Introduction:

In this project, we will build a fake news detection model using Natural Language Processing (NLP) techniques. We have a dataset consisting of genuine and fake articles' titles and text, and our goal is to distinguish between them.

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In [25]:

```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.naive_bayes import MultinomialNB
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report
from sklearn.naive_bayes import MultinomialNB
import matplotlib.pyplot as plt
import seaborn as sns
import nltk
from nltk.corpus import stopwords
nltk.download('punkt')
nltk.download('stopwords')
```

```
[nltk_data] Downloading package punkt to
[nltk_data]     /Users/pavanrudrapogu/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
[nltk_data] Downloading package stopwords to
[nltk_data]     /Users/pavanrudrapogu/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
```

Out[25]:

```
True
```

Step 2: Load and Explore the Dataset

In [3]:

```
import pandas as pd

# Load the dataset
true_df = pd.read_csv('/Users/pavanrudrapogu/Desktop/dataset/True.csv')
false_df = pd.read_csv('/Users/pavanrudrapogu/Desktop/dataset/Fake.csv')

# Add labels to indicate real and fake news
true_df['label'] = 1
false_df['label'] = 0

# Concatenate both datasets
data = pd.concat([true_df, false_df])
```

In [4]:

```

#True dataset
true_df.head()
```

Out[4]:

	title	text	subject	date	label
0	As U.S. budget fight looms, Republicans flip t...	WASHINGTON (Reuters) - The head of a conservat...	politicsNews	December 31, 2017	1
1	U.S. military to accept transgender recruits o...	WASHINGTON (Reuters) - Transgender people will...	politicsNews	December 29, 2017	1
2	Senior U.S. Republican senator: 'Let Mr. Muell...	WASHINGTON (Reuters) - The special counsel inv...	politicsNews	December 31, 2017	1
3	FBI Russia probe helped by Australian diplomat...	WASHINGTON (Reuters) - Trump campaign adviser ...	politicsNews	December 30, 2017	1
4	Trump wants Postal Service to charge 'much mor...	SEATTLE/WASHINGTON (Reuters) - President Donal...	politicsNews	December 29, 2017	1

In [7]:
```
#Fake dataset
false_df.head()
```

Out[7]:
```
                                      title                                              text  subject               date  label
0   Donald Trump Sends Out Embarrassing New Year’...   Donald Trump just couldn t wish all Americans ...     News  December 31, 2017      0
1       Drunk Bragging Trump Staffer Started Russian ...  House Intelligence Committee Chairman Devin Nu...     News  December 31, 2017      0
2       Sheriff David Clarke Becomes An Internet Joke...    On Friday, it was revealed that former Milwauk...     News  December 30, 2017      0
3   Trump Is So Obsessed He Even Has Obama’s Name...  On Christmas day, Donald Trump announced that ...     News  December 29, 2017      0
4      Pope Francis Just Called Out Donald Trump Dur...   Pope Francis used his annual Christmas Day mes...     News  December 25, 2017      0
```

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Step 3: Data Preprocessing

In [6]:
```
# Lowercasing and tokenization
data['text'] = data['text'].str.lower()
data['title'] = data['title'].str.lower()
data['text'] = data['text'].apply(nltk.word_tokenize)
data['title'] = data['title'].apply(nltk.word_tokenize)

# Remove stopwords
stop_words = set(stopwords.words('english'))
data['text'] = data['text'].apply(lambda x: [word for word in x if word not in stop_words])
data['title'] = data['title'].apply(lambda x: [word for word in x if word not in stop_words])
```

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Step 4: Feature Extraction (TF-IDF)

In [8]:
```
tfidf_vectorizer = TfidfVectorizer(max_features=5000)
text_tfidf = tfidf_vectorizer.fit_transform(data['text'].apply(lambda x: ' '.join(x)))
title_tfidf = tfidf_vectorizer.transform(data['title'].apply(lambda x: ' '.join(x)))
```

Step 5: Split the Data into Training and Testing Sets

In [9]:
```
X = text_tfidf
y = data['label']

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
# Display the shapes of training and testing data
print(f"X_train shape: {X_train.shape}")
print(f"X_test shape: {X_test.shape}")
print(f"y_train shape: {y_train.shape}")
print(f"y_test shape: {y_test.shape}")
```

```
X_train shape: (35918, 5000)
X_test shape: (8980, 5000)
y_train shape: (35918,)
y_test shape: (8980,)
```

Step 6: Model Training

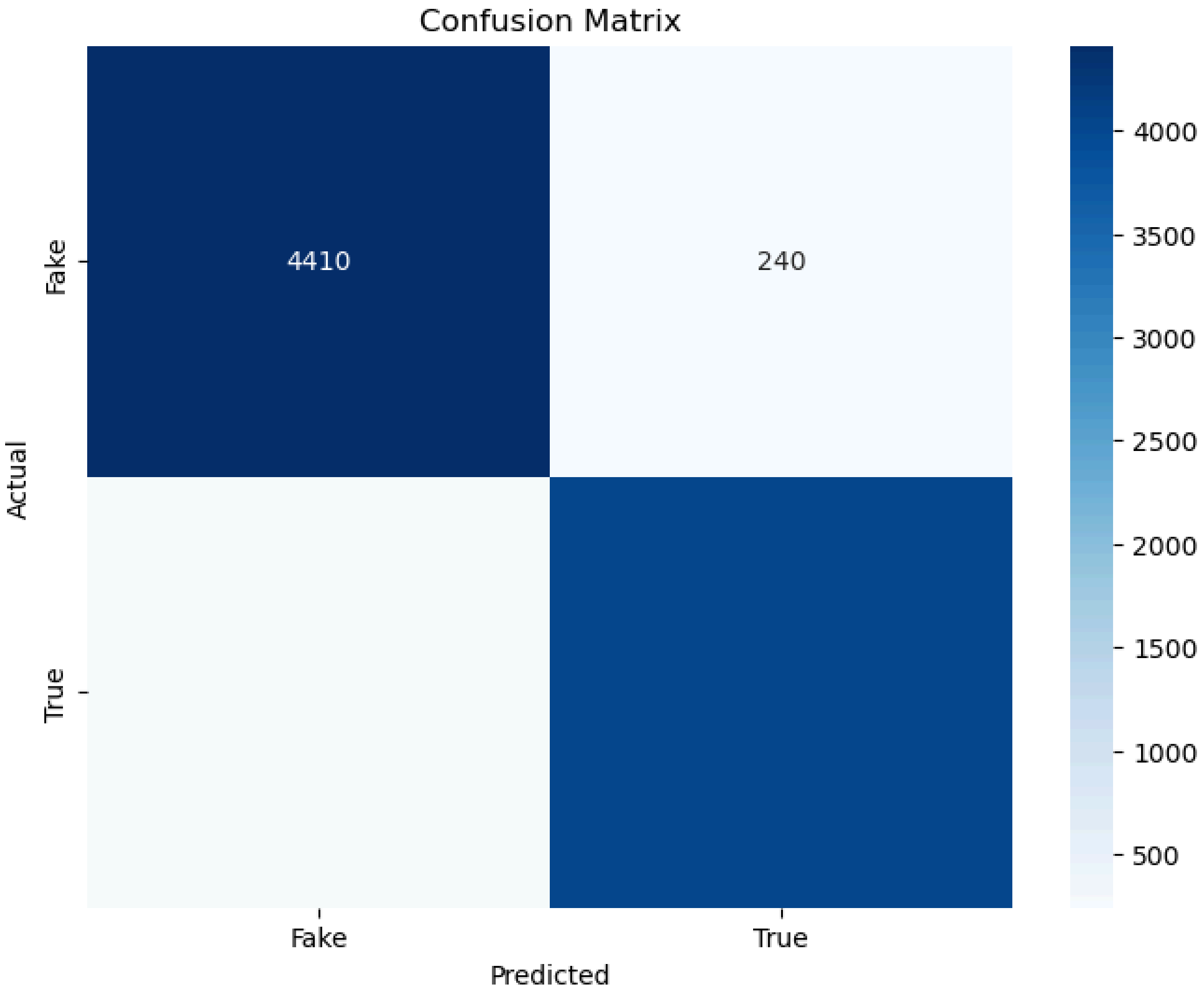
Training our model with different algorithms using the training data and evaluating its performance on the testing data.

```
# Multinomial Naive Bayes Model
```

In [11]:

```
# Initialize and train the Multinomial Naive Bayes model
naive_bayes_model = MultinomialNB()
naive_bayes_model.fit(X_train, y_train)

# Predict on the test data
y_pred = naive_bayes_model.predict(X_test)

# Evaluate the model
accuracy = accuracy_score(y_test, y_pred)
confusion = confusion_matrix(y_test, y_pred)
classification_rep = classification_report(y_test, y_pred)

# Format and display the metrics
print(f"Accuracy: {accuracy:.2f}")

# Plot the confusion matrix
plt.figure(figsize=(8, 6))
sns.heatmap(confusion, annot=True, fmt='d', cmap='Blues', xticklabels=['Fake', 'True'], yticklabels=[
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.title('Confusion Matrix')
plt.show()

# Print the classification report
print("Classification Report:")
print(classification_rep)
```

```
Accuracy: 0.94
```



```
Classification Report:
              precision    recall  f1-score   support

           0       0.94      0.95      0.94      4650
           1       0.94      0.94      0.94      4330

    accuracy                           0.94      8980
   macro avg       0.94      0.94      0.94      8980
weighted avg       0.94      0.94      0.94      8980
```

Decision Tree

In [12]:

```python
from sklearn.tree import DecisionTreeClassifier

# Define and train the Decision Tree model
decision_tree = DecisionTreeClassifier()
decision_tree.fit(X_train, y_train)

# Evaluate the Decision Tree model
def evaluate_decision_tree(model, X_test, y_test):
    y_pred = model.predict(X_test)
    accuracy = accuracy_score(y_test, y_pred)
    confusion = confusion_matrix(y_test, y_pred)
    classification_rep = classification_report(y_test, y_pred)

    return accuracy, confusion, classification_rep

# Evaluate Decision Tree
dt_accuracy, dt_confusion, dt_classification = evaluate_decision_tree(decision_tree, X_test, y_test)
print("Decision Tree Accuracy:", dt_accuracy)
print("Decision Tree Confusion Matrix:\n", dt_confusion)
print("Decision Tree Classification Report:\n", dt_classification)
```

```
Decision Tree Accuracy: 0.9972160356347439
Decision Tree Confusion Matrix:
 [[4640   10]
 [  15 4315]]
Decision Tree Classification Report:
               precision    recall  f1-score   support

           0       1.00      1.00      1.00      4650
           1       1.00      1.00      1.00      4330

    accuracy                           1.00      8980
   macro avg       1.00      1.00      1.00      8980
weighted avg       1.00      1.00      1.00      8980
```

Passive Aggressive Classifier

In [14]:

```
from sklearn.linear_model import PassiveAggressiveClassifier

# Define and train the Passive Aggressive Classifier model
passive_aggressive = PassiveAggressiveClassifier()
passive_aggressive.fit(X_train, y_train)

# Evaluate the Passive Aggressive Classifier model
def evaluate_passive_aggressive(model, X_test, y_test):
    y_pred = model.predict(X_test)
    accuracy = accuracy_score(y_test, y_pred)
    confusion = confusion_matrix(y_test, y_pred)
    classification_rep = classification_report(y_test, y_pred)

    return accuracy, confusion, classification_rep

# Evaluate Passive Aggressive Classifier
pa_accuracy, pa_confusion, pa_classification = evaluate_passive_aggressive(passive_aggressive, X_test
print("Passive Aggressive Classifier Accuracy:", pa_accuracy)
print("Passive Aggressive Classifier Confusion Matrix:\n", pa_confusion)
print("Passive Aggressive Classifier Classification Report:\n", pa_classification)
```

```
Passive Aggressive Classifier Accuracy: 0.9966592427616926
Passive Aggressive Classifier Confusion Matrix:
 [[4634   16]
 [  14 4316]]
Passive Aggressive Classifier Classification Report:
               precision    recall  f1-score   support

           0       1.00      1.00      1.00      4650
           1       1.00      1.00      1.00      4330

    accuracy                           1.00      8980
   macro avg       1.00      1.00      1.00      8980
weighted avg       1.00      1.00      1.00      8980
```

Random Forest

In [15]:

```
from sklearn.ensemble import RandomForestClassifier

# Define and train the Random Forest model
random_forest = RandomForestClassifier(n_estimators=100)
random_forest.fit(X_train, y_train)

# Evaluate the Random Forest model
def evaluate_random_forest(model, X_test, y_test):
    y_pred = model.predict(X_test)
    accuracy = accuracy_score(y_test, y_pred)
    confusion = confusion_matrix(y_test, y_pred)
    classification_rep = classification_report(y_test, y_pred)

    return accuracy, confusion, classification_rep

# Evaluate Random Forest
rf_accuracy, rf_confusion, rf_classification = evaluate_random_forest(random_forest, X_test, y_test)
print("Random Forest Accuracy:", rf_accuracy)
print("Random Forest Confusion Matrix:\n", rf_confusion)
print("Random Forest Classification Report:\n", rf_classification)
```

```
Random Forest Accuracy: 0.9983296213808464
Random Forest Confusion Matrix:
 [[4643    7]
 [   8 4322]]
Random Forest Classification Report:
               precision    recall  f1-score   support

           0       1.00      1.00      1.00      4650
           1       1.00      1.00      1.00      4330

    accuracy                           1.00      8980
   macro avg       1.00      1.00      1.00      8980
weighted avg       1.00      1.00      1.00      8980
```

Logistic Regression

In [16]:

```
from sklearn.linear_model import LogisticRegression

# Define and train the Logistic Regression model
logistic_regression = LogisticRegression()
logistic_regression.fit(X_train, y_train)

# Evaluate the Logistic Regression model
def evaluate_logistic_regression(model, X_test, y_test):
    y_pred = model.predict(X_test)
    accuracy = accuracy_score(y_test, y_pred)
    confusion = confusion_matrix(y_test, y_pred)
    classification_rep = classification_report(y_test, y_pred)

    return accuracy, confusion, classification_rep

# Evaluate Logistic Regression
lr_accuracy, lr_confusion, lr_classification = evaluate_logistic_regression(logistic_regression, X_te
print("Logistic Regression Accuracy:", lr_accuracy)
print("Logistic Regression Confusion Matrix:\n", lr_confusion)
print("Logistic Regression Classification Report:\n", lr_classification)
```

```
Logistic Regression Accuracy: 0.9922048997772829
Logistic Regression Confusion Matrix:
 [[4603   47]
 [  23 4307]]
Logistic Regression Classification Report:
               precision    recall  f1-score   support

           0       1.00      0.99      0.99      4650
           1       0.99      0.99      0.99      4330

    accuracy                           0.99      8980
   macro avg       0.99      0.99      0.99      8980
weighted avg       0.99      0.99      0.99      8980
```

Step 7: Model Validation and Evaluation

Logistic Regression

In [17]:
```
from sklearn.metrics import precision_score, recall_score, f1_score

# Testing and evaluating Logistic Regression
lr_test_predictions = logistic_regression.predict(X_test)
lr_test_precision = precision_score(y_test, lr_test_predictions)
lr_test_recall = recall_score(y_test, lr_test_predictions)
lr_test_f1 = f1_score(y_test, lr_test_predictions)

# Print precision, recall, and F1 score for Logistic Regression
print("Logistic Regression Test Precision:", lr_test_precision)
print("Logistic Regression Test Recall:", lr_test_recall)
print("Logistic Regression Test F1 Score:", lr_test_f1)

# Repeat the testing and evaluation for the other classifiers (Random Forest, Passive Aggressive, Dec
```

```
Logistic Regression Test Precision: 0.9892053284336243
Logistic Regression Test Recall: 0.994688221709007
Logistic Regression Test F1 Score: 0.991939198526025
```

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Random forest

In [18]:

```
from sklearn.metrics import precision_score, recall_score, f1_score

# Testing the Random Forest model on the test data
rf_test_predictions = random_forest.predict(X_test)

# Evaluate Random Forest on the test data
rf_test_precision = precision_score(y_test, rf_test_predictions)
rf_test_recall = recall_score(y_test, rf_test_predictions)
rf_test_f1 = f1_score(y_test, rf_test_predictions)

# Print precision, recall, and F1 score for Random Forest
print("Random Forest Test Precision:", rf_test_precision)
print("Random Forest Test Recall:", rf_test_recall)
print("Random Forest Test F1 Score:", rf_test_f1)
```

```
Random Forest Test Precision: 0.9983829983829984
Random Forest Test Recall: 0.9981524249422633
Random Forest Test F1 Score: 0.9982676983485391
```

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Passive Aggressive Classifier

In [20]:

```
from sklearn.metrics import precision_score, recall_score, f1_score

# Testing the Passive Aggressive Classifier model on the test data
pa_test_predictions = passive_aggressive.predict(X_test)

# Evaluate Passive Aggressive Classifier on the test data
pa_test_precision = precision_score(y_test, pa_test_predictions)
pa_test_recall = recall_score(y_test, pa_test_predictions)
pa_test_f1 = f1_score(y_test, pa_test_predictions)

# Print precision, recall, and F1 score for Passive Aggressive Classifier
print("Passive Aggressive Classifier Test Precision:", pa_test_precision)
print("Passive Aggressive Classifier Test Recall:", pa_test_recall)
print("Passive Aggressive Classifier Test F1 Score:", pa_test_f1)
```

```
Passive Aggressive Classifier Test Precision: 0.9963065558633426
Passive Aggressive Classifier Test Recall: 0.9967667436489608
Passive Aggressive Classifier Test F1 Score: 0.9965365966289541
```

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Decision Tree

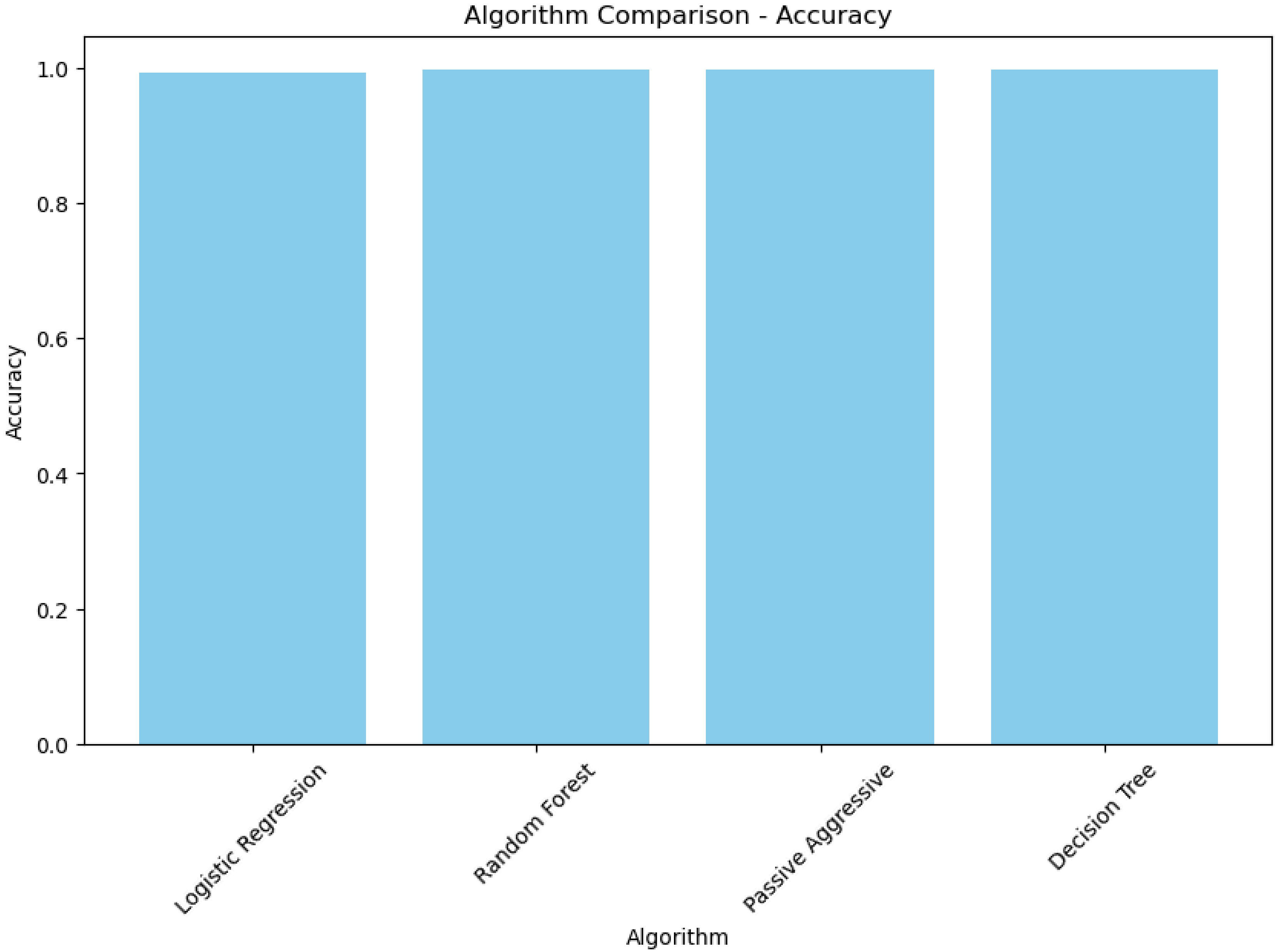
In [21]:

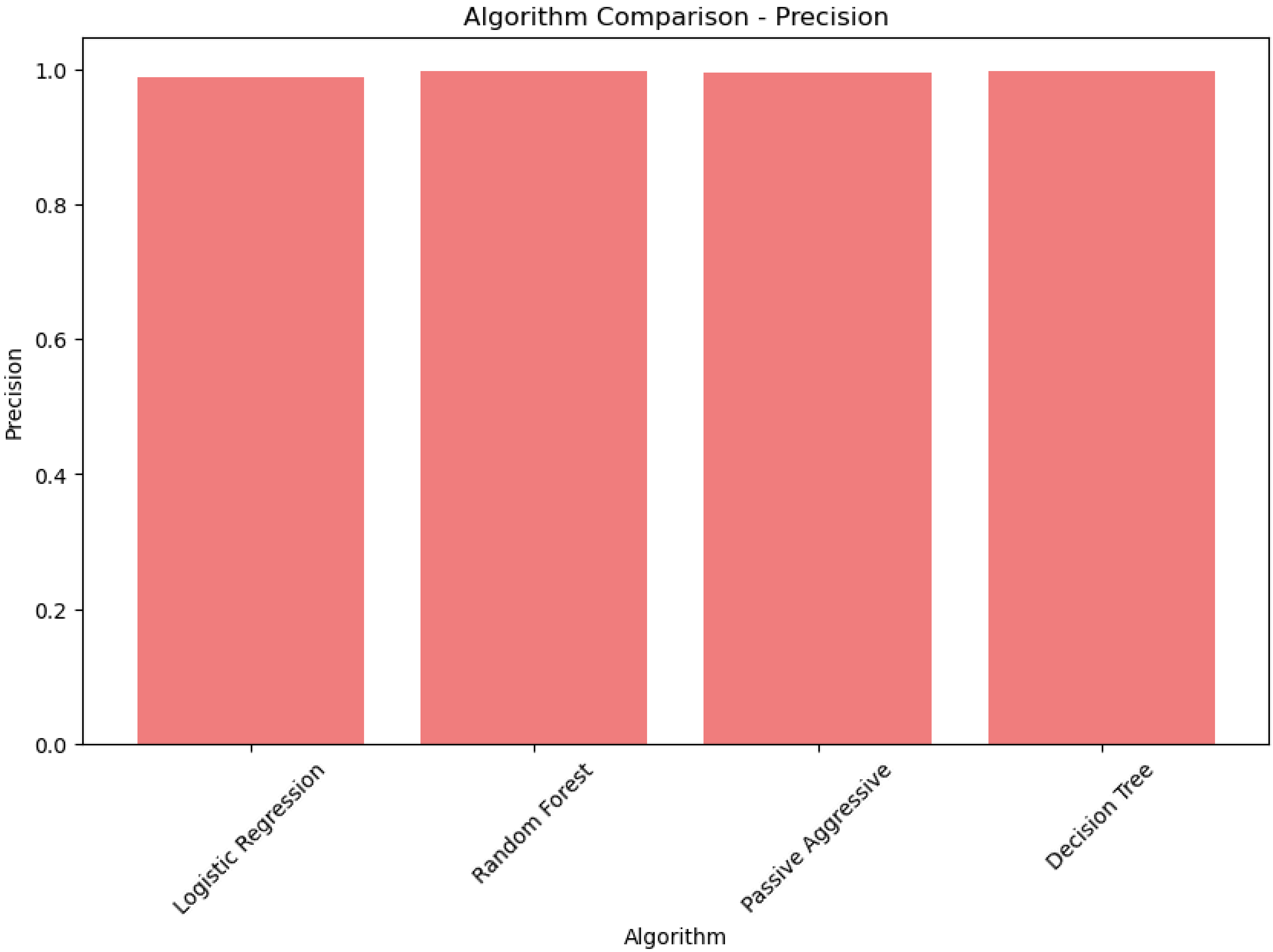
```
from sklearn.metrics import precision_score, recall_score, f1_score

# Testing the Decision Tree model on the test data
dt_test_predictions = decision_tree.predict(X_test)

# Evaluate Decision Tree on the test data
dt_test_precision = precision_score(y_test, dt_test_predictions)
dt_test_recall = recall_score(y_test, dt_test_predictions)
dt_test_f1 = f1_score(y_test, dt_test_predictions)

# Print precision, recall, and F1 score for Decision Tree
print("Decision Tree Test Precision:", dt_test_precision)
print("Decision Tree Test Recall:", dt_test_recall)
print("Decision Tree Test F1 Score:", dt_test_f1)
```

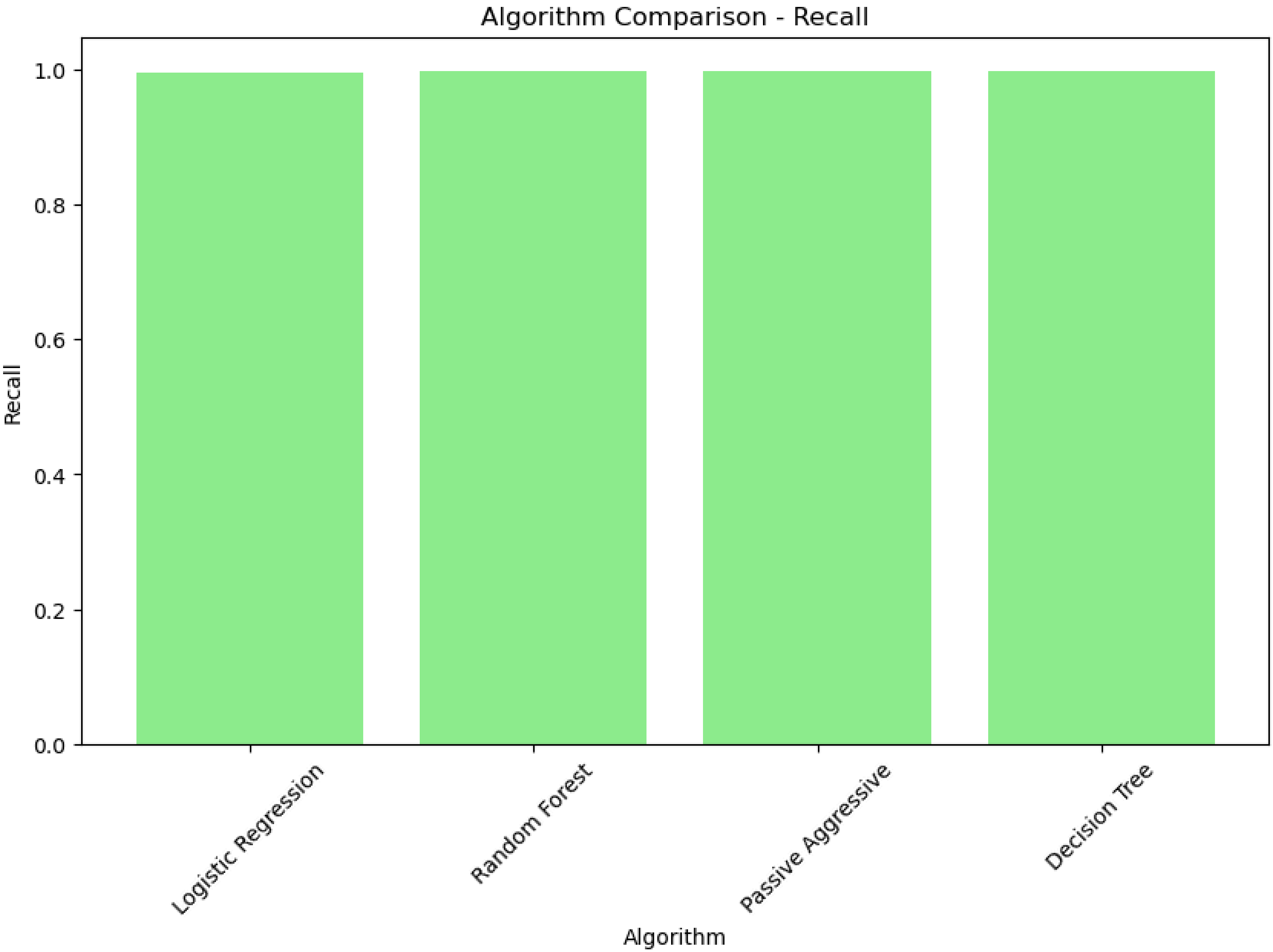
```
Decision Tree Test Precision: 0.9976878612716763
Decision Tree Test Recall: 0.9965357967667436
Decision Tree Test F1 Score: 0.997111496244945
```

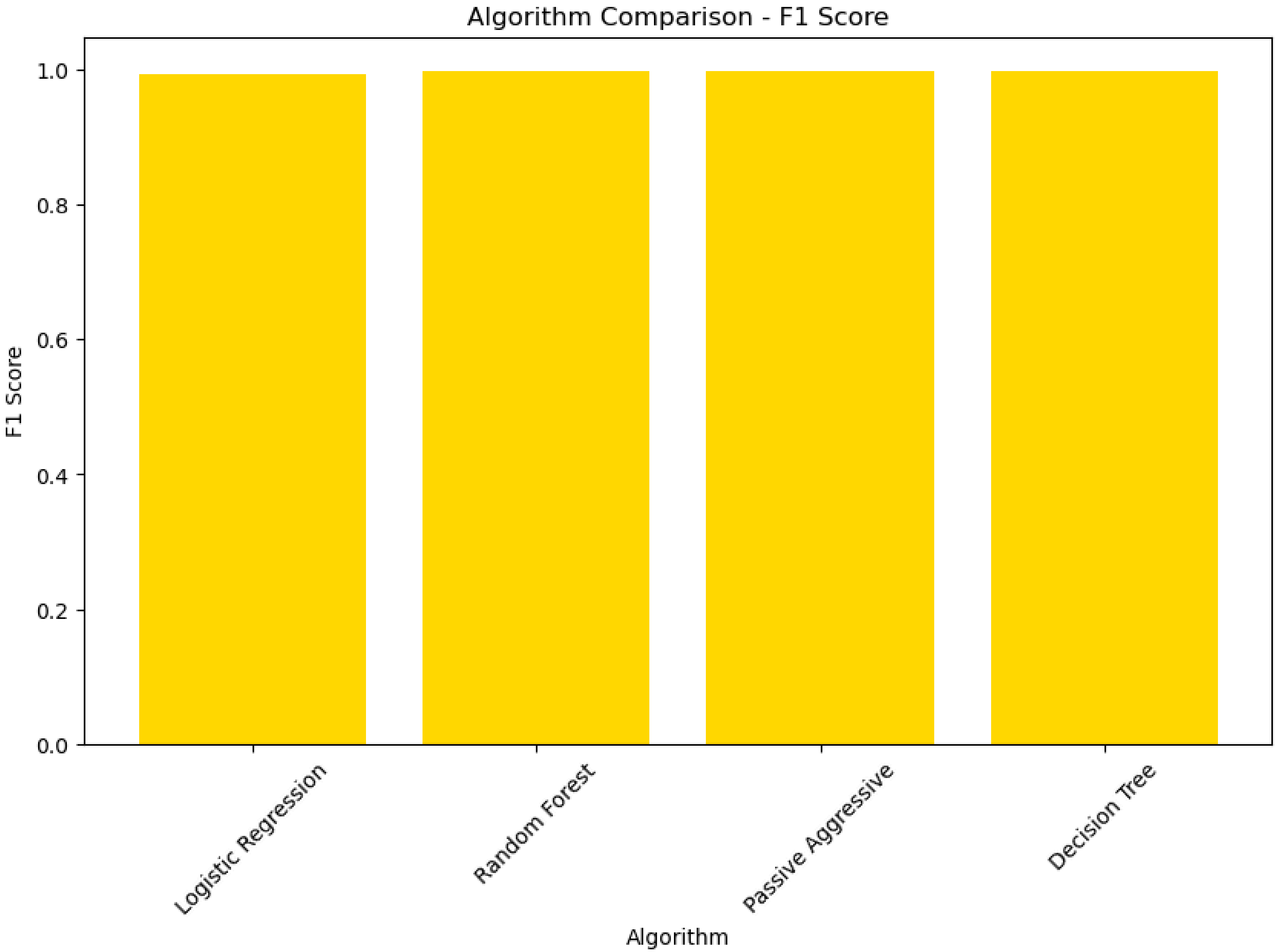
In [22]:

```python
import matplotlib.pyplot as plt

# Define the algorithm names and their corresponding metrics
algorithms = ['Logistic Regression', 'Random Forest', 'Passive Aggressive', 'Decision Tree']
accuracies = [lr_accuracy, rf_accuracy, pa_accuracy, dt_accuracy]
precisions = [lr_test_precision, rf_test_precision, pa_test_precision, dt_test_precision]
recalls = [lr_test_recall, rf_test_recall, pa_test_recall, dt_test_recall]
f1_scores = [lr_test_f1, rf_test_f1, pa_test_f1, dt_test_f1]

# Create a bar chart for accuracy
plt.figure(figsize=(10, 6))
plt.bar(algorithms, accuracies, color='skyblue')
plt.xlabel('Algorithm')
plt.ylabel('Accuracy')
plt.title('Algorithm Comparison - Accuracy')
plt.xticks(rotation=45)
plt.show()

# Create a bar chart for precision
plt.figure(figsize=(10, 6))
plt.bar(algorithms, precisions, color='lightcoral')
plt.xlabel('Algorithm')
plt.ylabel('Precision')
plt.title('Algorithm Comparison - Precision')
plt.xticks(rotation=45)
plt.show()

# Create a bar chart for recall
plt.figure(figsize=(10, 6))
plt.bar(algorithms, recalls, color='lightgreen')
plt.xlabel('Algorithm')
plt.ylabel('Recall')
plt.title('Algorithm Comparison - Recall')
plt.xticks(rotation=45)
plt.show()

# Create a bar chart for F1 score
plt.figure(figsize=(10, 6))
plt.bar(algorithms, f1_scores, color='gold')
plt.xlabel('Algorithm')
plt.ylabel('F1 Score')
plt.title('Algorithm Comparison - F1 Score')
plt.xticks(rotation=45)
plt.show()
```




Algorithm Comparison - Precision
Precision
1.0
0.8
0.6
0.4
0.2
0.0
Logistic Regression
Random Forest
Passive Aggressive
Decision Tree
Algorithm

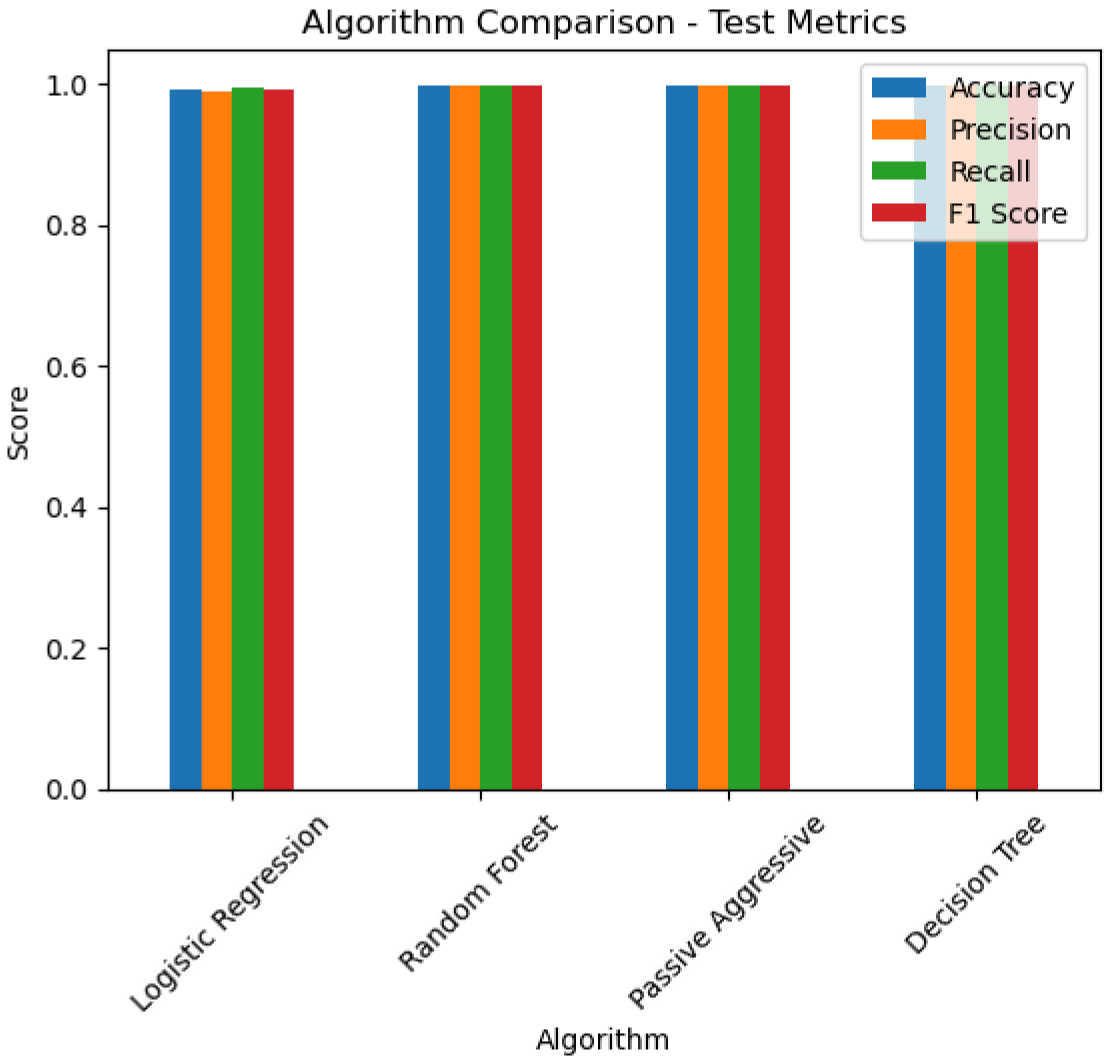

Algorithm Comparison - Recall
Recall
1.0
0.8
0.6
0.4
0.2
0.0
Logistic Regression
Random Forest
Passive Aggressive
Decision Tree
Algorithm


Algorithm Comparison - F1 Score
F1 Score
1.0
0.8
0.6
0.4
0.2
0.0
Logistic Regression
Random Forest
Passive Aggressive
Decision Tree
Algorithm

In [23]:

```
import matplotlib.pyplot as plt
import pandas as pd

# Define the algorithm names and their corresponding metrics
algorithms = ['Logistic Regression', 'Random Forest', 'Passive Aggressive', 'Decision Tree']
accuracy_scores = [lr_accuracy, rf_accuracy, pa_accuracy, dt_accuracy]
precision_scores = [lr_test_precision, rf_test_precision, pa_test_precision, dt_test_precision]
recall_scores = [lr_test_recall, rf_test_recall, pa_test_recall, dt_test_recall]
f1_scores = [lr_test_f1, rf_test_f1, pa_test_f1, dt_test_f1]

# Create a DataFrame to store the results
results_df = pd.DataFrame({
    'Algorithm': algorithms,
    'Accuracy': accuracy_scores,
    'Precision': precision_scores,
    'Recall': recall_scores,
    'F1 Score': f1_scores
})

# Set the algorithm column as the index for plotting
results_df.set_index('Algorithm', inplace=True)

# Create a bar chart for all metrics
plt.figure(figsize=(12, 8))
results_df.plot(kind='bar', stacked=False)
plt.xlabel('Algorithm')
plt.ylabel('Score')
plt.title('Algorithm Comparison - Test Metrics')
plt.xticks(rotation=45)
plt.legend(loc='upper right')
plt.show()
```

```
<Figure size 1200x800 with 0 Axes>
```



MODEL VALIDATION

News Prediction

In [24]:

```
import nltk
from nltk.corpus import stopwords

# Define a function for predicting titles
def predict_title(title_text):
    # Preprocess the title
    preprocessed_title_text = title_text.lower()
    preprocessed_title_text = nltk.word_tokenize(preprocessed_title_text)
    preprocessed_title_text = [word for word in preprocessed_title_text if word not in stop_words]

    # Convert the preprocessed text into TF-IDF vectors
    tfidf_vector = tfidf_vectorizer.transform([" ".join(preprocessed_title_text)])

    # Make the prediction
    prediction = naive_bayes_model.predict(tfidf_vector)

    return prediction

# Example titles
title_text_1 = "Donald Trump Sends Out Embarrassing New Year"
title_text_2 = "As U.S. budget fight looms, Republicans flip their fiscal script"

# Predict and display results for both titles
prediction_1 = predict_title(title_text_1)
prediction_2 = predict_title(title_text_2)

if prediction_1 == 1:
    print("Title 1: The news is likely true.")
else:
    print("Title 1: The news is likely fake.")

if prediction_2 == 1:
    print("Title 2: The news is likely true.")
else:
    print("Title 2: The news is likely fake.")
```

```
Title 1: The news is likely fake.
Title 2: The news is likely true.
```