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Tugas Prapraktikum

Tugas Prapraktikum dikerjakan dengan *dataset* Rain in Australia. Tanpa meninjau waktu (`date`), prediksi status hujan pada keesokan harinya (`RainTomorrow`). Berikan nilai `1` jika diprediksi hujan pada keesokan harinya, `0` jika tidak.

Tugas dikerjakan secara berkelompok. Setiap kelompok terdiri atas 2 (dua) mahasiswa. Kumpulkan paling lambat pada Minggu, 16 April 2023, pukul 23:59 WIB melalui Edunex.

0. Persiapan Data and Pustaka

In [1]:
```
# Letakkan pustaka di sini.
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from math import ceil, floor
from sklearn import datasets, metrics
from sklearn.svm import SVC
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.preprocessing import LabelEncoder, MinMaxScaler
from sklearn.linear_model import LogisticRegression, SGDClassifier
from sklearn.pipeline import make_pipeline
from sklearn.model_selection import cross_validate
from sklearn.model_selection import cross_val_score
from sklearn.ensemble import VotingClassifier, StackingClassifier
from imblearn.over_sampling import RandomOverSampler
from imblearn.under_sampling import RandomUnderSampler
```

In [2]:
```
# Baca data di sini.
data = pd.read_csv('weatherAUS.csv')
data.drop(["Date"], axis = 1, inplace = True)
data.head()
```

Out[2]:

	Location	MinTemp	MaxTemp	Rainfall	Evaporation	Sunshine	WindGustDir	WindGustSpeed	Wi
0	Albury	13.4	22.9	0.6	NaN	NaN	W	44.0	
1	Albury	7.4	25.1	0.0	NaN	NaN	WNW	44.0	
2	Albury	12.9	25.7	0.0	NaN	NaN	WSW	46.0	
3	Albury	9.2	28.0	0.0	NaN	NaN	NE	24.0	
4	Albury	17.5	32.3	1.0	NaN	NaN	W	41.0	

5 rows × 22 columns

I. Pemahaman Data

Tujuan dari bagian ini adalah peserta dapat memahami kualitas dari data yang diberikan. Hal yang diliputi adalah sebagai berikut:

1. Ukuran data
2. Statistik dari tiap fitur
3. Pencilan (*outlier*)
4. Korelasi
5. Distribusi

I.1

Carilah:

1. Ukuran dari data (instansi dan fitur)
2. Tipe dari setiap fitur
3. Banyak nilai unik dari fitur yang bertipe kategorikal
4. Nilai minimum, maksimum, rata-rata, median, dan standar deviasi dari fitur nonkategorikal

In [3]:

```
# I.1 Kode di sini.

# 1. Ukuran dari data (instansi dan fitur)
print("1. Ukuran dari data (instansi dan fitur)")
print("Jumlah instansi:", data.shape[0])
print("Jumlah fitur:", data.shape[1]-1)

# 2. Tipe dari setiap fitur
print("2. Tipe dari setiap fitur")
print(data.dtypes)

# 3. Banyak nilai unik dari fitur yang bertipe kategorikal
print("3. Banyak nilai unik dari fitur yang bertipe kategorikal")
data_unique = {}
for col in data:
```

```
    if data[col].dtype == "object":
        data_unique[col] = [data[col].nunique()]
data_unique = pd.DataFrame(data_unique)
print(data_unique)

# 4. Nilai minimum, maksimum, rata-rata, median, dan standar deviasi dari fitur nonkat
print("4. Nilai minimum, maksimum, rata-rata, median, dan standar deviasi dari fitur n
print("Minimum")
print(data.min(numeric_only=True))

print("\nMaximum")
print(data.max(numeric_only=True))

print("\nMedian")
print(data.median(numeric_only=True))

print("\nStandar Deviasi")
print(data.std(numeric_only=True))
```

```
1. Ukuran dari data (instansi dan fitur)
Jumlah instansi: 145460
Jumlah fitur: 21
2. Tipe dari setiap fitur
Location          object
MinTemp          float64
MaxTemp          float64
Rainfall         float64
Evaporation      float64
Sunshine         float64
WindGustDir       object
WindGustSpeed    float64
WindDir9am        object
WindDir3pm        object
WindSpeed9am     float64
WindSpeed3pm     float64
Humidity9am      float64
Humidity3pm      float64
Pressure9am      float64
Pressure3pm      float64
Cloud9am         float64
Cloud3pm         float64
Temp9am          float64
Temp3pm          float64
RainToday         object
RainTomorrow      object
dtype: object
3. Banyak nilai unik dari fitur yang bertipe kategorikal
   Location  WindGustDir  WindDir9am  WindDir3pm  RainToday  RainTomorrow
0        49           16          16          16          2             2
4. Nilai minimum, maksimum, rata-rata, median, dan standar deviasi dari fitur nonkate
gorikal
Minimum
MinTemp           -8.5
MaxTemp           -4.8
Rainfall           0.0
Evaporation        0.0
Sunshine           0.0
WindGustSpeed      6.0
WindSpeed9am       0.0
WindSpeed3pm       0.0
Humidity9am        0.0
Humidity3pm        0.0
Pressure9am      980.5
Pressure3pm      977.1
Cloud9am           0.0
Cloud3pm           0.0
Temp9am           -7.2
Temp3pm           -5.4
dtype: float64

Maximum
MinTemp            33.9
MaxTemp            48.1
Rainfall          371.0
Evaporation       145.0
Sunshine           14.5
WindGustSpeed     135.0
WindSpeed9am      130.0
WindSpeed3pm       87.0
```

```
Humidity9am       100.0
Humidity3pm       100.0
Pressure9am      1041.0
Pressure3pm      1039.6
Cloud9am            9.0
Cloud3pm            9.0
Temp9am            40.2
Temp3pm            46.7
dtype: float64

Median
MinTemp            12.0
MaxTemp            22.6
Rainfall            0.0
Evaporation         4.8
Sunshine            8.4
WindGustSpeed      39.0
WindSpeed9am       13.0
WindSpeed3pm       19.0
Humidity9am        70.0
Humidity3pm        52.0
Pressure9am      1017.6
Pressure3pm      1015.2
Cloud9am            5.0
Cloud3pm            5.0
Temp9am            16.7
Temp3pm            21.1
dtype: float64

Standar Deviasi
MinTemp           6.398495
MaxTemp           7.119049
Rainfall          8.478060
Evaporation       4.193704
Sunshine          3.785483
WindGustSpeed    13.607062
WindSpeed9am      8.915375
WindSpeed3pm      8.809800
Humidity9am      19.029164
Humidity3pm      20.795902
Pressure9am       7.106530
Pressure3pm       7.037414
Cloud9am          2.887159
Cloud3pm          2.720357
Temp9am           6.488753
Temp3pm           6.936650
dtype: float64
```

I.2

Carilah:

1. Nilai hilang (*missing*) dari setiap fitur
2. Nilai pencilan (*outlier*) dari setiap fitur

In [4]:
```
# I.2 Kode di sini.
```

```python
# 1. Nilai hilang (missing) dari setiap fitur
print("1. Nilai hilang (missing) dari setiap fitur")
print("Missing value count:")
print(data.isnull().sum())

# 2. Nilai pencilan (outlier) dari setiap fitur
print("2. Nilai pencilan (outlier) dari setiap fitur")
print("\nOutlier count:")
dataNum = data.select_dtypes(include=[np.number])
Q1 = dataNum.quantile(0.25)
Q3 = dataNum.quantile(0.75)
IQR = Q3 - Q1
((dataNum < (Q1 - 1.5 * IQR)) | (dataNum > (Q3 + 1.5 * IQR))).sum()
```

```
1. Nilai hilang (missing) dari setiap fitur
Missing value count:
Location             0
MinTemp           1485
MaxTemp           1261
Rainfall          3261
Evaporation      62790
Sunshine         69835
WindGustDir      10326
WindGustSpeed    10263
WindDir9am       10566
WindDir3pm        4228
WindSpeed9am      1767
WindSpeed3pm      3062
Humidity9am       2654
Humidity3pm       4507
Pressure9am      15065
Pressure3pm      15028
Cloud9am         55888
Cloud3pm         59358
Temp9am           1767
Temp3pm           3609
RainToday         3261
RainTomorrow      3267
dtype: int64
2. Nilai pencilan (outlier) dari setiap fitur

Outlier count:
```

Out[4]:

```
MinTemp             54
MaxTemp            489
Rainfall         25578
Evaporation       1995
Sunshine             0
WindGustSpeed     3092
WindSpeed9am      1817
WindSpeed3pm      2523
Humidity9am       1425
Humidity3pm          0
Pressure9am       1191
Pressure3pm        919
Cloud9am             0
Cloud3pm             0
Temp9am            262
Temp3pm            764
dtype: int64
```

I.3

Lakukan:

1. Pencarian korelasi antarfitur
2. Visualisasi distribusi setiap fitur (kategorikal dan kontinu)
3. Visualisasi distribusi setiap fitur per target (`RainTomorrow`)

In [5]:

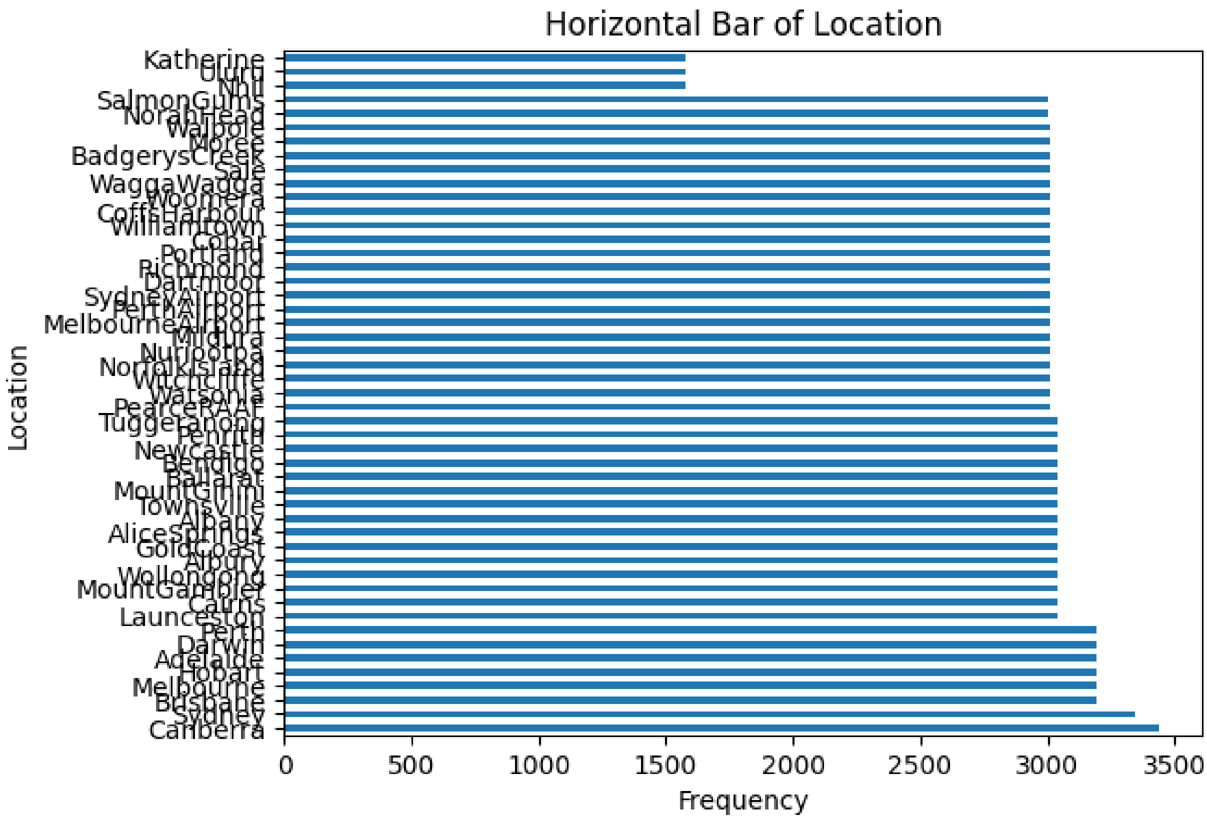
```
# I.3 Kode di sini.

# 1. Pencarian korelasi antarfitur
print("1. Pencarian korelasi antarfitur")
print(data.corr())

# 2. Visualisasi distribusi setiap fitur (kategorikal dan kontinu)
print("2. Visualisasi distribusi setiap fitur (kategorikal dan kontinu)")
for col in data:
    if data[col].dtype == "object":
        data[col].value_counts(dropna = True).plot(kind='barh')
        plt.title('Horizontal Bar of ' + col)
        plt.xlabel('Frequency')
        plt.ylabel(col)
        plt.show()
    else:
        data[col].plot(kind='hist', bins=50)
        plt.title('Histogram of ' + col)
        plt.xlabel(col)
        plt.ylabel('Frequency')
        plt.show()

# 3. Visualisasi distribusi setiap fitur per target (RainTomorrow)
print("3. Visualisasi distribusi setiap fitur per target (RainTomorrow)")
for col in data:
    if data[col].dtype == object:
        data.groupby(col)['RainTomorrow'].value_counts(dropna = True).unstack().plot(k
        plt.title('Bar Horizontal of ' + col)
        plt.xlabel(col)
        plt.ylabel('Frequency')
        plt.legend()
        plt.show()
    else:
        data.groupby('RainTomorrow')[col].plot(kind='hist', bins=50, stacked=True)
        plt.title('Histogram of ' + col)
        plt.xlabel(col)
        plt.ylabel('Frequency')
        plt.legend()
        plt.show()
```

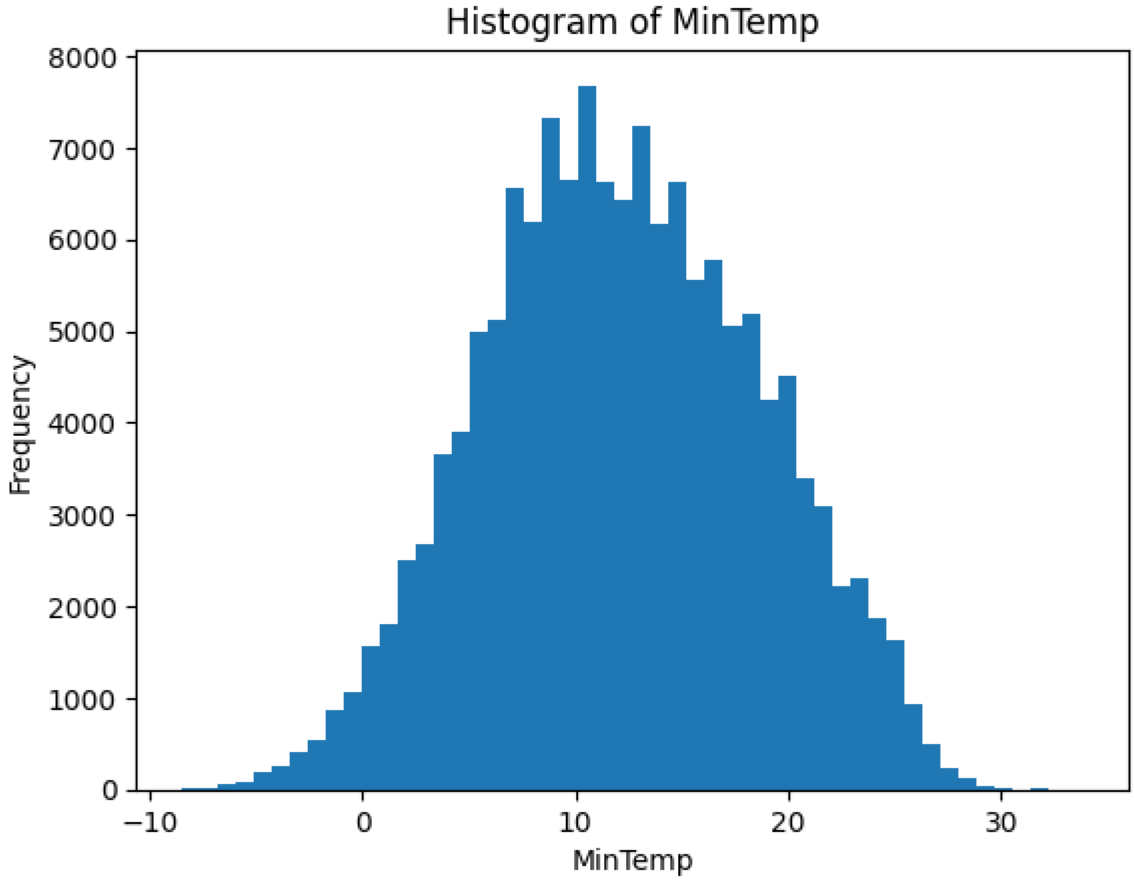
1. Pencarian korelasi antarfitur

```
                MinTemp   MaxTemp  Rainfall  Evaporation  Sunshine  \
MinTemp        1.000000  0.736555  0.103938     0.466993  0.072586
MaxTemp        0.736555  1.000000 -0.074992     0.587932  0.470156
Rainfall       0.103938 -0.074992  1.000000    -0.064351 -0.227549
Evaporation    0.466993  0.587932 -0.064351     1.000000  0.365602
Sunshine       0.072586  0.470156 -0.227549     0.365602  1.000000
WindGustSpeed  0.177415  0.067615  0.133659     0.203021 -0.034750
WindSpeed9am   0.175064  0.014450  0.087338     0.193084  0.005499
WindSpeed3pm   0.175173  0.050300  0.057887     0.129400  0.053834
Humidity9am   -0.232899 -0.504110  0.224405    -0.504092 -0.490819
Humidity3pm    0.006089 -0.508855  0.255755    -0.390243 -0.629130
Pressure9am   -0.450970 -0.332061 -0.168154    -0.270362  0.041970
Pressure3pm   -0.461292 -0.427167 -0.126534    -0.293581 -0.019719
Cloud9am       0.078754 -0.289370  0.198528    -0.183793 -0.675323
Cloud3pm       0.021605 -0.277921  0.172403    -0.182618 -0.703930
Temp9am        0.901821  0.887210  0.011192     0.545115  0.291188
Temp3pm        0.708906  0.984503 -0.079657     0.572893  0.490501

               WindGustSpeed  WindSpeed9am  WindSpeed3pm  Humidity9am  \
MinTemp             0.177415      0.175064      0.175173    -0.232899
MaxTemp             0.067615      0.014450      0.050300    -0.504110
Rainfall            0.133659      0.087338      0.057887     0.224405
Evaporation         0.203021      0.193084      0.129400    -0.504092
Sunshine           -0.034750      0.005499      0.053834    -0.490819
WindGustSpeed       1.000000      0.605303      0.686307    -0.215070
WindSpeed9am        0.605303      1.000000      0.519547    -0.270858
WindSpeed3pm        0.686307      0.519547      1.000000    -0.145525
Humidity9am        -0.215070     -0.270858     -0.145525     1.000000
Humidity3pm        -0.026327     -0.031614      0.016432     0.666949
Pressure9am        -0.458744     -0.228743     -0.296351     0.139442
Pressure3pm        -0.413749     -0.175817     -0.255439     0.186858
Cloud9am            0.071736      0.025112      0.053337     0.452297
Cloud3pm            0.109168      0.054639      0.025396     0.357326
Temp9am             0.150150      0.128545      0.163030    -0.471354
Temp3pm             0.032748      0.004569      0.027778    -0.498399

               Humidity3pm  Pressure9am  Pressure3pm  Cloud9am  Cloud3pm  \
MinTemp           0.006089    -0.450970    -0.461292  0.078754  0.021605
MaxTemp          -0.508855    -0.332061    -0.427167 -0.289370 -0.277921
Rainfall          0.255755    -0.168154    -0.126534  0.198528  0.172403
Evaporation      -0.390243    -0.270362    -0.293581 -0.183793 -0.182618
Sunshine         -0.629130     0.041970    -0.019719 -0.675323 -0.703930
WindGustSpeed    -0.026327    -0.458744    -0.413749  0.071736  0.109168
WindSpeed9am     -0.031614    -0.228743    -0.175817  0.025112  0.054639
WindSpeed3pm      0.016432    -0.296351    -0.255439  0.053337  0.025396
Humidity9am       0.666949     0.139442     0.186858  0.452297  0.357326
Humidity3pm       1.000000    -0.027544     0.051997  0.517120  0.523120
Pressure9am      -0.027544     1.000000     0.961326 -0.129796 -0.147861
Pressure3pm       0.051997     0.961326     1.000000 -0.060772 -0.084778
Cloud9am          0.517120    -0.129796    -0.060772  1.000000  0.603564
Cloud3pm          0.523120    -0.147861    -0.084778  0.603564  1.000000
Temp9am          -0.221019    -0.422556    -0.470187 -0.136959 -0.126659
Temp3pm          -0.557841    -0.286770    -0.389548 -0.302060 -0.317420

                Temp9am   Temp3pm
MinTemp        0.901821  0.708906
MaxTemp        0.887210  0.984503
Rainfall       0.011192 -0.079657
Evaporation    0.545115  0.572893
```

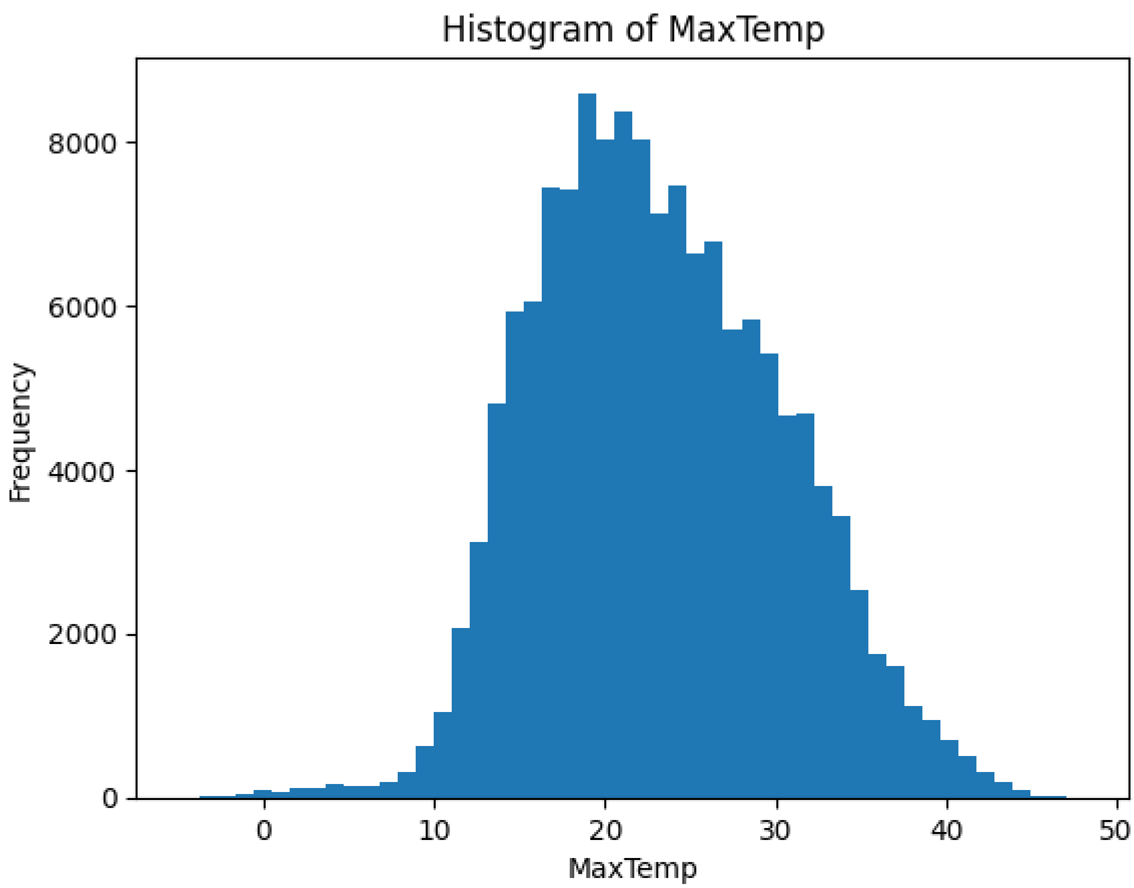
```
Sunshine       0.291188  0.490501
WindGustSpeed  0.150150  0.032748
WindSpeed9am   0.128545  0.004569
WindSpeed3pm   0.163030  0.027778
Humidity9am   -0.471354 -0.498399
Humidity3pm   -0.221019 -0.557841
Pressure9am   -0.422556 -0.286770
Pressure3pm   -0.470187 -0.389548
Cloud9am      -0.136959 -0.302060
Cloud3pm      -0.126659 -0.317420
Temp9am        1.000000  0.860591
Temp3pm        0.860591  1.000000
```

2. Visualisasi distribusi setiap fitur (kategorikal dan kontinu)

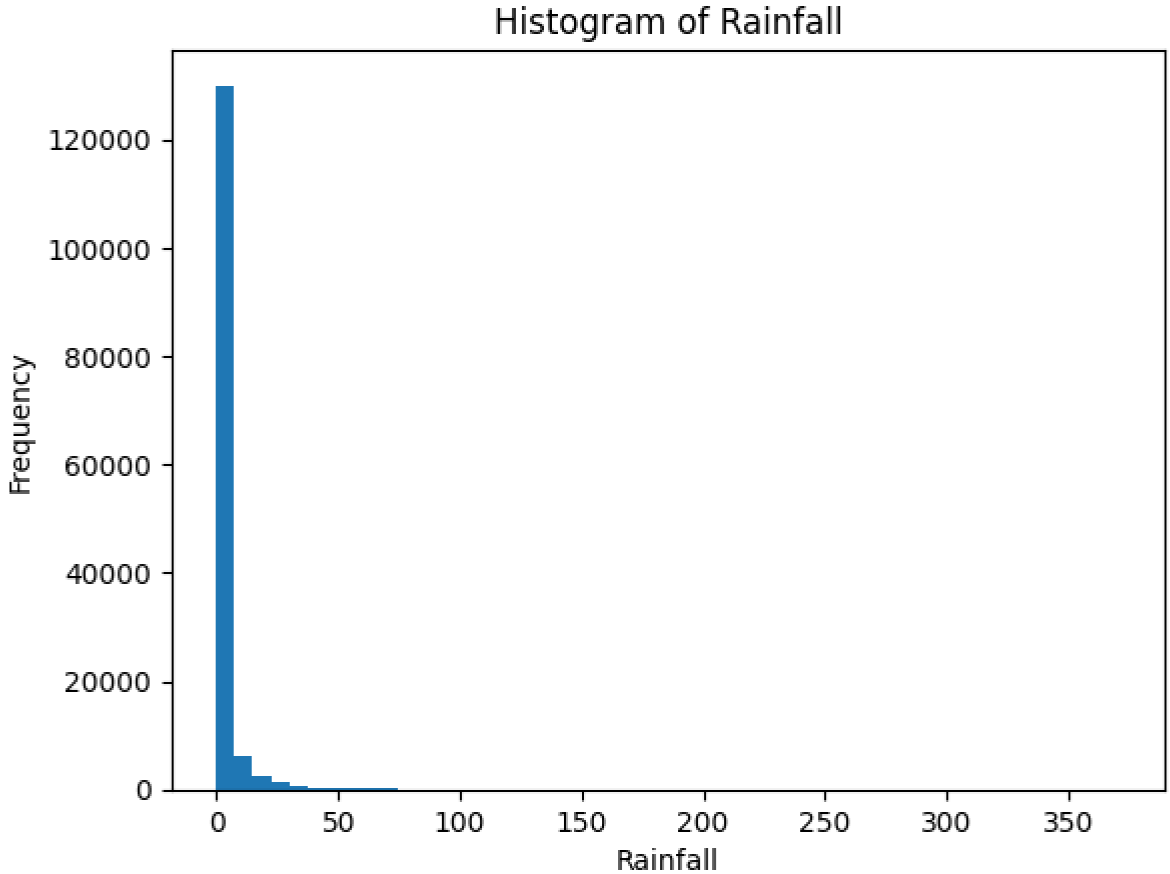


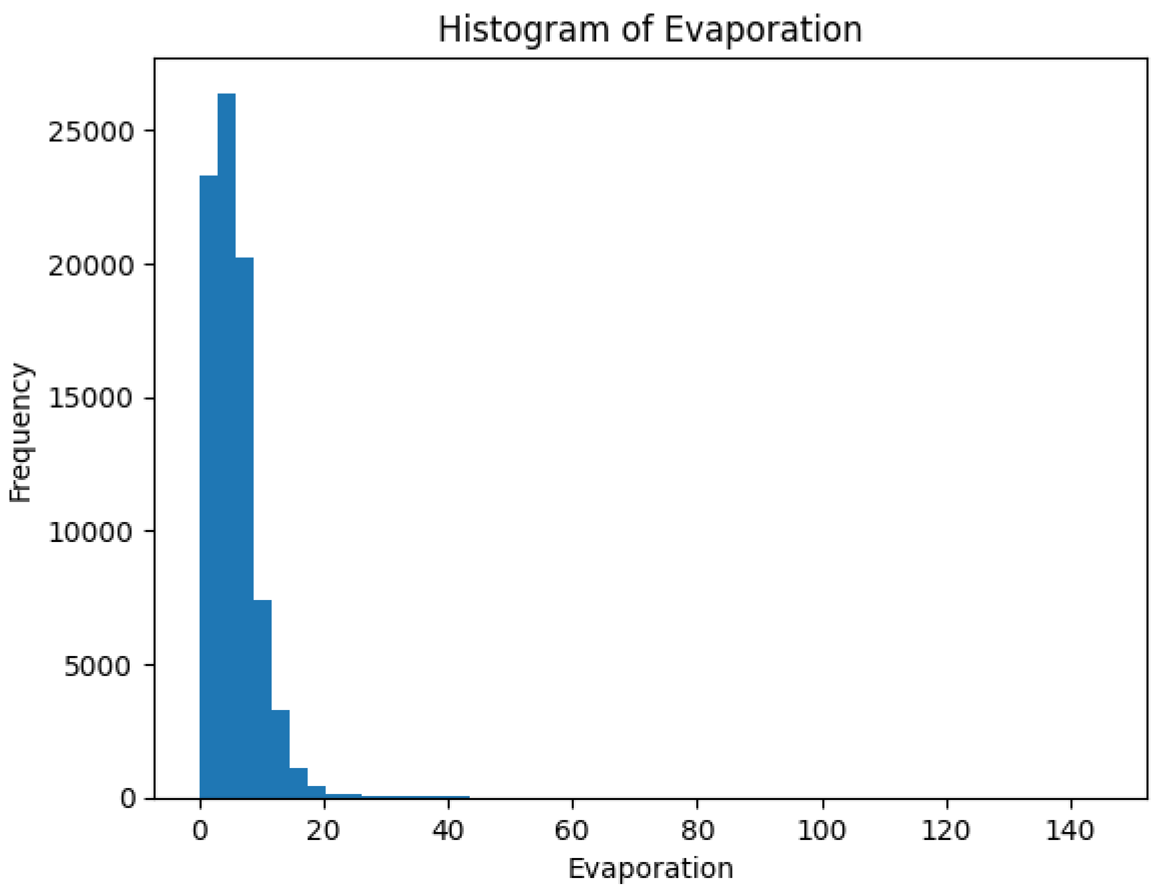


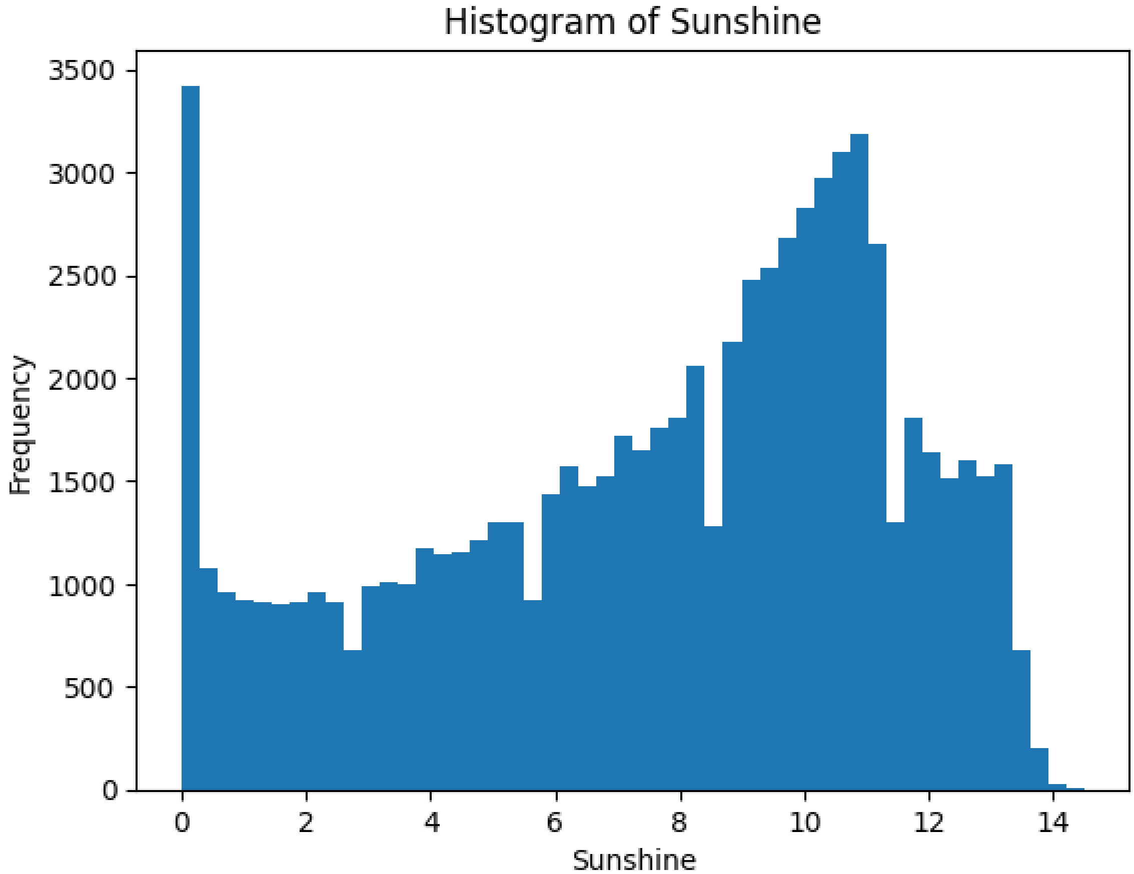
Histogram of MinTemp
Frequency
MinTemp
0
1000
2000
3000
4000
5000
6000
7000
8000
−10
0
10
20
30



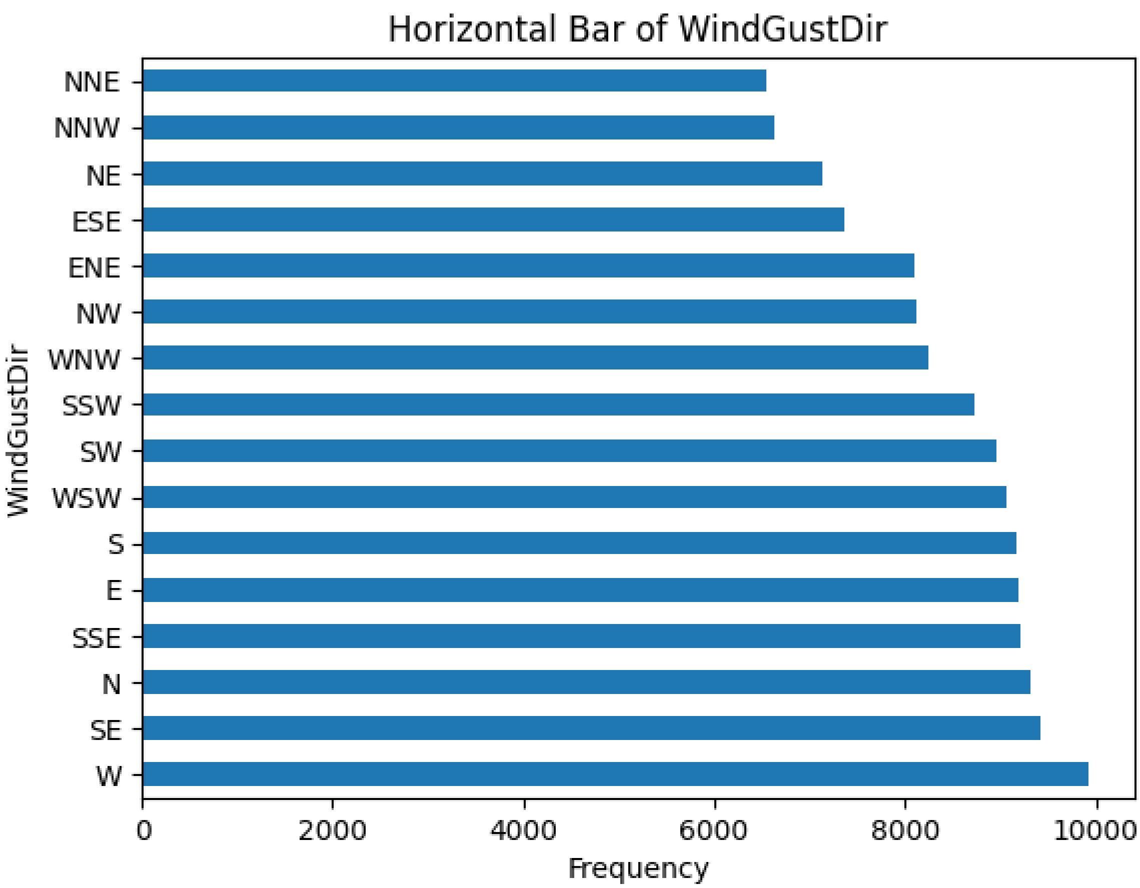
Histogram of MaxTemp
Frequency
MaxTemp
0
2000
4000
6000
8000
0
10
20
30
40
50


Histogram of Rainfall
Frequency
Rainfall
0
20000
40000
60000
80000
100000
120000
0
50
100
150
200
250
300
350

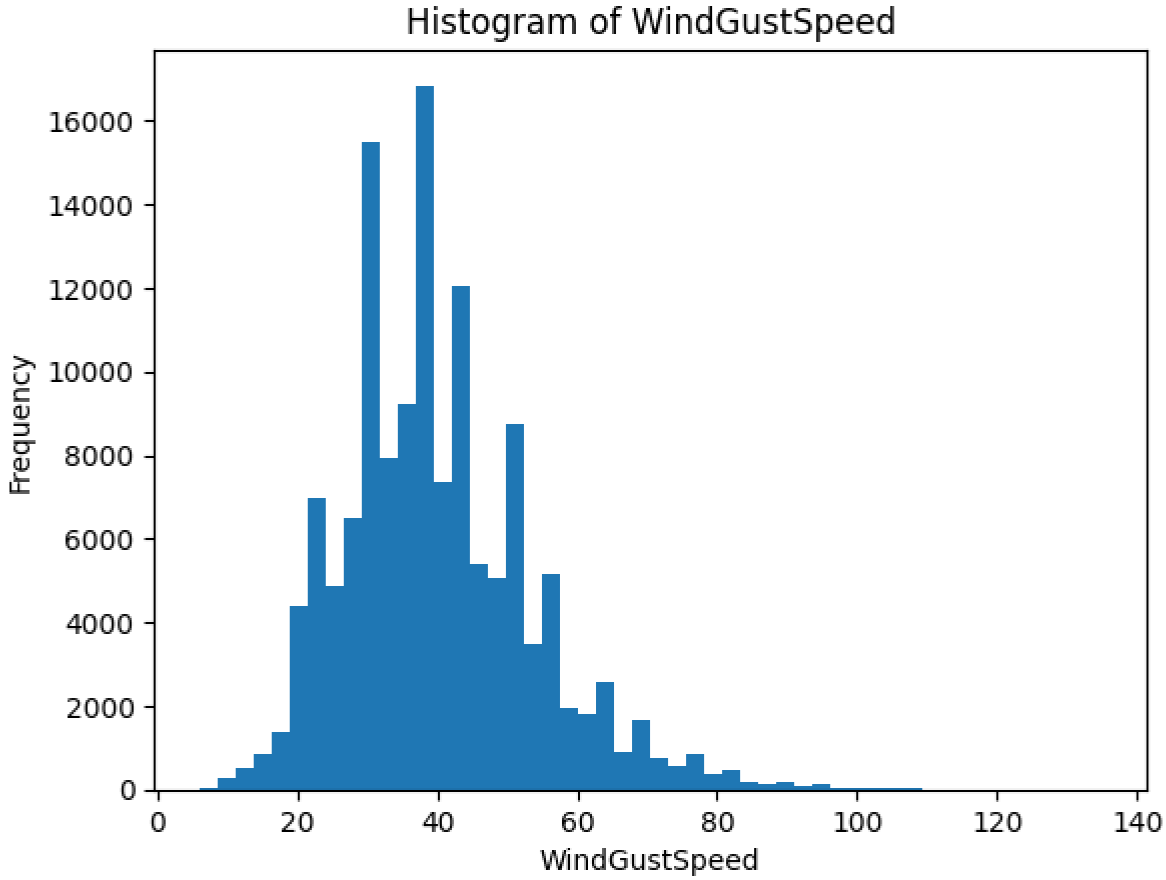

Histogram of Evaporation
Frequency
Evaporation
0
5000
10000
15000
20000
25000
0
20
40
60
80
100
120
140



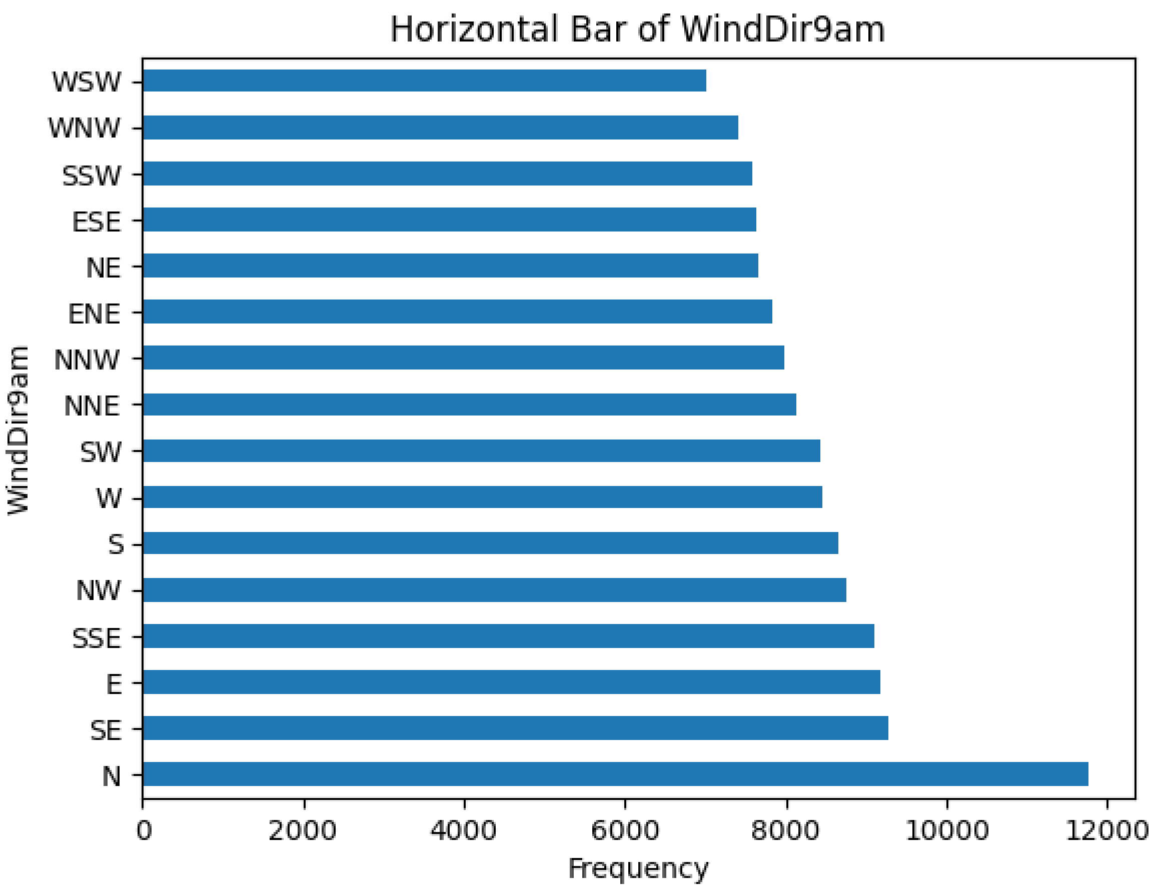
Histogram of Sunshine
Frequency
Sunshine
0
500
1000
1500
2000
2500
3000
3500
0
2
4
6
8
10
12
14



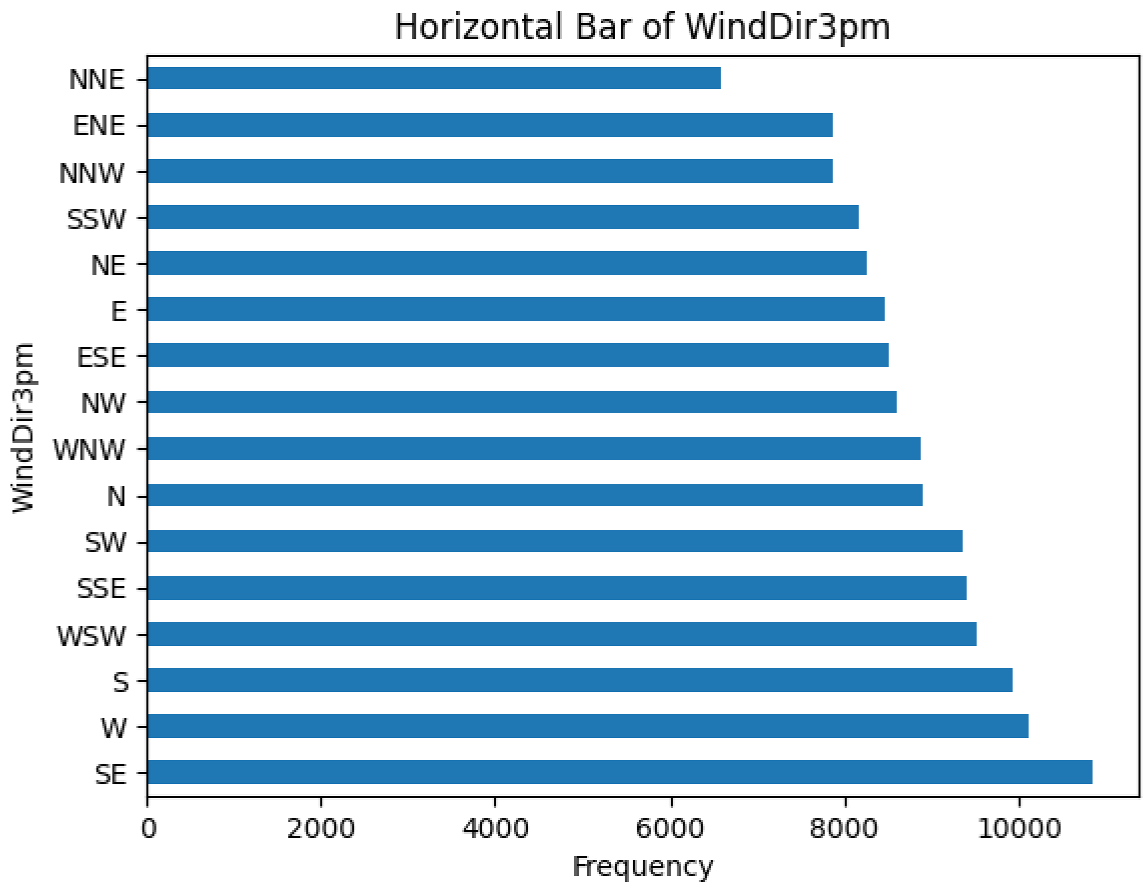
Horizontal Bar of WindGustDir
WindGustDir
Frequency
NNE
NNW
NE
ESE
ENE
NW
WNW
SSW
SW
WSW
S
E
SSE
N
SE
W
0
2000
4000
6000
8000
10000

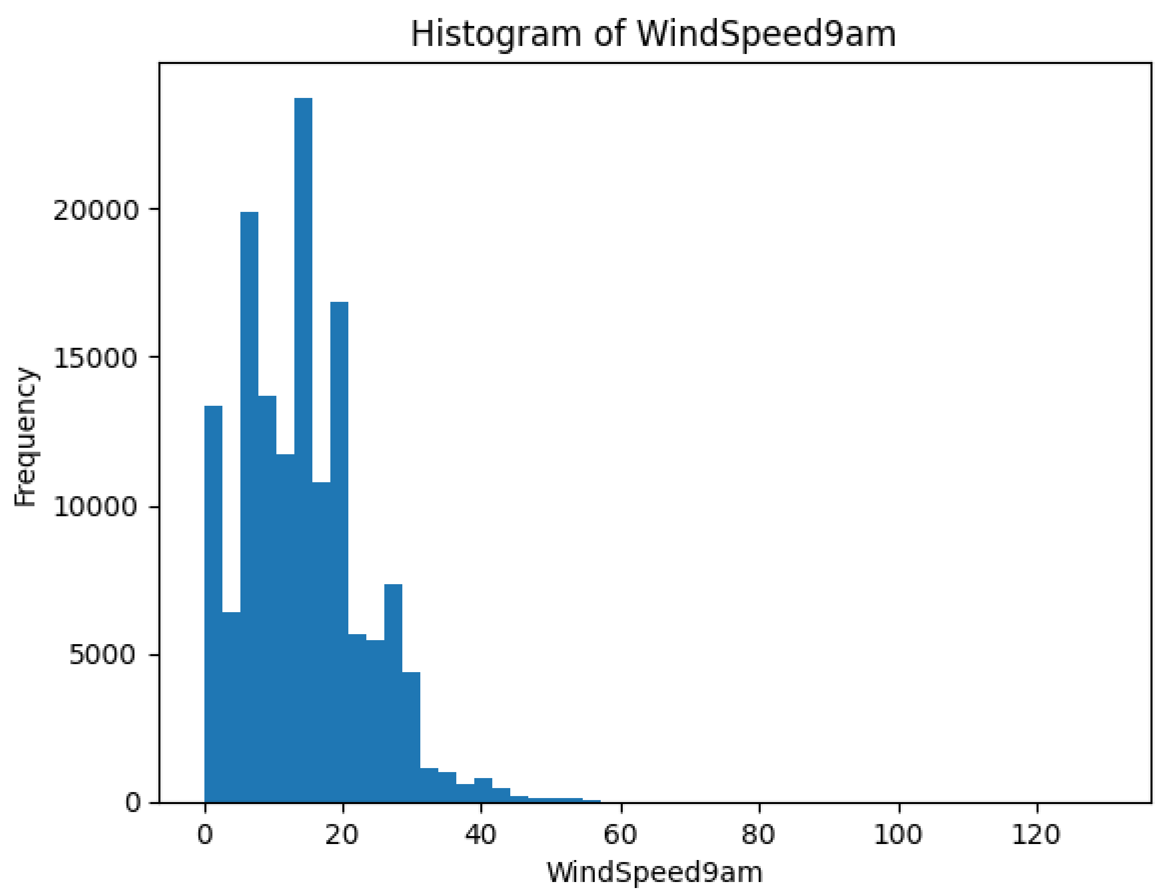


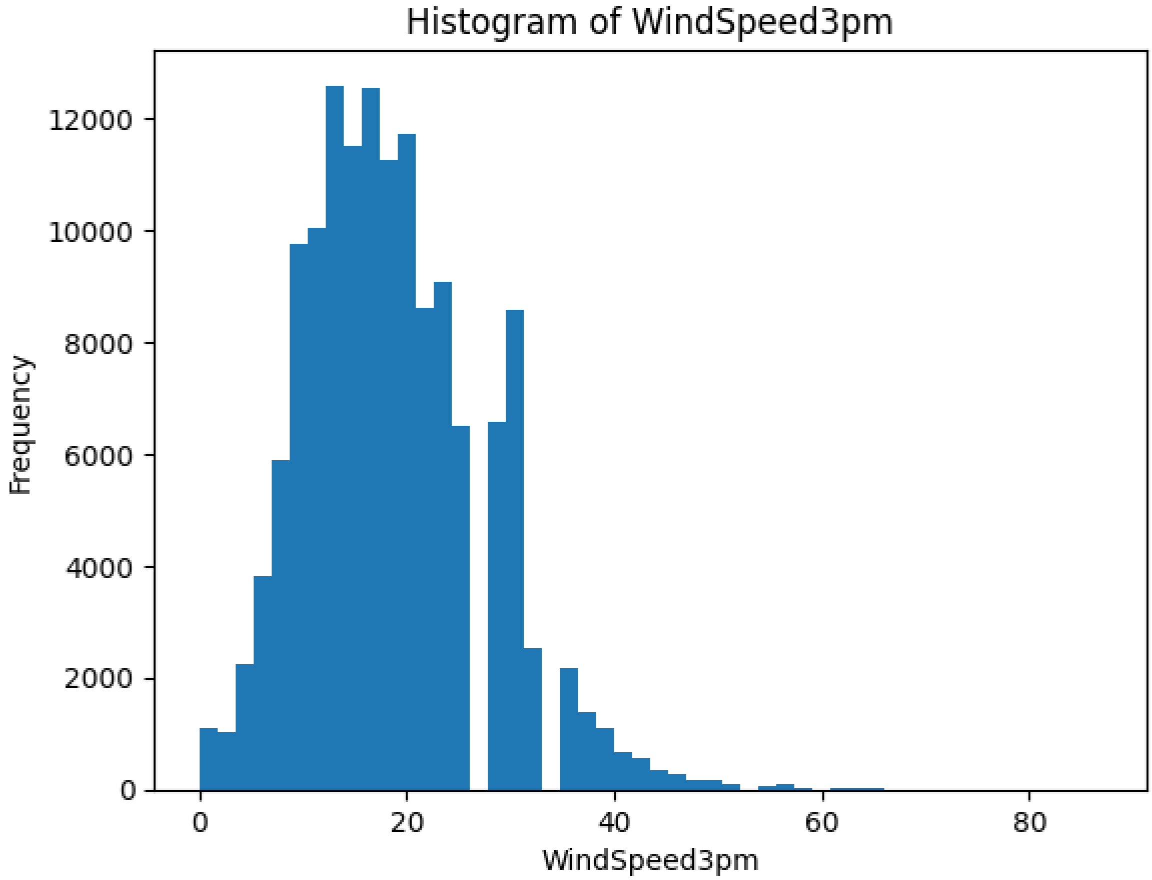
Histogram of WindGustSpeed
Frequency
WindGustSpeed
0
2000
4000
6000
8000
10000
12000
14000
16000
0
20
40
60
80
100
120
140



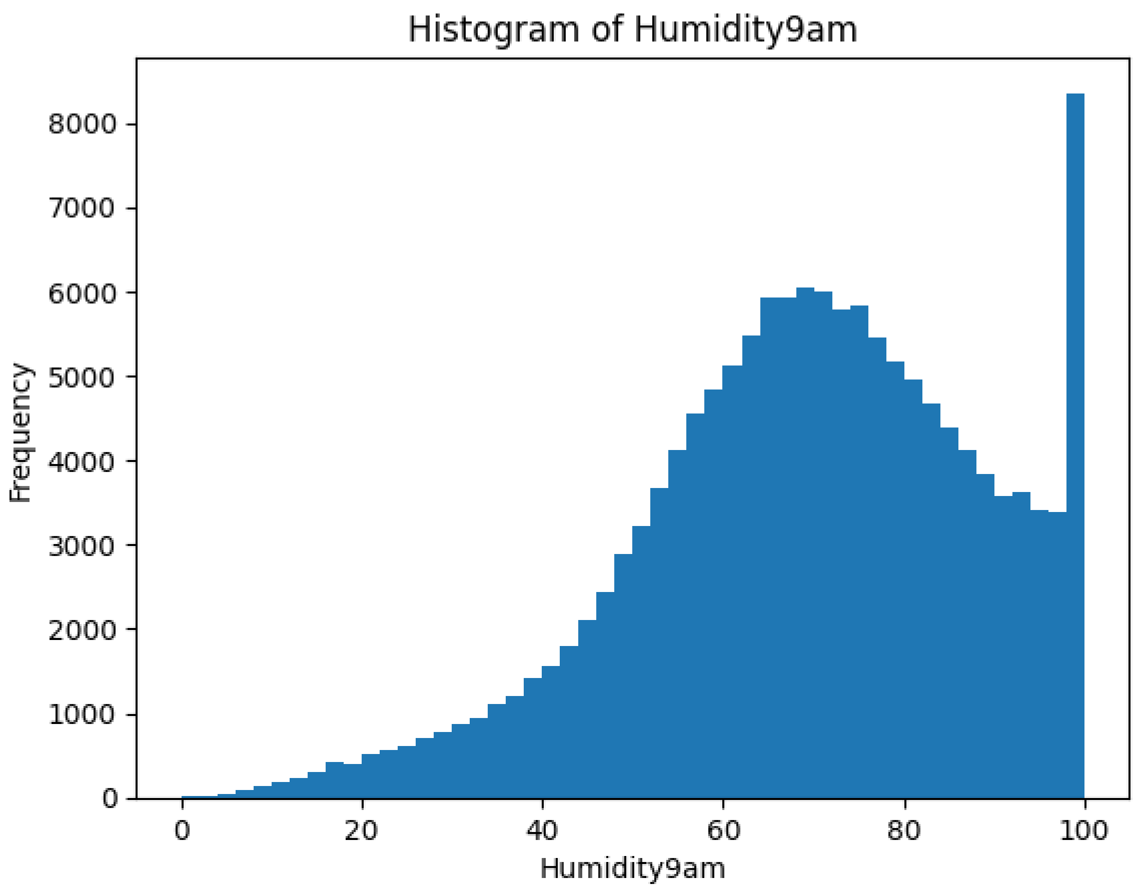
Horizontal Bar of WindDir9am
WindDir9am
Frequency
WSW
WNW
SSW
ESE
NE
ENE
NNW
NNE
SW
W
S
NW
SSE
E
SE
N
0
2000
4000
6000
8000
10000
12000


Horizontal Bar of WindDir3pm
NNE
ENE
NNW
SSW
NE
E
ESE
NW
WNW
N
SW
SSE
WSW
S
W
SE
WindDir3pm
0
2000
4000
6000
8000
10000
Frequency

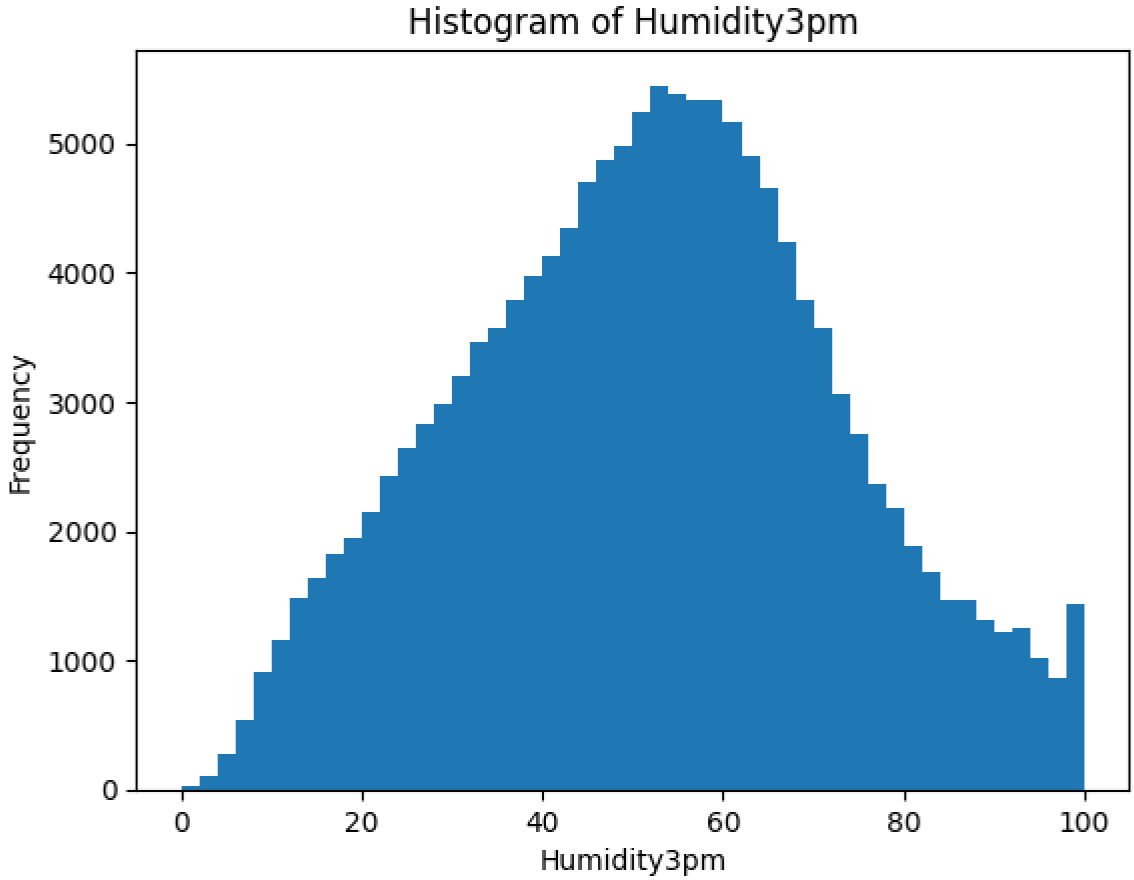

Histogram of WindSpeed9am
20000
15000
10000
5000
0
Frequency
0
20
40
60
80
100
120
WindSpeed9am

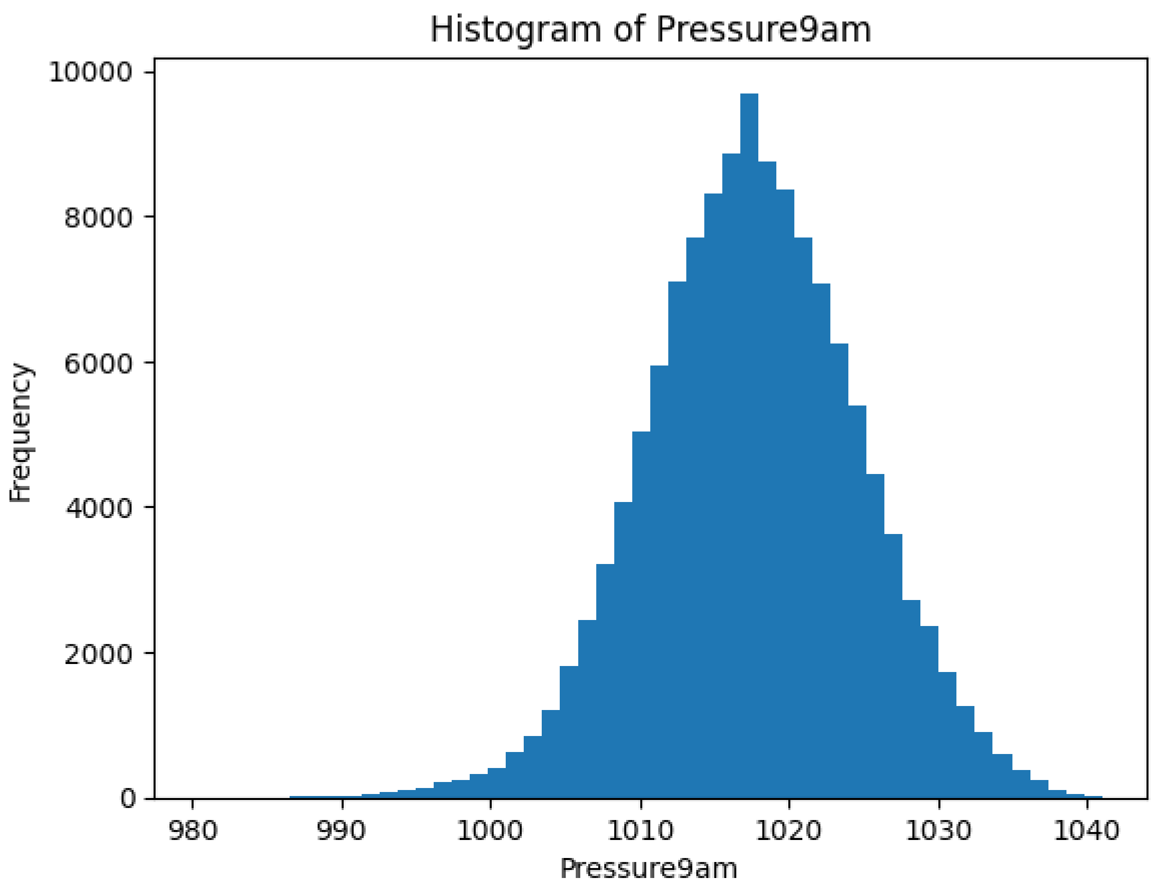


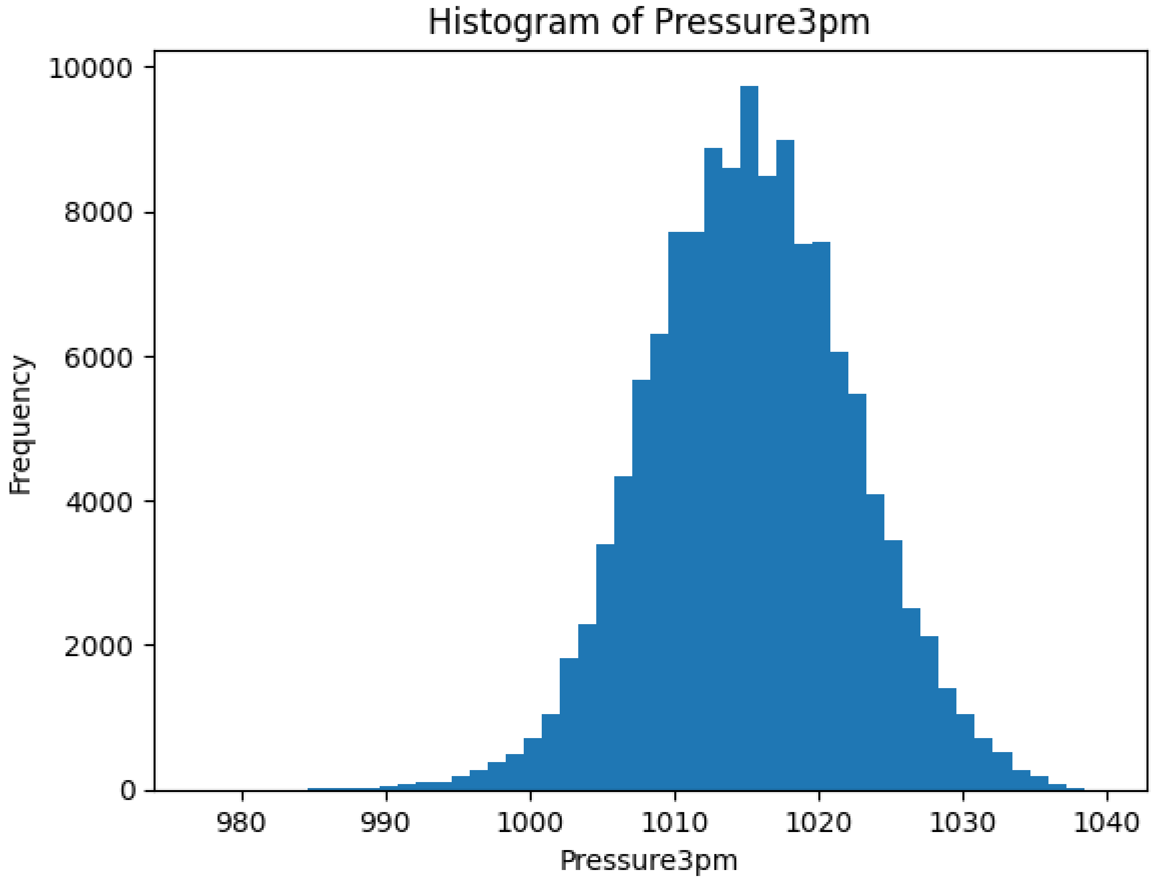
Histogram of WindSpeed3pm
Frequency
12000
10000
8000
6000
4000
2000
0
0
20
40
60
80
WindSpeed3pm

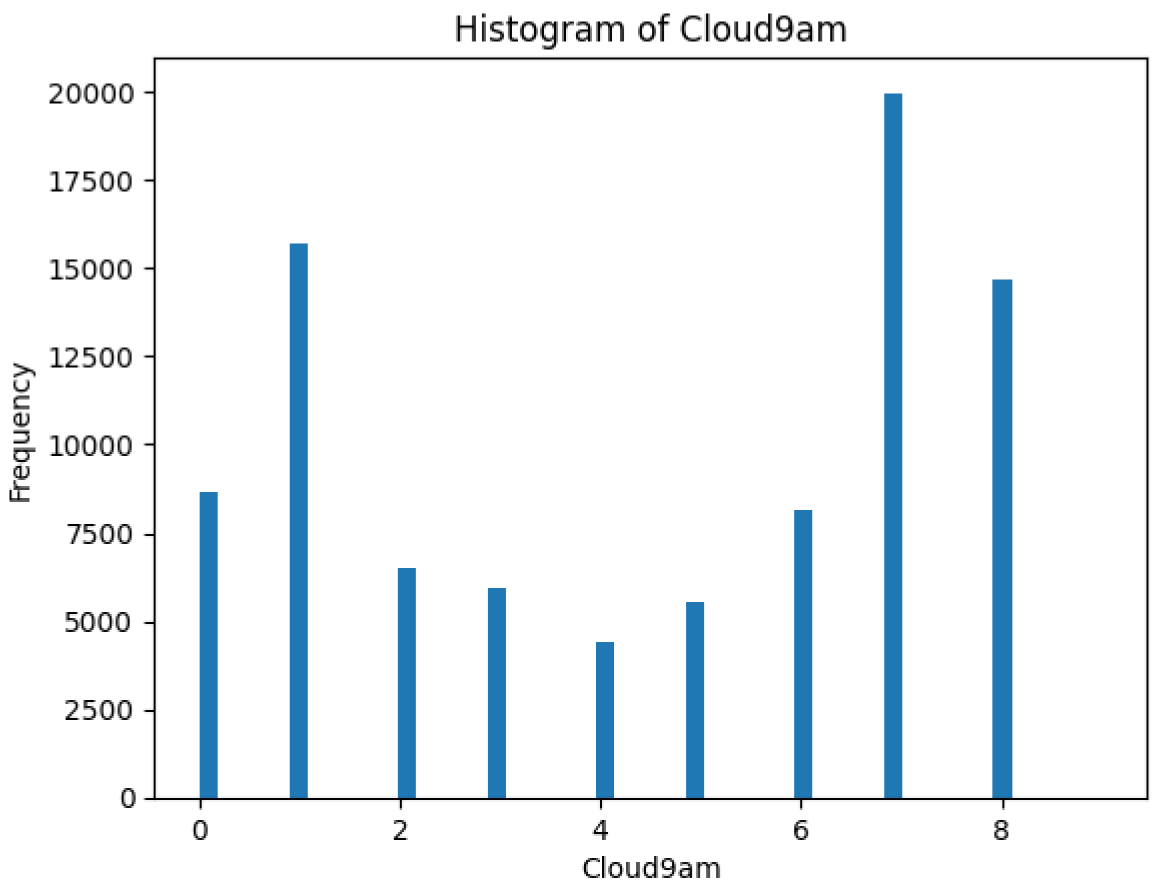


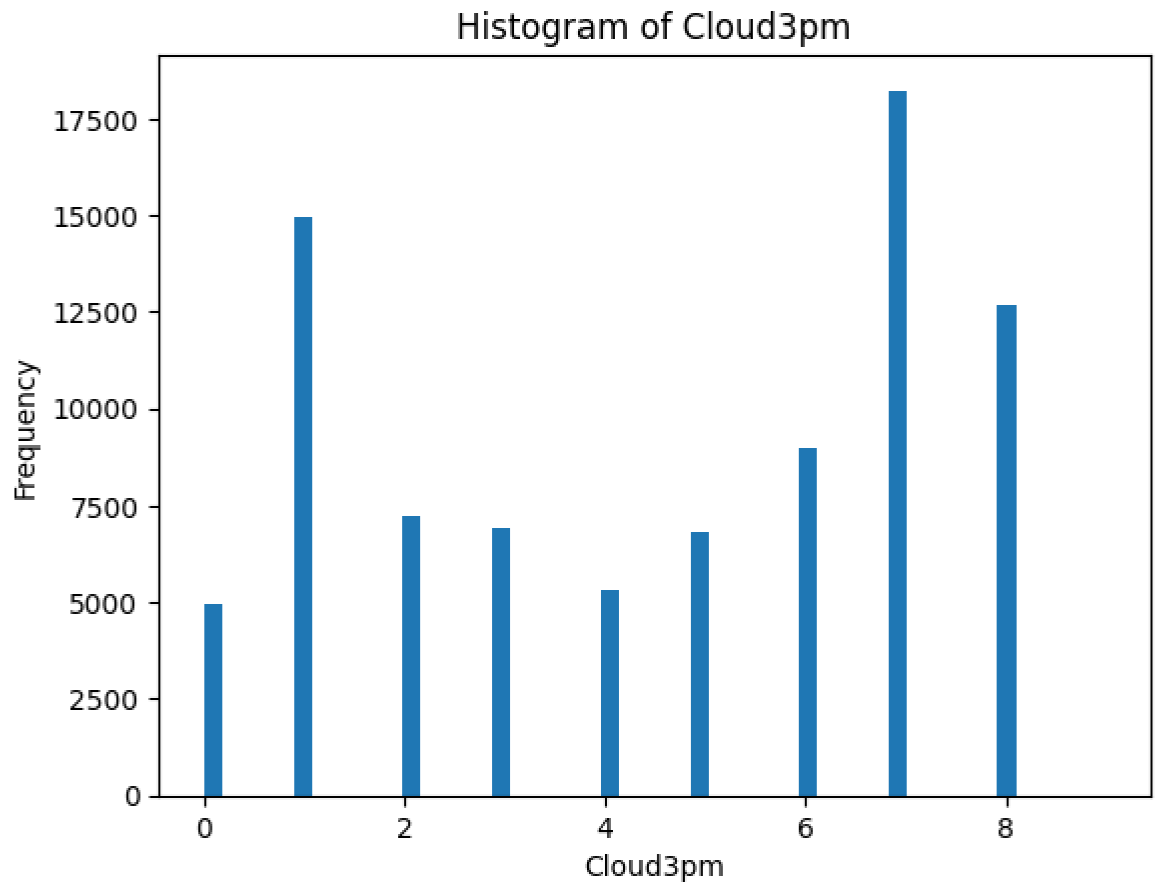
Histogram of Humidity9am
Frequency
8000
7000
6000
5000
4000
3000
2000
1000
0
0
20
40
60
80
100
Humidity9am

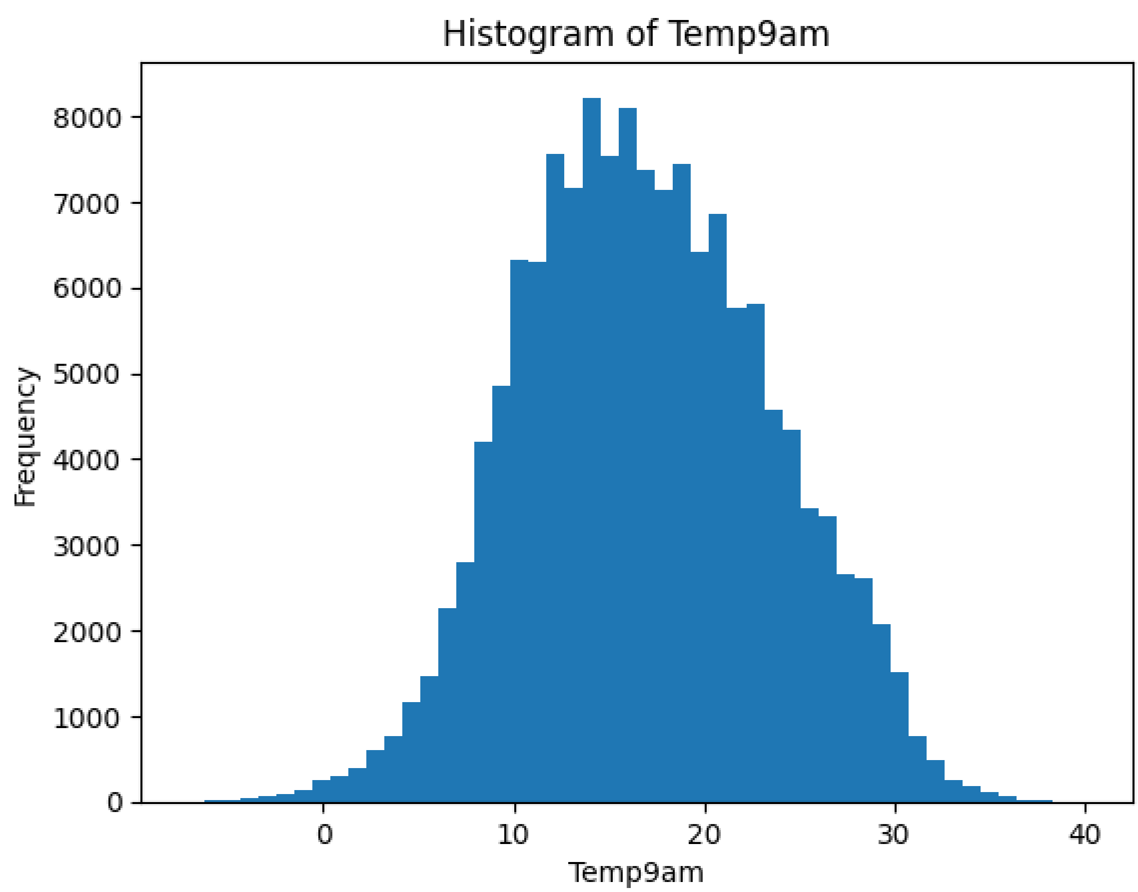

Histogram of Humidity3pm
Frequency
0
1000
2000
3000
4000
5000
0
20
40
60
80
100
Humidity3pm

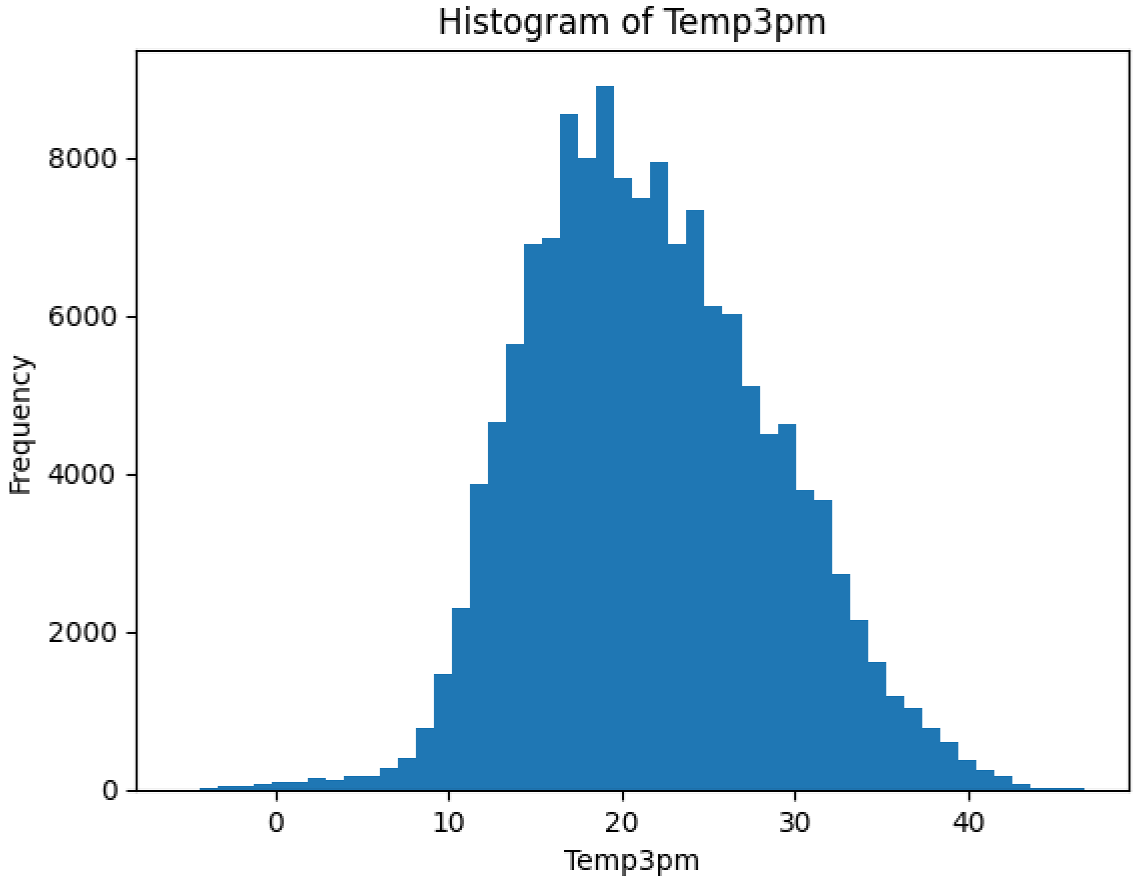

Histogram of Pressure9am
Frequency
0
2000
4000
6000
8000
10000
980
990
1000
1010
1020
1030
1040
Pressure9am

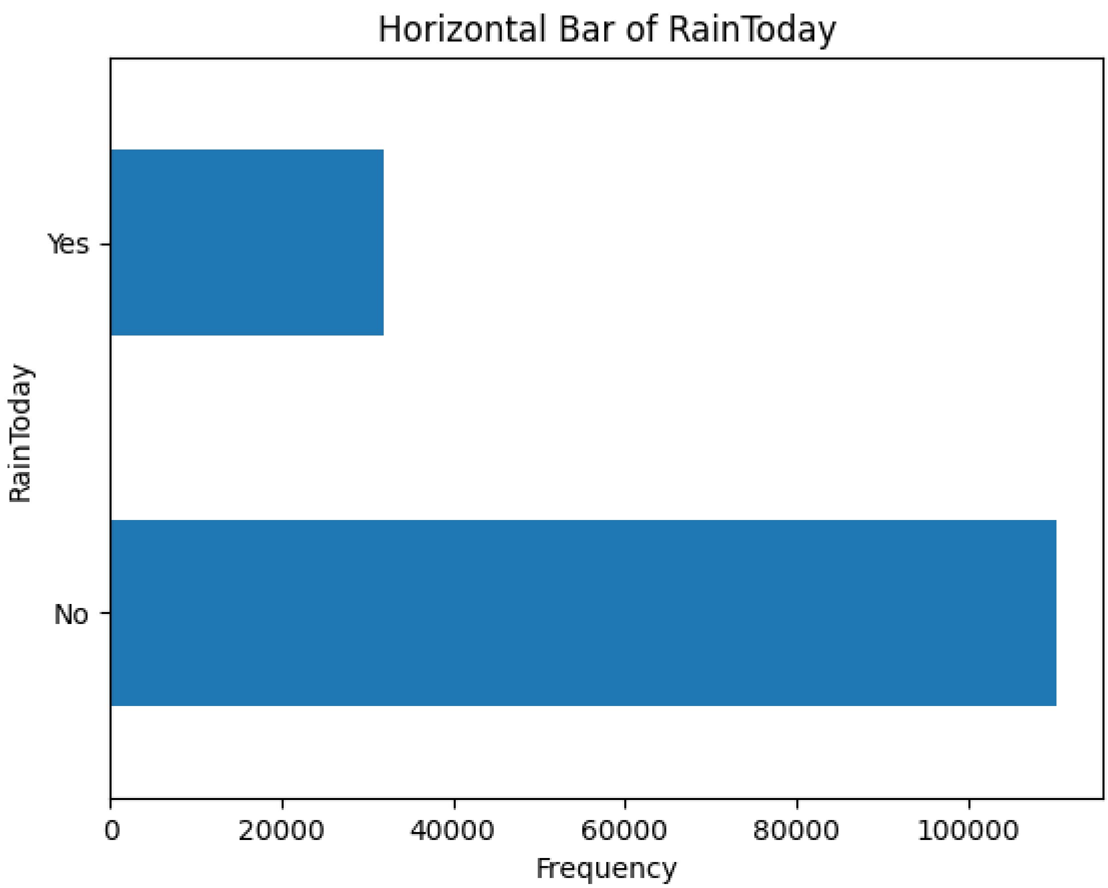

Histogram of Pressure3pm
Frequency
Pressure3pm
0
2000
4000
6000
8000
10000
980
990
1000
1010
1020
1030
1040

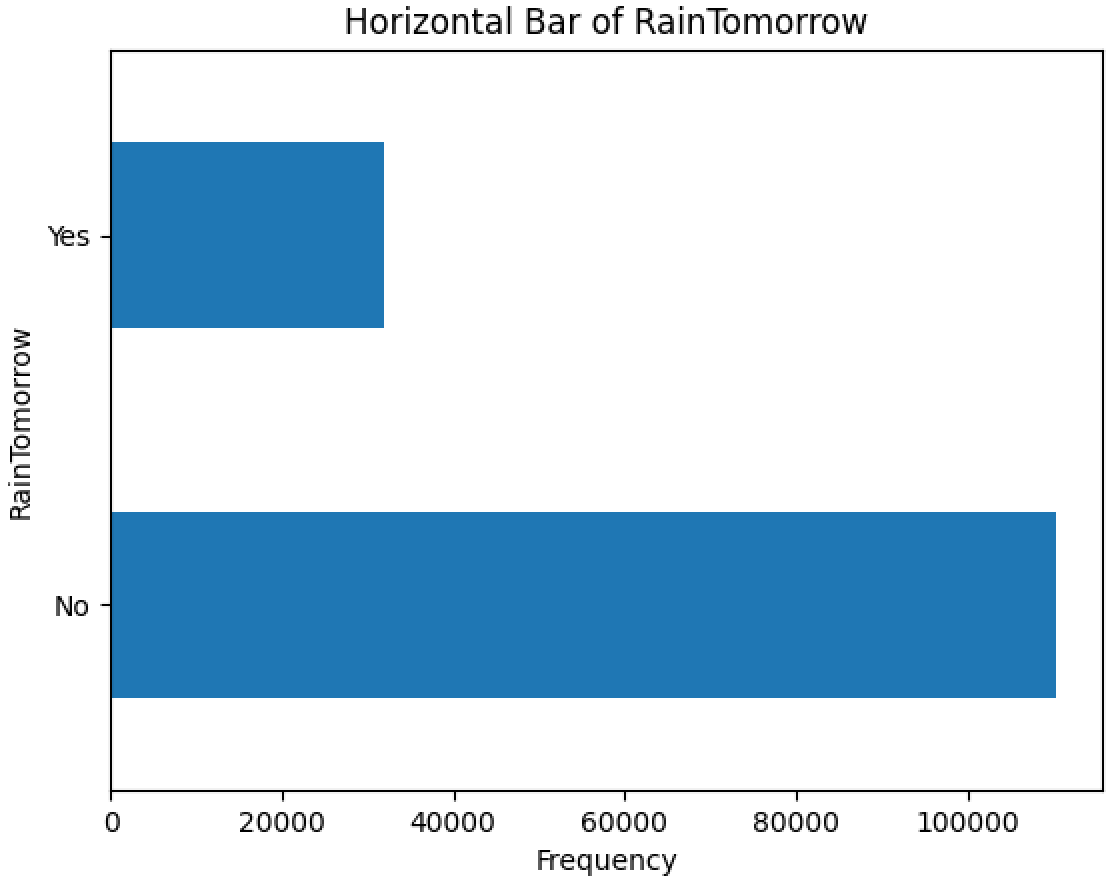

Histogram of Cloud9am
Frequency
Cloud9am
0
2500
5000
7500
10000
12500
15000
17500
20000
0
2
4
6
8


Histogram of Cloud3pm
Frequency
17500
15000
12500
10000
7500
5000
2500
0
0
2
4
6
8
Cloud3pm

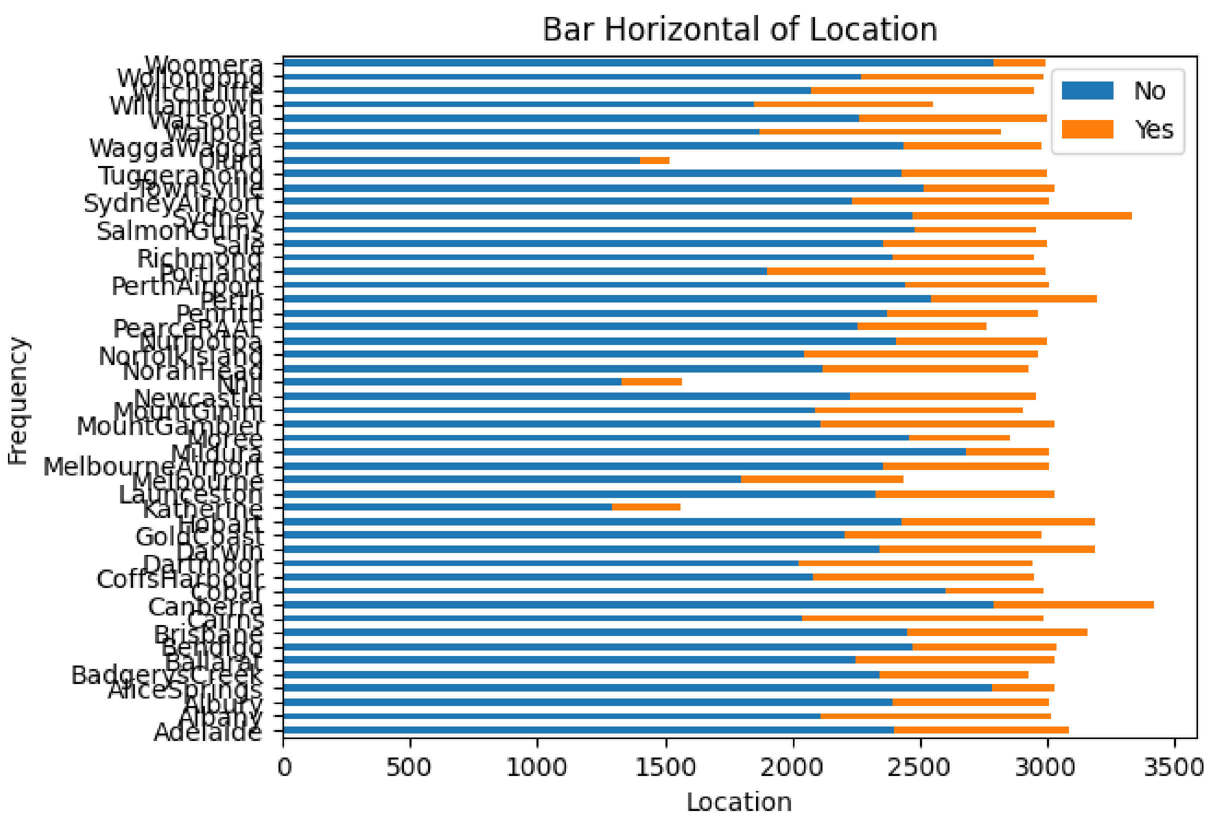

Histogram of Temp9am
Frequency
8000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
Temp9am

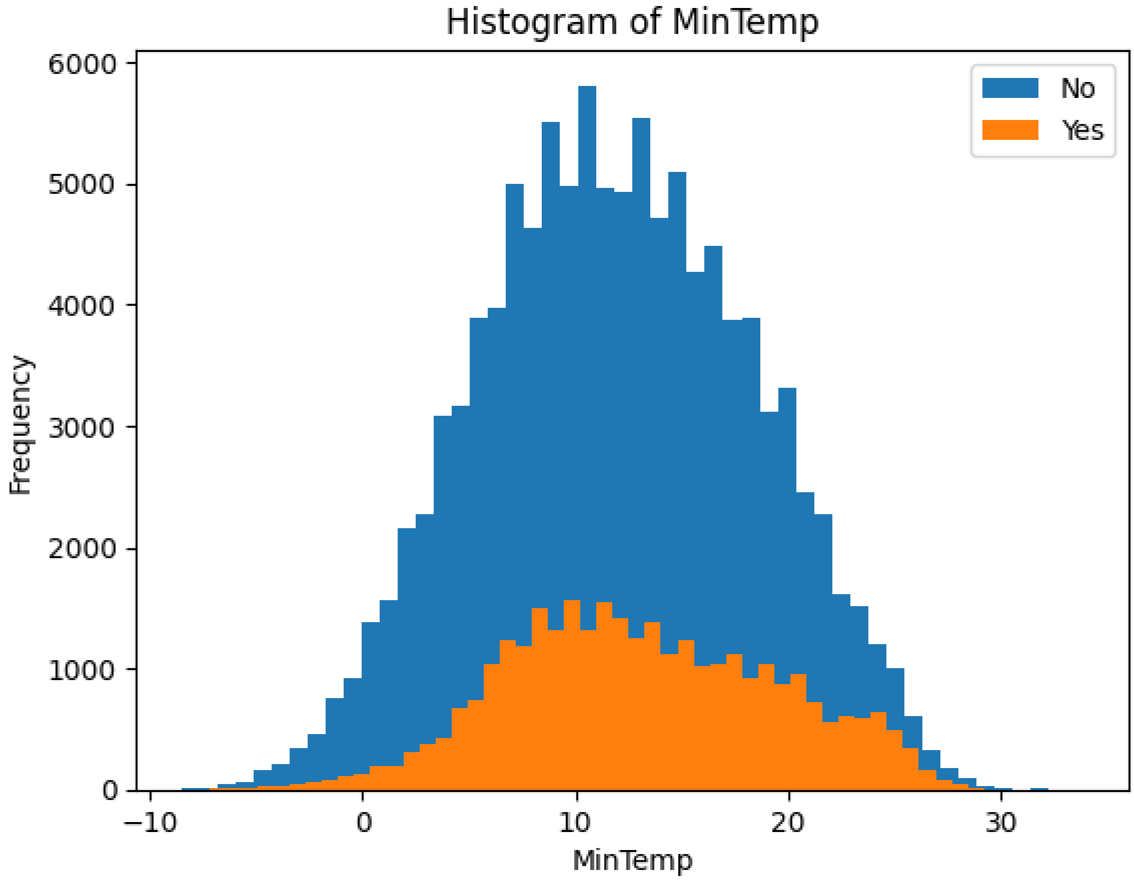

Histogram of Temp3pm
Frequency
8000
6000
4000
2000
0
0
10
20
30
40
Temp3pm


Horizontal Bar of RainToday
RainToday
Yes
No
0
20000
40000
60000
80000
100000
Frequency

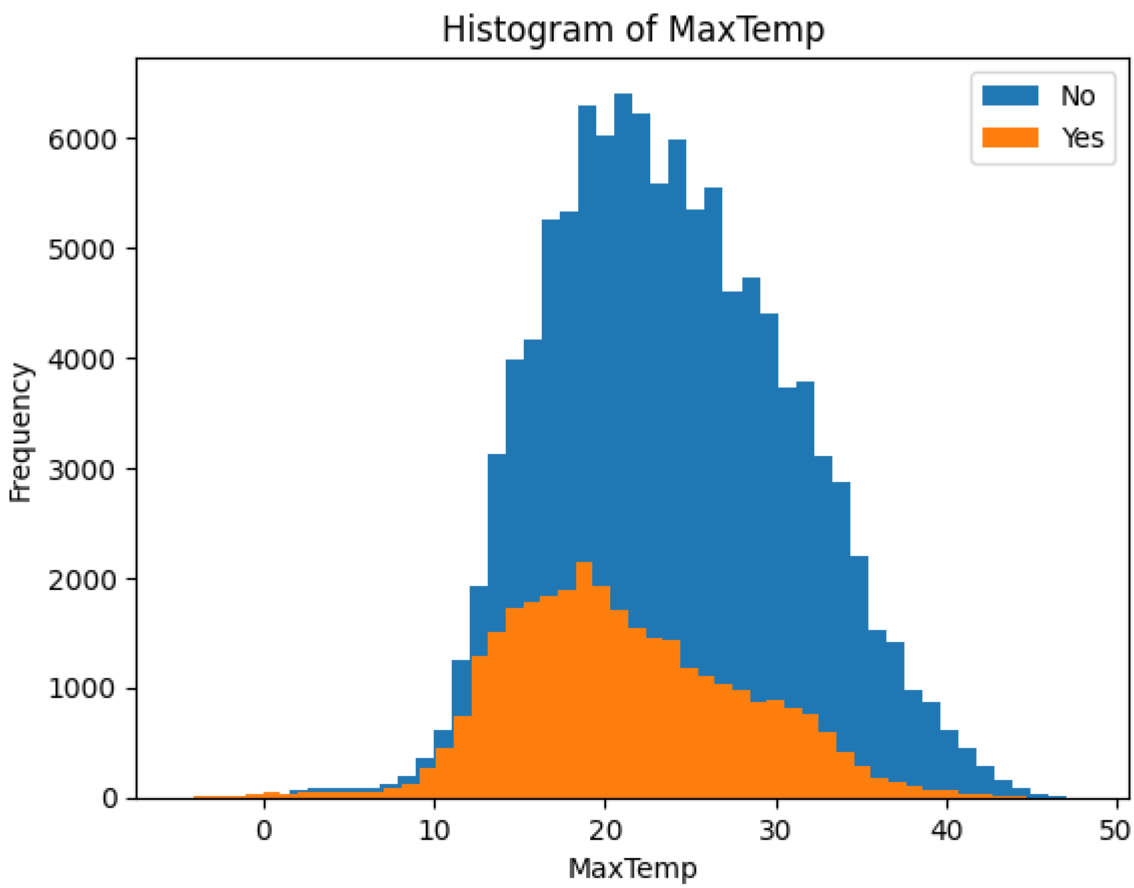


3. Visualisasi distribusi setiap fitur per target (RainTomorrow)

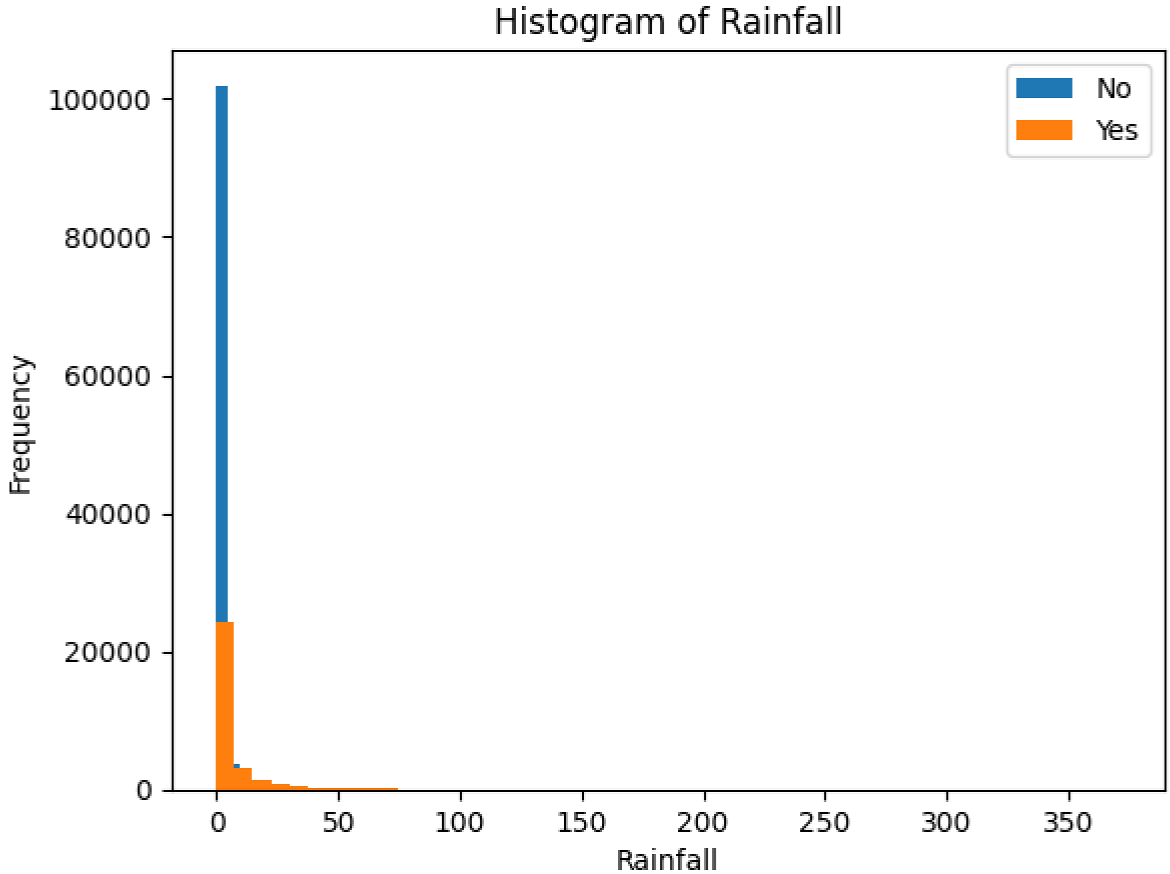




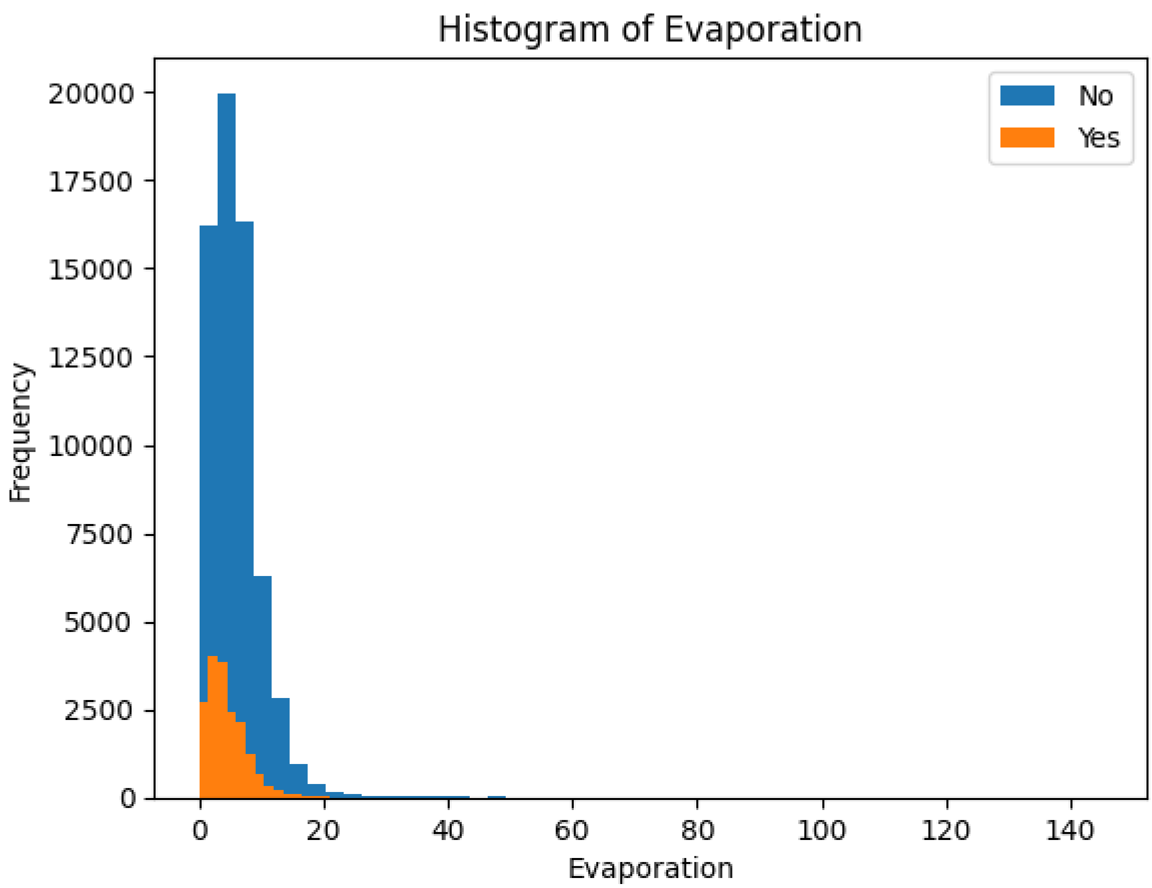
Histogram of MinTemp
No
Yes
Frequency
0
1000
2000
3000
4000
5000
6000
−10
0
10
20
30
MinTemp



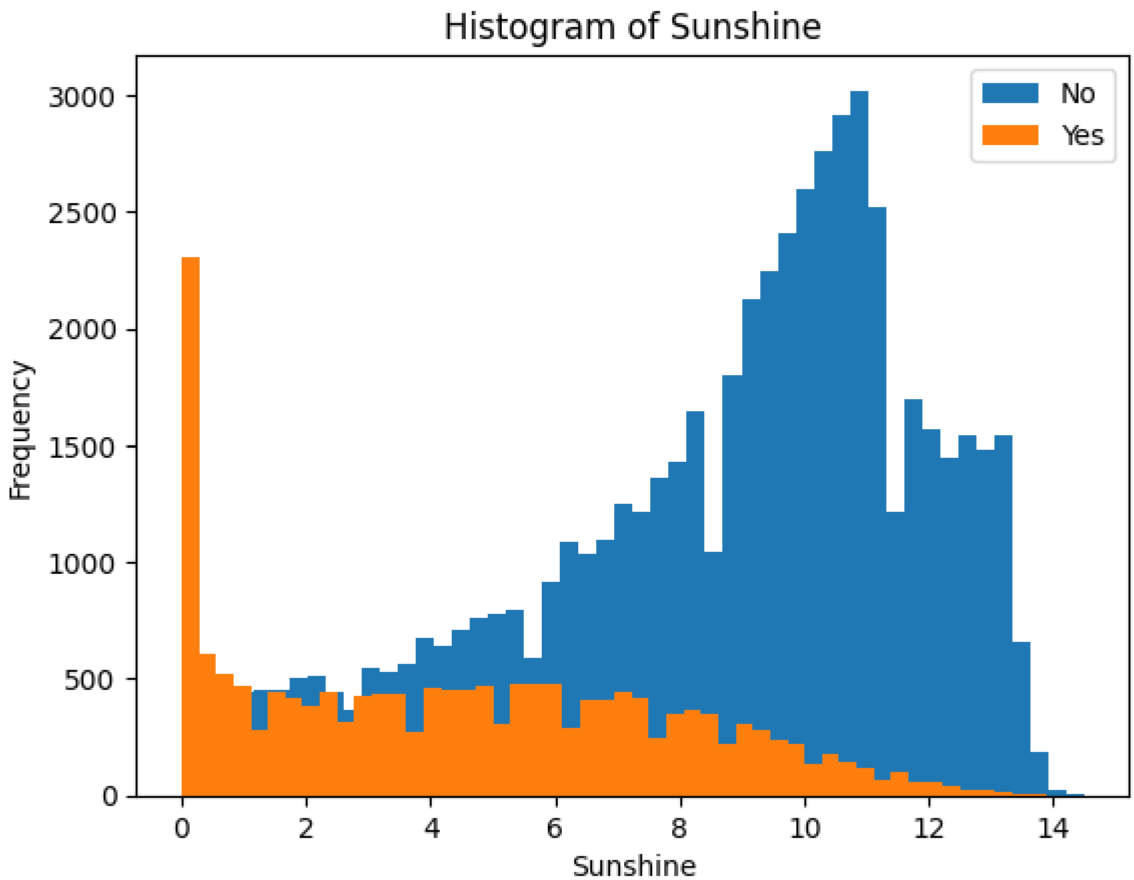
Histogram of MaxTemp
No
Yes
Frequency
0
1000
2000
3000
4000
5000
6000
0
10
20
30
40
50
MaxTemp



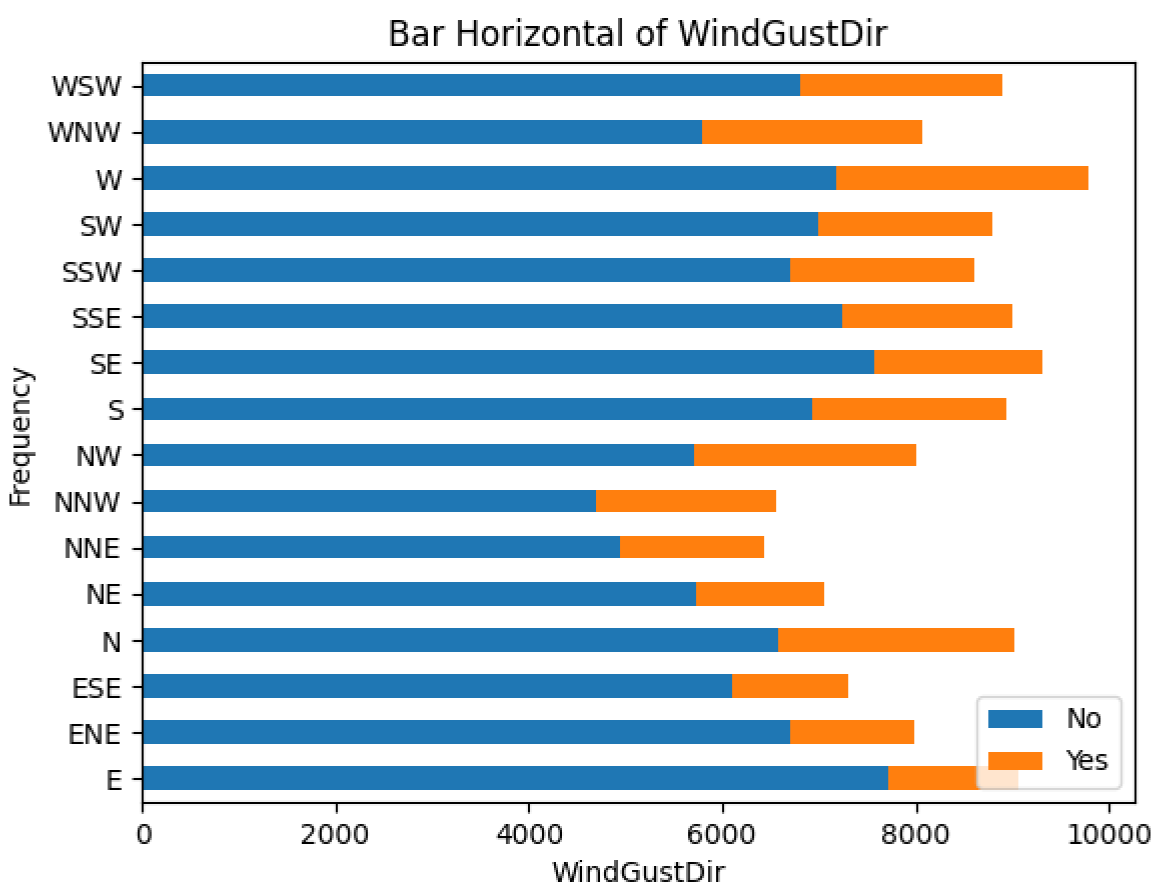
Histogram of Rainfall
No
Yes
Frequency
100000
80000
60000
40000
20000
0
0
50
100
150
200
250
300
350
Rainfall



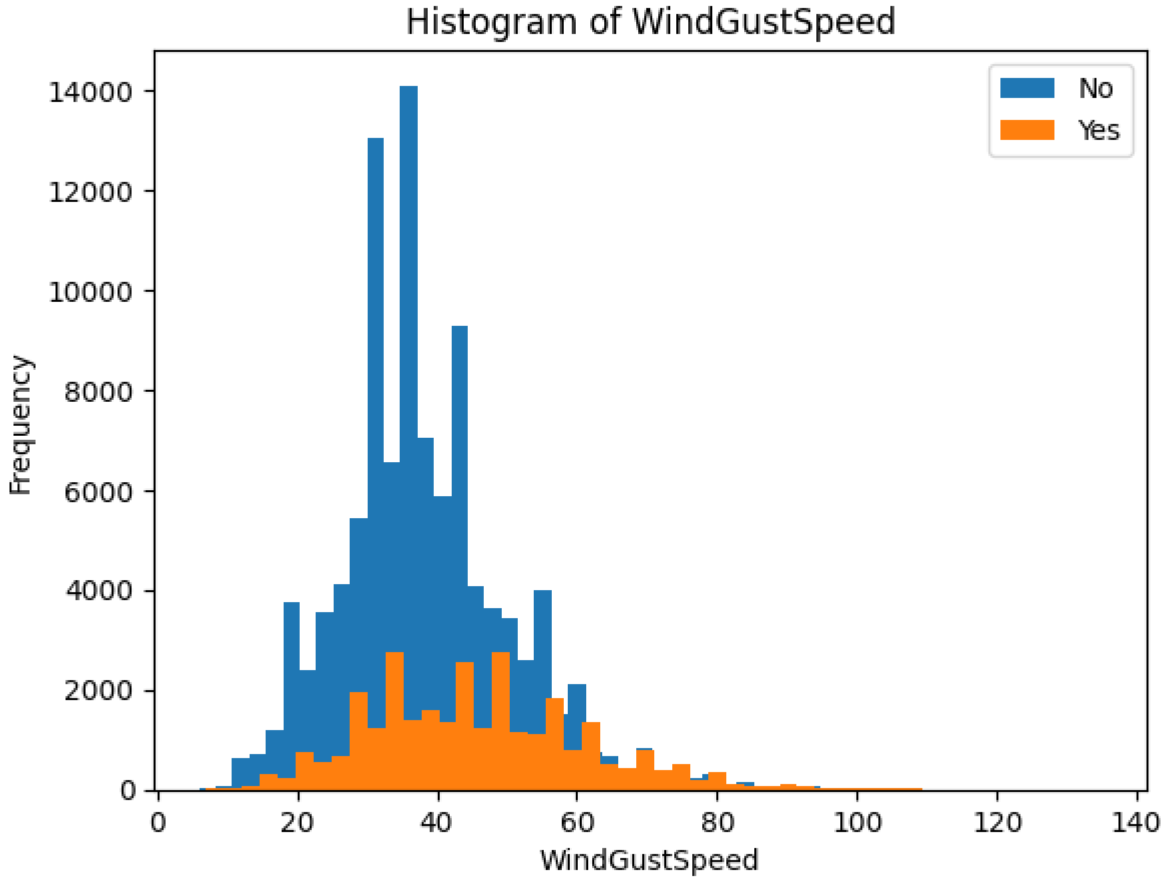
Histogram of Evaporation
No
Yes
Frequency
20000
17500
15000
12500
10000
7500
5000
2500
0
0
20
40
60
80
100
120
140
Evaporation

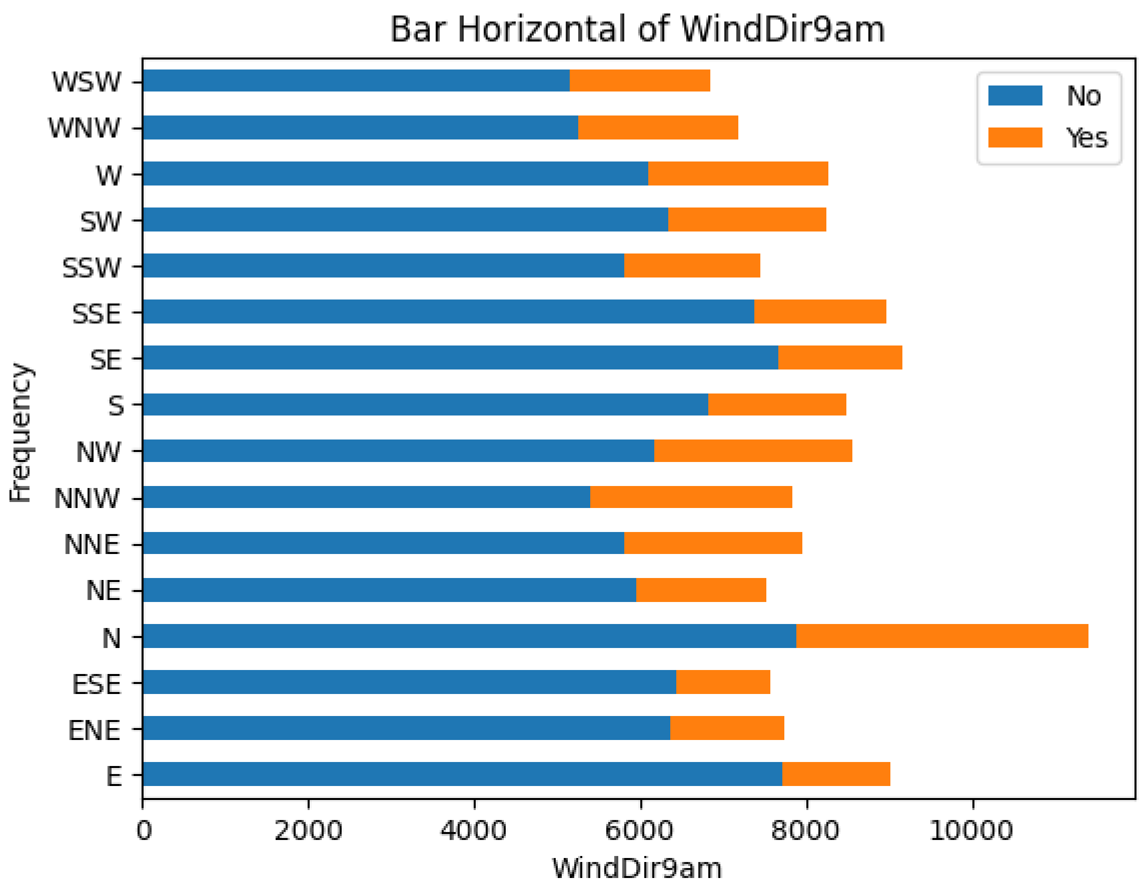


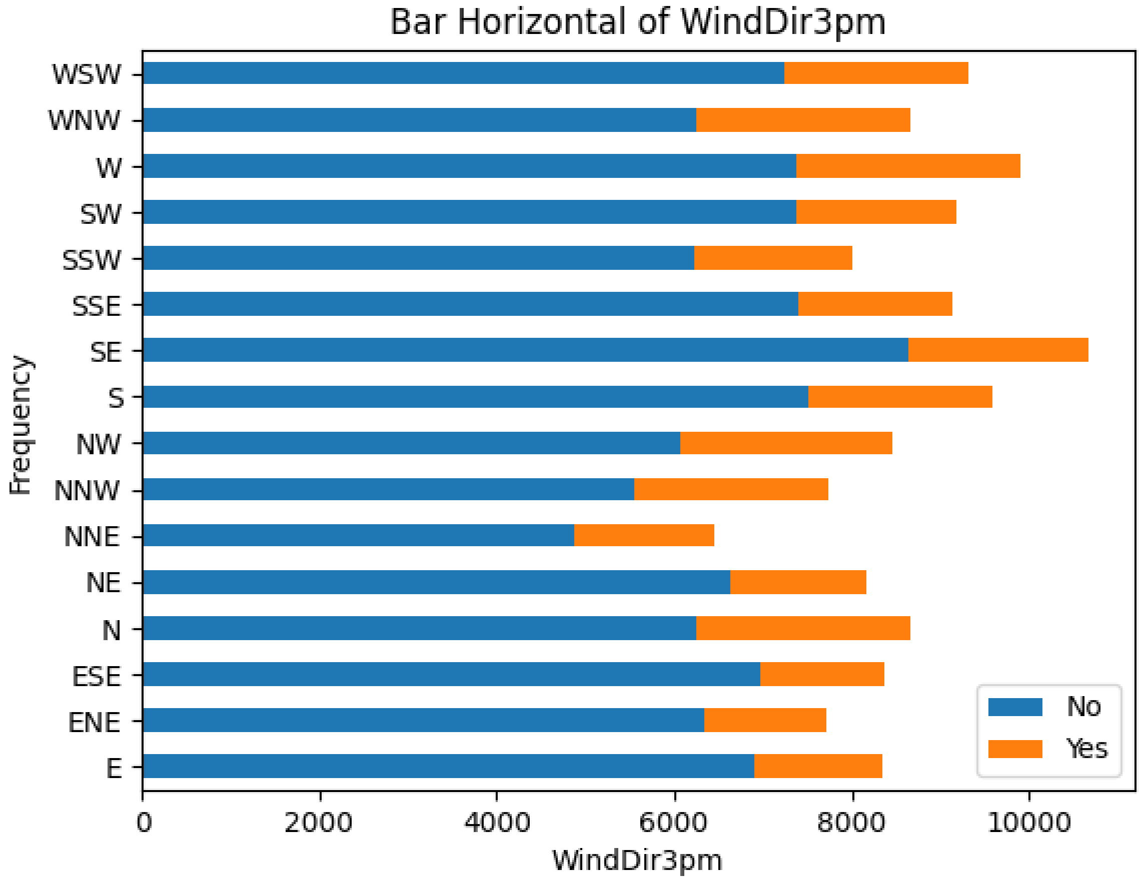
Histogram of Sunshine
No
Yes
Frequency
Sunshine
0
500
1000
1500
2000
2500
3000
0
2
4
6
8
10
12
14



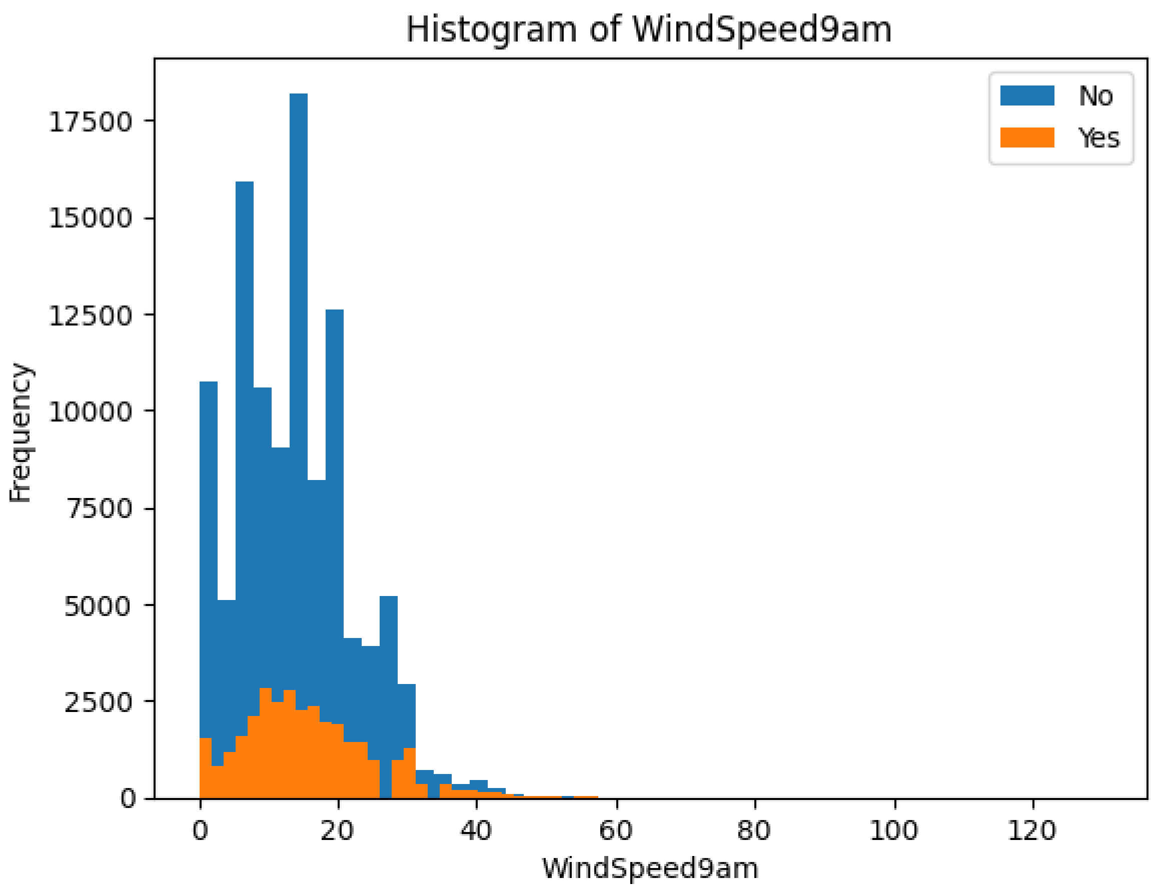
Bar Horizontal of WindGustDir
WSW
WNW
W
SW
SSW
SSE
SE
S
NW
NNW
NNE
NE
N
ESE
ENE
E
No
Yes
Frequency
WindGustDir
0
2000
4000
6000
8000
10000


Histogram of WindGustSpeed
No
Yes
Frequency
0
2000
4000
6000
8000
10000
12000
14000
0
20
40
60
80
100
120
140
WindGustSpeed

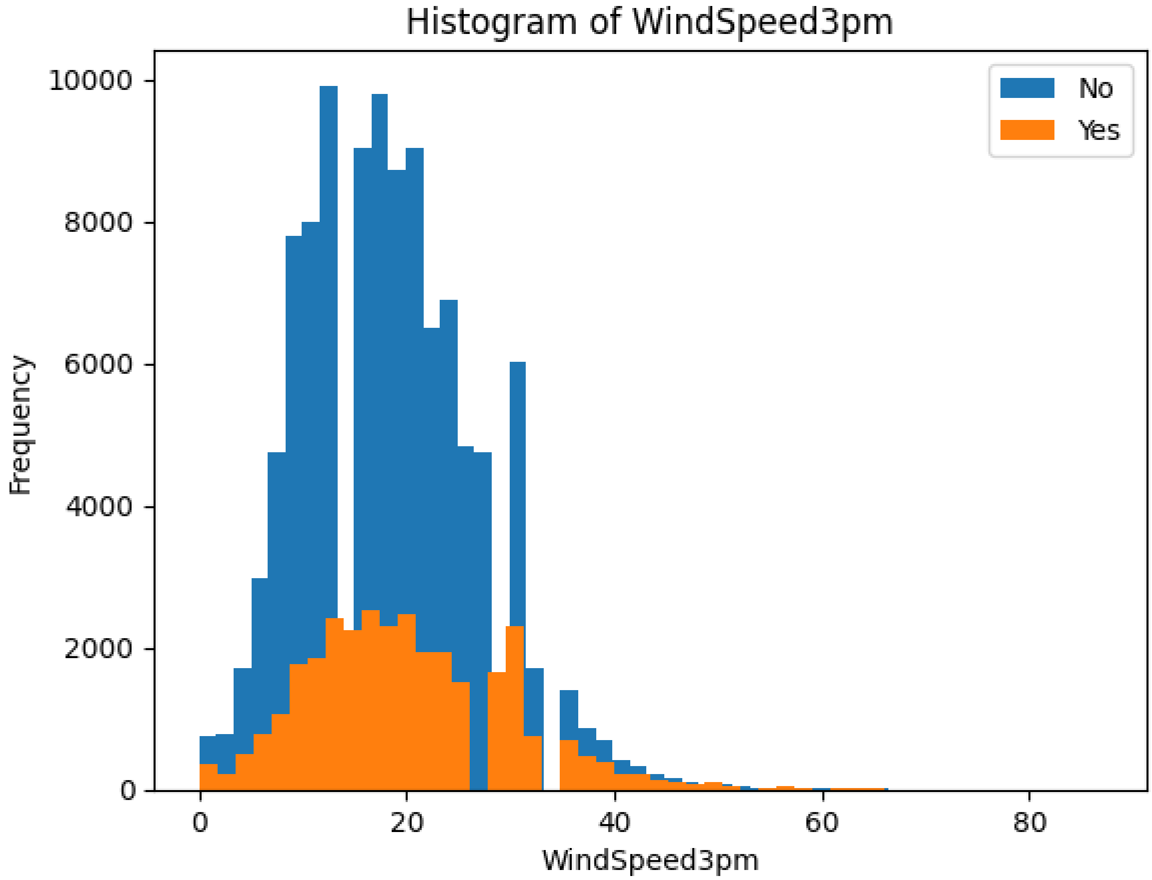

Bar Horizontal of WindDir9am
No
Yes
Frequency
WSW
WNW
W
SW
SSW
SSE
SE
S
NW
NNW
NNE
NE
N
ESE
ENE
E
0
2000
4000
6000
8000
10000
WindDir9am

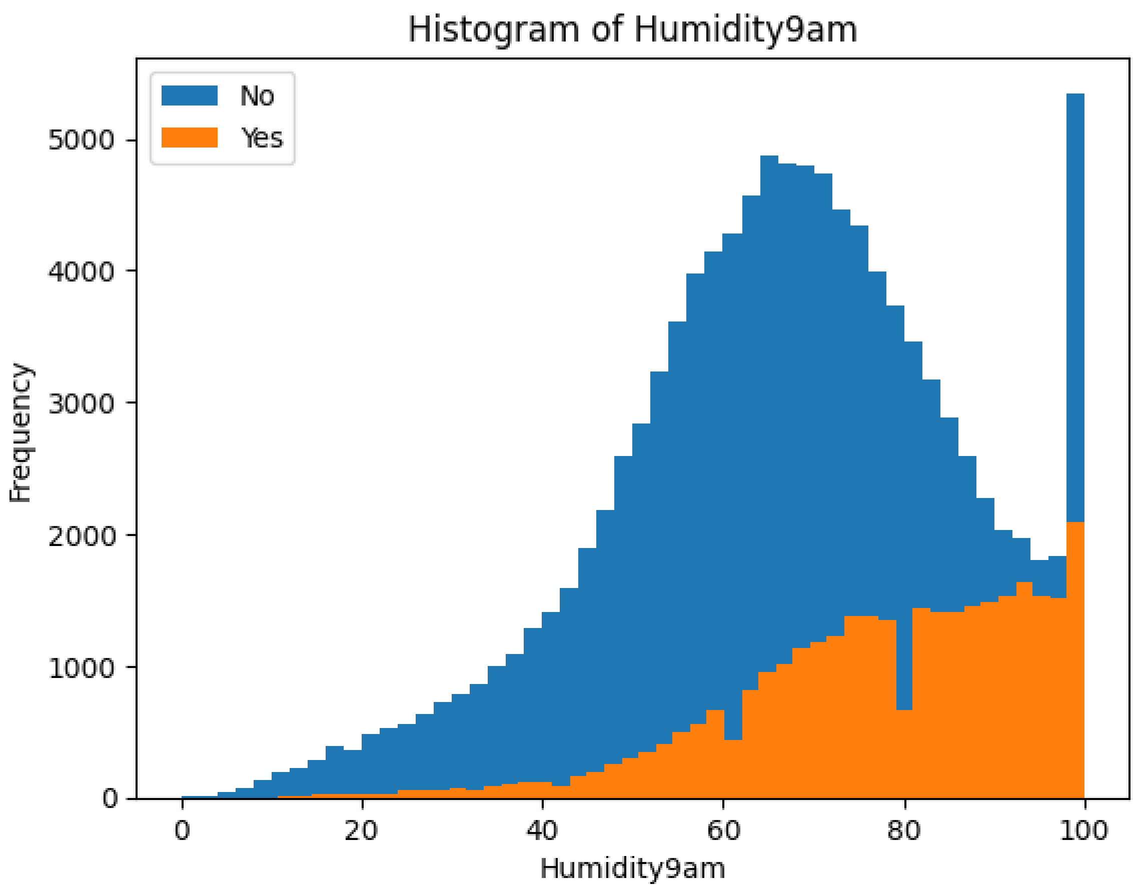


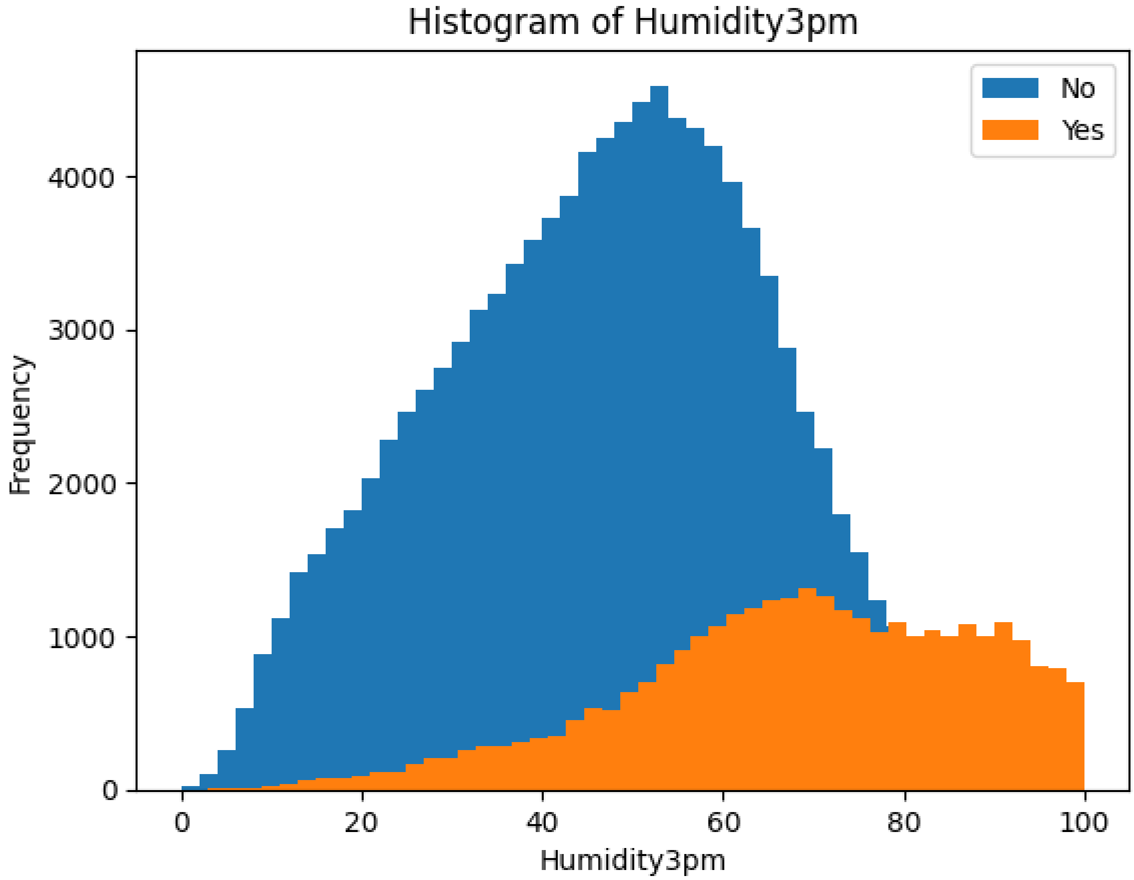
Bar Horizontal of WindDir3pm
WSW
WNW
W
SW
SSW
SSE
SE
S
NW
NNW
NNE
NE
N
ESE
ENE
E
Frequency
0
2000
4000
6000
8000
10000
WindDir3pm
No
Yes



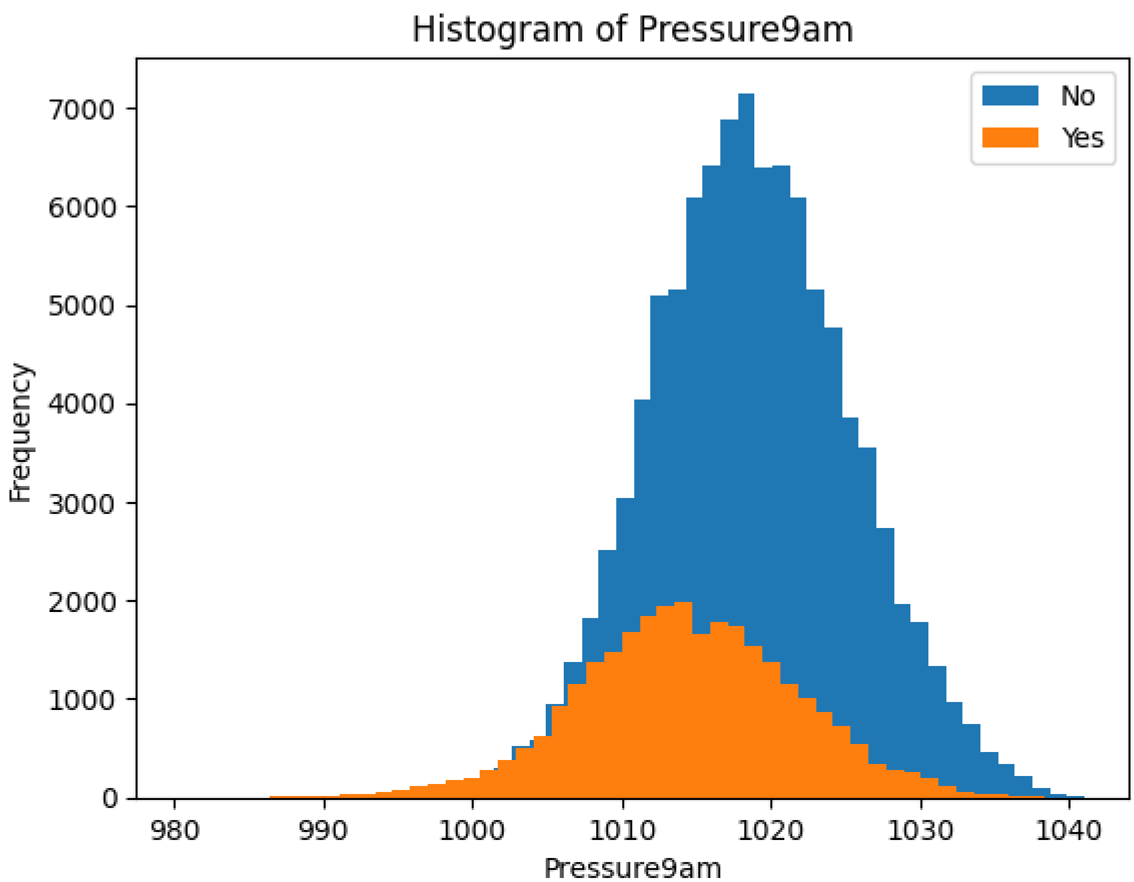
Histogram of WindSpeed9am
17500
15000
12500
10000
7500
5000
2500
0
Frequency
0
20
40
60
80
100
120
WindSpeed9am
No
Yes


Histogram of WindSpeed3pm
No
Yes
Frequency
WindSpeed3pm
0
2000
4000
6000
8000
10000
0
20
40
60
80

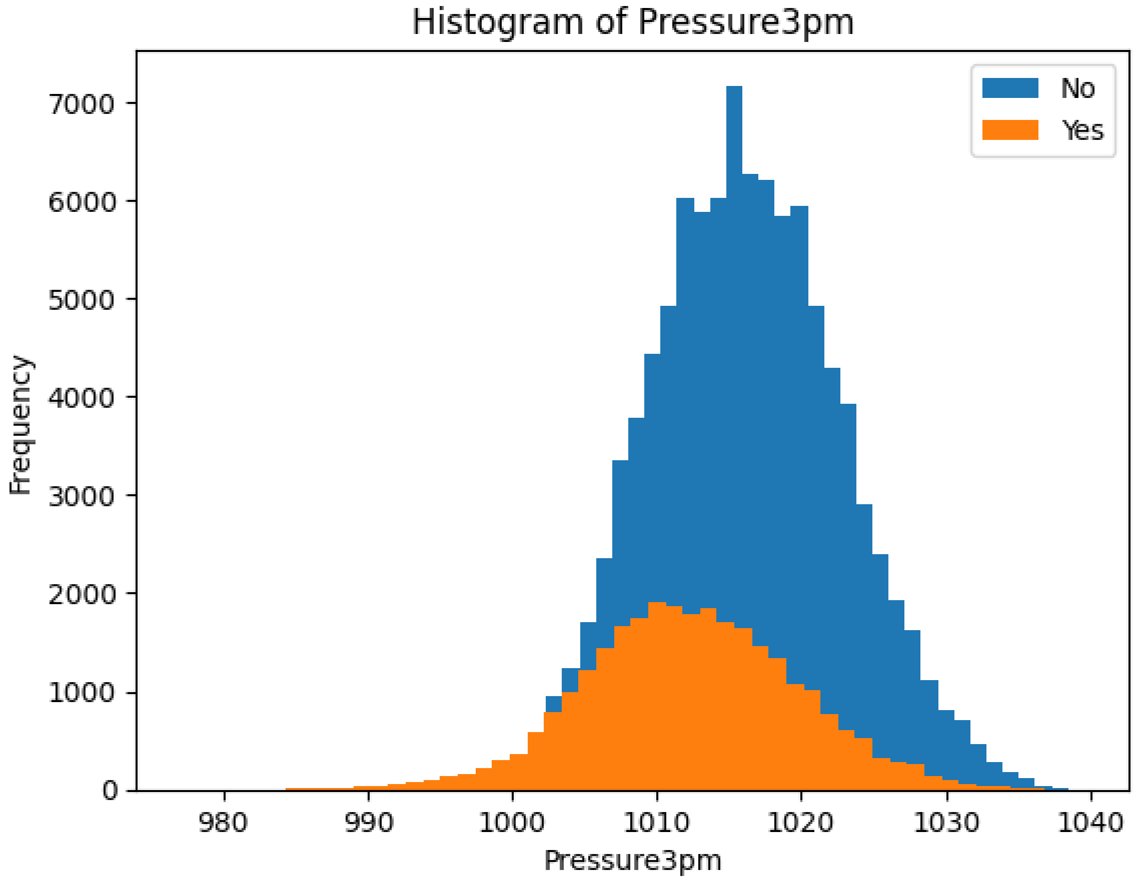

Histogram of Humidity9am
No
Yes
Frequency
Humidity9am
0
1000
2000
3000
4000
5000
0
20
40
60
80
100



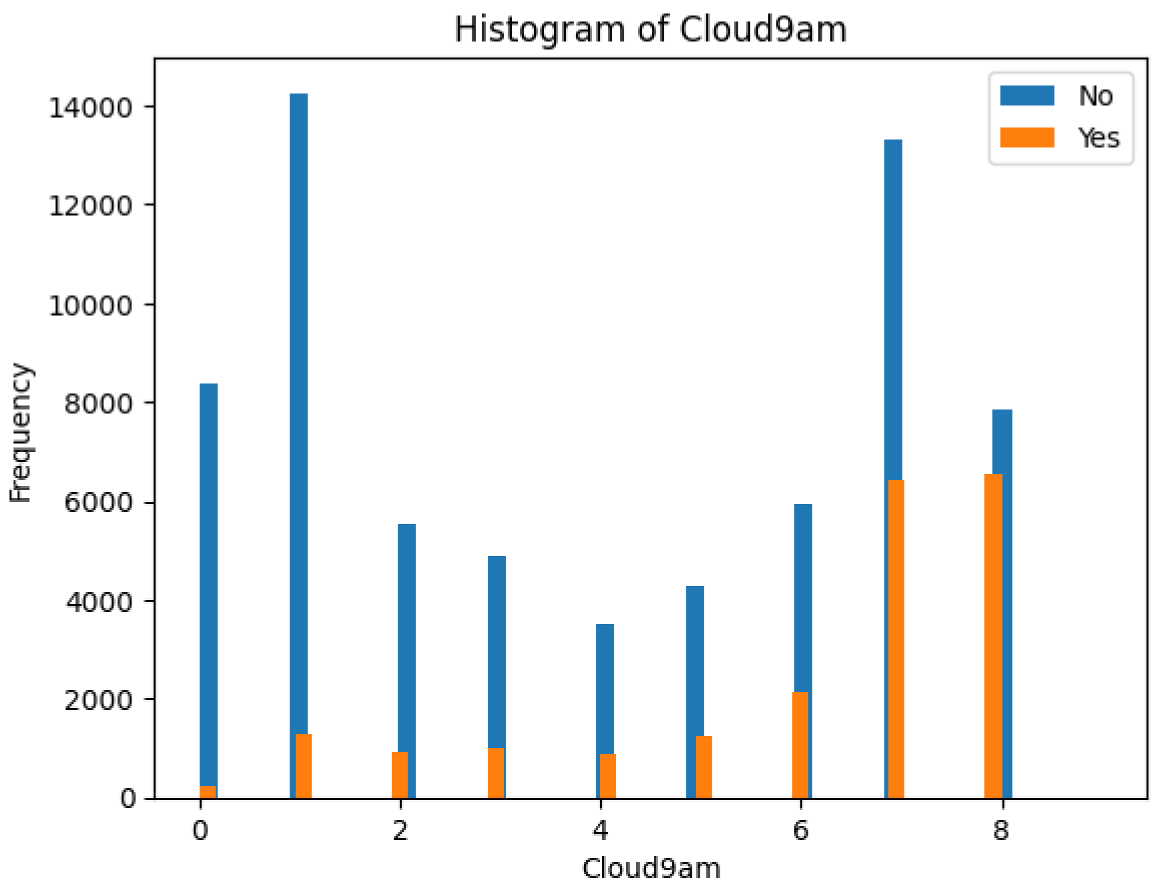
Histogram of Humidity3pm
No
Yes
Frequency
0
1000
2000
3000
4000
0
20
40
60
80
100
Humidity3pm



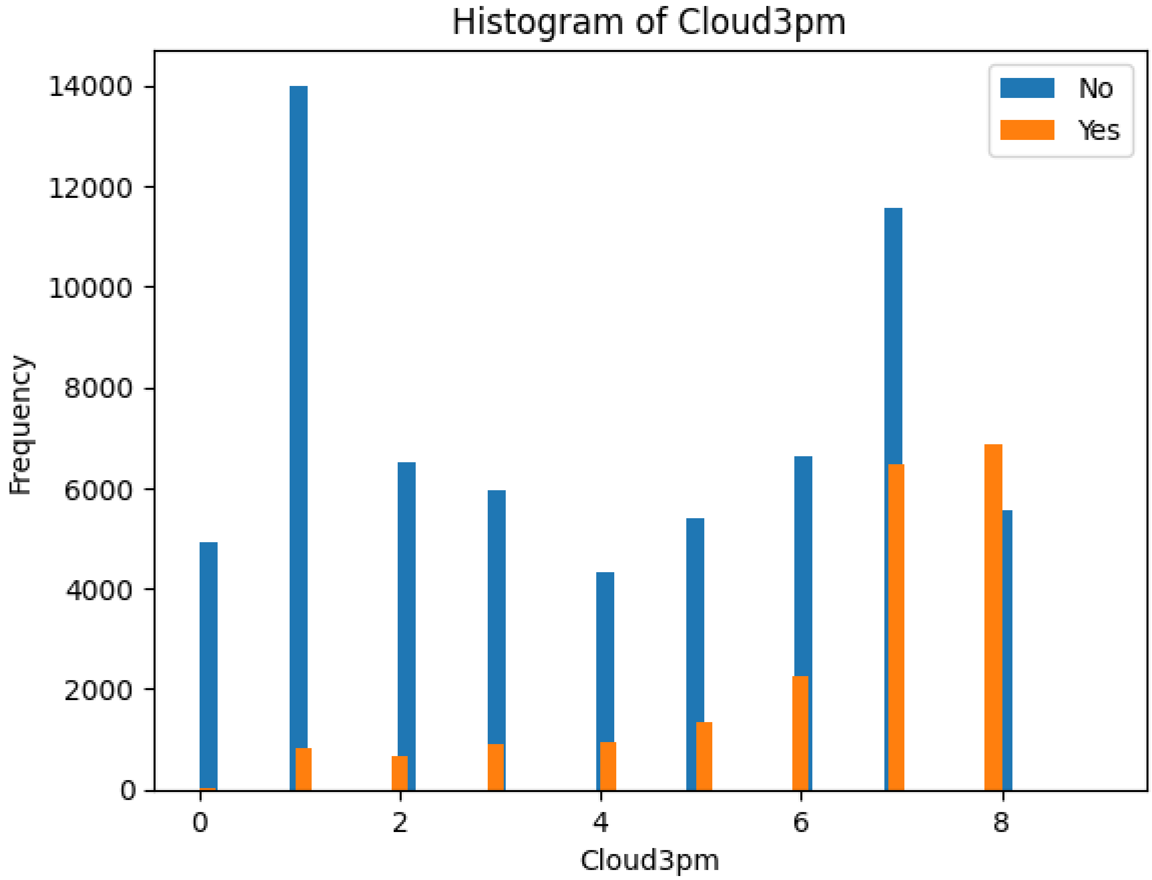
Histogram of Pressure9am
No
Yes
Frequency
0
1000
2000
3000
4000
5000
6000
7000
980
990
1000
1010
1020
1030
1040
Pressure9am

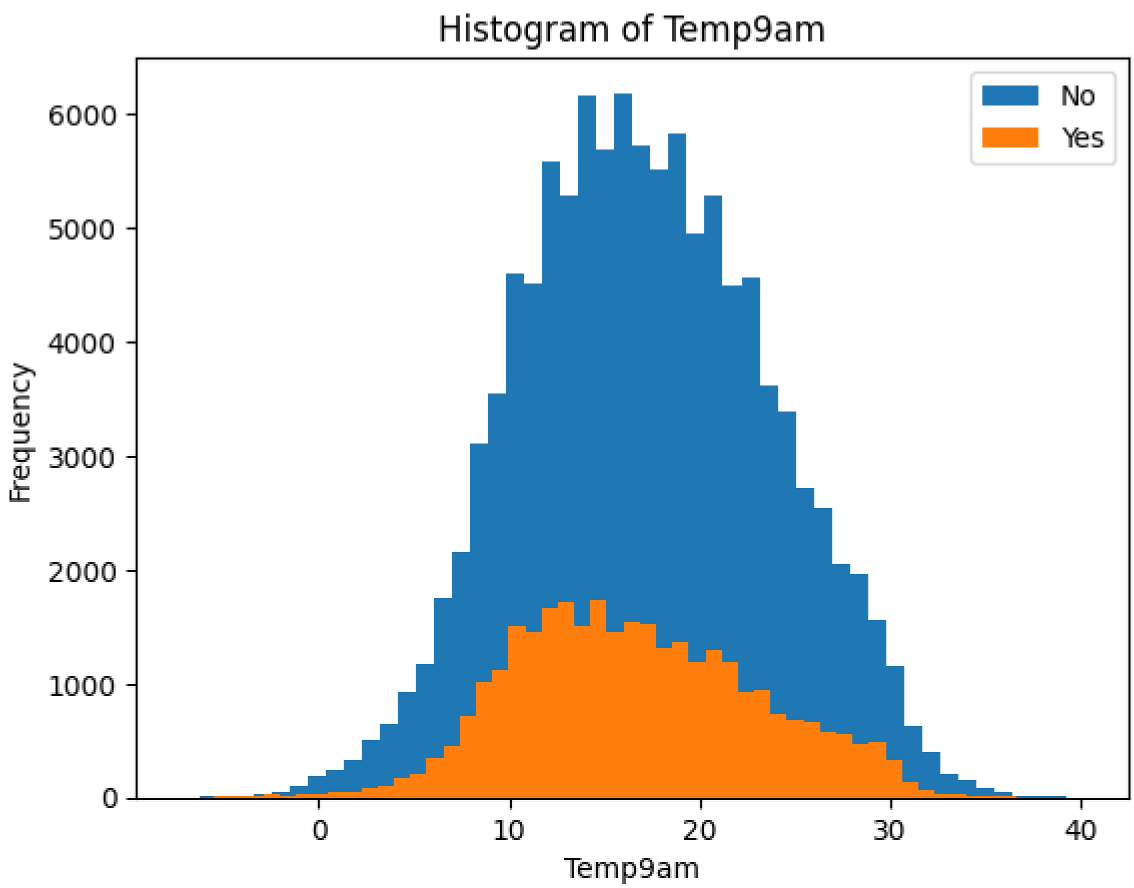


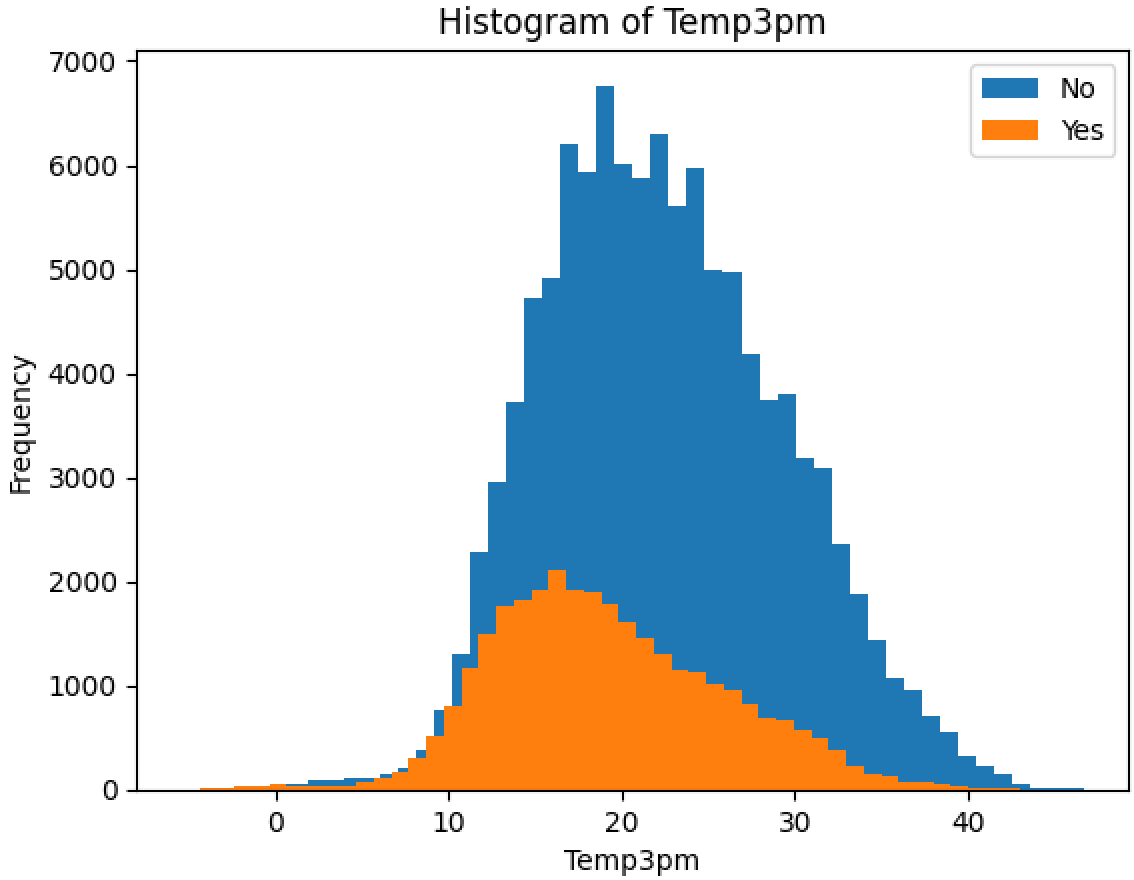
Histogram of Pressure3pm
No
Yes
Frequency
0
1000
2000
3000
4000
5000
6000
7000
980
990
1000
1010
1020
1030
1040
Pressure3pm

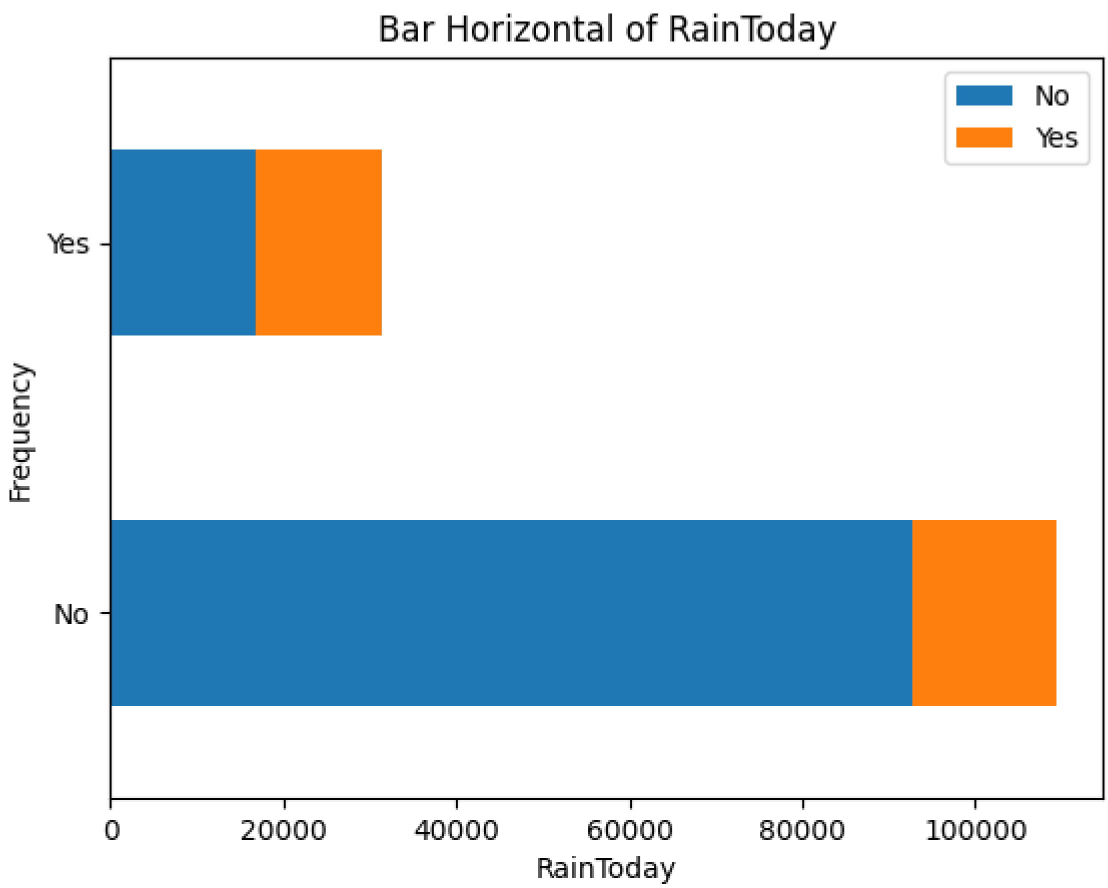


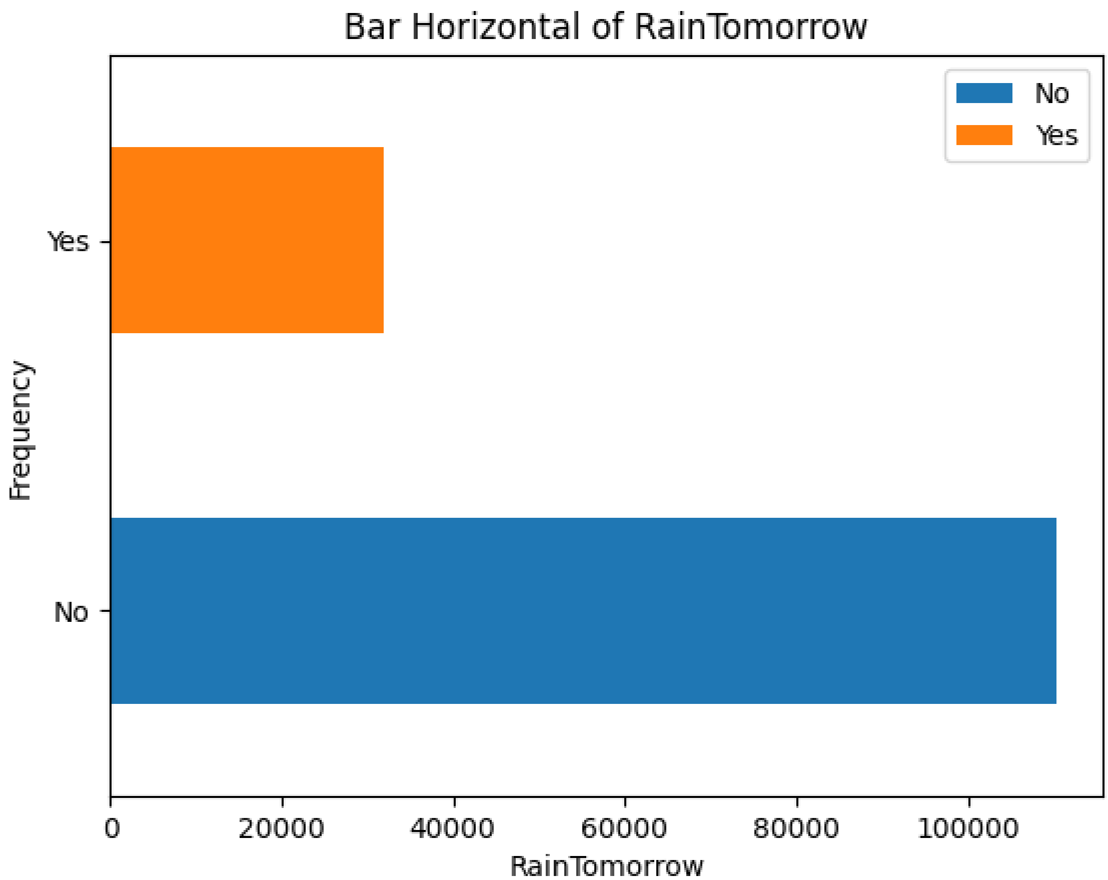
Histogram of Cloud9am
No
Yes
Frequency
0
2000
4000
6000
8000
10000
12000
14000
0
2
4
6
8
Cloud9am


Histogram of Cloud3pm
No
Yes
Frequency
Cloud3pm
0
2000
4000
6000
8000
10000
12000
14000
0
2
4
6
8


Histogram of Temp9am
No
Yes
Frequency
Temp9am
0
1000
2000
3000
4000
5000
6000
0
10
20
30
40


Histogram of Temp3pm
No
Yes
Frequency
0
1000
2000
3000
4000
5000
6000
7000
0
10
20
30
40
Temp3pm


Bar Horizontal of RainToday
No
Yes
Frequency
Yes
No
0
20000
40000
60000
80000
100000
RainToday



I.4

Lakukanlah analisis lebih lanjut jika diperlukan, kemudian lakukan hal berikut:

1. Penambahan fitur jika memungkinkan
2. Pembuangan fitur yang menurut kalian tidak dibutuhkan
3. Penanganan nilai hilang
4. Transformasi data kategorikal menjadi numerikal (*encoding*)
5. *Scaling* dengan `MinMaxScaler`

In [6]:
```
# I.4 Put your code here

# 1. Penambahan fitur jika memungkinkan
# Tidak perlu dilakukan penambahan fitur karena fitur pada dataset cukup untuk membuat

# 2. Pembuangan fitur yang menurut kalian tidak dibutuhkan#
# Fitur yang tidak diperlukan adalah Location
DROP_COLUMN = ["Location"]
data.drop(DROP_COLUMN, axis = 1, inplace = True)

# 3. Penanganan nilai hilang
# Ubah missing value dengan most common value per column
for col in data.columns:
    common_value = data[col].value_counts(dropna = True).idxmax()
    data[col].fillna(common_value, inplace=True)

# 4. Transformasi data kategorikal menjadi numerikal (encoding)
```

```
encoder = LabelEncoder()
data['WindGustDir'] = encoder.fit_transform(data['WindGustDir'])
data['WindDir9am'] = encoder.fit_transform(data['WindDir9am'])
data['WindDir3pm'] = encoder.fit_transform(data['WindDir3pm'])
data['RainToday'] = encoder.fit_transform(data['RainToday'])
data['RainTomorrow'] = encoder.fit_transform(data['RainTomorrow'])

# 5. Scaling dengan MinMaxScaler
scaler = MinMaxScaler()
scaled_data = scaler.fit_transform(data)
data = pd.DataFrame(scaled_data, columns = data.columns)
data.head()
```

Out[6]:

	MinTemp	MaxTemp	Rainfall	Evaporation	Sunshine	WindGustDir	WindGustSpeed	WindDir9am
0	0.516509	0.523629	0.001617	0.027586	0.0	0.866667	0.294574	0.866667
1	0.375000	0.565217	0.000000	0.027586	0.0	0.933333	0.294574	0.400000
2	0.504717	0.576560	0.000000	0.027586	0.0	1.000000	0.310078	0.866667
3	0.417453	0.620038	0.000000	0.027586	0.0	0.266667	0.139535	0.600000
4	0.613208	0.701323	0.002695	0.027586	0.0	0.866667	0.271318	0.066667

5 rows × 21 columns

II. Desain Eksperimen

Tujuan dari bagian ini adalah peserta dapat memahami cara melakukan eksperimen mencari metode terbaik dengan benar. Hal yang diliputi adalah sebagai berikut:

1. Pembuatan model
2. Proses validasi
3. *Hyperparameter tuning*

II.1

Tentukanlah metrik yang akan digunakan pada eksperimen kali ini. Metrik yang dapat lebih dari satu jenis.

1. Accuracy
2. Precision
3. Recall
4. F1-score

II.2

Bagi data dengan perbandingan 0,8 untuk data latih dan 0,2 untuk data validasi.

In [7]:
```
# II.2 Kode di sini
x = data.loc[:, data.columns != 'RainTomorrow']
y = data['RainTomorrow']
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.20, shuffle=Fals
```

II.3

Lakukan hal berikut:

1. Prediksi dengan menggunakan model *logistic regression* sebagai *baseline*.
2. Tampilkan evaluasi dari model yang dibangun dari metrik yang ditentukan pada II.1
3. Tampilkan *confusion matrix*.

In [8]:
```
# II.3 Kode di sini

# 1. Prediksi dengan menggunakan model logistic regression sebagai baseline.
lr = LogisticRegression(random_state=0).fit(x_train, y_train)
pred = lr.predict(x_test)

# 2. Tampilkan evaluasi dari model yang dibangun dari metrik yang ditentukan pada II.1
print("Accuracy: " + str(metrics.accuracy_score(y_test, pred)))
print("Precision: " + str(metrics.precision_score(y_test, pred)))
print("Recall: " + str(metrics.recall_score(y_test, pred)))
print("F1: " + str(metrics.f1_score(y_test, pred)))
print("Confusion Matrix: ")

# 3. Tampilkan confusion matrix
metrics.confusion_matrix(y_test, pred)
```

```
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/linear_model/_logistic.
py:444: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
Accuracy: 0.8614395710160869
Precision: 0.7385283736084713
Recall: 0.469937802349689
F1: 0.574384964628867
Confusion Matrix:
```

Out[8]:
```
array([[22341,   963],
       [ 3068,  2720]])
```

II.4

Lakukanlah:

1. Pembelajaran dengan model lain

2. *Hyperparameter tuning* untuk model yang dipakai dengan menggunakan *grid search* (perhatikan *random factor* pada beberapa algoritma model)
3. Validasi dengan *cross validation*

In [9]:
```
# # II.4 Kode di sini.

# 1. Pembelajaran dengan model lain
sgd = SGDClassifier(random_state = 0).fit(x_train, y_train)
pred = sgd.predict(x_test)

print("Accuracy: " + str(metrics.accuracy_score(y_test, pred)))
print("Precision: " + str(metrics.precision_score(y_test, pred)))
print("Recall: " + str(metrics.recall_score(y_test, pred)))
print("F1: " + str(metrics.f1_score(y_test, pred)))
print("Confusion Matrix: ")
metrics.confusion_matrix(y_test, pred)
```

```
Accuracy: 0.8549429396397635
Precision: 0.810126582278481
Recall: 0.3538355217691776
F1: 0.4925444925444925
Confusion Matrix:
```

Out[9]:
```
array([[22824,   480],
       [ 3740,  2048]])
```

In [10]:
```
# 2. Hyperparameter tuning untuk model yang dipakai dengan menggunakan grid search (pe
sgd = SGDClassifier(random_state = 0)
sgd_tuning = GridSearchCV(sgd, {
    'alpha': (0.0001, 0.001, 0.01),
    'penalty': ('l1','l2')
    }, refit = True)
sgd_tuning.fit(x_train, y_train)
pred = sgd_tuning.predict(x_test)

print("Accuracy: " + str(metrics.accuracy_score(y_test, pred)))
print("Precision: " + str(metrics.precision_score(y_test, pred)))
print("Recall: " + str(metrics.recall_score(y_test, pred)))
print("F1: " + str(metrics.f1_score(y_test, pred)))
print("Confusion Matrix: ")
metrics.confusion_matrix(y_test, pred)
```

```
Accuracy: 0.8591365323800357
Precision: 0.767743979721166
Recall: 0.4186247408431237
F1: 0.5418157423971377
Confusion Matrix:
```

Out[10]:
```
array([[22571,   733],
       [ 3365,  2423]])
```

In [11]:
```
# 3. Validasi dengan cross validation
cv = cross_validate(sgd_tuning, x_train, y_train, cv=5, scoring=['accuracy','precisior
print("Accuracy with Cross Validate:", cv['test_accuracy'].mean())
print("Precision Score with Cross Validate:", cv['test_precision'].mean())
print("Recall Score with Cross Validate:", cv['test_recall'].mean())
print("F1 Score with Cross Validate:", cv['test_f1'].mean())
```

```
Accuracy with Cross Validate: 0.8319298929987277
Precision Score with Cross Validate: 0.729606306007229
Recall Score with Cross Validate: 0.42067593391977887
F1 Score with Cross Validate: 0.5254900393055454
```

III. Improvement

Pada bagian ini, kalian diharapkan dapat:

1. melakukan pelatihan dengan data hasil *oversampling* / *undersampling*, disertai dengan validasi yang benar; serta
2. menerapkan beberapa metode untuk menggabungkan beberapa model.

Kedua hal ini adalah contoh metode untuk meningkatkan kinerja dari model.

III.1

Lakukanlah:

1. *Oversampling* pada kelas minoritas pada data latih
2. *Undersampling* pada kelas mayoritas pada data latih

Pada setiap tahap, latih dengan model *baseline* (II.3), dan validasi dengan data validasi. Data latih dan validasi adalah data yang disusun pada bagian II.2.

In [12]:

```
# III.1 Kode di sini.

# 1. Oversampling pada kelas minoritas pada data latih
over_x_train, over_y_train = RandomOverSampler(random_state = 0, sampling_strategy="mi
lr = LogisticRegression(random_state=0).fit(over_x_train, over_y_train)
pred = lr.predict(x_test)

print("Accuracy: " + str(metrics.accuracy_score(y_test, pred)))
print("Precision: " + str(metrics.precision_score(y_test, pred)))
print("Recall: " + str(metrics.recall_score(y_test, pred)))
print("F1: " + str(metrics.f1_score(y_test, pred)))
print("Confusion Matrix: ")
metrics.confusion_matrix(y_test, pred)
```

```
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/linear_model/_logistic.
py:444: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
Accuracy: 0.8135569916128145
Precision: 0.5213615023474178
Recall: 0.7674498963372495
F1: 0.62091137824993
Confusion Matrix:
```

Out[12]:
```
array([[19226,  4078],
       [ 1346,  4442]])
```

In [13]:
```python
# 2. Undersampling pada kelas mayoritas pada data latih
under_x_train, under_y_train = RandomUnderSampler(random_state = 0, sampling_strategy=
lr = LogisticRegression(random_state=0).fit(under_x_train, under_y_train)

pred = lr.predict(x_test)

print("Accuracy: " + str(metrics.accuracy_score(y_test, pred)))
print("Precision: " + str(metrics.precision_score(y_test, pred)))
print("Recall: " + str(metrics.recall_score(y_test, pred)))
print("F1: " + str(metrics.f1_score(y_test, pred)))
print("Confusion Matrix: ")
metrics.confusion_matrix(y_test, pred)
```

```
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/linear_model/_logistic.
py:444: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
Accuracy: 0.8112539529767634
Precision: 0.5173056753292157
Recall: 0.7669315825846579
F1: 0.6178578885099868
Confusion Matrix:
```

Out[13]:
```
array([[19162,  4142],
       [ 1349,  4439]])
```

III.2

Lakukanlah:

1. Eksplorasi *soft voting*, *hard voting*, dan *stacking*.
2. Buatlah model *logistic regression* dan SVM.
3. Lakukanlah *soft voting* dari model-model yang dibangun pada poin 2.
4. Lakukan *hard voting* dari model-model yang dibangun pada poin 2.
5. Lakukanlah *stacking* dengan *final classifier* adalah *logistic regression* dari model-model yang dibangun pada poin 2.
6. Lakukan validasi dengan metrics yang telah ditentukan untuk poin 3, 4, dan 5.

(Tuliskan hasil eksplorasi III.2 poin 1 di sini.)

In [14]:
```python
# III.2 Kode di sini.

# 1. Eksplorasi soft voting, hard voting, dan stacking.
# 2. Buatlah model logistic regression dan SVM.
lr = LogisticRegression(random_state=0)
svm = SVC(random_state = 0,probability=True, max_iter = 1000)

# 3. Lakukanlah soft voting dari model-model yang dibangun pada poin 2.
```

```
softvoting_clf = VotingClassifier(estimators=[('lr', lr), ('svm', svm)], voting='soft'
pred = softvoting_clf.predict(x_test)

print("Accuracy: " + str(metrics.accuracy_score(y_test, pred)))
print("Precision: " + str(metrics.precision_score(y_test, pred)))
print("Recall: " + str(metrics.recall_score(y_test, pred)))
print("F1: " + str(metrics.f1_score(y_test, pred)))
print("Confusion Matrix: ")
metrics.confusion_matrix(y_test, pred)
```

```
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/linear_model/_logistic.
py:444: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/svm/_base.py:301: Conve
rgenceWarning: Solver terminated early (max_iter=1000).  Consider pre-processing your
data with StandardScaler or MinMaxScaler.
  warnings.warn(
Accuracy: 0.8382373161006462
Precision: 0.9086102719033232
Recall: 0.20784381478921907
F1: 0.3383014623172103
Confusion Matrix:
```

Out[14]:
```
array([[23183,   121],
       [ 4585,  1203]])
```

In [15]:
```
# 4. Lakukan hard voting dari model-model yang dibangun pada poin 2.
hardvoting_clf = VotingClassifier(estimators=[('lr', lr), ('svm', svm)], voting='hard'
pred = hardvoting_clf.predict(x_test)

print("Accuracy: " + str(metrics.accuracy_score(y_test, pred)))
print("Precision: " + str(metrics.precision_score(y_test, pred)))
print("Recall: " + str(metrics.recall_score(y_test, pred)))
print("F1: " + str(metrics.f1_score(y_test, pred)))
print("Confusion Matrix: ")
metrics.confusion_matrix(y_test, pred)
```

```
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/linear_model/_logistic.
py:444: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/svm/_base.py:301: Conve
rgenceWarning: Solver terminated early (max_iter=1000).  Consider pre-processing your
data with StandardScaler or MinMaxScaler.
  warnings.warn(
Accuracy: 0.8179224529080159
Precision: 0.7287977632805219
Recall: 0.13510711817553558
F1: 0.2279551085847544
Confusion Matrix:
```

Out[15]:

```
array([[23013,   291],
       [ 5006,   782]])
```

In [16]:

```
# 5. Lakukanlah stacking dengan final classifier adalah logistic regression dari model
stacking_clf = StackingClassifier(estimators=[('lr', lr), ('svm', svm)], final_estimat
pred = stacking_clf.predict(x_test)

print("Accuracy: " + str(metrics.accuracy_score(y_test, pred)))
print("Precision: " + str(metrics.precision_score(y_test, pred)))
print("Recall: " + str(metrics.recall_score(y_test, pred)))
print("F1: " + str(metrics.f1_score(y_test, pred)))
print("Confusion Matrix: ")
metrics.confusion_matrix(y_test, pred)
```

```
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/linear_model/_logistic.
py:444: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/svm/_base.py:301: Conve
rgenceWarning: Solver terminated early (max_iter=1000).  Consider pre-processing your
data with StandardScaler or MinMaxScaler.
  warnings.warn(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/linear_model/_logistic.
py:444: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/linear_model/_logistic.
py:444: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/linear_model/_logistic.
py:444: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/linear_model/_logistic.
py:444: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/linear_model/_logistic.
py:444: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/svm/_base.py:301: Conve
rgenceWarning: Solver terminated early (max_iter=1000).  Consider pre-processing your
```

```
data with StandardScaler or MinMaxScaler.
  warnings.warn(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/svm/_base.py:301: Conve
rgenceWarning: Solver terminated early (max_iter=1000).  Consider pre-processing your
data with StandardScaler or MinMaxScaler.
  warnings.warn(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/svm/_base.py:301: Conve
rgenceWarning: Solver terminated early (max_iter=1000).  Consider pre-processing your
data with StandardScaler or MinMaxScaler.
  warnings.warn(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/svm/_base.py:301: Conve
rgenceWarning: Solver terminated early (max_iter=1000).  Consider pre-processing your
data with StandardScaler or MinMaxScaler.
  warnings.warn(
/shared-libs/python3.9/py/lib/python3.9/site-packages/sklearn/svm/_base.py:301: Conve
rgenceWarning: Solver terminated early (max_iter=1000).  Consider pre-processing your
data with StandardScaler or MinMaxScaler.
  warnings.warn(
Accuracy: 0.8609239653512993
Precision: 0.7474431818181818
Recall: 0.4545611610228058
F1: 0.5653201547056296
Confusion Matrix:
```

Out[16]:
```
array([[22415,   889],
       [ 3157,  2631]])
```

IV. Analisis

Bandingkan hasil dari hal-hal berikut:

1. Model *baseline* (II.3)
2. Model lain (II.4)
3. Hasil *undersampling*
4. Hasil *oversampling*
5. Hasil *soft voting*
6. Hasil *hard voting*
7. Hasil *stacking*

(Tuliskan jawaban bagian IV di sini.)

1. Model baseline (II.3)

Pada Logistic Regression, didapatkan 2720 data berlabel True Positive, 3068 data berlabel False Negative, 963 data berlabel False Positive, dan 22341 data berlabel True Negative dari keseluruhan data. Accuracy, Precision, Recall, dan F1 yang didapatkan berturut-turut bernilai 86.14%, 73.85%, 46.99%, dan 57.43%.

2. Model lain (II.4)

Model lain yang digunakan adalah Stochastic Gradient Descent (SGD). Alasan digunakannya SGD karena data yang digunakan sangatlah besar yaitu lebih dari 100.000 data sehingga apabila digunakan SVM, akan menghabiskan waktu yang sangat lama. Pada SGD, didapatkan 2048 data berlabel True Positive, 3740 data berlabel False Negative, 480 data berlabel False Positive, dan 22824 data berlabel True Negative dari keseluruhan data. Accuracy, Precision, Recall, dan F1 yang didapatkan berturut-turut bernilai 85.49%, 81.01%, 35.38%, dan 49.25%.

Kemudian, dilakukan Hyperparameter Tuning dengan cara Grid Search terhadap SGD dengan random factor nilai alpha dan penalty. Dari proses tersebut, didapatkan 2423 data berlabel True Positive, 3365 data berlabel False Negative, 733 data berlabel False Positive, dan 22571 data berlabel True Negative dari keseluruhan data. Accuracy, Precision, Recall, dan F1, yang didapatkan berturut-turut bernilai 85.9%, 76.77%, 41.86%, 54.18%.

Lalu, dilakukan Cross Validation terhadap hasil dari Hyperparameter Tuning dengan K-Fold = 5. Accuracy, Precision, Recall, dan F1 yang didapatkan dari proses tersebut berturut-turut bernilai 83.19%, 72.96%, 42.06%, dan 52.54%.

Dapat dilihat bahwa secara umum, model baseline memiliki nilai metric yang lebih baik dibandingkan model SGD baik pada bentuk model awal, setelah dilakukan Hyperparameter Tuning, dan setelah dilakukan cross validation. Hal tersebut mengatakan bahwa model Logistic Regression lebih baik dalam menangani dataset ini. Dari nilai metric juga dapat dilihat bahwa nilai akurasi lumayan bagus dan presisi dapat ditoleransi akan tetapi nilai recall dan f1 lumayan buruk. Hal tersebut dikarenakan terdapat kelas minoritas yaitu kelas "Yes" yang mempengaruhi nilai kedua metric tersebut. Kelas minoritas menyebabkan model yang dibuat menjadi kurang bagus dalam memprediksi kelas seharusnya kelas minoritas. Untuk meningkatkan nilai metric, dapat dilakukan beberapa metode seperti oversampling atau undersampling.

3. Hasil undersampling

Setelah dilakukan undersampling pada Logistic Regression, didapatkan 4439 data berlabel True Positive, 1349 data berlabel False Negative, 4142 data berlabel False Positive, dan 19162 data berlabel True Negative dari keseluruhan data. Accuracy, Precision, Recall, dan F1 yang didapatkan berturut-turut bernilai 81.12%, 51.73%, 76.69%, dan 61.78%.

4. Hasil oversampling

Setelah dilakukan oversampling pada Logistic Regression, didapatkan 4442 data berlabel True Positive, 1346 data berlabel False Negative, 4078 data berlabel False Positive, dan 19226 data berlabel True Negative dari keseluruhan data. Accuracy, Precision, Recall, dan F1 yang didapatkan berturut-turut bernilai 81.35%, 52.13%, 76.74%, dan 61.79%.

Setelah dilakukan undersampling dan oversampling, maka dapat dilihat bahwa terdapat perbedaan nilai metric bila dibandingkan dengan nilai metric yang didapat menggunakan kelas baseline. Nilai recall dan F1 mengalami peningkatan yang cukup signifikan yang disebabkan oleh "hilangnya" kelas minoritas pada data training. Akan tetapi dapat dilihat juga bahwa nilai akurasi dan presisi mengalami penurunan akibat proses undersampling dan oversampling. Hal tersebut dikarenakan kedua proses ini memanipulasi dataset sedemikian rupa hingga terdapat perubahan yang cukup signifikan antara dataset awal dan dataset hasil manipulasi. Pada kasus undersampling, data yang memprediksi kelas majoritas dibuang dan pada kasus oversampling, dilakukan sebuah duplikasi data terhadap kelas mionritas. Hal tersebut tentunya mempengaruhi penilaian metric karena terjadi pembuangan data dan duplikasi data.

5. Hasil soft voting

Setelah dilakukan soft voting dengan model Logistic Regression dan SVM (dengan iterasi max = 1000), didapatkan 1203 data berlabel True Positive, 4585 data berlabel False Negative, 121 data berlabel False Positive, dan 23183 data berlabel True Negative dari keseluruhan data. Accuracy, Precision, Recall, dan F1 yang didapatkan berturut-turut bernilai 83.82%, 90.86%, 20.78%, dan 33.83%.

6. Hasil hard voting

Setelah dilakukan hard voting dengan model Logistic Regression dan SVM (dengan iterasi max = 1000), didapatkan 782 data berlabel True Positive, 5006 data berlabel False Negative, 291 data berlabel False Positive, dan 23013 data berlabel True Negative dari keseluruhan data. Accuracy, Precision, Recall, dan F1 yang didapatkan berturut-turut bernilai 81.79%, 72.87%, 13.51%, dan 22.79%.

7. Hasil stacking

Setelah dilakukan stacking dengan model Logistic Regression dan SVM (dengan iterasi max = 1000) dengan final classifier merupakan Logictis Regression, didapatkan 2631 data berlabel True Positive, 3157 data berlabel False Negative, 889 data berlabel False Positive, dan 22415 data berlabel True Negative dari keseluruhan data. Accuracy, Precision, Recall, dan F1 yang didapatkan berturut-turut bernilai 86.09%, 74.74%, 45.45%, dan 56.53%.

Dari proses soft voting, hard voting, dan stacking dapat terlihat bahwa terdapat perbedaan metric penilaian antara ketiga proses tersebut dengan model baseline. Perlu diketahui terlebih dahulu bahwa metric dari ketiga proses ini akan jauh lebih baik apabila model SVM menggunakan iterasi yang lebih besar atau melakukan iterasi hingga konvergen, akan tetapi pada kasus ini kurang feasible karena ukuran dataset yang sangat besar dan SVM dapat dibilang sangatlah lama dalam memproses data yang sangat besar.

Dari ketiga proses, metode hard voting memiliki metric yang palik buruk dan stacking memiliki metric yang paling baik. Dapat diketahui juga bahwa soft voting memiliki nilai presisi yang paling tinggi dari ketiga proses. Metode stacking merupakan metode yang menghasilkan metric yang paling baik dan metric tersebut dapat dibilang cukup memuaskan bila memperhitungkan bahwa iterasi yang dilakuakn pada model SVM hanyalah 1000 (walaupun memang proses ini membutuhkan waktu yang sangat lama yaitu sekitar 1 jam). Metode stacking diperkirakan dapat menghasilkan metric yang sangat bagus (bahkan dapat melampaui baseline atau model lain yang telah dibuat pada prapraktikum ini) apabila iterasi pada model SVM dilakukan hingga konvergen.