E-COMMERCE

Problem Statement

- Amazon is an online shopping website that now caters to millions of people everywhere. Over 34,000 consumer reviews for Amazon brand products like Kindle, Fire TV Stick and more are provided.
- The dataset has attributes like brand, categories, primary categories, reviews.title, reviews.text, and the sentiment. Sentiment is a categorical variable with three levels "Positive", "Negative", and "Neutral". For a given unseen data, the sentiment needs to be predicted.
- You are required to predict Sentiment or Satisfaction of a purchase based on multiple features and review text.

Dataset Snapshot 

Project Task: Week 1

Class Imbalance Problem:

1. Perform an EDA on the dataset.

a) See what a positive, negative, and neutral review looks like.

b) Check the class count for each class. It's a class imbalance problem.

2. Convert the reviews in Tf-Idf score.
3. Run multinomial Naive Bayes classifier. Everything will be classified as positive because of the class imbalance.

Project Task: Week 2

Tackling Class Imbalance Problem:

1. Oversampling or undersampling can be used to tackle the class imbalance problem.
2. In case of class imbalance criteria, use the following metrices for evaluating model performance: precision, recall, F1-score, AUC-ROC curve. Use F1-Score as the evaluation criteria for this project.
3. Use Tree-based classifiers like Random Forest and XGBoost. Note: Tree-based classifiers work on two ideologies namely, Bagging or Boosting and have fine-tuning parameter which takes care of the imbalanced class.

Project Task: Week 3

Model Selection:

1. Apply multi-class SVM's and neural nets.
2. Use possible ensemble techniques like: XGboost + oversampled_multinomial_NB.
3. Assign a score to the sentence sentiment (engineer a feature called sentiment score). Use this engineered feature in the model and check for improvements. Draw insights on the same.

Markdown Python 3 [3.10]

Project Task: Week 4

Applying LSTM:

1. Use LSTM for the previous problem (use parameters of LSTM like top-word, embedding-length, Dropout, epochs, number of layers, etc.) Hint: Another variation of LSTM, GRU (Gated Recurrent Units) can be tried as well.
2. Compare the accuracy of neural nets with traditional ML based algorithms.
3. Find the best setting of LSTM (Neural Net) and GRU that can best classify the reviews as positive, negative, and neutral. Hint: Use techniques like Grid Search, Cross-Validation and Random Search

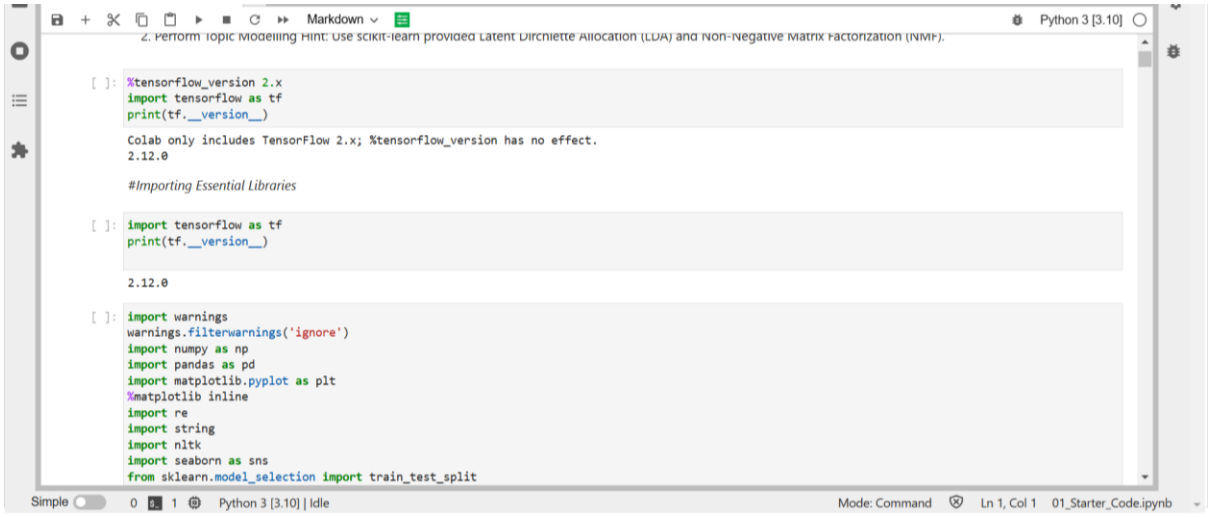
Optional Tasks: Week 4

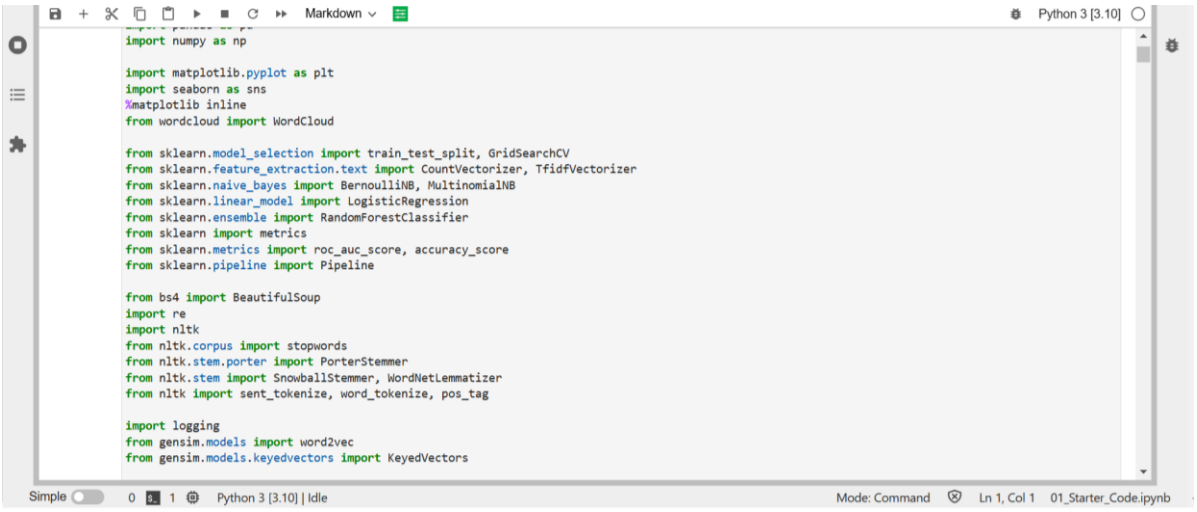
Topic Modelling:

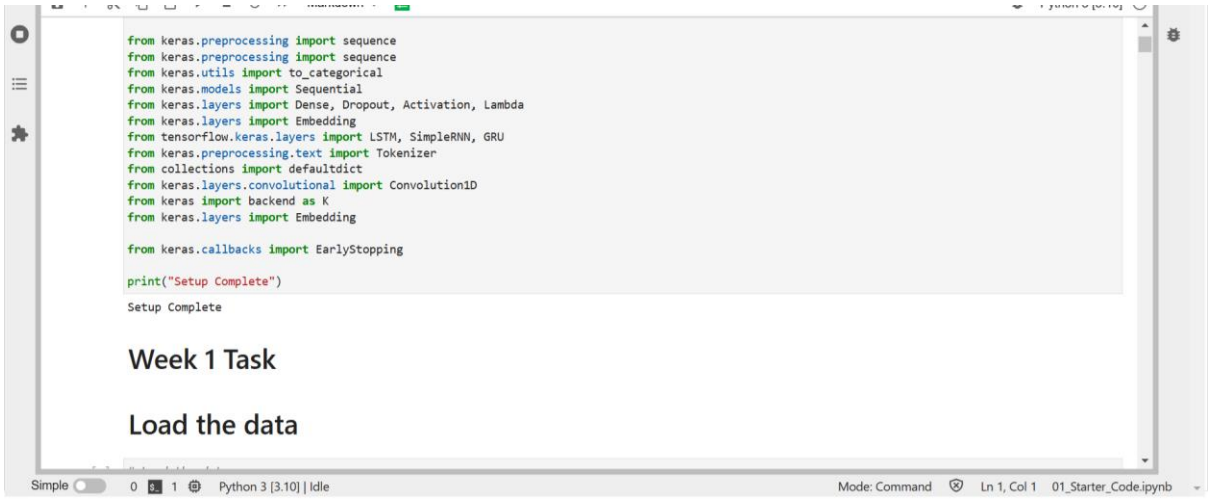
1. Cluster similar reviews. Note: Some reviews may talk about the device as a gift-option. Other reviews may be about product looks and some may highlight about its battery and performance. Try naming the clusters.
2. Perform Topic Modelling Hint: Use scikit-learn provided Latent Dirchlette Allocation (LDA) and Non-Negative Matrix Factorization (NMF).

```
[ ]: %tensorflow_version 2.x
```

Simple 0 1 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 01_Starter_Code.ipynb


Markdown
Python 3 [3.10]
2. Perform Topic Modelling Hint: Use scikit-learn provided Latent Dirichlette Allocation (LDA) and Non-Negative Matrix Factorization (NMF).
%tensorflow_version 2.x
import tensorflow as tf
print(tf.__version__)
Colab only includes TensorFlow 2.x; %tensorflow_version has no effect.
2.12.0
#Importing Essential Libraries
import tensorflow as tf
print(tf.__version__)
2.12.0
import warnings
warnings.filterwarnings('ignore')
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import re
import string
import nltk
import seaborn as sns
from sklearn.model_selection import train_test_split
Simple
0 1
Python 3 [3.10] | Idle
Mode: Command
Ln 1, Col 1
01_Starter_Code.ipynb


Markdown
Python 3 [3.10]
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
from wordcloud import WordCloud
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer
from sklearn.naive_bayes import BernoulliNB, MultinomialNB
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn import metrics
from sklearn.metrics import roc_auc_score, accuracy_score
from sklearn.pipeline import Pipeline
from bs4 import BeautifulSoup
import re
import nltk
from nltk.corpus import stopwords
from nltk.stem.porter import PorterStemmer
from nltk.stem import SnowballStemmer, WordNetLemmatizer
from nltk import sent_tokenize, word_tokenize, pos_tag
import logging
from gensim.models import word2vec
from gensim.models.keyedvectors import KeyedVectors
Simple
0 1
Python 3 [3.10] | Idle
Mode: Command
Ln 1, Col 1
01_Starter_Code.ipynb


from keras.preprocessing import sequence
from keras.preprocessing import sequence
from keras.utils import to_categorical
from keras.models import Sequential
from keras.layers import Dense, Dropout, Activation, Lambda
from keras.layers import Embedding
from tensorflow.keras.layers import LSTM, SimpleRNN, GRU
from keras.preprocessing.text import Tokenizer
from collections import defaultdict
from keras.layers.convolutional import Convolution1D
from keras import backend as K
from keras.layers import Embedding
from keras.callbacks import EarlyStopping
print("Setup Complete")
Setup Complete
Week 1 Task
Load the data
Simple
0 1
Python 3 [3.10] | Idle
Mode: Command
Ln 1, Col 1
01_Starter_Code.ipynb

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Python 3 [3.10]

```
[14]: # Keeping only those features that we need for further exploring.
data1 = data [["sentiment","reviews.text"]]

[15]: data1.head()
```

[15]:

	sentiment	reviews.text
0	Positive	Purchased on Black FridayPros - Great Price (e...
1	Positive	I purchased two Amazon in Echo Plus and two do...
2	Neutral	Just an average Alexa option. Does show a few ...
3	Positive	very good product. Exactly what I wanted, and ...
4	Positive	This is the 3rd one I've purchased. I've bough...

```
[16]: # Resetting the Index.
data1.index = pd.Series(list(range(data1.shape[0])))

[17]: print('Shape : ',data1.shape)
data1.head()

Shape :  (4000, 2)
```

[17]:

	sentiment	reviews.text
0	Positive	Purchased on Black FridayPros - Great Price (e...

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb

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Python 3 [3.10]

```
Setup Complete
[nltk_data] Downloading package wordnet to /voc/work/nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
[nltk_data] Downloading package stopwords to /voc/work/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!

[19]: data1['Processed_Review'] = data1['reviews.text'].apply(preprocess)

data1.head()
```

[19]:

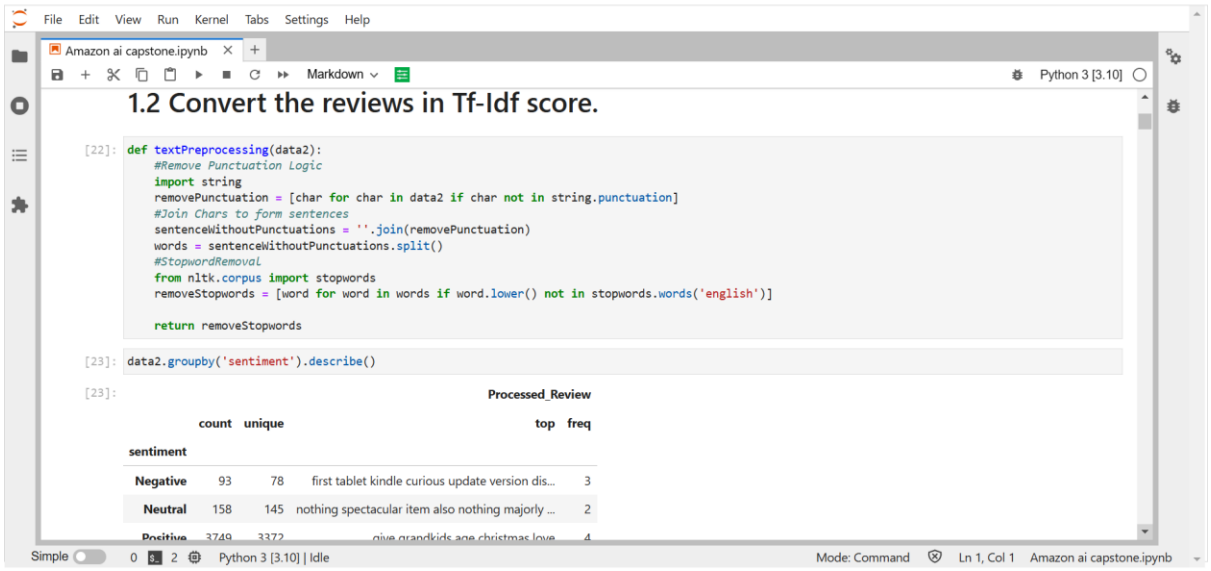
	sentiment	reviews.text	Processed_Review
0	Positive	Purchased on Black FridayPros - Great Price (e...	purchase black fridaypros great price even sal...
1	Positive	I purchased two Amazon in Echo Plus and two do...	purchase two amazon echo plus two dot plus fou...
2	Neutral	Just an average Alexa option. Does show a few ...	average alexa option show thing screen still l...
3	Positive	very good product. Exactly what I wanted, and ...	good product exactly want good price
4	Positive	This is the 3rd one I've purchased. I've bough...	rd one purchase buy one niece case compare one...

```
[21]: data2 = data1 [["sentiment","Processed_Review"]]
data2.head()
```

[21]:

	sentiment	Processed_Review
0	Positive	purchase black fridaypros great price even sal...

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb



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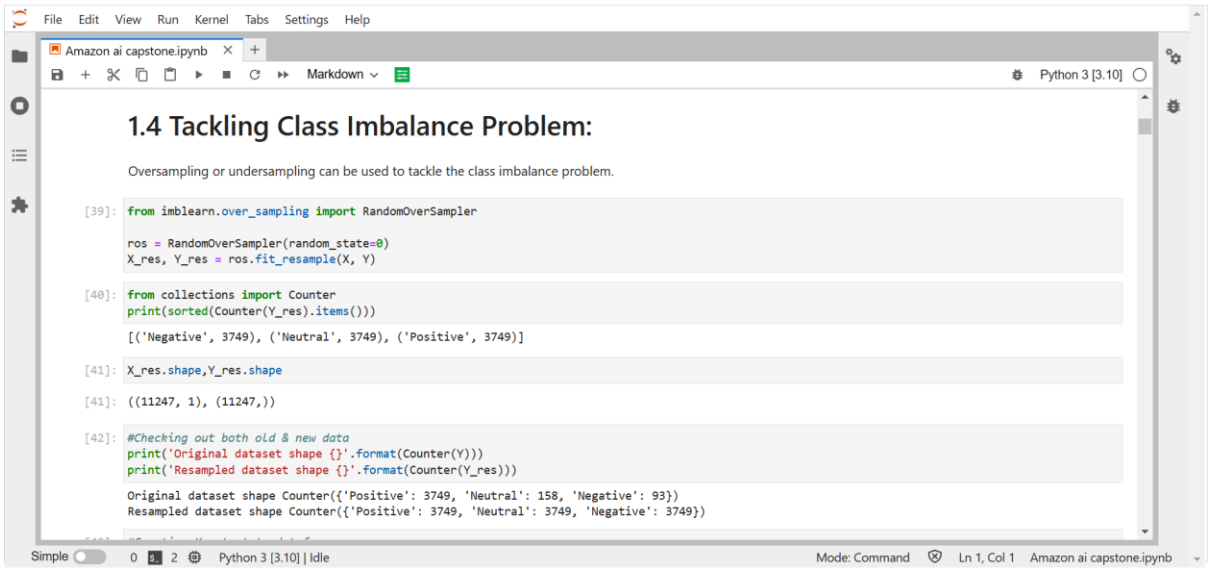

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Code Python 3 [3.10]

```
Y1=pd.DataFrame(Y_res,columns=['sentiment'])
```

[45]:
```
#Merging the X & Y output to Final data
Final_data=pd.concat([X1,Y1],axis=1)
Final_data.head()
```

[45]:

	Processed_Review	sentiment
0	purchase black fridaypros great price even sal...	Positive
1	purchase two amazon echo plus two dot plus fou...	Positive
2	average alexa option show thing screen still l...	Neutral
3	good product exactly want good price	Positive
4	rd one purchase buy one niece case compare one...	Positive

[46]:
```
Final_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 11247 entries, 0 to 11246
Data columns (total 2 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   Processed_Review  11247 non-null  object
 1   sentiment         11247 non-null  object
dtypes: object(2)
```

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb

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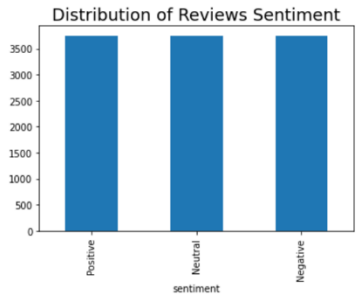
Code Python 3 [3.10]

```
Positive    3749
Neutral     3749
Negative    3749
Name: count, dtype: int64
```

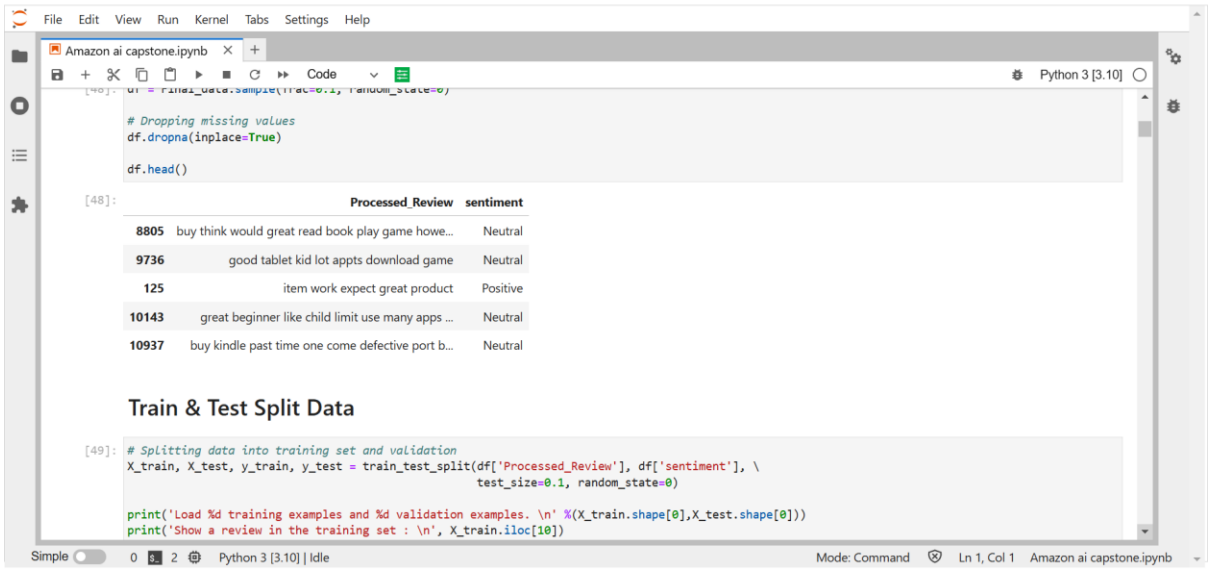
[47]:
```
Text(0.5, 1.0, 'Distribution of Reviews Sentiment')
```



[48]:
```
df = Final_data.sample(frac=0.1, random_state=0)

# Dropping missing values
```

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb



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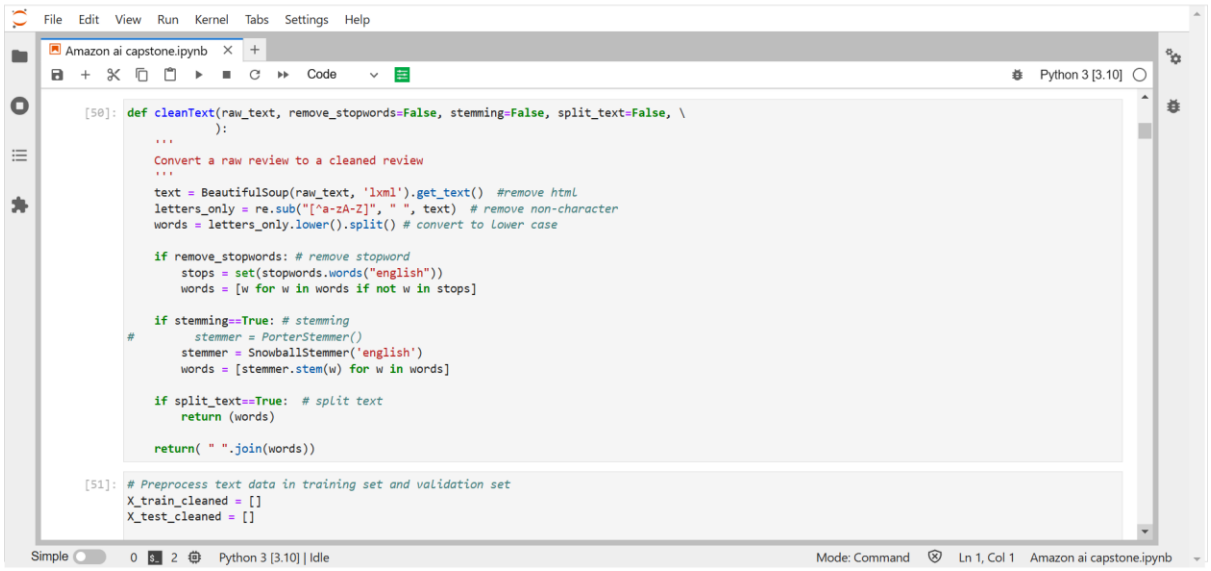

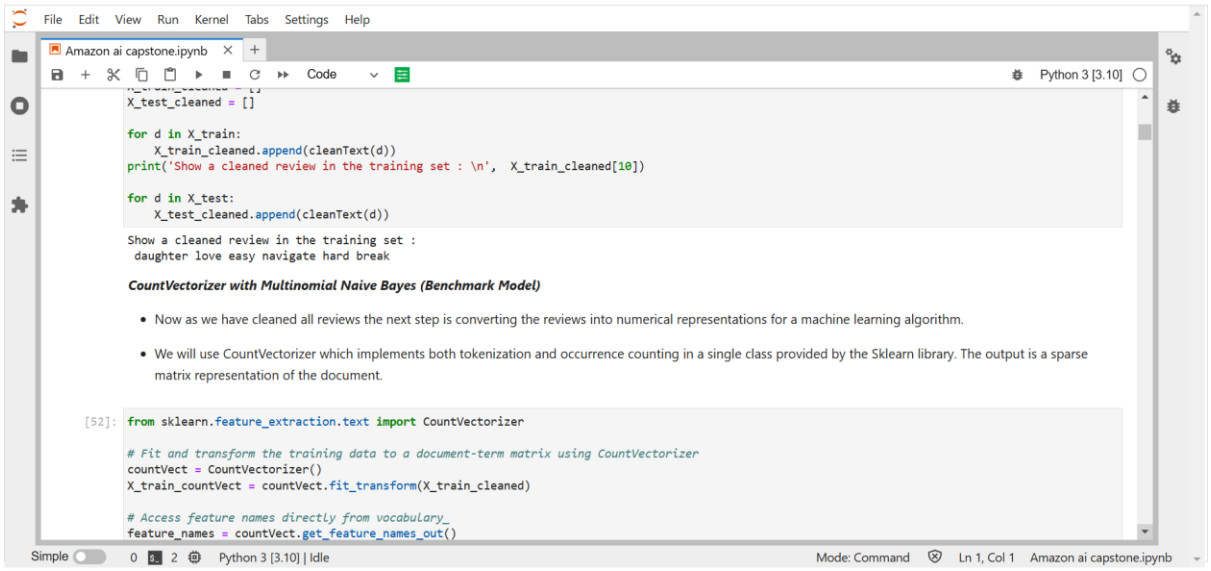

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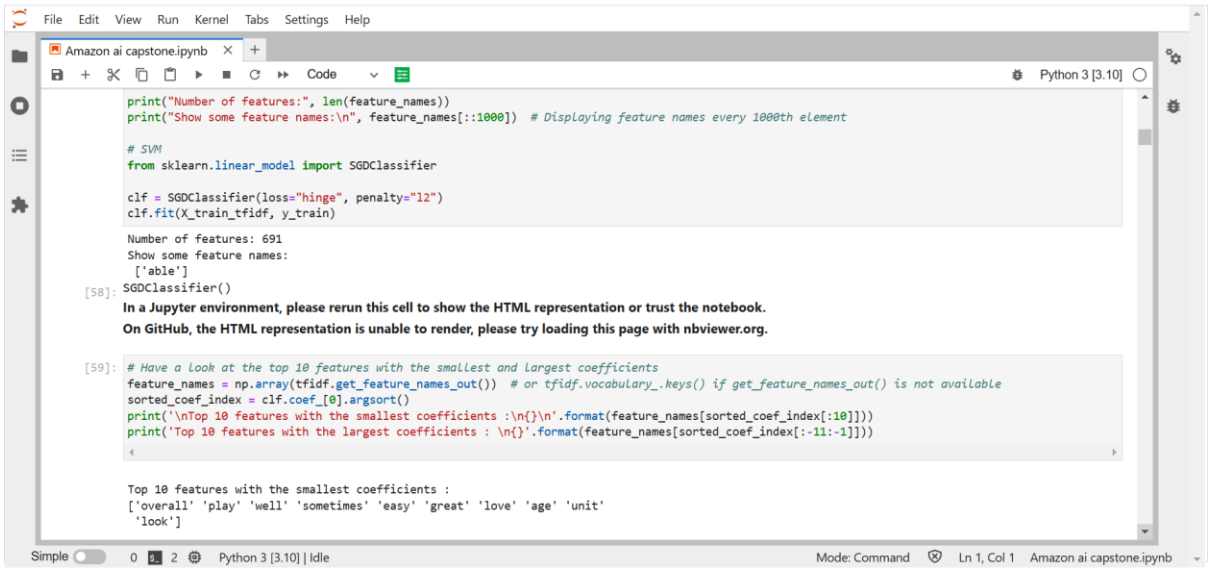

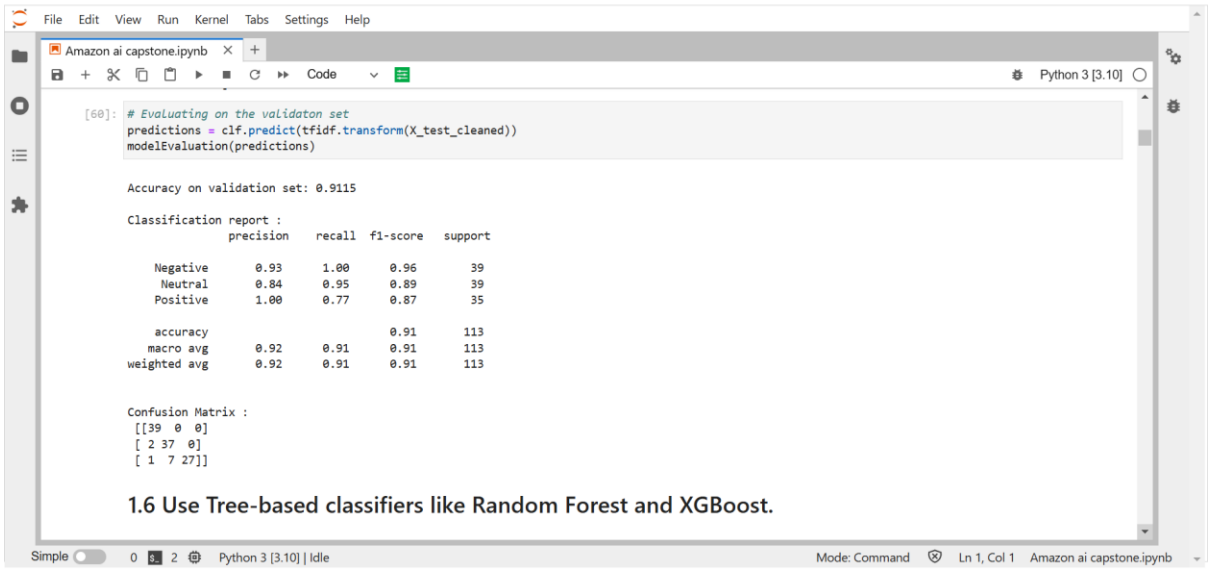

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Code

Python 3 [3.10]

[60]:
```
# Evaluating on the validaton set
predictions = clf.predict(tfidf.transform(X_test_cleaned))
modelEvaluation(predictions)
```

```
Accuracy on validation set: 0.9115

Classification report :
              precision    recall  f1-score   support

    Negative       0.93      1.00      0.96        39
     Neutral       0.84      0.95      0.89        39
    Positive       1.00      0.77      0.87        35

    accuracy                           0.91       113
   macro avg       0.92      0.91      0.91       113
weighted avg       0.92      0.91      0.91       113


Confusion Matrix :
 [[39  0  0]
 [ 2 37  0]
 [ 1  7 27]]
```

1.6 Use Tree-based classifiers like Random Forest and XGBoost.

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb

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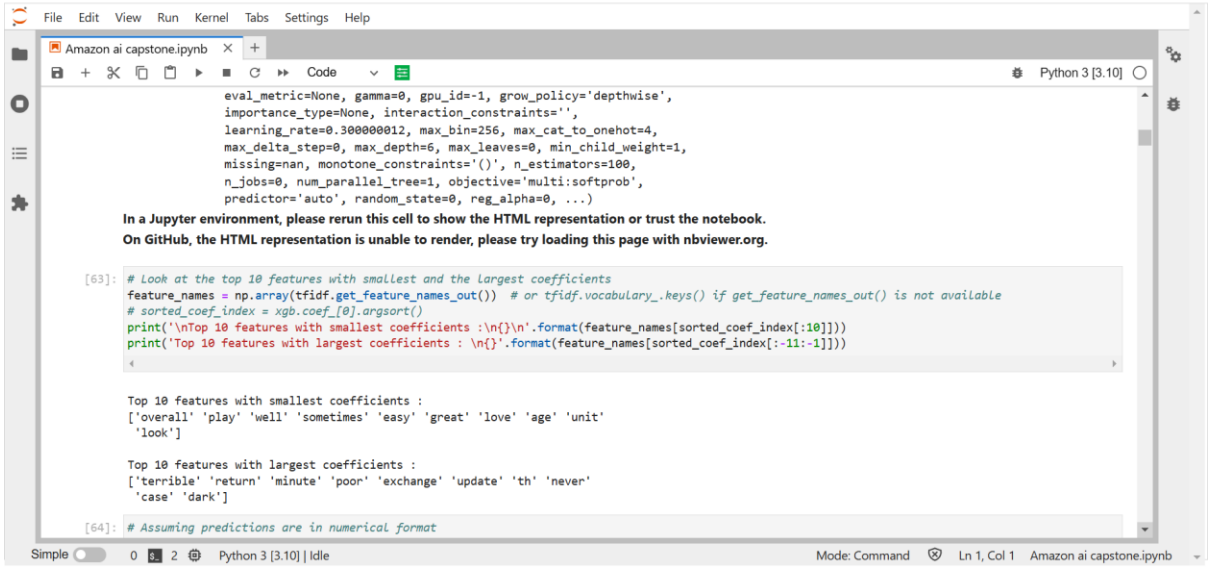

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Code

Python 3 [3.10]

```
                  eval_metric=None, gamma=0, gpu_id=-1, grow_policy='depthwise',
                  importance_type=None, interaction_constraints='',
                  learning_rate=0.300000012, max_bin=256, max_cat_to_onehot=4,
                  max_delta_step=0, max_depth=6, max_leaves=0, min_child_weight=1,
                  missing=nan, monotone_constraints='()', n_estimators=100,
                  n_jobs=0, num_parallel_tree=1, objective='multi:softprob',
                  predictor='auto', random_state=0, reg_alpha=0, ...)
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

[63]:
```
# Look at the top 10 features with smallest and the largest coefficients
feature_names = np.array(tfidf.get_feature_names_out())  # or tfidf.vocabulary_.keys() if get_feature_names_out() is not available
# sorted_coef_index = xgb.coef_[0].argsort()
print('\nTop 10 features with smallest coefficients :\n{}\n'.format(feature_names[sorted_coef_index[:10]]))
print('Top 10 features with largest coefficients : \n{}'.format(feature_names[sorted_coef_index[:-11:-1]]))
```

```
Top 10 features with smallest coefficients :
['overall' 'play' 'well' 'sometimes' 'easy' 'great' 'love' 'age' 'unit'
 'look']

Top 10 features with largest coefficients :
['terrible' 'return' 'minute' 'poor' 'exchange' 'update' 'th' 'never'
 'case' 'dark']
```

[64]:
```
# Assuming predictions are in numerical format
```

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb

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Code

Python 3 [3.10]

[64]:
```
# Assuming predictions are in numerical format
predictions = xgb.predict(tfidf.transform(X_test_cleaned))

# Convert numerical predictions to the same type as the original labels
predictions = label_encoder.inverse_transform(predictions)

# Now perform evaluation
modelEvaluation(predictions)
```

```
Accuracy on validation set: 0.9292

Classification report :
              precision    recall  f1-score   support

    Negative       0.95      0.97      0.96        39
     Neutral       0.90      0.95      0.92        39
    Positive       0.94      0.86      0.90        35

    accuracy                           0.93       113
   macro avg       0.93      0.93      0.93       113
weighted avg       0.93      0.93      0.93       113


Confusion Matrix :
 [[38  0  1]
 [ 1 37  1]
```

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb

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Code

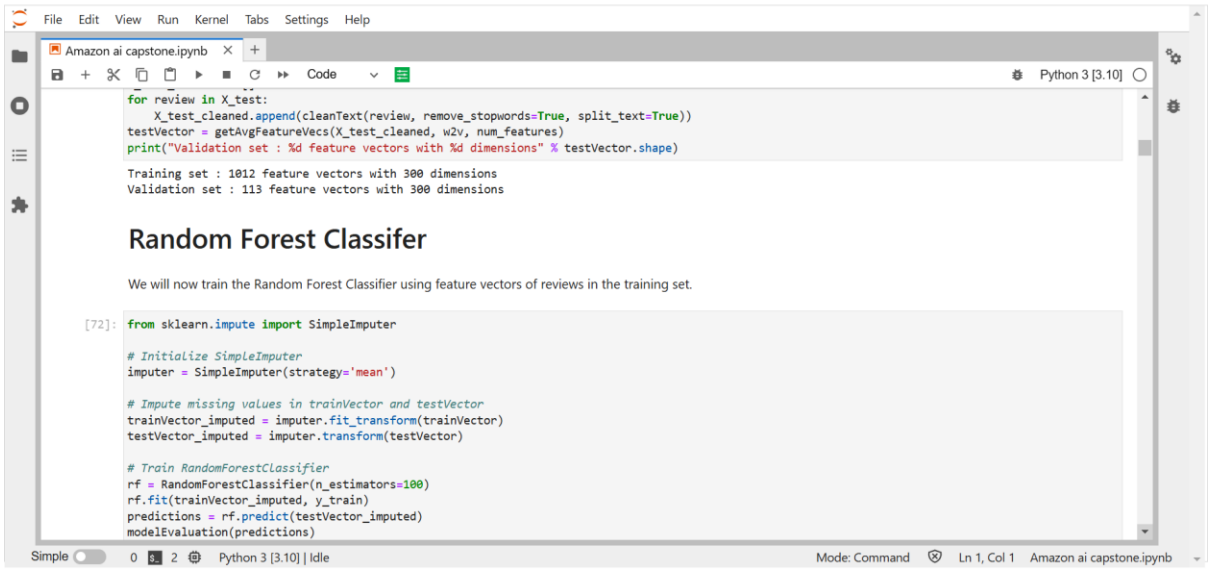
Python 3 [3.10]

```
        if word in index2word_set:
            nwords += 1
            featureVec = np.add(featureVec, model.wv[word])
    featureVec = np.divide(featureVec, nwords)
    return featureVec

def cleanText(text, remove_stopwords=False, split_text=False):
    # Your cleaning code here
    cleaned_text = text  # Example: Placeholder for actual cleaning code
    return cleaned_text

X_train_cleaned = []
for review in X_train:
    X_train_cleaned.append(cleanText(review, remove_stopwords=True, split_text=True))
trainVector = getAvgFeatureVecs(X_train_cleaned, w2v, num_features)
print("Training set : %d feature vectors with %d dimensions" % trainVector.shape)

# Getting feature vectors for validation set
X_test_cleaned = []
for review in X_test:
    X_test_cleaned.append(cleanText(review, remove_stopwords=True, split_text=True))
testVector = getAvgFeatureVecs(X_test_cleaned, w2v, num_features)
print("Validation set : %d feature vectors with %d dimensions" % testVector.shape)
```

```
Training set : 1012 feature vectors with 300 dimensions
Validation set : 113 feature vectors with 300 dimensions
```

Random Forest Classifer

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb



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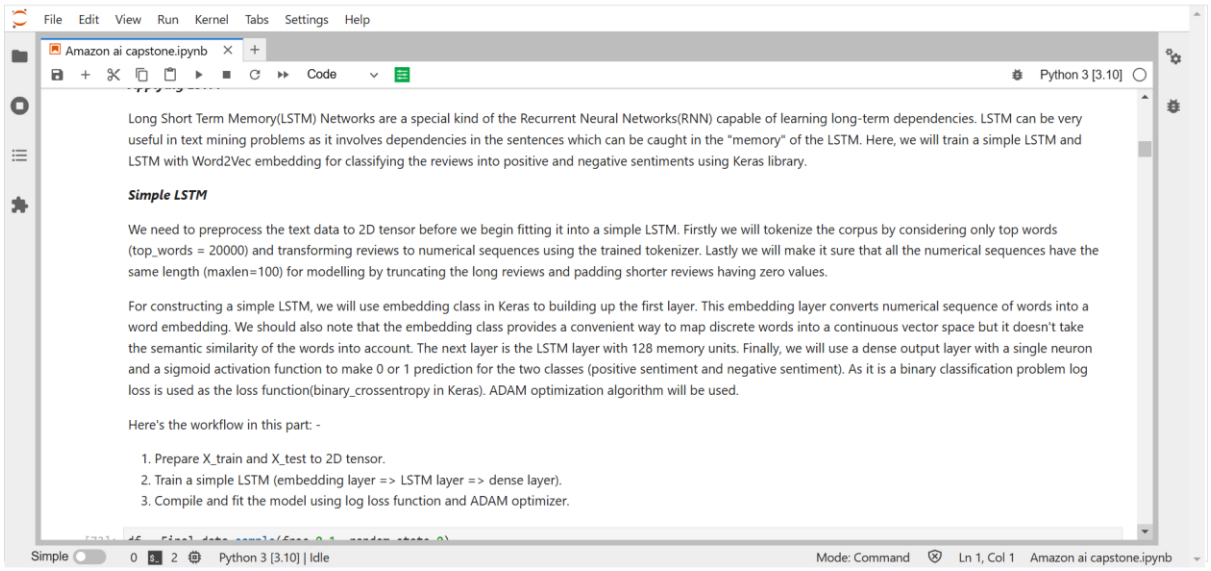

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Code Python 3 [3.10]

[75]:
```
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.utils import to_categorical

top_words = 20000
maxlen = 100
batch_size = 32
nb_classes = 3
nb_epoch = 3

# Vectorize X_train and X_test to 2D tensor
tokenizer = Tokenizer(nb_words=top_words) #Considering only top 20000 words in the corpus
tokenizer.fit_on_texts(X_train)
sequences_train = tokenizer.texts_to_sequences(X_train)
sequences_test = tokenizer.texts_to_sequences(X_test)

X_train_seq = pad_sequences(sequences_train, maxlen=maxlen)
X_test_seq = pad_sequences(sequences_test, maxlen=maxlen)

# One-Hot Encoding of y_train and y_test
y_train_seq = to_categorical(y_train, nb_classes)
y_test_seq = to_categorical(y_test, nb_classes)

print('X_train shape:', X_train_seq.shape) #(27799, 100)
print('X_test shape:', X_test_seq.shape) #(3089, 100)
print('y_train shape:', y_train_seq.shape) #(27799, 3)
print('y_test shape:', y_test_seq.shape) #(3089, 3)
```

```
X_train shape: (1012, 100)
X_test shape: (113, 100)
```

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb

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Code Python 3 [3.10]

```
y_train shape: (1012, 3)
y_test shape: (113, 3)
```

[76]:
```
from keras.layers import Embedding, LSTM, Dense, Activation, Dropout
from keras.models import Sequential

# Constructing a Simple LSTM
model1 = Sequential()
model1.add(Embedding(top_words, 128))
model1.add(Dropout(0.2))  # Adding Dropout regularization after Embedding layer
model1.add(LSTM(128, dropout=0.2, recurrent_dropout=0.2))  # Recurrent dropout
model1.add(Dense(nb_classes))
model1.add(Activation('softmax'))
model1.summary()

# Compiling LSTM
model1.compile(loss='binary_crossentropy',
               optimizer='adam',
               metrics=['accuracy'])

model1.fit(X_train_seq, y_train_seq, batch_size=batch_size, epochs=nb_epoch, verbose=1)  # Use epochs instead of nb_epoch

# Model Evaluation
score = model1.evaluate(X_test_seq, y_test_seq, batch_size=batch_size)
print('Test loss : {:.4f}'.format(score[0]))
print('Test accuracy : {:.4f}'.format(score[1]))
```

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb

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Code Python 3 [3.10]

```
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
Epoch 1/3
32/32 [==============================] - 9s 207ms/step - loss: 0.6434 - accuracy: 0.4051
Epoch 2/3
32/32 [==============================] - 7s 207ms/step - loss: 0.5430 - accuracy: 0.6245
Epoch 3/3
32/32 [==============================] - 7s 207ms/step - loss: 0.3220 - accuracy: 0.8567
4/4 [==============================] - 0s 13ms/step - loss: 0.2705 - accuracy: 0.8496
Test loss : 0.2705
Test accuracy : 0.8496
```

LSTM with Word2Vec Embedding

In the simple LSTM model constructed above, the embedding class in Keras comes in handy for converting the numerical sequence of words into a word embedding but it doesn't take the semantic similarity of the words into account. The model assigns random weights to the embedding layer and learn the embeddings by minimizing the global error of the network.

Instead of using random weights we will use pretrained word embeddings for initializing the weight of an embedding layer. Here, we will use the Word2Vec embedding trained in Part 4 for intializing the weights of embedding layer in LSTM.

1. Load pretrained word embedding model.
2. Construct embedding layer using embedding matrix as weights.
3. Train a LSTM with Word2Vec embedding (embedding layer => LSTM layer => dense layer).
4. Compile and fit the model using log loss function and ADAM optimizer.

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Code Python 3 [3.10]

4. Compile and fit the model using log loss function and ADAM optimizer.

[77]:
```
# Loading pretrained Word2Vec model
w2v = Word2Vec.load("w2v_300features_10minwordcounts_10context")

# Getting Word2Vec embedding matrix
embedding_matrix = w2v.wv.vectors  # embedding matrix, type = numpy.ndarray
print("Shape of embedding matrix : ", embedding_matrix.shape)  # (vocabulary size, embedding dimension)
# w2v.wv.vectors[0] # feature vector of the first word in the vocabulary list
```

```
Shape of embedding matrix :  (416, 300)
```

[78]:
```
from tensorflow.keras.utils import to_categorical

# Your existing code here
top_words = embedding_matrix.shape[0]  # 4016
maxlen = 100
batch_size = 32
nb_classes = 3
nb_epoch = 3

# Vectorizing X_train and X_test to 2D tensor
tokenizer = Tokenizer(nb_words=top_words)  # Considering only top 20000 words in the corpus
tokenizer.fit_on_texts(X_train)
# tokenizer.word_index # access word-to-index dictionary of trained tokenizer

sequences_train = tokenizer.texts_to_sequences(X_train)
sequences_test = tokenizer.texts_to_sequences(X_test)
```

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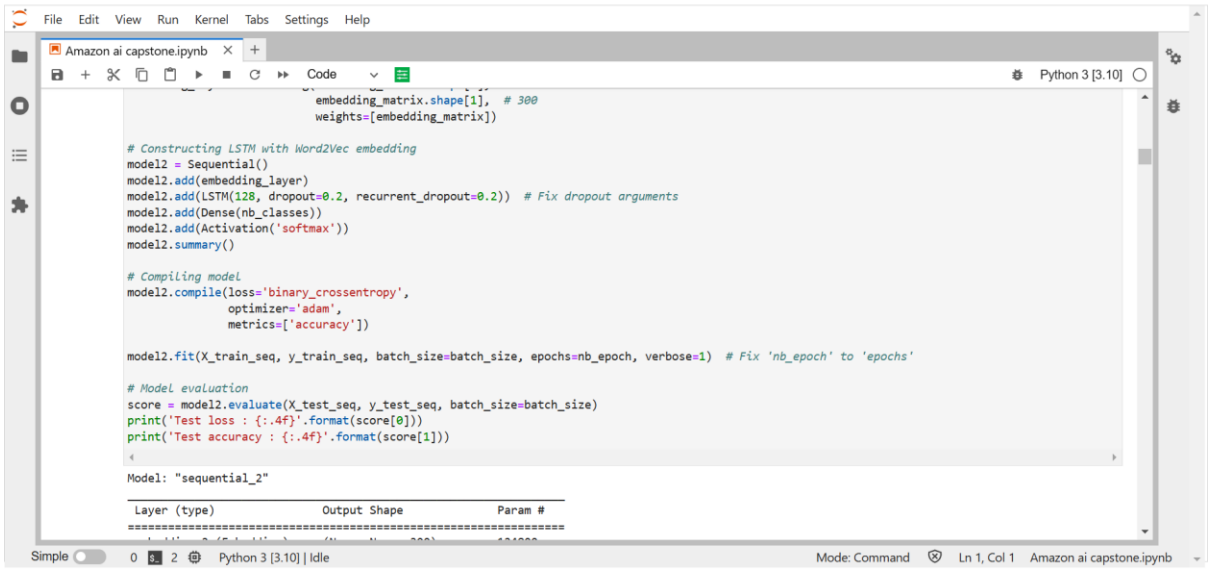

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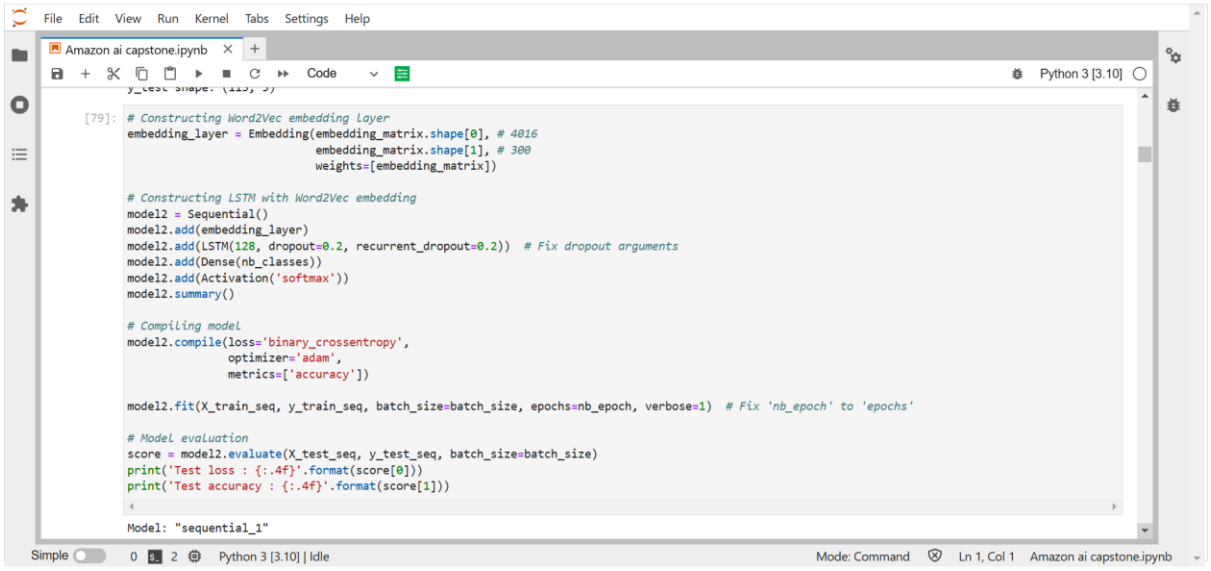

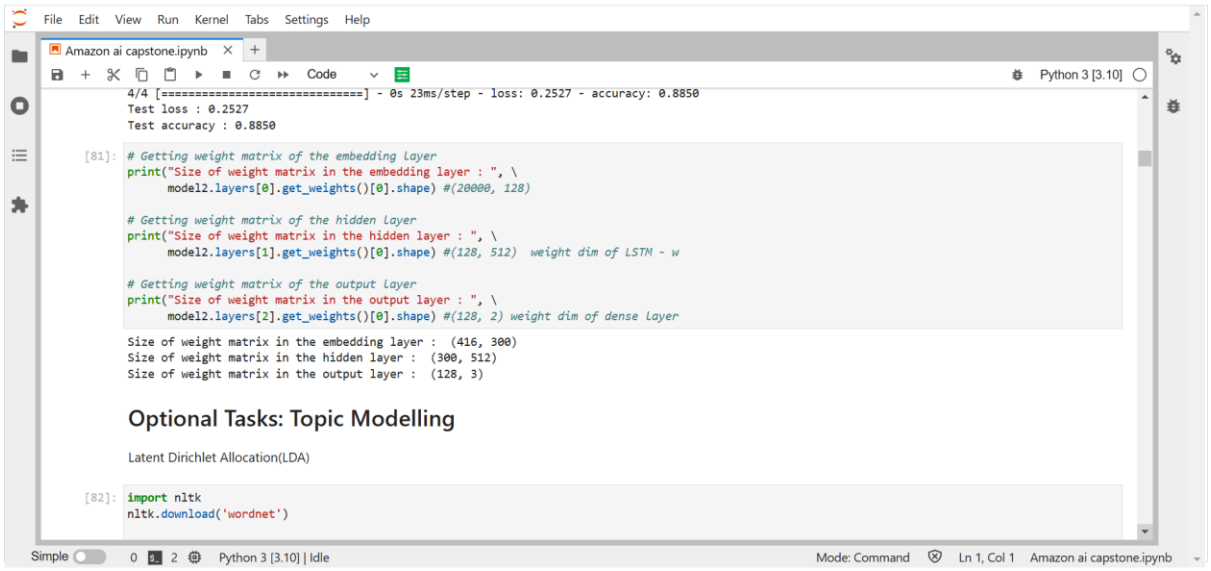

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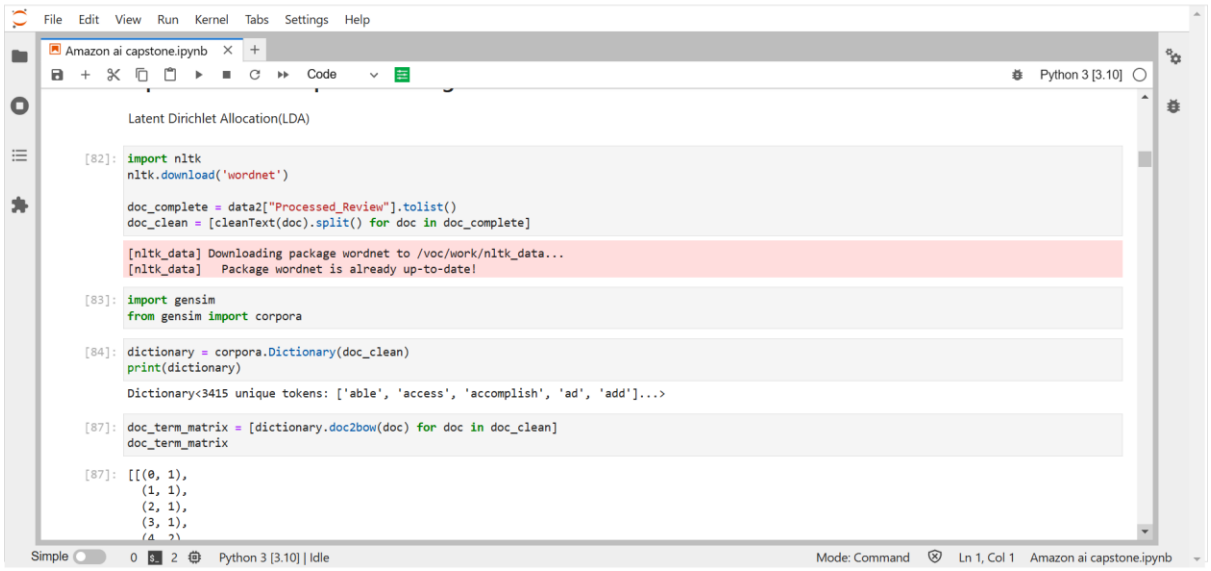

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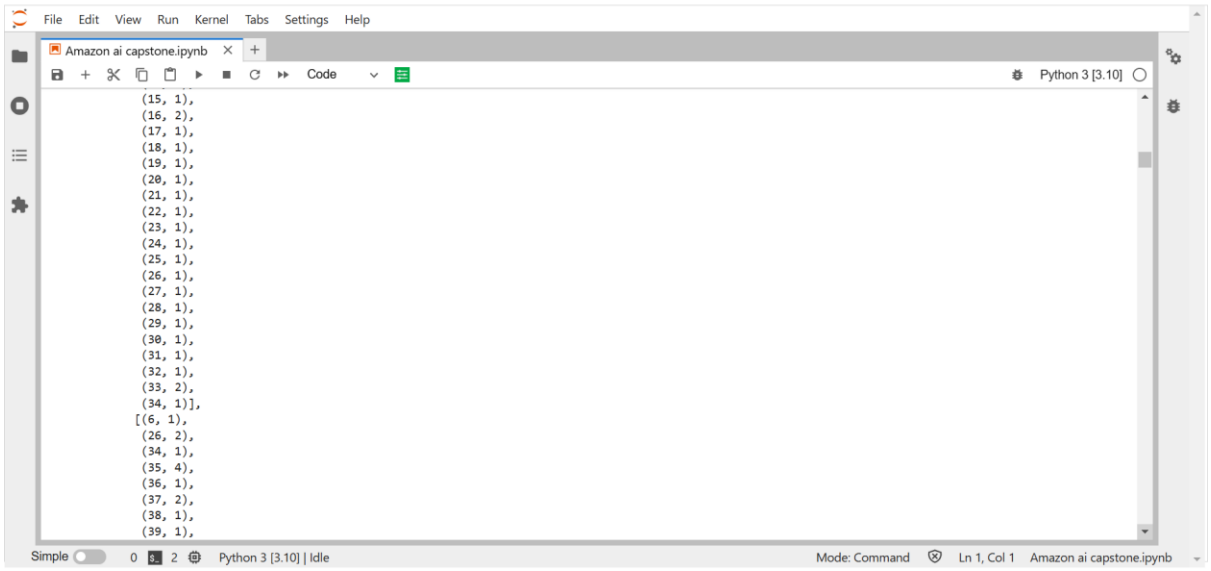

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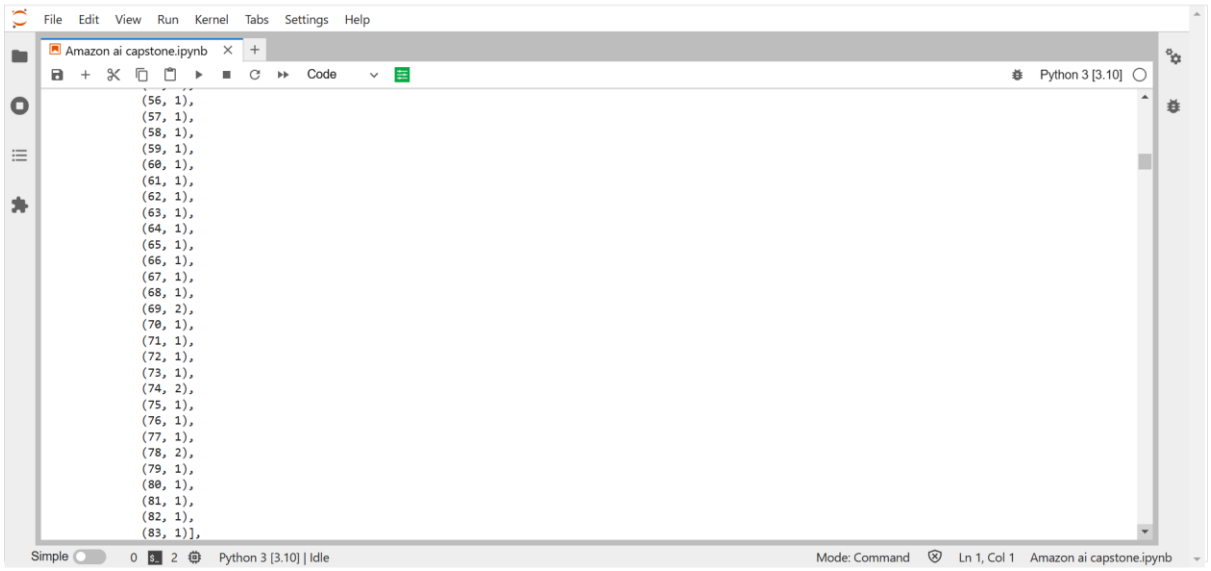

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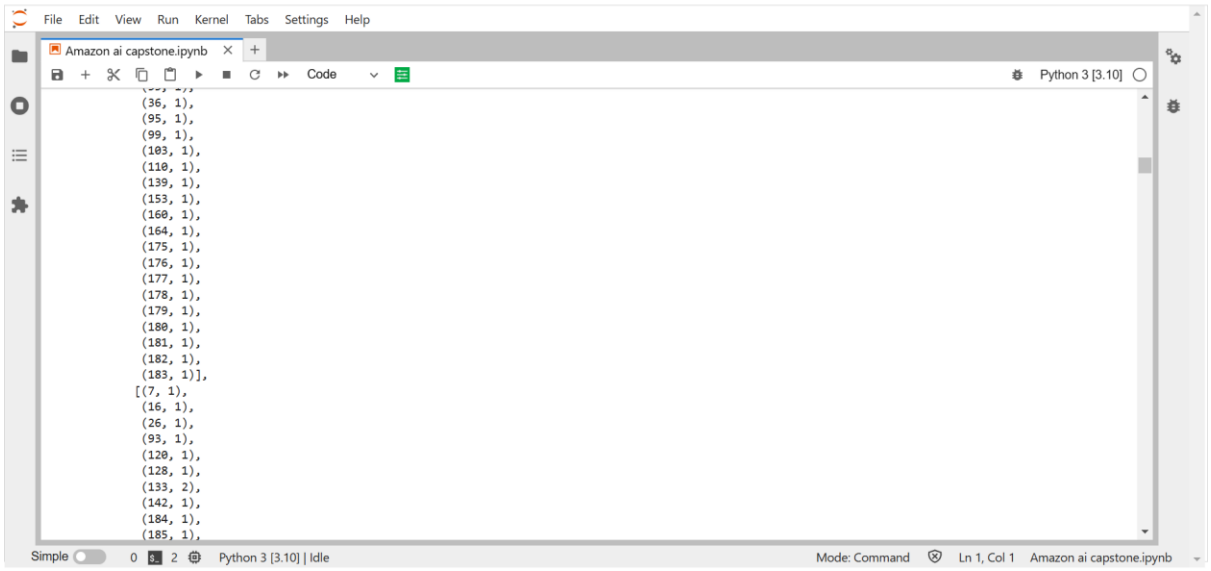

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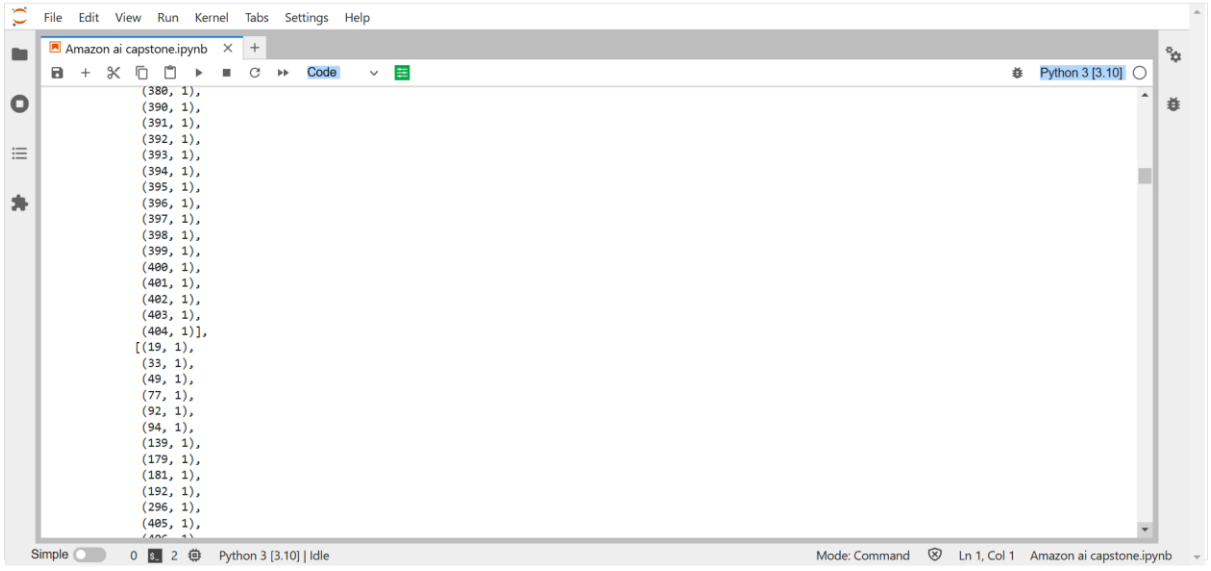

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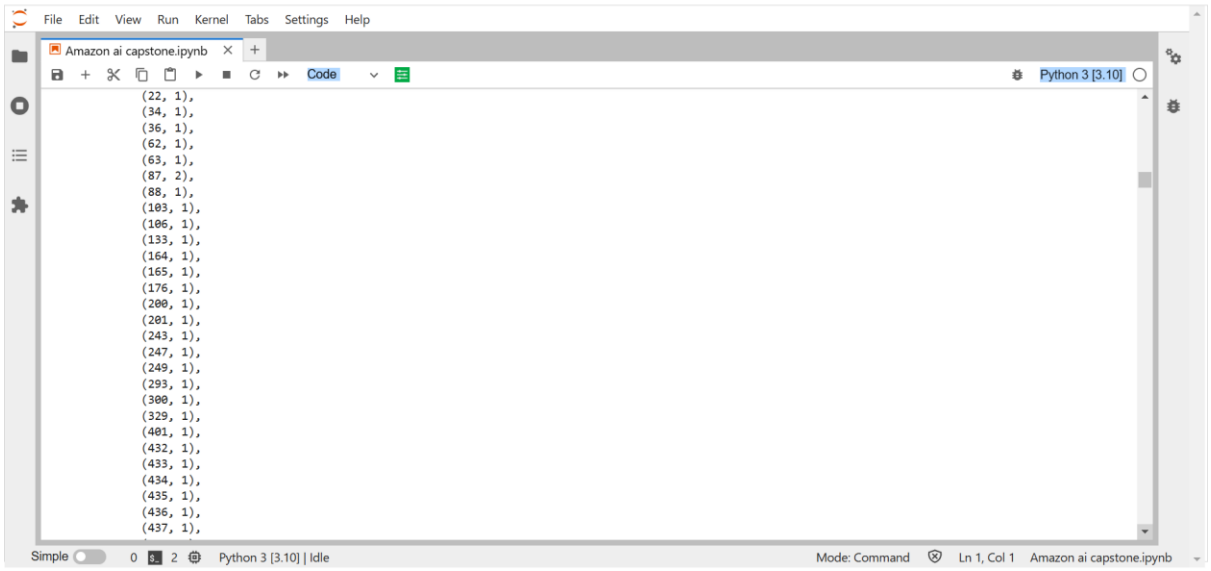

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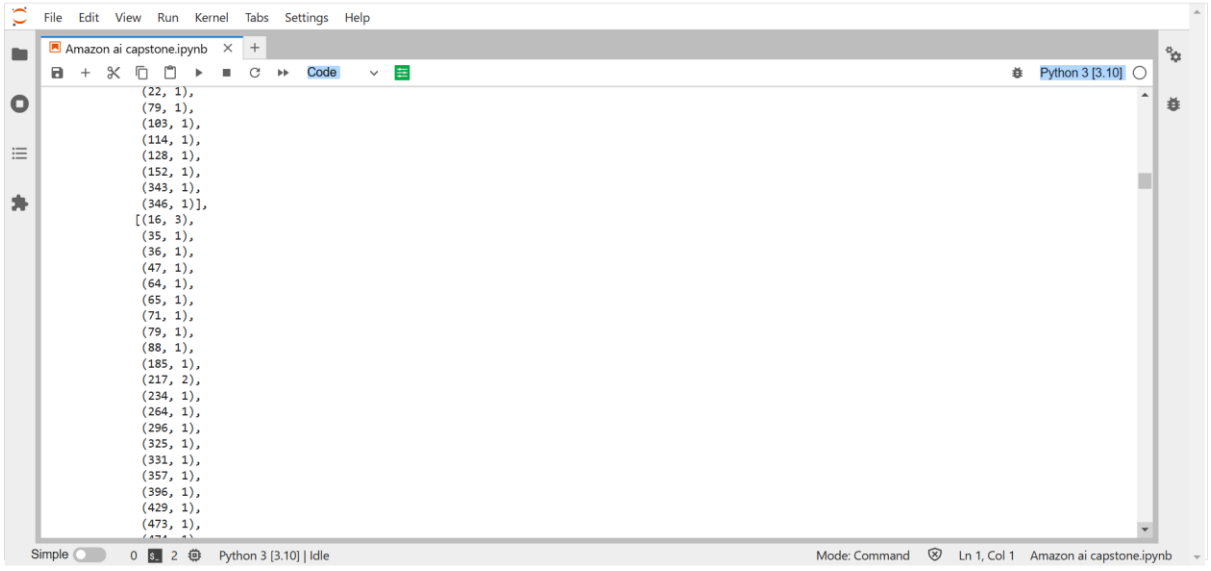

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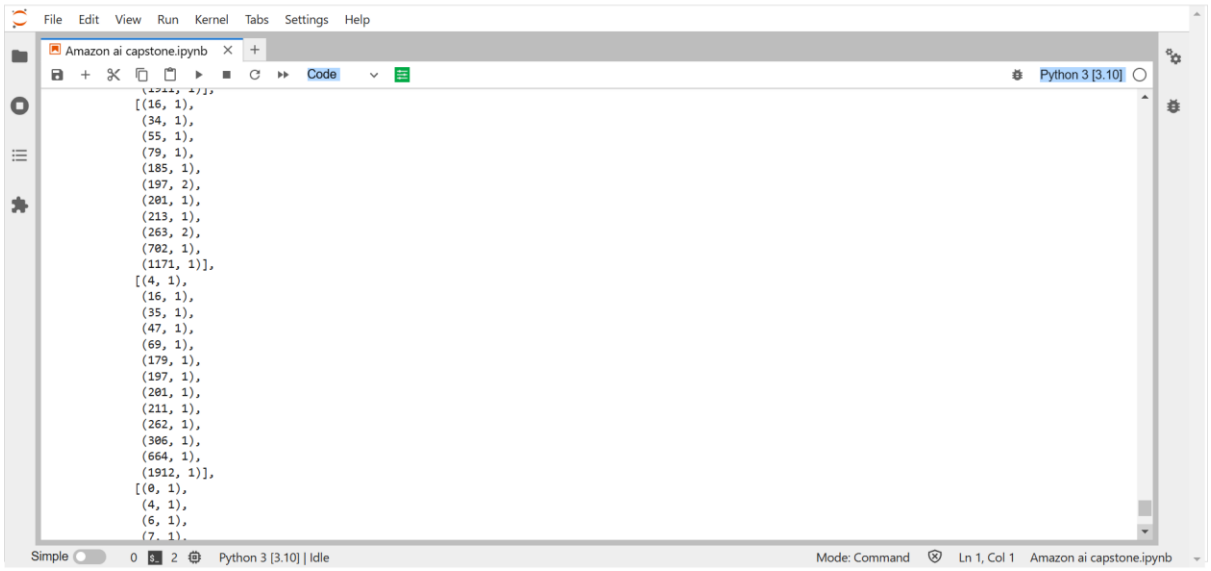

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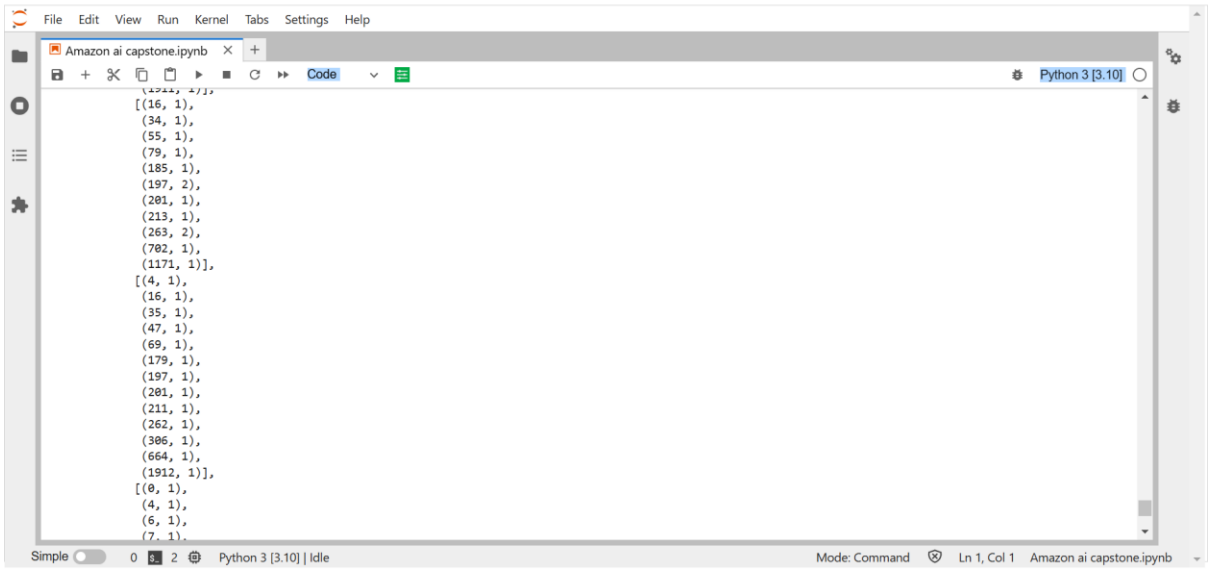

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Code Python 3 [3.10]

```
[(16, 1),
 (34, 1),
 (55, 1),
 (79, 1),
 (185, 1),
 (197, 2),
 (201, 1),
 (213, 1),
 (263, 2),
 (702, 1),
 (1171, 1)],
[(4, 1),
 (16, 1),
 (35, 1),
 (47, 1),
 (69, 1),
 (179, 1),
 (197, 1),
 (201, 1),
 (211, 1),
 (262, 1),
 (306, 1),
 (664, 1),
 (1912, 1)],
[(0, 1),
 (4, 1),
 (6, 1),
 (7, 1),
```

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb

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Code Python 3 [3.10]

[91]:
```
word_dict = {}
for i in range(NUM_TOPICS):
    words = ldamodel.show_topic(i, topn = 20)
    word_dict["Topic # " + "{}".format(i)] = [i[0] for i in words]
```

[92]:
```
pd.DataFrame(word_dict)
```

[92]:

	Topic # 0	Topic # 1	Topic # 2	Topic # 3	Topic # 4	Topic # 5	Topic # 6	Topic # 7	Topic # 8
0	echo	great	love	easy	tablet	kindle	good	battery	screen
1	alexa	use	buy	love	read	one	sound	charge	amazon
2	show	product	tablet	use	need	buy	great	life	good
3	music	work	old	read	great	get	quality	use	tablet
4	great	easy	year	size	kindle	fire	speaker	read	store
5	love	recommend	kid	purchase	price	amazon	like	tablet	device
6	home	tablet	game	much	good	love	tap	long	apps
7	use	good	play	kindle	book	use	portable	kindle	like
8	device	price	get	book	game	time	price	would	google
9	amazon	would	gift	screen	light	new	product	good	use

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb

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Code Python 3 [3.10]

[95]:
```
pip install --upgrade pip
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: pip in ./.local/lib/python3.10/site-packages (24.3.1)
Note: you may need to restart the kernel to use updated packages.
```

Displaying Results & Getting Insights

[96]:
```
import pyLDAvis.gensim
```

[97]:
```
# Import PyLDAvis
import pyLDAvis.gensim

# Set workers parameter to 1 to avoid parallel execution
Lda_display = pyLDAvis.gensim.prepare(ldamodel, doc_term_matrix, dictionary, sort_topics=False, n_jobs=1)

# Display the visualization
pyLDAvis.display(Lda_display)
```

[97]:

Creating a Wordcloud

[ ]:
```
from wordcloud import WordCloud, STOPWORDS
txt = data2["Processed_Review"].values
```

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb

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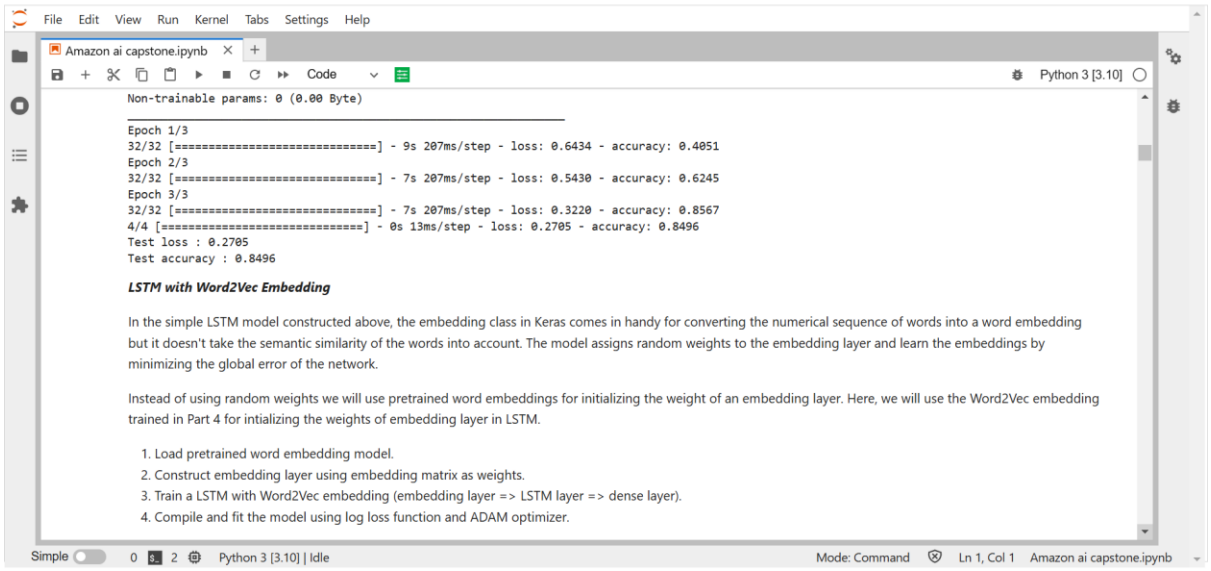
Code Python 3 [3.10]

```
txt = data2["Processed_Review"].values
wc = WordCloud(width=200, height=100, background_color="white", stopwords=STOPWORDS).generate(str(txt))
fig = plt.figure(figsize=(20,20), facecolor='k', edgecolor='w')
plt.imshow(wc, interpolation="bilinear")
plt.axis("off")
plt.tight_layout()
plt.show()
```

Simple 0 2 Python 3 [3.10] | Idle Mode: Command Ln 1, Col 1 Amazon ai capstone.ipynb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Code
Python 3 [3.10]
Non-trainable params: 0 (0.00 Byte)
Epoch 1/3
32/32 [==========] - 9s 207ms/step - loss: 0.6434 - accuracy: 0.4051
Epoch 2/3
32/32 [==========] - 7s 207ms/step - loss: 0.5430 - accuracy: 0.6245
Epoch 3/3
32/32 [==========] - 7s 207ms/step - loss: 0.3220 - accuracy: 0.8567
4/4 [==========] - 0s 13ms/step - loss: 0.2705 - accuracy: 0.8496
Test loss : 0.2705
Test accuracy : 0.8496
LSTM with Word2Vec Embedding
In the simple LSTM model constructed above, the embedding class in Keras comes in handy for converting the numerical sequence of words into a word embedding but it doesn't take the semantic similarity of the words into account. The model assigns random weights to the embedding layer and learn the embeddings by minimizing the global error of the network.
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Simple
Python 3 [3.10] | Idle
Mode: Command
Ln 1, Col 1
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