xuq3ul6wt

December 10, 2023

[1]:
```
from google.colab import drive
drive.mount('/gdrive')
```

```
Drive already mounted at /gdrive; to attempt to forcibly remount, call
drive.mount("/gdrive", force_remount=True).
```

[2]:
```
import os
import numpy as np
from PIL import Image
from sklearn.decomposition import PCA
import matplotlib.pyplot as plt
import cv2
import os
```

0.1 Question 2:

0.1.1 Part 1

- Create your own dataset for text classification. It should contain at least 1000 words in total and at least two categories with at least 100 examples per category.

[3]:
```
import zipfile
from google.colab import drive
import pandas as pd

csv_file_path = "/gdrive/MyDrive/sentiment_dataset.csv"

# Read CSV file into a Pandas DataFrame
df = pd.read_csv(csv_file_path)
```

[4]:
```
df
```

[4]:

	sentence	sentiment
0	I absolutely love the new movie; it's a master…	Positive
1	The weather is fantastic today; I'm enjoying e…	Positive
2	My friends always make me feel supported and h…	Positive
3	This book is incredibly inspiring; it changed …	Positive
4	I'm grateful for the opportunities that come m…	Positive

```
..                                                   …       …
205  Just what I needed - a flat tire on Monday mor…  Negative
206  My computer crashed again. What a fantastic op…  Negative
207  Another rejection letter! Because who doesn't …  Negative
208  Oh, marvelous, the grocery store ran out of my…  Negative
209  My flight got canceled. Perfect! I've always d…  Negative

[210 rows x 2 columns]
```

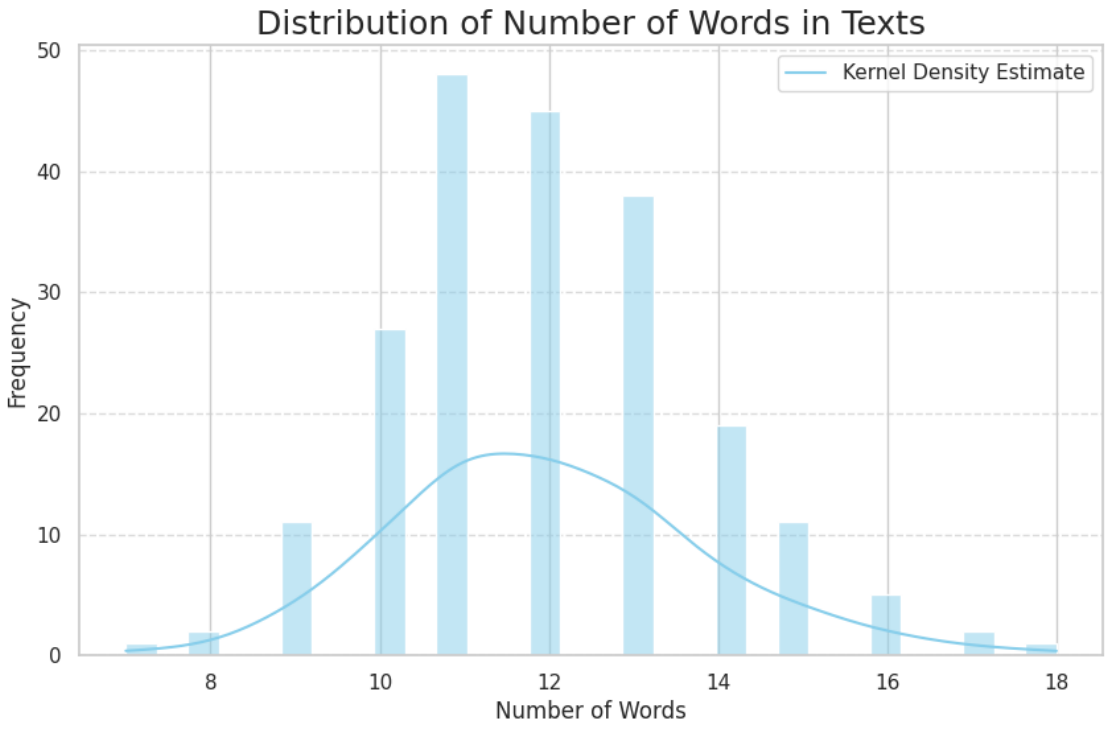
[5]:
```
sentiment_count = df['sentiment'].value_counts()
sentiment = sentiment_count.index
print("Unique sentiment:", sentiment)
sentiment_count
```

```
Unique sentiment: Index(['Negative', 'Positive'], dtype='object')
```

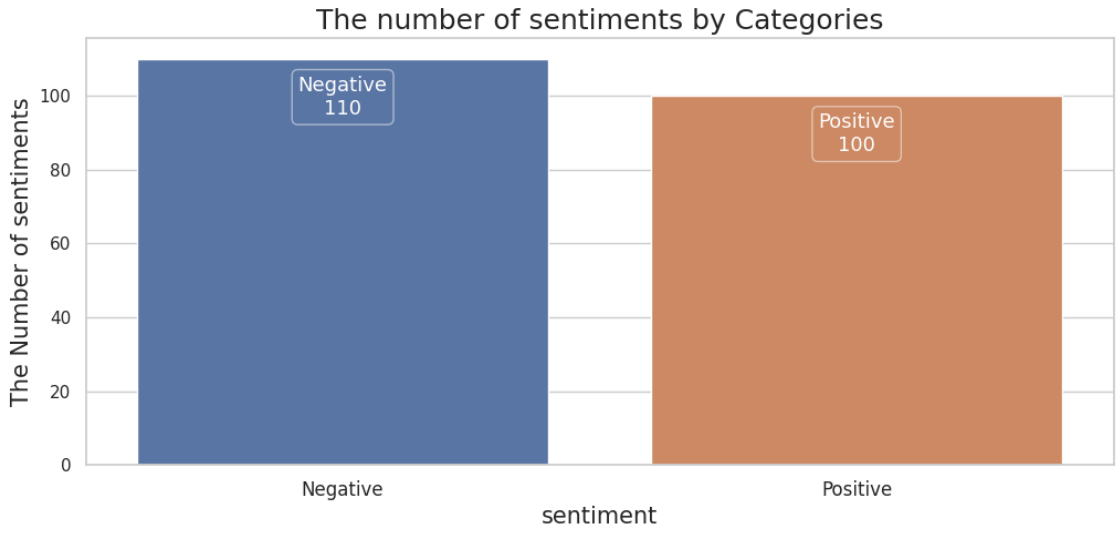
[5]:
```
Negative    110
Positive    100
Name: sentiment, dtype: int64
```

[6]:
```
df['word_count'] = df['sentence'].apply(lambda x: len(x.split()))
```

[7]:
```
import matplotlib.pyplot as plt
import seaborn as sns
sns.set(style="whitegrid")
plt.figure(figsize=(10, 6))
ax = sns.histplot(df['word_count'], bins=30, kde=True, color='skyblue')
ax.set(xlabel='Number of Words', ylabel='Frequency')
ax.set_title('Distribution of Number of Words in Texts', fontsize=18)
ax.grid(axis='y', linestyle='--', alpha=0.7)

# Customize the legend
ax.legend(['Kernel Density Estimate'], loc='upper right')

# Show the plot
plt.show()
```



[8]:
```
fig = plt.figure(figsize= (12, 5))
ax = fig.add_subplot(111)
sns.barplot(x = sentiment_count.index, y = sentiment_count )

for a, p in enumerate(ax.patches):
    ax.annotate(f'{sentiment[a]}\n' + format(p.get_height(), '.0f'), xy = (p.
 ↪get_x() + p.get_width() / 2.0, p.get_height()), xytext = (0,-25), size = 13,␣
 ↪color = 'white' , ha = 'center', va = 'center', textcoords = 'offset␣
 ↪points', bbox = dict(boxstyle = 'round', facecolor='none',edgecolor='white',␣
 ↪alpha = 0.5) )

plt.xlabel('sentiment', size = 15)

plt.ylabel('The Number of sentiments', size= 15)

plt.xticks(size = 12)

plt.title("The number of sentiments by Categories" , size = 18)

plt.show()
```



[9]:
```
df['sentiment_boolean'] = df['sentiment'].astype('category').cat.codes
df
```

[9]:

	sentence	sentiment	word_count	\
0	I absolutely love the new movie; it's a master…	Positive	9	
1	The weather is fantastic today; I'm enjoying e…	Positive	11	
2	My friends always make me feel supported and h…	Positive	9	
3	This book is incredibly inspiring; it changed …	Positive	11	
4	I'm grateful for the opportunities that come m…	Positive	9	
..	…	…	…	
205	Just what I needed - a flat tire on Monday mor…	Negative	17	
206	My computer crashed again. What a fantastic op…	Negative	13	
207	Another rejection letter! Because who doesn't …	Negative	15	
208	Oh, marvelous, the grocery store ran out of my…	Negative	15	
209	My flight got canceled. Perfect! I've always d…	Negative	15	

	sentiment_boolean
0	1
1	1
2	1
3	1
4	1
..	…
205	0
206	0
207	0
208	0
209	0

```
[210 rows x 4 columns]
```

[10]:
```
data_texts = df['sentence'].to_list()
data_labels = df['sentiment_boolean'].to_list()
```

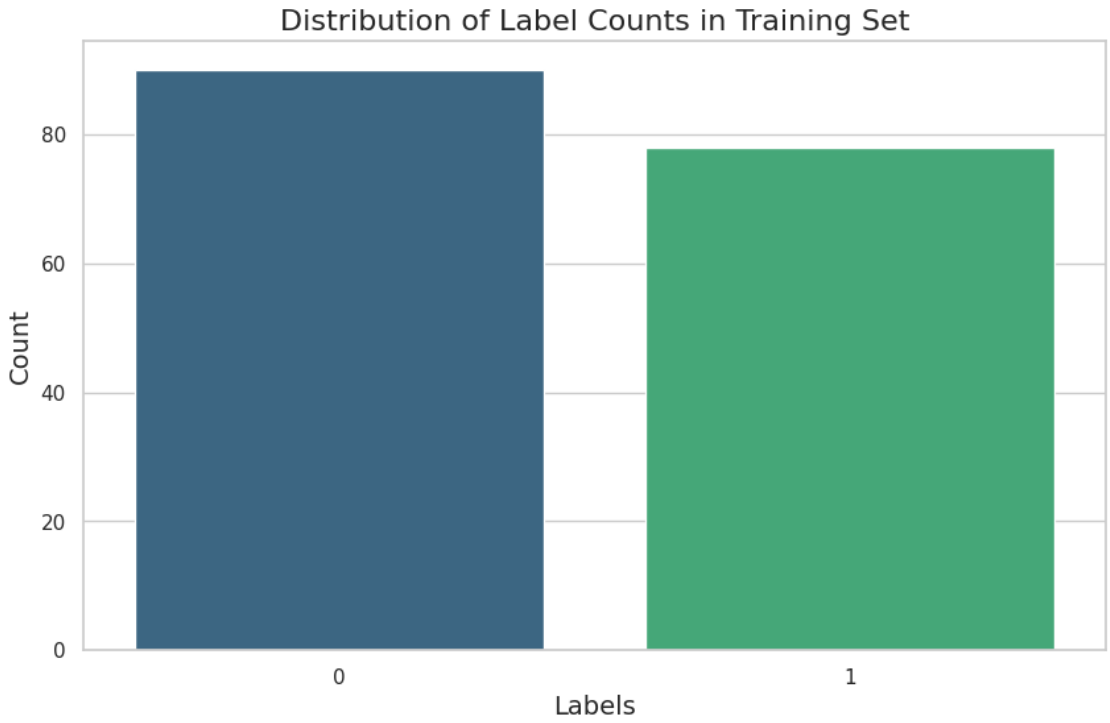
0.1.2 Part 2

0.1.3 Performing Train and Test Split

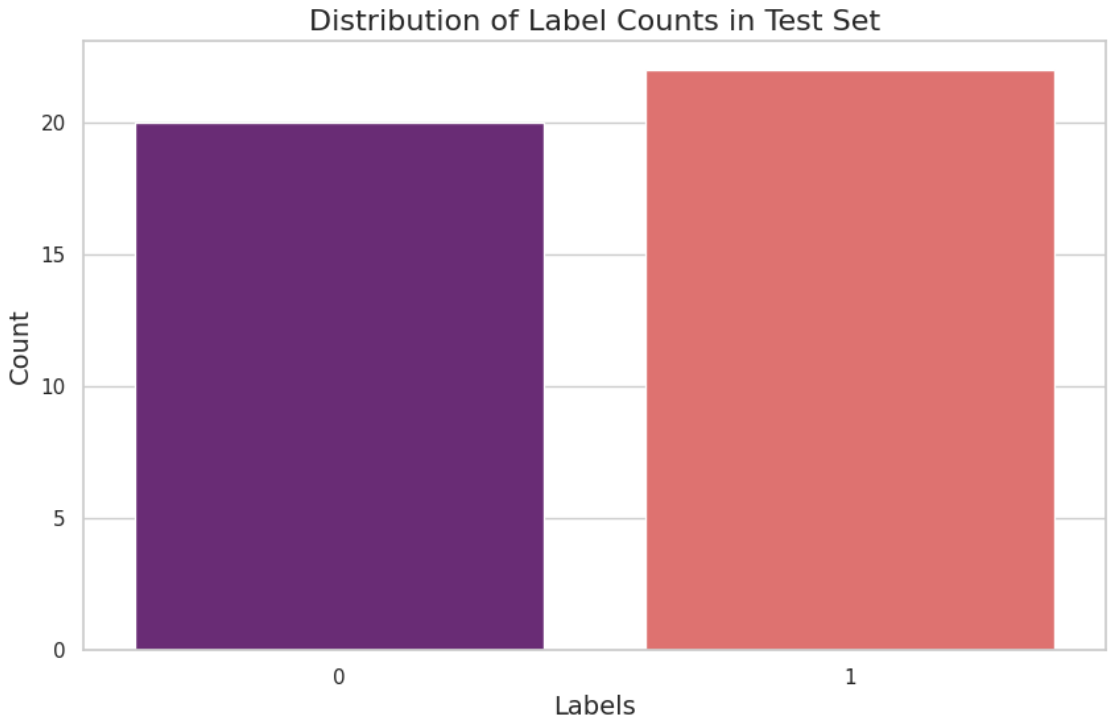
[11]:
```
from sklearn.model_selection import train_test_split
train_texts, test_texts, train_labels, test_labels =␣
 ↪train_test_split(data_texts, data_labels, test_size=0.2, random_state=42)
```

0.1.4 Validating Train and Test Split

[12]:
```
import matplotlib.pyplot as plt
import seaborn as sns
from collections import Counter

# Assuming train_labels is a list containing your labels
item_counts = Counter(train_labels)

# Create a bar plot
plt.figure(figsize=(10, 6))
sns.barplot(x=list(item_counts.keys()), y=list(item_counts.values()),␣
 ↪palette="viridis")
plt.title('Distribution of Label Counts in Training Set', fontsize=16)
plt.xlabel('Labels', fontsize=14)
plt.ylabel('Count', fontsize=14)
plt.show()
```



[13]:
```
import matplotlib.pyplot as plt
import seaborn as sns
from collections import Counter

# Assuming test_labels is a list containing your labels|
item_counts_test = Counter(test_labels)

# Create a bar plot for the test set
plt.figure(figsize=(10, 6))
sns.barplot(x=list(item_counts_test.keys()), y=list(item_counts_test.values()),␣
 ↪palette="magma")
plt.title('Distribution of Label Counts in Test Set', fontsize=16)
plt.xlabel('Labels', fontsize=14)
plt.ylabel('Count', fontsize=14)
plt.show()
```



[14]:
```
import transformers
from tensorflow import keras
from transformers import DistilBertTokenizer
from transformers import TFDistilBertForSequenceClassification
from transformers import TextClassificationPipeline

import tensorflow as tf
import pandas as pd
import json
import gc

from sklearn.model_selection import train_test_split

import re
import nltk
from nltk.corpus import stopwords
nltk.download('stopwords')
stopw = stopwords.words('english')

import seaborn as sns
import matplotlib.pyplot as plt
from plotly.offline import iplot
```

```
from tqdm import tqdm
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data…
[nltk_data]   Package stopwords is already up-to-date!
```

[15]:
```
tokenizer = DistilBertTokenizer.from_pretrained('distilbert-base-uncased')

train_encodings = tokenizer(train_texts, truncation=True, padding=True)

test_encodings = tokenizer(test_texts, truncation=True, padding=True)
```

[16]:
```
# Print the first example's encoding from the training set
print("Training Encoding - Example 1:")
print("Input IDs:", train_encodings['input_ids'][0])
print("Attention Mask:", train_encodings['attention_mask'][0])
print("\n")

# Print the first example's encoding from the test set
print("Test Encoding - Example 1:")
print("Input IDs:", test_encodings['input_ids'][0])
print("Attention Mask:", test_encodings['attention_mask'][0])
print("\n")
```

```
Training Encoding - Example 1:
Input IDs: [101, 1996, 5573, 4530, 1999, 4860, 3236, 2033, 4895, 28139, 19362,
2098, 1010, 2877, 2000, 17964, 1012, 102, 0, 0, 0, 0, 0, 0, 0]
Attention Mask: [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0,
0, 0, 0, 0]


Test Encoding - Example 1:
Input IDs: [101, 1996, 8013, 2326, 4387, 2001, 19776, 3512, 1998, 4895, 16001,
14376, 5313, 1012, 102, 0, 0, 0, 0, 0, 0]
Attention Mask: [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0]
```

[17]:
```
# Training Dataset
train_dataset = tf.data.Dataset.from_tensor_slices((
    dict(train_encodings),  # Features: tokenized and encoded representations␣
 ↪of training texts
    train_labels            # Labels: corresponding labels for the training␣
 ↪texts
))

# Test Dataset
test_dataset = tf.data.Dataset.from_tensor_slices((
```

```
    dict(test_encodings),    # Features: tokenized and encoded representations␣
 ↪of test texts
    test_labels              # Labels: corresponding labels for the test texts
))
```

[18]:
```
# Print the contents of the training dataset
for features, labels in train_dataset.take(5):  # Print the first 5 examples␣
 ↪for illustration
    print("Features:", features)
    print("Labels:", labels)
    print("\n")
```

```
Features: {'input_ids': <tf.Tensor: shape=(25,), dtype=int32, numpy=
array([  101,  1996,  5573,  4530,  1999,  4860,  3236,  2033,  4895,
       28139, 19362,  2098,  1010,  2877,  2000, 17964,  1012,   102,
           0,     0,     0,     0,     0,     0,     0], dtype=int32)>,
'attention_mask': <tf.Tensor: shape=(25,), dtype=int32, numpy=
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0,
       0, 0, 0], dtype=int32)>}
Labels: tf.Tensor(0, shape=(), dtype=int32)


Features: {'input_ids': <tf.Tensor: shape=(25,), dtype=int32, numpy=
array([  101,  4087,  1043, 15909,  8376,  2076,  2019,  2590,  8312,
        3303, 14325,  1012,   102,     0,     0,     0,     0,     0,
           0,     0,     0,     0,     0,     0,     0], dtype=int32)>,
'attention_mask': <tf.Tensor: shape=(25,), dtype=int32, numpy=
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0], dtype=int32)>}
Labels: tf.Tensor(0, shape=(), dtype=int32)


Features: {'input_ids': <tf.Tensor: shape=(25,), dtype=int32, numpy=
array([ 101, 2821, 1010, 2307, 1010, 2178, 4026, 9389,  999, 1045, 2074,
       2293, 5938, 3737, 2051, 2007, 2026, 2482, 2006, 1996, 3307, 1012,
        102,    0,    0], dtype=int32)>, 'attention_mask': <tf.Tensor:
shape=(25,), dtype=int32, numpy=
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 0, 0], dtype=int32)>}
Labels: tf.Tensor(0, shape=(), dtype=int32)


Features: {'input_ids': <tf.Tensor: shape=(25,), dtype=int32, numpy=
array([  101,  1045,  2293,  1996,  3110,  1997, 24718,  2044, 10863,
        1037, 18856, 23128,  2686,  1012,   102,     0,     0,     0,
           0,     0,     0,     0,     0,     0,     0], dtype=int32)>,
'attention_mask': <tf.Tensor: shape=(25,), dtype=int32, numpy=
```

```
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0], dtype=int32)>}
Labels: tf.Tensor(1, shape=(), dtype=int32)


Features: {'input_ids': <tf.Tensor: shape=(25,), dtype=int32, numpy=
array([  101,  1037,  5573,  3623,  1999,  2147, 11066,  2012,  1996,
        2436,  2038,  2580,  6911,  1998,  2058,  2860, 24546,  1012,
         102,     0,     0,     0,     0,     0,     0], dtype=int32)>,
'attention_mask': <tf.Tensor: shape=(25,), dtype=int32, numpy=
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0,
       0, 0, 0], dtype=int32)>}
Labels: tf.Tensor(0, shape=(), dtype=int32)
```

0.1.5 Part 3:

0.1.6 Base pretrained model implementation:

[35]:
```python
# Import necessary components from the transformers library
from transformers import TFDistilBertForSequenceClassification, TFTrainer,␣
 ↪TFTrainingArguments

model = TFDistilBertForSequenceClassification.
 ↪from_pretrained('distilbert-base-uncased', num_labels=2)

for layer in model.layers[:-3]:
    layer.trainable = False
optimizer = tf.keras.optimizers.Adam(learning_rate=0.0001)
model.compile(optimizer=optimizer, loss=model.hf_compute_loss,␣
 ↪metrics=['accuracy'])

model.fit(train_dataset.shuffle(100).batch(16), epochs=3,
          validation_data=test_dataset.shuffle(100).batch(16)
          )
```

```
Some weights of the PyTorch model were not used when initializing the TF 2.0
model TFDistilBertForSequenceClassification: ['vocab_layer_norm.bias',
'vocab_projector.bias', 'vocab_transform.bias', 'vocab_transform.weight',
'vocab_layer_norm.weight']
- This IS expected if you are initializing TFDistilBertForSequenceClassification
from a PyTorch model trained on another task or with another architecture (e.g.
initializing a TFBertForSequenceClassification model from a BertForPreTraining
model).
- This IS NOT expected if you are initializing
TFDistilBertForSequenceClassification from a PyTorch model that you expect to be
exactly identical (e.g. initializing a TFBertForSequenceClassification model
```

```
from a BertForSequenceClassification model).
Some weights or buffers of the TF 2.0 model
TFDistilBertForSequenceClassification were not initialized from the PyTorch
model and are newly initialized: ['pre_classifier.weight',
'pre_classifier.bias', 'classifier.weight', 'classifier.bias']
You should probably TRAIN this model on a down-stream task to be able to use it
for predictions and inference.

Epoch 1/3
11/11 [==============================] - 71s 946ms/step - loss: 0.6670 -
accuracy: 0.6667 - val_loss: 0.6309 - val_accuracy: 0.6667
Epoch 2/3
11/11 [==============================] - 5s 446ms/step - loss: 0.6003 -
accuracy: 0.8095 - val_loss: 0.5587 - val_accuracy: 1.0000
Epoch 3/3
11/11 [==============================] - 6s 531ms/step - loss: 0.5369 -
accuracy: 0.9226 - val_loss: 0.4899 - val_accuracy: 1.0000
```

[35]:
```
<keras.src.callbacks.History at 0x78cf342641c0>
```

[36]:
```
model.summary()
```

```
Model: "tf_distil_bert_for_sequence_classification_4"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 distilbert (TFDistilBertMa  multiple                  66362880
 inLayer)

 pre_classifier (Dense)      multiple                  590592

 classifier (Dense)          multiple                  1538

 dropout_99 (Dropout)        multiple                  0

=================================================================
Total params: 66955010 (255.41 MB)
Trainable params: 592130 (2.26 MB)
Non-trainable params: 66362880 (253.15 MB)
_________________________________________________________________
```

0.1.7 Transfer Learning: Model hyperparameter finetuning and training

[49]:
```
base_model = TFDistilBertForSequenceClassification.
 ↪from_pretrained('distilbert-base-uncased', num_labels = 2)

for layer in base_model.layers[:-5]:
    layer.trainable = False
```

```
# Create a custom model by extending the base model
class CustomDistilBERTModel(tf.keras.Model):
    def __init__(self, base_model):
        super(CustomDistilBERTModel, self).__init__()
        self.base_model = base_model  # Store the base model
        self.dense_layer = tf.keras.layers.Dense(256, activation='relu')
        self.output_layer = tf.keras.layers.Dense(2, activation='softmax')

    def call(self, inputs, training=False):
        logits = self.base_model(inputs, training=training).logits
        dense_output = self.dense_layer(logits)
        predictions = self.output_layer(dense_output)
        return predictions

# Instantiate the custom model
ammended_model = CustomDistilBERTModel(base_model)

optimizer = tf.keras.optimizers.Adam(learning_rate=0.0001)
ammended_model.compile(optimizer=optimizer, loss=model.hf_compute_loss,␣
 ↪metrics=["accuracy"])

# Train the model
ammended_model.fit(train_dataset.batch(16), epochs=3,␣
 ↪validation_data=test_dataset.batch(16))

# Evaluate the model on the test set
test_loss, test_accuracy = ammended_model.evaluate(test_dataset.batch(32))
print(f"Test Accuracy: {test_accuracy * 100:.2f}%")
```

```
Some weights of the PyTorch model were not used when initializing the TF 2.0
model TFDistilBertForSequenceClassification: ['vocab_layer_norm.bias',
'vocab_projector.bias', 'vocab_transform.bias', 'vocab_transform.weight',
'vocab_layer_norm.weight']
- This IS expected if you are initializing TFDistilBertForSequenceClassification
from a PyTorch model trained on another task or with another architecture (e.g.
initializing a TFBertForSequenceClassification model from a BertForPreTraining
model).
- This IS NOT expected if you are initializing
TFDistilBertForSequenceClassification from a PyTorch model that you expect to be
exactly identical (e.g. initializing a TFBertForSequenceClassification model
from a BertForSequenceClassification model).
Some weights or buffers of the TF 2.0 model
TFDistilBertForSequenceClassification were not initialized from the PyTorch
model and are newly initialized: ['pre_classifier.weight',
'pre_classifier.bias', 'classifier.weight', 'classifier.bias']
You should probably TRAIN this model on a down-stream task to be able to use it
```

```
for predictions and inference.

Epoch 1/3
11/11 [==============================] - 44s 3s/step - loss: 0.6505 - accuracy:
0.8333 - val_loss: 0.5583 - val_accuracy: 1.0000
Epoch 2/3
11/11 [==============================] - 33s 3s/step - loss: 0.4822 - accuracy:
0.9881 - val_loss: 0.3972 - val_accuracy: 0.9762
Epoch 3/3
11/11 [==============================] - 23s 2s/step - loss: 0.3043 - accuracy:
1.0000 - val_loss: 0.2421 - val_accuracy: 0.9762
2/2 [==============================] - 1s 347ms/step - loss: 0.2421 - accuracy:
0.9762
Test Accuracy: 97.62%
```

[50]:
```
ammended_model.summary()
```

```
Model: "custom_distil_bert_model_12"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 tf_distil_bert_for_sequenc  multiple                  66955010
 e_classification_17 (TFDis
 tilBertForSequenceClassifi
 cation)

 dense_22 (Dense)            multiple                  768

 dense_23 (Dense)            multiple                  514

=================================================================
Total params: 66956292 (255.42 MB)
Trainable params: 66956292 (255.42 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

[52]:
```
save_directory = "/saved_models"

ammended_model.save(save_directory)

tokenizer.save_pretrained(save_directory)
```

```
WARNING:tensorflow:Skipping full serialization of Keras layer
<keras.src.layers.regularization.dropout.Dropout object at 0x78cf613947c0>,
because it is not built.
WARNING:tensorflow:Skipping full serialization of Keras layer
<keras.src.layers.regularization.dropout.Dropout object at 0x78cf60dd35e0>,
because it is not built.
```

```
WARNING:tensorflow:Skipping full serialization of Keras layer
<keras.src.layers.regularization.dropout.Dropout object at 0x78cf617d6a10>,
because it is not built.
WARNING:tensorflow:Skipping full serialization of Keras layer
<keras.src.layers.regularization.dropout.Dropout object at 0x78cf617d4fd0>,
because it is not built.
WARNING:tensorflow:Skipping full serialization of Keras layer
<keras.src.layers.regularization.dropout.Dropout object at 0x78cf60e02650>,
because it is not built.
WARNING:tensorflow:Skipping full serialization of Keras layer
<keras.src.layers.regularization.dropout.Dropout object at 0x78cf60e11d80>,
because it is not built.
WARNING:tensorflow:Model's `__init__()` arguments contain non-serializable
objects. Please implement a `get_config()` method in the subclassed Model for
proper saving and loading. Defaulting to empty config.
WARNING:tensorflow:Model's `__init__()` arguments contain non-serializable
objects. Please implement a `get_config()` method in the subclassed Model for
proper saving and loading. Defaulting to empty config.
WARNING:tensorflow:Model's `__init__()` arguments contain non-serializable
objects. Please implement a `get_config()` method in the subclassed Model for
proper saving and loading. Defaulting to empty config.
WARNING:tensorflow:Model's `__init__()` arguments contain non-serializable
objects. Please implement a `get_config()` method in the subclassed Model for
proper saving and loading. Defaulting to empty config.
```

[52]:
```
('/saved_models/tokenizer_config.json',
 '/saved_models/special_tokens_map.json',
 '/saved_models/vocab.txt',
 '/saved_models/added_tokens.json')
```

Predicting Sentiment for sample sentences

[53]:
```python
import pandas as pd

# Function to generate predicted labels for a dataset
def predict_labels(model, dataset):
    predicted_labels = []
    for batch in dataset:
        predictions = ammended_model.predict(batch[0])
        predicted_labels.extend(tf.argmax(predictions, axis=1).numpy())
    return predicted_labels

# Generate predicted labels on the test set
predicted_labels = predict_labels(ammended_model, test_dataset)
```

```
1/1 [==============================] - 2s 2s/step
1/1 [==============================] - 0s 95ms/step
1/1 [==============================] - 0s 103ms/step
```

```
1/1 [==============================] - 0s 136ms/step
1/1 [==============================] - 0s 139ms/step
1/1 [==============================] - 0s 118ms/step
1/1 [==============================] - 0s 111ms/step
1/1 [==============================] - 0s 92ms/step
1/1 [==============================] - 0s 88ms/step
1/1 [==============================] - 0s 98ms/step
1/1 [==============================] - 0s 89ms/step
1/1 [==============================] - 0s 104ms/step
1/1 [==============================] - 0s 86ms/step
1/1 [==============================] - 0s 87ms/step
1/1 [==============================] - 0s 90ms/step
1/1 [==============================] - 0s 89ms/step
1/1 [==============================] - 0s 95ms/step
1/1 [==============================] - 0s 90ms/step
1/1 [==============================] - 0s 90ms/step
1/1 [==============================] - 0s 88ms/step
1/1 [==============================] - 0s 87ms/step
1/1 [==============================] - 0s 126ms/step
1/1 [==============================] - 0s 111ms/step
1/1 [==============================] - 0s 142ms/step
1/1 [==============================] - 0s 147ms/step
1/1 [==============================] - 0s 131ms/step
1/1 [==============================] - 0s 151ms/step
1/1 [==============================] - 0s 164ms/step
1/1 [==============================] - 0s 205ms/step
1/1 [==============================] - 0s 184ms/step
1/1 [==============================] - 0s 159ms/step
1/1 [==============================] - 0s 96ms/step
1/1 [==============================] - 0s 145ms/step
1/1 [==============================] - 0s 96ms/step
1/1 [==============================] - 0s 116ms/step
1/1 [==============================] - 0s 106ms/step
1/1 [==============================] - 0s 137ms/step
1/1 [==============================] - 0s 150ms/step
1/1 [==============================] - 0s 120ms/step
1/1 [==============================] - 0s 182ms/step
1/1 [==============================] - 0s 181ms/step
1/1 [==============================] - 0s 134ms/step
```

[54]:
```
df_results = pd.DataFrame({
    'Test_Texts': test_texts,
    'Test_Labels': test_labels,
    'Predicted_Labels': predicted_labels
})
```

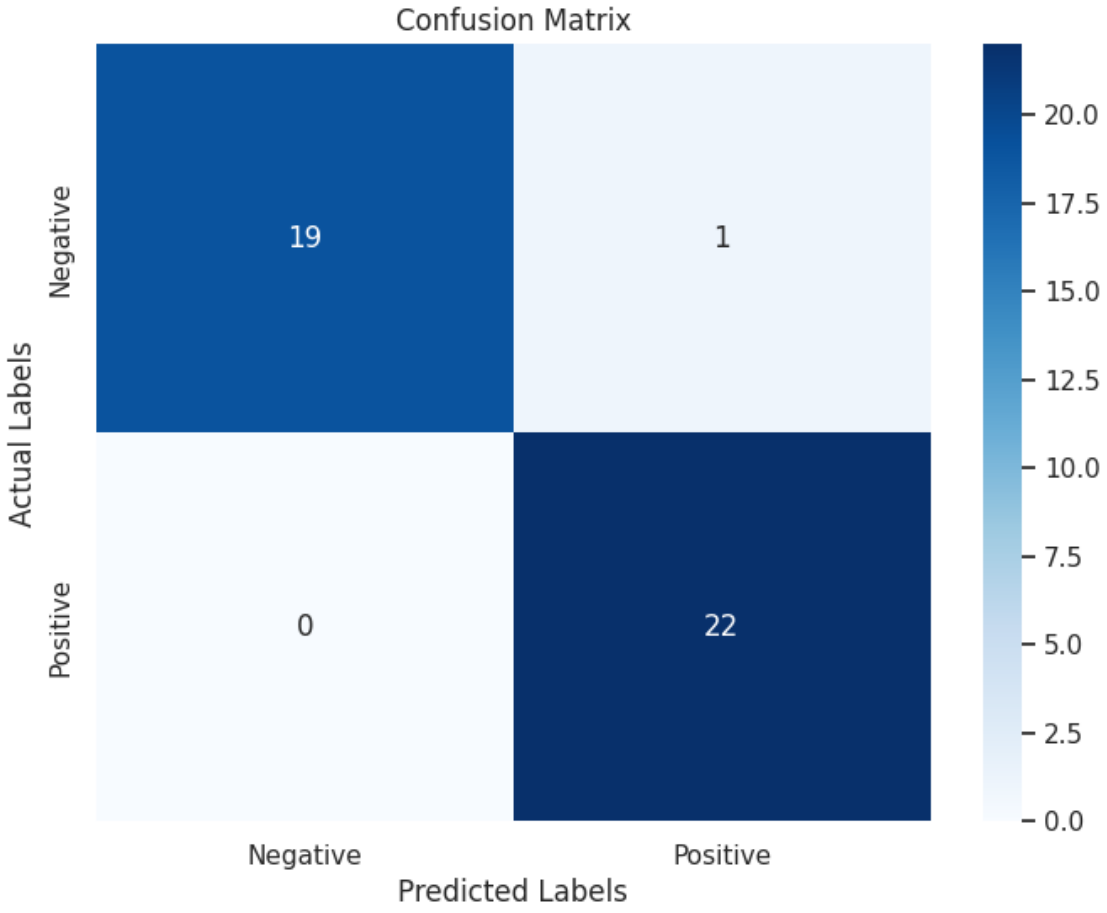
[55]:
```
df_results.head(10)
```

[55]:
```
                                        Test_Texts  Test_Labels  \
0  The customer service representative was dismis…            0
1  The sudden change in plans left me feeling dis…            0
2  Connecting with nature during a hike rejuvenat…            1
3  The unexpected financial setback has caused st…            0
4  Rediscovering an old favorite song brings back…            1
5  The persistent noise from a nearby constructio…            0
6  Witnessing a random act of kindness in public …            1
7  A surprise weekend getaway to a scenic locatio…            1
8  The beach vacation was relaxing and rejuvenati…            1
9  The unexpected increase in workload is overwhe…            0

   Predicted_Labels
0                 0
1                 0
2                 1
3                 0
4                 1
5                 0
6                 1
7                 1
8                 1
9                 0
```

[56]:
```
label_mapping = dict(enumerate(df['sentiment'].astype('category').cat.
 ↪categories))
```

[57]:
```
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import confusion_matrix, classification_report

# Assuming df_results has 'Test_Labels' and 'Predicted_Labels' columns
y_true = df_results['Test_Labels']
y_pred = df_results['Predicted_Labels']

# Confusion Matrix
conf_matrix = confusion_matrix(y_true, y_pred)
plt.figure(figsize=(8, 6))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues',␣
 ↪xticklabels=label_mapping.values(), yticklabels=label_mapping.values())
plt.title('Confusion Matrix')
plt.xlabel('Predicted Labels')
plt.ylabel('Actual Labels')
plt.show()

# Classification Report
```

```
class_report = classification_report(y_true, y_pred, target_names=label_mapping.
  ↪values())
print("\nClassification Report:")
print(class_report)
```




```
Classification Report:
              precision    recall  f1-score   support

    Negative       1.00      0.95      0.97        20
    Positive       0.96      1.00      0.98        22

    accuracy                           0.98        42
   macro avg       0.98      0.97      0.98        42
weighted avg       0.98      0.98      0.98        42
```

0.1.8 Discuss what could be done to improve accuracy

Despite achieving close to a 100% accuracy on a simplistic and straightforward artificial dataset, it's important to recognize that real-world scenarios present unique challenges. Here are some key aspects to investigate and address in order to enhance model accuracy in more complex and practical situations.

0.1.9 Exploring Hyperparameters:

1. **Learning Rate:**
   - Adjust the learning rate for optimal convergence without overshooting or slowing down.
2. **Batch Size:**
   - Experiment with different batch sizes for stable training and memory efficiency.
3. **Number of Epochs:**
   - Tune the number of epochs to avoid overfitting and find the right training duration.
4. **Fine-Tuning Transformer Layers:**
   - Experiment with freezing and training transformer layers for optimal pre-trained features.

0.1.10 Model training and prediction:

1. **Try different model architectures:**
   - Switch to a larger model like BERT for more complex pattern capture.
2. **Batch Normalization:**
   - Improve training stability with batch normalization.
3. **Learning Rate Schedule:**
   - Implement schedules like warm-up or decay for adaptive learning.
4. **Early Stopping:**
   - Halt training when performance plateaus to prevent overfitting.
5. **Ensemble Learning:**
   - Combine predictions from multiple models for robustness.
6. **Domain-Specific Considerations:**
   - Adapt model and hyperparameters for domain-specific tasks.

Ensure continuous evaluation at each step to achieve the right balance.