Email Spam Classification Using Naïve Bayes

A PROJECT REPORT
FOR
Introduction to AI (AI101B)
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1. Introduction

Objective

To build a machine learning model that classifies emails as spam or not spam using the Naive Bayes algorithm.

Motivation

- Email spam is a major concern for users, organizations, and ISPs.
- Automating spam detection helps improve communication efficiency and cyber security.
- This project showcases how Natural Language Processing (NLP) and Machine Learning solve real-world problems.

2. Dataset Description

Source: Public dataset from GitHub (emails.csv)

- **Features**:
- text: Content of the email
- spam: Target label (1 = spam, 0 = not spam)
- Dataset Size: Approximately 5728 email samples

3. Methodology

A. Data Preprocessing

- Train-Test Split → 80% training, 20% testing.
- Using CountVectorizer to convert email text into numeric vectors.

B. Machine Learning Models Used

- Multinomial Naive Bayes :-
- Suitable for text classification problems.
- Assumes independence between features (bag-of-words model).

C. Evaluation Metrics

- Accuracy: Proportion of correctly predicted emails.
- Confusion Matrix: Comparison of actual vs predicted labels.
- Precision, Recall, F1-score: For spam classification effectiveness.

Python Code:

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

```
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.naive_bayes import MultinomialNB
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score
from wordcloud import WordCloud

url = 'https://raw.githubusercontent.com/nikhilkr29/Email-Spam-Classifier-using-Naive-Bayes/main/emails.csv'
df = pd.read_csv(url)

print(df.head())
print("\nClass Distribution:")
print(df['spam'].value_counts())
plt.figure(figsize=(6,4))
sns.countplot(x='spam', data=df, palette='mako')
plt.title('Spam vs Not Spam Count')
plt.xticks([0, 1], ['Not Spam', 'Spam'])
plt.show()
spam_words = ' '.join(df[df['spam'] == 1]['text'])
spam_wc = WordCloud(width=600, height=400,
background_color='black').generate(spam_words)
plt.figure(figsize=(8,6))
plt.imshow(spam_wc, interpolation='bilinear')
plt.axis('off')
plt.title("Most Common Words in Spam Emails", fontsize=15)
plt.show()
ham_words = ' '.join(df[df['spam'] == 0]['text'])
ham_wc = WordCloud(width=600, height=400,
background_color='white').generate(ham_words)
plt.figure(figsize=(8,6))
plt.imshow(ham_wc, interpolation='bilinear')
plt.axis('off')
plt.title("Most Common Words in Non-Spam Emails", fontsize=15)
plt.show()
X = df['text']
y = df['spam']
vectorizer = CountVectorizer()
X_transformed = vectorizer.fit_transform(X)
X_train, X_test, y_train, y_test = train_test_split(X_transformed, y, test_size=0.2,
random_state=42)
model = MultinomialNB()
model.fit(X_train, y_train)
y_pred = model.predict(X_test)
print("\nAccuracy Score:", accuracy_score(y_test, y_pred))
print("\nClassification Report:\n", classification_report(y_test, y_pred))
```

```
cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(5,4))
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', xticklabels=['Not Spam',
'Spam'], yticklabels=['Not Spam', 'Spam'])
plt.title('Confusion Matrix')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.show()
sample = ["Congratulations! You have won a free iPhone. Click here to claim it."]
sample_transformed = vectorizer.transform(sample)
print("\nPrediction (1 = Spam, 0 = Not Spam):",
model.predict(sample_transformed)[0])
```

4. Results & Discussion

Spam vs Not Spam Count Plot

WordClouds for visualizing common words in spam and non-spam emails

Confusion Matrix Heatmap to evaluate classification results

Sample Results:

Accuracy Score: ~98%

Prediction Example:

Input: “Congratulations! You have won a free iPhone.”

Output: Spam (1)

WordClouds for visualizing common words in spam and non-spam emails

Confusion Matrix Heatmap to evaluate classification results

Sample Results:

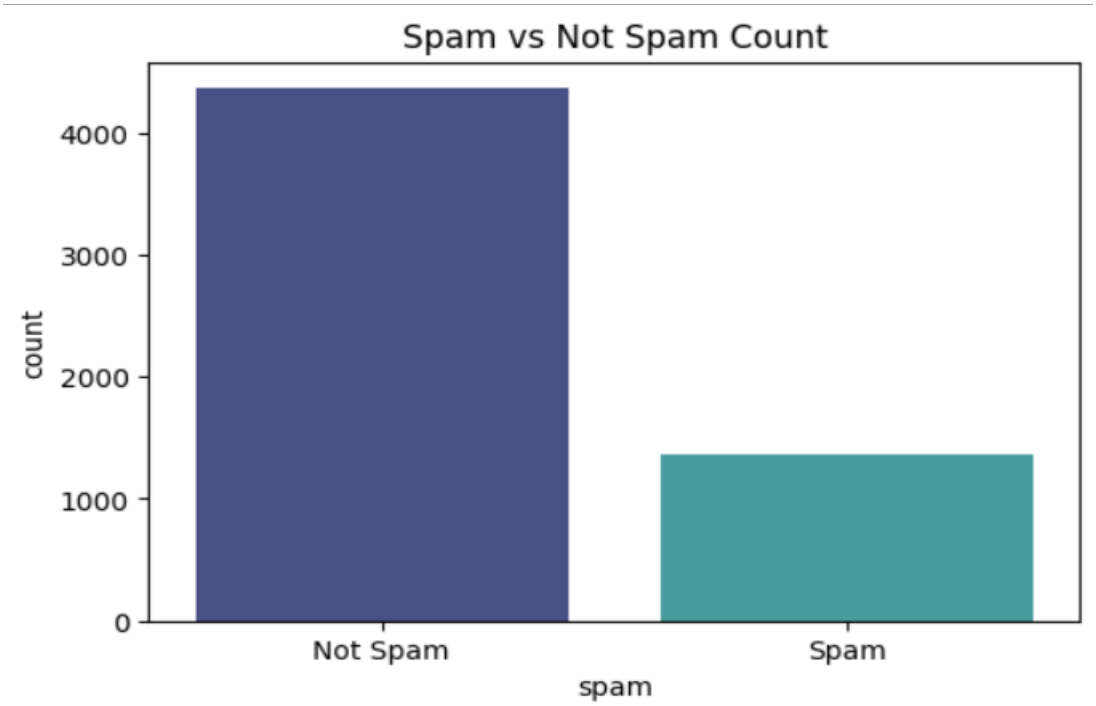
Accuracy Score: ~98%

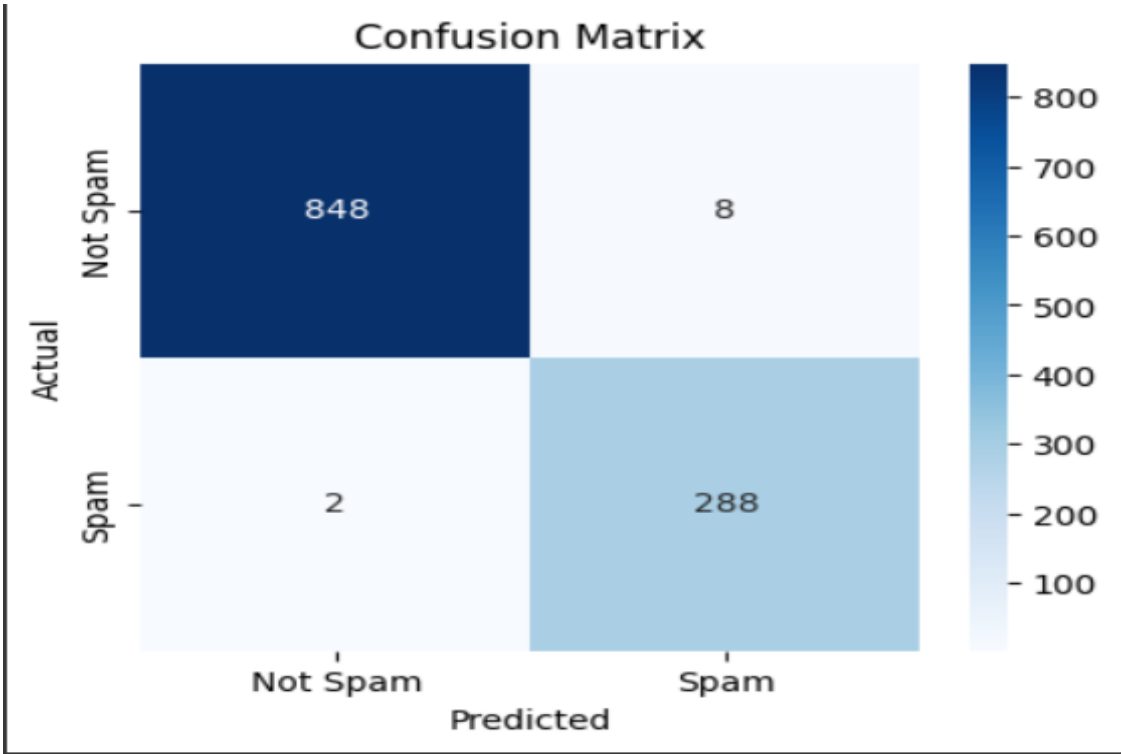
Prediction Example:

Input: “Congratulations! You have won a free iPhone.”

Output: Spam (1)

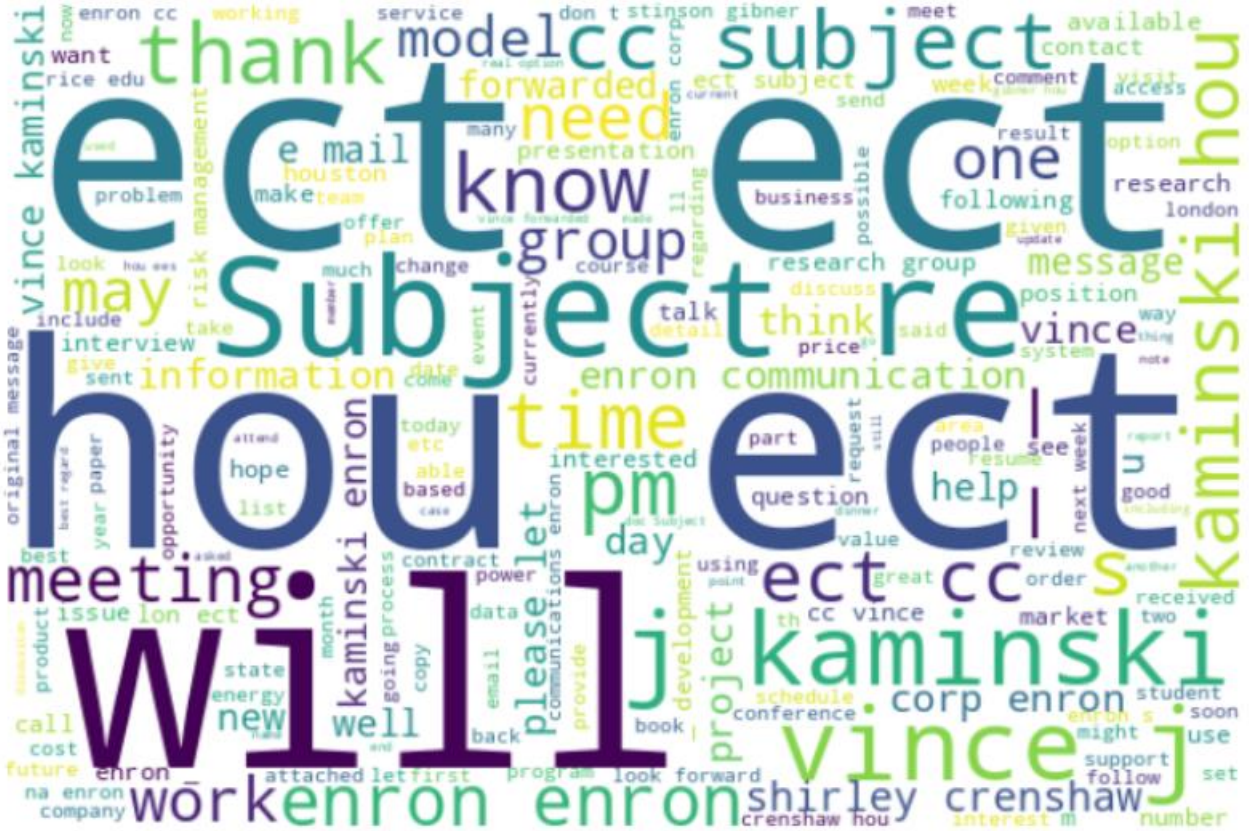
Output Screenshots






```
Prediction (1 = Spam, 0 = Not Spam): 1
```

Most Common Words in Non-Spam Emails



Most Common Words in Spam Emails

5. Conclusion & Future Scope

Conclusion

- Naive Bayes is a powerful algorithm for classifying text-based data like emails.
- With minimal preprocessing, it provides high accuracy and fast predictions.

Future Scope

- Implement TF-IDF Vectorization for improved feature weighting.
- Compare with other models like Logistic Regression, SVM, or XGBoost.
- Add more data fields like sender info or metadata for enhanced detection.

6. References

- Scikit-learn Documentation.
- GitHub: Email Spam Dataset.
- WordCloud & Seaborn libraries.
- Research papers on spam detection with ML.