Assignment Date	22-10-2022
Student Name	Saiusha.S
Student Roll No	960519104070
Maximum Mark	2 Marks

Dataset Importing

In [1]:

```
from google.colab import drive
drive.mount('/content/drive')
```

Mounted at /content/drive

In [2]:

```
import pandas as pd
dataset = pd.read_csv('/content/drive/MyDrive/spam.csv', encoding='latin-1')
print(dataset.head())
print(dataset.info())
```

```
   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

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
None
```

Importing libraries ,Reading dataset and doing pre-processing

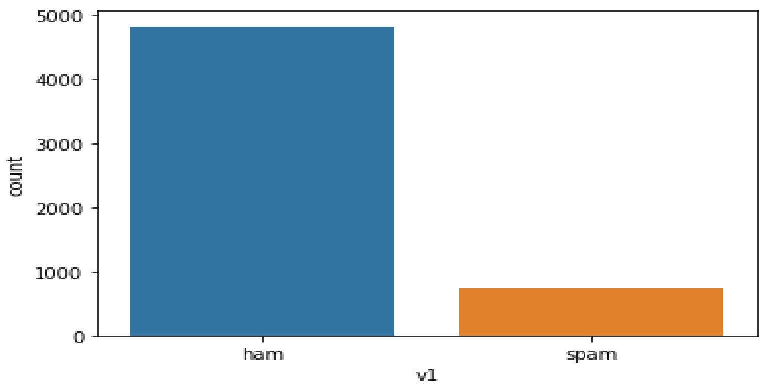
In [3]:

```
import matplotlib.pyplot as plt
import seaborn as sns
```

In [4]:

```
sns.countplot(data=dataset, x=dataset['v1'])
```

Out[4]:



In [5]:

```
text = dataset.loc[:, 'v2']
classification = dataset.loc[:, 'v1']
print(text)
print(classification)
```

```
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: v2, Length: 5572, dtype: object
0        ham
1        ham
2       spam
3        ham
4        ham
        ...
5567    spam
5568     ham
5569     ham
5570     ham
5571     ham
Name: v1, Length: 5572, dtype: object
```

In [10]:

```
from nltk import word_tokenize
from sklearn.model_selection import train_test_split
import nltk
nltk.download('punkt')
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt.zip.
```

Out[10]:

True

In [11]:

```
x_train, x_test, y_train, y_test = train_test_split(text, classification, test_size=0.2, random_state=42)
```

In [12]:

```
text_length = []
for i in x_train :
  text_length.append(len(word_tokenize(i)))
```

In [13]:

```
print(max(text_length))
```

220

In [14]:

```
from keras.preprocessing.text import Tokenizer
```

In [15]:

```
max_sequence_length = 38

tok = Tokenizer()
tok.fit_on_texts(x_train.values)
```

In [16]:

```
vocab_length = len(tok.word_index)
```

In [17]:

```
vocab_length = len(tok.word_index)
```

In [18]:

```
x_train_sequences = tok.texts_to_sequences(x_train.values)
x_test_sequences = tok.texts_to_sequences(x_test.values)
```

In [19]:

```
from tensorflow.keras.utils import pad_sequences
```

In [22]:

```
x_train = pad_sequences(x_train_sequences, maxlen=max_sequence_length)
x_test = pad_sequences(x_test_sequences, maxlen=max_sequence_length)
```

In [21]:

```
x_train[:2]
```

Out[21]:

```
array([[   0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,   38,   30,    8,
           5,  273, 1989,   81,  116,   26,   11, 1656,  322,   10,   53,
          18,  299,   30,  349, 1990],
       [   0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,  799,   15, 2555, 1442, 1127,  192, 2556,
         171,   12,   98, 1991,   44,  195, 1657, 2557, 1992, 2558,   21,
           9,    4,  203, 1025,  225]], dtype=int32)
```

In [23]:

```
y_train.values
```

Out[23]:

```
array(['ham', 'spam', 'ham', ..., 'ham', 'ham', 'ham'], dtype=object)
```

In [24]:

```
from sklearn.preprocessing import LabelEncoder
```

In [25]:

```
le = LabelEncoder()
y_train = le.fit_transform(y_train)
y_test = le.fit_transform(y_test)
print(y_train)
```

[0 1 0 ... 0 0 0]

In [26]:

```
from keras.models import Model, load_model
from keras.layers import LSTM, Activation, Dense, Dropout, Input, Embedding
from keras.optimizers import RMSprop
```

Creating models and Adding layers

In [27]:

```
def create_model(vocab_len, max_seq_len):
    inputs = Input(name='inputs', shape=[max_seq_len])   #None, 150
    layer = Embedding(vocab_length + 1, 50, input_length=max_seq_len)(inputs) #None, 150, 50
    layer = LSTM(64)(layer)  #None, 64
    layer = Dense(256,name='FC1')(layer) #None, 256
    layer = Activation('relu')(layer) #None, 256
    layer = Dropout(0.5)(layer) #None, 256
    layer = Dense(1,name='out_layer')(layer) #None, 1
    layer = Activation('sigmoid')(layer) #None, 1
    model = Model(inputs=inputs,outputs=layer)
    model.compile(loss='binary_crossentropy',optimizer=RMSprop(), metrics=['acc'])
    return model

model = create_model(vocab_length, max_sequence_length)
model.summary()
```

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 inputs (InputLayer)         [(None, 38)]              0

 embedding (Embedding)       (None, 38, 50)            397750

 lstm (LSTM)                 (None, 64)                29440

 FC1 (Dense)                 (None, 256)               16640

 activation (Activation)     (None, 256)               0

 dropout (Dropout)           (None, 256)               0

 out_layer (Dense)           (None, 1)                 257

 activation_1 (Activation)   (None, 1)                 0

=================================================================
Total params: 444,087
Trainable params: 444,087
Non-trainable params: 0
_________________________________________________________________
```

Compiling model

In [28]:

```
from keras.callbacks import EarlyStopping, ModelCheckpoint, TensorBoard
```

In [29]:

```
history = model.fit(x_train, y_train, batch_size=128, epochs=20, validation_split=0.2)
```

```
Epoch 1/20
28/28 [==============================] - 5s 98ms/step - loss: 0.2984 - acc: 0.8741 - val_loss: 0.
1544 - val_acc: 0.9552
Epoch 2/20
28/28 [==============================] - 2s 74ms/step - loss: 0.0803 - acc: 0.9820 - val_loss: 0.
0573 - val_acc: 0.9821
Epoch 3/20
28/28 [==============================] - 2s 75ms/step - loss: 0.0268 - acc: 0.9924 - val_loss: 0.
0419 - val_acc: 0.9865
```

Epoch 4/20
28/28 [==============================] - 3s 98ms/step - loss: 0.0151 - acc: 0.9961 - val_loss: 0.
0412 - val_acc: 0.9843
Epoch 5/20
28/28 [==============================] - 2s 75ms/step - loss: 0.0083 - acc: 0.9969 - val_loss: 0.
0678 - val_acc: 0.9843
Epoch 6/20
28/28 [==============================] - 2s 74ms/step - loss: 0.0052 - acc: 0.9983 - val_loss: 0.
0690 - val_acc: 0.9854
Epoch 7/20
28/28 [==============================] - 2s 75ms/step - loss: 4.3604e-04 - acc: 1.0000 - val_los
s: 0.0707 - val_acc: 0.9865
Epoch 8/20
28/28 [==============================] - 2s 75ms/step - loss: 4.3695e-05 - acc: 1.0000 - val_los
s: 0.0848 - val_acc: 0.9888
Epoch 9/20
28/28 [==============================] - 2s 74ms/step - loss: 0.0029 - acc: 0.9994 - val_loss: 0.
0913 - val_acc: 0.9798
Epoch 10/20
28/28 [==============================] - 2s 74ms/step - loss: 2.9656e-04 - acc: 1.0000 - val_los
s: 0.0992 - val_acc: 0.9832
Epoch 11/20
28/28 [==============================] - 2s 76ms/step - loss: 1.8744e-05 - acc: 1.0000 - val_los
s: 0.1156 - val_acc: 0.9854
Epoch 12/20
28/28 [==============================] - 2s 76ms/step - loss: 2.5507e-06 - acc: 1.0000 - val_los
s: 0.1101 - val_acc: 0.9888
Epoch 13/20
28/28 [==============================] - 2s 75ms/step - loss: 1.1500e-06 - acc: 1.0000 - val_los
s: 0.1304 - val_acc: 0.9865
Epoch 14/20
28/28 [==============================] - 2s 75ms/step - loss: 3.2071e-07 - acc: 1.0000 - val_los
s: 0.2487 - val_acc: 0.9821
Epoch 15/20
28/28 [==============================] - 2s 74ms/step - loss: 0.0046 - acc: 0.9994 - val_loss: 0.
0985 - val_acc: 0.9832
Epoch 16/20
28/28 [==============================] - 2s 76ms/step - loss: 1.4251e-04 - acc: 1.0000 - val_los
s: 0.1183 - val_acc: 0.9854
Epoch 17/20
28/28 [==============================] - 2s 75ms/step - loss: 8.2607e-06 - acc: 1.0000 - val_los
s: 0.1241 - val_acc: 0.9854
Epoch 18/20
28/28 [==============================] - 2s 74ms/step - loss: 3.0136e-06 - acc: 1.0000 - val_los
s: 0.1288 - val_acc: 0.9843
Epoch 19/20
28/28 [==============================] - 2s 75ms/step - loss: 1.9952e-06 - acc: 1.0000 - val_los
s: 0.1374 - val_acc: 0.9843
Epoch 20/20
28/28 [==============================] - 2s 75ms/step - loss: 4.4795e-07 - acc: 1.0000 - val_los
s: 0.1438 - val_acc: 0.9854

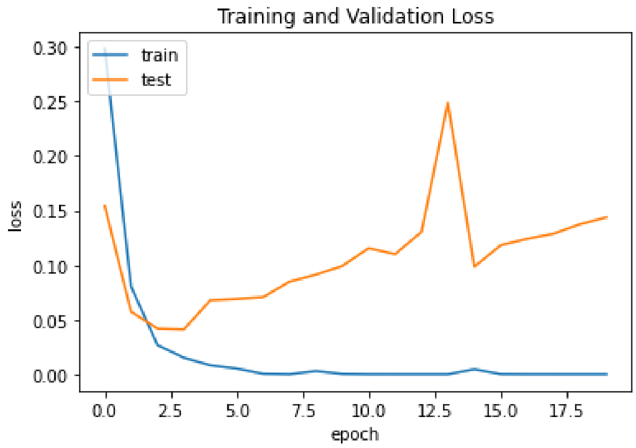
Fitting and Saving the model

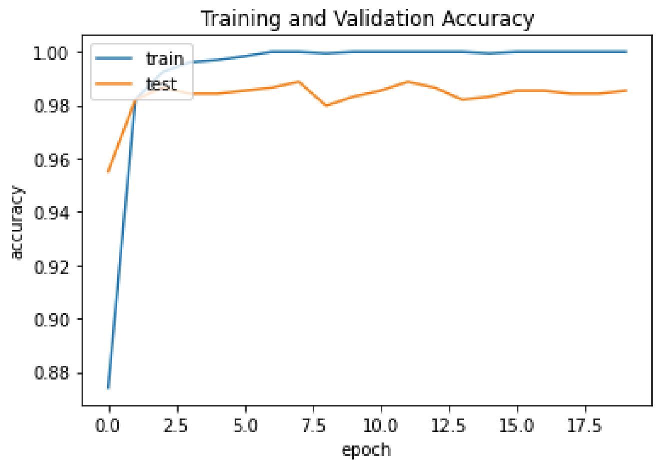
In [30]:

```
history_dict = history.history

# list all data in history
```

```
print(history_dict.keys())

# summarize history for loss
plt.plot(history_dict['loss'])
plt.plot(history_dict['val_loss'])
plt.title('Training and Validation Loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()

# summarize history for accuracy
plt.plot(history_dict['acc'])
plt.plot(history_dict['val_acc'])
plt.title('Training and Validation Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()
```

dict_keys(['loss', 'acc', 'val_loss', 'val_acc'])





In [32]:

```
model.save('/content/drive/MyDrive/spam.h5')
```

Testing the model

In [34]:

```
loaded_model = load_model('/content/drive/MyDrive/spam.h5')
test_loss, test_acc = accr = loaded_model.evaluate(x_test, y_test)
print('Test set\n  Loss: {:0.3f}\n  Accuracy: {:0.3f}'.format(test_loss, test_acc))
```

```
35/35 [==============================] - 1s 8ms/step - loss: 0.1899 - acc: 0.9848
Test set
  Loss: 0.190
  Accuracy: 0.985
```

In [35]:

```
import numpy as np
```

In [36]:

```
y_pred_prob = loaded_model.predict(x_test)

print(np.round(y_pred_prob, 3))
y_pred = y_pred_prob > 0.5
y_pred
```

```
35/35 [==============================] - 1s 9ms/step
[[0.006]
 [0.   ]
 [1.   ]
 ...
 [0.   ]
 [0.   ]
 [1.   ]]
```

Out[36]:

```
array([[False],
       [False],
       [ True],
       ...,
       [False],
       [False],
       [ True]])
```

In [37]:

```
for i in range(5):
    print('%s => %d (expected %d)' % (x_test[i].tolist(), y_pred[i], y_test[i]))
```

```
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1366, 1578, 1432, 19, 7893, 19, 19, 38, 118, 1650, 19, 738, 4, 449, 3023, 35, 1285] => 0 (expected 0)
[1, 188, 11, 6440, 2, 7, 1, 135, 2, 28, 12, 4, 290, 7931, 1, 104, 33, 3, 22, 647, 15, 28, 4, 3607, 18, 374, 191, 224, 2137, 107, 433, 9, 74, 10, 5, 1097, 1806, 1171] => 0 (expected 0)
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 39, 54, 258, 144, 3, 54, 21, 3428, 3, 16, 2, 173, 53, 144, 761, 264, 7182, 208] => 1 (expected 1)
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 64, 33, 3, 1528, 13, 263, 53, 79, 228, 79, 3, 31, 7, 838, 69, 10, 8, 5, 168, 2, 205, 10, 54, 3, 499, 14, 8, 46] => 0 (expected 0)
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 715, 29, 357, 532, 622, 15, 1107, 528, 706, 49, 435, 19, 98, 563, 496, 292, 71, 521, 2, 906, 1546, 138, 1200, 2216] => 1 (expected 1)
```

In [38]:

```
from sklearn.metrics import classification_report
```

In [39]:

```
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.98      1.00      0.99       965
```

1	1.00	0.89	0.94	150
accuracy			0.98	1115
macro avg	0.99	0.94	0.97	1115
weighted avg	0.99	0.98	0.98	1115