1. Download the Dataset

The given dataset has been downloaded as spam.csv file.

2. Import required libraries

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers
```

3. Read dataset and do pre-processing

```
df = pd.read_csv("/content/spam.csv", encoding="latin-1")

df.head() # an overview
```

```
     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
```

Since the given dataset has three Unnamed columns that we don't need, we will drop them and also our label is in string form -> spam and ham, we will map them in numerical form.

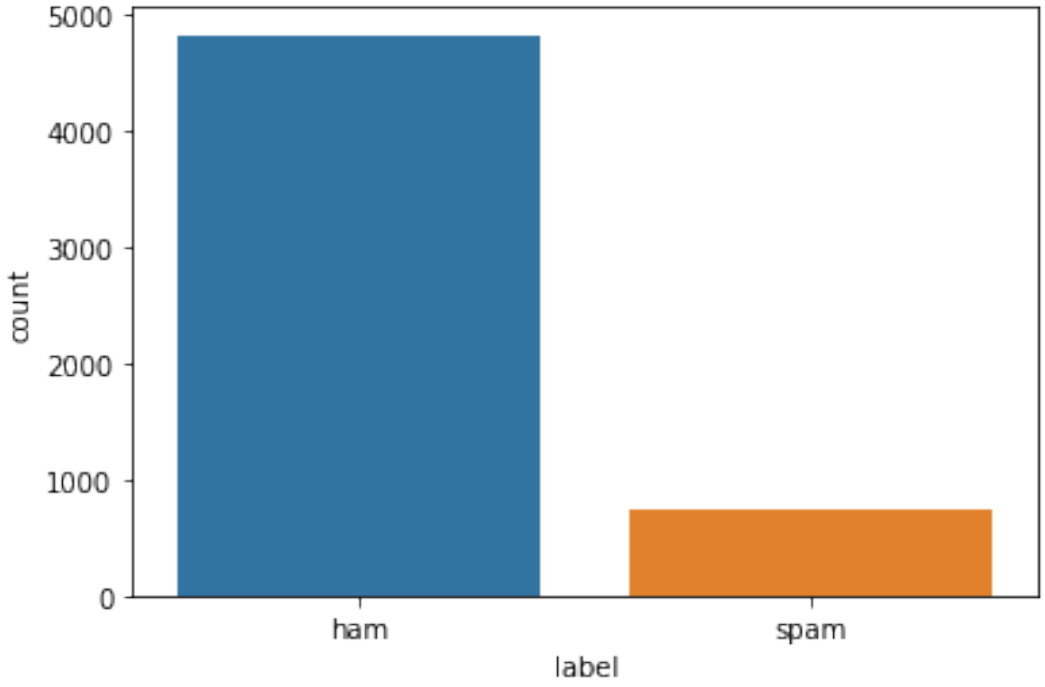
```
df = df.drop(['Unnamed: 2', 'Unnamed: 3', 'Unnamed: 4'], axis=1)
df = df.rename(columns={'v1':'label', 'v2':'Text'})
df['label_in_num'] = df['label'].map({'ham':0,'spam':1})
df.head()
```

```
  label                                               Text
label_in_num
```

```
0   ham  Go until jurong point, crazy.. Available only ...
0
1   ham                      Ok lar... Joking wif u oni...
0
2  spam  Free entry in 2 a wkly comp to win FA Cup fina...
1
3   ham  U dun say so early hor... U c already then say...
0
4   ham  Nah I don't think he goes to usf, he lives aro...
0
```

```
sns.countplot(x=df['label']) # countplot for label
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f63837cae90>
```



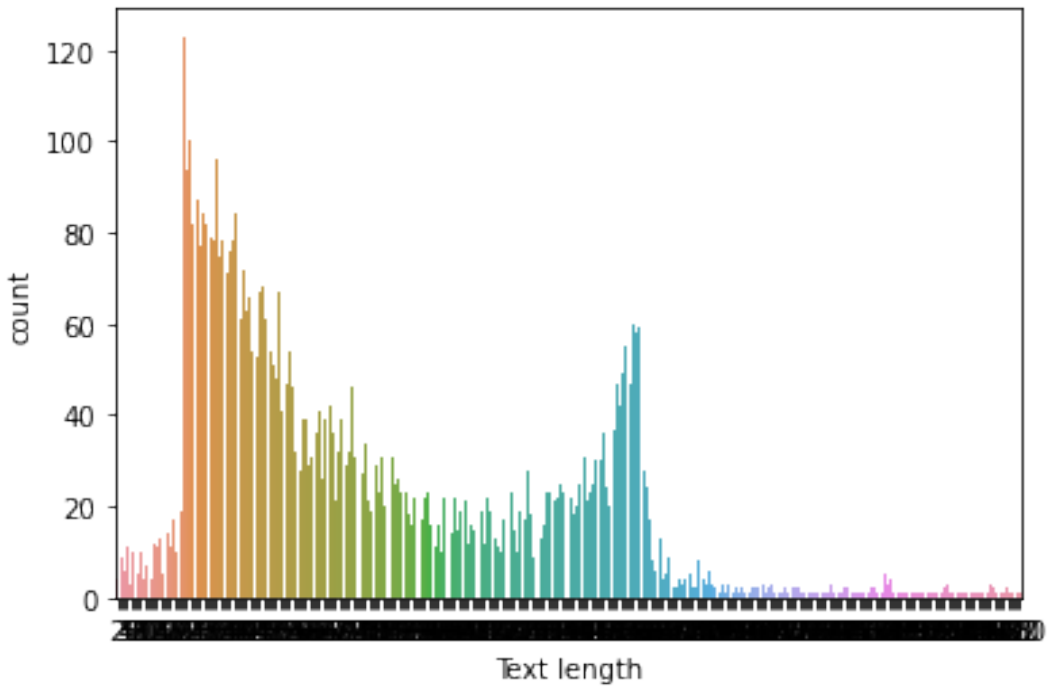

```
df['label'].value_counts()
```

```
ham     4825
spam     747
Name: label, dtype: int64
```

Since the data points with ham label are 6.5 times more than points with spam labels, this makes the data an imbalanced dataset.

```
sns.countplot(x=[len(df.loc[i]['Text']) for i in range(len(df))])
plt.xlabel('Text length')
```

```
Text(0.5, 0, 'Text length')
```



Since we want to find no of words in the dataset and mean of word count in every to process for model building we will perform the below code.

```
text_words_lengths = [len(df.loc[i]['Text'].split()) for i in range(0,
len(df))]
total_length = np.sum(text_words_lengths)
text_words_mean = int(np.mean(text_words_lengths))
print('we have ' + str(total_length) + ' words in our Dataframe')
print('the average word count in every scentence is ' +
str(text_words_mean))
text_words_lengths[:5], total_length, text_words_mean
```

```
we have 86335 words in our Dataframe
the average word count in every scentence is 15
```

```
([20, 6, 28, 11, 13], 86335, 15)
```

Train & Test Split

```
from sklearn.model_selection import train_test_split
X, y = np.asanyarray(df['Text']), np.asanyarray(df['label_in_num'])
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=24)
len(X_train), len(X_test), X_train[:2], y_train[:2]
```

```
(4457, 1115, array(['Kallis wont bat in 2nd innings.',
        'Ringtone Club: Get the UK singles chart on your mobile each
week and choose any top quality ringtone! This message is free of
charge.'],
       dtype=object), array([0, 1]))
```

Helper Functions

Text vectorization is the process of converting text into a numerical representation. Example: Bag of words frequency, Binary Term frequency, etc.; A word embedding is a learned representation of text in which words with related meanings have similar representations. Each word is assigned to a single vector, and the vector values are learned like that of a neural network.Now, we'll create a custom text vectorization layer using TensorFlow.

```
MAXTOKENS = total_length #maximum size of the vocabulary which was
found earlier
OUTPUTLEN = text_words_mean #length to which the sentences should be
padded irrespective of the sentence length.
text_vec = layers.TextVectorization(
    max_tokens=MAXTOKENS,
    standardize='lower_and_strip_punctuation',
    output_mode='int',
    output_sequence_length=OUTPUTLEN
)
text_vec.adapt(X_train)

#input_dim is the size of vocabulary
#output_dim is the dimension of the embedding layer i.e, the size of
the vector in which the words will be embedded
#input_length is the length of input sequences
embedding_layer = layers.Embedding(
    input_dim=MAXTOKENS,
    output_dim=128,
    embeddings_initializer='uniform',
    input_length=OUTPUTLEN
)
```

4. Create Model

```
input_layer = layers.Input(shape=(1,), dtype=tf.string) # Input layer,
string type(text)
vec_layer = text_vec(input_layer) # text vectorization layer(built
previous lines)
embedding_layer_model = embedding_layer(vec_layer) # word embedding
layer
bi_lstm = layers.Bidirectional(layers.LSTM(64, activation='tanh',
return_sequences=True))(embedding_layer_model) # Bidirectional-LSTM,
64 units
lstm = layers.Bidirectional(layers.LSTM(64))(bi_lstm)
flatten = layers.Flatten()(lstm) # Flatten layer for enering in dense
layers
dropout = layers.Dropout(.1)(flatten) # drop out layer
x = layers.Dense(32, activation='relu')(dropout) # Dense layer
output_layer = layers.Dense(1, activation='sigmoid')(x) # output layer
model_2 = keras.Model(input_layer, output_layer) # final model
```

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

```
# Input layer
input_layer = layers.Input(shape=(1,), dtype=tf.string)
# Text Vectorizatino layer
vec_layer = text_vec(input_layer)
# Embedding layer
embedding_layer_model = embedding_layer(vec_layer)
# Global Average Pooling layer
x = layers.GlobalAveragePooling1D()(embedding_layer_model)
# Flatten layer for Dense layers
x = layers.Flatten()(x)
# 32 units dense layer
x = layers.Dense(32, activation='relu')(x)
# output layer with sigmoid activation function
output_layer = layers.Dense(1, activation='sigmoid')(x)
# final model
model_1 = keras.Model(input_layer, output_layer)
```

6. Compile the Model, Fit the Model

```
def compile_model(model):
    model.compile(optimizer=keras.optimizers.Adam(),
                  loss=keras.losses.BinaryCrossentropy(),
                  metrics=['accuracy'])
def fit_model(model, epochs, X_train=X_train, y_train=y_train,
X_test=X_test, y_test=y_test):
    history = model.fit(X_train,
                y_train,
               epochs=epochs,
               validation_data=(X_test, y_test),
               validation_steps=int(0.2*len(X_test)))
    return history

compile_model(model_2) # compile the model
history_2 = fit_model(model_2, epochs=5) # fit the model
```

```
Epoch 1/5
140/140 [==============================] - 39s 216ms/step - loss:
0.1722 - accuracy: 0.9390 - val_loss: 0.0642 - val_accuracy: 0.9821
Epoch 2/5
140/140 [==============================] - 26s 188ms/step - loss:
0.0314 - accuracy: 0.9915 - val_loss: 0.0662 - val_accuracy: 0.9749
Epoch 3/5
140/140 [==============================] - 26s 186ms/step - loss:
0.0099 - accuracy: 0.9975 - val_loss: 0.0828 - val_accuracy: 0.9803
Epoch 4/5
140/140 [==============================] - 26s 185ms/step - loss:
0.0034 - accuracy: 0.9991 - val_loss: 0.0774 - val_accuracy: 0.9830
Epoch 5/5
```

```
129/140 [==========================>...] - ETA: 1s - loss: 0.0015 -
accuracy: 0.9995
```

```
from sklearn.metrics import precision_score, recall_score, f1_score,
accuracy_score
def evaluate_model(model, X, y):
    y_preds = np.round(model.predict(X))
    accuracy = accuracy_score(y, y_preds)
    precision = precision_score(y, y_preds)
    recall = recall_score(y, y_preds)
    f1 = f1_score(y, y_preds)
    model_results_dict = {'accuracy':accuracy,
                          'precision':precision,
                          'recall':recall,
                          'f1-score':f1}
    return model_results_dict
```

7. Saving and testing the model

```
model_2.save('spam')
```

```
model_2.evaluate(X_test, y_test)
```

```
35/35 [==============================] - 6s 32ms/step - loss: 0.0934 -
accuracy: 0.9785
```

```
[0.09340307861566544, 0.9784753322601318]
```

```
print(evaluate_model(model_2,X_test, y_test))
```

```
35/35 [==============================] - 3s 12ms/step
{'accuracy': 0.97847533632287, 'precision': 0.9054054054054054,
'recall': 0.9305555555555556, 'f1-score': 0.9178082191780821}
```