openmic-VGG-DL

March 2, 2020

[1]:
```
import librosa as lb
import librosa.display
import pandas as pd
import scipy
import json
import numpy as np
import sklearn
from sklearn.metrics import classification_report
from sklearn.model_selection import train_test_split
import os
from pylab import plot, show, figure, imshow, xlim, ylim, title
import matplotlib.pyplot as plt
import keras
from keras.utils import np_utils
from keras import layers
from keras import models
```

```
Using TensorFlow backend.
```

[2]:
```
#CONSTANTS

DATA_DIR = "openmic-2018/"
CATEGORY_COUNT = 8
```

[3]:
```
df = pd.read_csv('openmic-2018/openmic-2018-aggregated-labels.csv')
del df['relevance']
del df['num_responses']
```

[4]:
```
labels = df.values
labels
```

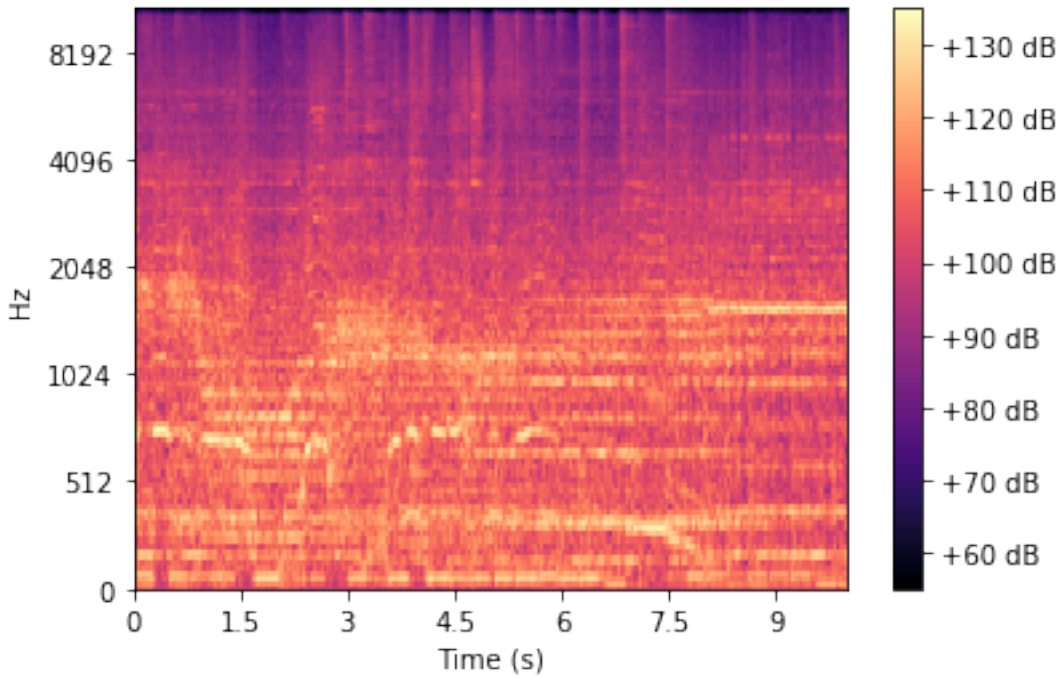
[4]:
```
array([['000046_3840', 'clarinet'],
       ['000046_3840', 'flute'],
       ['000046_3840', 'trumpet'],
       ...,
       ['155311_453120', 'saxophone'],
       ['155311_453120', 'trumpet'],
       ['155311_453120', 'trombone']], dtype=object)
```

[5]:
```
y, sr = lb.load(DATA_DIR + 'audio/000/000135_483840.ogg')
S = lb.feature.melspectrogram(y=y, sr=sr)

S_dB = lb.power_to_db(S, ref=0) # 10 * log10(S / ref)


print(y.shape)
print(sr)
print(S.shape)
print(S_dB.shape)
```

```
(220544,)
22050
(128, 431)
(128, 431)
```

[6]:
```
librosa.display.specshow(S_dB, x_axis='s', y_axis='mel')
plt.colorbar(format='%+2.0f dB')
```

[6]: <matplotlib.colorbar.Colorbar at 0x27ec65b1390>



[7]:
```
OPENMIC = np.load(os.path.join(DATA_DIR, 'openmic-2018.npz'), allow_pickle=True)
print(list(OPENMIC.keys()))
```

```
['X', 'Y_true', 'Y_mask', 'sample_key']
```

[8]:
```
X, Y_true, Y_mask, sample_key = OPENMIC['X'], OPENMIC['Y_true'],␣
 ↪OPENMIC['Y_mask'], OPENMIC['sample_key']
#print(X.shape)
#X = []
#print(len(sample_key))
#for key in sample_key:
#    key_dir = key[:3]
#    y, sr = lb.load(DATA_DIR + 'audio/'+ key_dir + '/' + key + '.ogg')
#    X.append(lb.feature.melspectrogram(y=y, sr=sr))
#    print(len(X))
```

[9]:
```
with open(os.path.join(DATA_DIR, 'class-map.json'), 'r') as f:
    class_map = json.load(f)
```

[10]:
```
split_train, split_test, X_train, X_test, Y_true_train, Y_true_test,␣
 ↪Y_mask_train, Y_mask_test = train_test_split(sample_key, X, Y_true, Y_mask)
train_set = np.asarray(set(split_train))
test_set = np.asarray(set(split_test))
print('# Train: {},  # Test: {}'.format(len(split_train), len(split_test)))
```

```
# Train: 15000,  # Test: 5000
```

[11]:
```
print(X_train.shape)
print(X_test.shape)
```

```
(15000, 10, 128)
(5000, 10, 128)
```

[13]:
```
# This dictionary will include the classifiers for each model
mymodels = dict()

# We'll iterate over all istrument classes, and fit a model for each one
# After training, we'll print a classification report for each instrument
for instrument in class_map:

    # Map the instrument name to its column number
    inst_num = class_map[instrument]

    # Step 1: sub-sample the data

    # First, we need to select down to the data for which we have annotations
    # This is what the mask arrays are for
    train_inst = Y_mask_train[:, inst_num]
    test_inst = Y_mask_test[:, inst_num]

    # Here, we're using the Y_mask_train array to slice out only the training␣
 ↪examples
```

```
    # for which we have annotations for the given class
    X_train_inst = X_train[train_inst]

    # Step 3: simplify the data by averaging over time

    # Let's arrange the data for a sklearn Random Forest model
    # Instead of having time-varying features, we'll summarize each track by its mean feature vector over time
    X_train_inst_sklearn = np.mean(X_train_inst, axis=1)

    # Again, we slice the labels to the annotated examples
    # We thresold the label likelihoods at 0.5 to get binary labels
    Y_true_train_inst = Y_true_train[train_inst, inst_num] >= 0.5


    # Repeat the above slicing and dicing but for the test set
    X_test_inst = X_test[test_inst]
    X_test_inst_sklearn = np.mean(X_test_inst, axis=1)
    Y_true_test_inst = Y_true_test[test_inst, inst_num] >= 0.5


    X_train_inst = X_train_inst.astype('float32')
    X_train_inst_sklearn = X_train_inst_sklearn.astype('float32')
    X_train_inst_sklearn = lb.util.normalize(X_train_inst_sklearn)
   # X_train_inst = S_dB
    print(X_train_inst.shape)
    shape = X_train_inst.shape
    X_train_inst = X_train_inst.reshape(shape[0],1, shape[1], shape[2])
    shape = X_test_inst.shape
    X_test_inst = X_test_inst.reshape(shape[0],1, shape[1], shape[2])
    #X_train_inst = X_train_inst.reshape(1,1,431,128)
    print(X_train_inst.shape)
    print(Y_true_train_inst[0])
    # Step 3.
    # Initialize a new classifier
    import keras,os
    from keras.models import Sequential
    from keras.layers import Dense, Conv2D, MaxPool2D , Flatten
    from keras.preprocessing.image import ImageDataGenerator
    import numpy as np
    model = models.Sequential()

    # model.add(layers.Conv2D(filters=8,kernel_size=(3,3),activation='relu',input_shape=(10,128,1,)))
    model.
add(Conv2D(input_shape=(1,10,128),data_format="channels_first",filters=32,kernel_size=(3,3)
activation="relu",strides=(2,2)))
```

```
   model.add(Conv2D(filters=32,kernel_size=(3,3),padding="same",␣
↪activation="relu",strides=(2,2)))
   model.add(MaxPool2D(pool_size=(3,3)))
   model.add(Conv2D(filters=128, kernel_size=(3,3), padding="same",␣
↪activation="relu"))
   model.add(Conv2D(filters=128, kernel_size=(3,3), padding="same",␣
↪activation="relu"))

   model.add(layers.Flatten())
   model.add(layers.Dense(units=512, activation='relu'))
   model.add(layers.Dense(units=256, activation='relu'))
   model.add(layers.Dense(units=100, activation='relu'))
   model.add(layers.Dense(units=1, activation='sigmoid'))

   model.compile(loss='binary_crossentropy',
                 optimizer='Adam',
                 metrics=['acc'])

  # model.summary()
   # Step 4.
   model.fit(X_train_inst,Y_true_train_inst , epochs=10, batch_size=64)

   # Step 5.
   # Finally, we'll evaluate the model on both train and test
   Y_pred_train = model.predict(X_train_inst)
   Y_pred_test = model.predict(X_test_inst)
   Y_pred_train_bool = Y_pred_train > 0.3 #THRESHOLD (should be lower than 0.
↪5)
   Y_pred_test_bool = Y_pred_test > 0.3 #THRESHOLD (should be lower than 0.5)
   print(Y_pred_train[0])
   print('-' * 52)
   print(instrument)
   print('\tTRAIN')
   print(classification_report(Y_true_train_inst, Y_pred_train_bool))

   print(Y_true_train_inst[3])
   print(Y_pred_train[3])
   print('\tTEST')
   print(classification_report(Y_true_test_inst, Y_pred_test_bool))
   sum = 0
 #  for i, prob in enumerate(Y_pred_train):
 #      print (i)
 #      print (prob)
 #      sum += prob
 #  print(sum)
   # Store the classifier in our dictionary
   mymodels[instrument] = model
```

```
(1539, 10, 128)
(1539, 1, 10, 128)
False
Epoch 1/10
1539/1539 [==============================] - 4s 2ms/step - loss: 0.8286 - acc:
0.7057
Epoch 2/10
1539/1539 [==============================] - 2s 1ms/step - loss: 0.5063 - acc:
0.7661
Epoch 3/10
1539/1539 [==============================] - 2s 1ms/step - loss: 0.4889 - acc:
0.7810
Epoch 4/10
1539/1539 [==============================] - 2s 1ms/step - loss: 0.4506 - acc:
0.7888
Epoch 5/10
1539/1539 [==============================] - 2s 1ms/step - loss: 0.3925 - acc:
0.8109
Epoch 6/10
1539/1539 [==============================] - 2s 1ms/step - loss: 0.3575 - acc:
0.8395
Epoch 7/10
1539/1539 [==============================] - 2s 1ms/step - loss: 0.3421 - acc:
0.8447
Epoch 8/10
1539/1539 [==============================] - 2s 1ms/step - loss: 0.3203 - acc:
0.8545A: 1s - los
Epoch 9/10
1539/1539 [==============================] - 2s 1ms/step - loss: 0.2954 - acc:
0.8824
Epoch 10/10
1539/1539 [==============================] - 2s 1ms/step - loss: 0.2957 - acc:
0.8661
[0.02420208]
--------------------------------------------------
accordion
        TRAIN
              precision    recall  f1-score   support

       False       0.95      0.91      0.93      1169
        True       0.74      0.84      0.79       370

    accuracy                           0.89      1539
   macro avg       0.84      0.87      0.86      1539
weighted avg       0.90      0.89      0.89      1539

True
[0.6667123]
```

```
        TEST
              precision    recall  f1-score   support

       False       0.89      0.85      0.87       413
        True       0.55      0.63      0.59       119

    accuracy                           0.80       532
   macro avg       0.72      0.74      0.73       532
weighted avg       0.81      0.80      0.81       532

(1679, 10, 128)
(1679, 1, 10, 128)
True
Epoch 1/10
1679/1679 [==============================] - 4s 2ms/step - loss: 0.7042 - acc:
0.6587
Epoch 2/10
1679/1679 [==============================] - 2s 1ms/step - loss: 0.4520 - acc:
0.7790
Epoch 3/10
1679/1679 [==============================] - 2s 1ms/step - loss: 0.4088 - acc:
0.8064
Epoch 4/10
1679/1679 [==============================] - 2s 1ms/step - loss: 0.3692 - acc:
0.8130
Epoch 5/10
1679/1679 [==============================] - 3s 2ms/step - loss: 0.3128 - acc:
0.8612
Epoch 6/10
1679/1679 [==============================] - 3s 2ms/step - loss: 0.2672 - acc:
0.8821
Epoch 7/10
1679/1679 [==============================] - 2s 1ms/step - loss: 0.2523 - acc:
0.8970
Epoch 8/10
1679/1679 [==============================] - 2s 1ms/step - loss: 0.1602 - acc:
0.9369
Epoch 9/10
1679/1679 [==============================] - 2s 1ms/step - loss: 0.1417 - acc:
0.9410
Epoch 10/10
1679/1679 [==============================] - 2s 1ms/step - loss: 0.0892 - acc:
0.9690
[0.99322283]
--------------------------------------------------
banjo
        TRAIN
              precision    recall  f1-score   support
```

```
       False       0.97      0.99      0.98      1120
        True       0.98      0.95      0.96       559

    accuracy                           0.98      1679
   macro avg       0.98      0.97      0.97      1679
weighted avg       0.98      0.98      0.98      1679

True
[0.9989266]
        TEST
              precision    recall  f1-score   support

       False       0.81      0.88      0.84       366
        True       0.69      0.57      0.62       173

    accuracy                           0.78       539
   macro avg       0.75      0.72      0.73       539
weighted avg       0.77      0.78      0.77       539

(1416, 10, 128)
(1416, 1, 10, 128)
False
Epoch 1/10
1416/1416 [==============================] - 4s 2ms/step - loss: 0.8830 - acc:
0.6780
Epoch 2/10
1416/1416 [==============================] - 2s 1ms/step - loss: 0.5550 - acc:
0.7295
Epoch 3/10
1416/1416 [==============================] - 2s 1ms/step - loss: 0.4950 - acc:
0.7613
Epoch 4/10
1416/1416 [==============================] - 2s 1ms/step - loss: 0.4179 - acc:
0.8072
Epoch 5/10
1416/1416 [==============================] - 2s 1ms/step - loss: 0.3977 - acc:
0.8185
Epoch 6/10
1416/1416 [==============================] - 2s 1ms/step - loss: 0.3409 - acc:
0.8482
Epoch 7/10
1416/1416 [==============================] - 2s 1ms/step - loss: 0.2942 - acc:
0.8764
Epoch 8/10
1416/1416 [==============================] - 2s 1ms/step - loss: 0.2433 - acc:
0.9054
Epoch 9/10
```

```
1416/1416 [==============================] - 2s 2ms/step - loss: 0.2353 - acc:
0.9054A: 0s - loss: 0.2331 - acc: 0.9
Epoch 10/10
1416/1416 [==============================] - 2s 2ms/step - loss: 0.1678 - acc:
0.9301
[0.95407677]
--------------------------------------------------
bass
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.70      0.82      1007
        True       0.58      1.00      0.73       409

    accuracy                           0.79      1416
   macro avg       0.79      0.85      0.78      1416
weighted avg       0.88      0.79      0.80      1416

False
[0.0468536]
        TEST
              precision    recall  f1-score   support

       False       0.89      0.56      0.69       332
        True       0.44      0.83      0.58       140

    accuracy                           0.64       472
   macro avg       0.67      0.70      0.63       472
weighted avg       0.76      0.64      0.66       472

(1441, 10, 128)
(1441, 1, 10, 128)
False
Epoch 1/10
1441/1441 [==============================] - 4s 3ms/step - loss: 0.9748 - acc:
0.5718
Epoch 2/10
1441/1441 [==============================] - 2s 1ms/step - loss: 0.5209 - acc:
0.7245
Epoch 3/10
1441/1441 [==============================] - 2s 1ms/step - loss: 0.4502 - acc:
0.7668
Epoch 4/10
1441/1441 [==============================] - 2s 1ms/step - loss: 0.3901 - acc:
0.8071
Epoch 5/10
1441/1441 [==============================] - 2s 1ms/step - loss: 0.3758 - acc:
0.8189
```

```
Epoch 6/10
1441/1441 [==============================] - 2s 1ms/step - loss: 0.3448 - acc:
0.8411
Epoch 7/10
1441/1441 [==============================] - 2s 1ms/step - loss: 0.3110 - acc:
0.8605
Epoch 8/10
1441/1441 [==============================] - 2s 1ms/step - loss: 0.3104 - acc:
0.8577A: 1s - loss: 0.3454  - ETA: 0s - loss: 0.3014 - acc: 0.8
Epoch 9/10
1441/1441 [==============================] - 2s 1ms/step - loss: 0.3513 - acc:
0.8223
Epoch 10/10
1441/1441 [==============================] - 2s 1ms/step - loss: 0.2368 - acc:
0.9008
[0.00059983]
--------------------------------------------------
cello
        TRAIN
              precision    recall  f1-score   support

       False       0.99      0.87      0.93       829
        True       0.85      0.98      0.91       612

    accuracy                           0.92      1441
   macro avg       0.92      0.93      0.92      1441
weighted avg       0.93      0.92      0.92      1441

True
[0.92815673]
        TEST
              precision    recall  f1-score   support

       False       0.83      0.72      0.77       296
        True       0.67      0.80      0.73       212

    accuracy                           0.75       508
   macro avg       0.75      0.76      0.75       508
weighted avg       0.77      0.75      0.75       508

(1759, 10, 128)
(1759, 1, 10, 128)
False
Epoch 1/10
1759/1759 [==============================] - 4s 2ms/step - loss: 0.6442 - acc:
0.7504
Epoch 2/10
1759/1759 [==============================] - 2s 1ms/step - loss: 0.4823 - acc:
```

```
0.7658
Epoch 3/10
1759/1759 [==============================] - 3s 1ms/step - loss: 0.4430 - acc:
0.7834
Epoch 4/10
1759/1759 [==============================] - 2s 1ms/step - loss: 0.4259 - acc:
0.7874
Epoch 5/10
1759/1759 [==============================] - 2s 1ms/step - loss: 0.4028 - acc:
0.7897
Epoch 6/10
1759/1759 [==============================] - 2s 1ms/step - loss: 0.3288 - acc:
0.8368A: 0s - loss: 0.3405 - acc: 0.830 - ETA: 0s - loss: 0.3370 - acc
Epoch 7/10
1759/1759 [==============================] - 2s 1ms/step - loss: 0.3163 - acc:
0.8499
Epoch 8/10
1759/1759 [==============================] - 2s 1ms/step - loss: 0.2021 - acc:
0.9187
Epoch 9/10
1759/1759 [==============================] - 2s 1ms/step - loss: 0.1539 - acc:
0.9403A: 2s - los
Epoch 10/10
1759/1759 [==============================] - 2s 1ms/step - loss: 0.1341 - acc:
0.9551A: 0s - loss: 0.1261 - acc: 0
[0.05214179]
--------------------------------------------------
clarinet
        TRAIN
              precision    recall  f1-score   support

       False       0.96      0.99      0.97      1354
        True       0.95      0.87      0.91       405

    accuracy                           0.96      1759
   macro avg       0.96      0.93      0.94      1759
weighted avg       0.96      0.96      0.96      1759

False
[0.00090608]
        TEST
              precision    recall  f1-score   support

       False       0.82      0.88      0.85       498
        True       0.36      0.27      0.31       128

    accuracy                           0.75       626
   macro avg       0.59      0.58      0.58       626
```

```
weighted avg       0.73      0.75      0.74       626

(1343, 10, 128)
(1343, 1, 10, 128)
False
Epoch 1/10
1343/1343 [==============================] - 4s 3ms/step - loss: 1.0250 - acc:
0.6687
Epoch 2/10
1343/1343 [==============================] - 2s 1ms/step - loss: 0.3174 - acc:
0.8801
Epoch 3/10
1343/1343 [==============================] - 2s 1ms/step - loss: 0.2486 - acc:
0.9144
Epoch 4/10
1343/1343 [==============================] - 2s 1ms/step - loss: 0.2292 - acc:
0.9188
Epoch 5/10
1343/1343 [==============================] - 2s 1ms/step - loss: 0.1975 - acc:
0.9322
Epoch 6/10
1343/1343 [==============================] - 2s 1ms/step - loss: 0.2003 - acc:
0.9367
Epoch 7/10
1343/1343 [==============================] - 2s 1ms/step - loss: 0.1854 - acc:
0.9367
Epoch 8/10
1343/1343 [==============================] - 2s 1ms/step - loss: 0.1865 - acc:
0.9345
Epoch 9/10
1343/1343 [==============================] - 2s 1ms/step - loss: 0.1439 - acc:
0.9516
Epoch 10/10
1343/1343 [==============================] - 2s 1ms/step - loss: 0.1251 - acc:
0.9598
[5.9604645e-08]
--------------------------------------------------
cymbals
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.93      0.97       473
        True       0.97      1.00      0.98       870

    accuracy                           0.98      1343
   macro avg       0.98      0.97      0.97      1343
weighted avg       0.98      0.98      0.98      1343
```

```
True
[0.98833585]
        TEST
              precision    recall  f1-score   support

       False       0.91      0.85      0.88       151
        True       0.91      0.95      0.93       241

    accuracy                           0.91       392
   macro avg       0.91      0.90      0.90       392
weighted avg       0.91      0.91      0.91       392

(1321, 10, 128)
(1321, 1, 10, 128)
False
Epoch 1/10
1321/1321 [==============================] - 4s 3ms/step - loss: 0.5865 - acc:
0.7434
Epoch 2/10
1321/1321 [==============================] - 2s 2ms/step - loss: 0.2039 - acc:
0.9281
Epoch 3/10
1321/1321 [==============================] - 2s 1ms/step - loss: 0.1801 - acc:
0.9296
Epoch 4/10
1321/1321 [==============================] - 2s 1ms/step - loss: 0.1412 - acc:
0.9553
Epoch 5/10
1321/1321 [==============================] - 1s 1ms/step - loss: 0.0959 - acc:
0.9682
Epoch 6/10
1321/1321 [==============================] - 1s 1ms/step - loss: 0.0531 - acc:
0.9833
Epoch 7/10
1321/1321 [==============================] - 1s 1ms/step - loss: 0.0291 - acc:
0.9917
Epoch 8/10
1321/1321 [==============================] - 2s 1ms/step - loss: 0.1367 - acc:
0.9508
Epoch 9/10
1321/1321 [==============================] - 2s 1ms/step - loss: 0.0681 - acc:
0.9750
Epoch 10/10
1321/1321 [==============================] - 2s 1ms/step - loss: 0.0236 - acc:
0.9924
[0.]
--------------------------------------------------
drums
```

```
        TRAIN
              precision    recall  f1-score   support

       False       1.00      1.00      1.00       479
        True       1.00      1.00      1.00       842

    accuracy                           1.00      1321
   macro avg       1.00      1.00      1.00      1321
weighted avg       1.00      1.00      1.00      1321

True
[0.99965954]
        TEST
              precision    recall  f1-score   support

       False       0.91      0.86      0.88       162
        True       0.92      0.95      0.93       264

    accuracy                           0.91       426
   macro avg       0.91      0.90      0.91       426
weighted avg       0.91      0.91      0.91       426

(1570, 10, 128)
(1570, 1, 10, 128)
False
Epoch 1/10
1570/1570 [==============================] - 4s 2ms/step - loss: 0.9802 - acc:
0.6242
Epoch 2/10
1570/1570 [==============================] - 2s 1ms/step - loss: 0.5765 - acc:
0.7057
Epoch 3/10
1570/1570 [==============================] - 2s 1ms/step - loss: 0.5343 - acc:
0.7102
Epoch 4/10
1570/1570 [==============================] - 2s 1ms/step - loss: 0.4799 - acc:
0.7580
Epoch 5/10
1570/1570 [==============================] - 2s 1ms/step - loss: 0.4580 - acc:
0.7732
Epoch 6/10
1570/1570 [==============================] - 2s 1ms/step - loss: 0.4390 - acc:
0.7885
Epoch 7/10
1570/1570 [==============================] - 2s 1ms/step - loss: 0.4289 - acc:
0.8019
Epoch 8/10
1570/1570 [==============================] - 2s 1ms/step - loss: 0.3413 - acc:
```

```
0.8420
Epoch 9/10
1570/1570 [==============================] - 2s 1ms/step - loss: 0.2997 - acc:
0.8732
Epoch 10/10
1570/1570 [==============================] - 2s 1ms/step - loss: 0.2171 - acc:
0.9000
[0.29924047]
--------------------------------------------------
flute
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.83      0.91      1076
        True       0.73      1.00      0.85       494

    accuracy                           0.89      1570
   macro avg       0.87      0.92      0.88      1570
weighted avg       0.92      0.89      0.89      1570

False
[0.00135657]
        TEST
              precision    recall  f1-score   support

       False       0.84      0.59      0.69       361
        True       0.43      0.75      0.55       153

    accuracy                           0.63       514
   macro avg       0.64      0.67      0.62       514
weighted avg       0.72      0.63      0.65       514

(1230, 10, 128)
(1230, 1, 10, 128)
False
Epoch 1/10
1230/1230 [==============================] - 4s 3ms/step - loss: 0.8445 - acc:
0.7455
Epoch 2/10
1230/1230 [==============================] - 1s 1ms/step - loss: 0.2476 - acc:
0.9122
Epoch 3/10
1230/1230 [==============================] - 1s 1ms/step - loss: 0.1325 - acc:
0.9634
Epoch 4/10
1230/1230 [==============================] - 1s 1ms/step - loss: 0.1119 - acc:
0.9659
Epoch 5/10
```

```
1230/1230 [==============================] - 2s 2ms/step - loss: 0.1309 - acc:
0.9488
Epoch 6/10
1230/1230 [==============================] - 3s 2ms/step - loss: 0.1290 - acc:
0.9602
Epoch 7/10
1230/1230 [==============================] - 3s 2ms/step - loss: 0.0894 - acc:
0.9740
Epoch 8/10
1230/1230 [==============================] - 2s 2ms/step - loss: 0.0664 - acc:
0.9846
Epoch 9/10
1230/1230 [==============================] - 3s 2ms/step - loss: 0.0363 - acc:
0.9894
Epoch 10/10
1230/1230 [==============================] - 2s 2ms/step - loss: 0.0260 - acc:
0.9943
[3.874302e-07]
--------------------------------------------------
guitar
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.97      0.99       378
        True       0.99      1.00      0.99       852

    accuracy                           0.99      1230
   macro avg       0.99      0.99      0.99      1230
weighted avg       0.99      0.99      0.99      1230

True
[0.999998]
        TEST
              precision    recall  f1-score   support

       False       0.93      0.91      0.92       134
        True       0.96      0.97      0.96       286

    accuracy                           0.95       420
   macro avg       0.94      0.94      0.94       420
weighted avg       0.95      0.95      0.95       420

(1345, 10, 128)
(1345, 1, 10, 128)
True
Epoch 1/10
1345/1345 [==============================] - 5s 4ms/step - loss: 0.8501 - acc:
0.6104A: 11s - loss: 1.
```

```
Epoch 2/10
1345/1345 [==============================] - 2s 1ms/step - loss: 0.4930 - acc:
0.7279
Epoch 3/10
1345/1345 [==============================] - 3s 2ms/step - loss: 0.4327 - acc:
0.7948
Epoch 4/10
1345/1345 [==============================] - 2s 2ms/step - loss: 0.3678 - acc:
0.8320
Epoch 5/10
1345/1345 [==============================] - 3s 2ms/step - loss: 0.3244 - acc:
0.8506
Epoch 6/10
1345/1345 [==============================] - 2s 1ms/step - loss: 0.3129 - acc:
0.8572A: 1s - loss: 0.
Epoch 7/10
1345/1345 [==============================] - 2s 1ms/step - loss: 0.3694 - acc:
0.8409
Epoch 8/10
1345/1345 [==============================] - 2s 2ms/step - loss: 0.2657 - acc:
0.8914
Epoch 9/10
1345/1345 [==============================] - 2s 2ms/step - loss: 0.1968 - acc:
0.9197
Epoch 10/10
1345/1345 [==============================] - 2s 1ms/step - loss: 0.1436 - acc:
0.9532
[0.93632215]
--------------------------------------------------
mallet_percussion
        TRAIN
              precision    recall  f1-score   support

       False       0.71      1.00      0.83       800
        True       0.99      0.41      0.58       545

    accuracy                           0.76      1345
   macro avg       0.85      0.70      0.71      1345
weighted avg       0.82      0.76      0.73      1345

True
[0.98925805]
        TEST
              precision    recall  f1-score   support

       False       0.68      0.97      0.80       269
        True       0.88      0.35      0.50       188
```

```
    accuracy                           0.71       457
   macro avg       0.78      0.66      0.65       457
weighted avg       0.76      0.71      0.67       457

(1864, 10, 128)
(1864, 1, 10, 128)
False
Epoch 1/10
1864/1864 [==============================] - 5s 3ms/step - loss: 0.8315 - acc:
0.6615
Epoch 2/10
1864/1864 [==============================] - 3s 1ms/step - loss: 0.4982 - acc:
0.7430
Epoch 3/10
1864/1864 [==============================] - 2s 1ms/step - loss: 0.4716 - acc:
0.7559
Epoch 4/10
1864/1864 [==============================] - 3s 1ms/step - loss: 0.4560 - acc:
0.7677
Epoch 5/10
1864/1864 [==============================] - 3s 2ms/step - loss: 0.4211 - acc:
0.7822
Epoch 6/10
1864/1864 [==============================] - 3s 1ms/step - loss: 0.4010 - acc:
0.8053
Epoch 7/10
1864/1864 [==============================] - 3s 1ms/step - loss: 0.3639 - acc:
0.8289A: 2s -
Epoch 8/10
1864/1864 [==============================] - 3s 2ms/step - loss: 0.3250 - acc:
0.8466
Epoch 9/10
1864/1864 [==============================] - 3s 1ms/step - loss: 0.3472 - acc:
0.8401
Epoch 10/10
1864/1864 [==============================] - 3s 1ms/step - loss: 0.2752 - acc:
0.8739A: 1s - loss: 0.2931 -
[6.7949295e-06]
--------------------------------------------------
mandolin
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.77      0.87      1223
        True       0.70      1.00      0.82       641

    accuracy                           0.85      1864
   macro avg       0.85      0.89      0.85      1864
```

```
weighted avg       0.89      0.85      0.85      1864

True
[0.97260296]
        TEST
              precision    recall  f1-score   support

       False       0.89      0.58      0.70       396
        True       0.51      0.86      0.64       204

    accuracy                           0.67       600
   macro avg       0.70      0.72      0.67       600
weighted avg       0.76      0.67      0.68       600

(1449, 10, 128)
(1449, 1, 10, 128)
True
Epoch 1/10
1449/1449 [==============================] - 4s 3ms/step - loss: 1.0355 - acc:
0.6632
Epoch 2/10
1449/1449 [==============================] - 2s 1ms/step - loss: 0.4317 - acc:
0.8012
Epoch 3/10
1449/1449 [==============================] - 2s 1ms/step - loss: 0.3757 - acc:
0.8171
Epoch 4/10
1449/1449 [==============================] - 2s 1ms/step - loss: 0.3604 - acc:
0.8233
Epoch 5/10
1449/1449 [==============================] - 2s 1ms/step - loss: 0.3185 - acc:
0.8420
Epoch 6/10
1449/1449 [==============================] - 2s 1ms/step - loss: 0.3039 - acc:
0.8496
Epoch 7/10
1449/1449 [==============================] - 2s 1ms/step - loss: 0.3003 - acc:
0.8606
Epoch 8/10
1449/1449 [==============================] - 2s 1ms/step - loss: 0.2076 - acc:
0.9068
Epoch 9/10
1449/1449 [==============================] - 2s 1ms/step - loss: 0.1692 - acc:
0.9303
Epoch 10/10
1449/1449 [==============================] - 2s 1ms/step - loss: 0.1405 - acc:
0.9413
[0.9638747]
```

```
--------------------------------------------------
organ
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.94      0.97       983
        True       0.89      1.00      0.94       466

    accuracy                           0.96      1449
   macro avg       0.95      0.97      0.96      1449
weighted avg       0.96      0.96      0.96      1449

False
[5.4091215e-05]
        TEST
              precision    recall  f1-score   support

       False       0.90      0.75      0.82       304
        True       0.60      0.81      0.69       137

    accuracy                           0.77       441
   macro avg       0.75      0.78      0.75       441
weighted avg       0.80      0.77      0.78       441

(1291, 10, 128)
(1291, 1, 10, 128)
False
Epoch 1/10
1291/1291 [==============================] - 5s 4ms/step - loss: 0.6743 - acc:
0.7266
Epoch 2/10
1291/1291 [==============================] - 2s 1ms/step - loss: 0.1667 - acc:
0.9388
Epoch 3/10
1291/1291 [==============================] - 2s 1ms/step - loss: 0.1288 - acc:
0.9558
Epoch 4/10
1291/1291 [==============================] - 2s 1ms/step - loss: 0.1218 - acc:
0.9613
Epoch 5/10
1291/1291 [==============================] - 2s 1ms/step - loss: 0.0967 - acc:
0.9675
Epoch 6/10
1291/1291 [==============================] - 2s 1ms/step - loss: 0.1056 - acc:
0.9659
Epoch 7/10
1291/1291 [==============================] - 2s 1ms/step - loss: 0.0887 - acc:
0.9752
```

```
Epoch 8/10
1291/1291 [==============================] - 2s 1ms/step - loss: 0.0523 - acc:
0.9830
Epoch 9/10
1291/1291 [==============================] - 2s 1ms/step - loss: 0.0382 - acc:
0.9884
Epoch 10/10
1291/1291 [==============================] - 2s 1ms/step - loss: 0.0523 - acc:
0.9845
[0.1406048]
--------------------------------------------------
piano
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.89      0.94       414
        True       0.95      1.00      0.97       877

    accuracy                           0.97      1291
   macro avg       0.98      0.95      0.96      1291
weighted avg       0.97      0.97      0.96      1291

False
[0.00920945]
        TEST
              precision    recall  f1-score   support

       False       0.98      0.82      0.90       136
        True       0.92      0.99      0.96       293

    accuracy                           0.94       429
   macro avg       0.95      0.91      0.93       429
weighted avg       0.94      0.94      0.94       429

(1733, 10, 128)
(1733, 1, 10, 128)
True
Epoch 1/10
1733/1733 [==============================] - 8s 5ms/step - loss: 0.9876 - acc:
0.5026A: 3s - loss: 1.1127 - ac
Epoch 2/10
1733/1733 [==============================] - 2s 1ms/step - loss: 0.6010 - acc:
0.6705
Epoch 3/10
1733/1733 [==============================] - 3s 1ms/step - loss: 0.5303 - acc:
0.7224
Epoch 4/10
1733/1733 [==============================] - 3s 2ms/step - loss: 0.4989 - acc:
```

```
0.7340
Epoch 5/10
1733/1733 [==============================] - 3s 2ms/step - loss: 0.4368 - acc:
0.7825
Epoch 6/10
1733/1733 [==============================] - 2s 1ms/step - loss: 0.4158 - acc:
0.8096
Epoch 7/10
1733/1733 [==============================] - 2s 1ms/step - loss: 0.3781 - acc:
0.8171
Epoch 8/10
1733/1733 [==============================] - 2s 1ms/step - loss: 0.3367 - acc:
0.8488
Epoch 9/10
1733/1733 [==============================] - 2s 1ms/step - loss: 0.4156 - acc:
0.8130
Epoch 10/10
1733/1733 [==============================] - 2s 1ms/step - loss: 0.2951 - acc:
0.8731
[0.92669]
--------------------------------------------------
saxophone
        TRAIN
              precision    recall  f1-score   support

       False       0.98      0.77      0.87       900
        True       0.80      0.98      0.88       833

    accuracy                           0.87      1733
   macro avg       0.89      0.88      0.87      1733
weighted avg       0.89      0.87      0.87      1733

True
[0.8732294]
        TEST
              precision    recall  f1-score   support

       False       0.85      0.58      0.69       330
        True       0.66      0.89      0.76       302

    accuracy                           0.73       632
   macro avg       0.75      0.73      0.72       632
weighted avg       0.76      0.73      0.72       632

(1185, 10, 128)
(1185, 1, 10, 128)
False
Epoch 1/10
```

```
1185/1185 [==============================] - 4s 4ms/step - loss: 0.6299 - acc:
0.7840
Epoch 2/10
1185/1185 [==============================] - 2s 1ms/step - loss: 0.2077 - acc:
0.9367
Epoch 3/10
1185/1185 [==============================] - 1s 1ms/step - loss: 0.1712 - acc:
0.9426
Epoch 4/10
1185/1185 [==============================] - 1s 1ms/step - loss: 0.1402 - acc:
0.9603
Epoch 5/10
1185/1185 [==============================] - 1s 1ms/step - loss: 0.1054 - acc:
0.9705
Epoch 6/10
1185/1185 [==============================] - 2s 2ms/step - loss: 0.1158 - acc:
0.9654
Epoch 7/10
1185/1185 [==============================] - 2s 2ms/step - loss: 0.0950 - acc:
0.9738
Epoch 8/10
1185/1185 [==============================] - 3s 2ms/step - loss: 0.0810 - acc:
0.9806
Epoch 9/10
1185/1185 [==============================] - 2s 1ms/step - loss: 0.0653 - acc:
0.9865
Epoch 10/10
1185/1185 [==============================] - 1s 1ms/step - loss: 0.0575 - acc:
0.9831
[7.897615e-06]
--------------------------------------------------
synthesizer
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.97      0.99       376
        True       0.99      1.00      0.99       809

    accuracy                           0.99      1185
   macro avg       0.99      0.99      0.99      1185
weighted avg       0.99      0.99      0.99      1185

True
[0.99991584]
        TEST
              precision    recall  f1-score   support

       False       0.96      0.90      0.93       135
```

```
        True       0.95      0.98      0.97       282

    accuracy                           0.95       417
   macro avg       0.96      0.94      0.95       417
weighted avg       0.95      0.95      0.95       417

(2036, 10, 128)
(2036, 1, 10, 128)
True
Epoch 1/10
2036/2036 [==============================] - 5s 3ms/step - loss: 0.7733 - acc:
0.6660
Epoch 2/10
2036/2036 [==============================] - 2s 1ms/step - loss: 0.4876 - acc:
0.7677
Epoch 3/10
2036/2036 [==============================] - 3s 1ms/step - loss: 0.4180 - acc:
0.8158
Epoch 4/10
2036/2036 [==============================] - 2s 1ms/step - loss: 0.3678 - acc:
0.8418
Epoch 5/10
2036/2036 [==============================] - 2s 1ms/step - loss: 0.3313 - acc:
0.8561
Epoch 6/10
2036/2036 [==============================] - 2s 1ms/step - loss: 0.2626 - acc:
0.8924
Epoch 7/10
2036/2036 [==============================] - 2s 1ms/step - loss: 0.2182 - acc:
0.9190
Epoch 8/10
2036/2036 [==============================] - 3s 1ms/step - loss: 0.1714 - acc:
0.9322
Epoch 9/10
2036/2036 [==============================] - 3s 1ms/step - loss: 0.1119 - acc:
0.9578
Epoch 10/10
2036/2036 [==============================] - 3s 1ms/step - loss: 0.0983 - acc:
0.9661A: 2s - lo
[0.989437]
--------------------------------------------------
trombone
        TRAIN
              precision    recall  f1-score   support

       False       0.99      0.99      0.99      1409
        True       0.99      0.98      0.98       627
```

```
    accuracy                           0.99      2036
   macro avg       0.99      0.98      0.99      2036
weighted avg       0.99      0.99      0.99      2036

False
[0.00032526]
        TEST
              precision    recall  f1-score   support

       False       0.83      0.86      0.85       488
        True       0.69      0.63      0.66       236

    accuracy                           0.79       724
   macro avg       0.76      0.75      0.75       724
weighted avg       0.78      0.79      0.78       724

(2183, 10, 128)
(2183, 1, 10, 128)
True
Epoch 1/10
2183/2183 [==============================] - 6s 3ms/step - loss: 0.8680 - acc:
0.5767
Epoch 2/10
2183/2183 [==============================] - 3s 1ms/step - loss: 0.5370 - acc:
0.7169A: 1s - loss: 0.562
Epoch 3/10
2183/2183 [==============================] - 3s 1ms/step - loss: 0.4889 - acc:
0.7572
Epoch 4/10
2183/2183 [==============================] - 2s 1ms/step - loss: 0.4261 - acc:
0.7975
Epoch 5/10
2183/2183 [==============================] - 2s 1ms/step - loss: 0.4126 - acc:
0.8090
Epoch 6/10
2183/2183 [==============================] - 2s 1ms/step - loss: 0.3808 - acc:
0.8296
Epoch 7/10
2183/2183 [==============================] - 3s 1ms/step - loss: 0.3219 - acc:
0.8562
Epoch 8/10
2183/2183 [==============================] - 3s 1ms/step - loss: 0.2890 - acc:
0.8754
Epoch 9/10
2183/2183 [==============================] - 3s 1ms/step - loss: 0.2240 - acc:
0.9020A: 1s - loss: 0.
Epoch 10/10
2183/2183 [==============================] - 2s 1ms/step - loss: 0.2024 - acc:
```

```
0.9180
[0.86600804]
--------------------------------------------------
trumpet
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.82      0.90      1335
        True       0.78      1.00      0.88       848

    accuracy                           0.89      2183
   macro avg       0.89      0.91      0.89      2183
weighted avg       0.91      0.89      0.89      2183

True
[0.8923961]
        TEST
              precision    recall  f1-score   support

       False       0.87      0.61      0.72       435
        True       0.60      0.87      0.71       298

    accuracy                           0.71       733
   macro avg       0.74      0.74      0.71       733
weighted avg       0.76      0.71      0.71       733

(1812, 10, 128)
(1812, 1, 10, 128)
True
Epoch 1/10
1812/1812 [==============================] - 5s 3ms/step - loss: 0.6498 - acc:
0.7053
Epoch 2/10
1812/1812 [==============================] - 2s 1ms/step - loss: 0.4708 - acc:
0.7472
Epoch 3/10
1812/1812 [==============================] - 2s 1ms/step - loss: 0.4387 - acc:
0.7710
Epoch 4/10
1812/1812 [==============================] - 3s 2ms/step - loss: 0.3833 - acc:
0.8102
Epoch 5/10
1812/1812 [==============================] - 3s 1ms/step - loss: 0.3722 - acc:
0.8201
Epoch 6/10
1812/1812 [==============================] - 2s 1ms/step - loss: 0.3077 - acc:
0.8571
Epoch 7/10
```

```
1812/1812 [==============================] - 2s 1ms/step - loss: 0.2764 - acc:
0.8775
Epoch 8/10
1812/1812 [==============================] - 3s 1ms/step - loss: 0.2015 - acc:
0.9178
Epoch 9/10
1812/1812 [==============================] - 3s 1ms/step - loss: 0.1961 - acc:
0.9150A: 1s - loss: 0.1089 - acc: - ETA: 0s - loss: 0.1466 - a
Epoch 10/10
1812/1812 [==============================] - 2s 1ms/step - loss: 0.1642 - acc:
0.9338
[0.8599187]
--------------------------------------------------
ukulele
        TRAIN
              precision    recall  f1-score   support

       False       0.99      0.98      0.98      1271
        True       0.94      0.98      0.96       541

    accuracy                           0.98      1812
   macro avg       0.97      0.98      0.97      1812
weighted avg       0.98      0.98      0.98      1812

True
[0.974316]
        TEST
              precision    recall  f1-score   support

       False       0.80      0.81      0.80       416
        True       0.59      0.56      0.58       197

    accuracy                           0.73       613
   macro avg       0.69      0.69      0.69       613
weighted avg       0.73      0.73      0.73       613

(1503, 10, 128)
(1503, 1, 10, 128)
True
Epoch 1/10
1503/1503 [==============================] - 5s 3ms/step - loss: 1.0332 - acc:
0.6028
Epoch 2/10
1503/1503 [==============================] - 2s 1ms/step - loss: 0.4492 - acc:
0.8011
Epoch 3/10
1503/1503 [==============================] - 2s 1ms/step - loss: 0.3653 - acc:
0.8363
```

```
Epoch 4/10
1503/1503 [==============================] - 2s 1ms/step - loss: 0.3303 - acc:
0.8417
Epoch 5/10
1503/1503 [==============================] - 2s 1ms/step - loss: 0.3248 - acc:
0.8536
Epoch 6/10
1503/1503 [==============================] - 2s 1ms/step - loss: 0.3090 - acc:
0.8709
Epoch 7/10
1503/1503 [==============================] - 2s 1ms/step - loss: 0.2930 - acc:
0.8729
Epoch 8/10
1503/1503 [==============================] - 2s 1ms/step - loss: 0.2492 - acc:
0.9002
Epoch 9/10
1503/1503 [==============================] - 3s 2ms/step - loss: 0.2047 - acc:
0.9142A: 0s - loss: 0.2119 - acc: 0.90
Epoch 10/10
1503/1503 [==============================] - 2s 2ms/step - loss: 0.1844 - acc:
0.9295
[0.943087]
--------------------------------------------------
violin
        TRAIN
              precision    recall  f1-score   support

       False       0.99      0.90      0.94       629
        True       0.93      1.00      0.96       874

    accuracy                           0.96      1503
   macro avg       0.96      0.95      0.95      1503
weighted avg       0.96      0.96      0.96      1503

True
[0.95510423]
        TEST
              precision    recall  f1-score   support

       False       0.81      0.71      0.76       231
        True       0.79      0.88      0.83       299

    accuracy                           0.80       530
   macro avg       0.80      0.79      0.79       530
weighted avg       0.80      0.80      0.80       530

(1188, 10, 128)
(1188, 1, 10, 128)
```

```
False
Epoch 1/10
1188/1188 [==============================] - 8s 7ms/step - loss: 0.9186 - acc:
0.6490
Epoch 2/10
1188/1188 [==============================] - 2s 1ms/step - loss: 0.3191 - acc:
0.8847
Epoch 3/10
1188/1188 [==============================] - 2s 1ms/step - loss: 0.2256 - acc:
0.9234
Epoch 4/10
1188/1188 [==============================] - 1s 1ms/step - loss: 0.1700 - acc:
0.9411
Epoch 5/10
1188/1188 [==============================] - 1s 1ms/step - loss: 0.1404 - acc:
0.9529
Epoch 6/10
1188/1188 [==============================] - 1s 1ms/step - loss: 0.1197 - acc:
0.9562
Epoch 7/10
1188/1188 [==============================] - 1s 1ms/step - loss: 0.0945 - acc:
0.9621
Epoch 8/10
1188/1188 [==============================] - 1s 1ms/step - loss: 0.1684 - acc:
0.9402
Epoch 9/10
1188/1188 [==============================] - 1s 1ms/step - loss: 0.0842 - acc:
0.9722
Epoch 10/10
1188/1188 [==============================] - 1s 1ms/step - loss: 0.0437 - acc:
0.9857
[1.1444092e-05]
--------------------------------------------------
voice
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.98      0.99       429
        True       0.99      1.00      0.99       759

    accuracy                           0.99      1188
   macro avg       0.99      0.99      0.99      1188
weighted avg       0.99      0.99      0.99      1188

True
[0.99902856]
        TEST
              precision    recall  f1-score   support
```

```
              precision    recall  f1-score   support

       False       0.90      0.84      0.87       147
        True       0.90      0.94      0.92       229

    accuracy                           0.90       376
   macro avg       0.90      0.89      0.90       376
weighted avg       0.90      0.90      0.90       376
```

[ ]:
```
print(X_train_inst_sklearn)
print(Y_pred_train)
```

[ ]:
```

```