Depression Detection

July 22, 2024

1 Importing Libraries

```
[29]: !pip install wordcloud
```

```
Defaulting to user installation because normal site-packages is not writeable
Looking in links: /usr/share/pip-wheels
Requirement already satisfied: wordcloud in ./.local/lib/python3.10/site-
packages (1.9.3)
Requirement already satisfied: numpy>=1.6.1 in
/opt/conda/envs/anaconda-2024.02-py310/lib/python3.10/site-packages (from
wordcloud) (1.26.4)
Requirement already satisfied: pillow in
/opt/conda/envs/anaconda-2024.02-py310/lib/python3.10/site-packages (from
wordcloud) (10.2.0)
Requirement already satisfied: matplotlib in
/opt/conda/envs/anaconda-2024.02-py310/lib/python3.10/site-packages (from
wordcloud) (3.8.0)
Requirement already satisfied: contourpy>=1.0.1 in
/opt/conda/envs/anaconda-2024.02-py310/lib/python3.10/site-packages (from
matplotlib->wordcloud) (1.2.0)
Requirement already satisfied: cycler>=0.10 in
/opt/conda/envs/anaconda-2024.02-py310/lib/python3.10/site-packages (from
matplotlib->wordcloud) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in
/opt/conda/envs/anaconda-2024.02-py310/lib/python3.10/site-packages (from
matplotlib->wordcloud) (4.25.0)
Requirement already satisfied: kiwisolver>=1.0.1 in
/opt/conda/envs/anaconda-2024.02-py310/lib/python3.10/site-packages (from
matplotlib->wordcloud) (1.4.4)
Requirement already satisfied: packaging>=20.0 in
/opt/conda/envs/anaconda-2024.02-py310/lib/python3.10/site-packages (from
matplotlib->wordcloud) (23.2)
Requirement already satisfied: pyparsing>=2.3.1 in
/opt/conda/envs/anaconda-2024.02-py310/lib/python3.10/site-packages (from
matplotlib->wordcloud) (3.0.9)
Requirement already satisfied: python-dateutil>=2.7 in
/opt/conda/envs/anaconda-2024.02-py310/lib/python3.10/site-packages (from
matplotlib->wordcloud) (2.8.2)
```

```
Requirement already satisfied: six>=1.5 in
/opt/conda/envs/anaconda-2024.02-py310/lib/python3.10/site-packages (from
python-dateutil>=2.7->matplotlib->wordcloud) (1.16.0)
```

[30]:
```
import pandas as pd
from wordcloud import WordCloud
import matplotlib.pyplot as plt
import seaborn as sns
import re
import nltk
from nltk.corpus import stopwords
from nltk.stem import WordNetLemmatizer
from nltk.tokenize import word_tokenize
```

2 Loading dataset

[31]:
```
df= pd.read_csv('sentiment_tweets3.csv')
```

[32]:
```
df.head()
```

[32]:
```
   Index                               message to examine  \
0    106  just had a real good moment. i missssssssss hi…
1    217         is reading manga  http://plurk.com/p/mzp1e
2    220  @comeagainjen http://twitpic.com/2y2lx - http:…
3    288  @lapcat Need to send 'em to my accountant tomo…
4    540      ADD ME ON MYSPACE!!!  myspace.com/LookThunder

   label (depression result)
0                          0
1                          0
2                          0
3                          0
4                          0
```

[33]:
```
df.tail()
```

[33]:
```
        Index                               message to examine  \
10309  802309  No Depression by G Herbo is my mood from now o…
10310  802310  What do you do when depression succumbs the br…
10311  802311  Ketamine Nasal Spray Shows Promise Against Dep…
10312  802312  dont mistake a bad day with depression! everyo…
10313  802313                                                0

       label (depression result)
10309                          1
10310                          1
```

```
10311                          1
10312                          1
10313                          1
```

[34]:
```
df.shape
```

[34]:
```
(10314, 3)
```

[35]:
```
df.dtypes
```

[35]:
```
Index                           int64
message to examine             object
label (depression result)       int64
dtype: object
```

[36]:
```
df.describe
```

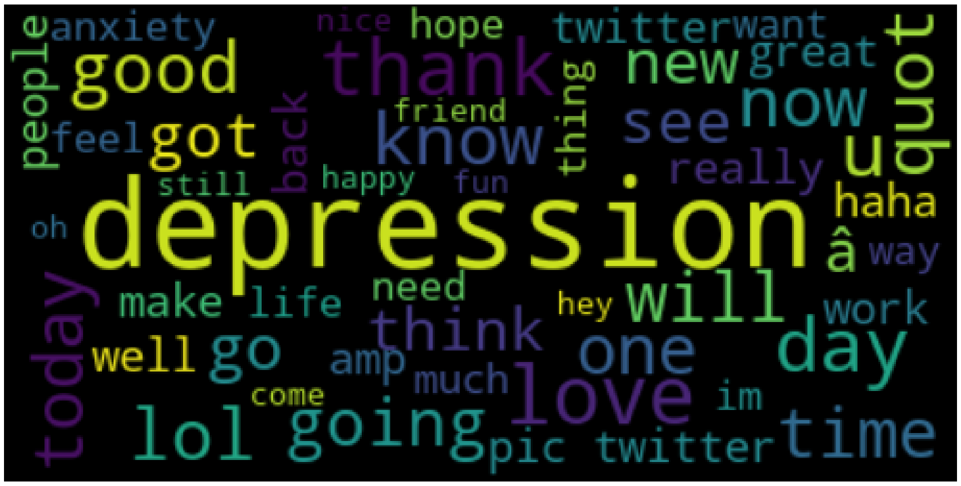
[36]:
```
<bound method NDFrame.describe of          Index
message to examine  \
0          106  just had a real good moment. i missssssssss hi…
1          217         is reading manga  http://plurk.com/p/mzp1e
2          220  @comeagainjen http://twitpic.com/2y2lx - http:…
3          288  @lapcat Need to send 'em to my accountant tomo…
4          540      ADD ME ON MYSPACE!!!  myspace.com/LookThunder
…        …                                                   …
10309  802309  No Depression by G Herbo is my mood from now o…
10310  802310  What do you do when depression succumbs the br…
10311  802311  Ketamine Nasal Spray Shows Promise Against Dep…
10312  802312  dont mistake a bad day with depression! everyo…
10313  802313                                                 0

       label (depression result)
0                              0
1                              0
2                              0
3                              0
4                              0
…                          …
10309                          1
10310                          1
10311                          1
10312                          1
10313                          1

[10314 rows x 3 columns]>
```

2.1 Dropping index

[37]:
```
df.drop('Index', axis=1, inplace = True)
```

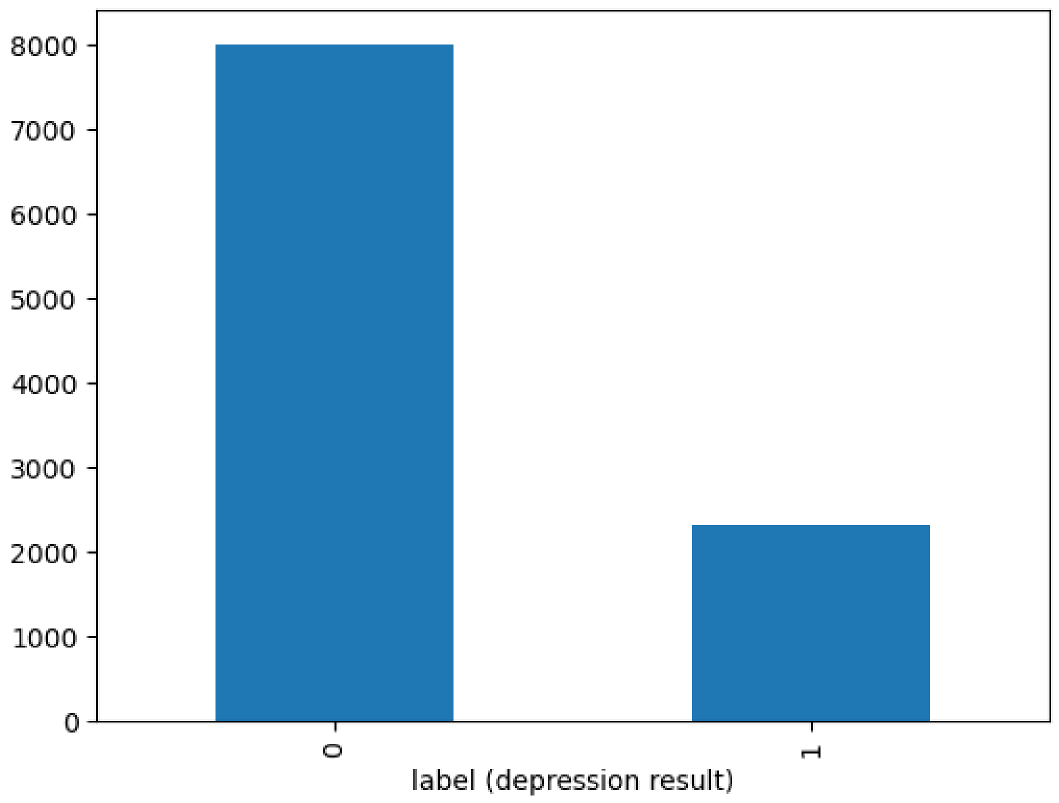
2.2 Generating wordcloud

[38]:
```
text = ' '.join(df['message to examine'])
wordcloud = WordCloud(max_words=50).generate(text)

plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



[39]:
```
df.groupby('label (depression result)').size().plot(kind='bar')
```

[39]:
```
<Axes: xlabel='label (depression result)'>
```



[40]:
```
# For first 10 rows

for i in range(10):
    print(df['message to examine'][i], "\n")
```

```
just had a real good moment. i missssssssss him so much,

is reading manga  http://plurk.com/p/mzp1e

@comeagainjen http://twitpic.com/2y2lx -
http://www.youtube.com/watch?v=zoGfqvh2ME8

@lapcat Need to send 'em to my accountant tomorrow. Oddly, I wasn't even
referring to my taxes. Those are supporting evidence, though.

ADD ME ON MYSPACE!!!  myspace.com/LookThunder

so sleepy. good times tonight though

@SilkCharm re: #nbn as someone already said, does fiber to the home mean we will
all at least be regular now
```

```
23 or 24ï¿½C possible today. Nice

nite twitterville  workout in the am  -ciao

@daNanner Night, darlin'!  Sweet dreams to you
```

2.3 Normalizing text

```
[41]:  df['clean_message'] = df['message to examine'].apply(lambda x: re.
        ↪sub(r'[^a-zA-Z0-9]+', ' ', x))
      df['clean_message'] = df['message to examine'].apply(lambda x: re.
        ↪sub(r'http\S+', ' ', x))

      df.head()
```

```
[41]:                                   message to examine  \
     0  just had a real good moment. i missssssssss hi…
     1         is reading manga  http://plurk.com/p/mzp1e
     2  @comeagainjen http://twitpic.com/2y2lx - http:…
     3  @lapcat Need to send 'em to my accountant tomo…
     4      ADD ME ON MYSPACE!!!  myspace.com/LookThunder

        label (depression result)  \
     0                          0
     1                          0
     2                          0
     3                          0
     4                          0

                                             clean_message
     0  just had a real good moment. i missssssssss hi…
     1                                 is reading manga
     2                               @comeagainjen   -
     3  @lapcat Need to send 'em to my accountant tomo…
     4      ADD ME ON MYSPACE!!!  myspace.com/LookThunder
```

2.4 Removing stopwords

```
[42]: import nltk
      nltk.download('stopwords')
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]     /home/e8e42a42-e1e1-4631-a378-
[nltk_data]     6aaf03fe59ed/nltk_data…
[nltk_data]   Package stopwords is already up-to-date!
```

```
[42]: True
```

```
[43]: stop_words = set(stopwords.words('english'))
      df['clean_message'] = df['clean_message'].apply(lambda x: ' '.join([word for␣
       ↪word in x.split() if word not in (stop_words)]))
```

```
[44]: df.head()
```

```
[44]:                                   message to examine  \
      0  just had a real good moment. i missssssssss hi…
      1         is reading manga  http://plurk.com/p/mzp1e
      2  @comeagainjen http://twitpic.com/2y2lx - http:…
      3  @lapcat Need to send 'em to my accountant tomo…
      4      ADD ME ON MYSPACE!!!  myspace.com/LookThunder

         label (depression result)  \
      0                          0
      1                          0
      2                          0
      3                          0
      4                          0

                                             clean_message
      0               real good moment. missssssssss much,
      1                                      reading manga
      2                                    @comeagainjen -
      3  @lapcat Need send 'em accountant tomorrow. Odd…
      4       ADD ME ON MYSPACE!!! myspace.com/LookThunder
```

```
[25]: df['clean_message'] = df['clean_message'].str.lower()
      df.head()
```

```
[25]:                                   message to examine  \
      0  just had a real good moment. i missssssssss hi…
      1         is reading manga  http://plurk.com/p/mzp1e
      2  @comeagainjen http://twitpic.com/2y2lx - http:…
      3  @lapcat Need to send 'em to my accountant tomo…
      4      ADD ME ON MYSPACE!!!  myspace.com/LookThunder

         label (depression result)  \
      0                          0
      1                          0
      2                          0
      3                          0
      4                          0

                                             clean_message
```

```
0                real good moment. missssssssss much,
1                                       reading manga
2                                     @comeagainjen -
3  @lapcat need send 'em accountant tomorrow. odd…
4       add me on myspace!!! myspace.com/lookthunder
```

2.5 Tokenizing words

[46]:
```python
import nltk
nltk.download('punkt')
```

```
[nltk_data] Downloading package punkt to
[nltk_data]     /home/e8e42a42-e1e1-4631-a378-
[nltk_data]     6aaf03fe59ed/nltk_data…
[nltk_data]   Unzipping tokenizers/punkt.zip.
```

[46]:
```
True
```

[47]:
```python
df['tokenized_clean_message'] = df['clean_message'].apply(word_tokenize)
df.head()
```

[47]:
```
                                    message to examine  \
0  just had a real good moment. i missssssssss hi…
1         is reading manga  http://plurk.com/p/mzp1e
2  @comeagainjen http://twitpic.com/2y2lx - http:…
3  @lapcat Need to send 'em to my accountant tomo…
4      ADD ME ON MYSPACE!!!  myspace.com/LookThunder

   label (depression result)  \
0                          0
1                          0
2                          0
3                          0
4                          0

                                         clean_message  \
0                real good moment. missssssssss much,
1                                       reading manga
2                                     @comeagainjen -
3  @lapcat Need send 'em accountant tomorrow. Odd…
4       ADD ME ON MYSPACE!!! myspace.com/LookThunder

                              tokenized_clean_message
0     [real, good, moment, ., missssssssss, much, ,]
1                                    [reading, manga]
2                                [@, comeagainjen, -]
3  [@, lapcat, Need, send, 'em, accountant, tomor…
```

```
4  [ADD, ME, ON, MYSPACE, !, !, !, myspace.com/Lo…
```

2.6 Lemmatizing words

```
[50]: import nltk
      nltk.download('wordnet')
```

```
[nltk_data] Downloading package wordnet to
[nltk_data]     /home/e8e42a42-e1e1-4631-a378-
[nltk_data]     6aaf03fe59ed/nltk_data…
```

```
[50]: True
```

```
[51]: lemmatizer = WordNetLemmatizer()

      df['lemmatized_tokenized_clean_message'] = df['tokenized_clean_message'].
       ↪apply(lambda x: [lemmatizer.lemmatize(word) for word in x])

      df.head()
```

```
[51]:                                       message to examine  \
      0  just had a real good moment. i missssssssss hi…
      1         is reading manga  http://plurk.com/p/mzp1e
      2  @comeagainjen http://twitpic.com/2y2lx - http:…
      3  @lapcat Need to send 'em to my accountant tomo…
      4      ADD ME ON MYSPACE!!!  myspace.com/LookThunder

         label (depression result)  \
      0                          0
      1                          0
      2                          0
      3                          0
      4                          0


                                           clean_message  \
      0             real good moment. missssssssss much,
      1                                    reading manga
      2                                  @comeagainjen -
      3  @lapcat Need send 'em accountant tomorrow. Odd…
      4      ADD ME ON MYSPACE!!! myspace.com/LookThunder

                                 tokenized_clean_message  \
      0     [real, good, moment, ., missssssssss, much, ,]
      1                                  [reading, manga]
      2                              [@, comeagainjen, -]
      3  [@, lapcat, Need, send, 'em, accountant, tomor…
      4  [ADD, ME, ON, MYSPACE, !, !, !, myspace.com/Lo…
```

```
                   lemmatized_tokenized_clean_message
0               [real, good, moment, ., miss, much, ,]
1                                    [reading, manga]
2                                [@, comeagainjen, -]
3  [@, lapcat, Need, send, 'em, accountant, tomor…
4  [ADD, ME, ON, MYSPACE, !, !, !, myspace.com/Lo…
```

```
[52]: df['lemmatized_text'] = df['lemmatized_tokenized_clean_message'].apply(lambda x:
       ↪ ' '.join(x))
      df.head()
```

```
[52]:                                  message to examine  \
0  just had a real good moment. i missssssssss hi…
1         is reading manga  http://plurk.com/p/mzp1e
2  @comeagainjen http://twitpic.com/2y2lx - http:…
3  @lapcat Need to send 'em to my accountant tomo…
4      ADD ME ON MYSPACE!!!  myspace.com/LookThunder

   label (depression result)  \
0                          0
1                          0
2                          0
3                          0
4                          0

                                     clean_message  \
0                 real good moment. missssssssss much,
1                                     reading manga
2                                   @comeagainjen -
3  @lapcat Need send 'em accountant tomorrow. Odd…
4       ADD ME ON MYSPACE!!! myspace.com/LookThunder

                           tokenized_clean_message  \
0     [real, good, moment, ., missssssssss, much, ,]
1                                    [reading, manga]
2                                [@, comeagainjen, -]
3  [@, lapcat, Need, send, 'em, accountant, tomor…
4  [ADD, ME, ON, MYSPACE, !, !, !, myspace.com/Lo…

                lemmatized_tokenized_clean_message  \
0               [real, good, moment, ., miss, much, ,]
1                                    [reading, manga]
2                                [@, comeagainjen, -]
3  [@, lapcat, Need, send, 'em, accountant, tomor…
4  [ADD, ME, ON, MYSPACE, !, !, !, myspace.com/Lo…
```

```
                                    lemmatized_text
0                      real good moment . miss much ,
1                                     reading manga
2                                  @ comeagainjen -
3  @ lapcat Need send 'em accountant tomorrow . O…
4    ADD ME ON MYSPACE ! ! ! myspace.com/LookThunder
```

2.7 Importing Libraries for Machine Learning Algorithms

[71]:
```python
from sklearn.feature_extraction.text import TfidfVectorizer

from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import MultinomialNB, GaussianNB, BernoulliNB
from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import SVC
from sklearn.metrics import precision_score, recall_score, f1_score,␣
 ↪roc_auc_score, roc_curve, auc
from sklearn.model_selection import train_test_split
from sklearn.pipeline import Pipeline

from sklearn.metrics import accuracy_score, confusion_matrix
```

2.8 Train-Test Splitting

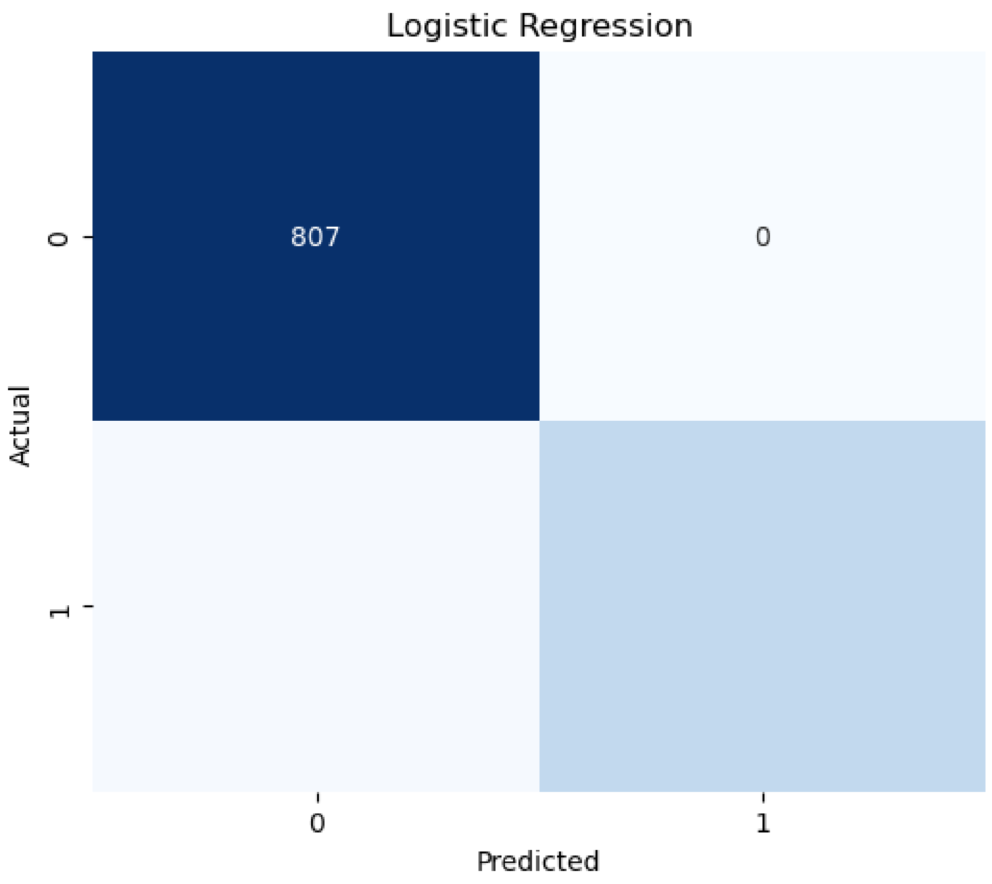
[55]:
```python
X = df["lemmatized_text"]
y = df["label (depression result)"]

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.10,␣
 ↪random_state=42)

tfidf = TfidfVectorizer()
logistic_regression = LogisticRegression()
naive_bayes = MultinomialNB()
decision_tree = DecisionTreeClassifier()
support_vector_machine = SVC()
```

2.9 Logistic Regression

[56]:
```python
lr = Pipeline([("tfidf", tfidf), ("logistic_regression", logistic_regression)])
lr.fit(X_train, y_train)
y_pred_lr = lr.predict(X_test)
accuracylr = accuracy_score(y_test, y_pred_lr)
print("Logistic Regression Accuracy:", accuracylr)
```

```
Logistic Regression Accuracy: 0.9893410852713178
```

[67]:
```
cm_lr = confusion_matrix(y_test, y_pred_lr)

def plot_confusion_matrix(cm, title):
    plt.figure(figsize=(6, 5))
    sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', cbar=False)
    plt.title(title)
    plt.xlabel('Predicted')
    plt.ylabel('Actual')
    plt.show()

# Plot the confusion matrix for Logistic Regression
plot_confusion_matrix(cm_lr, 'Logistic Regression')
```



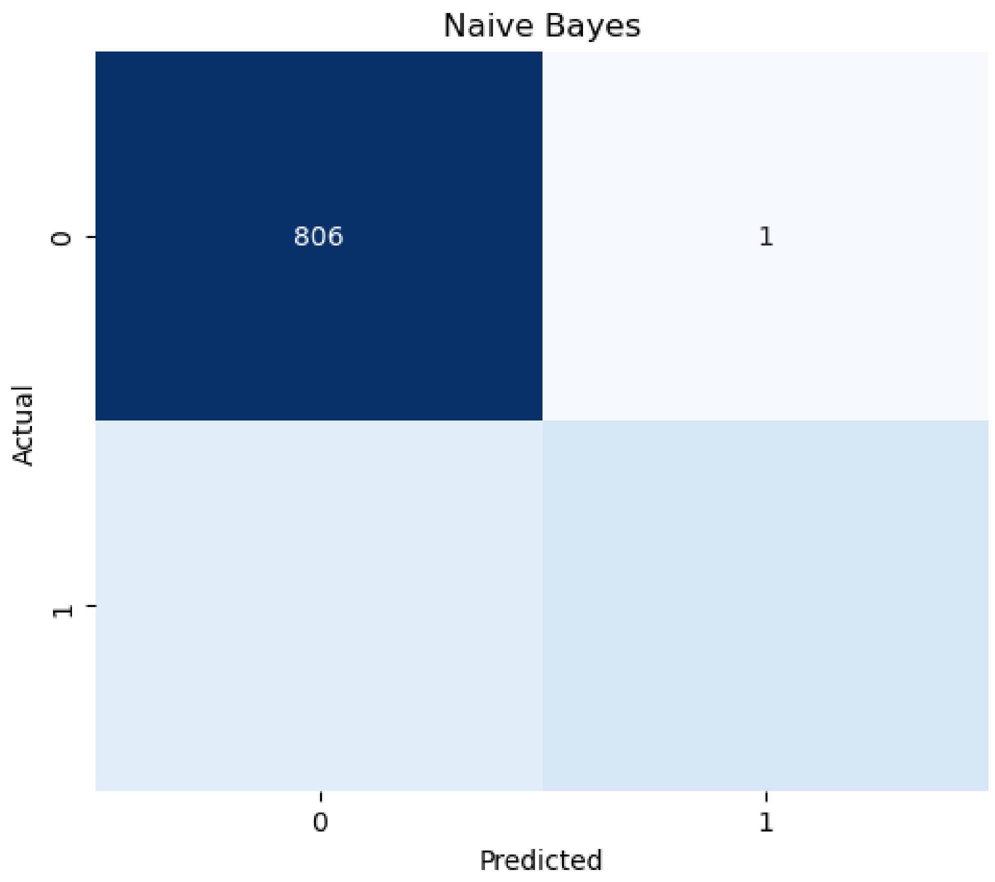
2.10 Naive Bayes

[57]:
```
nb = Pipeline([("tfidf", tfidf), ("naive_bayes", naive_bayes)])
nb.fit(X_train, y_train)
y_pred_nb = nb.predict(X_test)
accuracynb = accuracy_score(y_test, y_pred_nb)
```

```
print("Naive Bayes Accuracy:", accuracynb)
```

```
Naive Bayes Accuracy: 0.9098837209302325
```

```
[68]: cm_nb = confusion_matrix(y_test, y_pred_nb)
      def plot_confusion_matrix(cm, title):
          plt.figure(figsize=(6, 5))
          sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', cbar=False)
          plt.title(title)
          plt.xlabel('Predicted')
          plt.ylabel('Actual')
          plt.show()
      plot_confusion_matrix(cm_nb, 'Naive Bayes')
```

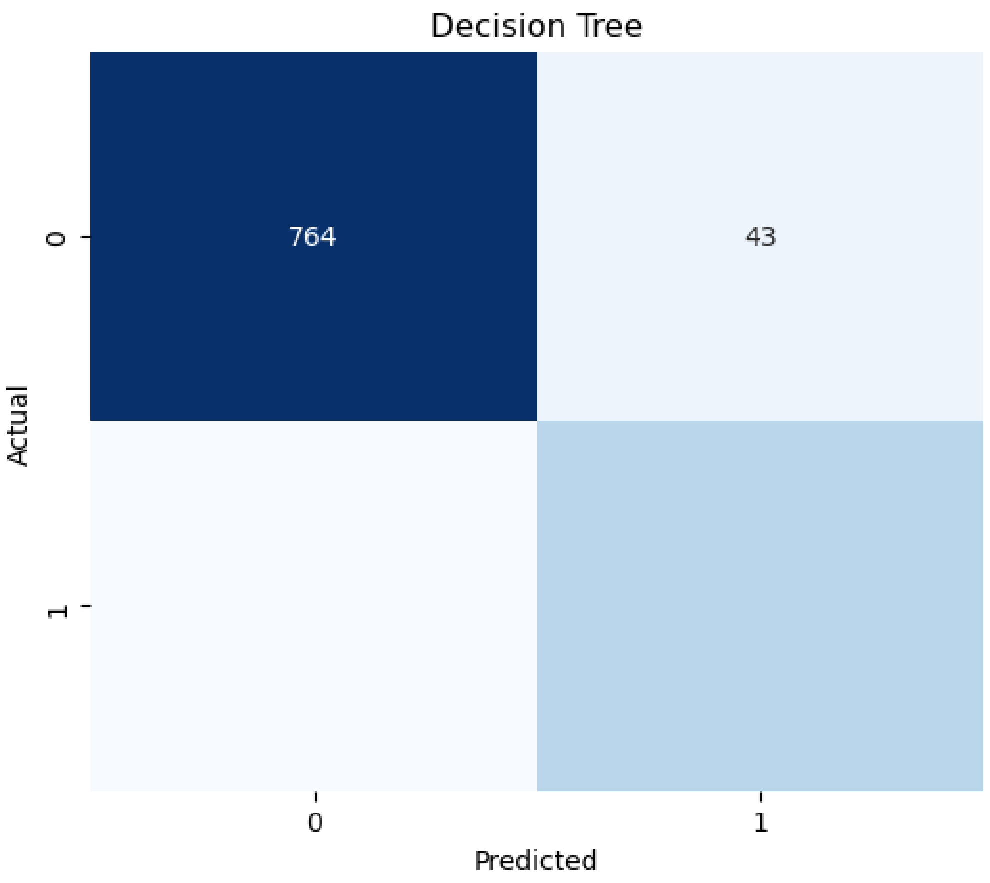


2.11 Decision Tree

[58]:
```
dt = Pipeline([("tfidf", tfidf), ("decision_tree", decision_tree)])
dt.fit(X_train, y_train)
y_pred_dt = dt.predict(X_test)
accuracydt = accuracy_score(y_test, y_pred_dt)
print("Decision Tree Accuracy:", accuracydt)
```

```
Decision Tree Accuracy: 0.9563953488372093
```

[69]:
```
cm_dt = confusion_matrix(y_test, y_pred_dt)
def plot_confusion_matrix(cm, title):
    plt.figure(figsize=(6, 5))
    sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', cbar=False)
    plt.title(title)
    plt.xlabel('Predicted')
    plt.ylabel('Actual')
    plt.show()
plot_confusion_matrix(cm_dt, 'Decision Tree')
```

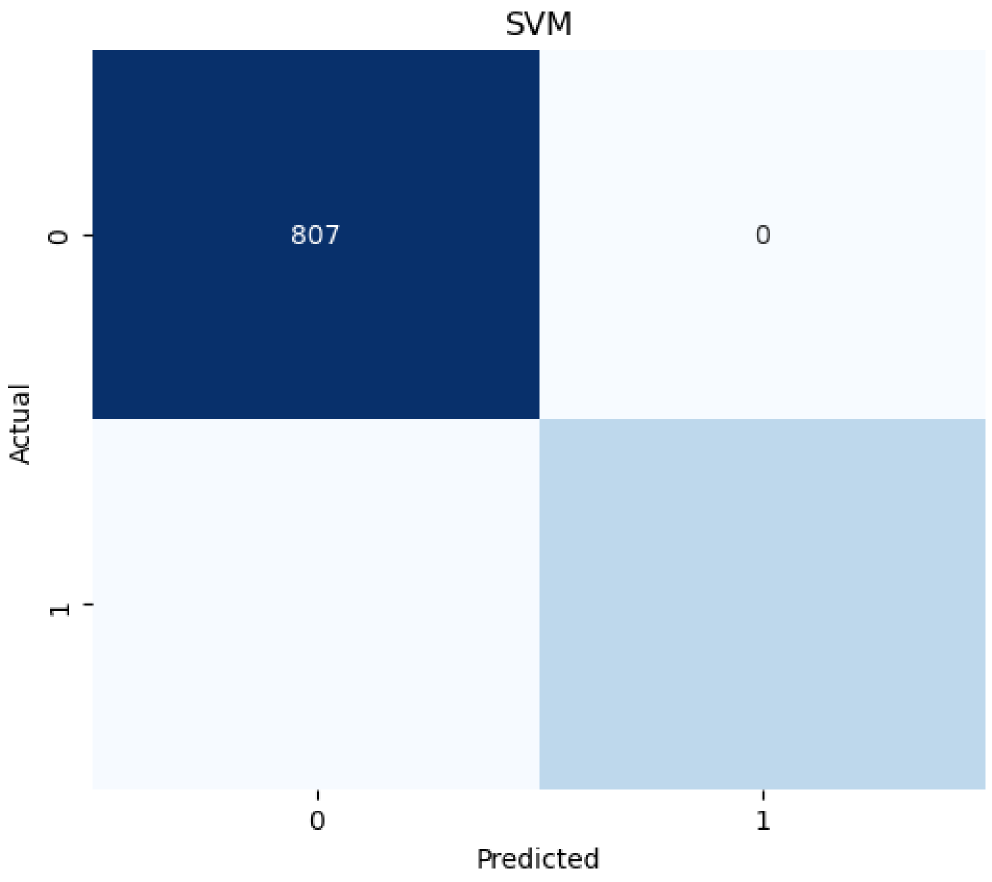


2.12 Support Vector Machine

[60]:
```
svm = Pipeline([("tfidf", tfidf), ("support_vector_machine",␣
 ↪support_vector_machine)])
svm.fit(X_train, y_train)
y_pred_svm = svm.predict(X_test)
accuracysvm = accuracy_score(y_test, y_pred_svm)
print("SVM Accuracy:", accuracysvm)
```

```
SVM Accuracy: 0.9961240310077519
```

[70]:
```
cm_svm = confusion_matrix(y_test, y_pred_svm)
def plot_confusion_matrix(cm, title):
    plt.figure(figsize=(6, 5))
    sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', cbar=False)
    plt.title(title)
    plt.xlabel('Predicted')
    plt.ylabel('Actual')
    plt.show()
plot_confusion_matrix(cm_svm, 'SVM')
```



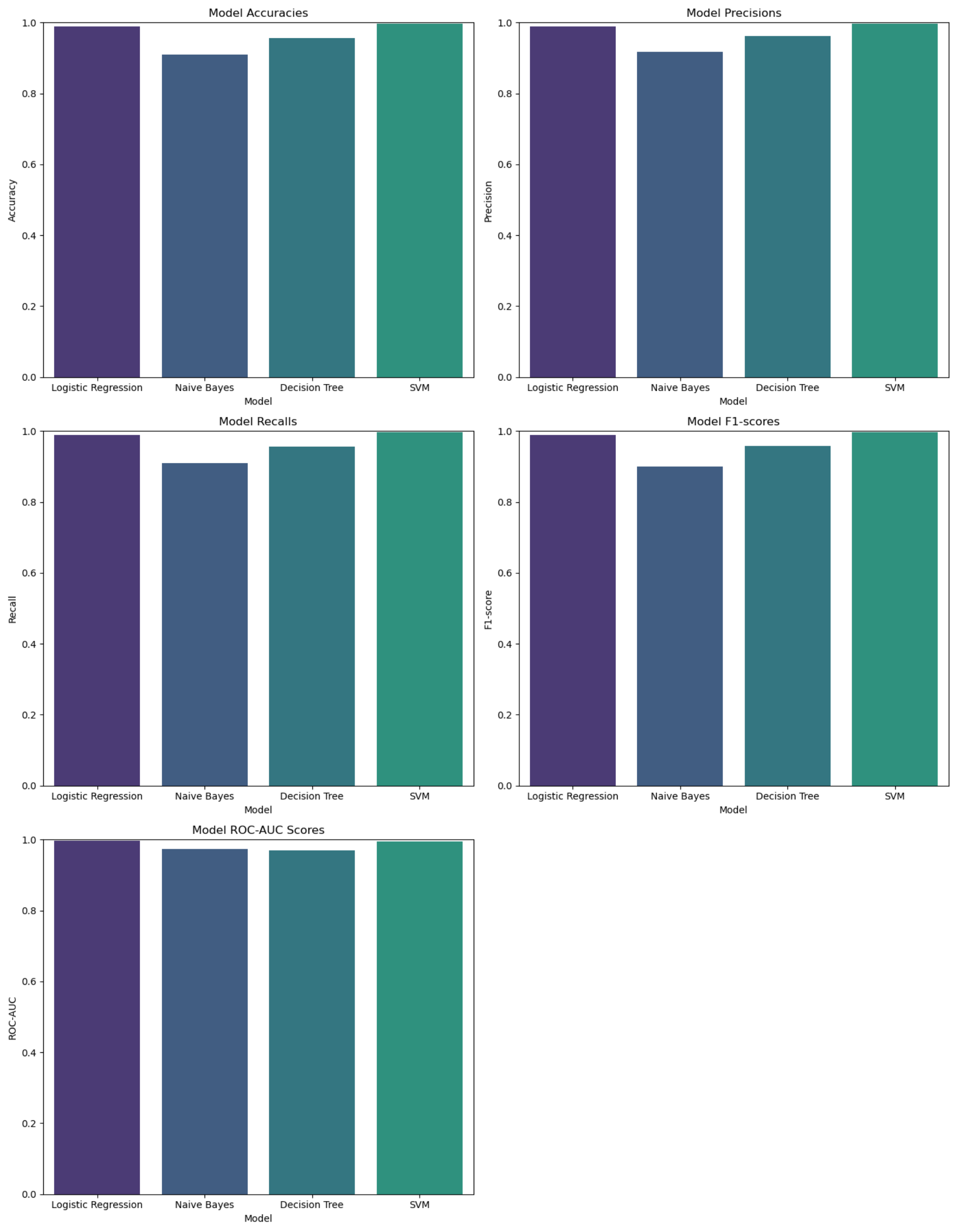
```
[72]: models = ["Logistic Regression", "Naive Bayes", "Decision Tree", "SVM"]
accuracies = []
precisions = []
recalls = []
f1_scores = []
roc_aucs = []

for model, y_pred in zip([lr, nb, dt, svm], [y_pred_lr, y_pred_nb, y_pred_dt,␣
 ↪y_pred_svm]):
    accuracies.append(accuracy_score(y_test, y_pred))
    precisions.append(precision_score(y_test, y_pred, average='weighted'))
    recalls.append(recall_score(y_test, y_pred, average='weighted'))
    f1_scores.append(f1_score(y_test, y_pred, average='weighted'))

    if hasattr(model, "predict_proba"):
        y_pred_proba = model.predict_proba(X_test)[:, 1]
    else:
        y_pred_proba = model.decision_function(X_test)

    roc_aucs.append(roc_auc_score(y_test, y_pred_proba))

metrics_df = pd.DataFrame({
    "Model": models,
    "Accuracy": accuracies,
    "Precision": precisions,
    "Recall": recalls,
    "F1-score": f1_scores,
    "ROC-AUC": roc_aucs
})

metrics_df.head()
```

```
[72]:                  Model  Accuracy  Precision    Recall  F1-score   ROC-AUC
      0  Logistic Regression  0.989341   0.989484  0.989341  0.989244  0.996641
      1          Naive Bayes  0.909884   0.918260  0.909884  0.900867  0.974429
      2        Decision Tree  0.956395   0.962714  0.956395  0.957648  0.968914
      3                  SVM  0.996124   0.996143  0.996124  0.996111  0.995534
```

2.13 Results

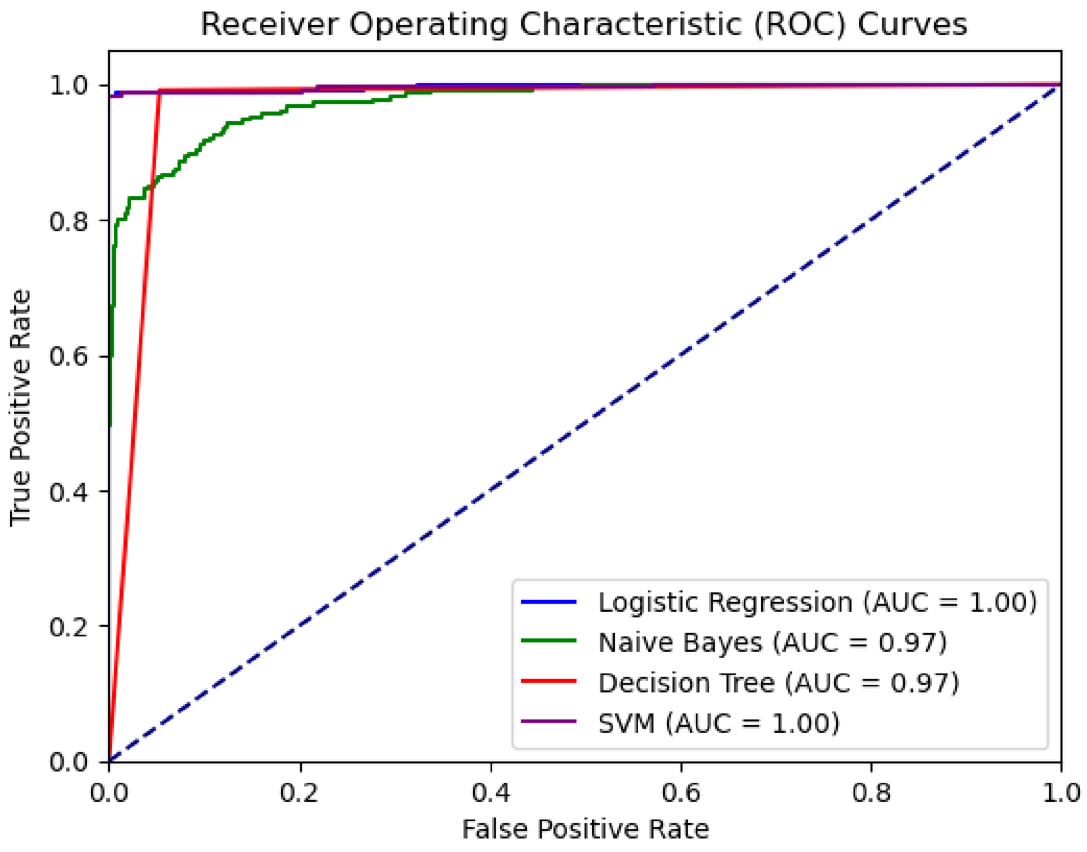
```
[81]: fig, axes = plt.subplots(3, 2, figsize=(14, 18))
palette = sns.color_palette("viridis")

sns.barplot(x="Model", y="Accuracy", data=metrics_df, palette=palette,␣
 ↪ax=axes[0, 0])
```

```
axes[0, 0].set_title("Model Accuracies")
axes[0, 0].set_ylim(0, 1)

sns.barplot(x="Model", y="Precision", data=metrics_df, palette=palette,␣
 ↪ax=axes[0, 1])
axes[0, 1].set_title("Model Precisions")
axes[0, 1].set_ylim(0, 1)

sns.barplot(x="Model", y="Recall", data=metrics_df, palette=palette, ax=axes[1,␣
 ↪0])
axes[1, 0].set_title("Model Recalls")
axes[1, 0].set_ylim(0, 1)

sns.barplot(x="Model", y="F1-score", data=metrics_df, palette=palette,␣
 ↪ax=axes[1, 1])
axes[1, 1].set_title("Model F1-scores")
axes[1, 1].set_ylim(0, 1)

sns.barplot(x="Model", y="ROC-AUC", data=metrics_df, palette=palette,␣
 ↪ax=axes[2, 0])
axes[2, 0].set_title("Model ROC-AUC Scores")
axes[2, 0].set_ylim(0, 1)


fig.delaxes(axes[2, 1])

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


Model Accuracies
Accuracy
Model Precisions
Precision
Model Recalls
Recall
Model F1-scores
F1-score
Model ROC-AUC Scores
ROC-AUC
Model
Logistic Regression
Naive Bayes
Decision Tree
SVM
0.0
0.2
0.4
0.6
0.8
1.0

2.14 Plotting ROC

[76]:
```
colors = ['blue', 'green', 'red', 'purple']

for model, label, color in zip([lr, nb, dt, svm], models, colors):
    if hasattr(model, "predict_proba"):
        y_pred_proba = model.predict_proba(X_test)[:, 1]
    else:
        y_pred_proba = model.decision_function(X_test)
    fpr, tpr, _ = roc_curve(y_test, y_pred_proba)
    roc_auc = auc(fpr, tpr)
    plt.plot(fpr, tpr, color=color, label=f'{label} (AUC = {roc_auc:.2f})')


plt.plot([0, 1], [0, 1], color='navy', linestyle='--')


plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver Operating Characteristic (ROC) Curves')
plt.legend(loc="lower right")

plt.show()
```



2.15 Summary of findings

In this analysis, four models were used to detect depression people using sentimental tweets: Logistic Regression, Naive Bayes, Decision Tree and Support Vector Machine. The purpose of this analysis was to check the best fit model using various performance metrics.

2.16 Model Performance Matrix

[85]:
```
print(metrics_df)
```

```
                 Model  Accuracy  Precision    Recall  F1-score   ROC-AUC
0  Logistic Regression  0.989341   0.989484  0.989341  0.989244  0.996641
1          Naive Bayes  0.909884   0.918260  0.909884  0.900867  0.974429
2        Decision Tree  0.956395   0.962714  0.956395  0.957648  0.968914
3                  SVM  0.996124   0.996143  0.996124  0.996111  0.995534
```

2.17 Important Findings

- Best performing Model: SVM model acheived the highest scores across most of the metrics, including Accuracy, Precision, Recall, F1 Score, indicating that it is the most effective model for detecting depression using tweets.

- Logistic Regression: This model provided good accuracy in comparison to rest of the models (Naive Bayes and Decision tree) and is very close to SVM.

- Naive Bayes: This model has the lowest accuracy, precision and recall across all the models. - Decision Tree: This model has good performance as compared to Naive Bayes but has slightly low accuracy as compared to SVM and Logistic Regression.