1. Download The Dataset

https://www.kaggle.com/code/kredy10/simple-lstm-for-text-classification/data

1. Import The Required Libraries

```
import os
import re
import pandas as pd
import numpy as np
import nltk
from nltk.corpus import stopwords
from nltk.stem import WordNetLemmatizer
from wordcloud import WordCloud
import matplotlib.pyplot as plt
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, LSTM, Dropout, Embedding
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.preprocessing.text import Tokenizer
import keras
from sklearn.preprocessing import LabelEncoder
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.model_selection import train_test_split
from google.colab import drive

#Mount and access drive
drive.mount('/content/drive',force_remount=True)
os.chdir('/content/drive/My Drive')
print("Change successful.")
```

```
Mounted at /content/drive
Change successful.
```

3.Read The Dataset And Do Pre-Processing

```
spam_df = pd.read_csv(filepath_or_buffer='/content/spam.csv',
delimiter=',',encoding='latin-1')
spam_df.head()
```

```
     v1                                                 v2 Unnamed: 2
\
0   ham  Go until jurong point, crazy.. Available only ...        NaN

1   ham                      Ok lar... Joking wif u oni...        NaN

2  spam  Free entry in 2 a wkly comp to win FA Cup fina...        NaN

3   ham  U dun say so early hor... U c already then say...        NaN

4   ham  Nah I don't think he goes to usf, he lives aro...        NaN
```

```
  Unnamed: 3 Unnamed: 4
0        NaN        NaN
1        NaN        NaN
2        NaN        NaN
3        NaN        NaN
4        NaN        NaN
```

```
#List the column names
spam_df.columns
```

```
Index(['v1', 'v2', 'Unnamed: 2', 'Unnamed: 3', 'Unnamed: 4'],
dtype='object')
```

```
#Drop the unnamed columns
spam_df.drop(columns=['Unnamed: 2', 'Unnamed: 3', 'Unnamed: 4'],
axis=1, inplace=True)
spam_df.columns
```

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

```
#Print the number of rows in the dataset
spam_df.shape
```

```
(5572, 2)
```

```
#Get the summary statistics of the dataset
spam_df.describe()
```

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

```
#Check for null values
spam_df.isna().sum()
```

```
v1    0
v2    0
dtype: int64
```

```
#Check for duplicated rows
spam_df.duplicated().sum()
```

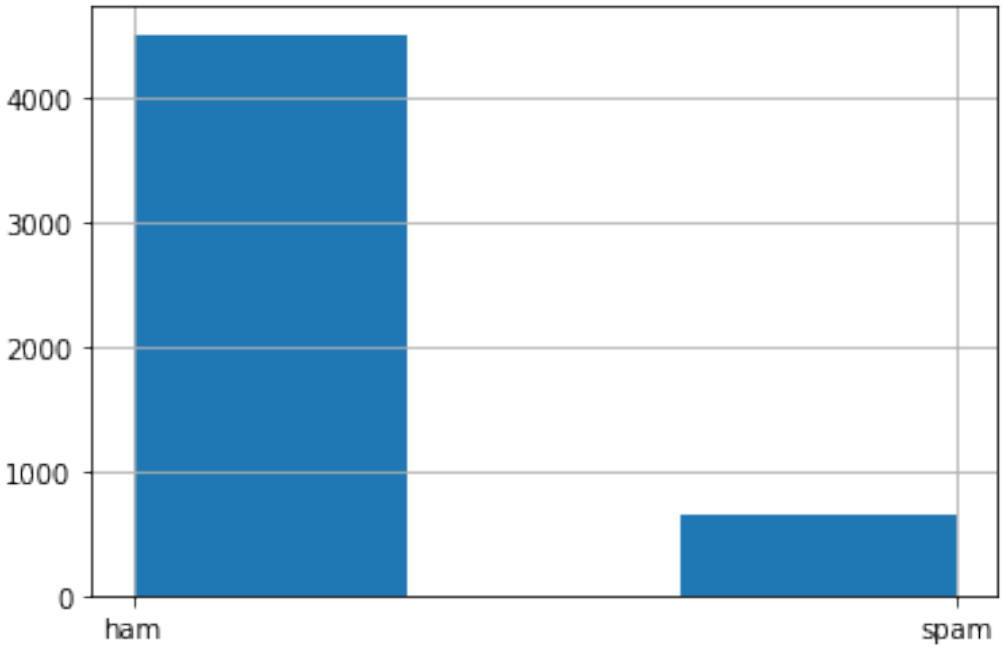
```
403
```

```
#Remove the duplicated rows
spam_df = spam_df.drop_duplicates()
spam_df.duplicated().sum()
```

```
0
```

```
#Display the count of spam and ham labels and Stratified-split is
required
spam_df['v1'].hist(bins=3)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fa7b5a8ca10>
```




```
def wordcloud_vis(column):
  mostcommon = nltk.FreqDist(spam_df[column]).most_common(100)
  wordcloud = WordCloud(width=1600, height=800,
background_color='white').generate(str(mostcommon))
  fig = plt.figure(figsize=(30,10), facecolor='white')
  plt.imshow(wordcloud) #, interpolation="bilinear")
  plt.axis('off')
  plt.show()

#Plot the word-cloud before removing stopwords, performing
lemmatization
wordcloud_vis('v2')
```


```
#Retain only the letters and spaces
spam_df['alpha_text'] = spam_df['v2'].apply(lambda x: re.sub(r'[^a-zA-
Z ]+', '', x.lower()))
spam_df.head()
```

```
     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...

                                          alpha_text
0  go until jurong point crazy available only in ...
1                            ok lar joking wif u oni
2  free entry in  a wkly comp to win fa cup final...
3        u dun say so early hor u c already then say
4  nah i dont think he goes to usf he lives aroun...
```

```
#Remove stop-words
nltk.download('stopwords')
spam_df['imp_text'] = spam_df['alpha_text'].apply(lambda x : '
'.join([word for word in x.split() if not word in
set(stopwords.words('english'))]))
spam_df.head()
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
```

```
     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...

                                          alpha_text  \
0  go until jurong point crazy available only in ...
1                            ok lar joking wif u oni
2  free entry in  a wkly comp to win fa cup final...
3        u dun say so early hor u c already then say
4  nah i dont think he goes to usf he lives aroun...

                                            imp_text
0  go jurong point crazy available bugis n great ...
1                            ok lar joking wif u oni
2  free entry wkly comp win fa cup final tkts st ...
3                u dun say early hor u c already say
4        nah dont think goes usf lives around though
```

```
#Tokenize the data
def tokenize(data):
  generated_token = list(data.split())
  return generated_token
spam_df['token_text'] = spam_df['imp_text'].apply(lambda x:
tokenize(x))
spam_df.head()
```

```
     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...

                                          alpha_text  \
0  go until jurong point crazy available only in ...
1                            ok lar joking wif u oni
2  free entry in  a wkly comp to win fa cup final...
3        u dun say so early hor u c already then say
4  nah i dont think he goes to usf he lives aroun...

                                            imp_text  \
0  go jurong point crazy available bugis n great ...
1                            ok lar joking wif u oni
2  free entry wkly comp win fa cup final tkts st ...
3                u dun say early hor u c already say
4        nah dont think goes usf lives around though

                                          token_text
0  [go, jurong, point, crazy, available, bugis, n...
1                    [ok, lar, joking, wif, u, oni]
2  [free, entry, wkly, comp, win, fa, cup, final,...
```

```
3      [u, dun, say, early, hor, u, c, already, say]
4  [nah, dont, think, goes, usf, lives, around, t...
```

```
#Perform lemmatization
nltk.download('wordnet')
nltk.download('omw-1.4')
lemmatizer = WordNetLemmatizer()
def lemmatization(list_of_words):
  lemmatized_list = [lemmatizer.lemmatize(word) for word in
list_of_words]
  return lemmatized_list
spam_df['lemmatized_text'] = spam_df['token_text'].apply(lambda x:
lemmatization(x))
spam_df.head()
```

```
[nltk_data] Downloading package wordnet to /root/nltk_data...
[nltk_data] Downloading package omw-1.4 to /root/nltk_data...
```

```
     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...

                                          alpha_text  \
0  go until jurong point crazy available only in ...
1                          ok lar joking wif u oni
2  free entry in  a wkly comp to win fa cup final...
3        u dun say so early hor u c already then say
4  nah i dont think he goes to usf he lives aroun...

                                            imp_text  \
0  go jurong point crazy available bugis n great ...
1                          ok lar joking wif u oni
2  free entry wkly comp win fa cup final tkts st ...
3                u dun say early hor u c already say
4       nah dont think goes usf lives around though

                                          token_text  \
0  [go, jurong, point, crazy, available, bugis, n...
1                    [ok, lar, joking, wif, u, oni]
2  [free, entry, wkly, comp, win, fa, cup, final,...
3      [u, dun, say, early, hor, u, c, already, say]
4  [nah, dont, think, goes, usf, lives, around, t...

                                     lemmatized_text
0  [go, jurong, point, crazy, available, bugis, n...
1                    [ok, lar, joking, wif, u, oni]
2  [free, entry, wkly, comp, win, fa, cup, final,...
```

```
3      [u, dun, say, early, hor, u, c, already, say]
4  [nah, dont, think, go, usf, life, around, though]
```

```
#Combine the tokens (into sentences) to get the final cleansed data
spam_df['clean'] = spam_df['lemmatized_text'].apply(lambda x: '
'.join(x))
spam_df.head()
```

```
     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...

                                          alpha_text  \
0  go until jurong point crazy available only in ...
1                            ok lar joking wif u oni
2  free entry in  a wkly comp to win fa cup final...
3        u dun say so early hor u c already then say
4  nah i dont think he goes to usf he lives aroun...

                                            imp_text  \
0  go jurong point crazy available bugis n great ...
1                            ok lar joking wif u oni
2  free entry wkly comp win fa cup final tkts st ...
3                u dun say early hor u c already say
4         nah dont think goes usf lives around though

                                          token_text  \
0  [go, jurong, point, crazy, available, bugis, n...
1                     [ok, lar, joking, wif, u, oni]
2  [free, entry, wkly, comp, win, fa, cup, final,...
3      [u, dun, say, early, hor, u, c, already, say]
4  [nah, dont, think, goes, usf, lives, around, t...

                                       lemmatized_text  \
0  [go, jurong, point, crazy, available, bugis, n...
1                     [ok, lar, joking, wif, u, oni]
2  [free, entry, wkly, comp, win, fa, cup, final,...
3      [u, dun, say, early, hor, u, c, already, say]
4  [nah, dont, think, go, usf, life, around, though]

                                                clean
0  go jurong point crazy available bugis n great ...
1                            ok lar joking wif u oni
2  free entry wkly comp win fa cup final tkts st ...
3                u dun say early hor u c already say
4           nah dont think go usf life around though
```

```
#Display the word cloud after preprocessing
wordcloud_vis('clean')
```


```
#Number of unique words in spam and ham
df1 = spam_df.loc[spam_df['v1'] == 'spam']
df2 = spam_df.loc[spam_df['v1'] == 'ham']

spam = set()
df1['clean'].str.lower().str.split().apply(spam.update)
print("Number of unique words in spam", len(spam))

ham = set()
df2['clean'].str.lower().str.split().apply(ham.update)
print("Number of unique words in ham", len(ham))

Number of unique words in spam 2037
Number of unique words in ham 6738

#Find the number of overlapping words between spam and ham labels
print("Number of overlapping words between spam and ham: ", len(spam &
ham))

Number of overlapping words between spam and ham:  895

#Maximum number of words in a sentence and Useful for applying padding
spam_df['clean'].apply(lambda x:len(str(x).split())).max()

80

#Prepare the data for training
X = spam_df['clean']
y = spam_df['v1']
```

```
#Convert the class labels into integer values
le = LabelEncoder()
y = le.fit_transform(y)
y
```

```
array([0, 0, 1, ..., 0, 0, 0])
```

```
X.shape
```

```
(5169,)
```

```
y.shape
```

```
(5169,)
```

```
#Split the data into train, test
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.15, random_state=42, stratify=y)
```

```
tokenizer = Tokenizer(num_words=1000)
tokenizer.fit_on_texts(X_train)
tokenized_train = tokenizer.texts_to_sequences(X_train)
X_train = tf.keras.utils.pad_sequences(tokenized_train, maxlen=100)
tokenized_test = tokenizer.texts_to_sequences(X_test)
X_test = tf.keras.utils.pad_sequences(tokenized_test, maxlen=100)
```

1. Create The Model

```
#Create a wrapper to add layers to the model
model = Sequential()
```

1. Add Layers (LSTM, Dense-(Hidden Layers), Output)

```
model.add(Embedding(1000, output_dim=50, input_length=100))
model.add(LSTM(units=64 , return_sequences = True, dropout = 0.2))
model.add(LSTM(units=32 , dropout = 0.1))
model.add(Dense(units = 64 , activation = 'relu'))
model.add(Dense(units = 32 , activation = 'relu'))
model.add(Dense(1, activation='sigmoid'))
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding (Embedding)       (None, 100, 50)           50000

 lstm (LSTM)                 (None, 100, 64)           29440

 lstm_1 (LSTM)               (None, 32)                12416

 dense (Dense)               (None, 64)                2112

 dense_1 (Dense)             (None, 32)                2080
```

```
 dense_2 (Dense)             (None, 1)                 33

=================================================================
Total params: 96,081
Trainable params: 96,081
Non-trainable params: 0
_________________________________________________________________
```

1. Compile The Model

```
model.compile(optimizer='adam', loss='binary_crossentropy',
metrics=['accuracy'])
```

1. Fit The Model

```
model.fit(X_train, y_train,
batch_size=128,epochs=10,validation_split=0.2,callbacks=[EarlyStopping
(monitor='val_loss',patience=2)])
```

```
Epoch 1/10
28/28 [==============================] - 7s 242ms/step - loss: 0.0057
- accuracy: 0.9986 - val_loss: 0.1574 - val_accuracy: 0.9716
Epoch 2/10
28/28 [==============================] - 7s 240ms/step - loss: 0.0047
- accuracy: 0.9986 - val_loss: 0.1487 - val_accuracy: 0.9738
Epoch 3/10
28/28 [==============================] - 7s 238ms/step - loss: 0.0037
- accuracy: 0.9991 - val_loss: 0.1627 - val_accuracy: 0.9761
Epoch 4/10
28/28 [==============================] - 7s 240ms/step - loss: 0.0043
- accuracy: 0.9989 - val_loss: 0.1641 - val_accuracy: 0.9750

<keras.callbacks.History at 0x7fa7ae547b50>
```

1. Save The Model

```
model.save('spam-classifier.h5')
```

1. Test The Model

```
print("Accuracy of the model on Testing Data is - " ,
model.evaluate(X_test,y_test)[1]*100 , "%")
```

```
25/25 [==============================] - 1s 24ms/step - loss: 0.1436 -
accuracy: 0.9755
Accuracy of the model on Testing Data is -  97.55154848098755 %
```