Assignment_9_3_Raghuwanshi_Prashant_DSC550

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Assignment: 9.3 Exercise: Neural Network Classifiers

Name: Prashant Raghuwanshi

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Course: DSC550-T301 Data Mining (2221-1) Neural Network Classifier with Scikit

Using the multi-label classifier dataset (categorized-comments.jsonl), fit a neural network classifier using scikit-learn to predict the comment category. Use the code found in chapter 12 of the Applied Text Analysis with Python book as a guide, but you will need to modify the code for this dataset. Report the accuracy, precision, recall, F1-score, and confusion matrix.

[1]:
```
import pandas as pd
import numpy as np
import jsonlines
import time
from textblob import TextBlob
import json
```

[2]:
```
# 1.Load the data from the "categorized-comments.jsonl" file into a DataFrame.
addr1 = "C:/Users/dell/Documents/Machine_learning_assigments/week-9/
↪categorized-comments.jsonl"
```

[3]:
```
# Reading the JSON line file into a dataframe
newlist = []
with jsonlines.open(addr1) as f:
    for obj in f.iter(type=dict, skip_invalid=True):
        newlist.append(obj)
ccjsonsrc = pd.DataFrame(newlist)
ccjsonsrc.head(5)
```

[3]:
```
      cat                                                txt
0  sports  Barely better than Gabbert? He was significant…
1  sports  Fuck the ducks and the Angels! But welcome to …
2  sports  Should have drafted more WRs.\n\n- Matt Millen…
3  sports            [Done](https://i.imgur.com/2YZ90pm.jpg)
4  sports                                       No!! NOO!!!!!
```

[4]:
```
# using lambda function and convert the string to lower case
ccjsonlower = ccjsonsrc.apply(lambda x: x.astype(str).str.lower())
# limitting the records in dataframe
sampledf = ccjsonlower.head(80000)
sampledf.head()
```

[4]:
```
      cat                                                txt
0  sports  barely better than gabbert? he was significant…
1  sports  fuck the ducks and the angels! but welcome to …
2  sports  should have drafted more wrs.\n\n- matt millen…
3  sports            [done](https://i.imgur.com/2yz90pm.jpg)
4  sports                                    no!! noo!!!!!
```

[5]:
```
#Remove all punctuation from the text.
# Create the punctuation dictionary by using unicodedata
import sys
import unicodedata
punctuation = dict.fromkeys(i for i in range(sys.maxunicode)
                  if unicodedata.category(chr(i)).startswith('P'))
```

[6]:
```
# removing punctuation from each row of dataframe's txt column
for i in range(len(sampledf)) :
    test = [string.translate(punctuation) for string in (sampledf.loc[i,␣
 ↪"txt"])]
    # coverting list to string
    test1 = "".join(str(x) for x in test)
    # updating the row values
    sampledf.loc[i, ["txt"]] = test1
# print dataframe after removing punctuations from txt column
sampledf.head()
```

```
C:\ProgramData\Anaconda3\lib\site-packages\pandas\core\indexing.py:1637:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  self._setitem_single_block(indexer, value, name)
C:\ProgramData\Anaconda3\lib\site-packages\pandas\core\indexing.py:692:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  iloc._setitem_with_indexer(indexer, value, self.name)
```

[6]:
```
      cat                                                txt
0  sports  barely better than gabbert he was significantl…
```

```
1  sports  fuck the ducks and the angels but welcome to a…
2  sports  should have drafted more wrs\n\n matt millen p…
3  sports                        donehttpsiimgurcom2yz90pmjpg
4  sports                                              no noo
```

[7]:

```
# Remove stop words.
# load library
import nltk
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
# load stop words
stop_words = stopwords.words('english')
```

[8]:

```
# remove stop words from each row of dataframe's txt column
for i in range(len(sampledf)) :
    # tokenized each row of dataframe's txt column
    test_token = word_tokenize(sampledf.loc[i, "txt"])
    # remove stop words
    rem_words = [word for word in test_token if word not in stop_words]
    # coverting list to string
    rem_words1 = " ".join(str(x) for x in rem_words)
    # writting back processed removed stop words to dataframe
    # updating the row values for txt column
    sampledf.loc[i, ["txt"]] = rem_words1
# printing last rows of dataframe showing removed stop words
print(rem_words)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\pandas\core\indexing.py:1637:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  self._setitem_single_block(indexer, value, name)
C:\ProgramData\Anaconda3\lib\site-packages\pandas\core\indexing.py:692:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  iloc._setitem_with_indexer(indexer, value, self.name)
```

```
['love', 'latest', 'deck', 'video']
```

[9]:

```
#print dataframe after updating the removed stop words to txt column
sampledf.head()
```

[9]:

```
      cat                                                txt
0  sports  barely better gabbert significantly better yea…
1  sports          fuck ducks angels welcome new niners fans
2  sports                   drafted wrs matt millen probably
3  sports                       donehttpsiimgurcom2yz90pmjpg
4  sports                                                noo
```

[10]:

```python
# load library
from nltk.stem.porter import PorterStemmer
# create stemmer
porter = PorterStemmer()
# apply stemmer to each row of dataframe's txt column
for i in range(len(sampledf)) :
    # tokenized each row of dataframe's txt column
    test_token1 = word_tokenize(sampledf.loc[i, "txt"])
    # apply stemmer
    porter_words = [porter.stem(word) for word in test_token1]
    # coverting list to string
    porter_words1 = " ".join(str(x) for x in porter_words)
    # writting back processed removed stop words to dataframe
    # updating the row values for txt column
    sampledf.loc[i, ["txt"]] = porter_words1
# printing last rows of dataframe showing removed stop words
print(porter_words)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\pandas\core\indexing.py:1637:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  self._setitem_single_block(indexer, value, name)
C:\ProgramData\Anaconda3\lib\site-packages\pandas\core\indexing.py:692:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  iloc._setitem_with_indexer(indexer, value, self.name)
```

```
['love', 'latest', 'deck', 'video']
```

[11]:

```python
# print dataframe after updating the applied stemmer to each row of dataframe's␣
 ↪txt column
sampledf.head()
```

[11]:

```
      cat                                                txt
0  sports  bare better gabbert significantli better year …
```

```
1  sports                fuck duck angel welcom new niner fan
2  sports                        draft wr matt millen probabl
3  sports                        donehttpsiimgurcom2yz90pmjpg
4  sports                                                 noo
```

[12]:

```
sampledf3 = sampledf
```

[13]:

```
from io import StringIO
sampledf3['category_id'] = sampledf3['cat'].factorize()[0]
category_id_df = sampledf3[['cat', 'category_id']].drop_duplicates().
 ↪sort_values('category_id')
category_to_id = dict(category_id_df.values)
id_to_category = dict(category_id_df[['category_id', 'cat']].values)
sampledf3.head()
```

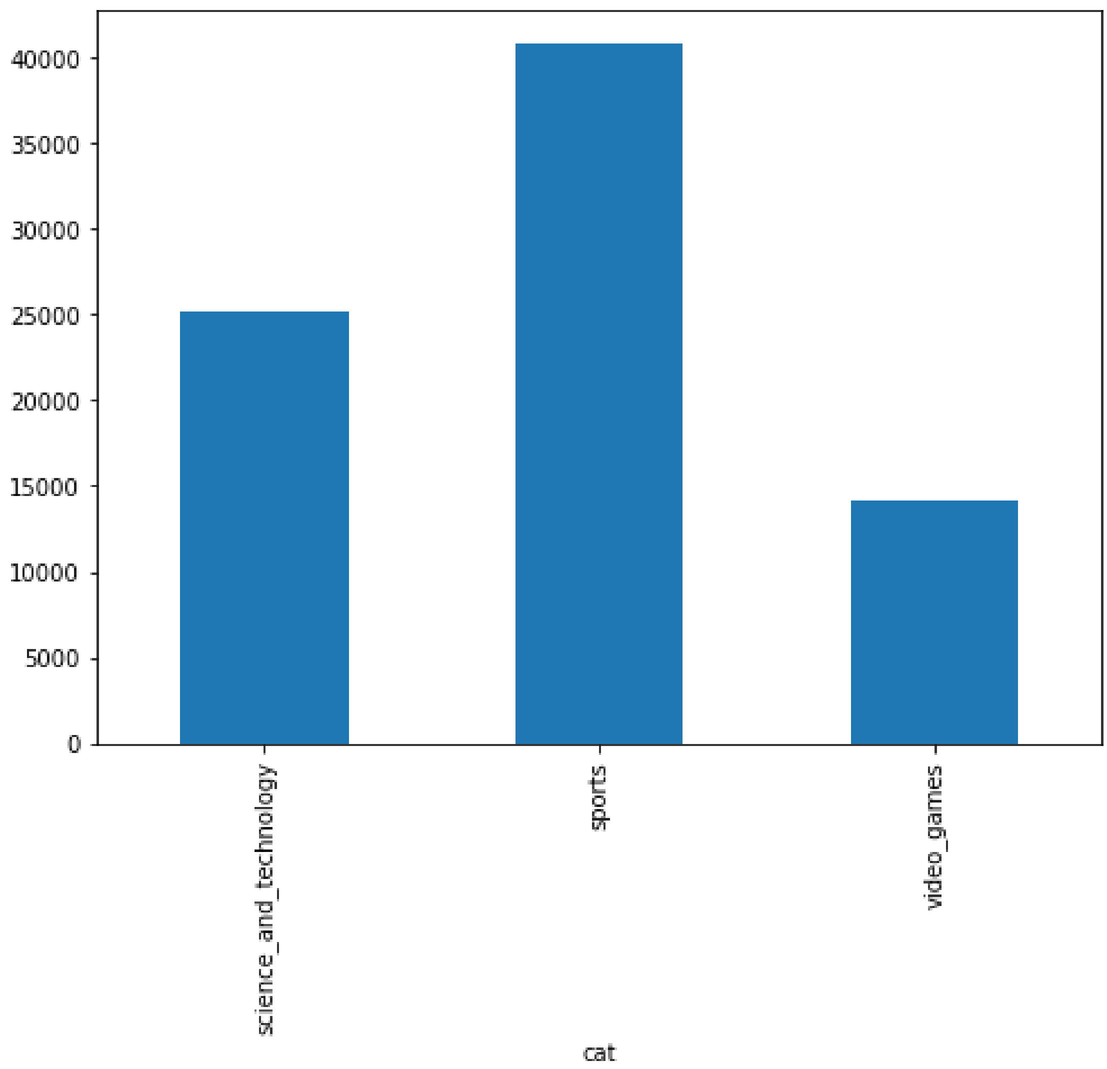
```
<ipython-input-13-8e3e7fec068a>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  sampledf3['category_id'] = sampledf3['cat'].factorize()[0]
```

[13]:

```
      cat                                                 txt  category_id
0  sports  bare better gabbert significantli better year …            0
1  sports                fuck duck angel welcom new niner fan            0
2  sports                        draft wr matt millen probabl            0
3  sports                        donehttpsiimgurcom2yz90pmjpg            0
4  sports                                                 noo            0
```

[14]:

```
# verifying Imbalanced Classes
import matplotlib.pyplot as plt
fig = plt.figure(figsize=(8,6))
sampledf3.groupby('cat').txt.count().plot.bar(ylim=0)
plt.show()
```



[15]:
```
print(sampledf3.columns)
```

```
Index(['cat', 'txt', 'category_id'], dtype='object')
```

[16]:
```
sampledf4 = sampledf3.head(40000)
sampledf5 = sampledf4
```

[17]:
```
# Convert each entry into a term frequency-inverse document frequency (tfidf)␣
 ↪vector
#### Weighted Word Importance
#### here we are comparing the frequence of words in a document (a tweet,␣
 ↪moview review speech transcripyt)
#### with the frequency of words in all other documents using term␣
 ↪frequency-inverse document frequency
```

```
# import libraries
from sklearn.feature_extraction.text import TfidfVectorizer
ftidf = TfidfVectorizer()
```

```
[18]: from sklearn.feature_extraction.text import TfidfVectorizer
      tfidf = TfidfVectorizer(sublinear_tf=True, min_df=5, norm='l2',␣
       ↪encoding='latin-1', ngram_range=(1, 2), stop_words='english')
      features = tfidf.fit_transform(sampledf4.txt).toarray()
      labels = sampledf4.category_id
      features.shape
```

```
[18]: (40000, 15229)
```

```
[19]: from sklearn.model_selection import train_test_split
      from sklearn.feature_extraction.text import CountVectorizer
      from sklearn.feature_extraction.text import TfidfTransformer
      from sklearn.naive_bayes import MultinomialNB
      X_train, X_test, y_train, y_test = train_test_split(sampledf4['txt'],␣
       ↪sampledf4['category_id'], random_state = 0)
      count_vect = CountVectorizer()
      X_train_counts = count_vect.fit_transform(X_train)
      tfidf_transformer = TfidfTransformer()
      X_train_tfidf = tfidf_transformer.fit_transform(X_train_counts).toarray()
      #clf = MultinomialNB().fit(X_train_tfidf, y_train)
```

```
[20]: print(X_train.shape); print(X_test.shape); print(y_train.shape); print(y_test.
       ↪shape);print(X_train_tfidf.shape)
```

```
(30000,)
(10000,)
(30000,)
(10000,)
(30000, 24587)
```

```
[21]: from sklearn.neural_network import MLPClassifier

      mlp = MLPClassifier(hidden_layer_sizes=(500,500,500), activation='relu',␣
       ↪solver='adam', max_iter=5)
      #mlp = MLPClassifier(hidden_layer_sizes=(500, 150))
      #mlp.fit(X_train,y_train)
      mlp.fit(X_train_tfidf, y_train)
```

```
C:\ProgramData\Anaconda3\lib\site-
packages\sklearn\neural_network\_multilayer_perceptron.py:582:
ConvergenceWarning: Stochastic Optimizer: Maximum iterations (5) reached and the
optimization hasn't converged yet.
  warnings.warn(
[21]: MLPClassifier(hidden_layer_sizes=(500, 500, 500), max_iter=5)
```

```
[22]: predict_train = mlp.predict(X_train_tfidf)
```

```
[23]: ## we can evaluate the performance of the model. Being a classification␣
       ↪algorithm,
      # we will first import the required modules, which is done in the first line of␣
       ↪code below.
      # The second and third lines of code print the confusion matrix and the␣
       ↪confusion report results on the training data.
      from sklearn.metrics import classification_report,confusion_matrix
      print(confusion_matrix(y_train,predict_train))
      print(classification_report(y_train,predict_train))
      #print(classification_report(y_train,predict_train))
      #print(confusion_matrix(y_train.argmax(axis=1),predict_train.argmax(axis=1)))
```

```
[[10433   739]
 [   51 18777]]
              precision    recall  f1-score   support

           0       1.00      0.93      0.96     11172
           1       0.96      1.00      0.98     18828

    accuracy                           0.97     30000
   macro avg       0.98      0.97      0.97     30000
weighted avg       0.97      0.97      0.97     30000
```

```
[24]: ## The above output shows the performance of the model on training data. The␣
       ↪accuracy and the F1 score is around 0.98 and 0.99
```

```
[25]: X_test_counts = count_vect.fit_transform(X_test)
      tfidf_transformer = TfidfTransformer()
      X_test_tfidf = tfidf_transformer.fit_transform(X_test_counts).toarray()
```

```
[26]: X_test_tfidf.shape
```

```
[26]: (10000, 13354)
```

```
[27]: X_test1_tfidf = np.resize(X_test_tfidf, (10000, 24587))
```

```
[28]: X_test1_tfidf.shape
```

```
[28]: (10000, 24587)
```

```
[29]: predict_test = mlp.predict(X_test1_tfidf)
```

[30]:

```
print(confusion_matrix(y_test,predict_test))
print(classification_report(y_test,predict_test))
```

```
[[1688 2029]
 [2858 3425]]
              precision    recall  f1-score   support

           0       0.37      0.45      0.41      3717
           1       0.63      0.55      0.58      6283

    accuracy                           0.51     10000
   macro avg       0.50      0.50      0.50     10000
weighted avg       0.53      0.51      0.52     10000
```

[31]:

```
## The above output shows the performance of the model on test data. The␣
 ↪accuracy and the F1 score is around 0.54 and 0.53
```

0.0.1 Neural Network Classifier with Keras

[32]:

```
# Keras specific
import keras
from keras.models import Sequential
from keras.layers import Dense
from tensorflow.keras.utils import to_categorical
```

[33]:

```
# Since our target variable represents a binary category which has been coded␣
 ↪as numbers 0 and 1, we will have to encode it.
# We can easily achieve that using the "to_categorical" function from the Keras␣
 ↪utilities package.
# The two lines of code below accomplishes that in both training and test␣
 ↪datasets.
# one hot encode outputs
y_train2 = to_categorical(y_train)
y_test2 = to_categorical(y_test)

count_classes = y_test2.shape[1]
print(count_classes)
```

```
2
```

[34]:

```
print(X_train_tfidf.shape, y_train2.shape)
```

```
(30000, 24587) (30000, 2)
```

[47]:

```
# downsizeing the records due to memorry issue\n",
X_train5 = X_train.head(100)
```

[41]:

```
# converting words to numbers
count = CountVectorizer()
bag_of_words = count.fit_transform(X_train5.to_numpy())
X_train4 = bag_of_words.toarray()
```

[43]:

```
print(X_train4.shape, y_train2.shape)
```

```
(100, 747) (30000, 2)
```

[59]:

```
y_train4 = np.resize(y_train2, (100, 2))
```

[60]:

```
y_train4.shape
```

[60]:

```
(100, 2)
```

[53]:

```
model = Sequential()
model.add(Dense(500, activation='relu', input_dim=747))
model.add(Dense(100, activation='relu'))
model.add(Dense(50, activation='relu'))
model.add(Dense(2, activation='softmax'))

# Compile the model
model.compile(loss='categorical_crossentropy', optimizer='adam',␣
 ↪metrics=['accuracy'])
```

[61]:

```
import tensorflow as tf
# build the model
tf.config.run_functions_eagerly(True)
#model.fit(X_train, y_train, epochs=20)
model.fit(X_train4, y_train4, epochs=20)
```

```
Epoch 1/20
4/4 [==============================] - 1s 43ms/step - loss: 0.6917 - accuracy:
0.5200
Epoch 2/20
4/4 [==============================] - 0s 31ms/step - loss: 0.5592 - accuracy:
0.7200
Epoch 3/20
4/4 [==============================] - 0s 39ms/step - loss: 0.4653 - accuracy:
0.7900
Epoch 4/20
4/4 [==============================] - 0s 42ms/step - loss: 0.3845 - accuracy:
0.9200
Epoch 5/20
4/4 [==============================] - 0s 37ms/step - loss: 0.3066 - accuracy:
0.9700
Epoch 6/20
4/4 [==============================] - 0s 31ms/step - loss: 0.2354 - accuracy:
0.9800
```

```
Epoch 7/20
4/4 [==============================] - 0s 28ms/step - loss: 0.1711 - accuracy:
0.9900
Epoch 8/20
4/4 [==============================] - 0s 29ms/step - loss: 0.1218 - accuracy:
0.9900
Epoch 9/20
4/4 [==============================] - 0s 31ms/step - loss: 0.0862 - accuracy:
0.9900
Epoch 10/20
4/4 [==============================] - 0s 31ms/step - loss: 0.0614 - accuracy:
0.9900
Epoch 11/20
4/4 [==============================] - 0s 33ms/step - loss: 0.0454 - accuracy:
0.9900
Epoch 12/20
4/4 [==============================] - 0s 40ms/step - loss: 0.0360 - accuracy:
0.9900
Epoch 13/20
4/4 [==============================] - 0s 40ms/step - loss: 0.0315 - accuracy:
0.9900
Epoch 14/20
4/4 [==============================] - 0s 33ms/step - loss: 0.0251 - accuracy:
0.9900
Epoch 15/20
4/4 [==============================] - 0s 33ms/step - loss: 0.0316 - accuracy:
0.9800
Epoch 16/20
4/4 [==============================] - ETA: 0s - loss: 0.0330 - accuracy: 0.98 -
0s 48ms/step - loss: 0.0330 - accuracy: 0.9800
Epoch 17/20
4/4 [==============================] - 0s 34ms/step - loss: 0.0311 - accuracy:
0.9800
Epoch 18/20
4/4 [==============================] - 0s 29ms/step - loss: 0.0285 - accuracy:
0.9800
Epoch 19/20
4/4 [==============================] - 0s 46ms/step - loss: 0.0248 - accuracy:
0.9700
Epoch 20/20
4/4 [==============================] - 0s 35ms/step - loss: 0.0217 - accuracy:
0.9900
```

[61]:
```
<keras.callbacks.History at 0x17cf23997f0>
```

[62]:
```
from sklearn.metrics import f1_score, precision_score, recall_score,␣
 ↪confusion_matrix
```

```
y_pred1 = model.predict(X_train4)
y_pred = np.argmax(y_pred1, axis=1)
```

[63]:
```
y_train6 = np.resize(y_train2, (100))
```

[64]:
```
from sklearn.metrics import classification_report,confusion_matrix
print(confusion_matrix(y_train6,y_pred))
print(classification_report(y_train6,y_pred))
```

```
[[16 34]
 [19 31]]
              precision    recall  f1-score   support

         0.0       0.46      0.32      0.38        50
         1.0       0.48      0.62      0.54        50

    accuracy                           0.47       100
   macro avg       0.47      0.47      0.46       100
weighted avg       0.47      0.47      0.46       100
```

[ ]:
```
## The above output shows the performance of the model on train data. The␣
 ↪accuracy and the F1 score is around 0.47 and 0.46
```

[65]:
```
X_test.shape
```

[65]:
```
(10000,)
```

[66]:
```
#downsizing the test records, due to memory issue
X_test3 = X_test.head(100)
```

[67]:
```
# converting words to numbers
bag_of_words1 = count.fit_transform(X_test3.to_numpy())
X_test4 = bag_of_words1.toarray()
```

[68]:
```
X_test4.shape
```

[68]:
```
(100, 811)
```

[69]:
```
# resizing the array, due to difference in feature of trained model dataset and␣
 ↪test model data set
X_test6 = np.resize(X_test4, (100, 747))
```

[70]:
```
# evaluating the model with test data
y_test_pred1 = model.predict(X_test6)
y_test_pred = np.argmax(y_pred1, axis=1)
```

[71]:
```
# resizing the array, due to difference in counts of test model dataset and␣
 ↪test model data set
y_test3 = np.resize(y_test, (100))
```

[72]:
```
print(confusion_matrix(y_test3,y_test_pred))
print(classification_report(y_test3,y_test_pred))
```

```
[[12 27]
 [23 38]]
              precision    recall  f1-score   support

           0       0.34      0.31      0.32        39
           1       0.58      0.62      0.60        61

    accuracy                           0.50       100
   macro avg       0.46      0.47      0.46       100
weighted avg       0.49      0.50      0.49       100
```

[74]:
```
## The above output shows the performance of the model on test data. The␣
 ↪accuracy and the F1 score is around 0.49 and 0.49
```

Classifying Images

[75]:
```
from keras.datasets import mnist
from keras.models import sequential
from keras.layers import Dense, Dropout, Flatten
from keras.layers.convolutional import Conv2D, MaxPooling2D
from keras.utils import np_utils
from keras import backend as k
```

[76]:
```
# ste that the color channel value will be first
k.set_image_data_format("channels_last")
```

[77]:
```
#set seed
np.random.seed(0)
```

[78]:
```
# set image information
channels = 1
height = 28
width =28
```

[79]:
```
# load data and target from MNIST data
(data_train, target_train), (data_test, target_test) = mnist.load_data()
```

[80]:
```
# reshape training image data into features
data_train = data_train.reshape(data_train.shape[0], height, width, channels)
```

[81]:

```
# reshape test image data into features
data_test = data_test.reshape(data_test.shape[0], height, width, channels)
```

[83]:

```
# rescsle pixel intensity to between 0 and 1
features_train = data_train/255
features_test = data_test/255
```

[84]:

```
# one hot encoding target
target_train = np_utils.to_categorical(target_train)
target_test = np_utils.to_categorical(target_test)
number_of_classes = target_test.shape[1]
```

[85]:

```
# start neural network
network = Sequential()
```

[86]:

```
# add convolutional layer with 64 filters
network.add(Conv2D(filters = 64, kernel_size=(5, 5), input_shape=(height,␣
 ↪width, channels), activation='relu'))

#network.add(Conv2D(filters = 64, kernel_size=(5, 5), input_shape= tf.
 ↪reshape(2, (1, 2, 1)), activation='relu'))
```

[87]:

```
# add max pooling layer
network.add(MaxPooling2D(pool_size=(2,2), data_format='channels_last'))
```

[88]:

```
# add dropout layer
network.add(Dropout(0.5))
```

[89]:

```
network.add(Flatten())
```

[90]:

```
network.add(Dense(128, activation="relu"))
```

[91]:

```
#add dropout layer
network.add(Dropout(0.5))
```

[92]:

```
# Add dropout layer
network.add(Dense(number_of_classes, activation="softmax"))
```

[93]:

```
# compile neural network\
network.compile(loss="categorical_crossentropy", optimizer = "rmsprop",␣
 ↪metrics=["accuracy"])
```

[94]:

```
print(features_train.shape); print(target_train.shape); print(features_test.
 ↪shape), print(target_test.shape)
```

```
(60000, 28, 28, 1)
(60000, 10)
```

```
(10000, 28, 28, 1)
(10000, 10)
```

[94]:
```
(None, None)
```

[95]:
```
# train neural network
network.fit(features_train, target_train, epochs=2, verbose=0, batch_size=1000,␣
 ↪validation_data=(features_test, target_test))
```

[95]:
```
<keras.callbacks.History at 0x17cf1fab5e0>
```

[ ]:
```
```