In [1]:

```
!pip install joblib
```

```
Requirement already satisfied: joblib in c:\users\thinithi\anaconda3\lib\site-pack
ages (1.2.0)
```

In [1]:

```
import os  # cheeck currently directory
import pandas as pd  # Load pandas library for data wrangling
# to convert weather station to a numeric number
from sklearn.preprocessing import LabelEncoder
# Split dataset and conduct cross-validation
from sklearn.model_selection import train_test_split, cross_val_score
# build a randomn forest model model
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import precision_score, recall_score, f1_score, accuracy_score
from IPython.display import display
from sklearn.preprocessing import StandardScaler  # Standardize column
# build a logisitic regression model
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier  # build a decision tree model
# build a gradient boosting model
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.neighbors import KNeighborsClassifier  # build a knn model
from sklearn.svm import SVC  # Build a svm model
from sklearn.naive_bayes import GaussianNB  # build naive bayes model
from collections import Counter  # obtain counts
import matplotlib.pyplot as plt  # plot correlation matrix
import seaborn as sns  # plot feature importance
import joblib  # save model
# utilize calss weight balancing in models
from sklearn.utils.class_weight import compute_class_weight
from PIL import Image  # Import model evaluation report image
from sklearn.model_selection import GridSearchCV  # conduct hyper parameter tuning
```

In [ ]:

```
# Get the current working directory
current_directory = os.getcwd()
current_directory
```

Data Exploration

In [2]:

```
file_path = 'Bushfire_Weather_data.xlsx'

# Read the Excel file into a DataFrame
df = pd.read_excel(file_path)
df.head()
```

Out[2]:

	Page_URL	Page_title	Date	Day	Temps_Min	Temps_Max	Rain	AM9_Temp	AM9_RH	AM9_D
0	201401	Benalla	1	We	9.8	26.9	0.0	21.1	37	S
1	201401	Benalla	2	Th	14.9	25.9	3.6	19.0	72	SSV
2	201401	Benalla	3	Fr	15.8	30.2	0.0	22.0	35	SS
3	201401	Benalla	4	Sa	11.4	25.0	0.0	15.5	51	SSV
4	201401	Benalla	7	Tu	9.2	25.9	0.0	15.0	43	

In [3]:

```
df.count()
```

Out[3]:

```
Page_URL       20021
Page_title     20021
Date           20021
Day            20021
Temps_Min      20021
Temps_Max      20021
Rain           20021
AM9_Temp       20021
AM9_RH         20021
AM9_Dir        20015
AM9_Spd        20021
PM3_Temp       20021
PM3_RH         20021
PM3_Dir        20011
PM3_Spd        20021
KEY            20021
dtype: int64
```

In [4]:

```
file_path = 'Bushfire_Wstation_2016_2023_01.csv'

# Read the CSV file into a DataFrame with a different encoding
df2 = pd.read_csv(file_path, encoding='ISO-8859-1')

df2.head()
```

Out[4]:

	FIRETYPE	SEASON	FIRE_NO	NAME	START_DATE	STRTDATIT	TREAT_TYPE	FIREKE
0	BUSHFIRE	2017	32	BARANDUDA - BARANDUDA RANGE TRACK	3/2/2017	20170302	FIRE	W20173403
1	BUSHFIRE	2017	32	GLENROWAN RIDGE TRACK	12/20/2016	20161220	FIRE	W20173703
2	BUSHFIRE	2016	61	MT BRUNO - JONES RD	12/20/2015	20151220	FIRE	W20163706
3	BUSHFIRE	2018	49	OVENS 49 - BEECHWORTH - WARNERS TRACK	1/23/2018	20180123	FIRE	W20183404
4	BUSHFIRE	2016	2	BAILIESTON - REEDY LAKE	8/18/2015	20150818	FIRE	W201699

In [5]:

```
df2.count()
```

Out[5]:
```
FIRETYPE      519
SEASON        519
FIRE_NO       516
NAME          519
START_DATE    519
STRTDATIT     519
TREAT_TYPE    519
FIREKEY       493
DSE_ID        507
CFA_ID         81
AREA_HA       519
latitude      519
longitude     519
WStation      519
Year          519
Month         519
Day           519
dtype: int64
```

In [6]:
```
# Rename Wstation
df['Page_title'].replace('Wangaratta', 'WANGARATTA', inplace=True)
df['Page_title'].replace('Benalla', 'BENALLA', inplace=True)
df['Page_title'].replace('Shepparton', 'SHEPPARTON', inplace=True)
df['Page_title'].replace('Falls Creek', 'FALLS_CREEK', inplace=True)
df['Page_title'].replace('Mount Buller', 'MOUNT_BULLER', inplace=True)
df['Page_title'].replace('Yarrawonga', 'YARRAWONGA', inplace=True)
df['Page_title'].replace('Albury', 'ALBURY', inplace=True)
df['Page_title'].replace('Corryong', 'CARRYONG', inplace=True)
df['Page_title'].replace('Edi Upper', 'EDI_UPPER', inplace=True)
df['Page_title'].replace('Hunters Hill', 'HUNTERS_HILL', inplace=True)
df['Page_title'].replace('Rutherglen', 'RUTHERGLEN', inplace=True)
```

In [7]:
```
# Rename Wstation
df2['WStation'].replace('WANGARATTA AERO', 'WANGARATTA', inplace=True)
df2['WStation'].replace('BENALLA AIRPORT', 'BENALLA', inplace=True)
df2['WStation'].replace('SHEPPARTON AIRPORT', 'SHEPPARTON', inplace=True)
df2['WStation'].replace('FALLS CREEK', 'FALLS_CREEK', inplace=True)
df2['WStation'].replace('MOUNT BULLER', 'MOUNT_BULLER', inplace=True)
df2['WStation'].replace('YARRAWONGA', 'YARRAWONGA', inplace=True)
df2['WStation'].replace('ALBURY AIRPORT AWS', 'ALBURY', inplace=True)
df2['WStation'].replace('CORRYONG AIRPORT', 'CARRYONG', inplace=True)
df2['WStation'].replace('EDI UPPER', 'EDI_UPPER', inplace=True)
df2['WStation'].replace('HUNTERS HILL', 'HUNTERS_HILL', inplace=True)
df2['WStation'].replace('RUTHERGLEN RESEARCH', 'RUTHERGLEN', inplace=True)
```

In [8]:
```
df = df.drop(['Page_URL', 'Date','Day'], axis=1)
df.rename(columns = {'Page_title':'Station_Region'}, inplace = True)
df.head()
```

Out[8]:

	Station_Region	Temps_Min	Temps_Max	Rain	AM9_Temp	AM9_RH	AM9_Dir	AM9_Spd	PM3
0	BENALLA	9.8	26.9	0.0	21.1	37	SE	7.0	
1	BENALLA	14.9	25.9	3.6	19.0	72	SSW	4.0	
2	BENALLA	15.8	30.2	0.0	22.0	35	SSE	4.0	
3	BENALLA	11.4	25.0	0.0	15.5	51	SSW	6.0	
4	BENALLA	9.2	25.9	0.0	15.0	43	S	19.0	

In [9]:

```
# Summarizing the DataFrame
summary_df = df2.groupby(['WStation', 'STRTDATIT']).agg(
    total_area_ha=('AREA_HA', 'sum'),
    count_of_rows=('AREA_HA', 'size')
).reset_index().sort_values(by='count_of_rows', ascending=False)

# Display the summary DataFrame
summary_df.head()
```

Out[9]:

	WStation	STRTDATIT	total_area_ha	count_of_rows
168	MOUNT_BULLER	20191231	83.4484	41
57	DARTMOUTH RESERVOIR	20191121	6282.5712	31
118	FALLS_CREEK	20191231	35830.2541	21
119	FALLS_CREEK	20200101	44315.9390	14
110	FALLS_CREEK	20190228	13236.3868	14

In [10]:

```
df['Station_Region'].unique()
```

Out[10]:

```
array(['BENALLA', 'WANGARATTA', 'YARRAWONGA', 'SHEPPARTON', 'FALLS_CREEK',
       'MOUNT_BULLER', 'RUTHERGLEN', 'ALBURY', 'CARRYONG', 'EDI_UPPER',
       'HUNTERS_HILL'], dtype=object)
```

In [11]:

```
summary_df['WStation'].unique()
```

Out[11]:

```
array(['MOUNT_BULLER', 'DARTMOUTH RESERVOIR', 'FALLS_CREEK', 'EDI_UPPER',
       'CARRYONG', 'ALBURY', 'HUNTERS_HILL', 'STRATHBOGIE', 'SHEPPARTON',
       'YARRAWONGA', 'BENALLA', 'RUTHERGLEN', 'WANGARATTA'], dtype=object)
```

In [12]:

```
# Convert the `KEY` column in df to string
df['KEY'] = df['KEY'].astype(str)

# Create a new column by concatenating WStation and STRTDATIT
summary_df['JOINKEY1'] = summary_df['WStation'] + '_' + summary_df['STRTDATIT'].ast
df['JOINKEY2'] = df['Station_Region'] + '_' + df['KEY']

# Left join df (weather data) with df2 (fire data) on KEY and STRTDATIT
data = df.merge(summary_df, how='left', left_on='JOINKEY2', right_on='JOINKEY1')
data.head()
```

Out[12]:

	Station_Region	Temps_Min	Temps_Max	Rain	AM9_Temp	AM9_RH	AM9_Dir	AM9_Spd	PM3
0	BENALLA	9.8	26.9	0.0	21.1	37	SE	7.0	
1	BENALLA	14.9	25.9	3.6	19.0	72	SSW	4.0	
2	BENALLA	15.8	30.2	0.0	22.0	35	SSE	4.0	
3	BENALLA	11.4	25.0	0.0	15.5	51	SSW	6.0	
4	BENALLA	9.2	25.9	0.0	15.0	43	S	19.0	

In [13]:

```
# Create a new column based on the value of count_of_rows
data['Bushfire_Event_Target'] = data['count_of_rows'].apply(lambda x: 0 if pd.isna(
data.head()
```

Out[13]:

	Station_Region	Temps_Min	Temps_Max	Rain	AM9_Temp	AM9_RH	AM9_Dir	AM9_Spd	PM3
0	BENALLA	9.8	26.9	0.0	21.1	37	SE	7.0	
1	BENALLA	14.9	25.9	3.6	19.0	72	SSW	4.0	
2	BENALLA	15.8	30.2	0.0	22.0	35	SSE	4.0	
3	BENALLA	11.4	25.0	0.0	15.5	51	SSW	6.0	
4	BENALLA	9.2	25.9	0.0	15.0	43	S	19.0	

In [14]:

```python
# Remove unwanted columns from the DataFrame
data = data.drop(columns=['WStation'])
data = data.drop(columns=['STRTDATIT'])
data = data.drop(columns=['count_of_rows'])
data = data.drop(columns=['AM9_Dir'])
data = data.drop(columns=['PM3_Dir'])
data = data.drop(columns=['KEY'])
data = data.drop(columns=['JOINKEY1'])
data = data.drop(columns=['JOINKEY2'])

# Replace NaN values in the 'Total_Area' column with 0
data['total_area_ha'] = data['total_area_ha'].fillna(0)
data.rename(columns = {'total_area_ha':'Total_Area'}, inplace = True)
# Normalize the Total_Area column
data['Total_Area'] = (data['Total_Area'] - data['Total_Area'].min()) / (data['Total
```

In [15]:

```python
data.head()
```

Out[15]:

	Station_Region	Temps_Min	Temps_Max	Rain	AM9_Temp	AM9_RH	AM9_Spd	PM3_Temp	PI
0	BENALLA	9.8	26.9	0.0	21.1	37	7.0	25.8	
1	BENALLA	14.9	25.9	3.6	19.0	72	4.0	24.4	
2	BENALLA	15.8	30.2	0.0	22.0	35	4.0	25.5	
3	BENALLA	11.4	25.0	0.0	15.5	51	6.0	22.9	
4	BENALLA	9.2	25.9	0.0	15.0	43	19.0	23.9	

In [16]:

```python
# Initialize the encoder
label_encoder = LabelEncoder()

# Fit and transform the data
data["Station_Region"] = label_encoder.fit_transform(data["Station_Region"])

data.head()
```

Out[16]:

	Station_Region	Temps_Min	Temps_Max	Rain	AM9_Temp	AM9_RH	AM9_Spd	PM3_Temp	PI
0	1	9.8	26.9	0.0	21.1	37	7.0	25.8	
1	1	14.9	25.9	3.6	19.0	72	4.0	24.4	
2	1	15.8	30.2	0.0	22.0	35	4.0	25.5	
3	1	11.4	25.0	0.0	15.5	51	6.0	22.9	
4	1	9.2	25.9	0.0	15.0	43	19.0	23.9	

In [17]:

```
# Print the mapping of original values to encoded values
mapping = dict(zip(label_encoder.classes_, label_encoder.transform(label_encoder.cl
print("Mapping", mapping)
```

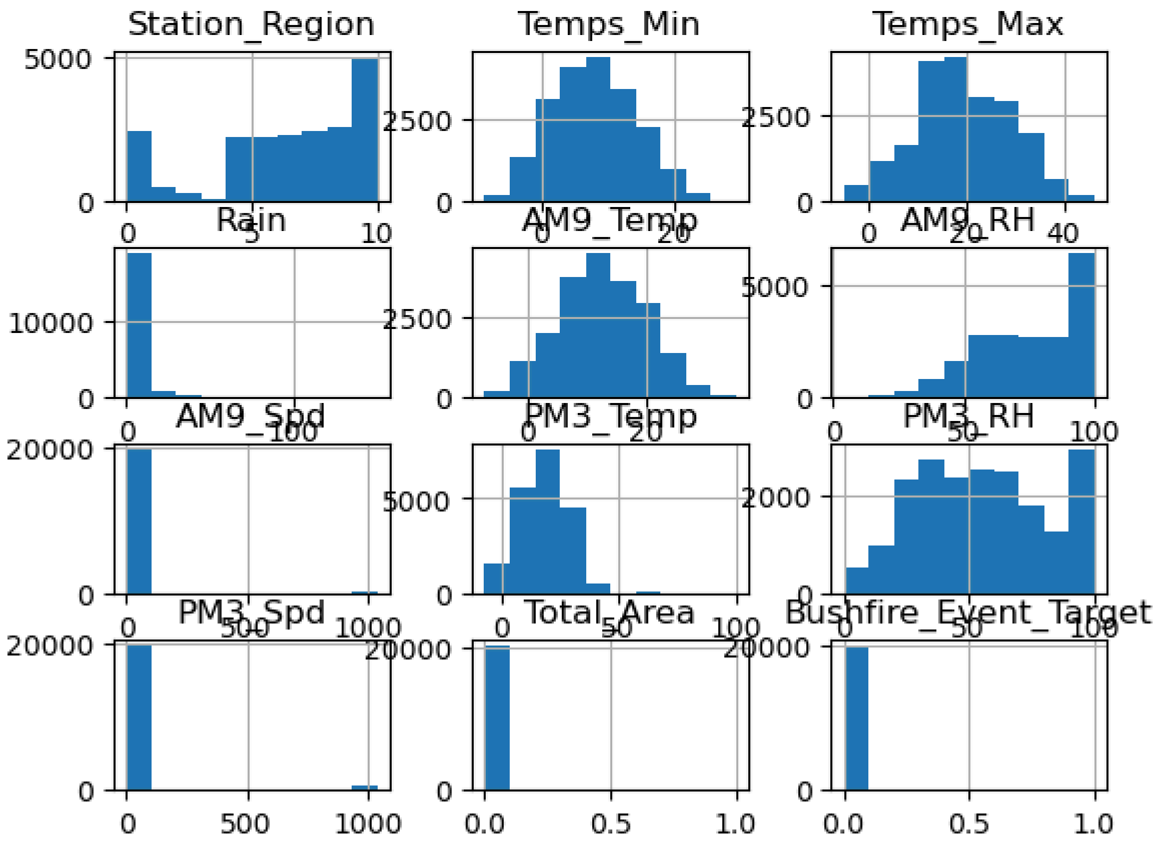
```
Mapping {'ALBURY': 0, 'BENALLA': 1, 'CARRYONG': 2, 'EDI_UPPER': 3, 'FALLS_CREEK':
4, 'HUNTERS_HILL': 5, 'MOUNT_BULLER': 6, 'RUTHERGLEN': 7, 'SHEPPARTON': 8, 'WANGAR
ATTA': 9, 'YARRAWONGA': 10}
```

In [18]:

```
# Assigning the data to the DataFrame
df = pd.DataFrame(data)
df.hist()
```

Out[18]:

```
array([[<Axes: title={'center': 'Station_Region'}>,
        <Axes: title={'center': 'Temps_Min'}>,
        <Axes: title={'center': 'Temps_Max'}>],
       [<Axes: title={'center': 'Rain'}>,
        <Axes: title={'center': 'AM9_Temp'}>,
        <Axes: title={'center': 'AM9_RH'}>],
       [<Axes: title={'center': 'AM9_Spd'}>,
        <Axes: title={'center': 'PM3_Temp'}>,
        <Axes: title={'center': 'PM3_RH'}>],
       [<Axes: title={'center': 'PM3_Spd'}>,
        <Axes: title={'center': 'Total_Area'}>,
        <Axes: title={'center': 'Bushfire_Event_Target'}>]], dtype=object)
```



In [ ]:

```
df.head()
```

In [19]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 20021 entries, 0 to 20020
Data columns (total 12 columns):
 #   Column                 Non-Null Count  Dtype  
---  ------                 --------------  -----  
 0   Station_Region         20021 non-null  int32  
 1   Temps_Min              20021 non-null  float64
 2   Temps_Max              20021 non-null  float64
 3   Rain                   20021 non-null  float64
 4   AM9_Temp               20021 non-null  float64
 5   AM9_RH                 20021 non-null  int64  
 6   AM9_Spd                20021 non-null  float64
 7   PM3_Temp               20021 non-null  float64
 8   PM3_RH                 20021 non-null  int64  
 9   PM3_Spd                20021 non-null  float64
 10  Total_Area             20021 non-null  float64
 11  Bushfire_Event_Target  20021 non-null  int64  
dtypes: float64(8), int32(1), int64(3)
memory usage: 1.8 MB
```

Resolving Class Imbalance Issues

In [20]:

```
# Separate the majority and minority classes
X_0 = df[df['Bushfire_Event_Target'] == 0]  # Majority class
X_1 = df[df['Bushfire_Event_Target'] == 1]  # Minority class

# Randomly sample from the majority class
n_samples = 200  # Number of samples to keep from the majority class
X_0_sampled = X_0.sample(n=n_samples, random_state=42)

# Combine the undersampled majority class with the minority class
df = pd.concat([X_0_sampled, X_1])
```

In [21]:

```
a = df[df['Bushfire_Event_Target'] == 0]
a.count()
```

Out[21]:

```
Station_Region           200
Temps_Min                200
Temps_Max                200
Rain                     200
AM9_Temp                 200
AM9_RH                   200
AM9_Spd                  200
PM3_Temp                 200
PM3_RH                   200
PM3_Spd                  200
Total_Area               200
Bushfire_Event_Target    200
dtype: int64
```

In [22]:

```
a = df[df['Bushfire_Event_Target'] == 1]
a.count()
```

Out[22]:

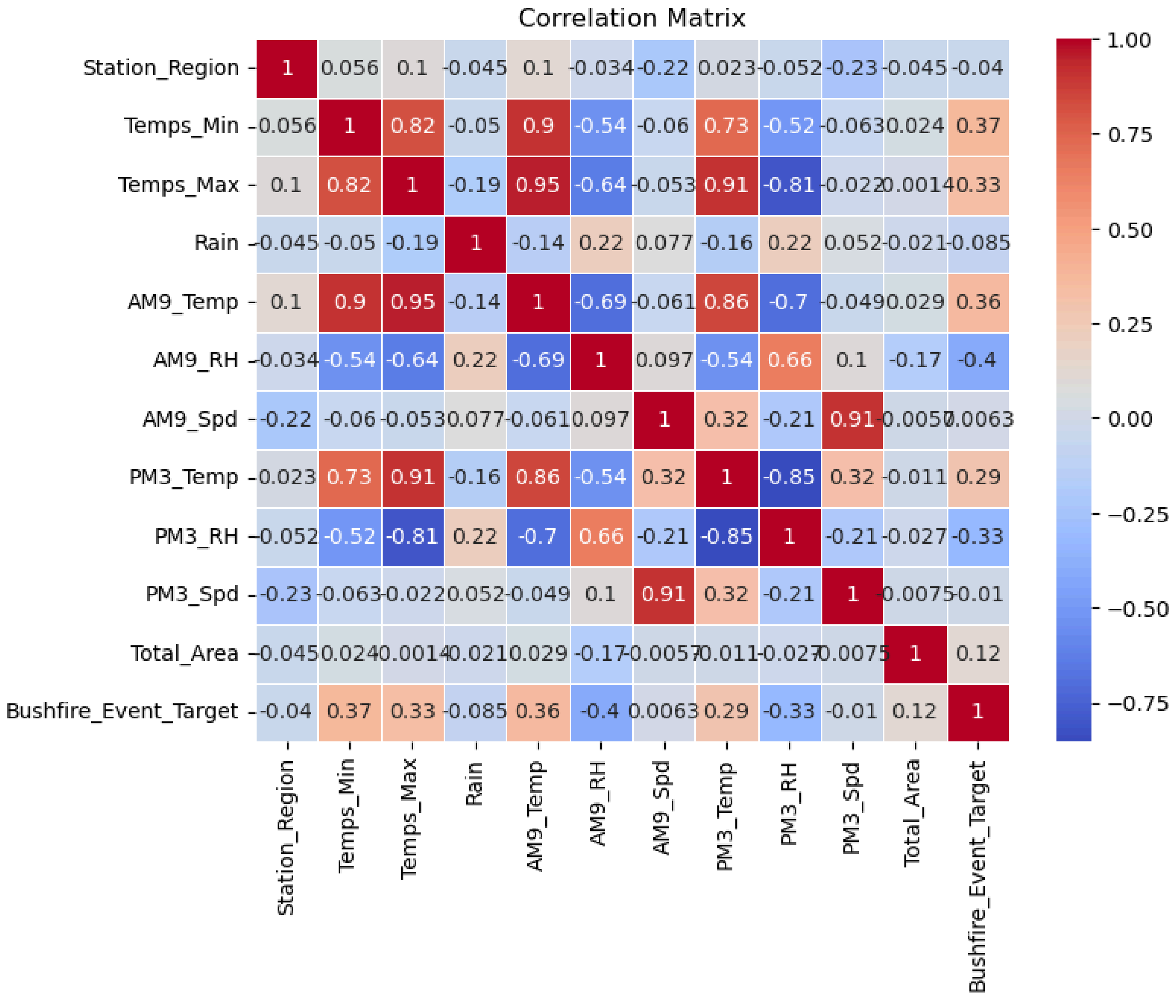
```
Station_Region          140
Temps_Min               140
Temps_Max               140
Rain                    140
AM9_Temp                140
AM9_RH                  140
AM9_Spd                 140
PM3_Temp                140
PM3_RH                  140
PM3_Spd                 140
Total_Area              140
Bushfire_Event_Target   140
dtype: int64
```

Check for correlation among the variables

In [23]:

```
# Calculate the correlation matrix
corr_matrix = df.corr()

# Print the correlation matrix
print(corr_matrix)

# Visualize the correlation matrix using a heatmap
plt.figure(figsize=(8, 6))
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm', linewidths=0.5)
plt.title('Correlation Matrix')
plt.show()
```

```
                       Station_Region  Temps_Min  Temps_Max      Rain  \
Station_Region               1.000000   0.056108   0.102297 -0.044611   
Temps_Min                    0.056108   1.000000   0.817511 -0.049770   
Temps_Max                    0.102297   0.817511   1.000000 -0.185224   
Rain                        -0.044611  -0.049770  -0.185224  1.000000   
AM9_Temp                     0.103578   0.900393   0.951034 -0.136218   
AM9_RH                      -0.033659  -0.540743  -0.639255  0.220045   
AM9_Spd                     -0.221265  -0.060050  -0.053351  0.076960   
PM3_Temp                     0.022910   0.729600   0.907651 -0.160921   
PM3_RH                      -0.052221  -0.520047  -0.808371  0.215631   
PM3_Spd                     -0.232512  -0.063154  -0.022239  0.051807   
Total_Area                  -0.045184   0.024080  -0.001396 -0.020690   
Bushfire_Event_Target       -0.040034   0.374604   0.330619 -0.084738   

                       AM9_Temp    AM9_RH   AM9_Spd  PM3_Temp    PM3_RH  \
Station_Region         0.103578 -0.033659 -0.221265  0.022910 -0.052221   
Temps_Min              0.900393 -0.540743 -0.060050  0.729600 -0.520047   
Temps_Max              0.951034 -0.639255 -0.053351  0.907651 -0.808371   
Rain                  -0.136218  0.220045  0.076960 -0.160921  0.215631   
AM9_Temp               1.000000 -0.693031 -0.060826  0.855122 -0.704679   
AM9_RH                -0.693031  1.000000  0.096861 -0.539372  0.656707   
AM9_Spd               -0.060826  0.096861  1.000000  0.317872 -0.206275   
PM3_Temp               0.855122 -0.539372  0.317872  1.000000 -0.852059   
PM3_RH                -0.704679  0.656707 -0.206275 -0.852059  1.000000   
PM3_Spd               -0.048645  0.101668  0.908667  0.316223 -0.208112   
Total_Area             0.029026 -0.165727 -0.005684 -0.011271 -0.027407   
Bushfire_Event_Target  0.359640 -0.404650  0.006320  0.286659 -0.329608   

                        PM3_Spd  Total_Area  Bushfire_Event_Target  
Station_Region        -0.232512   -0.045184              -0.040034  
Temps_Min             -0.063154    0.024080               0.374604  
Temps_Max             -0.022239   -0.001396               0.330619  
Rain                   0.051807   -0.020690              -0.084738  
AM9_Temp              -0.048645    0.029026               0.359640  
AM9_RH                 0.101668   -0.165727              -0.404650  
AM9_Spd                0.908667   -0.005684               0.006320  
PM3_Temp               0.316223   -0.011271               0.286659  
PM3_RH                -0.208112   -0.027407              -0.329608  
PM3_Spd                1.000000   -0.007472              -0.010300  
Total_Area            -0.007472    1.000000               0.117251  
Bushfire_Event_Target -0.010300    0.117251               1.000000  
```



In [ ]:

```
# Write DataFrame to CSV
csv_file_path = 'BB_R_Model_Data.csv'  # Specify the path to the output CSV file
df.to_csv(csv_file_path, index=False)  # Set index=False to avoid writing row indic
```

In [26]:

```
features = ['Station_Region','Temps_Min','Temps_Max','Rain','AM9_Temp','AM9_RH','AM
#features = ['Station_Region','Temps_Min','Temps_Max','Rain','AM9_RH','AM9_Spd']
X = df.loc[:, features]
y = df.loc[:, ['Bushfire_Event_Target']]

# Perform stratified split to preserve the class distribution
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.20, random_st

# Check the distribution of target variable in training and test sets
print("Train set class distribution:\n", y_train.value_counts())
print("Test set class distribution:\n", y_test.value_counts())
```

```
Train set class distribution:
 Bushfire_Event_Target
0                        160
1                        112
Name: count, dtype: int64
Test set class distribution:
 Bushfire_Event_Target
0                        40
1                        28
Name: count, dtype: int64
```

In [27]:

```
X_train.head()
```

Out[27]:

	Station_Region	Temps_Min	Temps_Max	Rain	AM9_Temp	AM9_RH	AM9_Spd	PM3_Tem
11223	6	14.5	18.5	0.4	15.9	62	28.0	15.
2818	9	10.7	32.1	0.0	20.9	50	4.0	31.
9194	4	18.0	22.6	0.0	19.3	37	24.0	22.
13072	7	16.5	21.6	0.0	17.4	48	35.0	20.
6862	8	8.4	27.5	0.0	16.6	58	9.0	26.

In [28]:

```
X_test.head()
```

Out[28]:

	Station_Region	Temps_Min	Temps_Max	Rain	AM9_Temp	AM9_RH	AM9_Spd	PM3_Tem
13265	7	3.8	17.8	0.0	11.0	99	15.0	17.
16594	0	16.3	31.2	1.2	20.1	75	4.0	30.
4151	10	9.8	28.3	0.0	17.3	70	9.0	27.
7502	8	9.9	25.3	0.0	18.2	63	7.0	23.
13081	7	10.8	34.7	0.0	25.7	31	15.0	33.

In [29]:

```
y_train.head()
```

Out[29]:

	Bushfire_Event_Target
11223	1
2818	0
9194	0
13072	1
6862	1

In [30]:

```
X_test.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 68 entries, 13265 to 7492
Data columns (total 10 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   Station_Region  68 non-null     int32  
 1   Temps_Min       68 non-null     float64
 2   Temps_Max       68 non-null     float64
 3   Rain            68 non-null     float64
 4   AM9_Temp        68 non-null     float64
 5   AM9_RH          68 non-null     int64  
 6   AM9_Spd         68 non-null     float64
 7   PM3_Temp        68 non-null     float64
 8   PM3_RH          68 non-null     int64  
 9   PM3_Spd         68 non-null     float64
dtypes: float64(7), int32(1), int64(2)
memory usage: 5.6 KB
```

Randomn Forest Classifier

In [31]:
```
# Initialize RandomForestClassifier with class_weight="balanced"
rf = RandomForestClassifier(class_weight='balanced', random_state=42)
```

In [32]:
```
# Perform cross-validation
cv_scores = cross_val_score(rf, X_train, y_train.values.ravel(), cv=5)
print("Cross-validation scores:", cv_scores)
```

```
Cross-validation scores: [0.74545455 0.63636364 0.68518519 0.66666667 0.72222222]
```

In [33]:
```
rf.fit(X_train, y_train)
```

```
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\base.py:1151: DataConversion
Warning: A column-vector y was passed when a 1d array was expected. Please change
the shape of y to (n_samples,), for example using ravel().
  return fit_method(estimator, *args, **kwargs)
```

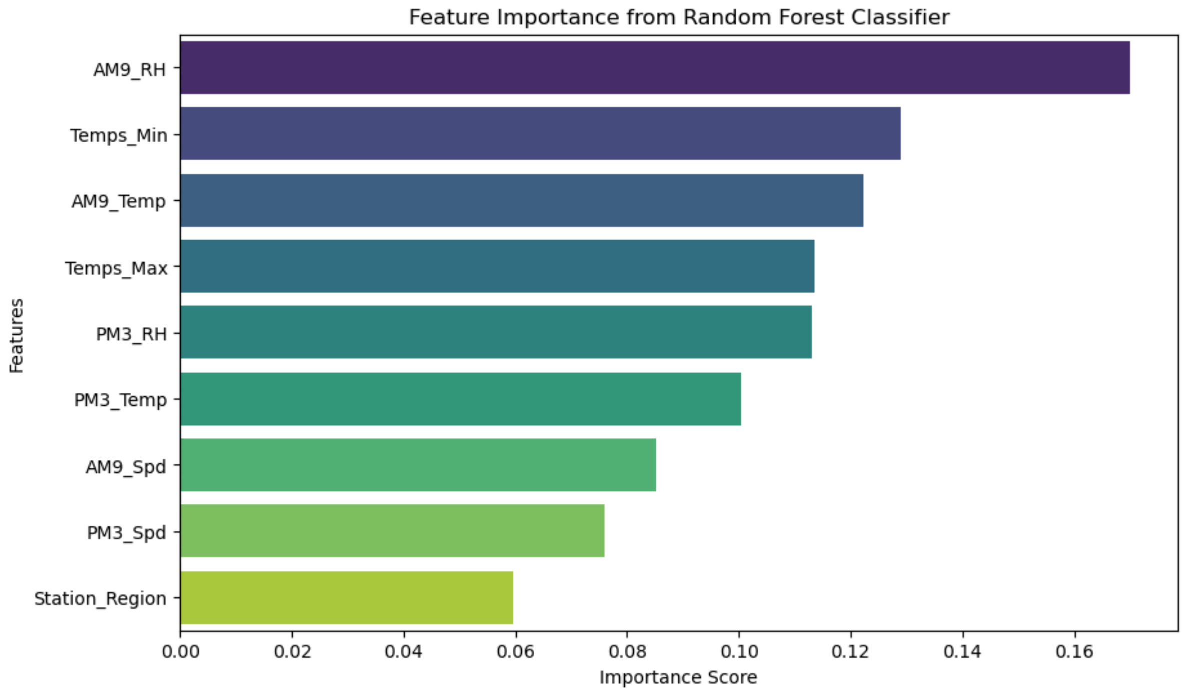
Out[33]:
```
▾                    RandomForestClassifier
RandomForestClassifier(class_weight='balanced', random_state=42)
```

In [34]:
```
# Make predictions
y_pred = rf.predict(X_test)
```

In [35]:
```
# Evaluate model performance
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)

# Generate a confusion matrix
conf_matrix = confusion_matrix(y_test, y_pred)
print("Confusion Matrix:\n", conf_matrix)

# Calculate precision, recall, and F1 score
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)

# Print precision, recall, and F1 score
print("Precision:", precision)
print("Recall:", recall)
print("F1 Score:", f1)
```

```
Accuracy: 0.6323529411764706
Confusion Matrix:
 [[30 10]
 [15 13]]
Precision: 0.5652173913043478
Recall: 0.4642857142857143
F1 Score: 0.5098039215686274
```

In [36]:
```
# Get feature importances
feature_importances = pd.DataFrame(rf.feature_importances_, index=X.columns, colum
feature_importances['abs_importance'] = feature_importances['importance'].abs()

# Filter feature importances based on absolute value
feature_filtered = feature_importances[feature_importances['abs_importance'] > 0.05

# Plotting
plt.figure(figsize=(10, 6))
sns.barplot(x=feature_filtered['importance'], y=feature_filtered.index, palette='vi
plt.title('Feature Importance from Random Forest Classifier')
plt.xlabel('Importance Score')
plt.ylabel('Features')
plt.axvline(0, color='grey', linestyle='--')  # Add a vertical line at x=0
plt.show()
```



Dimensionality Reduction

In [37]:

```
features = ['Station_Region','Temps_Min','Temps_Max','Rain','AM9_RH','AM9_Spd','PM3
X = df.loc[:, features]
y = df.loc[:, ['Bushfire_Event_Target']]

# Perform stratified split to preserve the class distribution
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.20, random_st

# Check the distribution of target variable in training and test sets
print("Train set class distribution:\n", y_train.value_counts())
print("Test set class distribution:\n", y_test.value_counts())
```

```
Train set class distribution:
 Bushfire_Event_Target
0                        160
1                        112
Name: count, dtype: int64
Test set class distribution:
 Bushfire_Event_Target
0                        40
1                        28
Name: count, dtype: int64
```

In [38]:

```
# Initialize RandomForestClassifier with class_weight="balanced"
rf = RandomForestClassifier(class_weight='balanced', random_state=42)
```

In [39]:

```
# Perform cross-validation
cv_scores = cross_val_score(rf, X_train, y_train.values.ravel(), cv=5)
print("Cross-validation scores:", cv_scores)
```

```
Cross-validation scores: [0.70909091 0.58181818 0.72222222 0.72222222 0.7962963 ]
```

In [40]:

```
rf.fit(X_train, y_train)
```

```
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\base.py:1151: DataConversion
Warning: A column-vector y was passed when a 1d array was expected. Please change
the shape of y to (n_samples,), for example using ravel().
  return fit_method(estimator, *args, **kwargs)
```

Out[40]:

```
▾                    RandomForestClassifier
RandomForestClassifier(class_weight='balanced', random_state=42)
```

In [41]:

```
# Evaluate model performance
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)

# Generate a confusion matrix
conf_matrix = confusion_matrix(y_test, y_pred)
print("Confusion Matrix:\n", conf_matrix)

# Calculate precision, recall, and F1 score
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)

# Print precision, recall, and F1 score
print("Precision:", precision)
print("Recall:", recall)
print("F1 Score:", f1)
```

```
Accuracy: 0.6323529411764706
Confusion Matrix:
 [[30 10]
 [15 13]]
Precision: 0.5652173913043478
Recall: 0.4642857142857143
F1 Score: 0.5098039215686274
```

Dimesionality Reduced but the model performance is kept near the same level. By removing AM9_Temp majority of the model performance (F1 Score) increased as well.

Lositic regression with probability

In [784...

```
# Feature scaling (important for logistic regression)
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)
```

In [785...

```
# Create a logistic regression model with class weights
log_reg = LogisticRegression(random_state=0, class_weight='balanced')

# Perform cross-validation
cv_scores = cross_val_score(log_reg, X_train, y_train.values.ravel(), cv=5)
print("Cross-validation scores:", cv_scores)

# Train the model
log_reg.fit(X_train_scaled, y_train)
```

```
Cross-validation scores: [0.63636364 0.61818182 0.75925926 0.62962963 0.66666667]
```

```
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\linear_model\_logistic.py:46
0: 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(
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\linear_model\_logistic.py:46
0: 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(
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\utils\validation.py:1184: Da
taConversionWarning: A column-vector y was passed when a 1d array was expected. Pl
ease change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[785]:

```
▾ LogisticRegression
LogisticRegression(class_weight='balanced', random_state=0)
```

In [786…

```
# Make predictions
y_pred = log_reg.predict(X_test_scaled)
```

In [787…

```
# Evaluate model performance
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)

# Generate a confusion matrix
conf_matrix = confusion_matrix(y_test, y_pred)
print("Confusion Matrix:\n", conf_matrix)

# Calculate precision, recall, and F1 score
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)

# Print precision, recall, and F1 score
print("Precision:", precision)
print("Recall:", recall)
print("F1 Score:", f1)
```

```
Accuracy: 0.6470588235294118
Confusion Matrix:
 [[27 13]
 [11 17]]
Precision: 0.5666666666666667
Recall: 0.6071428571428571
F1 Score: 0.5862068965517241
```

In [788…

```
# Make predictions with probabilities
y_pred_proba = log_reg.predict_proba(X_test_scaled)

# Create a DataFrame to display test data with predicted probabilities
test_data_with_proba = pd.DataFrame(X_test, columns=features)
test_data_with_proba['Predicted_Class'] = log_reg.predict(X_test_scaled)
test_data_with_proba['Probability_Class_0'] = y_pred_proba[:, 0]
```

```
test_data_with_proba['Probability_Class_1'] = y_pred_proba[:, 1]

# Display the first few rows of the test data with probabilities
print(test_data_with_proba.head())
```

```
       Station_Region  Temps_Min  Temps_Max  Rain  AM9_RH  AM9_Spd  PM3_RH  \
13265               7        3.8       17.8   0.0      99     15.0      65
16594               0       16.3       31.2   1.2      75      4.0      27
4151               10        9.8       28.3   0.0      70      9.0      26
7502                8        9.9       25.3   0.0      63      7.0      39
13081               7       10.8       34.7   0.0      31     15.0      16

       Predicted_Class  Probability_Class_0  Probability_Class_1
13265                0             0.882791             0.117209
16594                1             0.312355             0.687645
4151                 0             0.600457             0.399543
7502                 0             0.515639             0.484361
13081                1             0.290802             0.709198
```

Decision Tree Classifier

In [789…

```
tree_clf = DecisionTreeClassifier(random_state=0, class_weight='balanced')

# Perform cross-validation
cv_scores = cross_val_score(tree_clf, X_train, y_train.values.ravel(), cv=5)
print("Cross-validation scores:", cv_scores)

tree_clf.fit(X_train, y_train)
```

```
Cross-validation scores: [0.6        0.63636364 0.66666667 0.66666667 0.68518519]
```

Out[789]:

```
▾                    DecisionTreeClassifier
DecisionTreeClassifier(class_weight='balanced', random_state=0)
```

In [790…

```
# Make predictions
y_pred = tree_clf.predict(X_test)
```

In [791…

```
# Evaluate model performance
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)

# Generate a confusion matrix
conf_matrix = confusion_matrix(y_test, y_pred)
print("Confusion Matrix:\n", conf_matrix)

# Calculate precision, recall, and F1 score
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)

# Print precision, recall, and F1 score
print("Precision:", precision)
print("Recall:", recall)
print("F1 Score:", f1)
```

```
Accuracy: 0.5735294117647058
Confusion Matrix:
 [[30 10]
 [19  9]]
Precision: 0.47368421052631576
Recall: 0.32142857142857145
F1 Score: 0.3829787234042553
```

Gradient Boosting Classifier

In [792…

```
from sklearn.ensemble import GradientBoostingClassifier

gb_clf = GradientBoostingClassifier(random_state=0)

# Perform cross-validation
cv_scores = cross_val_score(gb_clf, X_train, y_train.values.ravel(), cv=5)
print("Cross-validation scores:", cv_scores)

gb_clf.fit(X_train, y_train)
```

```
Cross-validation scores: [0.65454545 0.61818182 0.68518519 0.72222222 0.75925926]
```

```
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\ensemble\_gb.py:424: DataCon
versionWarning: A column-vector y was passed when a 1d array was expected. Please
change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[792]:

```
▾      GradientBoostingClassifier
GradientBoostingClassifier(random_state=0)
```

In [ ]:

```
# Make predictions
y_pred = gb_clf.predict(X_test)
```

In [793…

```
# Evaluate model performance
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)

# Generate a confusion matrix
conf_matrix = confusion_matrix(y_test, y_pred)
print("Confusion Matrix:\n", conf_matrix)

# Calculate precision, recall, and F1 score
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)

# Print precision, recall, and F1 score
print("Precision:", precision)
print("Recall:", recall)
print("F1 Score:", f1)
```

```
Accuracy: 0.5735294117647058
Confusion Matrix:
 [[30 10]
 [19  9]]
Precision: 0.47368421052631576
Recall: 0.32142857142857145
F1 Score: 0.3829787234042553
```

Support Vector Machine (SVM)

In [42]:

```
svc_clf = SVC(random_state=0, class_weight='balanced', probability=True)

# Perform cross-validation
cv_scores = cross_val_score(svc_clf, X_train, y_train.values.ravel(), cv=5)
print("Cross-validation scores:", cv_scores)

svc_clf.fit(X_train, y_train)
```

```
Cross-validation scores: [0.69090909 0.58181818 0.7962963  0.62962963 0.62962963]
```

```
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\utils\validation.py:1184: Da
taConversionWarning: A column-vector y was passed when a 1d array was expected. Pl
ease change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[42]:

```
▾ SVC
SVC(class_weight='balanced', probability=True, random_state=0)
```

In [43]:

```
X_train.head(10)
```

Out[43]:

	Station_Region	Temps_Min	Temps_Max	Rain	AM9_RH	AM9_Spd	PM3_RH
11223	6	14.5	18.5	0.4	62	28.0	83
2818	9	10.7	32.1	0.0	50	4.0	19
9194	4	18.0	22.6	0.0	37	24.0	37
13072	7	16.5	21.6	0.0	48	35.0	20
6862	8	8.4	27.5	0.0	58	9.0	26
3506	10	14.9	31.8	0.0	66	11.0	34
18317	5	18.0	30.6	0.0	48	7.0	29
17250	0	7.8	23.7	0.0	80	1032.1	2
10468	6	-1.3	7.3	14.6	100	20.0	83
19275	5	9.2	20.7	0.2	61	6.0	61

In [44]:

```
# Make predictions
y_pred = svc_clf.predict(X_test)
```

In [45]:

```
# Evaluate model performance
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)

# Generate a confusion matrix
conf_matrix = confusion_matrix(y_test, y_pred)
print("Confusion Matrix:\n", conf_matrix)

# Calculate precision, recall, and F1 score
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)

# Print precision, recall, and F1 score
print("Precision:", precision)
print("Recall:", recall)
print("F1 Score:", f1)
```

```
Accuracy: 0.6764705882352942
Confusion Matrix:
 [[23 17]
 [ 5 23]]
Precision: 0.575
Recall: 0.8214285714285714
F1 Score: 0.676470588235294
```

In [46]:

```
# Get model parameters
model_params = svc_clf.get_params()
print("Model parameters:", model_params)
```

```
Model parameters: {'C': 1.0, 'break_ties': False, 'cache_size': 200, 'class_weigh
t': 'balanced', 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamm
a': 'scale', 'kernel': 'rbf', 'max_iter': -1, 'probability': True, 'random_state':
0, 'shrinking': True, 'tol': 0.001, 'verbose': False}
```

k-Nearest Neighbors (k-NN)

In [797…

```
knn_clf = KNeighborsClassifier()

# Perform cross-validation
cv_scores = cross_val_score(knn_clf, X_train, y_train.values.ravel(), cv=5)
print("Cross-validation scores:", cv_scores)

knn_clf.fit(X_train, y_train)
```

```
Cross-validation scores: [0.63636364 0.6        0.68518519 0.68518519 0.72222222]
```

```
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\neighbors\_classification.p
y:228: DataConversionWarning: A column-vector y was passed when a 1d array was exp
ected. Please change the shape of y to (n_samples,), for example using ravel().
  return self._fit(X, y)
```

Out[797]:

```
▾ KNeighborsClassifier
KNeighborsClassifier()
```

In [798…

```
# Make predictions
y_pred = knn_clf.predict(X_test)
```

In [799…

```
# Evaluate model performance
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)

# Generate a confusion matrix
conf_matrix = confusion_matrix(y_test, y_pred)
print("Confusion Matrix:\n", conf_matrix)

# Calculate precision, recall, and F1 score
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)

# Print precision, recall, and F1 score
print("Precision:", precision)
print("Recall:", recall)
print("F1 Score:", f1)
```

```
Accuracy: 0.6029411764705882
Confusion Matrix:
 [[30 10]
 [17 11]]
Precision: 0.5238095238095238
Recall: 0.39285714285714285
F1 Score: 0.4489795918367347
```

Naive Bayes

In [800…

```
nb_clf = GaussianNB()

# Perform cross-validation
cv_scores = cross_val_score(nb_clf, X_train, y_train.values.ravel(), cv=5)
print("Cross-validation scores:", cv_scores)

nb_clf.fit(X_train, y_train)
```

```
Cross-validation scores: [0.63636364 0.61818182 0.75925926 0.59259259 0.57407407]
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\utils\validation.py:1184: Da
taConversionWarning: A column-vector y was passed when a 1d array was expected. Pl
ease change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

Out[800]:

```
▾ GaussianNB
GaussianNB()
```

In [801…

```
# Make predictions
y_pred = nb_clf.predict(X_test)
```

In [802…

```
# Evaluate model performance
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)

# Generate a confusion matrix
conf_matrix = confusion_matrix(y_test, y_pred)
print("Confusion Matrix:\n", conf_matrix)

# Calculate precision, recall, and F1 score
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)

# Print precision, recall, and F1 score
print("Precision:", precision)
print("Recall:", recall)
print("F1 Score:", f1)
```

```
Accuracy: 0.6470588235294118
Confusion Matrix:
 [[22 18]
 [ 6 22]]
Precision: 0.55
Recall: 0.7857142857142857
F1 Score: 0.6470588235294117
```

Neural Network

In [803…

```
!
```

In [804…

```
# Import necessary libraries
import numpy as np
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM, Dense, Dropout
from sklearn.metrics import accuracy_score
```

In [805…

```
# Reshape input for RNN (samples, time_steps, features)
# Assuming time_steps = 1 for non-sequential data, you can adjust if your data is s
X_train_rnn = X_train_scaled.reshape(X_train_scaled.shape[0], 1, X_train_scaled.sha
X_test_rnn = X_test_scaled.reshape(X_test_scaled.shape[0], 1, X_test_scaled.shape[1
```

In [806…

```
# Build the RNN model
model = Sequential()
```

In [807…

```
# Add LSTM layer
model.add(LSTM(50, activation='relu', input_shape=(X_train_rnn.shape[1], X_train_rr
```

```
C:\Users\Thinithi\anaconda3\Lib\site-packages\keras\src\layers\rnn\rnn.py:204: Use
rWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using
Sequential models, prefer using an `Input(shape)` object as the first layer in the
model instead.
  super().__init__(**kwargs)
```

In [808…

```
# Add a dropout layer to prevent overfitting
model.add(Dropout(0.2))
```

In [809…

```
# Output layer for binary classification
model.add(Dense(1, activation='sigmoid'))
```

In [810…

```
# Compile the model with optimizer, loss function, and evaluation metric
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy'])
```

In [811…

```
# Train the model with training data
model.fit(X_train_rnn, y_train, epochs=50, batch_size=32, validation_split=0.1, ver
Epoch 1/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 35ms/step - accuracy: 0.5214 - loss: 0.6869 - val_accu
racy: 0.6429 - val_loss: 0.6811
Epoch 2/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6366 - loss: 0.6773 - val_accur
acy: 0.7500 - val_loss: 0.6724
Epoch 3/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - accuracy: 0.6752 - loss: 0.6676 - val_accur
acy: 0.6786 - val_loss: 0.6638
Epoch 4/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - accuracy: 0.6333 - loss: 0.6686 - val_accur
acy: 0.6786 - val_loss: 0.6557
Epoch 5/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6919 - loss: 0.6541 - val_accur
acy: 0.6786 - val_loss: 0.6478
Epoch 6/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - accuracy: 0.7223 - loss: 0.6364 - val_accur
acy: 0.6786 - val_loss: 0.6399
Epoch 7/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6617 - loss: 0.6414 - val_accur
acy: 0.6786 - val_loss: 0.6323
Epoch 8/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6756 - loss: 0.6261 - val_accur
acy: 0.6786 - val_loss: 0.6238
Epoch 9/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6937 - loss: 0.6212 - val_accur
acy: 0.6786 - val_loss: 0.6148
Epoch 10/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - accuracy: 0.6509 - loss: 0.6236 - val_accur
acy: 0.6786 - val_loss: 0.6062
Epoch 11/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6883 - loss: 0.6110 - val_accur
acy: 0.6786 - val_loss: 0.5987
Epoch 12/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6805 - loss: 0.6028 - val_accur
acy: 0.6786 - val_loss: 0.5906
Epoch 13/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.7162 - loss: 0.5747 - val_accur
acy: 0.6786 - val_loss: 0.5837
Epoch 14/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.7225 - loss: 0.5721 - val_accur
acy: 0.6786 - val_loss: 0.5778
Epoch 15/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.7251 - loss: 0.5708 - val_accur
acy: 0.6786 - val_loss: 0.5714
Epoch 16/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.7190 - loss: 0.5558 - val_accur
acy: 0.6786 - val_loss: 0.5671
Epoch 17/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6944 - loss: 0.5686 - val_accur
acy: 0.6786 - val_loss: 0.5624
Epoch 18/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.7176 - loss: 0.5602 - val_accur
acy: 0.6786 - val_loss: 0.5586
Epoch 19/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6664 - loss: 0.5800 - val_accur
acy: 0.6786 - val_loss: 0.5544
Epoch 20/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.7134 - loss: 0.5382 - val_accur
acy: 0.6786 - val_loss: 0.5511
Epoch 21/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6496 - loss: 0.5748 - val_accur
acy: 0.6786 - val_loss: 0.5494
Epoch 22/50
```

```
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.7002 - loss: 0.5290 - val_accur
acy: 0.6786 - val_loss: 0.5469
Epoch 23/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - accuracy: 0.6857 - loss: 0.5493 - val_accur
acy: 0.6429 - val_loss: 0.5446
Epoch 24/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - accuracy: 0.7141 - loss: 0.5369 - val_accur
acy: 0.6429 - val_loss: 0.5442
Epoch 25/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.7192 - loss: 0.5369 - val_accur
acy: 0.6429 - val_loss: 0.5430
Epoch 26/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6812 - loss: 0.5782 - val_accur
acy: 0.6786 - val_loss: 0.5421
Epoch 27/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6729 - loss: 0.5773 - val_accur
acy: 0.6786 - val_loss: 0.5412
Epoch 28/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.7041 - loss: 0.5471 - val_accur
acy: 0.6786 - val_loss: 0.5408
Epoch 29/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6696 - loss: 0.5467 - val_accur
acy: 0.6786 - val_loss: 0.5390
Epoch 30/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.7234 - loss: 0.5178 - val_accur
acy: 0.6786 - val_loss: 0.5387
Epoch 31/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6994 - loss: 0.5397 - val_accur
acy: 0.6786 - val_loss: 0.5373
Epoch 32/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6958 - loss: 0.5714 - val_accur
acy: 0.6786 - val_loss: 0.5366
Epoch 33/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.6801 - loss: 0.5347 - val_accur
acy: 0.6786 - val_loss: 0.5356
Epoch 34/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - accuracy: 0.6789 - loss: 0.5449 - val_accur
acy: 0.6429 - val_loss: 0.5336
Epoch 35/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.7073 - loss: 0.5307 - val_accur
acy: 0.6429 - val_loss: 0.5325
Epoch 36/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6922 - loss: 0.5222 - val_accur
acy: 0.6429 - val_loss: 0.5320
Epoch 37/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - accuracy: 0.7108 - loss: 0.5247 - val_accur
acy: 0.6429 - val_loss: 0.5317
Epoch 38/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.6993 - loss: 0.5306 - val_accur
acy: 0.6429 - val_loss: 0.5317
Epoch 39/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.6940 - loss: 0.5204 - val_accur
acy: 0.6429 - val_loss: 0.5306
Epoch 40/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6607 - loss: 0.5692 - val_accur
acy: 0.6071 - val_loss: 0.5289
Epoch 41/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.7115 - loss: 0.5350 - val_accur
acy: 0.6071 - val_loss: 0.5276
Epoch 42/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 8ms/step - accuracy: 0.6637 - loss: 0.5549 - val_accur
acy: 0.6071 - val_loss: 0.5258
Epoch 43/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.7129 - loss: 0.5223 - val_accur
```

```
acy: 0.6071 - val_loss: 0.5260
Epoch 44/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.7380 - loss: 0.5169 - val_accur
acy: 0.6071 - val_loss: 0.5234
Epoch 45/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6716 - loss: 0.5583 - val_accur
acy: 0.6071 - val_loss: 0.5222
Epoch 46/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.6276 - loss: 0.5647 - val_accur
acy: 0.6071 - val_loss: 0.5207
Epoch 47/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.7199 - loss: 0.4986 - val_accur
acy: 0.6071 - val_loss: 0.5190
Epoch 48/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.7064 - loss: 0.5189 - val_accur
acy: 0.6429 - val_loss: 0.5165
Epoch 49/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 6ms/step - accuracy: 0.6878 - loss: 0.5158 - val_accur
acy: 0.6429 - val_loss: 0.5167
Epoch 50/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 0s 5ms/step - accuracy: 0.6812 - loss: 0.5474 - val_accur
acy: 0.6429 - val_loss: 0.5166
```

Out[811]:

```
<keras.src.callbacks.history.History at 0x2ba51dece90>
```

In [812…

```python
# Make predictions on the test set
y_pred_prob = model.predict(X_test_rnn)
y_pred = (y_pred_prob > 0.5).astype("int32")  # Convert probabilities to 0 or 1
```

```
3/3 ━━━━━━━━━━━━━━━━━━━━ 0s 59ms/step
```

In [813…

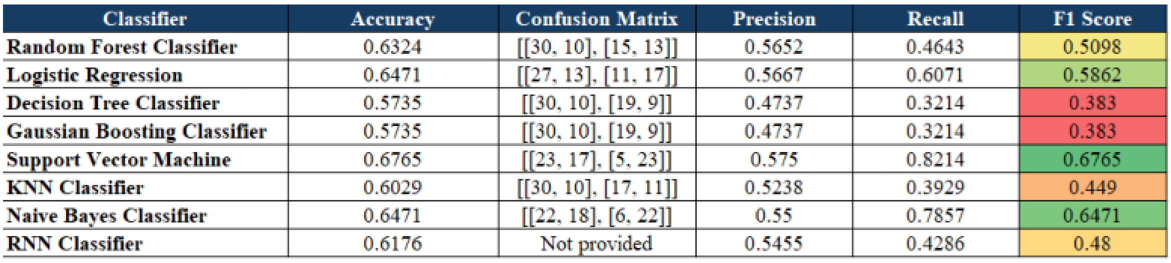
```python
# Calculate accuracy of the model
accuracy = accuracy_score(y_test, y_pred)
print(f"Accuracy: {accuracy}")

# Calculate precision, recall, and F1 score
precision = precision_score(y_test, y_pred)
recall = recall_score(y_test, y_pred)
f1 = f1_score(y_test, y_pred)

# Print precision, recall, and F1 score
print("Precision:", precision)
print("Recall:", recall)
print("F1 Score:", f1)
```

```
Accuracy: 0.6176470588235294
Precision: 0.5454545454545454
Recall: 0.42857142857142855
F1 Score: 0.47999999999999999
```

Model Evaluation

In [817…

```python
# Load the image
img = Image.open("Model Evaluation.png")  # replace with your image path

# Create a larger figure
plt.figure(figsize=(10, 10))

# Display the image
plt.imshow(img)
plt.axis('off')  # Turn off axis labels
plt.show()
```



Classifier	Accuracy	Confusion Matrix	Precision	Recall	F1 Score
Random Forest Classifier	0.6324	[[30, 10], [15, 13]]	0.5652	0.4643	0.5098
Logistic Regression	0.6471	[[27, 13], [11, 17]]	0.5667	0.6071	0.5862
Decision Tree Classifier	0.5735	[[30, 10], [19, 9]]	0.4737	0.3214	0.383
Gaussian Boosting Classifier	0.5735	[[30, 10], [19, 9]]	0.4737	0.3214	0.383
Support Vector Machine	0.6765	[[23, 17], [5, 23]]	0.575	0.8214	0.6765
KNN Classifier	0.6029	[[30, 10], [17, 11]]	0.5238	0.3929	0.449
Naive Bayes Classifier	0.6471	[[22, 18], [6, 22]]	0.55	0.7857	0.6471
RNN Classifier	0.6176	Not provided	0.5455	0.4286	0.48

In [ ]:

```
# Save the model
joblib.dump(svc_clf, 'BB_svm_model.pkl')
```

In [6]:

```
# Load the model
loaded_model = joblib.load('BB_svm_model.pkl')
```

In [7]:

```
X_test = [9,10.7,32.1,0.0,23,4.0,15]

# Reshape it to a 2D array
X_test = np.array(X_test).reshape(1, -1)

# Use the loaded model to make predictions
y_pred = loaded_model.predict(X_test)
print(y_pred)
```

```
[1]
```

```
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\base.py:464: UserWarning: X
does not have valid feature names, but SVC was fitted with feature names
  warnings.warn(
```

In [11]:

```
# Get probability estimates
probabilities = loaded_model.predict_proba(X_test)
print("Probabilities:", probabilities)
print(probabilities[:,1])
```

```
Probabilities: [[0.29005412 0.70994588]]
[0.70994588]
```

```
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\base.py:464: UserWarning: X
does not have valid feature names, but SVC was fitted with feature names
  warnings.warn(
```

In [12]:

```
X_test = [5,9.2,20.7,0.2,61,6.0,61]

# Reshape it to a 2D array
X_test = np.array(X_test).reshape(1, -1)

# Use the loaded model to make predictions
y_pred = loaded_model.predict(X_test)
print(y_pred)
```

```
[0]
```

```
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\base.py:464: UserWarning: X
does not have valid feature names, but SVC was fitted with feature names
  warnings.warn(
```

In [14]:

```
# Get probability estimates
probabilities = loaded_model.predict_proba(X_test)
print("Probabilities:", probabilities)
print(probabilities[:,0])
```

```
Probabilities: [[0.63029646 0.36970354]]
[0.63029646]
```

```
C:\Users\Thinithi\anaconda3\Lib\site-packages\sklearn\base.py:464: UserWarning: X
does not have valid feature names, but SVC was fitted with feature names
  warnings.warn(
```

Hyper Parameter Tuning

In [43]:

```
# Define the parameter grid for tuning
param_grid = {
    'C': [0.1, 1, 10, 100],  # Regularization parameter
    'gamma': ['scale', 'auto', 0.001, 0.01, 0.1],  # Kernel coefficient
    'kernel': ['rbf', 'linear'],  # Types of kernel
    'degree': [2, 3, 4]  # Degree for polynomial kernel
}
```

In [44]:

```
# Initialize the SVC classifier
svc_clf = SVC(class_weight='balanced', probability=True, random_state=0)
```

In [ ]:

```
# Initialize GridSearchCV
grid_search = GridSearchCV(estimator=svc_clf, param_grid=param_grid,
                           scoring='accuracy', cv=5, n_jobs=-1, verbose=1)

# Fit GridSearchCV
grid_search.fit(X_train, y_train.values.ravel())

# Retrieve the best parameters
best_params = grid_search.best_params_
best_score = grid_search.best_score_

print("Best Parameters:", best_params)
print("Best Cross-Validation Score:", best_score)
```

```
Fitting 5 folds for each of 120 candidates, totalling 600 fits
```

In [ ]: