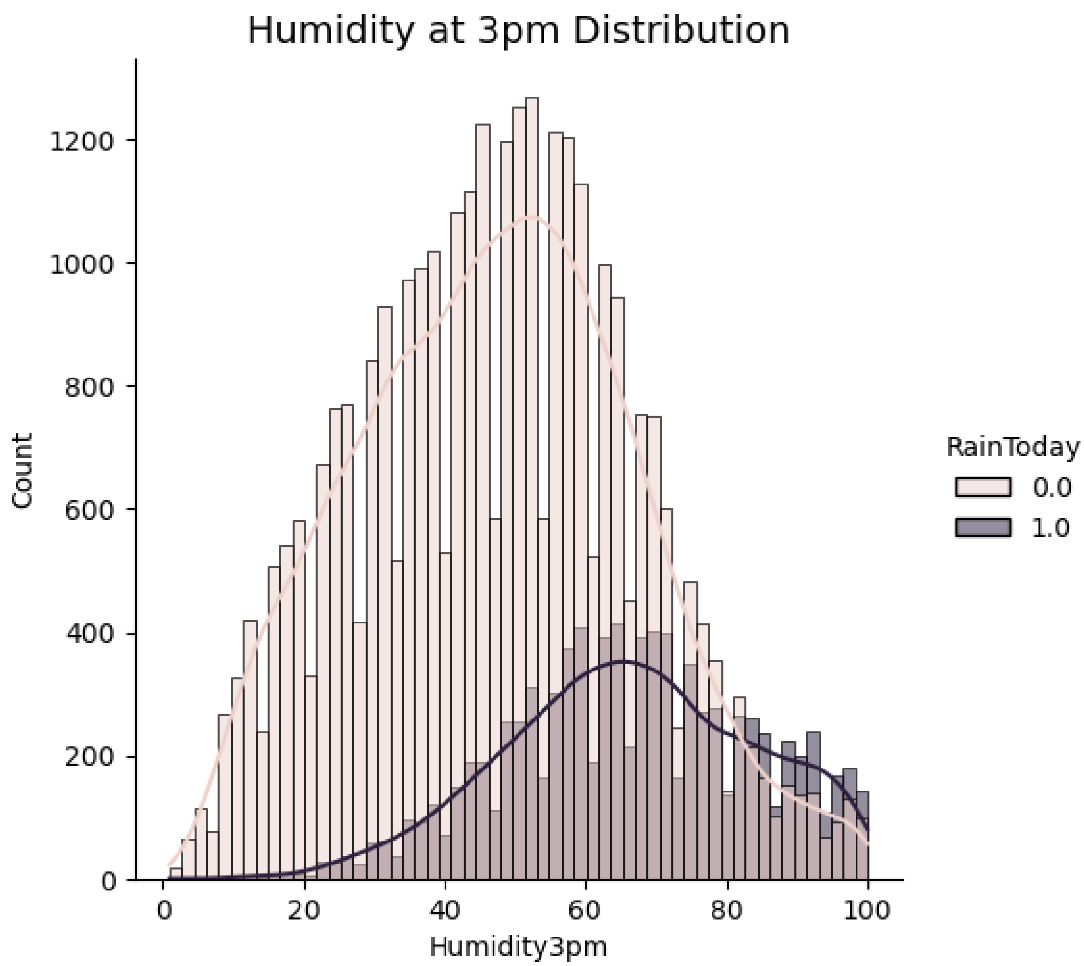
During the analysis, it was found that the range of gusts was from 6 main points to 135 main points and 39.98 main points of gusts had the highest frequency in the data set.

[ ]:
```
sns.displot(data_test, x="Humidity9am", hue='RainToday', kde=True)
plt.title("Humidity at 9am Distribution", fontsize = 14)
plt.show()
```



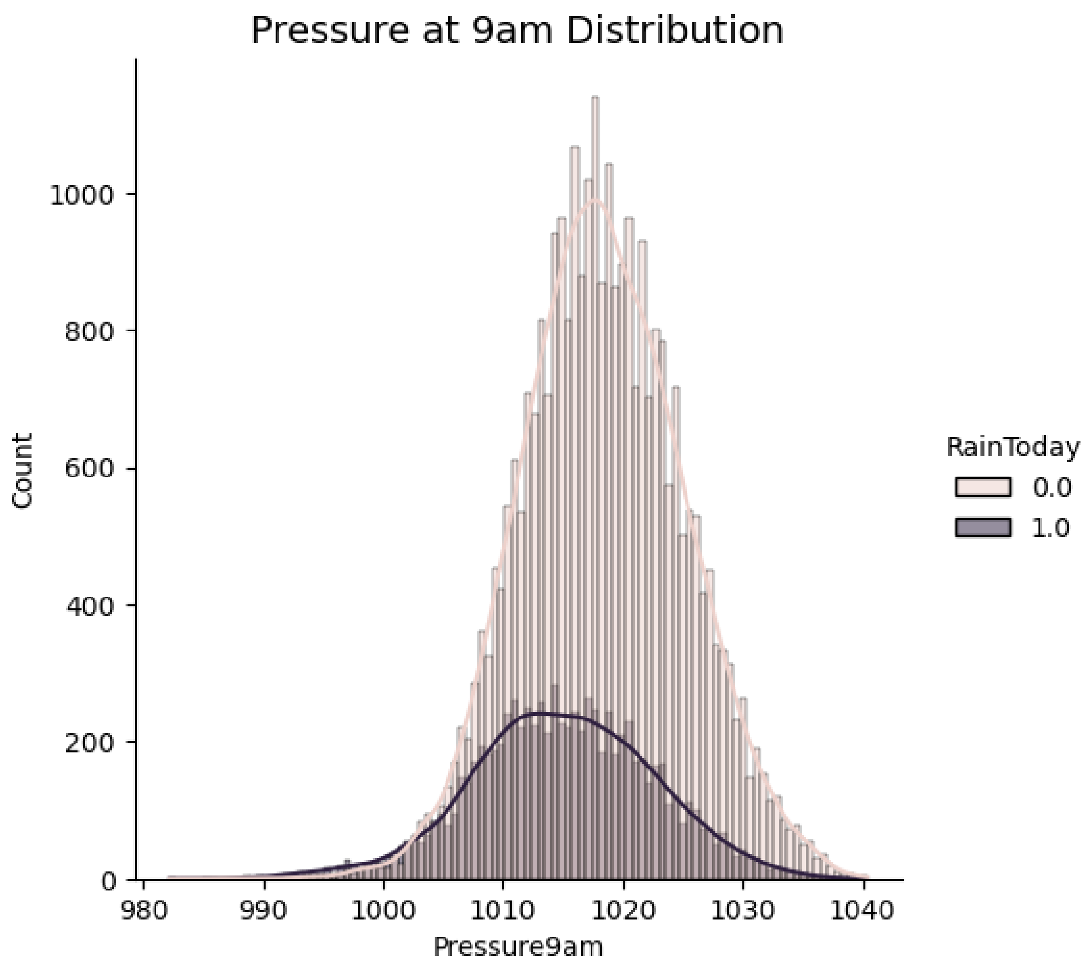
During the analysis, it was found that the range of air humidity at 9 o'clock in the morning. and at 3:00 p.m. from 0% to 100% and 99% humidity at 9:00 am. has the highest frequency in the data set.

[ ]:
```
sns.displot(data_test, x="Humidity3pm", hue='RainToday', kde=True)
plt.title("Humidity at 3pm Distribution", fontsize = 14)
plt.show()
```



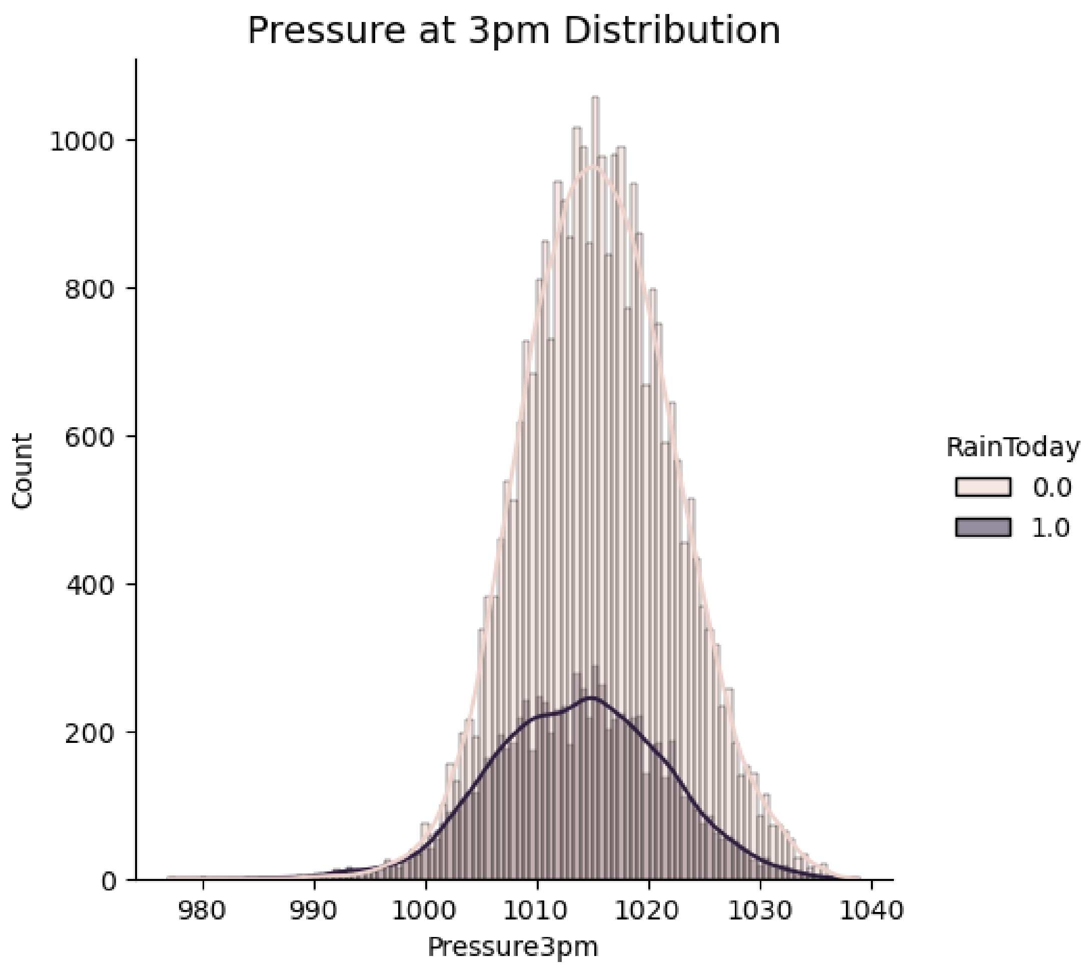
On the other hand, 54.43% of humidity at 3 pm has the highest frequency in the dataset.

[ ]:
```
sns.displot(data_test, x="Pressure9am", hue='RainToday', kde=True)
plt.title("Pressure at 9am Distribution", fontsize = 14)
plt.show()
```



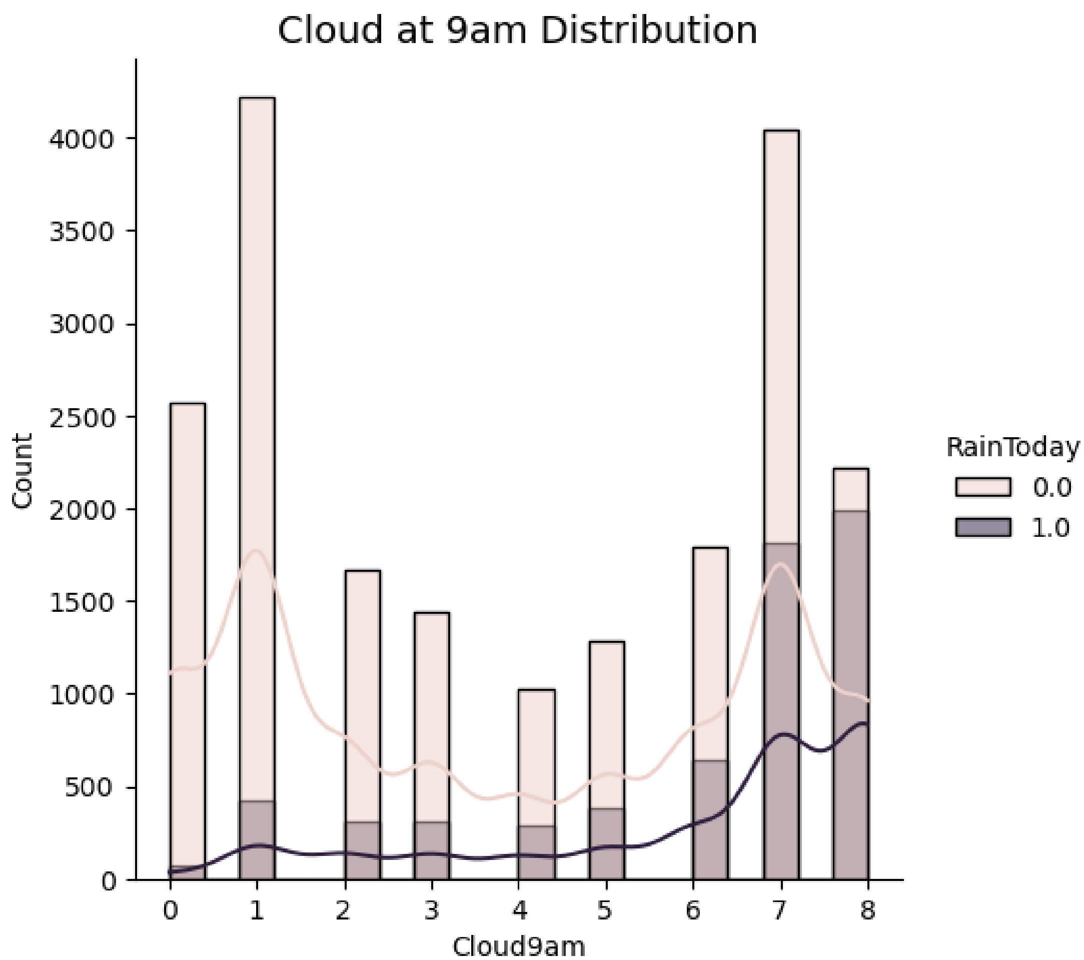
During the analysis, it was found that the range of wind pressure at 9 am. ranges from 980.5 hPa to 1042 hPa, and the pressure of 1017.68 hPa has the highest frequency in the data set.

[ ]:
```
sns.displot(data_test, x="Pressure3pm", hue='RainToday', kde=True)
plt.title("Pressure at 3pm Distribution", fontsize = 14)
plt.show()
```



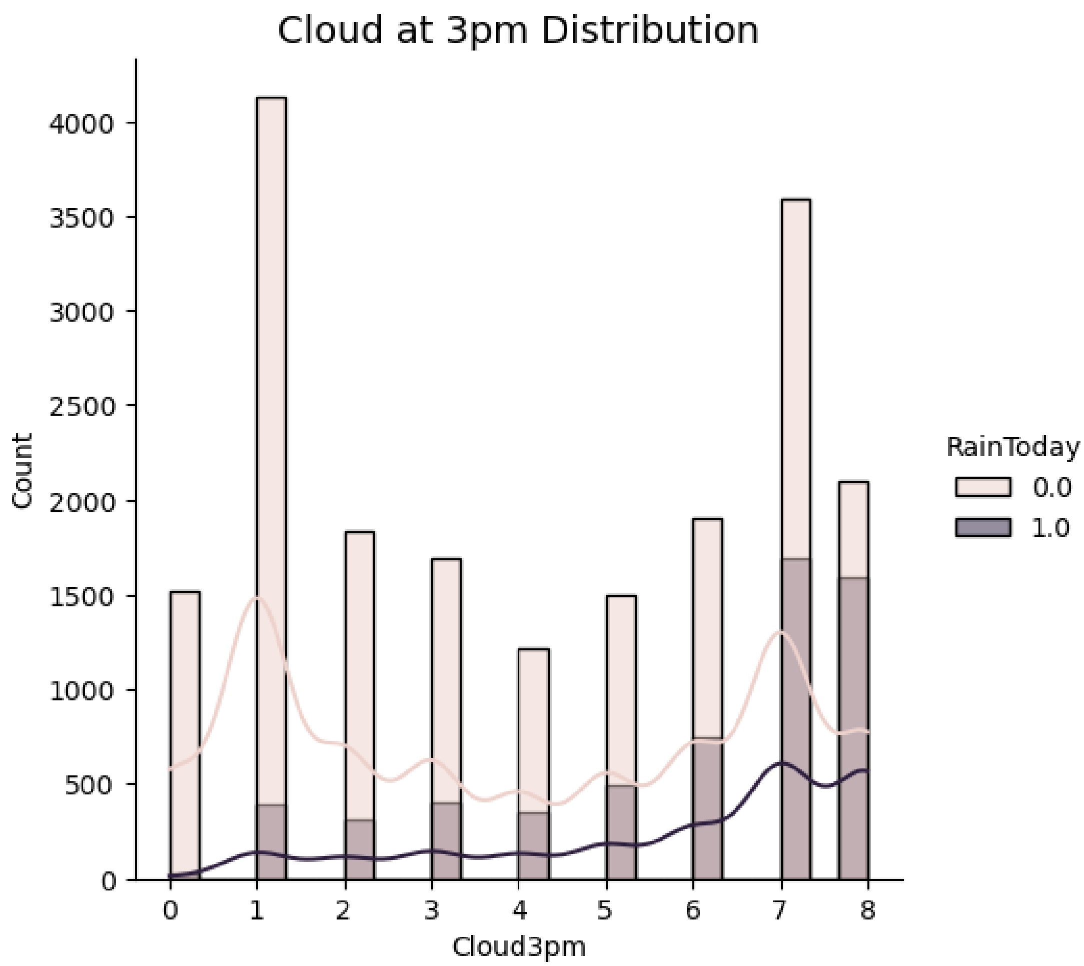
On the opposite hand, the variety of strain at three pm is from 978.2 hPa to 1039.6 hPa and 1015.28 hPa of strain has the very best frequency withinside the dataset.

[ ]:
```
sns.displot(data_test, x="Cloud9am", hue='RainToday', kde=True)
plt.title("Cloud at 9am Distribution", fontsize = 14)
plt.show()
```



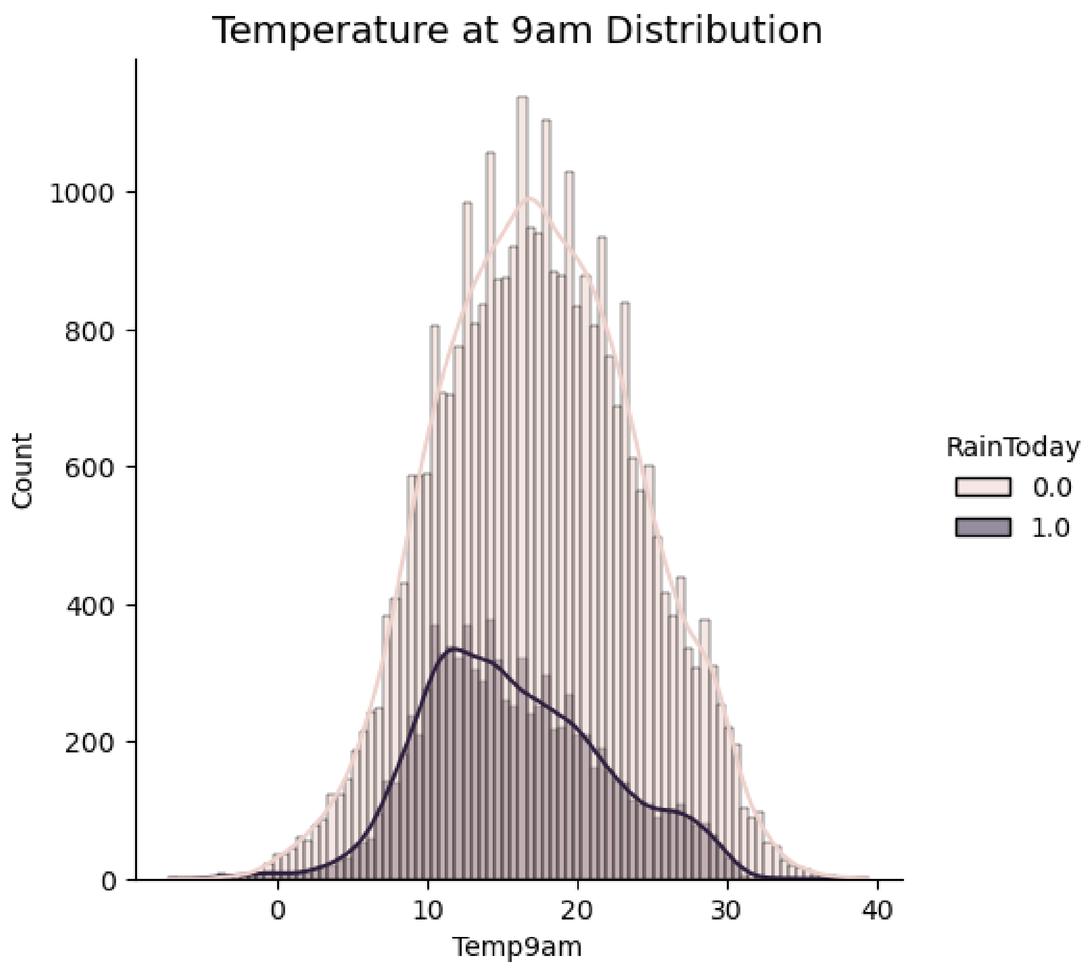
During the analysis, it's been determined that the variety of cloud at 9 am and 3 pm is from zero eighths to nine eighths and 4.44 eighths of cloud at nine am has the best frequency withinside the dataset.

[ ]:
```
sns.displot(data_test, x="Cloud3pm", hue='RainToday', kde=True)
plt.title("Cloud at 3pm Distribution", fontsize = 14)
plt.show()
```



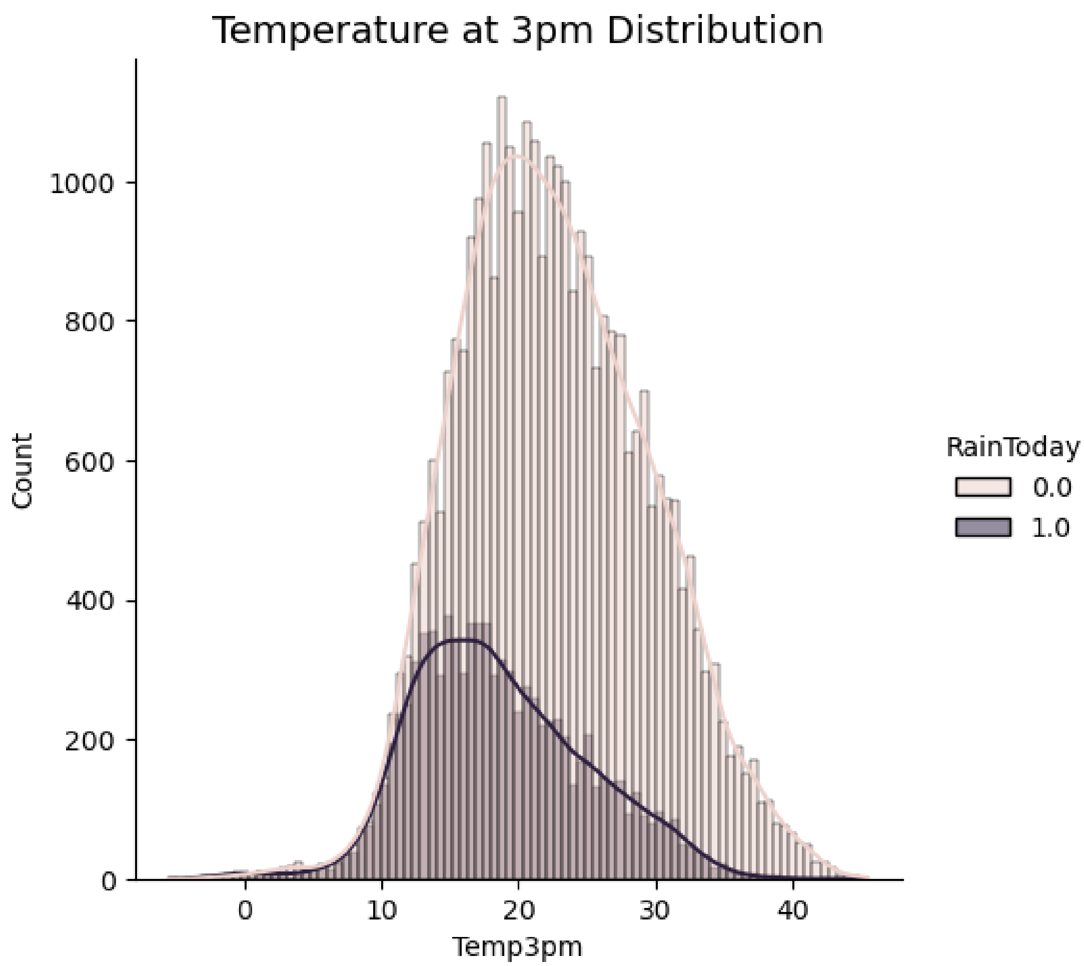
On the other hand, 4.52 eighths of cloud at 3 pm has the highest frequency in the dataset.

[ ]:
```
sns.displot(data_test, x="Temp9am", hue='RainToday', kde=True)
plt.title("Temperature at 9am Distribution", fontsize = 14)
plt.show()
```



During the analysis, it has been found that the range of wind temperature at 9 am is from -7 ℃ to 40.2 ℃ and 17 ℃ of temperature has the highest frequency in the dataset.

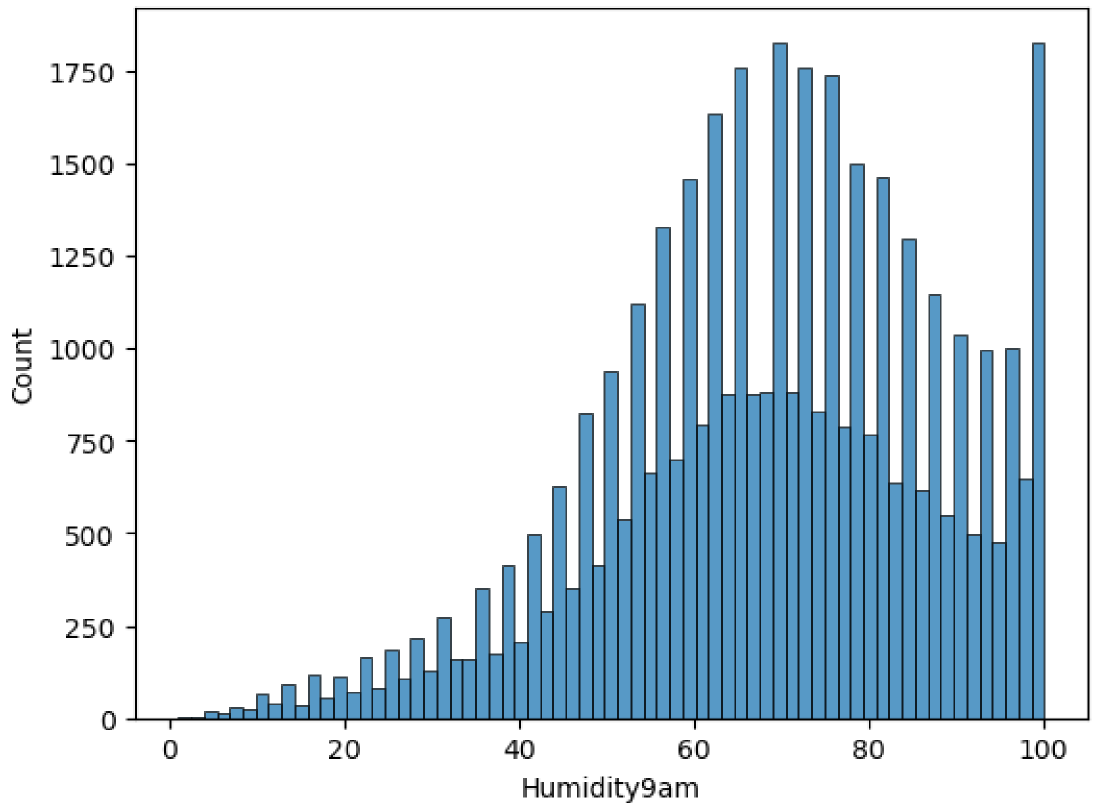
[ ]:
```
sns.displot(data_test, x="Temp3pm", hue='RainToday', kde=True)
plt.title("Temperature at 3pm Distribution", fontsize = 14)
plt.show()
```



On the other hand, the range of pressure at 3 pm is from -5.1 ℃ to 46.7 ℃ and 27.68 ℃ of temperature has the highest frequency in the dataset.

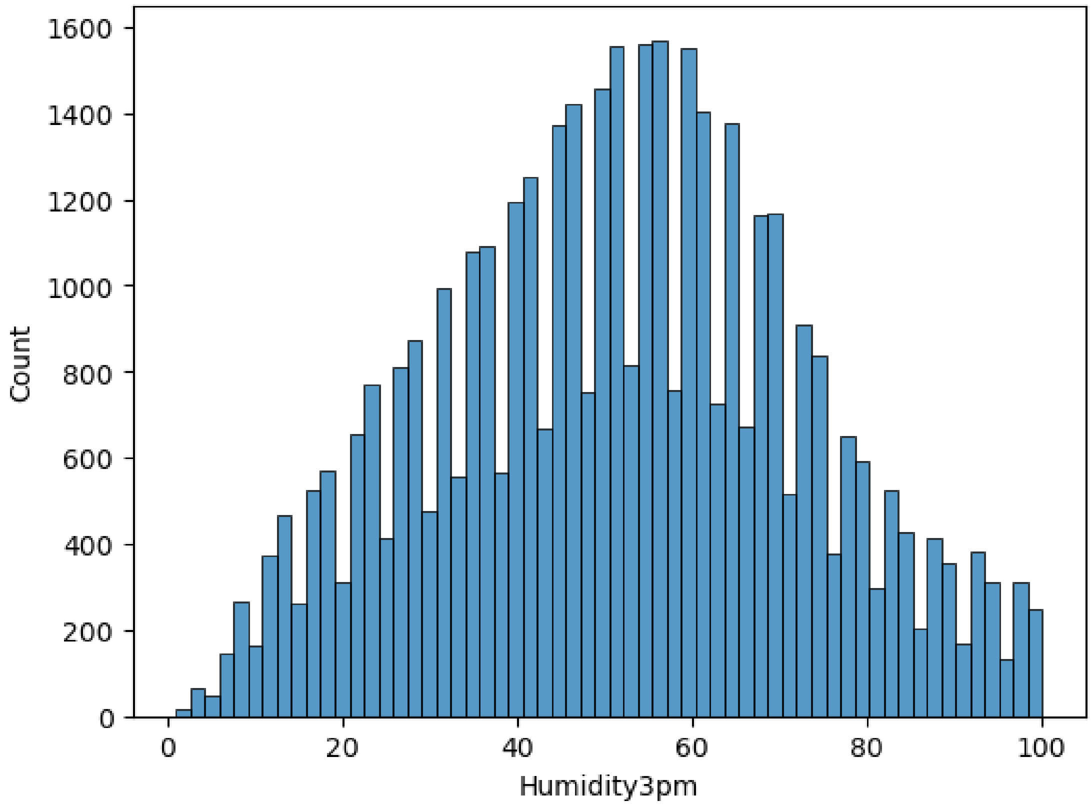
[ ]:
```
df=data_test
sns.histplot(df['Humidity9am'])
```

[ ]: <Axes: xlabel='Humidity9am', ylabel='Count'>



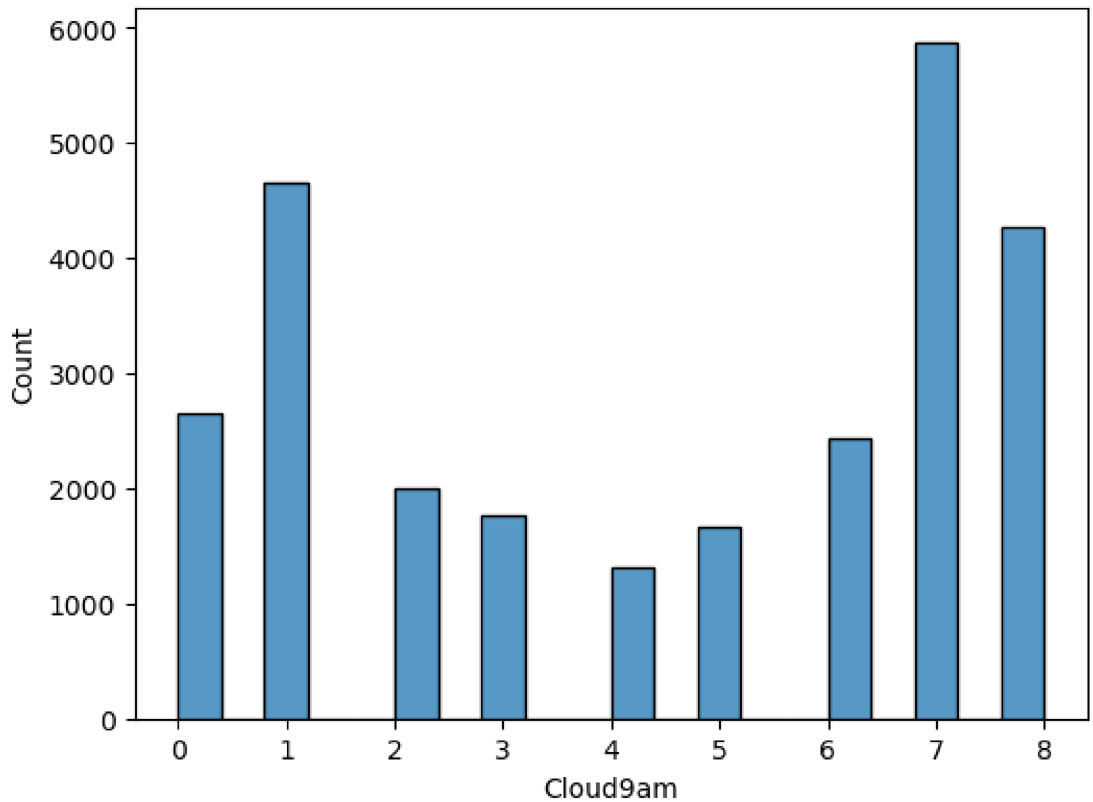
[ ]:
```
sns.histplot(df['Humidity3pm'])
```

[ ]: <Axes: xlabel='Humidity3pm', ylabel='Count'>



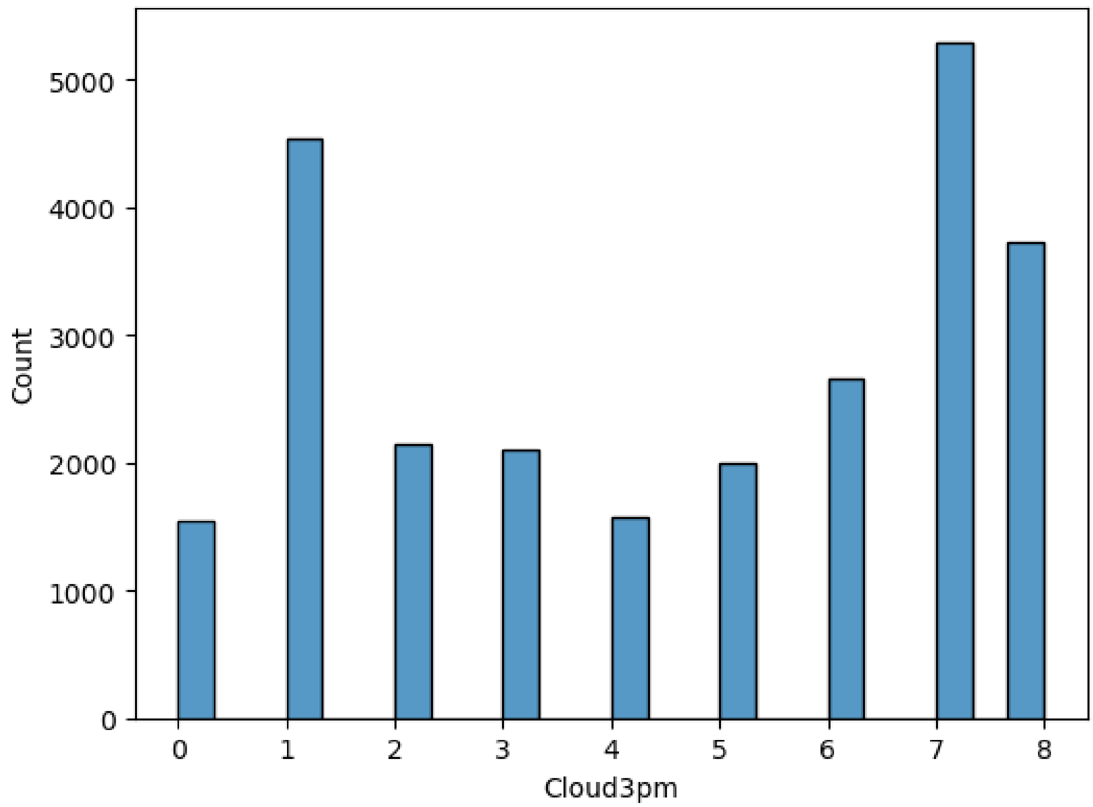
[ ]:
```
sns.histplot(df['Cloud9am'])
```

[ ]: <Axes: xlabel='Cloud9am', ylabel='Count'>



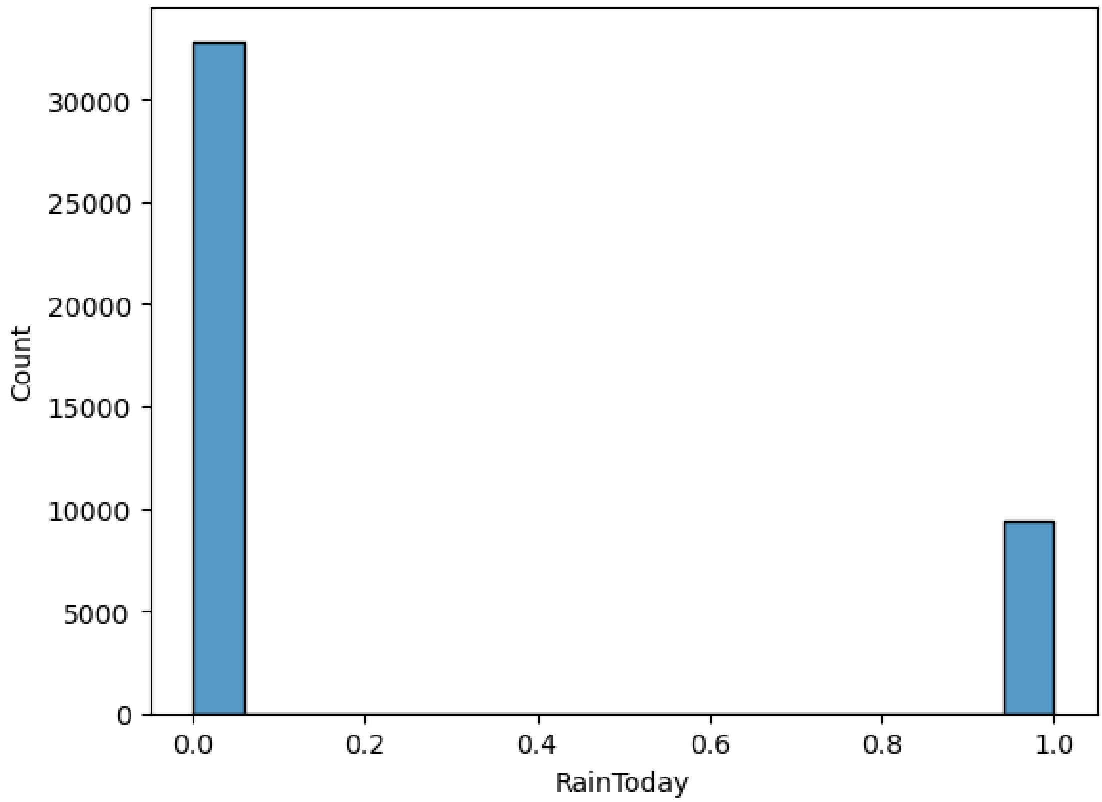
[ ]:
```
sns.histplot(df['Cloud3pm'])
```

[ ]: <Axes: xlabel='Cloud3pm', ylabel='Count'>

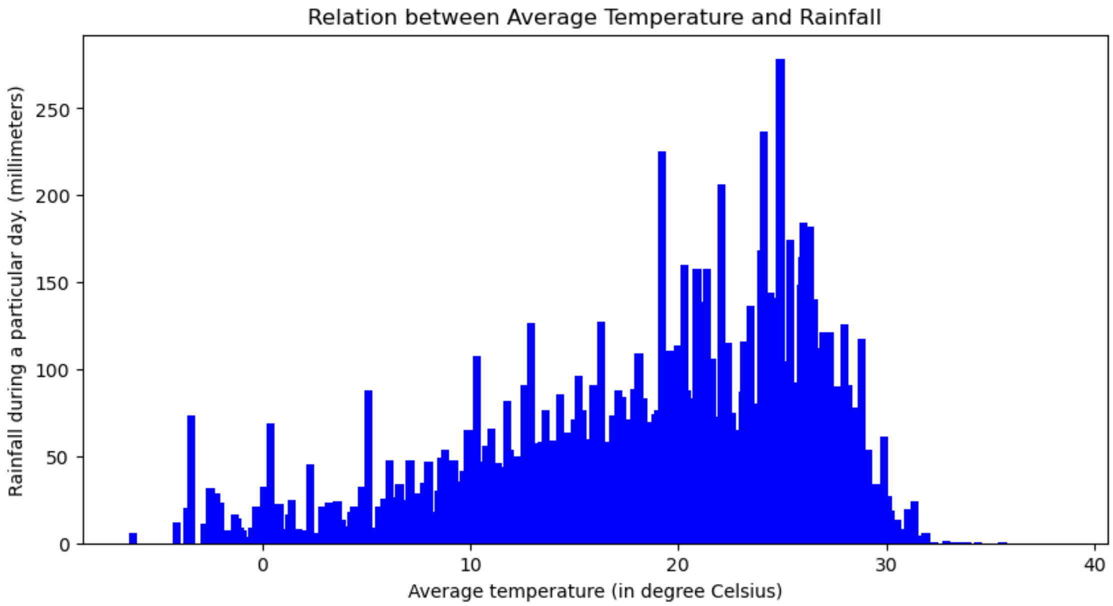


[ ]:
```
sns.histplot(df['RainToday'])
```

[ ]: <Axes: xlabel='RainToday', ylabel='Count'>



[ ]:
```
x = list(data_test.MeanTemp)
y = list(data_test.Rainfall)

fig = plt.figure(figsize = (10, 5))

# creating the bar plot
plt.bar(x, y, color ='blue',
        width = 0.4)

plt.xlabel("Average temperature (in degree Celsius)")
plt.ylabel("Rainfall during a particular day. (millimeters)")
plt.title("Relation between Average Temperature and Rainfall")
plt.show()
```



[ ]:
```
import seaborn as sns
import plotly.express as px

figure = px.scatter(data_frame = data_test, x="AvgHumidity",
                    y="MeanTemp", size="AvgHumidity",
                    trendline="ols",
                    labels={
                     "AvgHumidity": "Humidity (in percent)",
                     "MeanTemp": "Mean Temperature (in degree Celsius)"
                 },
                    title = "Relationship Between Temperature and Humidity")
figure.show()
```

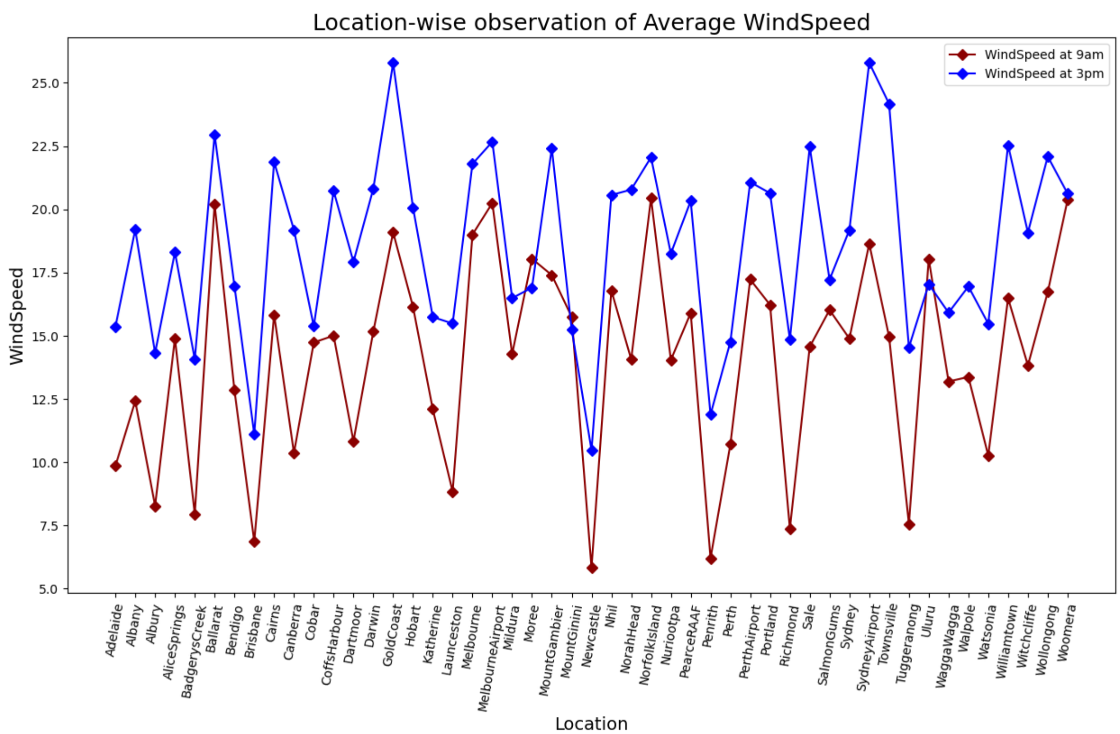
2.2 2. Average WindSpeed Analysis

[ ]:
```
windspeed_weather_df = data_test.groupby(['Location'])[['WindSpeed9am',␣
↪'WindSpeed3pm']].mean()
windspeed_weather_df = windspeed_weather_df.reset_index()
windspeed_weather_df.head()
```

[ ]:

	Location	WindSpeed9am	WindSpeed3pm
0	Adelaide	9.849616	15.354555
1	Albany	12.418605	19.203297
2	Albury	8.274194	14.317552
3	AliceSprings	14.890231	18.300768
4	BadgerysCreek	7.952273	14.075964

```
[ ]: x = windspeed_weather_df.loc[:, 'Location']
y1 = windspeed_weather_df['WindSpeed9am']
y2 = windspeed_weather_df['WindSpeed3pm']

plt.figure(figsize = (15, 8))

plt.plot(x, y1, marker='D', color = 'darkred', label = 'WindSpeed at 9am')
plt.plot(x, y2, marker='D', color = 'blue', label = 'WindSpeed at 3pm')

plt.xlabel('Location', fontsize = 14)
plt.ylabel('WindSpeed', fontsize = 14)
plt.title('Location-wise observation of Average WindSpeed', fontsize = 18)
plt.legend(fontsize = 10, loc = 'best')
plt.xticks(rotation=80)
plt.show()
```



From this analysis, the wind speed at Melbourne Airport was determined to be the highest at 9:00 AM. with a speed of 20.29 km/h. On the other hand, at 3 o'clock in the afternoon. The highest wind speed is on the Gold Coast of Australia with 25.77 km/h. It can be concluded that the wind speed at 15:00. it is much higher than the wind speed at 9 o'clock in the morning.

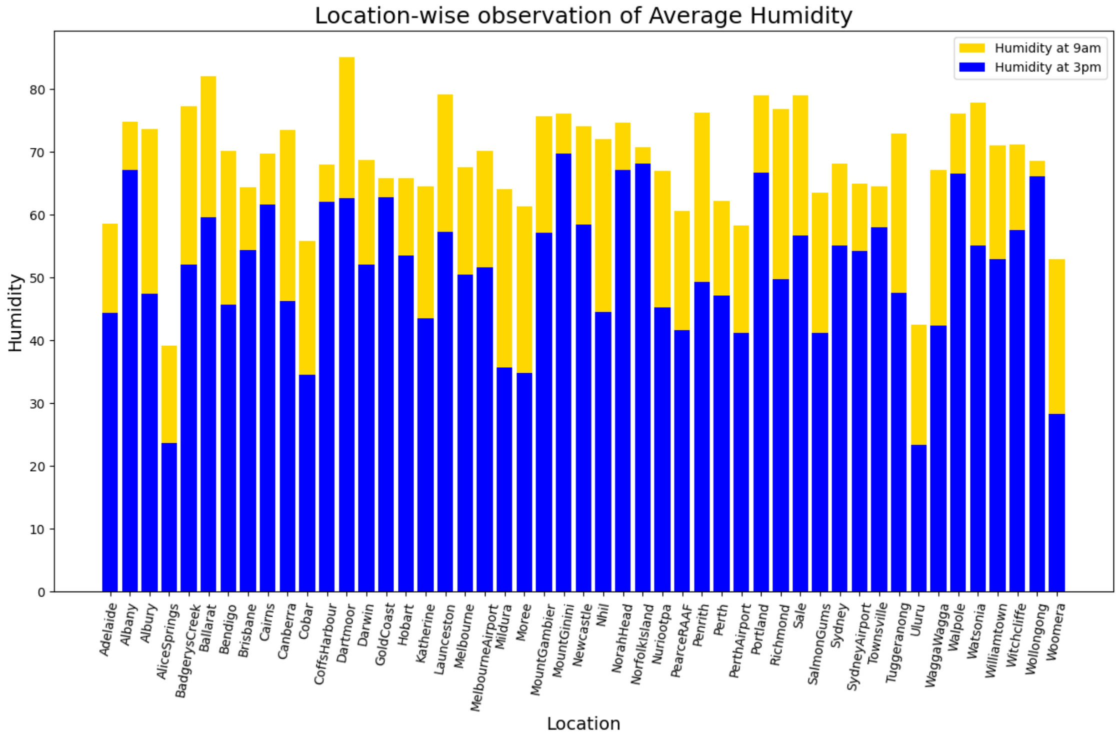
2.3 3. Average Humidity Analysis

[ ]:
```
humidity_weather_df = data_test.groupby(['Location'])[['Humidity9am',␣
↪'Humidity3pm']].mean()
humidity_weather_df = humidity_weather_df.reset_index()
humidity_weather_df.head()
```

[ ]:

	Location	Humidity9am	Humidity3pm
0	Adelaide	58.539560	44.398463
1	Albany	74.787592	67.116848
2	Albury	73.603926	47.346774
3	AliceSprings	39.140351	23.670692
4	BadgerysCreek	77.174603	52.029545

[ ]:
```
x = humidity_weather_df.loc[:, 'Location']
y1 = humidity_weather_df['Humidity9am']
y2 = humidity_weather_df['Humidity3pm']

plt.figure(figsize = (15, 8))

plt.bar(x, y1, color = 'gold', label = 'Humidity at 9am')
plt.bar(x, y2, color = 'blue',label = 'Humidity at 3pm')

plt.xlabel('Location', fontsize = 14)
plt.ylabel('Humidity', fontsize = 14)
plt.title('Location-wise observation of Average Humidity', fontsize = 18)
plt.legend(fontsize = 10, loc = 'best')
plt.xticks(rotation=80)
plt.show()
```



From this analysis it was found that the humidity of Dartmoor was highest at 9 am. 84.38%. On the other hand, at 3:00 p.m., Australia's Mount Ginnie has the highest humidity at 68.24%. In conclusion, it can be concluded that the humidity at 9 o'clock is much higher than the wind speed at 3 o'clock.

2.4 4. Average Pressure Analysis

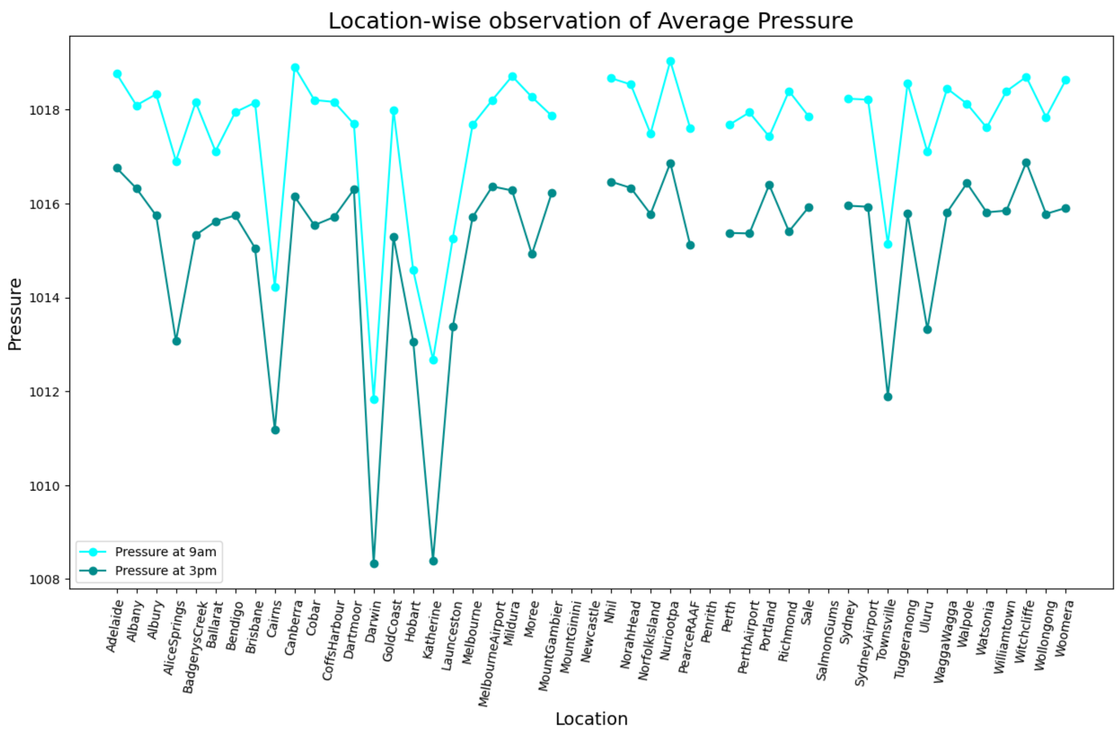
[ ]:
```
pressure_weather_df = data_test.groupby(['Location'])[['Pressure9am',␣
↪'Pressure3pm']].mean()
pressure_weather_df = pressure_weather_df.reset_index()
pressure_weather_df.head()
```

[ ]:

	Location	Pressure9am	Pressure3pm
0	Adelaide	1018.765897	1016.758901
1	Albany	1018.092685	1016.322547
2	Albury	1018.330725	1015.743894
3	AliceSprings	1016.907675	1013.070362
4	BadgerysCreek	1018.159763	1015.329858

[ ]:
```
x = pressure_weather_df.loc[:, 'Location']
y1 = pressure_weather_df['Pressure9am']
y2 = pressure_weather_df['Pressure3pm']

plt.figure(figsize = (15, 8))
```

```
plt.plot(x, y1, marker='o', color = 'cyan', label = 'Pressure at 9am')
plt.plot(x, y2, marker='o', color = 'darkcyan', label = 'Pressure at 3pm')

plt.xlabel('Location', fontsize = 14)
plt.ylabel('Pressure', fontsize = 14)
plt.title('Location-wise observation of Average Pressure', fontsize = 18)
plt.legend(fontsize = 10, loc = 'best')
plt.xticks(rotation=80)
plt.show()
```



During this analysis, it was found that the pressure in Canberra is the highest at 9 o'clock in the morning. at 1018.93 hPa. On the other hand, Adelaide, Australia has the highest pressure at 15:00 at 1016.79 hPa. In short, it can be concluded that the pressure at 9 o'clock is much higher than the wind speed at 3 o'clock.

2.5 5. Average Temperature Analysis

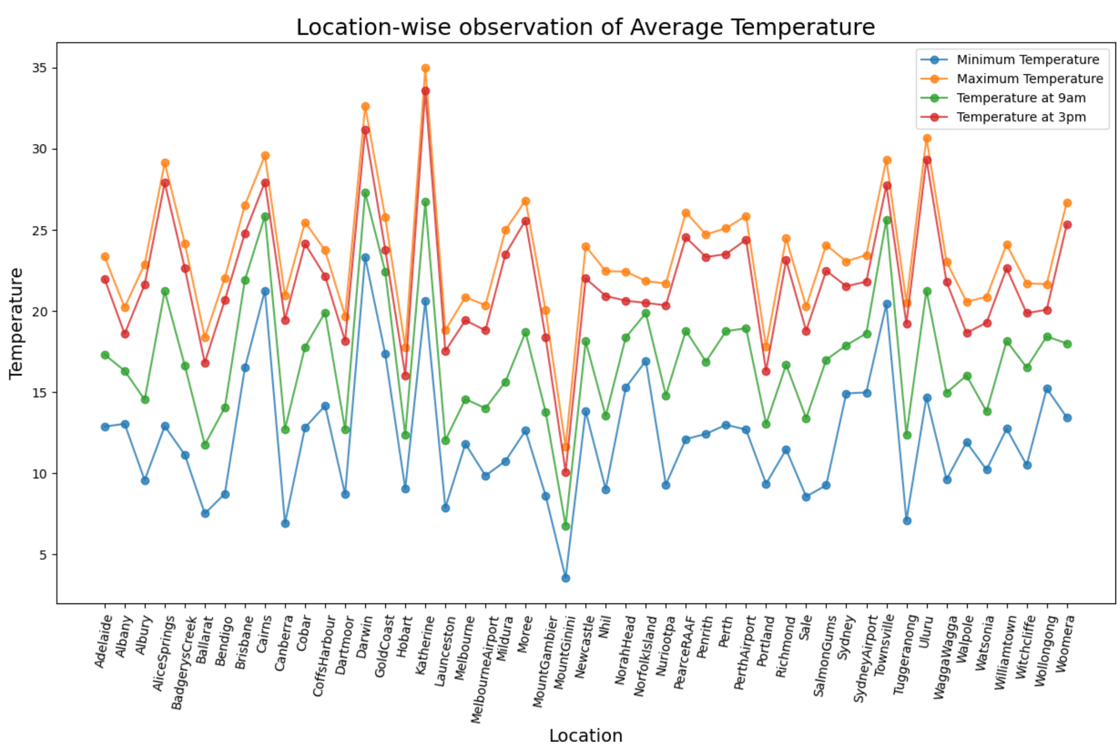
```
[ ]: location_weather_df = data_test.groupby(['Location'])[['MinTemp', 'MaxTemp',␣
     ↪'Temp9am', 'Temp3pm']].mean()
     location_weather_df = location_weather_df.reset_index()
     location_weather_df.head()
```

[ ]:

	Location	MinTemp	MaxTemp	Temp9am	Temp3pm
0	Adelaide	12.874643	23.337500	17.311868	21.972887
1	Albany	13.048097	20.219078	16.311321	18.584125
2	Albury	9.579700	22.881473	14.530370	21.622465
3	AliceSprings	12.905811	29.124808	21.212390	27.892645
4	BadgerysCreek	11.146833	24.163318	16.643552	22.636281

[ ]:

```python
x = location_weather_df.loc[:, 'Location']
y1 = location_weather_df['MinTemp']
y2 = location_weather_df['MaxTemp']
y3 = location_weather_df['Temp9am']
y4 = location_weather_df['Temp3pm']

plt.figure(figsize = (15, 8))

plt.plot(x, y1, label = 'Minimum Temperature', marker='o', alpha = 0.8)
plt.plot(x, y2, label = 'Maximum Temperature', marker='o', alpha = 0.8)
plt.plot(x, y3, label = 'Temperature at 9am', marker='o', alpha = 0.8)
plt.plot(x, y4, label = 'Temperature at 3pm', marker='o', alpha = 0.8)

plt.xlabel('Location', fontsize = 14)
plt.ylabel('Temperature', fontsize = 14)
plt.title('Location-wise observation of Average Temperature', fontsize = 18)
plt.legend(fontsize = 10, loc = 'best')
plt.xticks(rotation=80)
plt.show()
```



2.6 Models

[ ]:
```
X = df_upsampled.drop(columns='RainTomorrow')
y = df_upsampled['RainTomorrow']
```

[ ]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, train_size=0.9,␣
↪shuffle=True, random_state=44)
```

[ ]:
```
RandomForestClassifierModel = RandomForestClassifier(criterion = 'gini',␣
↪max_depth=17, n_estimators=100, random_state=44)
RandomForestClassifierModel.fit(X_train, y_train)


print('RandomForestClassifierModel Train Score is : ' ,␣
↪RandomForestClassifierModel.score(X_train, y_train))
print('RandomForestClassifierModel Test Score is : ' ,␣
↪RandomForestClassifierModel.score(X_test, y_test))
```

```
RandomForestClassifierModel Train Score is :  0.9804006278711425
RandomForestClassifierModel Test Score is :  0.9274235355106273
```

[ ]:
```
from sklearn.metrics import f1_score, accuracy_score

# Predict labels for training and test sets
y_train_pred = RandomForestClassifierModel.predict(X_train)
y_test_pred = RandomForestClassifierModel.predict(X_test)

# Calculate F1 score
f1 = f1_score(y_test, y_test_pred)
print('F1 Score:', f1)

# Calculate accuracy
accuracy = accuracy_score(y_test, y_test_pred)
print('Accuracy:', accuracy)
```

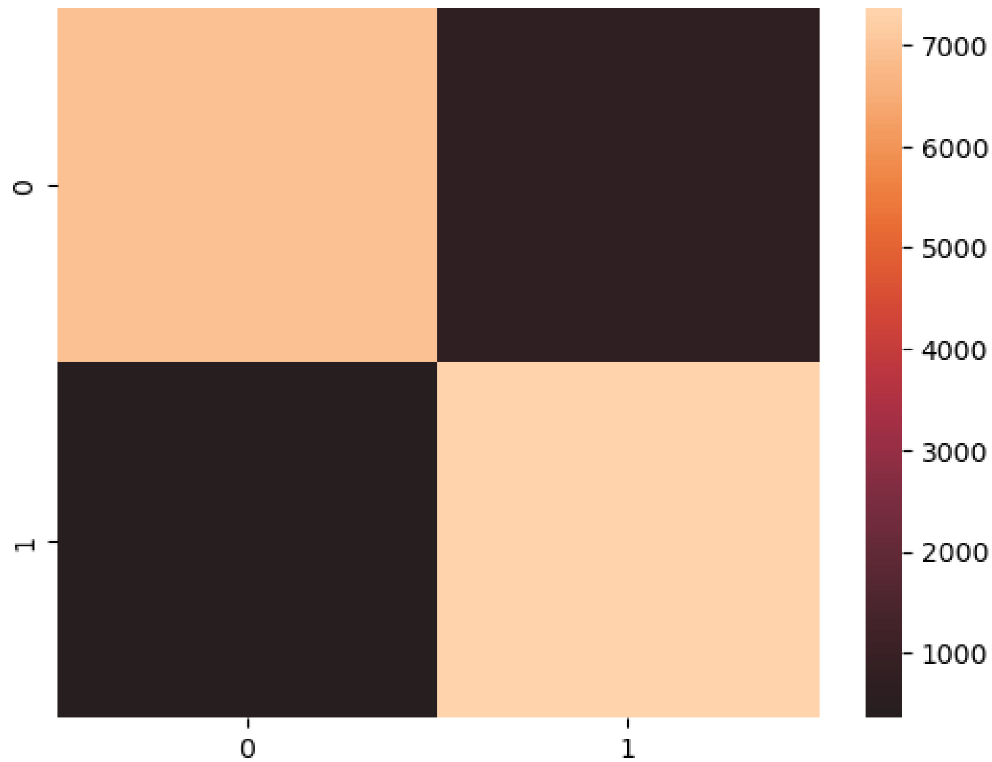
```
F1 Score: 0.9293464547060308
Accuracy: 0.9274235355106273
```

[ ]:
```
import joblib
from sklearn.ensemble import RandomForestClassifier

# Build and train your model
# fit your model on training data

# Save your trained model
```

```
joblib.dump(RandomForestClassifierModel, 'RandomForestClassifierModel.joblib')
```

[ ]: ['RandomForestClassifierModel.joblib']

[ ]:
```
y_pred_RF = RandomForestClassifierModel.predict(X_test)
CM_RF = confusion_matrix(y_test, y_pred_RF)

sns.heatmap(CM_RF, center=True)
plt.show()

print('Confusion Matrix is\n', CM_RF)
```




```
Confusion Matrix is
 [[6946  763]
 [ 357 7366]]
```

[ ]:
```
GBCModel = GradientBoostingClassifier(n_estimators=200, max_depth=11,␣
 ↪learning_rate=0.07, random_state=44)
GBCModel.fit(X_train, y_train)
print('GBCModel Train Score is : ' , GBCModel.score(X_train, y_train))
print('GBCModel Test Score is : ' , GBCModel.score(X_test, y_test))
```

```
GBCModel Train Score is :  0.9900923085785055
```

```
GBCModel Test Score is :  0.9331907724209435
```

[ ]:
```python
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.metrics import f1_score, accuracy_score
from sklearn.model_selection import train_test_split

X = df_upsampled.drop(columns='RainTomorrow')
y = df_upsampled['RainTomorrow']
X_train, X_test, y_train, y_test = train_test_split(X, y, train_size=0.9,␣
↪shuffle=True, random_state=44)

GradientBoostingClassifierModel = GradientBoostingClassifier(n_estimators=200,␣
↪max_depth=11, learning_rate=0.07, random_state=44)
GradientBoostingClassifierModel.fit(X_train, y_train)
```

[ ]:
```
GradientBoostingClassifier(learning_rate=0.07, max_depth=11, n_estimators=200,
                           random_state=44)
```

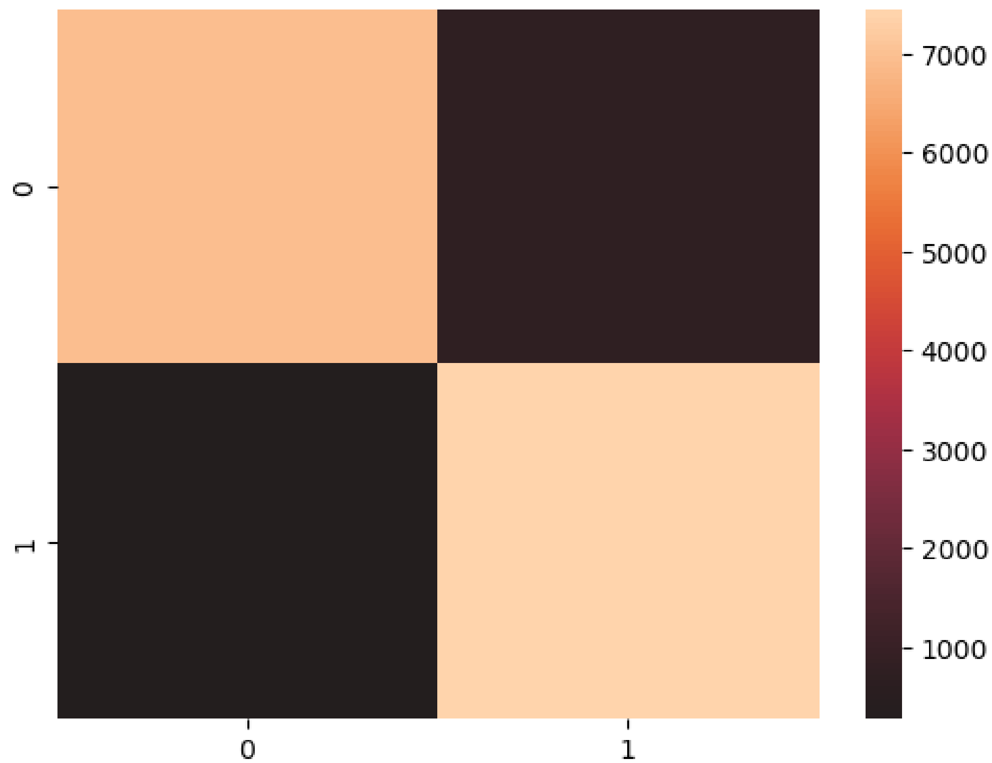
[ ]:
```python
print('GBCModel Train Score is : ' , GBCModel.score(X_train, y_train))
print('GBCModel Test Score is : ' , GBCModel.score(X_test, y_test))
# Predict labels for training and test sets
y_train_pred = GradientBoostingClassifierModel.predict(X_train)
y_test_pred = GradientBoostingClassifierModel.predict(X_test)

# Calculate F1 score
f1 = f1_score(y_test, y_test_pred)
print('F1 Score:', f1)

# Calculate accuracy
accuracy = accuracy_score(y_test, y_test_pred)
print('Accuracy:', accuracy)
```

```
GBCModel Train Score is :  0.9900923085785055
GBCModel Test Score is :  0.9331907724209435
F1 Score: 0.93528340970435
Accuracy: 0.9331907724209435
```

[ ]:
```python
joblib.dump(GBCModel, 'GBCModel.joblib')
```

[ ]:
```
['GBCModel.joblib']
```

[ ]:
```python
y_pred_GB = GBCModel.predict(X_test)
CM_GB = confusion_matrix(y_test, y_pred_GB)

sns.heatmap(CM_GB, center=True)
plt.show()

print('Confusion Matrix is\n', CM_GB)
```

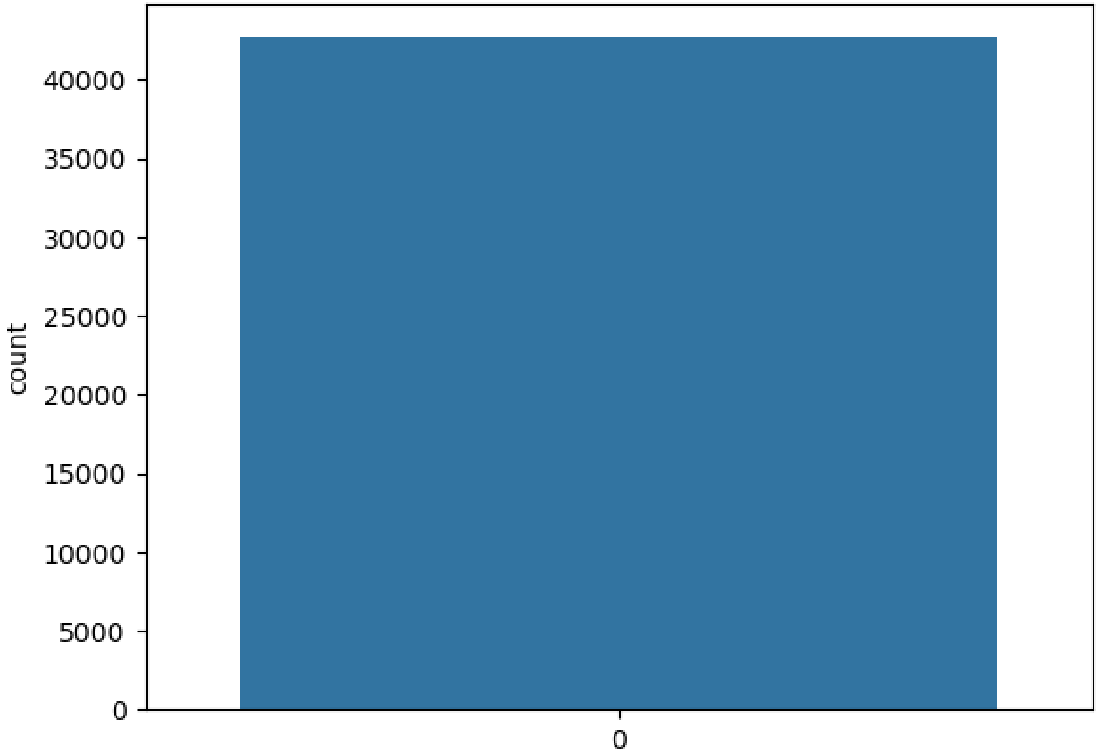



```
Confusion Matrix is
 [[6951  758]
 [ 273 7450]]
```

[ ]:
```
y_pred = GBCModel.predict(test)
```

[ ]:
```
sns.countplot(y_pred)
```

[ ]: <Axes: ylabel='count'>



[ ]:
```
test = pd.read_csv('WeatherTestData.csv')
submission = test[["row ID"]]
submission["RainTomorrow"] = y_pred
```

```
/var/folders/df/npmhf4fs0qb8cnwm2kmptxk00000gn/T/ipykernel_94084/1624392679.py:3
: SettingWithCopyWarning:


A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

[ ]:
```
submission.to_csv('predict_weather.csv', index=False)
```

Two different testing algorithms that we use:

1. Randomized Search Cross Validation for Hyperparameter Tuning: This algorithm randomly selects a set of hyperparameters and uses cross-validation to evaluate the model's performance. It then repeats this process multiple times and selects the best set of hyperparameters that give the highest accuracy score.

[ ]:

```python
from sklearn.model_selection import RandomizedSearchCV

# define the hyperparameter grid
param_grid = {
    'n_estimators': [100, 200, 300],
    'max_features': ['auto', 'sqrt'],
    'max_depth': [5, 10, 15, None],
    'min_samples_split': [2, 5, 10],
    'min_samples_leaf': [1, 2, 4]
}

# create a Random Forest Classifier object
rfc = RandomForestClassifier(random_state=42)

# create a RandomizedSearchCV object
rscv = RandomizedSearchCV(
    estimator=rfc, param_distributions=param_grid,
    n_iter=10, cv=5, verbose=2, random_state=42, n_jobs=-1
)

# fit the RandomizedSearchCV object on the training data
rscv.fit(X_train, y_train)

# print the best hyperparameters and the corresponding accuracy score
print("Best Hyperparameters:", rscv.best_params_)
print("Best Accuracy Score:", rscv.best_score_)

# evaluate the model on the test data
rfc_best = rscv.best_estimator_
print("Test Accuracy Score:", rfc_best.score(X_test, y_test))

joblib.dump(rfc, 'rfc.joblib')
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=4,
min_samples_split=10, n_estimators=100; total time=  19.4s
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=4,
min_samples_split=10, n_estimators=100; total time=  19.7s
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=4,
min_samples_split=10, n_estimators=100; total time=  19.7s
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=2,
min_samples_split=5, n_estimators=100; total time=  20.2s
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=2,
min_samples_split=5, n_estimators=100; total time=  20.3s
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=2,
min_samples_split=5, n_estimators=100; total time=  20.3s
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=2,
min_samples_split=5, n_estimators=100; total time=  20.3s
```

```
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=2,
min_samples_split=5, n_estimators=100; total time=  20.4s
```

```
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
```

```
[CV] END max_depth=15, max_features=sqrt, min_samples_leaf=1,
min_samples_split=5, n_estimators=100; total time=  16.9s
```

```
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
```

```
[CV] END max_depth=15, max_features=sqrt, min_samples_leaf=1,
min_samples_split=5, n_estimators=100; total time=  16.9s
[CV] END max_depth=15, max_features=sqrt, min_samples_leaf=1,
min_samples_split=5, n_estimators=100; total time=  16.9s
[CV] END max_depth=15, max_features=sqrt, min_samples_leaf=1,
min_samples_split=5, n_estimators=100; total time=  17.0s
```

```
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
```

```
[CV] END max_depth=15, max_features=sqrt, min_samples_leaf=1,
min_samples_split=5, n_estimators=100; total time=  17.2s
```

```
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
```

```
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(

[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=4,
min_samples_split=10, n_estimators=100; total time=  18.5s
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=4,
min_samples_split=10, n_estimators=100; total time=  18.4s

/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(

[CV] END max_depth=None, max_features=auto, min_samples_leaf=2,
min_samples_split=10, n_estimators=100; total time=  19.1s

/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(

[CV] END max_depth=5, max_features=auto, min_samples_leaf=2,
min_samples_split=10, n_estimators=100; total time=   6.7s

/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(

[CV] END max_depth=5, max_features=auto, min_samples_leaf=2,
min_samples_split=10, n_estimators=100; total time=   6.6s
[CV] END max_depth=5, max_features=auto, min_samples_leaf=2,
min_samples_split=10, n_estimators=100; total time=   6.6s

/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
```

```
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(

[CV] END max_depth=5, max_features=auto, min_samples_leaf=2,
min_samples_split=10, n_estimators=100; total time=   6.6s

/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(

[CV] END max_depth=5, max_features=auto, min_samples_leaf=2,
min_samples_split=10, n_estimators=100; total time=   6.9s

/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(

[CV] END max_depth=None, max_features=auto, min_samples_leaf=2,
min_samples_split=10, n_estimators=100; total time=  19.1s

/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(

[CV] END max_depth=None, max_features=auto, min_samples_leaf=2,
min_samples_split=10, n_estimators=100; total time=  19.0s
[CV] END max_depth=None, max_features=auto, min_samples_leaf=2,
min_samples_split=10, n_estimators=100; total time=  19.2s

/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
```

```
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
```

```
[CV] END max_depth=None, max_features=auto, min_samples_leaf=2,
min_samples_split=10, n_estimators=100; total time=  19.3s
```

```
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
```

```
[CV] END max_depth=15, max_features=auto, min_samples_leaf=1,
min_samples_split=5, n_estimators=100; total time=  17.2s
```

```
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
```

```
[CV] END max_depth=15, max_features=auto, min_samples_leaf=1,
min_samples_split=5, n_estimators=100; total time=  17.5s
[CV] END max_depth=15, max_features=auto, min_samples_leaf=1,
min_samples_split=5, n_estimators=100; total time=  17.4s
```

```
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
```

```
[CV] END max_depth=15, max_features=auto, min_samples_leaf=1,
min_samples_split=5, n_estimators=100; total time=  18.2s
```

```
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
```

```
[CV] END max_depth=15, max_features=auto, min_samples_leaf=1,
min_samples_split=5, n_estimators=100; total time=  17.8s
```

```
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
```

```
[CV] END max_depth=10, max_features=auto, min_samples_leaf=4,
min_samples_split=2, n_estimators=200; total time=  24.8s
```

```
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
```

```
[CV] END max_depth=10, max_features=auto, min_samples_leaf=4,
min_samples_split=2, n_estimators=200; total time=  24.4s
```

```
/Users/hemang/miniconda3/lib/python3.10/site-
packages/sklearn/ensemble/_forest.py:424: FutureWarning: `max_features='auto'`
has been deprecated in 1.1 and will be removed in 1.3. To keep the past
behaviour, explicitly set `max_features='sqrt'` or remove this parameter as it
is also the default value for RandomForestClassifiers and ExtraTreesClassifiers.
  warn(
```

```
[CV] END max_depth=10, max_features=auto, min_samples_leaf=4,
min_samples_split=2, n_estimators=200; total time=  24.0s
[CV] END max_depth=10, max_features=auto, min_samples_leaf=4,
min_samples_split=2, n_estimators=200; total time=  24.1s
[CV] END max_depth=None, max_features=auto, min_samples_leaf=4,
min_samples_split=2, n_estimators=300; total time=  56.8s
[CV] END max_depth=None, max_features=auto, min_samples_leaf=4,
min_samples_split=2, n_estimators=300; total time=  57.1s
[CV] END max_depth=None, max_features=auto, min_samples_leaf=4,
min_samples_split=2, n_estimators=300; total time=  57.1s
[CV] END max_depth=10, max_features=auto, min_samples_leaf=4,
min_samples_split=2, n_estimators=200; total time=  24.4s
[CV] END max_depth=None, max_features=auto, min_samples_leaf=4,
min_samples_split=2, n_estimators=300; total time=  56.8s
[CV] END max_depth=None, max_features=auto, min_samples_leaf=4,
min_samples_split=2, n_estimators=300; total time=  56.6s
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=2,
min_samples_split=10, n_estimators=200; total time=  38.0s
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=2,
min_samples_split=10, n_estimators=200; total time=  37.7s
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=2,
```

```
min_samples_split=10, n_estimators=200; total time=  37.9s
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=2,
min_samples_split=10, n_estimators=200; total time=  38.1s
[CV] END max_depth=15, max_features=sqrt, min_samples_leaf=1,
min_samples_split=5, n_estimators=200; total time=  33.3s
[CV] END max_depth=None, max_features=sqrt, min_samples_leaf=2,
min_samples_split=10, n_estimators=200; total time=  37.8s
[CV] END max_depth=15, max_features=sqrt, min_samples_leaf=1,
min_samples_split=5, n_estimators=200; total time=  33.7s
[CV] END max_depth=15, max_features=sqrt, min_samples_leaf=1,
min_samples_split=5, n_estimators=200; total time=  33.7s
[CV] END max_depth=15, max_features=sqrt, min_samples_leaf=1,
min_samples_split=5, n_estimators=200; total time=  30.0s
[CV] END max_depth=15, max_features=sqrt, min_samples_leaf=1,
min_samples_split=5, n_estimators=200; total time=  26.7s
Best Hyperparameters: {'n_estimators': 100, 'min_samples_split': 5,
'min_samples_leaf': 2, 'max_features': 'sqrt', 'max_depth': None}
Best Accuracy Score: 0.9268227680017898
Test Accuracy Score: 0.9444660445826853
```

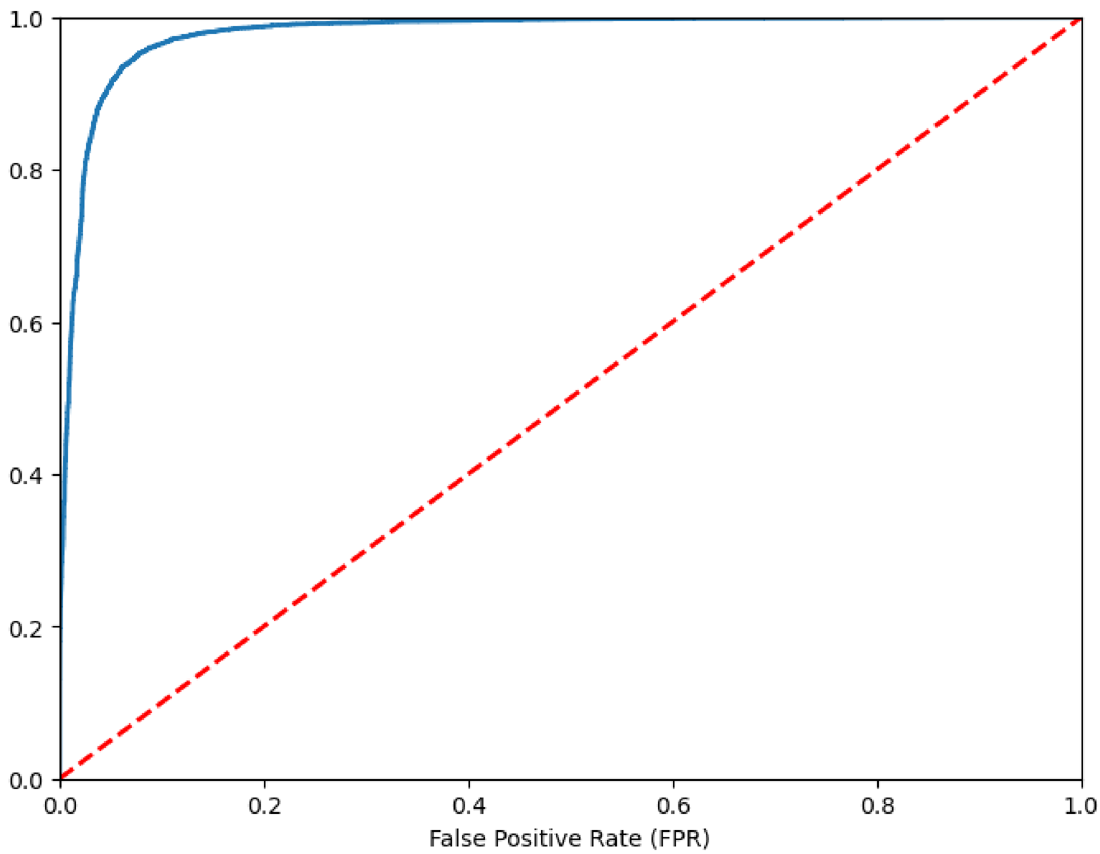
[ ]: ['rfc.joblib']

2. Receiver Operating Characteristic (ROC) Curve: This algorithm is used to evaluate the performance of a binary classifier at different classification thresholds. It plots the True Positive Rate (TPR) against the False Positive Rate (FPR) for different threshold values. The area under the ROC curve (AUC-ROC) is a performance metric that ranges from 0.5 to 1. A higher AUC-ROC indicates better model performance.

[ ]:
```
from sklearn.metrics import roc_curve, auc

# fit the Gradient Boosting Classifier on the training data
gbc = GradientBoostingClassifier(n_estimators=200, max_depth=11,␣
↪learning_rate=0.07, random_state=44)
gbc.fit(X_train, y_train)

# predict the probabilities of the positive class for the test data
y_proba = gbc.predict_proba(X_test)[:, 1]

# calculate the False Positive Rate (FPR), True Positive Rate (TPR), and␣
↪threshold values
fpr, tpr, thresholds = roc_curve(y_test, y_proba)

# calculate the Area Under the Curve (AUC-ROC)
auc_roc = auc(fpr, tpr)

# plot the ROC curve
plt.figure(figsize=(8, 6))
plt.plot(fpr, tpr, lw=2, label=f'AUC = {auc_roc:.2f}')
```

```
plt.plot([0, 1], [0, 1], linestyle='--', lw=2, color='r', label='Random Guess')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.0])
plt.xlabel('False Positive Rate (FPR)')

joblib.dump(gbc, 'gbc.joblib')
```

[ ]: ['gbc.joblib']



[ ]:
```
print(fpr, tpr)
```

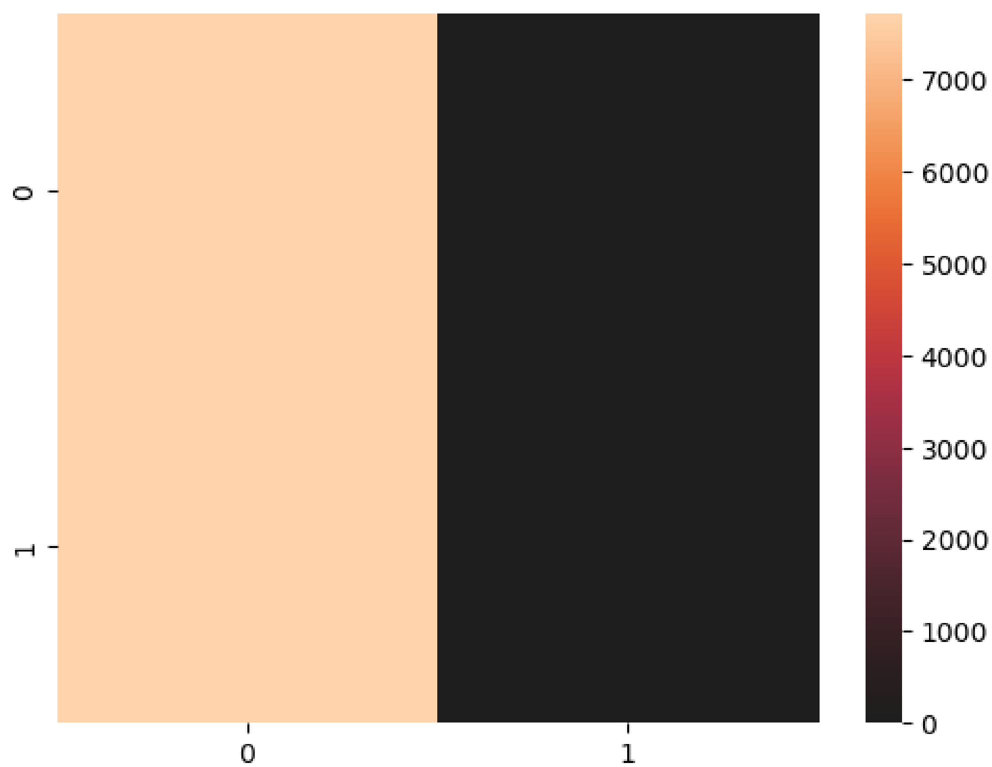
```
[0.         0.         0.         … 0.87624854 0.87624854 1.        ]
[0.00000000e+00 1.29483361e-04 6.47416807e-04 … 9.99870517e-01
 1.00000000e+00 1.00000000e+00]
```

The DummyClassifier in scikit-learn does not require explicit training or fitting since it employs simple rules for prediction based on the specified strategy. The strategy='most_frequent' strategy used in your code instructs the DummyClassifier to always predict the most frequent class in the training data. Hence, the model does not learn from the data during training.

DummyClassifier from scikit-learn, which provides a simple strategy for generating predictions.

[ ]:
```python
# import necessary modules
from sklearn.dummy import DummyClassifier
from sklearn.metrics import confusion_matrix
import seaborn as sns
import matplotlib.pyplot as plt

# create a new instance of the classifier
dummy = DummyClassifier(strategy='most_frequent')

# fit the model on the training data
dummy.fit(X_train, y_train)

# predict on the test data
y_pred_dummy = dummy.predict(X_test)

# evaluate the model
print('DummyClassifier Test Score is : ', dummy.score(X_test, y_test))

# calculate and print the confusion matrix
CM_dummy = confusion_matrix(y_test, y_pred_dummy)
sns.heatmap(CM_dummy, center=True)
plt.show()
print('Confusion Matrix is\n', CM_dummy)
```

```
DummyClassifier Test Score is :  0.49954639709694143
```



```
Confusion Matrix is
 [[7709    0]
 [7723    0]]
```

[ ]:
```
'''import statistics

# list of positive integer numbers
MinTemp = data_test['MinTemp']
MaxTemp = data_test['MaxTemp']
Rainfall= data_test['Rainfall']
WindGustSpeed= data_test['WindGustSpeed']
WindSpeed9am= data_test['WindSpeed9am']
WindSpeed3pm= data_test['WindSpeed3pm']
Humidity9am= data_test['Humidity9am']
Humidity3pm= data_test['Humidity3pm']
Pressure9am= data_test['Pressure9am']
Pressure3pm= data_test['Pressure3pm']
Cloud9am =  data_test['Cloud9am']
Cloud3pm = data_test['Cloud3pm']
Temp9am = data_test['Temp9am']
Temp3pm = data_test['Temp3pm']
RainToday = data_test['RainToday']

MinTemp_mean = statistics.mean(MinTemp)
MaxTemp_mean = statistics.mean(MaxTemp)
Rainfall_mean = statistics.mean(Rainfall)
WindGustSpeed_mean = statistics.mean(WindGustSpeed)
WindSpeed9am_mean = statistics.mean(WindSpeed9am)
WindSpeed3pm_mean = statistics.mean(WindSpeed3pm)
Humidity9am_mean = statistics.mean(Humidity9am)
Humidity3pm_mean = statistics.mean(Humidity3pm)
Pressure9am_mean = statistics.mean(Pressure9am)
Pressure3pm_mean = statistics.mean(Pressure3pm)
Cloud9am_mean  = statistics.mean(Cloud9am)
Cloud3pm_mean  = statistics.mean(Cloud3pm)
Temp9am_mean   = statistics.mean(Temp9am)
Temp3pm_mean = statistics.mean(Temp3pm)


# Printing the mean
print("MinTemp Mean is :", MinTemp_mean)
print("MaxTemp Mean is :", MaxTemp_mean)
print("Rainfall Mean is :", Rainfall_mean)
print("WindGustSpeed Mean is :", WindGustSpeed_mean)
print("WindSpeed9am Mean is :", WindSpeed9am_mean)
```

```
print("WindSpeed3pm Mean is :", WindSpeed3pm_mean)
print("Humidity9am Mean is :", Humidity9am_mean)
print("Humidity3pm Mean is :", Humidity3pm_mean)
print("Pressure9am Mean is :", Pressure9am_mean)
print("Pressure3pm Mean is :", Pressure3pm_mean)
print("Cloud9am Mean is :", Cloud9am_mean)
print("Cloud3pm Mean is :", Cloud3pm_mean)
print("Cloud3pm Mean is :", Cloud3pm_mean)
print("Temp9am Mean is :", Temp9am_mean)
print("Temp3pm Mean is :", Temp3pm_mean)

MinTemp_standard_deviation = statistics.stdev(MinTemp)
MaxTemp_standard_deviation  = statistics.stdev(MaxTemp)
Rainfall_standard_deviation  = statistics.stdev(Rainfall)
WindGustSpeed_standard_deviation  = statistics.stdev(WindGustSpeed)
WindSpeed9am_standard_deviation  = statistics.stdev(WindSpeed9am)
WindSpeed3pm_standard_deviation  = statistics.stdev(WindSpeed3pm)
Humidity9am_standard_deviation  = statistics.stdev(Humidity9am)
Humidity3pm_standard_deviation = statistics.stdev(Humidity3pm)
Pressure9am_standard_deviation  = statistics.stdev(Pressure9am)
Pressure3pm_standard_deviation  = statistics.stdev(Pressure3pm)
Cloud9am_standard_deviation   = statistics.stdev(Cloud9am)
Cloud3pm_standard_deviation  = statistics.stdev(Cloud3pm)
Temp9am_standard_deviation   = statistics.stdev(Temp9am)
Temp3pm_standard_deviation  = statistics.stdev(Temp3pm)


print("Standard Deviation of the MaxTemp is % s "%(statistics.stdev(MinTemp)))
print("Standard Deviation of the MaxTemp is % s "%(statistics.stdev(MaxTemp)))
print("Standard Deviation of the Rainfall is:", Rainfall_standard_deviation)
print("Standard Deviation of the WindGustSpeed is:
 ↪",WindGustSpeed_standard_deviation)
print("Standard Deviation of the WindSpeed9am is:",␣
 ↪WindSpeed9am_standard_deviation)
print("Standard Deviation of the WindSpeed3pm is:
 ↪",WindSpeed3pm_standard_deviation)
print("Standard Deviation of the Humidity9am is:",␣
 ↪Humidity9am_standard_deviation)
print("Standard Deviation of the Humidity3pm is:",␣
 ↪Humidity3pm_standard_deviation)
print("Standard Deviation of the Pressure9am is:
 ↪",Pressure9am_standard_deviation)
print("Standard Deviation of the Pressure3pm is:
 ↪",Pressure3pm_standard_deviation)
print("Standard Deviation of the Cloud9am is:", Cloud9am_standard_deviation)
print("Standard Deviation of the Cloud3pm is:", Cloud3pm_standard_deviation)
```

```
print("Standard Deviation of the Temp9am is:", Temp9am_standard_deviation)
print("Standard Deviation of the Temp3pm is:",Temp3pm_standard_deviation)

import scipy.stats as stats

# stats f_oneway functions takes the groups as input and returns ANOVA F and p␣
 ↪value
fvalue= stats.f_oneway(data_test['MinTemp'],␣
 ↪data_test['MaxTemp'],data_test['Rainfall'],␣
 ↪data_test['WindGustSpeed'],data_test['WindSpeed9am'],data_test['WindSpeed3pm'],data_test['H
 ↪data_test['Temp9am'],data_test['Temp3pm'])
pvalue = stats.f_oneway(data_test['MinTemp'],␣
 ↪data_test['MaxTemp'],data_test['Rainfall'],␣
 ↪data_test['WindGustSpeed'],data_test['WindSpeed9am'],data_test['WindSpeed3pm'],data_test['H
 ↪data_test['Temp9am'],data_test['Temp3pm'])

#print(fvalue, pvalue)
print("The result of Anova test is:",fvalue)
print("The result of p vaue is:",pvalue)

#kruskal's test
result = stats.kruskal(data_test['MinTemp'],␣
 ↪data_test['MaxTemp'],data_test['Rainfall'],␣
 ↪data_test['WindGustSpeed'],data_test['WindSpeed9am'],data_test['WindSpeed3pm'],data_test['H
 ↪data_test['Temp9am'],data_test['Temp3pm'])

# Print the result
print(result)


import statsmodels.api as sm
from statsmodels.formula.api import ols

#perform two-way ANOVA
model = ols('RainToday ~ MinTemp + MaxTemp + Rainfall + WindGustSpeed␣
 ↪+WindSpeed9am +WindSpeed3pm +Humidity9am +Humidity3pm +Pressure9am␣
 ↪+Pressure3pm +Cloud9am +Cloud3pm +Temp9am +Temp3pm', data=data_test).fit()
sm.stats.anova_lm(model, typ=2)

model = ols("""height ~ C(program) + C(gender) + C(division) +
               C(program):C(gender) + C(program):C(division) + C(gender):
 ↪C(division) +
               C(program):C(gender):C(division)""", data=df).fit()

sm.stats.anova_lm(model, typ=2)'''
```

```
[ ]: 'import statistics\n \n# list of positive integer numbers\nMinTemp =
data_test[\'MinTemp\']\nMaxTemp = data_test[\'MaxTemp\']\nRainfall=
data_test[\'Rainfall\']\nWindGustSpeed=
data_test[\'WindGustSpeed\']\nWindSpeed9am=
data_test[\'WindSpeed9am\']\nWindSpeed3pm=
data_test[\'WindSpeed3pm\']\nHumidity9am=
data_test[\'Humidity9am\']\nHumidity3pm=
data_test[\'Humidity3pm\']\nPressure9am=
data_test[\'Pressure9am\']\nPressure3pm= data_test[\'Pressure3pm\']\nCloud9am =
data_test[\'Cloud9am\']     \nCloud3pm = data_test[\'Cloud3pm\']
\nTemp9am = data_test[\'Temp9am\']         \nTemp3pm =
data_test[\'Temp3pm\']\nRainToday = data_test[\'RainToday\']\n\nMinTemp_mean =
statistics.mean(MinTemp)\nMaxTemp_mean = statistics.mean(MaxTemp)\nRainfall_mean
= statistics.mean(Rainfall)\nWindGustSpeed_mean =
statistics.mean(WindGustSpeed)\nWindSpeed9am_mean =
statistics.mean(WindSpeed9am)\nWindSpeed3pm_mean =
statistics.mean(WindSpeed3pm)\nHumidity9am_mean =
statistics.mean(Humidity9am)\nHumidity3pm_mean =
statistics.mean(Humidity3pm)\nPressure9am_mean =
statistics.mean(Pressure9am)\nPressure3pm_mean =
statistics.mean(Pressure3pm)\nCloud9am_mean  = statistics.mean(Cloud9am)
\nCloud3pm_mean  = statistics.mean(Cloud3pm)     \nTemp9am_mean   =
statistics.mean(Temp9am)      \nTemp3pm_mean = statistics.mean(Temp3pm)\n\n \n#
Printing the mean\nprint("MinTemp Mean is :", MinTemp_mean)\nprint("MaxTemp Mean
is :", MaxTemp_mean)\nprint("Rainfall Mean is :",
Rainfall_mean)\nprint("WindGustSpeed Mean is :",
WindGustSpeed_mean)\nprint("WindSpeed9am Mean is :",
WindSpeed9am_mean)\nprint("WindSpeed3pm Mean is :",
WindSpeed3pm_mean)\nprint("Humidity9am Mean is :",
Humidity9am_mean)\nprint("Humidity3pm Mean is :",
Humidity3pm_mean)\nprint("Pressure9am Mean is :",
Pressure9am_mean)\nprint("Pressure3pm Mean is :",
Pressure3pm_mean)\nprint("Cloud9am Mean is :", Cloud9am_mean)\nprint("Cloud3pm
Mean is :", Cloud3pm_mean)\nprint("Cloud3pm Mean is :",
Cloud3pm_mean)\nprint("Temp9am Mean is :", Temp9am_mean)\nprint("Temp3pm Mean is
:", Temp3pm_mean)\n\nMinTemp_standard_deviation =
statistics.stdev(MinTemp)\nMaxTemp_standard_deviation  =
statistics.stdev(MaxTemp)\nRainfall_standard_deviation  =
statistics.stdev(Rainfall)\nWindGustSpeed_standard_deviation  =
statistics.stdev(WindGustSpeed)\nWindSpeed9am_standard_deviation  =
statistics.stdev(WindSpeed9am)\nWindSpeed3pm_standard_deviation  =
statistics.stdev(WindSpeed3pm)\nHumidity9am_standard_deviation  =
statistics.stdev(Humidity9am)\nHumidity3pm_standard_deviation =
statistics.stdev(Humidity3pm)\nPressure9am_standard_deviation  =
statistics.stdev(Pressure9am)\nPressure3pm_standard_deviation  =
statistics.stdev(Pressure3pm)\nCloud9am_standard_deviation   =
statistics.stdev(Cloud9am)      \nCloud3pm_standard_deviation  =
```

```
statistics.stdev(Cloud3pm)     \nTemp9am_standard_deviation   =
statistics.stdev(Temp9am)      \nTemp3pm_standard_deviation  =
statistics.stdev(Temp3pm)\n\n\nprint("Standard Deviation of the MaxTemp is % s
"%(statistics.stdev(MinTemp)))\nprint("Standard Deviation of the MaxTemp is % s
"%(statistics.stdev(MaxTemp)))\nprint("Standard Deviation of the Rainfall is:",
Rainfall_standard_deviation)\nprint("Standard Deviation of the WindGustSpeed
is:",WindGustSpeed_standard_deviation)\nprint("Standard Deviation of the
WindSpeed9am is:", WindSpeed9am_standard_deviation)\nprint("Standard Deviation
of the WindSpeed3pm is:",WindSpeed3pm_standard_deviation)\nprint("Standard
Deviation of the Humidity9am is:",
Humidity9am_standard_deviation)\nprint("Standard Deviation of the Humidity3pm
is:", Humidity3pm_standard_deviation)\nprint("Standard Deviation of the
Pressure9am is:",Pressure9am_standard_deviation)\nprint("Standard Deviation of
the Pressure3pm is:",Pressure3pm_standard_deviation)\nprint("Standard Deviation
of the Cloud9am is:", Cloud9am_standard_deviation)\nprint("Standard Deviation of
the Cloud3pm is:", Cloud3pm_standard_deviation)\nprint("Standard Deviation of
the Temp9am is:", Temp9am_standard_deviation)\nprint("Standard Deviation of the
Temp3pm is:",Temp3pm_standard_deviation)\n\nimport scipy.stats as stats\n\n#
stats f_oneway functions takes the groups as input and returns ANOVA F and p
value\nfvalue= stats.f_oneway(data_test[\'MinTemp\'],
data_test[\'MaxTemp\'],data_test[\'Rainfall\'], data_test[\'WindGustSpeed\'],dat
a_test[\'WindSpeed9am\'],data_test[\'WindSpeed3pm\'],data_test[\'Humidity9am\'],
data_test[\'Humidity3pm\'],data_test[\'Pressure9am\'],data_test[\'Pressure3pm\']
,data_test[\'Cloud9am\'],data_test[\'Cloud3pm\'],
data_test[\'Temp9am\'],data_test[\'Temp3pm\'])\npvalue =
stats.f_oneway(data_test[\'MinTemp\'],
data_test[\'MaxTemp\'],data_test[\'Rainfall\'], data_test[\'WindGustSpeed\'],dat
a_test[\'WindSpeed9am\'],data_test[\'WindSpeed3pm\'],data_test[\'Humidity9am\'],
data_test[\'Humidity3pm\'],data_test[\'Pressure9am\'],data_test[\'Pressure3pm\']
,data_test[\'Cloud9am\'],data_test[\'Cloud3pm\'],
data_test[\'Temp9am\'],data_test[\'Temp3pm\'])\n\n#print(fvalue,
pvalue)\nprint("The result of Anova test is:",fvalue)\nprint("The result of p
vaue is:",pvalue)\n\n#kruskal\'s test\nresult =
stats.kruskal(data_test[\'MinTemp\'],
data_test[\'MaxTemp\'],data_test[\'Rainfall\'], data_test[\'WindGustSpeed\'],dat
a_test[\'WindSpeed9am\'],data_test[\'WindSpeed3pm\'],data_test[\'Humidity9am\'],
data_test[\'Humidity3pm\'],data_test[\'Pressure9am\'],data_test[\'Pressure3pm\']
,data_test[\'Cloud9am\'],data_test[\'Cloud3pm\'],
data_test[\'Temp9am\'],data_test[\'Temp3pm\'])\n\n# Print the
result\nprint(result)\n\n\nimport statsmodels.api as sm\nfrom
statsmodels.formula.api import ols\n\n#perform two-way ANOVA\nmodel =
ols(\'RainToday ~ MinTemp + MaxTemp + Rainfall + WindGustSpeed +WindSpeed9am
+WindSpeed3pm +Humidity9am +Humidity3pm +Pressure9am +Pressure3pm +Cloud9am
+Cloud3pm +Temp9am +Temp3pm\', data=data_test).fit()\nsm.stats.anova_lm(model,
typ=2)\n\nmodel = ols("""height ~ C(program) + C(gender) + C(division) +\n
C(program):C(gender) + C(program):C(division) + C(gender):C(division) +\n
C(program):C(gender):C(division)""", data=df).fit()\n\nsm.stats.anova_lm(model,
```

```
typ=2)'
```