BUILDING A SMARTER AI-POWERED SPAM CLASSIFIER :

In this project, we will use Python to create an email spam detection system. Our goal is to train a machine learning model that can classify emails as either spam or non-spam (ham). This will help us filter out unwanted and potentially harmful emails from our inbox. We'll follow the standard data science workflow, including data loading, preprocessing, feature extraction, model training, evaluation, and prediction. Let's begin building our email spam detector.

Understanding the Data :

```
In [1]:
```

```
#importing libraries
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import TfidfVectorize
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, confusion_matrix,
roc_curve, roc_auc_score
import nltk
from nltk.corpus import stopwords
from collections import Counter


#libraries for data visualization
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

Out [2] :

	v1	v2	Unnamed: 2	Unnamed: 3	Unnamed: 4
0	ham	Go until jurong point, crazy.. Available only ...	NaN	NaN	NaN
1	ham	Ok lar... Joking wif u oni...	NaN	NaN	NaN

2	spam	Free entry in 2 a wkly comp to win FA Cup fina...	NaN	NaN	NaN
3	ham	U dun say so early hor... U c already then say...	NaN	NaN	NaN
4	ham	Nah I don't think he goes to usf, he lives aro...	NaN	NaN	NaN
...	...	...	...	...	...
5567	spam	This is the 2nd time we have tried 2 contact u...	NaN	NaN	NaN
5568	ham	Will Ì_ b going to esplanade fr home?	NaN	NaN	NaN
5569	ham	Pity, * was in mood for that. So...any other s...	NaN	NaN	NaN
5570	ham	The guy did some bitching but I acted like i'd...	NaN	NaN	NaN
5571	ham	Rofl. Its true to its name	NaN	NaN	NaN

5572 rows × 5 columns

In [3] :

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5572 entries, 0 to 5571
Data columns (total 5 columns):
#   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   v1          5572 non-null   object
 1   v2          5572 non-null   object
 2   Unnamed: 2  50 non-null     object
 3   Unnamed: 3  12 non-null     object
 4   Unnamed: 4  6 non-null      object
dtypes: object(5)
memory usage: 217.8+ KB
```

In [4] :

```
# Downloading the stopwords dataset

nltk.download('stopwords')
```

```
[nltk_data] Error loading stopwords: <urlopen error [Errno -3]
[nltk_data]     Temporary failure in name resolution>
```

Out [4] :

```
False
```

In [5] :

```
# Drop unnecessary columns from the DataFrame

columns_to_drop = ["Unnamed: 2", "Unnamed: 3", "Unnamed: 4"]
df.drop(columns=columns_to_drop, inplace=True)
```

In [6] :

```
Df
```

Out [6] :

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...
...	...	...
5567	spam	This is the 2nd time we have tried 2 contact u...
5568	ham	Will Ì_ b going to esplanade fr home?
5569	ham	Pity, * was in mood for that. So...any other s...
5570	ham	The guy did some bitching but I acted like i'd...
5571	ham	Rofl. Its true to its name

5572 rows × 2 columns

In [7] :

```
 # Rename the columns "v1 and "v2" to new names

new_column_names = {"v1":"Category","v2":"Message"}
df.rename(columns = new_column_names,inplace = True)
```

In [8] :

```
 df[df.duplicated()]
```

Out [8] :

Category	Message	
102	ham	As per your request 'Melle Melle (Oru Minnamin...
153	ham	As per your request 'Melle Melle (Oru Minnamin...
206	ham	As I entered my cabin my PA said, '' Happy B'd...
222	ham	Sorry, I'll call later
325	ham	No calls..messages..missed calls
...	...	...

5524	spam	You are awarded a SiPix Digital Camera! call 0...
5535	ham	I know you are thinkin malaria. But relax, chi...
5539	ham	Just sleeping..and surfing
5553	ham	Hahaha..use your brain dear
5558	ham	Sorry, I'll call later

403 rows × 2 columns

In [9] :

```
#Drop duplicated values
df=df.drop_duplicates()
df
```

Out [9] :

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...
...	...	...
5567	spam	This is the 2nd time we have tried 2 contact u...
5568	ham	Will Ì_ b going to esplanade fr home?
5569	ham	Pity, * was in mood for that. So...any other s...
5570	ham	The guy did some bitching but I acted like i'd...
5571	ham	Rofl. Its true to its name

5169 rows × 2 columns

In [10] :

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 5169 entries, 0 to 5571
Data columns (total 2 columns):
 #   Column    Non-Null Count  Dtype 
---  ------    --------------  ----- 
 0   Category  5169 non-null   object
 1   Message   5169 non-null   object
dtypes: object(2)
memory usage: 121.1+ KB
```

In [11] :

```
df.describe()
```

Out [11] :

Category	Message	
count	5169	5169
unique	2	5169
top	ham	Go until jurong point, crazy.. Available only ...
freq	4516	1

In [12] :

```
Df.shape
```

Out [12]:

```
(5169, 2)
```

In [13] :

```
df['Category'].value_counts()
```

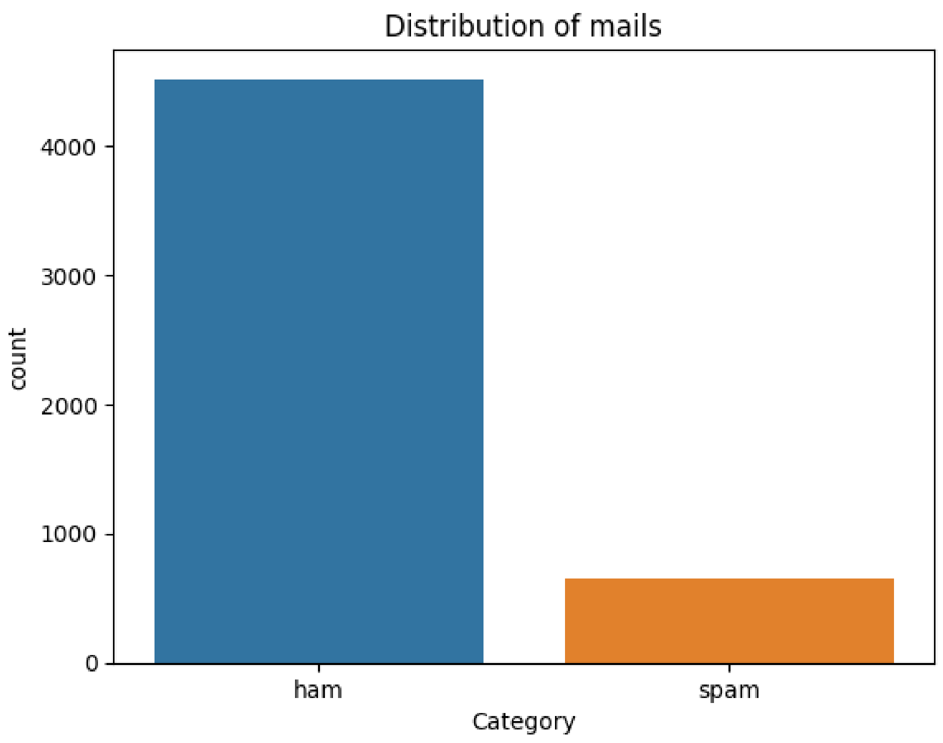
Out[13]:

```
Category
ham     4516
spam     653
Name: count, dtype: int64
```

Data Visualisation

In [14]:

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



Data Preprocessing

In [15]:

```
# Assuming you have a DataFrame named 'df'
df.loc[df["Category"] == "spam", "Category"] = 0
df.loc[df["Category"] == "ham", "Category"] = 1
df.head()
```

```
/tmp/ipykernel_20/3584819934.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation:
https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df.loc[df["Category"] == "spam", "Category"] = 0
/tmp/ipykernel_20/3584819934.py:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation:
https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df.loc[df["Category"] == "ham", "Category"] = 1
```

Out [15] :

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...

In [16] :

```
# Separate the feature (X) and target (Y) data

X = df["Message"]
Y = df["Category"]
```

In [17]:

```
X
```

Out[17]:

```
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: 5169, dtype: object
```

In [18]:

```
Y
```

Out [18] :

```
0       1
1       1
2       0
3       1
4       1
       ..
5567    0
5568    1
5569    1
5570    1
5571    1
Name: Category, Length: 5169, dtype: object
```

In [19] :

```
# Split the data into training and testing sets

X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size =
0.2, random_state = 42)
```

In [20]:

```
print(X.shape)
print(X_train.shape)
print(X_test.shape)
```

```
(5169,)
(4135,)
(1034,)
```

Feature Extraction: TF-IDF

In [21]:

```
# Create a TF-IDF vectorizer to convert text messages into numerical
features

feature_extraction = TfidfVectorizer(min_df=1, stop_words="english",
lowercase=True)
```

In [22]:

```
# Convert the training and testing text messages into numerical features
using TF-IDF

X_train_features = feature_extraction.fit_transform(X_train)
X_test_features = feature_extraction.transform(X_test)
```

In [23]:

```
# Convert the target values into 0 and 1

Y_train = Y_train.astype(int)
Y_test = Y_test.astype(int)
```

In [24]:

```
print(X_train)
```

```
2228                          Those were my exact intentions
5529                               What about this one then.
2149                       Waaaat?? Lololo ok next time then!
5058    Free video camera phones with Half Price line ...
5051    Tick, tick, tick .... Where are you ? I could ...
                              ...                        
4740    Many more happy returns of the day. I wish you...
474     Nice line said by a broken heart- Plz don't cu...
3266                        Ok then i come n pick u at engin?
4016    Eek that's a lot of time especially since Amer...
879     U have a Secret Admirer who is looking 2 make ...
Name: Message, Length: 4135, dtype: object
```

In [25]:

```
print(X_train_features)
```

```
 (0, 3545) 0.7455593142248959
  (0, 2588)     0.6664392762829205
  (2, 6589)     0.31366749842990076
  (2, 4696)     0.29654379102529516
  (2, 4002)     0.6378379419700079
  (2, 6999)     0.6378379419700079
  (3, 564) 0.2785767488573773
  (3, 1534)     0.23384958966251285
  (3, 52)  0.26549489341098675
  (3, 4344)     0.22076773421612225
  (3, 6770)     0.2300494583671639
  (3, 251) 0.19582167067522926
  (3, 4299)     0.18532229917229942
  (3, 4630)     0.26549489341098675
  (3, 1997)     0.26549489341098675
  (3, 516) 0.19460402332334106
  (3, 4419)     0.2562131692599451
  (3, 271) 0.23384958966251285
  (3, 5450)     0.2300494583671639
  (3, 3941)     0.18912243046764834
  (3, 5171)     0.20953002785296104
  (3, 3168)	0.19120469004402674
  (3, 4954)	0.23384958966251285
  (3, 1553)	0.20428654549041733
  (3, 6938)	0.19708708091575408
  :	:
  (4132, 1825)	0.3605065932469792
  (4132, 4696)	0.3418197199207224
  (4133, 5893)	0.376872105216547
  (4133, 4973)	0.36369662422743665
  (4133, 2451)	0.376872105216547
  (4133, 901)	0.36369662422743665
  (4133, 4029)	0.27296922168195425
  (4133, 4303)	0.2797666732547047
  (4133, 3930)	0.19090886726821316
  (4133, 2550)	0.326557029270423
  (4133, 4007)	0.2670514851432264
  (4133, 6192)	0.21536918062740018
  (4133, 6589)	0.19446518344396782
  (4134, 45)	0.36133141627364085
  (4134, 6198)	0.34436343393010593
  (4134, 216)	0.34436343393010593
  (4134, 6543)	0.29397934692144273
  (4134, 5512)	0.31535647652238075
  (4134, 799)	0.31535647652238075
  (4134, 5715)	0.3033175014581906
  (4134, 6069)	0.2508916342134232
  (4134, 4013)	0.26098383065689107
  (4134, 1895)	0.2301166472830892
  (4134, 4139)	0.20748487401135496
  (4134, 6867)	0.16697204675649222
```

Model Training

In [26]:

```
# Create a logistic regression model and train it on the training data

model = LogisticRegression()
model.fit(X_train_features, Y_train)
```

Out[26]:

```
    LogisticRegression
LogisticRegression()
```

Model Evaluation and Prediction

In [27]:

```
# Make predictions on the training data and calculate the accuracy

prediction_on_training_data = model.predict(X_train_features)
accuracy_on_training_data = accuracy_score(Y_train,
prediction_on_training_data)
```

In [28]:

```
print("Accuracy on training data:",accuracy_on_training_data)
```

```
Accuracy on training data: 0.9613059250302297
```

In [29]:

```
# Make predictions on the test data and calculate the accuracy

prediction_on_test_data = model.predict(X_test_features)
accuracy_on_test_data = accuracy_score(Y_test,prediction_on_test_data)
```

In [30]:

```
print("Accuracy on test data:",accuracy_on_test_data)
```

```
Accuracy on test data: 0.9642166344294004
```

In [31]:

```
# Test the model with some custom email messages
```

```
input_mail = ["Congratulations! You've won a free vacation to an exotic
island. Just click on the link below to claim your prize."]
input_data_features = feature_extraction.transform(input_mail)
prediction = model.predict(input_data_features)

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

```
Spam Mail
```

In [32]:

```
input_mail = ["This is a friendly reminder about our meeting scheduled
for tomorrow at 10:00 AM in the conference room. Please make sure to
prepare your presentation and bring any necessary materials."]
input_data_features = feature_extraction.transform(input_mail)
prediction = model.predict(input_data_features)

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

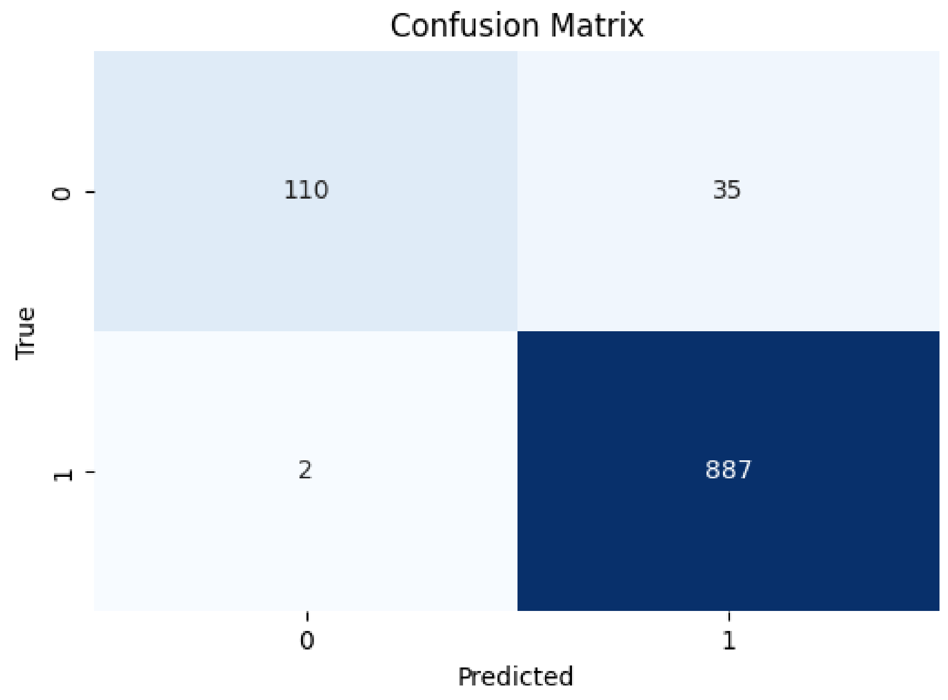
```
Ham Mail
```

In [33]:

```
# Data visualization - Confusion Matrix

cm = confusion_matrix(Y_test, prediction_on_test_data)

plt.figure(figsize=(6, 4))
sns.heatmap(cm, annot=True, fmt="d", cmap='Blues', cbar=False)
plt.xlabel('Predicted')
plt.ylabel('True')
plt.title('Confusion Matrix')
plt.show()
```



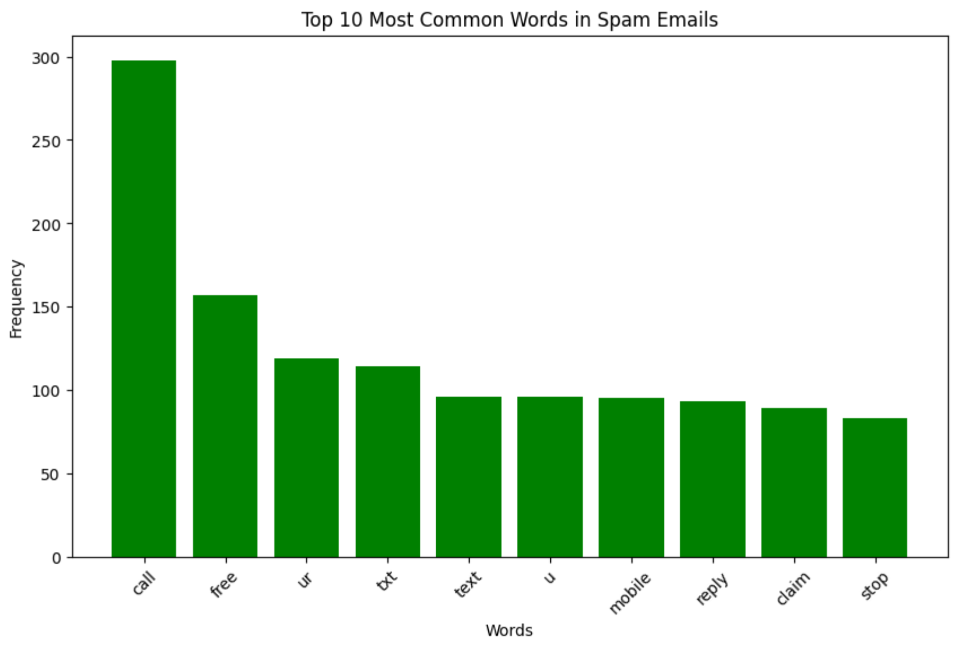
In [34]:

```
# Data visualization - Top 10 Most Common Words in Spam Emails

stop_words = set(stopwords.words('english'))
spam_words = " ".join(df[df['Category'] == 0]['Message']).split()
ham_words = " ".join(df[df['Category'] == 1]['Message']).split()

spam_word_freq = Counter([word.lower() for word in spam_words if
word.lower() not in stop_words and word.isalpha()])

plt.figure(figsize=(10, 6))
plt.bar(*zip(*spam_word_freq.most_common(10)), color='g')
plt.xlabel('Words')
plt.ylabel('Frequency')
plt.title('Top 10 Most Common Words in Spam Emails')
plt.xticks(rotation=45)
plt.show()
```

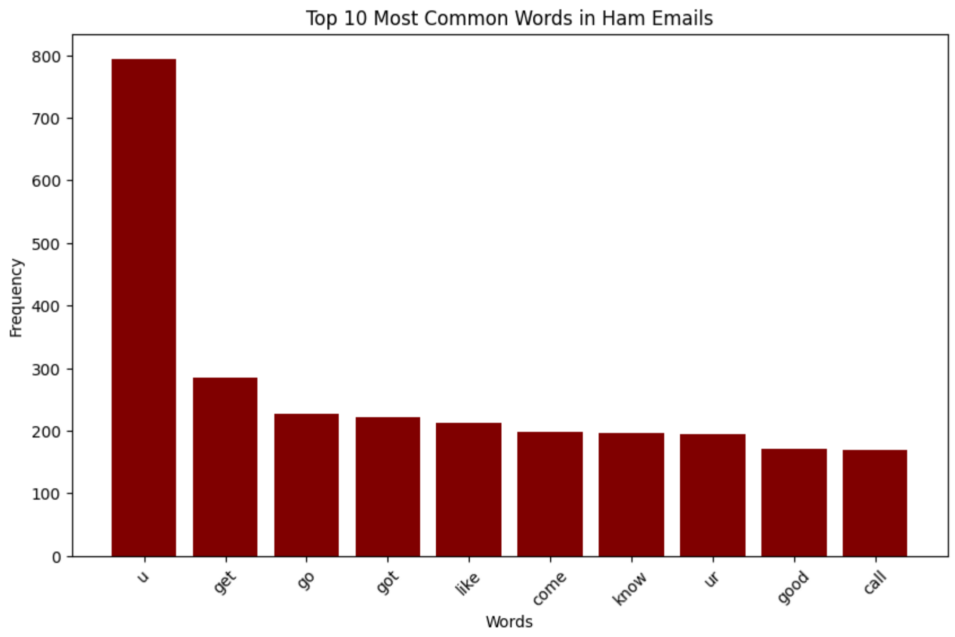


In [35]:

```
# Data visualization - Top 10 Most Common Words in Ham Emails

ham_word_freq = Counter([word.lower() for word in ham_words if
word.lower() not in stop_words and word.isalpha()])

plt.figure(figsize=(10, 6))
plt.bar(*zip(*ham_word_freq.most_common(10)), color='maroon')
plt.xlabel('Words')
plt.ylabel('Frequency')
plt.title('Top 10 Most Common Words in Ham Emails')
plt.xticks(rotation=45)
plt.show()
```


Top 10 Most Common Words in Ham Emails
Frequency
Words
0
100
200
300
400
500
600
700
800
u
get
go
got
like
come
know
ur
good
call