email-spam-detection

November 26, 2023

1 EMAIL SPAM DETECTION

2 Importing Libraries

[506]:

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

from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, confusion_matrix, roc_curve,␣
  ↪roc_auc_score, auc
import nltk
from nltk.corpus import stopwords
from collections import Counter

import warnings
warnings.filterwarnings('ignore')
```

[127]:

```
nltk.download('stopwords')
```

```
[nltk_data] Error loading stopwords: <urlopen error [WinError 10060] A
[nltk_data]     connection attempt failed because the connected party
[nltk_data]     did not properly respond after a period of time, or
[nltk_data]     established connection failed because connected host
[nltk_data]     has failed to respond>
```

[127]:

```
False
```

3 Reading and Describing Data

```
[381]: # Loading the dataset
       df = pd.read_csv("C:\PGA32\MeriSkill\Oasis Infobyte\spam.csv", encoding =␣
        ↪'latin', usecols = ['v1','v2'])
```

```
[382]: df.head(10)
```

```
[382]:      v1                                                 v2
       0   ham  Go until jurong point, crazy.. Available only …
       1   ham                      Ok lar… Joking wif u oni…
       2  spam  Free entry in 2 a wkly comp to win FA Cup fina…
       3   ham  U dun say so early hor… U c already then say…
       4   ham  Nah I don't think he goes to usf, he lives aro…
       5  spam  FreeMsg Hey there darling it's been 3 week's n…
       6   ham  Even my brother is not like to speak with me. …
       7   ham  As per your request 'Melle Melle (Oru Minnamin…
       8  spam  WINNER!! As a valued network customer you have…
       9  spam  Had your mobile 11 months or more? U R entitle…
```

```
[383]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5572 entries, 0 to 5571
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   v1      5572 non-null   object
 1   v2      5572 non-null   object
dtypes: object(2)
memory usage: 87.2+ KB
```

```
[384]: df.shape
```

```
[384]: (5572, 2)
```

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

```
[385]:    count unique                      top  freq
       v1  5572      2                      ham  4825
       v2  5572   5169  Sorry, I'll call later    30
```

```
[386]: df.isnull().sum()
```

```
[386]: v1    0
       v2    0
       dtype: int64
```

[387]:

```
df.columns
```

[387]:

```
Index(['v1', 'v2'], dtype='object')
```

[388]:

```
# Rename the columns "v1 and "v2" to new names
new_column_names = {"v1":"Category","v2":"Message"}
df.rename(columns = new_column_names,inplace = True)
```

[389]:

```
df.head()
```

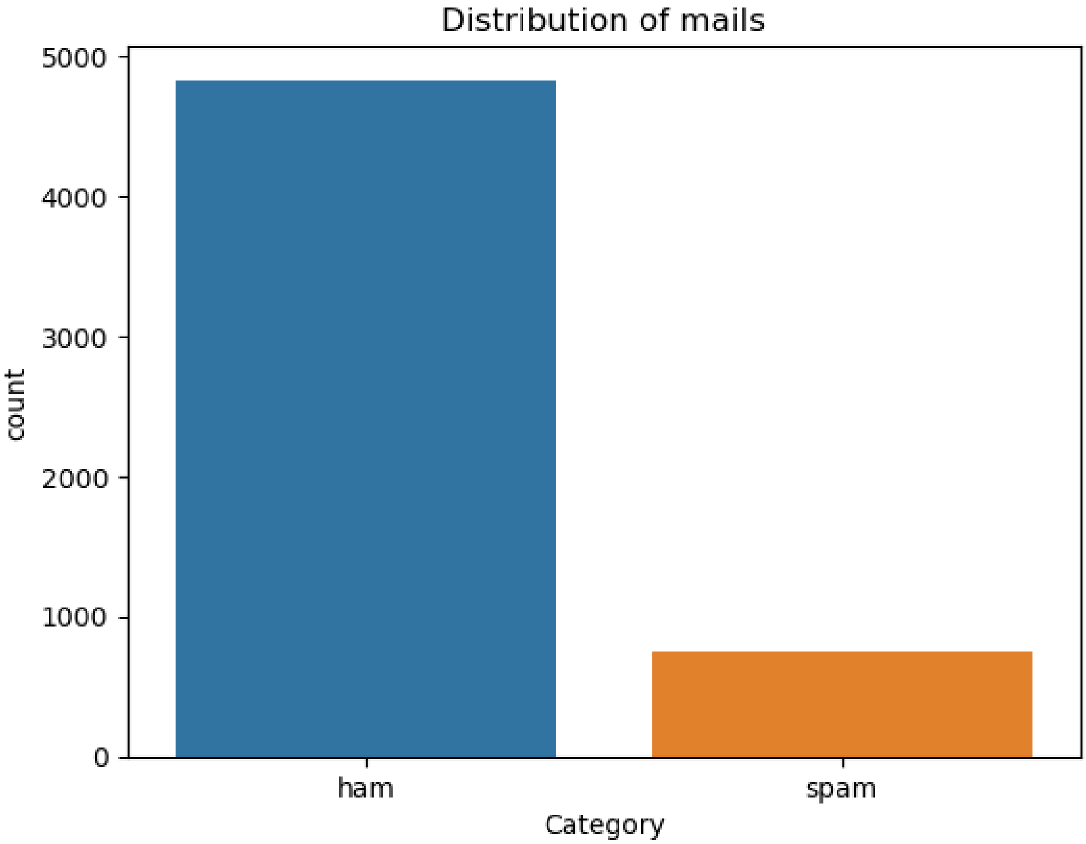
[389]:

```
  Category                                            Message
0      ham  Go until jurong point, crazy.. Available only …
1      ham                      Ok lar… Joking wif u oni…
2     spam  Free entry in 2 a wkly comp to win FA Cup fina…
3      ham  U dun say so early hor… U c already then say…
4      ham  Nah I don't think he goes to usf, he lives aro…
```

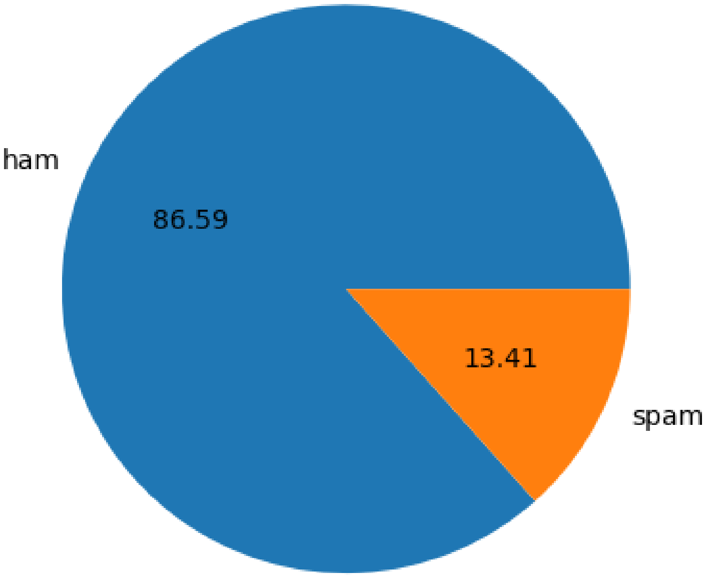
4 Data Visualisation

[390]:

```
sns.countplot(data=df, x='Category')
plt.xlabel('Category')
plt.ylabel('count')
plt.title('Distribution of mails')
plt.show()
```



[391]:
```
plt.pie(df['Category'].value_counts(),labels=['ham','spam'],autopct='%0.2f')
plt.show()
```



5 Data Preprocessing

5.1 Label Encoding

[392]:
```
# encoding "Category" Column
df.replace({'Category':{'spam':0}},inplace=True)

# encoding "Category" Column
df.replace({'Category':{'ham':1}},inplace=True)

df
```

[392]:
```
      Category                                            Message
0            1  Go until jurong point, crazy.. Available only …
1            1                      Ok lar… Joking wif u oni…
2            0  Free entry in 2 a wkly comp to win FA Cup fina…
3            1  U dun say so early hor… U c already then say…
4            1  Nah I don't think he goes to usf, he lives aro…
…        …                                                …
5567         0  This is the 2nd time we have tried 2 contact u…
5568         1              Will Ì_ b going to esplanade fr home?
5569         1  Pity, * was in mood for that. So…any other s…
5570         1  The guy did some bitching but I acted like i'd…
```

```
5571         1                         Rofl. Its true to its name

[5572 rows x 2 columns]
```

5.1.1 Feature Scaling

[393]:

```
# Separate the feature (message) and target (category) data
X = df["Message"]
Y = df["Category"]
```

[394]:

```
X
```

[394]:

```
0       Go until jurong point, crazy.. Available only …
1                           Ok lar… Joking wif u oni…
2       Free entry in 2 a wkly comp to win FA Cup fina…
3       U dun say so early hor… U c already then say…
4       Nah I don't think he goes to usf, he lives aro…
                              …
5567    This is the 2nd time we have tried 2 contact u…
5568                Will Ì_ b going to esplanade fr home?
5569    Pity, * was in mood for that. So…any other s…
5570    The guy did some bitching but I acted like i'd…
5571                               Rofl. Its true to its name
Name: Message, Length: 5572, dtype: object
```

[395]:

```
y
```

[395]:

```
0       1
1       1
2       0
3       1
4       1
       ..
5567    0
5568    1
5569    1
5570    1
5571    1
Name: Category, Length: 5572, dtype: int64
```

[396]:

```
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score, classification_report
```

5.2 Splitting the data into training data and test data

[397]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)
```

6 Feature Extraction

6.1 TF-IDF Vectorizer

[398]:

```
# Initialize the TF-IDF vectorizer
tfidf_vectorizer = TfidfVectorizer(stop_words='english', max_features=5000)
```

[399]:

```
# Fit and transform the training data
X_train_tfidf = tfidf_vectorizer.fit_transform(X_train)
```

[400]:

```
# Transform the test data
X_test_tfidf = tfidf_vectorizer.transform(X_test)
```

7 Model Selection and Training

8 Random Forest Regression Model

[419]:

```
# Initialize a Random Forest classifier
rf_forest = RandomForestClassifier(n_estimators=100)
```

[420]:

```
# Train the classifier on the TF-IDF transformed training data
rf_forest.fit(X_train_tfidf, y_train)
```

[420]:

```
RandomForestClassifier()
```

[421]:

```
# Make predictions on the test set
y_pred = rf_forest.predict(X_test_tfidf)
```

[422]:

```
# Evaluate the model
accuracy = accuracy_score(y_test, y_pred)
report = classification_report(y_test, y_pred)
```

[431]:

```
print(f"Random Forest Accuracy Score: {accuracy:.2f}")

print(f'Confusion Matrix:\n{conf_matrix}')

# print(f'Accuracy: {accuracy}')
print(f'Classification Report:\n{report}')
```

```
Random Forest Accuracy Score: 0.98
Confusion Matrix:
```

```
[[126  24]
 [  1 964]]
Classification Report:
              precision    recall  f1-score   support

           0       0.99      0.84      0.91       150
           1       0.98      1.00      0.99       965

    accuracy                           0.98      1115
   macro avg       0.98      0.92      0.95      1115
weighted avg       0.98      0.98      0.98      1115
```

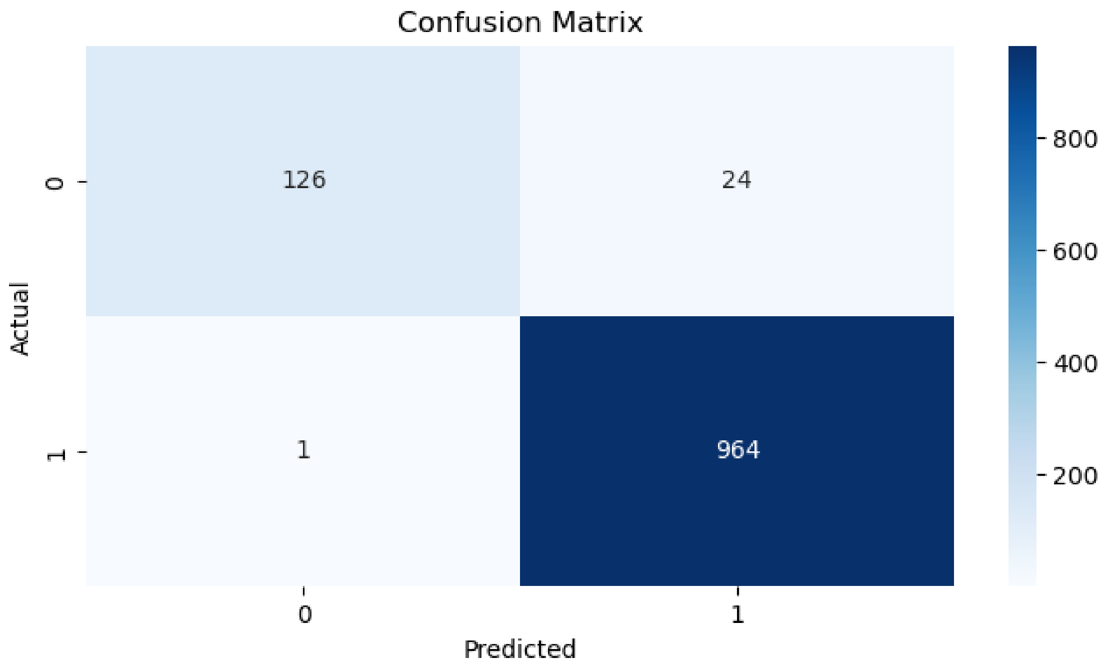
[433]:

```
# #Check the test score and train score to the RandomForestRegressor algorithm
print(f'The Test_accuracy: {rf_forest.score(X_test_tfidf, y_test)*100:.2f}')

#Train score for the data
print(f'The Train_accuracy: {rf_forest.score(X_train_tfidf, y_train)*100:.2f}')
```

```
The Test_accuracy: 97.76
The Train_accuracy: 100.00
```

[425]:

```
cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(8, 4))
sns.heatmap(cm, annot=True, fmt="d", cmap="Blues")
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.title('Confusion Matrix')
plt.show()
```



9 Naive Bayes Regression Model

[426]:
```
from sklearn.naive_bayes import MultinomialNB
```

[436]:
```
# Initialize a classifier (e.g., Naive Bayes)
naive_b = MultinomialNB()
```

[437]:
```
# Train the classifier on the TF-IDF transformed training data
naive_b.fit(X_train_tfidf, y_train)
```

[437]:
```
MultinomialNB()
```

[438]:
```
# Make predictions on the test set
y_preds = naive_b.predict(X_test_tfidf)
```

[439]:
```
# Evaluate the model
accuracy = accuracy_score(y_test, y_preds)
report = classification_report(y_test, y_preds)
```

[440]:
```
print(f"Naive Bayes Accuracy Score: {accuracy:.2f}")
print(f'Confusion Matrix:\n{conf_matrix}')

# print(f'Accuracy: {accuracy}')
print(f'Classification Report:\n{report}')
```

```
Naive Bayes Accuracy Score: 0.97
Confusion Matrix:
[[126  24]
 [  1 964]]
Classification Report:
              precision    recall  f1-score   support

           0       1.00      0.79      0.88       150
           1       0.97      1.00      0.98       965

    accuracy                           0.97      1115
   macro avg       0.98      0.90      0.93      1115
weighted avg       0.97      0.97      0.97      1115
```

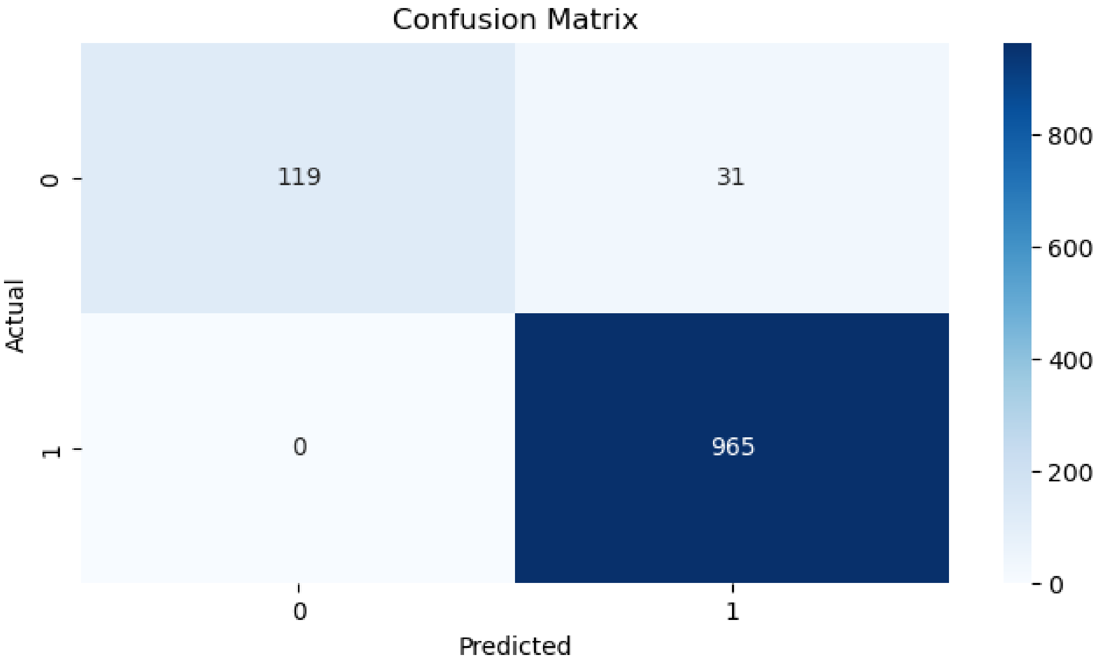
[441]:

```
#Check the test score and train score to the RandomForestRegressor algorithm
print(f'The Test_accuracy: {naive_b.score(X_test_tfidf, y_test)*100:.2f}')

#Train score for the data
print(f'The Train_accuracy: {naive_b.score(X_train_tfidf, y_train)*100:.2f}')
```

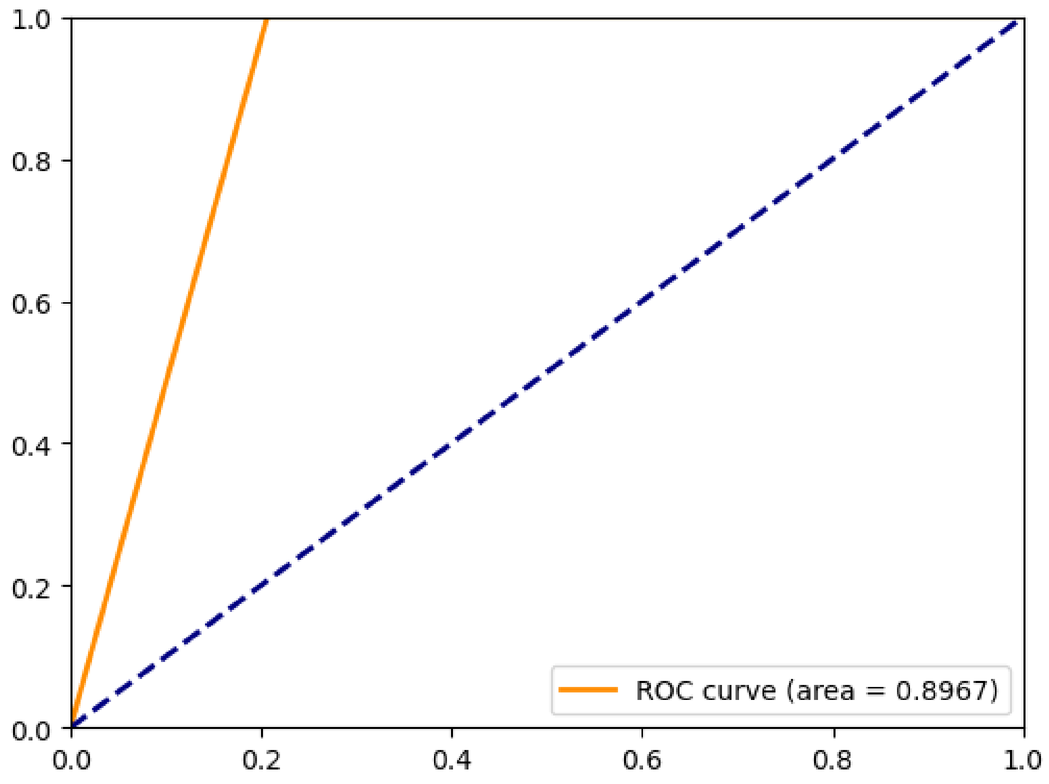
```
The Test_accuracy: 97.22
The Train_accuracy: 98.59
```

[442]:

```
cm = confusion_matrix(y_test, y_preds)
plt.figure(figsize=(8, 4))
sns.heatmap(cm, annot=True, fmt="d", cmap="Blues")
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.title('Confusion Matrix')
plt.show()
```



[505]:
```
fpr, tpr, _ = roc_curve(y_test, y_preds)
mnb_cv_roc_auc = auc(fpr, tpr)

plt.figure()
plt.plot(fpr, tpr, color="darkorange", lw=2, label=f"ROC curve (area =␣
  ↪{mnb_cv_roc_auc :.4f})")
plt.plot([0, 1], [0, 1], color="navy", lw=2, linestyle="--")
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.0])
plt.legend(loc="lower right")
plt.show()
```



10 Logistic Regresion Model

[443]:
```
# Creating and Fit Logistic Regression Model
Log_Reg = LogisticRegression()
Log_Reg.fit(X_train_tfidf, y_train)
```

[443]:
```
LogisticRegression()
```

11 Evaluating the trained model

[450]:
```
# Make predictions on the test set
y_pred_sss = Log_Reg.predict(X_test_tfidf)
```

[451]:
```
# Evaluate the model
accuracy = accuracy_score(y_test, y_pred_sss)
report = classification_report(y_test, y_pred_sss)
```

[452]:
```
print(f"Logistic Regression Accuracy Score: {accuracy:.2f}")

print(f'Confusion Matrix:\n{conf_matrix}')
```

```
# print(f'Accuracy: {accuracy}')
print(f'Classification Report:\n{report}')
```

```
Logistic Regression Accuracy Score: 0.96
Confusion Matrix:
[[126  24]
 [  1 964]]
Classification Report:
              precision    recall  f1-score   support

           0       0.97      0.71      0.82       150
           1       0.96      1.00      0.98       965

    accuracy                           0.96      1115
   macro avg       0.96      0.85      0.90      1115
weighted avg       0.96      0.96      0.95      1115
```

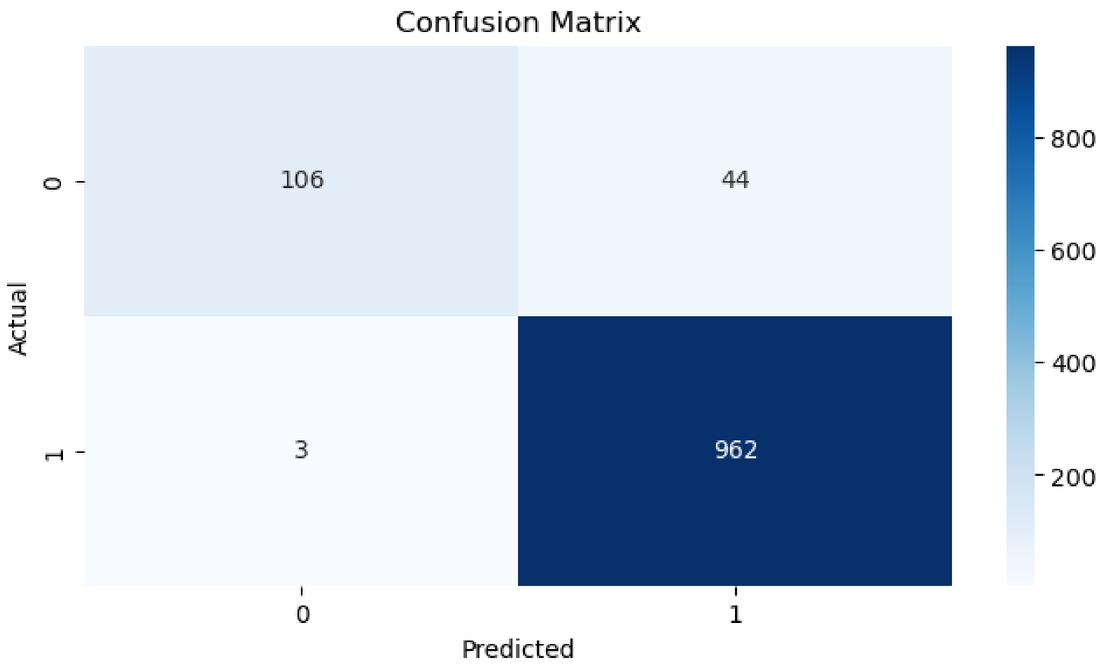
[453]:

```
#Check the test score and train score to the RandomForestRegressor algorithm
print(f'The Test_accuracy: {Log_Reg.score(X_test_tfidf,y_test)*100:.2f}')

#Train score for the data
print(f'The Train_accuracy: {Log_Reg.score(X_train_tfidf, y_train)*100:.2f}')
```

```
The Test_accuracy: 95.78
The Train_accuracy: 97.04
```

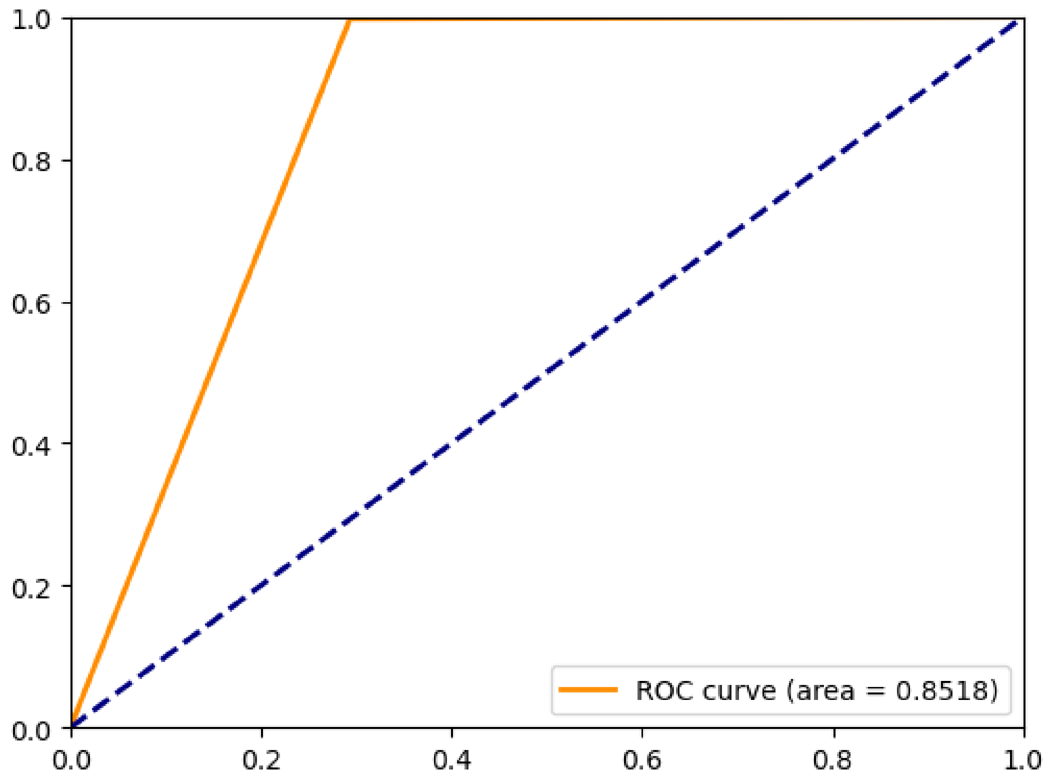
[454]:

```
cm = confusion_matrix(y_test, y_pred_sss)
plt.figure(figsize=(8, 4))
sns.heatmap(cm, annot=True, fmt="d", cmap="Blues")
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.title('Confusion Matrix')
plt.show()
```



[507]:

```
fpr, tpr, _ = roc_curve(y_test, y_pred_sss)
mnb_cv_roc_auc = auc(fpr, tpr)

plt.figure()
plt.plot(fpr, tpr, color="darkorange", lw=2, label=f"ROC curve (area =␣
 ↪{mnb_cv_roc_auc :.4f})")
plt.plot([0, 1], [0, 1], color="navy", lw=2, linestyle="--")
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.0])
plt.legend(loc="lower right")
plt.show()
```



12 Decision Tree Model

[471]:
```
from sklearn.tree import DecisionTreeClassifier
Deci_Tree = DecisionTreeClassifier()
```

[472]:
```
# Train the classifier on the TF-IDF transformed training data
Deci_Tree.fit(X_train_tfidf, y_train)
```

[472]:
```
DecisionTreeClassifier()
```

[473]:
```
# Make predictions on the test set
y_predit_s = Deci_Tree.predict(X_test_tfidf)
```

[474]:
```
# Evaluate the model
accuracy = accuracy_score(y_test, y_predit_s)
report = classification_report(y_test, y_predit_s)
```

[475]:
```
print(f"Logistic Regression Accuracy Score: {accuracy:.2f}")

print(f'Confusion Matrix:\n{conf_matrix}')
# print(f'Accuracy: {accuracy}')
```

```
print(f'Classification Report:\n{report}')
```

```
Logistic Regression Accuracy Score: 0.97
Confusion Matrix:
[[126  24]
 [  1 964]]
Classification Report:
              precision    recall  f1-score   support

           0       0.91      0.85      0.88       150
           1       0.98      0.99      0.98       965

    accuracy                           0.97      1115
   macro avg       0.94      0.92      0.93      1115
weighted avg       0.97      0.97      0.97      1115
```

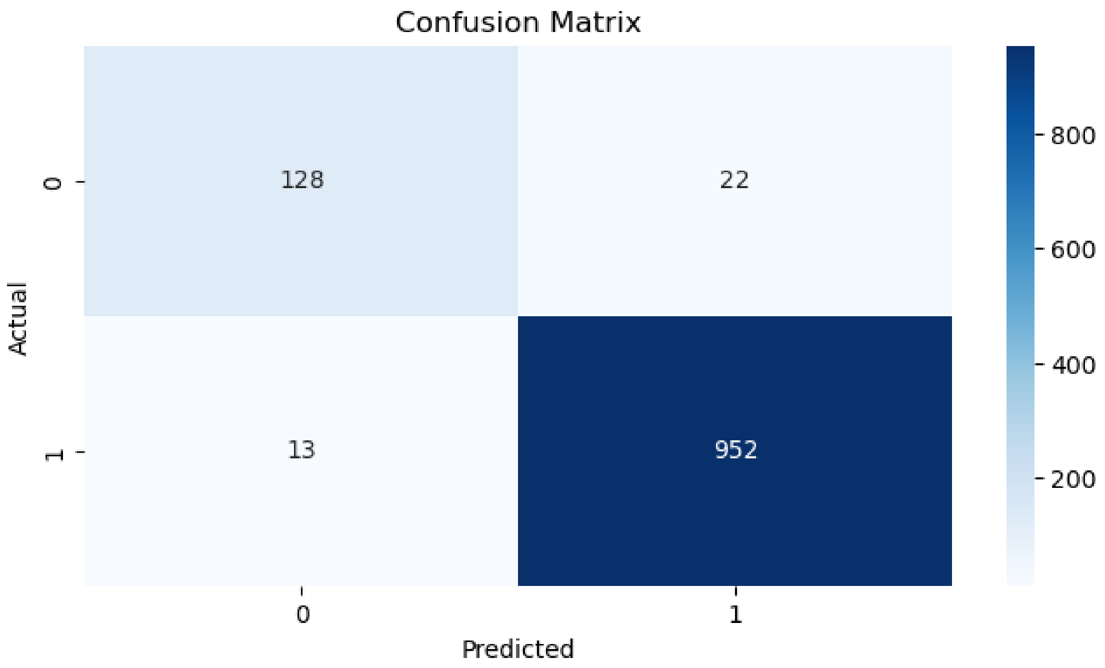
[476]:

```
#Check the test score and train score to the RandomForestRegressor algorithm
print(f'The Test_accuracy: {Deci_Tree.score(X_test_tfidf,y_test)*100:.2f}')

#Train score for the data
print(f'The Train_accuracy: {Deci_Tree.score(X_train_tfidf, y_train)*100:.2f}')
```

```
The Test_accuracy: 96.86
The Train_accuracy: 100.00
```

[478]:

```
cm = confusion_matrix(y_test, y_predit_s)
plt.figure(figsize=(8, 4))
sns.heatmap(cm, annot=True, fmt="d", cmap="Blues")
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.title('Confusion Matrix')
plt.show()
```



13 Support Vector Machine Model

```
[480]: from sklearn.svm import SVC
```

```
[481]: SVM = SVC(kernel='linear', C=1)
```

```
[484]: # Train the classifier on the TF-IDF transformed training data
       SVM.fit(X_train_tfidf, y_train)
```

```
[484]: SVC(C=1, kernel='linear')
```

```
[485]: # Make predictions on the test set
       y_prediitttt = SVM.predict(X_test_tfidf)
```

```
[486]: # Evaluate the model
       accuracy = accuracy_score(y_test, y_prediitttt)
       report = classification_report(y_test, y_prediitttt)
```

```
[487]: print(f"Logistic Regression Accuracy Score: {accuracy:.2f}")

       print(f'Confusion Matrix:\n{conf_matrix}')
       # print(f'Accuracy: {accuracy}')
       print(f'Classification Report:\n{report}')
```

```
Logistic Regression Accuracy Score: 0.98
Confusion Matrix:
[[126  24]
 [  1 964]]
Classification Report:
              precision    recall  f1-score   support

           0       0.97      0.87      0.92       150
           1       0.98      1.00      0.99       965

    accuracy                           0.98      1115
   macro avg       0.98      0.93      0.95      1115
weighted avg       0.98      0.98      0.98      1115
```

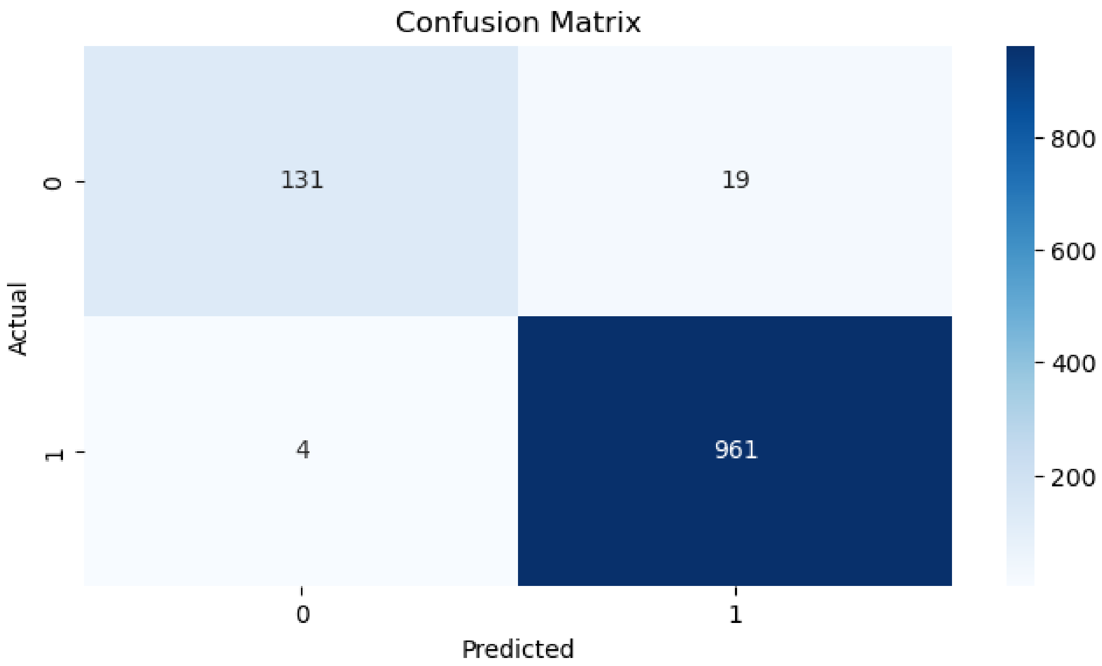
[488]:

```
#Check the test score and train score to the RandomForestRegressor algorithm
print(f'The Test_accuracy: {SVM.score(X_test_tfidf,y_test)*100:.2f}')

#Train score for the data
print(f'The Train_accuracy: {SVM.score(X_train_tfidf, y_train)*100:.2f}')
```

```
The Test_accuracy: 97.94
The Train_accuracy: 99.66
```

[489]:

```
cm = confusion_matrix(y_test, y_prediitttt)
plt.figure(figsize=(8, 4))
sns.heatmap(cm, annot=True, fmt="d", cmap="Blues")
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.title('Confusion Matrix')
plt.show()
```



13.1 Test the model with an email messages

```
[499]: # Assuming you have already trained your model and have the 'model' and␣
        ↪'feature_extraction' objects

       new_mail = ["U dun say so early hor... U c already then say..."]

       # Transform the new email using the same TF-IDF vectorizer
       new_data_features = feature_extraction.transform(new_mail)

       # Make a prediction using the trained model
       prediction = model.predict(new_data_features)

       # Output the prediction
       if prediction[0] == 1:
           print("Ham Mail")
       else:
           print("Spam Mail")
```

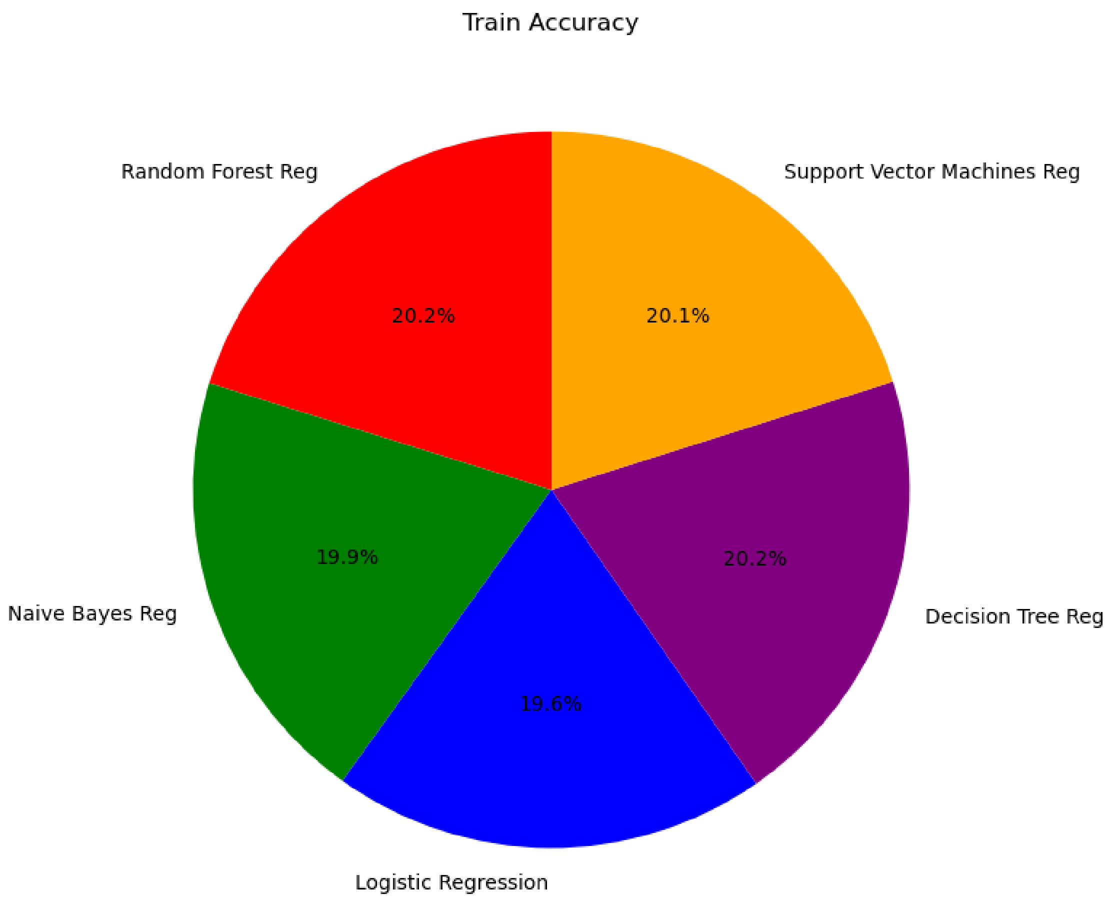
```
Spam Mail
```

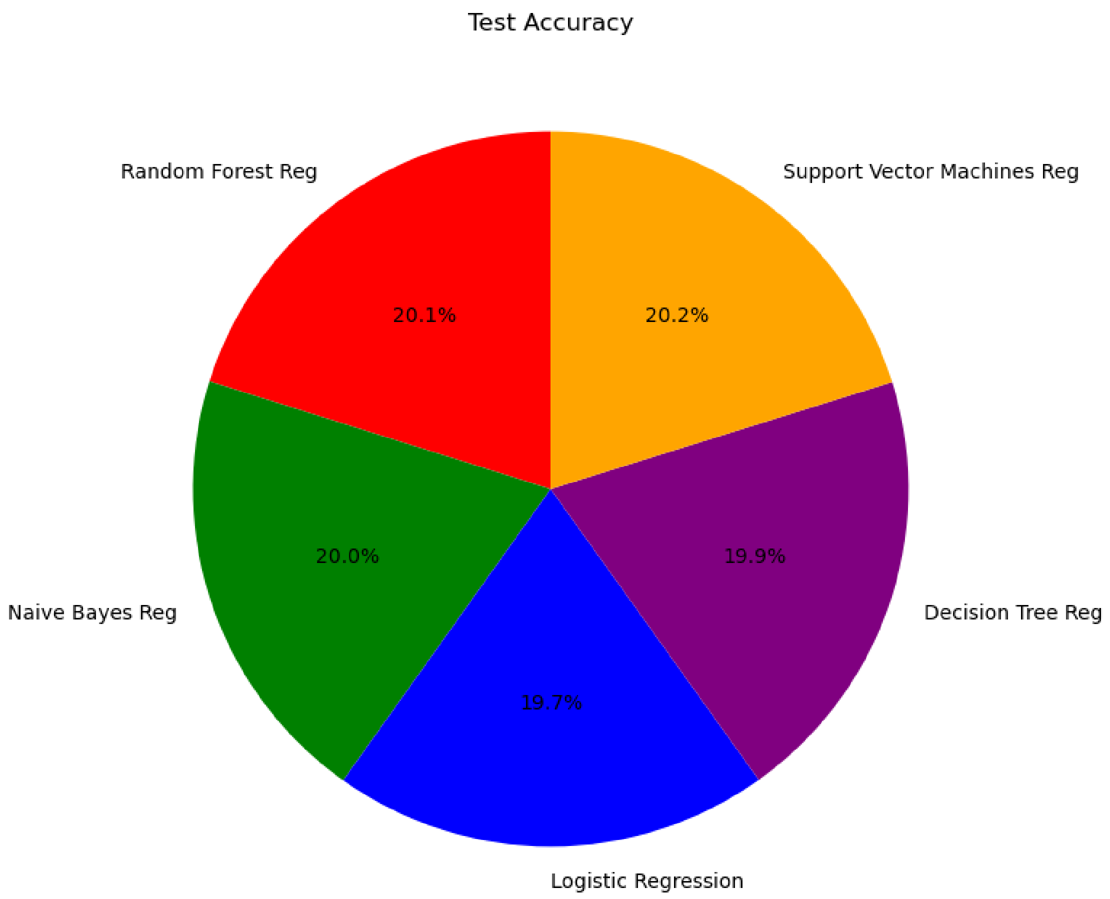
14 Project Report

14.1 All Train, Test Accuracy Reports through visualization

[493]:

```
models = ["Random Forest Reg", "Naive Bayes Reg", "Logistic Regression",␣
 ↪"Decision Tree Reg", "Support Vector Machines Reg"]
train_accuracies = [100.00, 98.59, 97.04, 100.00, 99.66]
test_accuracies = [97.76, 97.22, 95.78, 96.86, 97.94]

# Set the colors for the pie chart
colors = ['red', 'green', 'blue', 'purple', 'orange']

plt.figure(figsize=(8, 8))
plt.pie(train_accuracies, labels=models, autopct='%1.1f%%', colors=colors,␣
 ↪startangle=90)
plt.title("Train Accuracy")
plt.show()

plt.figure(figsize=(8, 8))
plt.pie(test_accuracies, labels=models, autopct='%1.1f%%', colors=colors,␣
 ↪startangle=90)
plt.title("Test Accuracy")
plt.show()
```

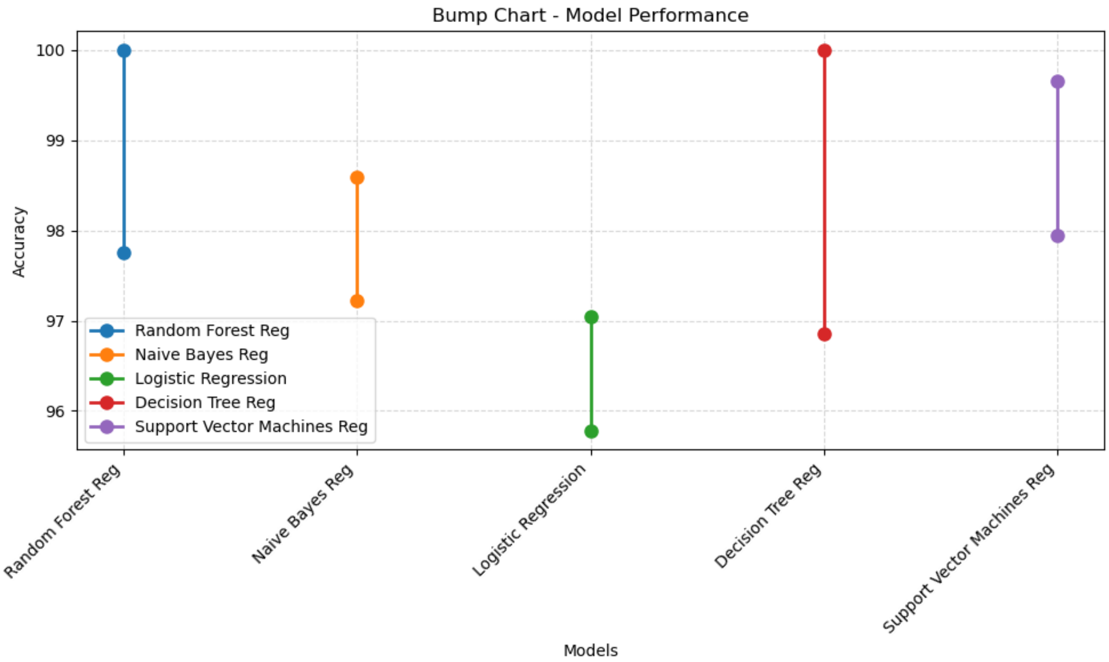

Train Accuracy
Random Forest Reg
20.2%
Support Vector Machines Reg
20.1%
Naive Bayes Reg
19.9%
Decision Tree Reg
20.2%
19.6%
Logistic Regression



[495]:

```
models = ["Random Forest Reg", "Naive Bayes Reg", "Logistic Regression", "Decision Tree Reg", "Support Vector Machines Reg"]
train_accuracies = [100.00, 98.59, 97.04, 100.00, 99.66]
test_accuracies = [97.76, 97.22, 95.78, 96.86, 97.94]

# Set the width of the lines
line_width = 2

# Create an array of equally spaced positions for the lines
x = np.arange(len(models))

plt.figure(figsize=(10, 6))
# Create lines for each model connecting train and test accuracies
for i in range(len(models)):
    plt.plot([x[i], x[i]], [train_accuracies[i], test_accuracies[i]], marker='o', markersize=8, linewidth=line_width, label=models[i])
```

```python
# Set title and labels
plt.title("Bump Chart - Model Performance")
plt.xlabel("Models")
plt.ylabel("Accuracy")
plt.legend()

# Rotate x-axis labels for better readability
plt.xticks(x, models, rotation=45, ha="right")

# Display the plot
plt.tight_layout()
plt.grid(True, linestyle='--', alpha=0.5)
plt.show()
```



15 Thank You For Reading