```
import tensorflow as tf
import pandas as pd
from tensorflow import keras
!pip install tensorflow-datasets
import tensorflow_datasets as tfds
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from tensorflow import keras
# import tensorflow_datasets as tfds
import numpy as np
import matplotlib.pyplot as plt
from tensorflow.keras.layers.experimental.preprocessing import TextVectorization
from tensorflow.keras import layers
from tensorflow.keras.preprocessing import sequence
tfds.disable_progress_bar()
```

```
Requirement already satisfied: tensorflow-datasets in /usr/local/lib/python3.10/dist-packages (4.9.2)
Requirement already satisfied: absl-py in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (1.4.0)
Requirement already satisfied: array-record in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (0.4.0)
Requirement already satisfied: click in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (8.1.4)
Requirement already satisfied: dm-tree in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (0.1.8)
Requirement already satisfied: etils[enp,epath]>=0.9.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (1.3.0)
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (1.22.4)
Requirement already satisfied: promise in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (2.3)
Requirement already satisfied: protobuf>=3.20 in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (3.20.3)
Requirement already satisfied: psutil in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (5.9.5)
Requirement already satisfied: requests>=2.19.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (2.27.1)
Requirement already satisfied: tensorflow-metadata in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (1.13.1)
Requirement already satisfied: termcolor in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (2.3.0)
Requirement already satisfied: toml in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (0.10.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (4.65.0)
Requirement already satisfied: wrapt in /usr/local/lib/python3.10/dist-packages (from tensorflow-datasets) (1.14.1)
Requirement already satisfied: importlib_resources in /usr/local/lib/python3.10/dist-packages (from etils[enp,epath]>=0.9.0->tensorflow-
Requirement already satisfied: typing_extensions in /usr/local/lib/python3.10/dist-packages (from etils[enp,epath]>=0.9.0->tensorflow-da
Requirement already satisfied: zipp in /usr/local/lib/python3.10/dist-packages (from etils[enp,epath]>=0.9.0->tensorflow-datasets) (3.15
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->tensorflow-datas
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->tensorflow-datasets
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->tensorflow-d
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->tensorflow-datasets) (3.4
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-packages (from promise->tensorflow-datasets) (1.16.0)
Requirement already satisfied: googleapis-common-protos<2,>=1.52.0 in /usr/local/lib/python3.10/dist-packages (from tensorflow-metadata-
```

```
# get data files
!wget https://cdn.freecodecamp.org/project-data/sms/train-data.tsv
!wget https://cdn.freecodecamp.org/project-data/sms/valid-data.tsv

train_file_path = "train-data.tsv"
test_file_path = "valid-data.tsv"
```

```
--2023-07-13 02:10:54--  https://cdn.freecodecamp.org/project-data/sms/train-data.tsv
Resolving cdn.freecodecamp.org (cdn.freecodecamp.org)... 104.26.3.33, 104.26.2.33, 172.67.70.149, ...
Connecting to cdn.freecodecamp.org (cdn.freecodecamp.org)|104.26.3.33|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 358233 (350K) [text/tab-separated-values]
Saving to: ‘train-data.tsv’

train-data.tsv      100%[===================>] 349.84K  --.-KB/s    in 0.04s

2023-07-13 02:10:54 (8.68 MB/s) - ‘train-data.tsv’ saved [358233/358233]

--2023-07-13 02:10:54--  https://cdn.freecodecamp.org/project-data/sms/valid-data.tsv
Resolving cdn.freecodecamp.org (cdn.freecodecamp.org)... 104.26.3.33, 104.26.2.33, 172.67.70.149, ...
Connecting to cdn.freecodecamp.org (cdn.freecodecamp.org)|104.26.3.33|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 118774 (116K) [text/tab-separated-values]
Saving to: ‘valid-data.tsv’

valid-data.tsv      100%[===================>] 115.99K  --.-KB/s    in 0.02s

2023-07-13 02:10:54 (5.19 MB/s) - ‘valid-data.tsv’ saved [118774/118774]
```

```
import pandas as pd
import nltk
from nltk.corpus import stopwords
```

```
import string
from nltk.stem import WordNetLemmatizer
from nltk.tokenize import word_tokenize
from nltk.corpus import wordnet
nltk.download('punkt')
nltk.download('stopwords')
nltk.download('wordnet')
nltk.download('averaged_perceptron_tagger')
traindata=pd.read_csv(train_file_path, sep="\t", header=None, names=["type", "msg"])
testdata= pd.read_csv(test_file_path, sep="\t", header=None, names=["type", "msg"])
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt.zip.
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
[nltk_data] Downloading package wordnet to /root/nltk_data...
[nltk_data] Downloading package averaged_perceptron_tagger to
[nltk_data]     /root/nltk_data...
[nltk_data]   Unzipping taggers/averaged_perceptron_tagger.zip.
```

```
traindata.head()
```

	type	msg
0	ham	ahhhh...just woken up!had a bad dream about u ...
1	ham	you can never do nothing
2	ham	now u sound like manky scouse boy steve,like! ...
3	ham	mum say we wan to go then go... then she can s...
4	ham	never y lei... i v lazy... got wat? dat day ü ...

```
testdata.head()
```

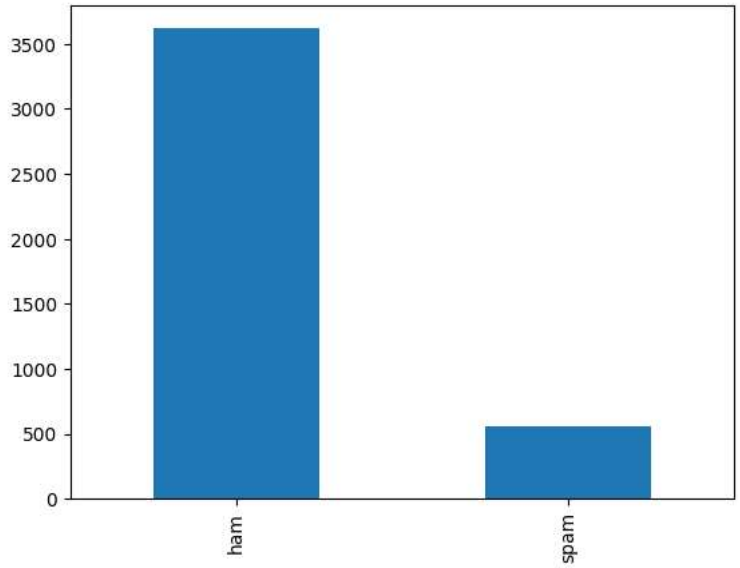
	type	msg
0	ham	i am in hospital da. . i will return home in e...
1	ham	not much, just some textin'. how bout you?
2	ham	i probably won't eat at all today. i think i'm...
3	ham	don't give a flying monkeys wot they think and...
4	ham	who are you seeing?

```
def pr(x):
   x=x.lower()
   tokens=nltk.word_tokenize(x)
   stop_words=set(stopwords.words('english'))
   punctuations = string.punctuation
   tagged_tokens = nltk.pos_tag(tokens)
   lemmatizer = WordNetLemmatizer()
   lemmas = []
   for token, tag in tagged_tokens:
     if token not in stop_words and token not in punctuations:
        pos = tag[0].lower() if tag[0].lower() in ['a', 'r', 'n', 'v'] else wordnet.NOUN
        lemma = lemmatizer.lemmatize(token, pos=pos)
        lemmas.append(lemma)

   filtered_sentence = ' '.join(lemmas)
   return filtered_sentence


traindata['msg'] = traindata['msg'].apply(pr)
traindata.head()
```

```
testdata['msg'] = testdata['msg'].apply(pr)
testdata.head()
```

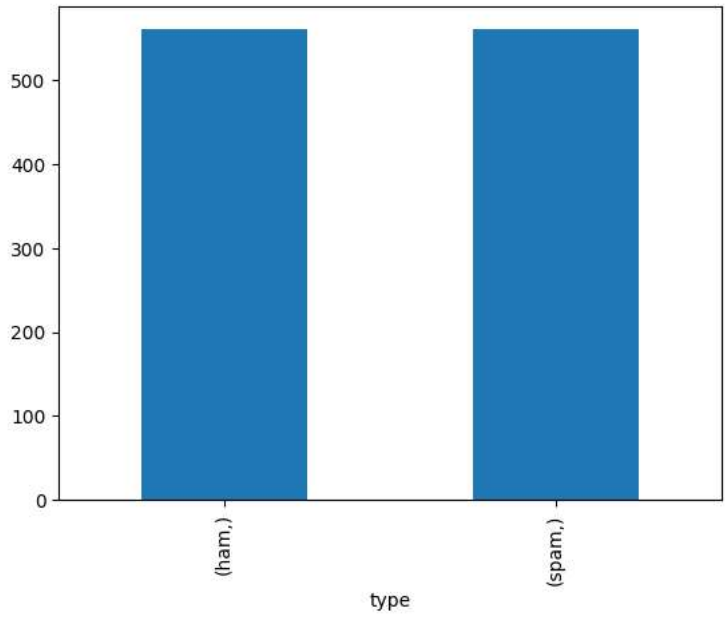
	type	msg
0	ham	hospital da return home even
1	ham	much textin bout
2	ham	probably wo n't eat today think 'm gon na pop ...
3	ham	‘ give fly monkey wot think certainly ‘ mind f...
4	ham	see

```
import matplotlib.pyplot as plt
from imblearn.under_sampling import RandomUnderSampler
traindata['type'].value_counts().plot(kind='bar')
rus = RandomUnderSampler(sampling_strategy='majority')
X_resampled, y_resampled = rus.fit_resample(traindata[['msg']], traindata[['type']])
```




```
y_resampled.value_counts().plot(kind='bar')
```

```
<Axes: xlabel='type'>
```



```
x_train=X_resampled['msg']
y_train=y_resampled['type']
print(x_train.shape)
print(y_train.shape)
```

```
(1120,)
(1120,)
```

```
x_train
```

```
0                                    lmao take pic send
1                                 old orchard near univ
2                          wot student discount u get book
3                            thanks look really appreciate
4                           yes finish watch day life love
                              ...
1115    free msg single find partner area 1000 real pe...
1116    free2day sexy st george 's day pic jordan txt ...
1117    winner specially select receive £1000 cash £20...
1118    free entry £250 weekly competition text word w...
1119    -pls stop bootydelious 32/f invite friend repl...
Name: msg, Length: 1120, dtype: object
```

```
y_train.value_counts()
```

```
ham     560
spam    560
Name: type, dtype: int64
```

```
label_mapper = lambda x: 1 if x == 'spam' else 0
y_train = y_train.map(label_mapper)
```

```
y_train
```

```
0       0
1       0
2       0
3       0
4       0
       ..
1115    1
1116    1
1117    1
1118    1
1119    1
Name: type, Length: 1120, dtype: int64
```

```
from sklearn.feature_extraction.text import TfidfVectorizer
vectorizer = TfidfVectorizer()
vectorizer.fit(x_train)
X_tfidf=vectorizer.transform(x_train)
x=X_tfidf
```

```
x.shape
x_train=x
```

```
df_train_tfidf = pd.DataFrame.sparse.from_spmatrix(x_train, columns=vectorizer.vocabulary_.keys())
df_train_tfidf
```

	lmao	take	pic	send	old	orchard	near	univ	wot	student	...	stopcs	08717890890	free2day
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0

```
label_mapper = lambda x: 1 if x == 'spam' else 0
testdata['type'] = testdata['type'].map(label_mapper)

x_test=testdata[['msg']]
y_test=testdata['type']

y_test
```

```
0       0
1       0
2       0
3       0
4       0
       ..
1387    0
1388    0
1389    0
1390    1
1391    1
Name: type, Length: 1392, dtype: int64
```

```
X_tfidf_test = vectorizer.transform(testdata['msg'])
x_test=X_tfidf_test


df_test_tfidf = pd.DataFrame.sparse.from_spmatrix(x_test, columns=vectorizer.vocabulary_.keys())
df_test_tfidf
```

	lmao	take	pic	send	old	orchard	near	univ	wot	student	...	stopcs	08717890890	free2day
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1387	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0
1388	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0
1389	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0
1390	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0
1391	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0

1392 rows × 3506 columns

```
df_train_tfidf
```

	lmao	take	pic	send	old	orchard	near	univ	wot	student	...	stopcs	08717890890	free2day
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0

```
y_train.value_counts()
```

```
0    560
1    560
Name: type, dtype: int64
```

	...	...	...	...	...	...	...	...	...	...	...	...	...	...

```
print('x_train', x_train.shape)
print('y_train', y_train.shape)
print('x_test', x_test.shape)
print('y_test', y_test.shape)
```

```
x_train (1120, 3506)
y_train (1120,)
x_test (1392, 3506)
y_test (1392,)
```

```
from sklearn import svm
from sklearn.metrics import accuracy_score, confusion_matrix
import numpy as np
clf = svm.SVC(kernel='rbf')
clf.fit(x_train,y_train)
y_pred = clf.predict(x_train)
y_testp = clf.predict(x_test)
acc_score = accuracy_score(y_train, y_pred)
acc_scoret = accuracy_score(y_test, y_testp)
print('Accuracy score train :', acc_score)
print('Accuracy score test :', acc_scoret)
```

```
Accuracy score train : 0.9991071428571429
Accuracy score test : 0.9734195402298851
```

```
train=df_train_tfidf
test=df_test_tfidf

print(train.shape)
print(test.shape)
```

```
(1120, 3506)
(1392, 3506)
```

```
inputs = tf.keras.Input(shape=(None,train.shape[1]))
x = tf.keras.layers.Dense(256, activation='relu', kernel_regularizer=tf.keras.regularizers.l2(0.01))(inputs)
x = tf.keras.layers.Dropout(0.2)(x)
x = tf.keras.layers.Dense(128, activation='relu', kernel_regularizer=tf.keras.regularizers.l2(0.01))(x)
x = tf.keras.layers.Dropout(0.5)(x)
x = tf.keras.layers.Dense(64, activation='relu', kernel_regularizer=tf.keras.regularizers.l2(0.01))(x)
x = tf.keras.layers.Dense(64, activation='relu', kernel_regularizer=tf.keras.regularizers.l2(0.01))(x)

outputs = tf.keras.layers.Dense(1, activation='sigmoid')(x)

model = tf.keras.Model(inputs=inputs, outputs=outputs)


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


model.summary()
```

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, None, 3506)]      0

 dense (Dense)               (None, None, 256)         897792

 dropout (Dropout)           (None, None, 256)         0

 dense_1 (Dense)             (None, None, 128)         32896
```

```
 dropout_1 (Dropout)         (None, None, 128)         0

 dense_2 (Dense)             (None, None, 64)          8256

 dense_3 (Dense)             (None, None, 64)          4160

 dense_4 (Dense)             (None, None, 1)           65

=================================================================
Total params: 943,169
Trainable params: 943,169
Non-trainable params: 0
_________________________________________________________________
```

```
train=np.array(train)
test=np.array(test)
```

```
early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=13)
```

```
h=model.fit(x=train,y=y_train,batch_size=32,validation_data=(test,y_test),epochs=100,callbacks=[early_stop],  validation_steps=30)
```

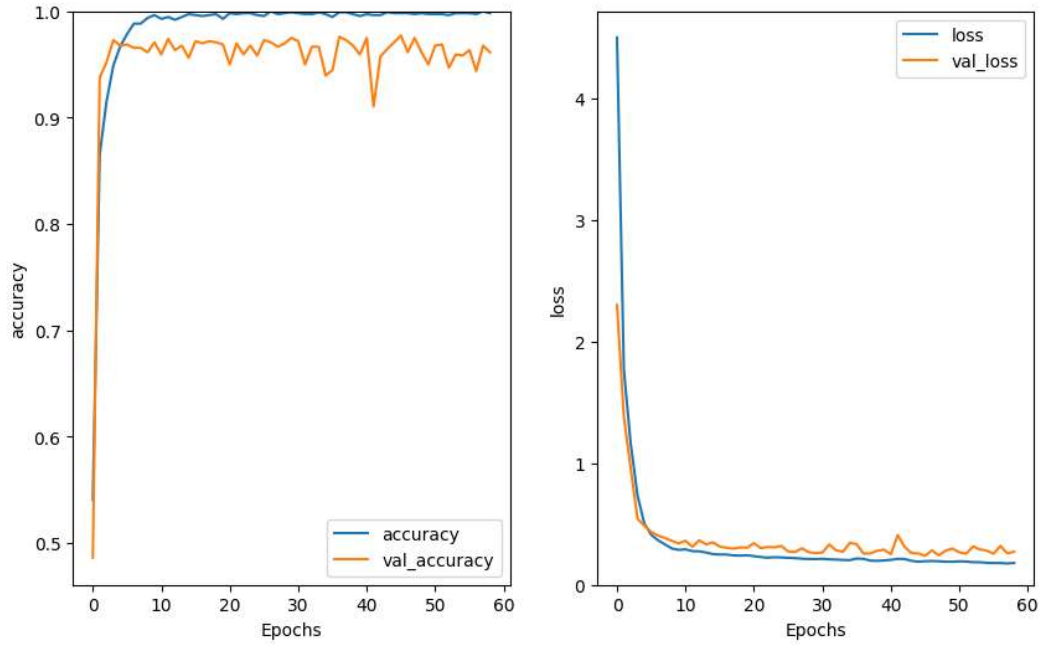
```
Epoch 1/100
35/35 [==============================] - 8s 15ms/step - loss: 4.5020 - accuracy: 0.5411 - val_loss: 2.3020 - val_accuracy: 0.4865
Epoch 2/100
35/35 [==============================] - 0s 9ms/step - loss: 1.7709 - accuracy: 0.8652 - val_loss: 1.3824 - val_accuracy: 0.9375
Epoch 3/100
35/35 [==============================] - 0s 9ms/step - loss: 1.1589 - accuracy: 0.9152 - val_loss: 0.9574 - val_accuracy: 0.9521
Epoch 4/100
35/35 [==============================] - 0s 7ms/step - loss: 0.7341 - accuracy: 0.9491 - val_loss: 0.5427 - val_accuracy: 0.9729
Epoch 5/100
35/35 [==============================] - 0s 7ms/step - loss: 0.5032 - accuracy: 0.9670 - val_loss: 0.4868 - val_accuracy: 0.9677
Epoch 6/100
35/35 [==============================] - 0s 8ms/step - loss: 0.4114 - accuracy: 0.9786 - val_loss: 0.4348 - val_accuracy: 0.9688
Epoch 7/100
35/35 [==============================] - 0s 9ms/step - loss: 0.3662 - accuracy: 0.9884 - val_loss: 0.4057 - val_accuracy: 0.9656
Epoch 8/100
35/35 [==============================] - 0s 9ms/step - loss: 0.3330 - accuracy: 0.9884 - val_loss: 0.3854 - val_accuracy: 0.9656
Epoch 9/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2991 - accuracy: 0.9937 - val_loss: 0.3620 - val_accuracy: 0.9615
Epoch 10/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2878 - accuracy: 0.9964 - val_loss: 0.3403 - val_accuracy: 0.9708
Epoch 11/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2919 - accuracy: 0.9929 - val_loss: 0.3625 - val_accuracy: 0.9594
Epoch 12/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2773 - accuracy: 0.9946 - val_loss: 0.3125 - val_accuracy: 0.9740
Epoch 13/100
35/35 [==============================] - 0s 9ms/step - loss: 0.2755 - accuracy: 0.9920 - val_loss: 0.3667 - val_accuracy: 0.9635
Epoch 14/100
35/35 [==============================] - 0s 9ms/step - loss: 0.2665 - accuracy: 0.9946 - val_loss: 0.3328 - val_accuracy: 0.9677
Epoch 15/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2528 - accuracy: 0.9973 - val_loss: 0.3498 - val_accuracy: 0.9563
Epoch 16/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2492 - accuracy: 0.9964 - val_loss: 0.3148 - val_accuracy: 0.9719
Epoch 17/100
35/35 [==============================] - 0s 8ms/step - loss: 0.2495 - accuracy: 0.9955 - val_loss: 0.3045 - val_accuracy: 0.9698
Epoch 18/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2423 - accuracy: 0.9964 - val_loss: 0.2985 - val_accuracy: 0.9719
Epoch 19/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2407 - accuracy: 0.9973 - val_loss: 0.3080 - val_accuracy: 0.9708
Epoch 20/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2431 - accuracy: 0.9929 - val_loss: 0.3060 - val_accuracy: 0.9688
Epoch 21/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2361 - accuracy: 0.9982 - val_loss: 0.3426 - val_accuracy: 0.9500
Epoch 22/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2287 - accuracy: 0.9973 - val_loss: 0.3014 - val_accuracy: 0.9698
Epoch 23/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2233 - accuracy: 0.9982 - val_loss: 0.3118 - val_accuracy: 0.9594
Epoch 24/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2271 - accuracy: 0.9982 - val_loss: 0.3085 - val_accuracy: 0.9677
Epoch 25/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2253 - accuracy: 0.9964 - val_loss: 0.3205 - val_accuracy: 0.9583
Epoch 26/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2220 - accuracy: 0.9955 - val_loss: 0.2740 - val_accuracy: 0.9729
Epoch 27/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2200 - accuracy: 1.0000 - val_loss: 0.2693 - val_accuracy: 0.9708
Epoch 28/100
35/35 [==============================] - 0s 7ms/step - loss: 0.2152 - accuracy: 0.9973 - val_loss: 0.3005 - val_accuracy: 0.9667
Epoch 29/100
```

```
35/35 [==============================] - 0s 8ms/step - loss: 0.2126 - accuracy: 0.9982 - val_loss: 0.2688 - val_accuracy: 0.9698
```

```
def plot_graphs(h, metric):
    plt.plot(h.history[metric])
    plt.plot(h.history['val_'+metric])
    plt.xlabel("Epochs")
    plt.ylabel(metric)
    plt.legend([metric, 'val_'+metric])
```

```
plt.figure(figsize=(10, 6))
plt.subplot(1, 2, 1)
plot_graphs(h, 'accuracy')
plt.ylim(None, 1)
plt.subplot(1, 2, 2)
plot_graphs(h, 'loss')
plt.ylim(0, None)
```

```
(0.0, 4.718320824205875)
```




```
traindata["type"] = pd.factorize(traindata["type"])[0]
testdata["type"] = pd.factorize(testdata["type"])[0]
```

```
train_labels =  traindata["type"].values
train_ds = tf.data.Dataset.from_tensor_slices(
    (traindata["msg"].values, train_labels)
)
```

```
test_labels =  testdata["type"].values
test_ds = tf.data.Dataset.from_tensor_slices(
    (testdata["msg"].values, test_labels)
)
test_ds.element_spec
```

```
(TensorSpec(shape=(), dtype=tf.string, name=None),
 TensorSpec(shape=(), dtype=tf.int64, name=None))
```

This step is important. It's not only about batching the data sets, but also reshape it to make it works when fitting the model. Otherwise, we will get incompatible layers errors: expecting ndim=3, got ndim=2.a

```
BUFFER_SIZE = 100
BATCH_SIZE = 32
train_ds = train_ds.shuffle(BUFFER_SIZE).batch(BATCH_SIZE).prefetch(tf.data.AUTOTUNE)
test_ds = test_ds.batch(BATCH_SIZE).prefetch(tf.data.AUTOTUNE)
```

```
vec = TextVectorization(
    output_mode='int',
    max_tokens=1000,
    output_sequence_length=1000,
)

vec.adapt(train_ds.map(lambda text, label: text))


vocab = np.array(vec.get_vocabulary())
vocab[:20]
```

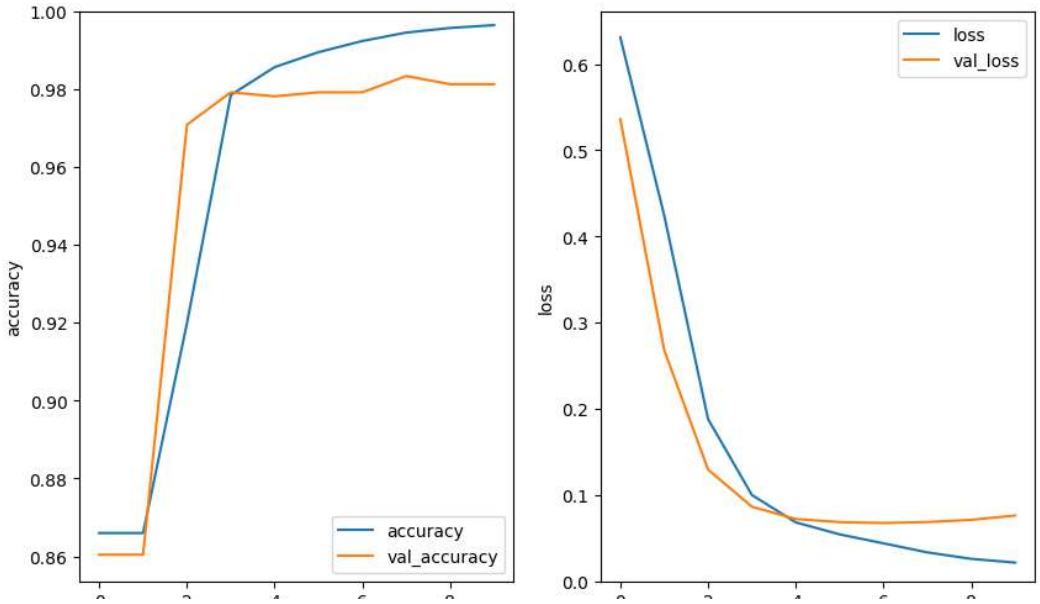
```
 array(['', '[UNK]', 'u', 'get', 'call', 'go', 's', '2', 'm', 'ur', 'nt',
        'come', 'gt', 'lt', '4', 'ok', 'know', 'free', 'like', 'send'],
       dtype='<U14')
```

```
model2 = tf.keras.Sequential([
    vec,
    tf.keras.layers.Embedding(
        len(vec.get_vocabulary()),
        64,
        mask_zero=True,
    ),
    tf.keras.layers.Bidirectional(tf.keras.layers.LSTM(64,  return_sequences=True)),
    tf.keras.layers.Bidirectional(tf.keras.layers.LSTM(32)),
    tf.keras.layers.Dense(64, activation='relu'),
    tf.keras.layers.Dropout(0.3),
    tf.keras.layers.Dense(1)
])


model2.compile(
    loss=tf.keras.losses.BinaryCrossentropy(from_logits=True),
    optimizer=tf.keras.optimizers.Adam(1e-4),
    metrics=['accuracy'],
)


history = model2.fit(
    train_ds,
    validation_data=test_ds,
    validation_steps=30,
    epochs=10,
)
```

```
 Epoch 1/10
 131/131 [==============================] - 104s 636ms/step - loss: 0.6310 - accuracy: 0.8660 - val_loss: 0.5360 - val_accuracy: 0.8604
 Epoch 2/10
 131/131 [==============================] - 56s 430ms/step - loss: 0.4245 - accuracy: 0.8660 - val_loss: 0.2682 - val_accuracy: 0.8604
 Epoch 3/10
 131/131 [==============================] - 54s 417ms/step - loss: 0.1882 - accuracy: 0.9198 - val_loss: 0.1296 - val_accuracy: 0.9708
 Epoch 4/10
 131/131 [==============================] - 53s 404ms/step - loss: 0.1000 - accuracy: 0.9785 - val_loss: 0.0864 - val_accuracy: 0.9792
 Epoch 5/10
 131/131 [==============================] - 55s 422ms/step - loss: 0.0683 - accuracy: 0.9856 - val_loss: 0.0722 - val_accuracy: 0.9781
 Epoch 6/10
 131/131 [==============================] - 52s 403ms/step - loss: 0.0544 - accuracy: 0.9895 - val_loss: 0.0686 - val_accuracy: 0.9792
 Epoch 7/10
 131/131 [==============================] - 52s 397ms/step - loss: 0.0440 - accuracy: 0.9923 - val_loss: 0.0676 - val_accuracy: 0.9792
 Epoch 8/10
 131/131 [==============================] - 51s 394ms/step - loss: 0.0335 - accuracy: 0.9945 - val_loss: 0.0687 - val_accuracy: 0.9833
 Epoch 9/10
 131/131 [==============================] - 51s 395ms/step - loss: 0.0260 - accuracy: 0.9957 - val_loss: 0.0712 - val_accuracy: 0.9812
 Epoch 10/10
 131/131 [==============================] - 52s 400ms/step - loss: 0.0217 - accuracy: 0.9964 - val_loss: 0.0762 - val_accuracy: 0.9812
```

```
plt.figure(figsize=(10, 6))
plt.subplot(1, 2, 1)
plot_graphs(history, 'accuracy')
plt.ylim(None, 1)
plt.subplot(1, 2, 2)
plot_graphs(history, 'loss')
plt.ylim(0, None)
```

```
(0.0, 0.6614282565191388)
```




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

```
Mounted at /content/drive
```

```
# function to predict messages based on model
# (should return list containing prediction and label, ex. [0.008318834938108921, 'ham'])

def predict_message(pred_text):
  pred_matrix_sparse = vectorizer.transform([pred_text])
  pred_matrix_dense = pred_matrix_sparse.toarray()
  yprediction = model.predict(pred_matrix_dense)


  if yprediction[0]<0.5:
    return [yprediction[0],'ham']
  else:
      return [y_pred[0],'spam']


pred_text = "sale today! to stop texts call 9891246032"

prediction = predict_message(pred_text)
print(prediction)
```

```
1/1 [==============================] - 0s 74ms/step
[0, 'spam']
```

```
# Run this cell to test your function and model. Do not modify contents.
def test_predictions():
  test_messages = ["how are you doing today",
                   "sale today! to stop texts call 98912460324",
                   "i dont want to go. can we try it a different day? available sat",
                   "our new mobile video service is live. just install on your phone to start watching.",
                   "you have won £1000 cash! call to claim your prize.",
                   "i'll bring it tomorrow. don't forget the milk.",
                   "wow, is your arm alright. that happened to me one time too"
                  ]

  test_answers = ["ham", "spam", "ham", "spam", "spam", "ham", "ham"]
  passed = True

  for msg, ans in zip(test_messages, test_answers):
    prediction = predict_message(msg)
    if prediction[1] != ans:
      passed = False

  if passed:
    print("You passed the challenge. Great job!")
  else:
```

```
        print("You haven't passed yet. Keep trying.")

    test_predictions()
```

```
        1/1 [==============================] - 0s 22ms/step
        1/1 [==============================] - 0s 21ms/step
        1/1 [==============================] - 0s 22ms/step
        1/1 [==============================] - 0s 24ms/step
        1/1 [==============================] - 0s 27ms/step
        1/1 [==============================] - 0s 21ms/step
        1/1 [==============================] - 0s 23ms/step
        You passed the challenge. Great job!
```