SHRI VILEPARLE KELAVANI MANDAL'S
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC ACCREDITED with "A" GRADE (CGPA : 3.18)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

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COURSE CODE: DJ19DSC501

COURSE NAME: Machine Learning - II **CLASS: AY 2023-24**

LAB EXPERIMENT NO.6

AIM / OBJECTIVE:

Implement LSTM Sentiment Analysis on text dataset to evaluate customer reviews.

DESCRIPTION OF EXPERIMENT:

Python sentiment analysis is a methodology for analyzing a piece of text to discover the sentiment hidden within it. It accomplishes this by combining machine learning and natural language processing (NLP). Sentiment analysis allows you to examine the feelings expressed in a piece of text. It is essential for businesses to gauge customer response.

Preprocessing -

1) Normalization - Words which look different due to casing or written another way but are the same in meaning need to be process correctly. Normalisation processes ensure that these words are treated equally. For example, changing numbers to their word equivalents or converting the casing of all the text.
   a) Casing the Characters - Converting character to the same case so the same words are recognised as the same. (all lowercase)
   b) Removing - Stand alone punctuations, special characters and numerical tokens are removed as they do not contribute to sentiment which leaves only alphabetic characters. This step needs the use of tokenized words as they have been split appropriately for us to remove. We need to remove the special characters, numbers from the text. We can use the regular expression operations library of Python.

2) Tokenization - Tokenization is the process of breaking down chunks of text into smaller pieces. It converts text into tokens before transforming it into vectors. It is also easier to filter out unnecessary tokens. spaCy comes with a default processing pipeline that begins with tokenization, making this process a snap. In spaCy, you can do either sentence tokenization or word tokenization:

- Word tokenization breaks text down into individual words.
- Sentence tokenization breaks text down into individual sentences.

3) Stopwords - Stop words are the most commonly occuring words which are not relevant in the context of the data and do not contribute any deeper meaning to the phrase. In this case it contains no sentiment. We need to remove them as part of text preprocessing. nltk has a list of stopwords of every language.

4) Obtaining the stem words

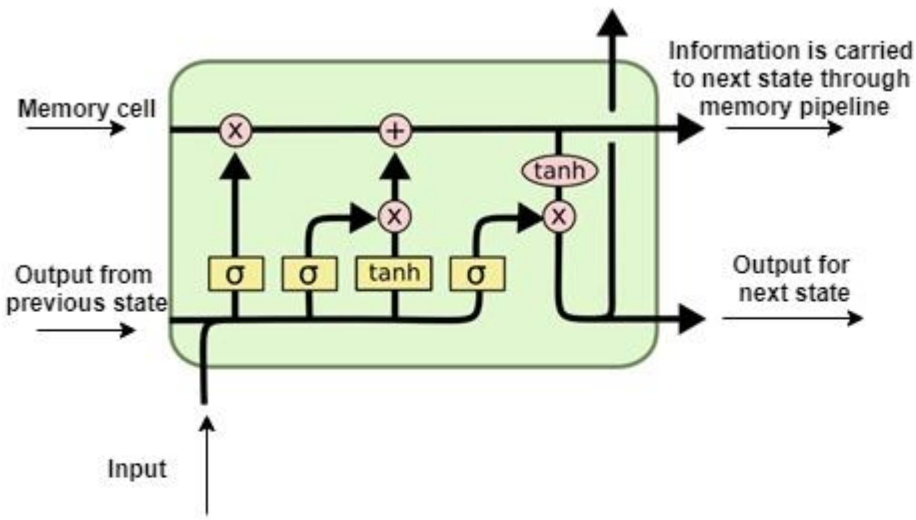
A stem is a part of a word responsible for its lexical meaning. The two popular techniques of obtaining the root/stem words are Stemming and Lemmatization

a) Stemming - Stemming is a technique used to extract the base form of the words by removing affixes from them. It is just like cutting down the branches of a tree to its stems. For example, the stem of the words eating, eats, eaten is eat.

b) Lemmitization - This process finds the base or dictionary form of the word known as the lemma. This is done through the use of vocabulary (dictionary importance of words) and morphological analysis (word structure and grammar relations)

5) Vectorization - use a count vectorizer from the Scikit-learn library to transform the text in data frame into a bag of words model, which will contain a sparse matrix of integers. The number of occurrences of each word will be counted.

Sentiment Analysis using LSTM: Use Keras



Hyperparameters to tune -

1. Layers - Explore additional hierarchical learning capacity by adding more layers and varied numbers of neurons in each layer
2. Number of inputs in dense layer - Dense layers improve overall accuracy and 5–10 units or nodes per layer is a good base
3. Dropout - Slow down learning with regularization methods like dropout on the recurrent LSTM connections.A good starting point is 20% but the dropout value should be kept small (up to 50%). The 20% value is widely accepted as the best compromise between preventing model overfitting and retaining model accuracy.
4. Learning Rate - This hyperparameter defines how quickly the network updates its parameters.
5. Decay Rate - weight decay can be added in the weight update rule that makes the weights decay to zero exponentially, if no other weight update is scheduled. After each update, the weights are multiplied by a factor slightly less than 1, thereby preventing them from growing to huge. This specifies regularization in the network.

6. Number of epochs

Sentiment Analysis using TextBlob:

TextBlob is a Python library for processing textual data. It provides a consistent API for diving into common natural language processing (NLP) tasks such as part-of-speech tagging, noun phrase extraction, sentiment analysis, and more.

The two measures that are used to analyze the sentiment are:

- Polarity – talks about how positive or negative the opinion is
- Subjectivity – talks about how subjective the opinion is

TextBlob(text).sentiment gives us the Polarity, Subjectivity values.

Polarity ranges from -1 to 1 (1 is more positive, 0 is neutral, -1 is more negative)

Subjectivity ranges from 0 to 1(0 being very objective and 1 being very subjective)

```
res = TextBlob("I love horror films").sentiment
res
```

```
Sentiment(polarity=0.5, subjectivity=0.6)
```

Example of TextBlob sentiment

Workflow -

1. Preprocess data.
2. Split data into training and evaluation sets.
3. Select a model architecture.
4. Use training data to train model.
5. Use test data to evaluate the performance of model.

1. **Apply preprocessing techniques and LSTM on the dataset. Show accuracy achieved on the test dataset by providing classification report.**
2. **Perform LSTM hyperparameter tuning to improve accuracy score.**
3. **Show how LSTM model compares to built-in classifier provided by TextBlob.**
4. **State the applications of sentiment analysis**
5. **State the challenges faced while performing sentiment analysis.**

LSTM model

In [3]:
```python
import pandas as pd
```

In [4]:
```python
df = pd.read_csv('/content/flipkart_reviews.csv')
```

In [5]:
```python
df
```

Out[5]:

	Reviewer Name	Review Title	Review Paragraph	Star Rating	Review Date
0	Nitin Singh	Great product	Great....	5	Mar, 2020
1	Flipkart Customer	Great product	It's another solid performer from the apple st...	5	Oct, 2016
2	Neeladri V	Great product	Nice product . u will feel the difference.	5	Jul, 2020
3	Kishore Gagan	Brilliant	Perfect mobile for iOS lovers	5	Feb, 2020
4	Flipkart Customer	Amazing service from Apple & Flipkart	On Time Delivery Best Part Of Flipkart.\n\nAma...	5	Oct, 2016
...	...	...	...	...	...
7022	Haresh Sachdev	Delivered on launch day itself	Got the delivery on launch day itself. Thanks ...	5	Oct, 2016
7023	Ankit Ruparel	Flipkart made my day!	Last year Flipkart had lost me as a customer. ...	5	Oct, 2016
7024	Swaroop SK	Review of my purchase of iphone7 through flipkart	I'm happy that I preordered iphone7 from flipk...	5	Oct, 2016
7025	Zeelan Basha	Simply awesome	IPhone 7 got it delivered much more early than...	5	Oct, 2016
7026	Rohit Ranjan	Awesome experience	Nicely packaged and before time delivery.	5	Oct, 2016

7027 rows × 5 columns

In [6]:
```python
import pandas as pd

df['Review'] = ''

for index, row in df.iterrows():
    if row['Star Rating'] <= 2:
        df.at[index, 'Review'] = 'Negative'
    elif row['Star Rating'] == 3:
        df.at[index, 'Review'] = 'Neutral'
    else:
        df.at[index, 'Review'] = 'Positive'
```

In [7]:
```python
df
```

Out[7]:

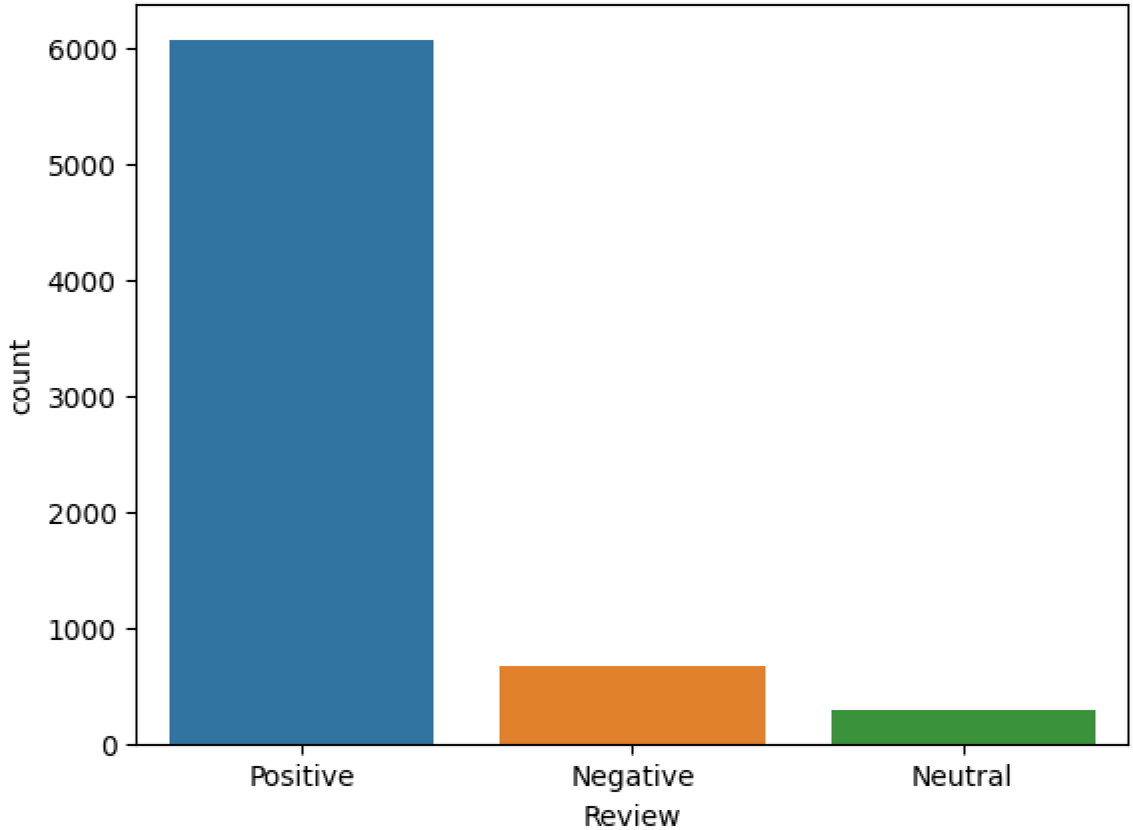
	Reviewer Name	Review Title	Review Paragraph	Star Rating	Review Date	Review

0	Nitin Singh	Great product	Great....	5	Mar, 2020	Positive
1	Flipkart Customer	Great product	It's another solid performer from the apple st...	5	Oct, 2016	Positive
2	Neeladri V	Great product	Nice product . u will feel the difference.	5	Jul, 2020	Positive
3	Kishore Gagan	Brilliant	Perfect mobile for iOS lovers	5	Feb, 2020	Positive
4	Flipkart Customer	Amazing service from Apple & Flipkart	On Time Delivery Best Part Of Flipkart.\n\nAma...	5	Oct, 2016	Positive
...	...	...	...	...	...	...
7022	Haresh Sachdev	Delivered on launch day itself	Got the delivery on launch day itself. Thanks ...	5	Oct, 2016	Positive
7023	Ankit Ruparel	Flipkart made my day!	Last year Flipkart had lost me as a customer. ...	5	Oct, 2016	Positive
7024	Swaroop SK	Review of my purchase of iphone7 through flipkart	I'm happy that I preordered iphone7 from flipk...	5	Oct, 2016	Positive
7025	Zeelan Basha	Simply awesome	IPhone 7 got it delivered much more early than...	5	Oct, 2016	Positive
7026	Rohit Ranjan	Awesome experience	Nicely packaged and before time delivery.	5	Oct, 2016	Positive

7027 rows × 6 columns

In [8]:
```
df.isnull().values.any()
```
Out[8]:
```
False
```

In [9]:
```
import seaborn as sns
sns.countplot(x='Review',data = df)
```
Out[9]:
```
<Axes: xlabel='Review', ylabel='count'>
```



In [10]:
```
import nltk
nltk.download('stopwords')
```

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

Out[10]:
```
True
```

In [11]:
```
from nltk.corpus import stopwords
```

In [12]:
```
import regex as re
```

In [13]:
```
def preprocess_text(sen):
    sentence = sen.lower()
    sentence = re.sub('[^a-zA-Z]','',sentence)
    sentence = re.sub(r"\s+[^a-zA-Z]\s+",'',sentence)
    sentence = re.sub(r'\s+','',sentence)
    pattern = re.compile(r'\b(' + r'|'.join(stopwords.words('english')) + r')\b\s*')
    sentence = pattern.sub('',sentence)
    return ' '.join(sentence.split(' '))
```

In [14]:
```
X = []
sentences = list(df['Review Paragraph'])
for sen in sentences :
  X.append(preprocess_text(sen))
```

In [15]:
```
X[1]
```

Out[15]:
```
'itsanothersolidperformerfromtheapplestabletheunpackingwasmadespecialbyflipkartforthepre
orderedonesidontwanttoelaborateastonotruinthesurpriseforothersthephoneperformseffortless
lyhavenothadanyissuessofarmigratingfromanearlieriphoneisquickandsimplebatterylifeisbette
rthantheearlierphonesandthenewhomebuttonbeautifullyengineeredprovidinganenhanceduserexpe
rienceiwoulddefinitelyrecommendthisphone'
```

In [16]:
```
import numpy as np
```

In [17]:
```
y = df['Review']
y = np.array(list(map(lambda x: 1 if x=="positive" else 0,y)))
```

In [18]:
```
from keras import Sequential
from keras import optimizers
from keras.preprocessing.sequence import pad_sequences
from keras.models import Sequential,Model
from keras.layers import LSTM, Dense, Bidirectional, Input,Dropout,BatchNormalization, E
from keras import backend as K
from keras import initializers, regularizers, constraints
from sklearn.model_selection import KFold, cross_val_score, train_test_split
```

In [19]:
```
X_train, X_test , y_train,y_test = train_test_split(X,y,test_size = 0.2 , random_state =
```

In [20]:
```
import nltk
nltk.download('punkt')
```

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

Out[20]:
```
True
```

In [21]:
```
from keras.preprocessing.text import Tokenizer
```

In [22]:
```
word_tokenizer = Tokenizer()
word_tokenizer.fit_on_texts(X_train)
X_train = word_tokenizer.texts_to_sequences(X_train)
X_test = word_tokenizer.texts_to_sequences(X_test)
```

In [23]:
```
vocab_length = len(word_tokenizer.word_index) + 1
vocab_length
```

Out[23]:
```
4574
```

In [24]:
```
maxlen = 100
X_train = pad_sequences(X_train,padding='post',maxlen = maxlen)
X_test =  pad_sequences(X_test,padding='post',maxlen = maxlen)
```

In [25]:
```
!pip install keras.utils.np_utils
```

```
ERROR: Could not find a version that satisfies the requirement keras.utils.np_utils (fro
m versions: none)
ERROR: No matching distribution found for keras.utils.np_utils
```

In [26]:
```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

from sklearn.feature_extraction.text import CountVectorizer
from keras.preprocessing.text import Tokenizer
from keras.preprocessing.sequence import pad_sequences
from keras.models import Sequential
from keras.layers import Dense, Embedding, LSTM, SpatialDropout1D
from sklearn.model_selection import train_test_split
import re
```

In [27]:
```
df = df[['Review Paragraph','Review']]
```

In [28]:
```
df
```

Out[28]:

	Review Paragraph	Review
0	Great....	Positive

1	It's another solid performer from the apple st...	Positive
2	Nice product . u will feel the difference.	Positive
3	Perfect mobile for iOS lovers	Positive
4	On Time Delivery Best Part Of Flipkart.\n\nAma...	Positive
...	...	...
7022	Got the delivery on launch day itself. Thanks ...	Positive
7023	Last year Flipkart had lost me as a customer. ...	Positive
7024	I'm happy that I preordered iphone7 from flipk...	Positive
7025	IPhone 7 got it delivered much more early than...	Positive
7026	Nicely packaged and before time delivery.	Positive

7027 rows × 2 columns

In [29]:

```
df = df[df.Review != "Neutral"]
df['Review Paragraph'] = df['Review Paragraph'].apply(lambda x: x.lower())
df['Review Paragraph'] = df['Review Paragraph'].apply((lambda x: re.sub('[^a-zA-z0-9\s]'

print(df[ df['Review'] == 'Positive'].size)
print(df[ df['Review'] == 'Negative'].size)

for idx,row in df.iterrows():
    row[0] = row[0].replace('rt',' ')

max_fatures = 2000
tokenizer = Tokenizer(num_words=max_fatures, split=' ')
tokenizer.fit_on_texts(df['Review Paragraph'].values)
X = tokenizer.texts_to_sequences(df['Review Paragraph'].values)
X = pad_sequences(X)
```

```
12142
1346
<ipython-input-29-d4fca0560a36>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_
guide/indexing.html#returning-a-view-versus-a-copy
  df['Review Paragraph'] = df['Review Paragraph'].apply(lambda x: x.lower())
<ipython-input-29-d4fca0560a36>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_
guide/indexing.html#returning-a-view-versus-a-copy
  df['Review Paragraph'] = df['Review Paragraph'].apply((lambda x: re.sub('[^a-zA-z0-9
\s]','',x)))
```

In [30]:

```
embed_dim = 128
lstm_out = 196

model = Sequential()
model.add(Embedding(max_fatures, embed_dim,input_length = X.shape[1]))
model.add(SpatialDropout1D(0.4))
model.add(LSTM(lstm_out, dropout=0.2, recurrent_dropout=0.2))
model.add(Dense(2,activation='softmax'))
model.compile(loss = 'categorical_crossentropy', optimizer='adam',metrics = ['accuracy']
print(model.summary())
```

```
WARNING:tensorflow:Layer lstm will not use cuDNN kernels since it doesn't meet the crite
ria. It will use a generic GPU kernel as fallback when running on GPU.
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding (Embedding)       (None, 553, 128)          256000

 spatial_dropout1d (Spatial  (None, 553, 128)          0
 Dropout1D)

 lstm (LSTM)                 (None, 196)               254800

 dense (Dense)               (None, 2)                 394

=================================================================
Total params: 511194 (1.95 MB)
Trainable params: 511194 (1.95 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
None
```

In [31]:

```python
Y = pd.get_dummies(df['Review']).values
X_train, X_test, Y_train, Y_test = train_test_split(X,Y, test_size = 0.33, random_state
print(X_train.shape,Y_train.shape)
print(X_test.shape,Y_test.shape)
```

```
(4518, 553) (4518, 2)
(2226, 553) (2226, 2)
```

In [32]:

```python
batch_size = 32
model.fit(X_train, Y_train, epochs = 7, batch_size=batch_size, verbose = 2)
```

```
Epoch 1/7
142/142 - 384s - loss: 0.2754 - accuracy: 0.9028 - 384s/epoch - 3s/step
Epoch 2/7
142/142 - 356s - loss: 0.1545 - accuracy: 0.9469 - 356s/epoch - 3s/step
Epoch 3/7
142/142 - 353s - loss: 0.1124 - accuracy: 0.9622 - 353s/epoch - 2s/step
Epoch 4/7
142/142 - 348s - loss: 0.0859 - accuracy: 0.9726 - 348s/epoch - 2s/step
Epoch 5/7
142/142 - 351s - loss: 0.0749 - accuracy: 0.9772 - 351s/epoch - 2s/step
Epoch 6/7
142/142 - 347s - loss: 0.0680 - accuracy: 0.9792 - 347s/epoch - 2s/step
Epoch 7/7
142/142 - 352s - loss: 0.0569 - accuracy: 0.9830 - 352s/epoch - 2s/step
```

Out[32]:

```
<keras.src.callbacks.History at 0x7d603582f8e0>
```

In [33]:

```python
validation_size = 1500

X_validate = X_test[-validation_size:]
Y_validate = Y_test[-validation_size:]
X_test = X_test[:-validation_size]
Y_test = Y_test[:-validation_size]
score,acc = model.evaluate(X_test, Y_test, verbose = 2, batch_size = batch_size)
print("score: %.2f" % (score))
print("acc: %.2f" % (acc))
```

```
23/23 - 4s - loss: 0.2641 - accuracy: 0.9242 - 4s/epoch - 160ms/step
score: 0.26
acc: 0.92
```

In [34]:

```python
pos_cnt, neg_cnt, pos_correct, neg_correct = 0, 0, 0, 0
for x in range(len(X_validate)):
```

```
    result = model.predict(X_validate[x].reshape(1,X_test.shape[1]),batch_size=1,verbose

    if np.argmax(result) == np.argmax(Y_validate[x]):
        if np.argmax(Y_validate[x]) == 0:
            neg_correct += 1
        else:
            pos_correct += 1

    if np.argmax(Y_validate[x]) == 0:
        neg_cnt += 1
    else:
        pos_cnt += 1



print("pos_acc", pos_correct/pos_cnt*100, "%")
print("neg_acc", neg_correct/neg_cnt*100, "%")
```

```
1/1 - 1s - 604ms/epoch - 604ms/step
1/1 - 0s - 143ms/epoch - 143ms/step
1/1 - 0s - 154ms/epoch - 154ms/step
1/1 - 0s - 146ms/epoch - 146ms/step
1/1 - 0s - 140ms/epoch - 140ms/step
1/1 - 0s - 150ms/epoch - 150ms/step
1/1 - 0s - 154ms/epoch - 154ms/step
1/1 - 0s - 154ms/epoch - 154ms/step
1/1 - 0s - 168ms/epoch - 168ms/step
1/1 - 0s - 142ms/epoch - 142ms/step
1/1 - 0s - 151ms/epoch - 151ms/step
1/1 - 0s - 147ms/epoch - 147ms/step
1/1 - 0s - 146ms/epoch - 146ms/step
1/1 - 0s - 146ms/epoch - 146ms/step
1/1 - 0s - 143ms/epoch - 143ms/step
1/1 - 0s - 149ms/epoch - 149ms/step
1/1 - 0s - 145ms/epoch - 145ms/step
1/1 - 0s - 151ms/epoch - 151ms/step
1/1 - 0s - 141ms/epoch - 141ms/step
1/1 - 0s - 151ms/epoch - 151ms/step
1/1 - 0s - 148ms/epoch - 148ms/step
1/1 - 0s - 146ms/epoch - 146ms/step
1/1 - 0s - 142ms/epoch - 142ms/step
1/1 - 0s - 150ms/epoch - 150ms/step
1/1 - 0s - 146ms/epoch - 146ms/step
1/1 - 0s - 155ms/epoch - 155ms/step
1/1 - 0s - 146ms/epoch - 146ms/step
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1/1 - 0s - 147ms/epoch - 147ms/step
1/1 - 0s - 145ms/epoch - 145ms/step
1/1 - 0s - 146ms/epoch - 146ms/step
1/1 - 0s - 154ms/epoch - 154ms/step
1/1 - 0s - 173ms/epoch - 173ms/step
1/1 - 0s - 261ms/epoch - 261ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 163ms/epoch - 163ms/step
1/1 - 0s - 224ms/epoch - 224ms/step
1/1 - 0s - 234ms/epoch - 234ms/step
1/1 - 0s - 214ms/epoch - 214ms/step
1/1 - 0s - 261ms/epoch - 261ms/step
1/1 - 0s - 240ms/epoch - 240ms/step
1/1 - 0s - 254ms/epoch - 254ms/step
1/1 - 0s - 230ms/epoch - 230ms/step
1/1 - 0s - 225ms/epoch - 225ms/step
1/1 - 0s - 146ms/epoch - 146ms/step
1/1 - 0s - 147ms/epoch - 147ms/step
1/1 - 0s - 143ms/epoch - 143ms/step
```

```
1/1 - 0s - 180ms/epoch - 180ms/step
1/1 - 0s - 150ms/epoch - 150ms/step
1/1 - 0s - 145ms/epoch - 145ms/step
1/1 - 0s - 145ms/epoch - 145ms/step
1/1 - 0s - 143ms/epoch - 143ms/step
1/1 - 0s - 147ms/epoch - 147ms/step
1/1 - 0s - 145ms/epoch - 145ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 148ms/epoch - 148ms/step
1/1 - 0s - 150ms/epoch - 150ms/step
1/1 - 0s - 148ms/epoch - 148ms/step
1/1 - 0s - 147ms/epoch - 147ms/step
1/1 - 0s - 150ms/epoch - 150ms/step
1/1 - 0s - 151ms/epoch - 151ms/step
1/1 - 0s - 141ms/epoch - 141ms/step
1/1 - 0s - 153ms/epoch - 153ms/step
1/1 - 0s - 146ms/epoch - 146ms/step
1/1 - 0s - 150ms/epoch - 150ms/step
1/1 - 0s - 143ms/epoch - 143ms/step
1/1 - 0s - 148ms/epoch - 148ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 143ms/epoch - 143ms/step
1/1 - 0s - 147ms/epoch - 147ms/step
1/1 - 0s - 149ms/epoch - 149ms/step
1/1 - 0s - 147ms/epoch - 147ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 143ms/epoch - 143ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 146ms/epoch - 146ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 146ms/epoch - 146ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 154ms/epoch - 154ms/step
1/1 - 0s - 151ms/epoch - 151ms/step
1/1 - 0s - 148ms/epoch - 148ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 147ms/epoch - 147ms/step
1/1 - 0s - 151ms/epoch - 151ms/step
1/1 - 0s - 147ms/epoch - 147ms/step
1/1 - 0s - 157ms/epoch - 157ms/step
1/1 - 0s - 143ms/epoch - 143ms/step
1/1 - 0s - 149ms/epoch - 149ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 142ms/epoch - 142ms/step
1/1 - 0s - 151ms/epoch - 151ms/step
1/1 - 0s - 160ms/epoch - 160ms/step
1/1 - 0s - 150ms/epoch - 150ms/step
1/1 - 0s - 144ms/epoch - 144ms/step
1/1 - 0s - 202ms/epoch - 202ms/step
1/1 - 0s - 238ms/epoch - 238ms/step
1/1 - 0s - 231ms/epoch - 231ms/step
1/1 - 0s - 221ms/epoch - 221ms/step
1/1 - 0s - 265ms/epoch - 265ms/step
1/1 - 0s - 237ms/epoch - 237ms/step
1/1 - 0s - 230ms/epoch - 230ms/step
1/1 - 0s - 245ms/epoch - 245ms/step
1/1 - 0s - 166ms/epoch - 166ms/step
1/1 - 0s - 148ms/epoch - 148ms/step
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```

```
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pos_acc 98.3751846381093 %
neg_acc 58.9041095890411 %
```
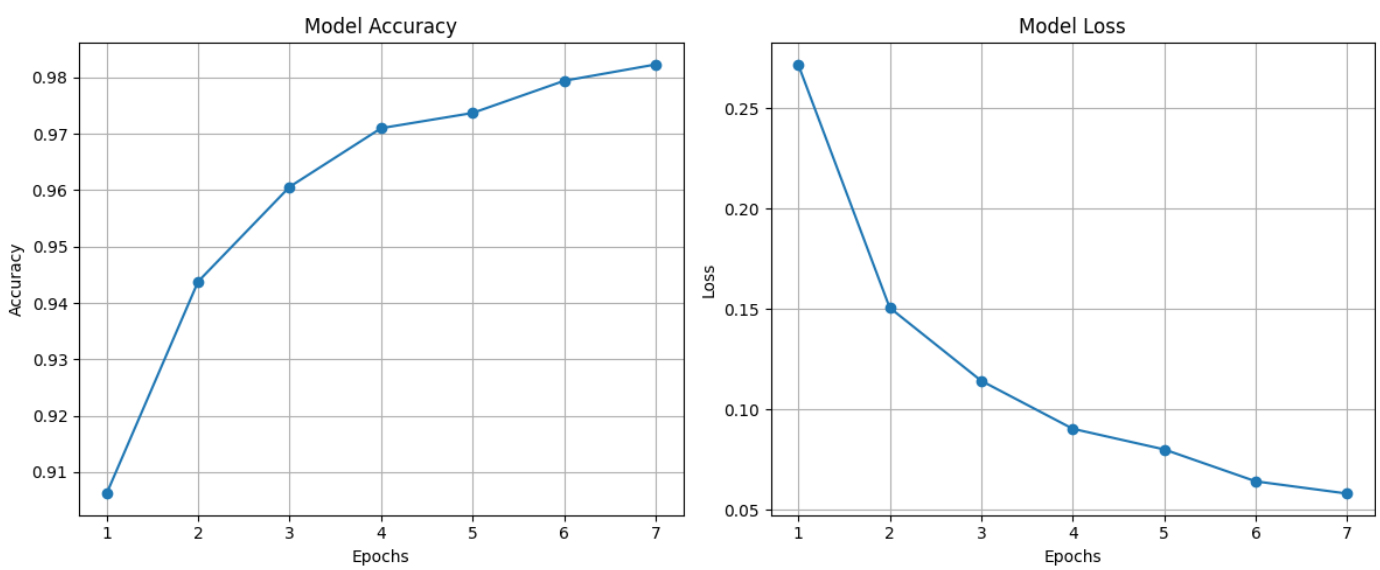

In [35]:
```python
# Import necessary libraries
import matplotlib.pyplot as plt

# Create lists with the same number of elements
accuracy_history = [0.9062, 0.9438, 0.9606, 0.9710, 0.9737, 0.9794, 0.9823]
loss_history = [0.2719, 0.1507, 0.1143, 0.0904, 0.0801, 0.0642, 0.0581]

# Define the number of epochs
epochs = len(accuracy_history)

# Plot accuracy
plt.figure(figsize=(12, 5))
plt.subplot(1, 2, 1)
plt.plot(range(1, epochs + 1), accuracy_history, marker='o', linestyle='-')
plt.title('Model Accuracy')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.grid(True)

# Plot loss
plt.subplot(1, 2, 2)
plt.plot(range(1, epochs + 1), loss_history, marker='o', linestyle='-')
plt.title('Model Loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.grid(True)

# Show the plots
plt.tight_layout()
plt.show()
```



TextBlob Sentiment Analysis

In [36]:
```python
from textblob import TextBlob
```

In [38]:
```python
res=TextBlob("Wassup").sentiment
res.polarity
```

Out[38]:
```
0.0
```

```
In [39]: X_test
```

```
Out[39]: array([[   0,    0,    0, ...,    4,   69,  111],
                [   0,    0,    0, ...,  223,  106,   36],
                [   0,    0,    0, ...,   37, 1727,    8],
                ...,
                [   0,    0,    0, ...,    0,   22,    9],
                [   0,    0,    0, ...,    0,   21,   32],
                [   0,    0,    0, ...,  223,    8,   62]], dtype=int32)
```

```
In [40]: df
```

Out[40]:

	Review Paragraph	Review
0	great	Positive
1	its another solid performer from the apple sta...	Positive
2	nice product u will feel the difference	Positive
3	perfect mobile for ios lovers	Positive
4	on time delivery best pa of flipka \n\namazin...	Positive
...	...	...
7022	got the delivery on launch day itself thanks f...	Positive
7023	last year flipka had lost me as a customer i ...	Positive
7024	im happy that i preordered iphone7 from flipka...	Positive
7025	iphone 7 got it delivered much more early than...	Positive
7026	nicely packaged and before time delivery	Positive

6744 rows × 2 columns

```
In [41]: X=df['Review Paragraph'].values
         y=df['Review'].values
```

```
In [42]: pd.value_counts(y)
```

```
Out[42]: Positive    6071
         Negative     673
         dtype: int64
```

```
In [55]: X_train, X_test, Y_train, Y_test = train_test_split(X,y, test_size = 0.3, random_state =
```

```
In [56]: X_test
```

```
Out[56]: array(['very good experience overall phone also working brilliantly',
                'excellent product and very good colou hanks flip ka  for delivering before tim
         e',
                'really its a very nice product dashing look professional features good battery b
         ackup etc have enjoyed it',
                ..., 'very nice',
                'when i received the product box seal was tempted previously',
                'really good one'], dtype=object)
```

```
In [57]: y_pred=[]
         for i in X_test:
           res=TextBlob(i).sentiment
           if(res.polarity<=0.0):
             y_pred.append(0)
```

```
  else:
    y_pred.append(1)
```

In [58]:
```
Y_test
```

Out[58]:
```
array(['Positive', 'Positive', 'Positive', ..., 'Positive', 'Negative',
       'Positive'], dtype=object)
```

In [59]:
```
y_test=[]
for i in Y_test:
  if(i=="Positive"):
    y_test.append(1)
  else:
    y_test.append(0)
```

In [60]:
```
pd.value_counts(y_test)
```

Out[60]:
```
1    1808
0     216
dtype: int64
```

In [62]:
```
from sklearn.metrics import classification_report
print(classification_report(y_test,y_pred))
```

```
              precision    recall  f1-score   support

           0       0.45      0.75      0.56       216
           1       0.97      0.89      0.93      1808

    accuracy                           0.88      2024
   macro avg       0.71      0.82      0.75      2024
weighted avg       0.91      0.88      0.89      2024
```

Thus we see that the LSTM model performs better as it has an accuracy of 98% while the TextBlob Sentiment Analyzer gives us only a 88% accuracy