openmic

December 19, 2019

[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
```

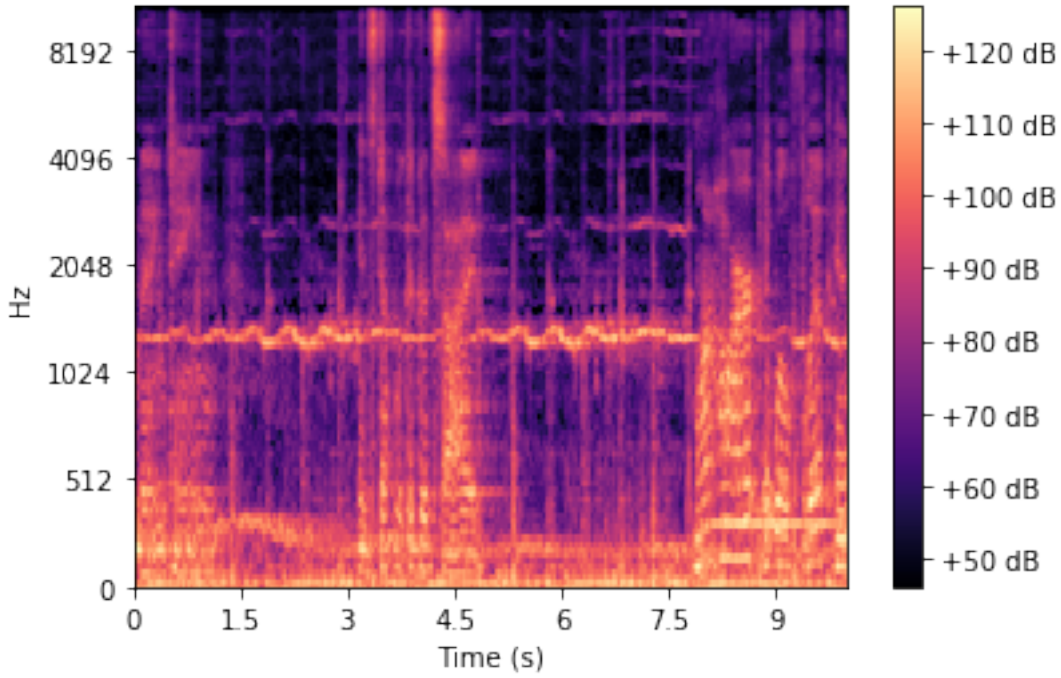
[4]:
```
array([['000046_3840', 'clarinet'],
       ['000046_3840', 'flute'],
       ['000046_3840', 'trumpet'],
       ...,
       ['155311_453120', 'saxophone'],
       ['155311_453120', 'trumpet'],
       ['155311_453120', 'trombone']], dtype=object)
```

[5]:
```
y, sr = lb.load(DATA_DIR + 'audio/000/000963_88320.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)
```

```
(220512,)
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 0x197a1f621d0>



[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)
split_val, split_test, X_val, X_test, Y_true_val, Y_true_test, Y_mask_val,␣
 ↪Y_mask_test = train_test_split(split_test, X_test, Y_true_test, Y_mask_test,␣
 ↪test_size=0.5)

train_set = np.asarray(set(split_train))
test_set = np.asarray(set(split_test))
print('# Train: {},  # Val: {},  # Test: {}'.format(len(split_train),␣
 ↪len(split_test), len(split_val)))
```

```
# Train: 15000,  # Val: 2500,  # Test: 2500
```

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

```
(15000, 10, 128)
(2500, 10, 128)
(2500, 10, 128)
```

[12]:
```
THRESHOLD = 0.5

# 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]
    val_inst = Y_mask_val[:, 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]
    X_val_inst = X_val[val_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] >= THRESHOLD
    Y_true_val_inst = Y_true_val[val_inst, inst_num] >= THRESHOLD


    # 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] >= THRESHOLD


    X_train_inst = X_train_inst.astype('float32')
    X_val_inst = X_val_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_val_inst.shape
    X_val_inst = X_val_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)
```

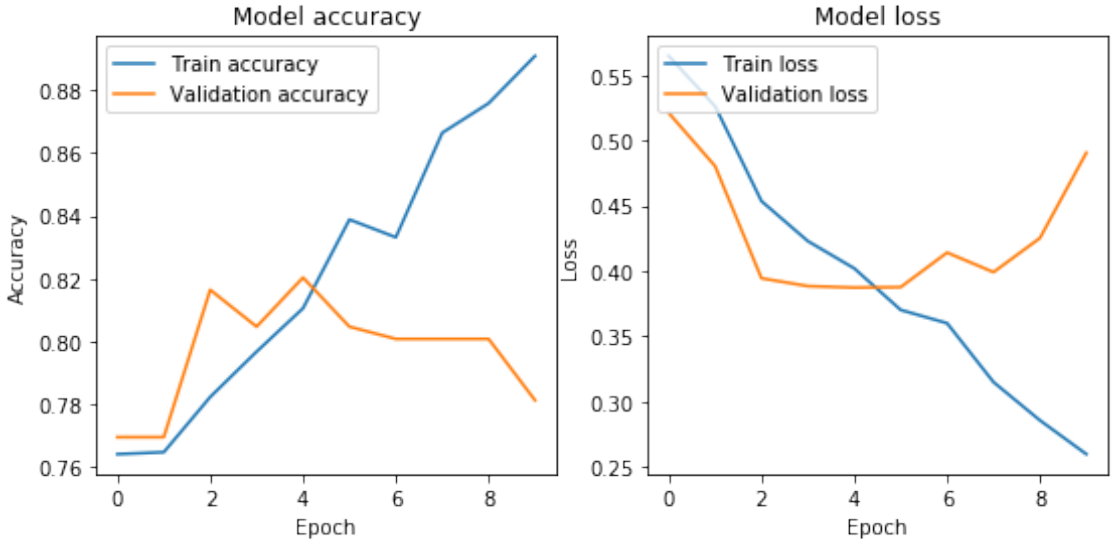
```
   print(Y_true_train_inst[0])
   # Step 3.
   # Initialize a new classifier
   import keras,os
   from keras.models import Sequential
   from keras.layers import Dense, Conv2D, MaxPool2D , Flatten, Dropout
   from keras.preprocessing.image import ImageDataGenerator
   import numpy as np
   model = 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=64,kernel_size=(3,3)
↪activation="relu"))
   model.add(Conv2D(filters=32,kernel_size=(3,3),padding="same",␣
↪activation="relu"))
   model.add(MaxPool2D(pool_size=(3,3),strides=(2,2)))
   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(MaxPool2D(pool_size=(2,2),strides=(2,2)))
   model.add(Dropout(0.2))
   model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same",␣
↪activation="relu"))
   model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same",␣
↪activation="relu"))
   model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same",␣
↪activation="relu"))
   model.add(MaxPool2D(pool_size=(2,2),strides=(2,2)))
   model.add(Dropout(0.2))
   model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same",␣
↪activation="relu"))
   model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same",␣
↪activation="relu"))
   model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same",␣
↪activation="relu"))
   model.add(layers.Flatten())
   model.add(layers.Dense(units=4096, activation='relu'))
   model.add(layers.Dense(units=4096, activation='relu'))
   model.add(layers.Dense(units=1, activation='sigmoid'))

   model.compile(loss='binary_crossentropy',
                 optimizer=keras.optimizers.Adam(lr=0.0001),
                  metrics = ['accuracy'])
```

```
  # model.summary()
   # Step 4.
   history = model.fit(X_train_inst,Y_true_train_inst , epochs=10,␣
↪batch_size=32, validation_data=(X_val_inst,Y_true_val_inst))

   plt.figure(figsize=(9,4))

   plt.subplot(1,2,1)
   plt.plot(history.history['acc'])
   plt.plot(history.history['val_acc'])
   plt.title('Model accuracy')
   plt.ylabel('Accuracy')
   plt.xlabel('Epoch')
   plt.legend(['Train accuracy', 'Validation accuracy'], loc='upper left')

   plt.subplot(1,2,2)
   plt.plot(history.history['loss'])
   plt.plot(history.history['val_loss'])
   plt.title('Model loss')
   plt.ylabel('Loss')
   plt.xlabel('Epoch')
   plt.legend(['Train loss', 'Validation loss'], loc='upper left')
   plt.show()

   loss, acc = model.evaluate(X_test_inst, Y_true_test_inst)
   print('Test loss: {}'.format(loss))
   print('Test accuracy: {:.2%}'.format(acc))

   # 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 > THRESHOLD - 0.3 #THRESHOLD (should be␣
↪lower than 0.5)
   Y_pred_test_bool = Y_pred_test > THRESHOLD - 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
```

```
(1594, 10, 128)
(1594, 1, 10, 128)
True
WARNING:tensorflow:From C:\Users\hjani\Documents\Conda\lib\site-
packages\tensorflow\python\framework\op_def_library.py:263: colocate_with (from
tensorflow.python.framework.ops) is deprecated and will be removed in a future
version.
Instructions for updating:
Colocations handled automatically by placer.
WARNING:tensorflow:From C:\Users\hjani\Documents\Conda\lib\site-
packages\keras\backend\tensorflow_backend.py:3445: calling dropout (from
tensorflow.python.ops.nn_ops) with keep_prob is deprecated and will be removed
in a future version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 -
keep_prob`.
WARNING:tensorflow:From C:\Users\hjani\Documents\Conda\lib\site-
packages\tensorflow\python\ops\math_ops.py:3066: to_int32 (from
tensorflow.python.ops.math_ops) is deprecated and will be removed in a future
version.
Instructions for updating:
Use tf.cast instead.
Train on 1594 samples, validate on 256 samples
Epoch 1/10
1594/1594 [==============================] - 116s 73ms/step - loss: 0.5646 -
acc: 0.7641 - val_loss: 0.5210 - val_acc: 0.7695
Epoch 2/10
1594/1594 [==============================] - 117s 74ms/step - loss: 0.5260 -
acc: 0.7647 - val_loss: 0.4802 - val_acc: 0.7695
Epoch 3/10
1594/1594 [==============================] - 118s 74ms/step - loss: 0.4534 -
acc: 0.7823 - val_loss: 0.3944 - val_acc: 0.8164
Epoch 4/10
1594/1594 [==============================] - 121s 76ms/step - loss: 0.4228 -
acc: 0.7967 - val_loss: 0.3884 - val_acc: 0.8047
Epoch 5/10
1594/1594 [==============================] - 116s 73ms/step - loss: 0.4019 -
acc: 0.8105 - val_loss: 0.3873 - val_acc: 0.8203
```

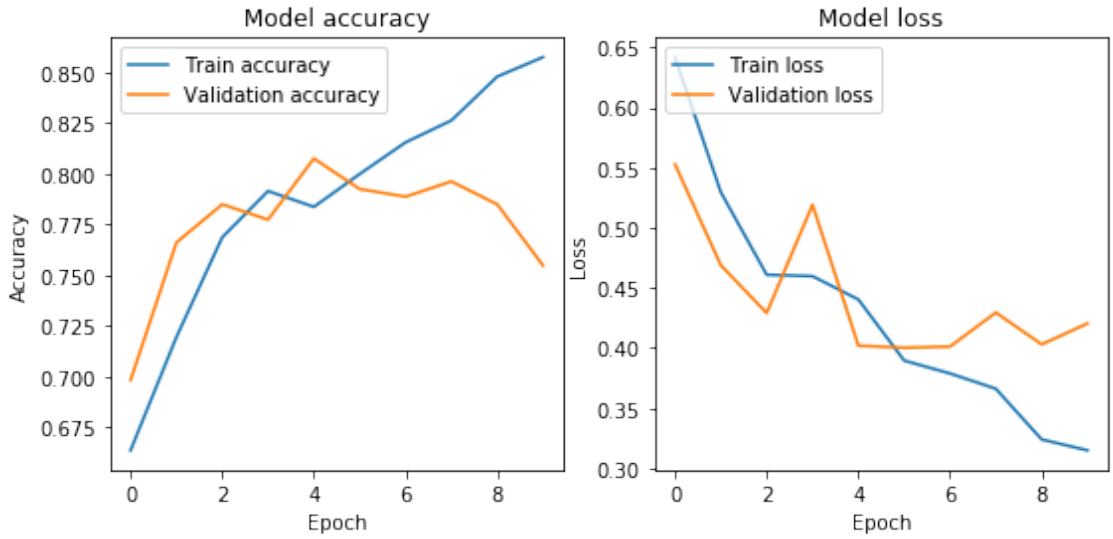
```
Epoch 6/10
1594/1594 [==============================] - 114s 72ms/step - loss: 0.3702 -
acc: 0.8388 - val_loss: 0.3876 - val_acc: 0.8047
Epoch 7/10
1594/1594 [==============================] - 112s 70ms/step - loss: 0.3600 -
acc: 0.8331 - val_loss: 0.4140 - val_acc: 0.8008
Epoch 8/10
1594/1594 [==============================] - 111s 70ms/step - loss: 0.3149 -
acc: 0.8664 - val_loss: 0.3991 - val_acc: 0.8008
Epoch 9/10
1594/1594 [==============================] - 112s 70ms/step - loss: 0.2857 -
acc: 0.8758 - val_loss: 0.4251 - val_acc: 0.8008
Epoch 10/10
1594/1594 [==============================] - 110s 69ms/step - loss: 0.2598 -
acc: 0.8908 - val_loss: 0.4904 - val_acc: 0.7812
```




```
221/221 [==============================] - 2s 9ms/step
Test loss: 0.437995489636158
Test accuracy: 81.45%
[0.6548375]
--------------------------------------------------
accordion
        TRAIN
              precision    recall  f1-score   support

       False       0.99      0.91      0.94      1219
        True       0.76      0.96      0.85       375

    accuracy                           0.92      1594
```

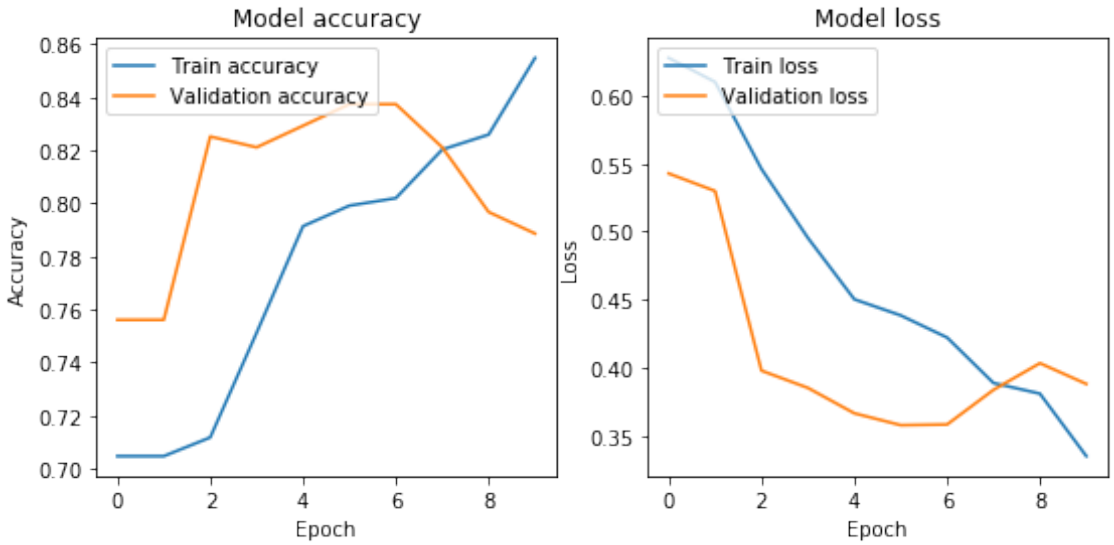
```
   macro avg       0.87      0.93      0.90      1594
weighted avg       0.93      0.92      0.92      1594

False
[0.10981479]
        TEST
              precision    recall  f1-score   support

       False       0.90      0.83      0.87       166
        True       0.59      0.73      0.65        55

    accuracy                           0.81       221
   macro avg       0.75      0.78      0.76       221
weighted avg       0.82      0.81      0.81       221

(1664, 10, 128)
(1664, 1, 10, 128)
False
Train on 1664 samples, validate on 265 samples
Epoch 1/10
1664/1664 [==============================] - 121s 73ms/step - loss: 0.6420 -
acc: 0.6635 - val_loss: 0.5529 - val_acc: 0.6981
Epoch 2/10
1664/1664 [==============================] - 119s 71ms/step - loss: 0.5296 -
acc: 0.7194 - val_loss: 0.4689 - val_acc: 0.7660
Epoch 3/10
1664/1664 [==============================] - 116s 70ms/step - loss: 0.4610 -
acc: 0.7686 - val_loss: 0.4292 - val_acc: 0.7849
Epoch 4/10
1664/1664 [==============================] - 135s 81ms/step - loss: 0.4598 -
acc: 0.7915 - val_loss: 0.5193 - val_acc: 0.7774
Epoch 5/10
1664/1664 [==============================] - 123s 74ms/step - loss: 0.4405 -
acc: 0.7837 - val_loss: 0.4020 - val_acc: 0.8075
Epoch 6/10
1664/1664 [==============================] - 122s 73ms/step - loss: 0.3896 -
acc: 0.7999 - val_loss: 0.4002 - val_acc: 0.7925
Epoch 7/10
1664/1664 [==============================] - 120s 72ms/step - loss: 0.3789 -
acc: 0.8155 - val_loss: 0.4013 - val_acc: 0.7887
Epoch 8/10
1664/1664 [==============================] - 124s 75ms/step - loss: 0.3661 -
acc: 0.8263 - val_loss: 0.4295 - val_acc: 0.7962
Epoch 9/10
1664/1664 [==============================] - 128s 77ms/step - loss: 0.3239 -
acc: 0.8480 - val_loss: 0.4031 - val_acc: 0.7849
Epoch 10/10
1664/1664 [==============================] - 130s 78ms/step - loss: 0.3149 -
```

```
acc: 0.8576 - val_loss: 0.4204 - val_acc: 0.7547
```



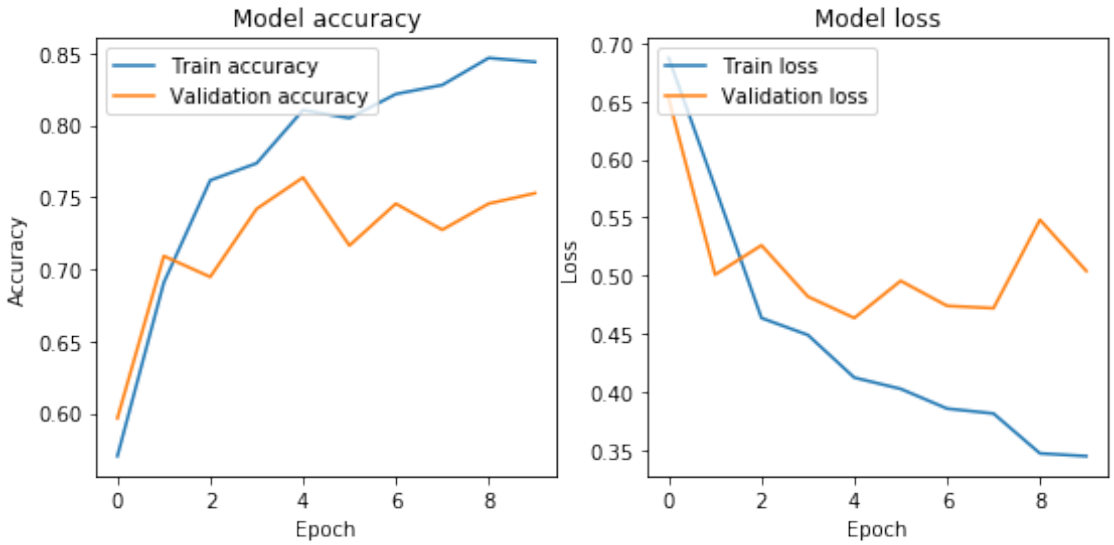

```
289/289 [==============================] - 3s 10ms/step
Test loss: 0.47478529078737675
Test accuracy: 75.78%
[0.13815153]
--------------------------------------------------
banjo
        TRAIN
              precision    recall  f1-score   support

       False       0.99      0.78      0.87      1114
        True       0.69      0.98      0.81       550

    accuracy                           0.85      1664
   macro avg       0.84      0.88      0.84      1664
weighted avg       0.89      0.85      0.85      1664

False
[0.00191763]
        TEST
              precision    recall  f1-score   support

       False       0.89      0.71      0.79       187
        True       0.61      0.83      0.70       102

    accuracy                           0.75       289
   macro avg       0.75      0.77      0.74       289
weighted avg       0.79      0.75      0.76       289
```

```
(1419, 10, 128)
(1419, 1, 10, 128)
False
Train on 1419 samples, validate on 246 samples
Epoch 1/10
1419/1419 [==============================] - 112s 79ms/step - loss: 0.6278 -
acc: 0.7047 - val_loss: 0.5428 - val_acc: 0.7561
Epoch 2/10
1419/1419 [==============================] - 110s 78ms/step - loss: 0.6102 -
acc: 0.7047 - val_loss: 0.5299 - val_acc: 0.7561
Epoch 3/10
1419/1419 [==============================] - 109s 77ms/step - loss: 0.5461 -
acc: 0.7118 - val_loss: 0.3977 - val_acc: 0.8252
Epoch 4/10
1419/1419 [==============================] - 112s 79ms/step - loss: 0.4954 -
acc: 0.7512 - val_loss: 0.3850 - val_acc: 0.8211
Epoch 5/10
1419/1419 [==============================] - 109s 77ms/step - loss: 0.4502 -
acc: 0.7914 - val_loss: 0.3663 - val_acc: 0.8293
Epoch 6/10
1419/1419 [==============================] - 104s 74ms/step - loss: 0.4384 -
acc: 0.7992 - val_loss: 0.3576 - val_acc: 0.8374
Epoch 7/10
1419/1419 [==============================] - 105s 74ms/step - loss: 0.4221 -
acc: 0.8020 - val_loss: 0.3581 - val_acc: 0.8374
Epoch 8/10
1419/1419 [==============================] - 107s 75ms/step - loss: 0.3886 -
acc: 0.8203 - val_loss: 0.3836 - val_acc: 0.8211
Epoch 9/10
1419/1419 [==============================] - 114s 80ms/step - loss: 0.3808 -
acc: 0.8259 - val_loss: 0.4032 - val_acc: 0.7967
Epoch 10/10
1419/1419 [==============================] - 120s 85ms/step - loss: 0.3348 -
acc: 0.8548 - val_loss: 0.3879 - val_acc: 0.7886
```



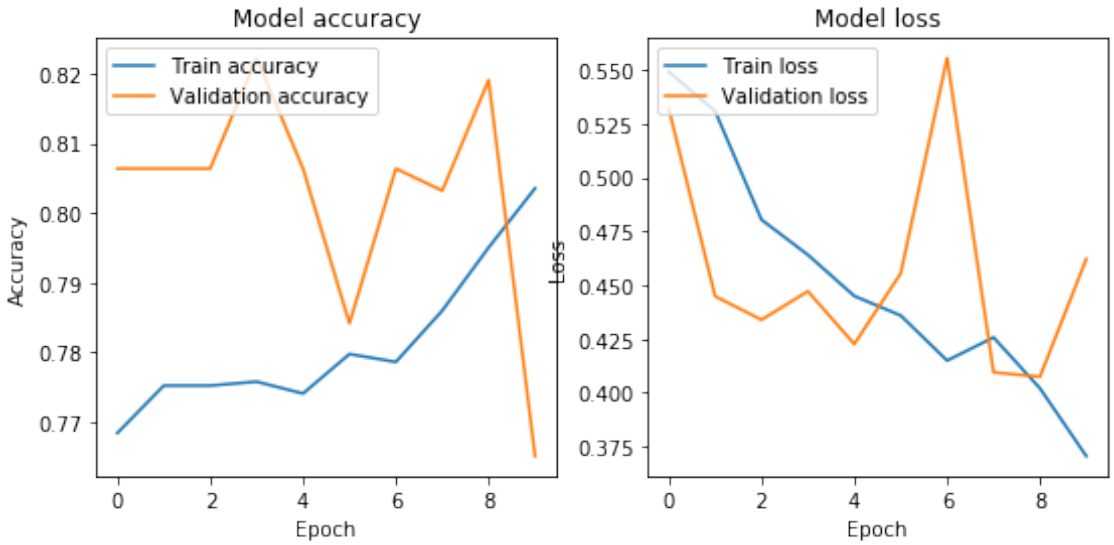

```
223/223 [==============================] - 3s 11ms/step
Test loss: 0.45042256349405363
Test accuracy: 76.23%
[0.01511016]
--------------------------------------------------
bass
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.57      0.72      1000
        True       0.49      1.00      0.66       419

    accuracy                           0.70      1419
   macro avg       0.75      0.78      0.69      1419
weighted avg       0.85      0.70      0.71      1419

False
[0.3186671]
        TEST
              precision    recall  f1-score   support

       False       0.94      0.54      0.69       153
        True       0.48      0.93      0.63        70

    accuracy                           0.66       223
   macro avg       0.71      0.74      0.66       223
weighted avg       0.80      0.66      0.67       223

(1435, 10, 128)
```

```
(1435, 1, 10, 128)
False
Train on 1435 samples, validate on 275 samples
Epoch 1/10
1435/1435 [==============================] - 120s 84ms/step - loss: 0.6873 -
acc: 0.5700 - val_loss: 0.6523 - val_acc: 0.5964
Epoch 2/10
1435/1435 [==============================] - 103s 72ms/step - loss: 0.5760 -
acc: 0.6906 - val_loss: 0.5007 - val_acc: 0.7091
Epoch 3/10
1435/1435 [==============================] - 102s 71ms/step - loss: 0.4634 -
acc: 0.7617 - val_loss: 0.5260 - val_acc: 0.6945
Epoch 4/10
1435/1435 [==============================] - 111s 78ms/step - loss: 0.4489 -
acc: 0.7735 - val_loss: 0.4819 - val_acc: 0.7418
Epoch 5/10
1435/1435 [==============================] - 101s 71ms/step - loss: 0.4121 -
acc: 0.8105 - val_loss: 0.4635 - val_acc: 0.7636
Epoch 6/10
1435/1435 [==============================] - 101s 70ms/step - loss: 0.4024 -
acc: 0.8049 - val_loss: 0.4954 - val_acc: 0.7164
Epoch 7/10
1435/1435 [==============================] - 115s 80ms/step - loss: 0.3855 -
acc: 0.8216 - val_loss: 0.4739 - val_acc: 0.7455
Epoch 8/10
1435/1435 [==============================] - 104s 72ms/step - loss: 0.3812 -
acc: 0.8279 - val_loss: 0.4719 - val_acc: 0.7273
Epoch 9/10
1435/1435 [==============================] - 103s 72ms/step - loss: 0.3469 -
acc: 0.8467 - val_loss: 0.5480 - val_acc: 0.7455
Epoch 10/10
1435/1435 [==============================] - 99s 69ms/step - loss: 0.3445 - acc:
0.8439 - val_loss: 0.5039 - val_acc: 0.7527
```



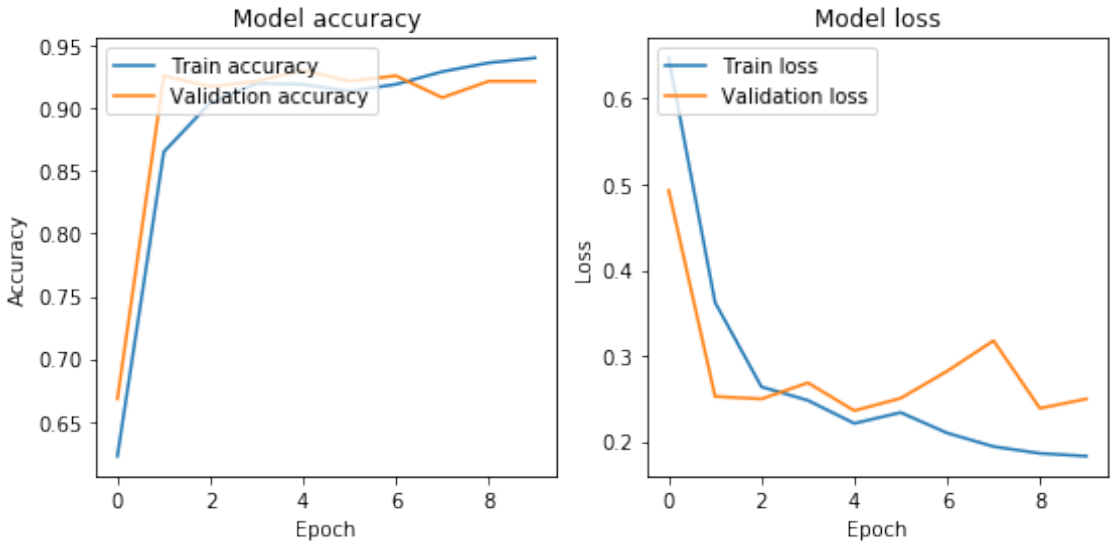

```
239/239 [==============================] - 2s 9ms/step
Test loss: 0.5433883659510433
Test accuracy: 74.90%
[0.00171691]
--------------------------------------------------
cello
        TRAIN
              precision    recall  f1-score   support

       False       0.98      0.79      0.87       833
        True       0.77      0.98      0.86       602

    accuracy                           0.87      1435
   macro avg       0.88      0.88      0.87      1435
weighted avg       0.89      0.87      0.87      1435

False
[0.00046462]
        TEST
              precision    recall  f1-score   support

       False       0.83      0.63      0.72       128
        True       0.67      0.85      0.75       111

    accuracy                           0.73       239
   macro avg       0.75      0.74      0.73       239
weighted avg       0.75      0.73      0.73       239

(1766, 10, 128)
```

```
(1766, 1, 10, 128)
True
Train on 1766 samples, validate on 315 samples
Epoch 1/10
1766/1766 [==============================] - 135s 77ms/step - loss: 0.5493 -
acc: 0.7684 - val_loss: 0.5322 - val_acc: 0.8063
Epoch 2/10
1766/1766 [==============================] - 127s 72ms/step - loss: 0.5309 -
acc: 0.7752 - val_loss: 0.4448 - val_acc: 0.8063
Epoch 3/10
1766/1766 [==============================] - 129s 73ms/step - loss: 0.4804 -
acc: 0.7752 - val_loss: 0.4339 - val_acc: 0.8063
Epoch 4/10
1766/1766 [==============================] - 127s 72ms/step - loss: 0.4641 -
acc: 0.7758 - val_loss: 0.4471 - val_acc: 0.8222
Epoch 5/10
1766/1766 [==============================] - 127s 72ms/step - loss: 0.4449 -
acc: 0.7741 - val_loss: 0.4225 - val_acc: 0.8063
Epoch 6/10
1766/1766 [==============================] - 125s 71ms/step - loss: 0.4358 -
acc: 0.7797 - val_loss: 0.4554 - val_acc: 0.7841
Epoch 7/10
1766/1766 [==============================] - 129s 73ms/step - loss: 0.4149 -
acc: 0.7786 - val_loss: 0.5557 - val_acc: 0.8063
Epoch 8/10
1766/1766 [==============================] - 129s 73ms/step - loss: 0.4257 -
acc: 0.7860 - val_loss: 0.4094 - val_acc: 0.8032
Epoch 9/10
1766/1766 [==============================] - 129s 73ms/step - loss: 0.4020 -
acc: 0.7950 - val_loss: 0.4074 - val_acc: 0.8190
Epoch 10/10
1766/1766 [==============================] - 124s 70ms/step - loss: 0.3704 -
acc: 0.8035 - val_loss: 0.4622 - val_acc: 0.7651
```



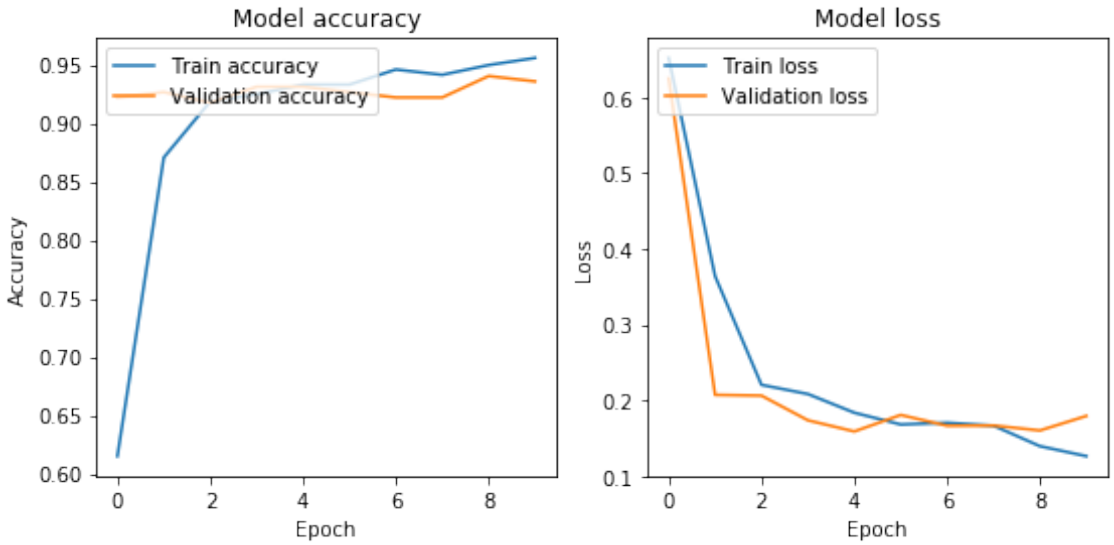

```
304/304 [==============================] - 3s 9ms/step
Test loss: 0.5573157260292455
Test accuracy: 66.45%
[0.5319122]
--------------------------------------------------
clarinet
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.46      0.63      1369
        True       0.35      1.00      0.52       397

    accuracy                           0.58      1766
   macro avg       0.67      0.73      0.58      1766
weighted avg       0.85      0.58      0.61      1766

False
[0.0020178]
        TEST
              precision    recall  f1-score   support

       False       0.94      0.39      0.55       229
        True       0.33      0.92      0.49        75

    accuracy                           0.52       304
   macro avg       0.63      0.66      0.52       304
weighted avg       0.79      0.52      0.54       304

(1282, 10, 128)
```

```
(1282, 1, 10, 128)
False
Train on 1282 samples, validate on 229 samples
Epoch 1/10
1282/1282 [==============================] - 94s 74ms/step - loss: 0.6474 - acc:
0.6225 - val_loss: 0.4931 - val_acc: 0.6681
Epoch 2/10
1282/1282 [==============================] - 93s 72ms/step - loss: 0.3621 - acc:
0.8651 - val_loss: 0.2525 - val_acc: 0.9258
Epoch 3/10
1282/1282 [==============================] - 94s 73ms/step - loss: 0.2636 - acc:
0.9041 - val_loss: 0.2496 - val_acc: 0.9170
Epoch 4/10
1282/1282 [==============================] - 93s 73ms/step - loss: 0.2479 - acc:
0.9197 - val_loss: 0.2684 - val_acc: 0.9214
Epoch 5/10
1282/1282 [==============================] - 91s 71ms/step - loss: 0.2210 - acc:
0.9189 - val_loss: 0.2358 - val_acc: 0.9301
Epoch 6/10
1282/1282 [==============================] - 90s 70ms/step - loss: 0.2337 - acc:
0.9134 - val_loss: 0.2504 - val_acc: 0.9214
Epoch 7/10
1282/1282 [==============================] - 90s 70ms/step - loss: 0.2098 - acc:
0.9189 - val_loss: 0.2820 - val_acc: 0.9258
Epoch 8/10
1282/1282 [==============================] - 90s 70ms/step - loss: 0.1940 - acc:
0.9290 - val_loss: 0.3176 - val_acc: 0.9083
Epoch 9/10
1282/1282 [==============================] - 94s 73ms/step - loss: 0.1861 - acc:
0.9360 - val_loss: 0.2386 - val_acc: 0.9214
Epoch 10/10
1282/1282 [==============================] - 93s 72ms/step - loss: 0.1828 - acc:
0.9399 - val_loss: 0.2496 - val_acc: 0.9214
```



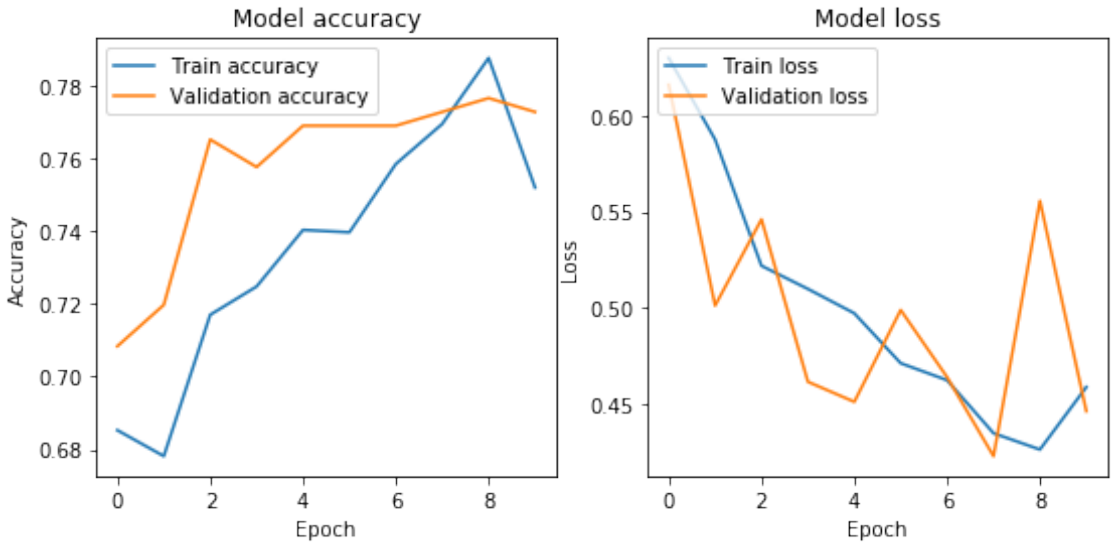

```
224/224 [==============================] - 2s 10ms/step
Test loss: 0.2819361814430782
Test accuracy: 91.52%
[0.00207818]
--------------------------------------------------
cymbals
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.84      0.91       469
        True       0.92      1.00      0.96       813

    accuracy                           0.94      1282
   macro avg       0.96      0.92      0.93      1282
weighted avg       0.95      0.94      0.94      1282

True
[0.95123166]
        TEST
              precision    recall  f1-score   support

       False       0.96      0.72      0.82        75
        True       0.88      0.99      0.93       149

    accuracy                           0.90       224
   macro avg       0.92      0.85      0.88       224
weighted avg       0.90      0.90      0.89       224

(1314, 10, 128)
```

```
(1314, 1, 10, 128)
False
Train on 1314 samples, validate on 218 samples
Epoch 1/10
1314/1314 [==============================] - 98s 74ms/step - loss: 0.6521 - acc:
0.6149 - val_loss: 0.6250 - val_acc: 0.9220
Epoch 2/10
1314/1314 [==============================] - 94s 71ms/step - loss: 0.3639 - acc:
0.8706 - val_loss: 0.2071 - val_acc: 0.9266
Epoch 3/10
1314/1314 [==============================] - 93s 71ms/step - loss: 0.2203 - acc:
0.9186 - val_loss: 0.2061 - val_acc: 0.9174
Epoch 4/10
1314/1314 [==============================] - 93s 71ms/step - loss: 0.2082 - acc:
0.9247 - val_loss: 0.1735 - val_acc: 0.9312
Epoch 5/10
1314/1314 [==============================] - 95s 72ms/step - loss: 0.1835 - acc:
0.9330 - val_loss: 0.1588 - val_acc: 0.9312
Epoch 6/10
1314/1314 [==============================] - 97s 74ms/step - loss: 0.1680 - acc:
0.9330 - val_loss: 0.1805 - val_acc: 0.9266
Epoch 7/10
1314/1314 [==============================] - 96s 73ms/step - loss: 0.1702 - acc:
0.9460 - val_loss: 0.1663 - val_acc: 0.9220
Epoch 8/10
1314/1314 [==============================] - 96s 73ms/step - loss: 0.1664 - acc:
0.9414 - val_loss: 0.1665 - val_acc: 0.9220
Epoch 9/10
1314/1314 [==============================] - 93s 71ms/step - loss: 0.1393 - acc:
0.9498 - val_loss: 0.1601 - val_acc: 0.9404
Epoch 10/10
1314/1314 [==============================] - 92s 70ms/step - loss: 0.1262 - acc:
0.9559 - val_loss: 0.1792 - val_acc: 0.9358
```



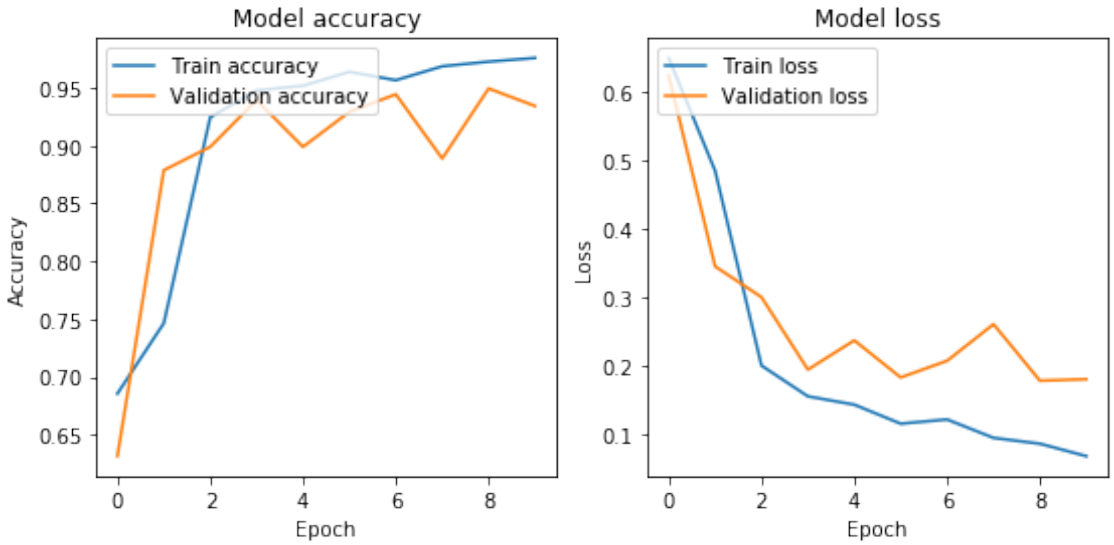

```
215/215 [==============================] - 2s 9ms/step
Test loss: 0.20257972887782164
Test accuracy: 93.95%
[0.0016264]
--------------------------------------------------
drums
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.92      0.96       485
        True       0.96      1.00      0.98       829

    accuracy                           0.97      1314
   macro avg       0.98      0.96      0.97      1314
weighted avg       0.97      0.97      0.97      1314

False
[0.47499835]
        TEST
              precision    recall  f1-score   support

       False       0.96      0.86      0.91        81
        True       0.92      0.98      0.95       134

    accuracy                           0.93       215
   macro avg       0.94      0.92      0.93       215
weighted avg       0.94      0.93      0.93       215

(1544, 10, 128)
```

```
(1544, 1, 10, 128)
True
Train on 1544 samples, validate on 264 samples
Epoch 1/10
1544/1544 [==============================] - 118s 77ms/step - loss: 0.6297 -
acc: 0.6852 - val_loss: 0.6158 - val_acc: 0.7083
Epoch 2/10
1544/1544 [==============================] - 109s 71ms/step - loss: 0.5874 -
acc: 0.6781 - val_loss: 0.5013 - val_acc: 0.7197
Epoch 3/10
1544/1544 [==============================] - 113s 73ms/step - loss: 0.5219 -
acc: 0.7170 - val_loss: 0.5460 - val_acc: 0.7652
Epoch 4/10
1544/1544 [==============================] - 110s 71ms/step - loss: 0.5099 -
acc: 0.7247 - val_loss: 0.4618 - val_acc: 0.7576
Epoch 5/10
1544/1544 [==============================] - 109s 71ms/step - loss: 0.4973 -
acc: 0.7403 - val_loss: 0.4514 - val_acc: 0.7689
Epoch 6/10
1544/1544 [==============================] - 110s 71ms/step - loss: 0.4714 -
acc: 0.7396 - val_loss: 0.4990 - val_acc: 0.7689
Epoch 7/10
1544/1544 [==============================] - 110s 71ms/step - loss: 0.4626 -
acc: 0.7584 - val_loss: 0.4642 - val_acc: 0.7689
Epoch 8/10
1544/1544 [==============================] - 109s 70ms/step - loss: 0.4351 -
acc: 0.7694 - val_loss: 0.4232 - val_acc: 0.7727
Epoch 9/10
1544/1544 [==============================] - 113s 73ms/step - loss: 0.4266 -
acc: 0.7876 - val_loss: 0.5556 - val_acc: 0.7765
Epoch 10/10
1544/1544 [==============================] - 110s 71ms/step - loss: 0.4590 -
acc: 0.7519 - val_loss: 0.4465 - val_acc: 0.7727
```



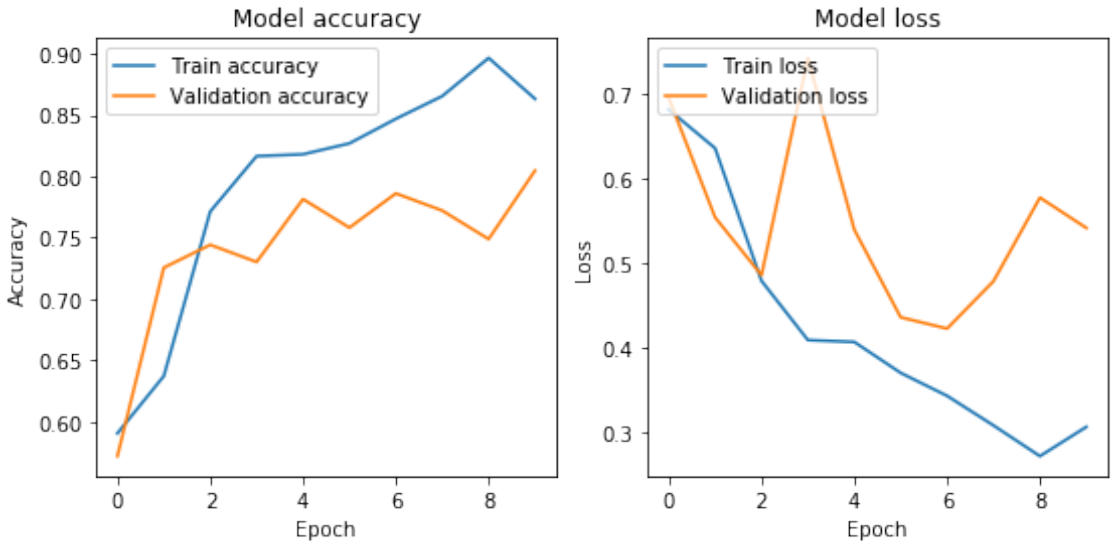

```
276/276 [==============================] - 3s 9ms/step
Test loss: 0.6236255212106566
Test accuracy: 70.29%
[0.65752745]
--------------------------------------------------
flute
        TRAIN
              precision    recall  f1-score   support

       False       0.97      0.69      0.80      1073
        True       0.57      0.95      0.71       471

    accuracy                           0.77      1544
   macro avg       0.77      0.82      0.76      1544
weighted avg       0.85      0.77      0.78      1544

True
[0.74695337]
        TEST
              precision    recall  f1-score   support

       False       0.84      0.58      0.69       177
        True       0.52      0.81      0.63        99

    accuracy                           0.66       276
   macro avg       0.68      0.70      0.66       276
weighted avg       0.73      0.66      0.67       276

(1246, 10, 128)
```

```
(1246, 1, 10, 128)
True
Train on 1246 samples, validate on 198 samples
Epoch 1/10
1246/1246 [==============================] - 96s 77ms/step - loss: 0.6507 - acc:
0.6854 - val_loss: 0.6250 - val_acc: 0.6313
Epoch 2/10
1246/1246 [==============================] - 91s 73ms/step - loss: 0.4856 - acc:
0.7464 - val_loss: 0.3456 - val_acc: 0.8788
Epoch 3/10
1246/1246 [==============================] - 88s 71ms/step - loss: 0.2004 - acc:
0.9246 - val_loss: 0.3005 - val_acc: 0.8990
Epoch 4/10
1246/1246 [==============================] - 90s 73ms/step - loss: 0.1554 - acc:
0.9478 - val_loss: 0.1945 - val_acc: 0.9394
Epoch 5/10
1246/1246 [==============================] - 89s 72ms/step - loss: 0.1432 - acc:
0.9518 - val_loss: 0.2373 - val_acc: 0.8990
Epoch 6/10
1246/1246 [==============================] - 88s 70ms/step - loss: 0.1154 - acc:
0.9639 - val_loss: 0.1830 - val_acc: 0.9293
Epoch 7/10
1246/1246 [==============================] - 87s 70ms/step - loss: 0.1215 - acc:
0.9567 - val_loss: 0.2074 - val_acc: 0.9444
Epoch 8/10
1246/1246 [==============================] - 88s 71ms/step - loss: 0.0946 - acc:
0.9687 - val_loss: 0.2610 - val_acc: 0.8889
Epoch 9/10
1246/1246 [==============================] - 87s 70ms/step - loss: 0.0860 - acc:
0.9727 - val_loss: 0.1783 - val_acc: 0.9495
Epoch 10/10
1246/1246 [==============================] - 87s 70ms/step - loss: 0.0679 - acc:
0.9759 - val_loss: 0.1805 - val_acc: 0.9343
```



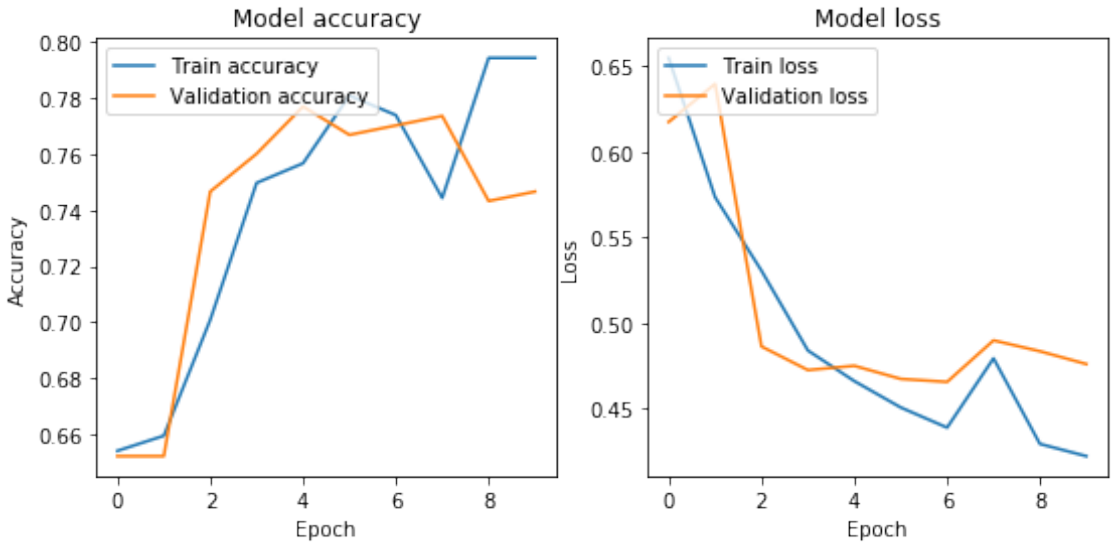

```
206/206 [==============================] - 2s 9ms/step
Test loss: 0.1476010004673334
Test accuracy: 96.60%
[0.9957912]
--------------------------------------------------
guitar
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.95      0.97       376
        True       0.98      1.00      0.99       870

    accuracy                           0.98      1246
   macro avg       0.99      0.97      0.98      1246
weighted avg       0.99      0.98      0.98      1246

True
[0.9896692]
        TEST
              precision    recall  f1-score   support

       False       0.91      0.95      0.93        63
        True       0.98      0.96      0.97       143

    accuracy                           0.96       206
   macro avg       0.94      0.96      0.95       206
weighted avg       0.96      0.96      0.96       206

(1351, 10, 128)
```

```
(1351, 1, 10, 128)
True
Train on 1351 samples, validate on 215 samples
Epoch 1/10
1351/1351 [==============================] - 106s 79ms/step - loss: 0.6811 -
acc: 0.5907 - val_loss: 0.6950 - val_acc: 0.5721
Epoch 2/10
1351/1351 [==============================] - 97s 71ms/step - loss: 0.6354 - acc:
0.6373 - val_loss: 0.5536 - val_acc: 0.7256
Epoch 3/10
1351/1351 [==============================] - 96s 71ms/step - loss: 0.4786 - acc:
0.7713 - val_loss: 0.4852 - val_acc: 0.7442
Epoch 4/10
1351/1351 [==============================] - 96s 71ms/step - loss: 0.4085 - acc:
0.8164 - val_loss: 0.7421 - val_acc: 0.7302
Epoch 5/10
1351/1351 [==============================] - 95s 70ms/step - loss: 0.4063 - acc:
0.8179 - val_loss: 0.5391 - val_acc: 0.7814
Epoch 6/10
1351/1351 [==============================] - 96s 71ms/step - loss: 0.3697 - acc:
0.8268 - val_loss: 0.4354 - val_acc: 0.7581
Epoch 7/10
1351/1351 [==============================] - 95s 70ms/step - loss: 0.3426 - acc:
0.8468 - val_loss: 0.4221 - val_acc: 0.7860
Epoch 8/10
1351/1351 [==============================] - 95s 70ms/step - loss: 0.3076 - acc:
0.8653 - val_loss: 0.4782 - val_acc: 0.7721
Epoch 9/10
1351/1351 [==============================] - 99s 74ms/step - loss: 0.2713 - acc:
0.8964 - val_loss: 0.5770 - val_acc: 0.7488
Epoch 10/10
1351/1351 [==============================] - 97s 72ms/step - loss: 0.3059 - acc:
0.8631 - val_loss: 0.5411 - val_acc: 0.8047
```



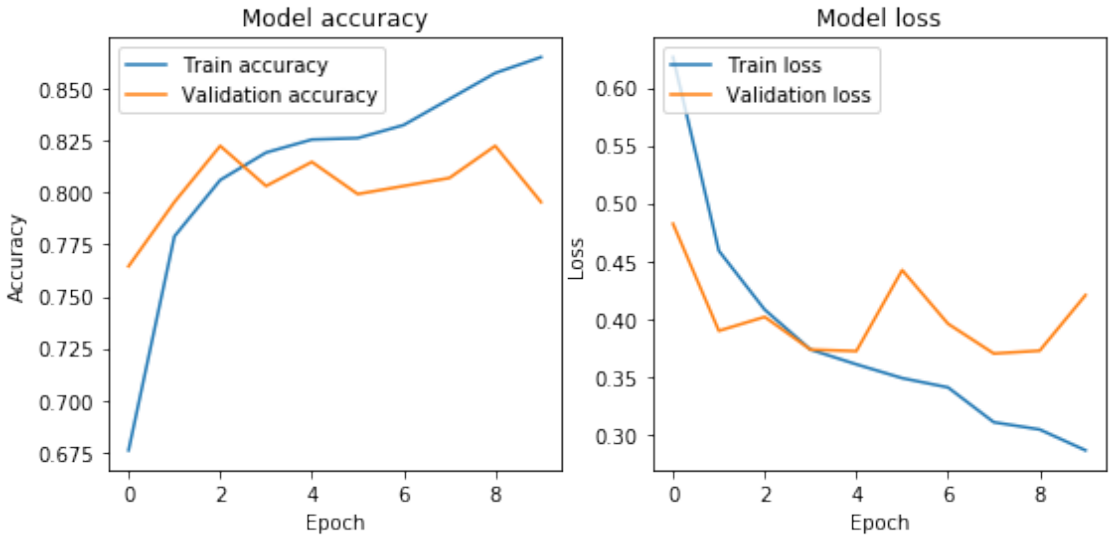

```
236/236 [==============================] - 2s 10ms/step
Test loss: 0.5606073989706525
Test accuracy: 78.39%
[0.9939307]
--------------------------------------------------
mallet_percussion
        TRAIN
              precision    recall  f1-score   support

       False       0.99      0.90      0.94       798
        True       0.87      0.99      0.93       553

    accuracy                           0.94      1351
   macro avg       0.93      0.94      0.94      1351
weighted avg       0.94      0.94      0.94      1351

False
[0.00234887]
        TEST
              precision    recall  f1-score   support

       False       0.88      0.78      0.83       148
        True       0.69      0.82      0.75        88

    accuracy                           0.80       236
   macro avg       0.79      0.80      0.79       236
weighted avg       0.81      0.80      0.80       236

(1858, 10, 128)
```

```
(1858, 1, 10, 128)
True
Train on 1858 samples, validate on 296 samples
Epoch 1/10
1858/1858 [==============================] - 137s 74ms/step - loss: 0.6545 -
acc: 0.6539 - val_loss: 0.6172 - val_acc: 0.6520
Epoch 2/10
1858/1858 [==============================] - 131s 71ms/step - loss: 0.5734 -
acc: 0.6593 - val_loss: 0.6394 - val_acc: 0.6520
Epoch 3/10
1858/1858 [==============================] - 133s 72ms/step - loss: 0.5305 -
acc: 0.7008 - val_loss: 0.4863 - val_acc: 0.7466
Epoch 4/10
1858/1858 [==============================] - 134s 72ms/step - loss: 0.4840 -
acc: 0.7497 - val_loss: 0.4726 - val_acc: 0.7601
Epoch 5/10
1858/1858 [==============================] - 130s 70ms/step - loss: 0.4662 -
acc: 0.7567 - val_loss: 0.4751 - val_acc: 0.7770
Epoch 6/10
1858/1858 [==============================] - 131s 70ms/step - loss: 0.4508 -
acc: 0.7809 - val_loss: 0.4674 - val_acc: 0.7669
Epoch 7/10
1858/1858 [==============================] - 131s 71ms/step - loss: 0.4390 -
acc: 0.7740 - val_loss: 0.4657 - val_acc: 0.7703
Epoch 8/10
1858/1858 [==============================] - 134s 72ms/step - loss: 0.4794 -
acc: 0.7443 - val_loss: 0.4899 - val_acc: 0.7736
Epoch 9/10
1858/1858 [==============================] - 132s 71ms/step - loss: 0.4295 -
acc: 0.7944 - val_loss: 0.4836 - val_acc: 0.7432
Epoch 10/10
1858/1858 [==============================] - 130s 70ms/step - loss: 0.4224 -
acc: 0.7944 - val_loss: 0.4761 - val_acc: 0.7466
```



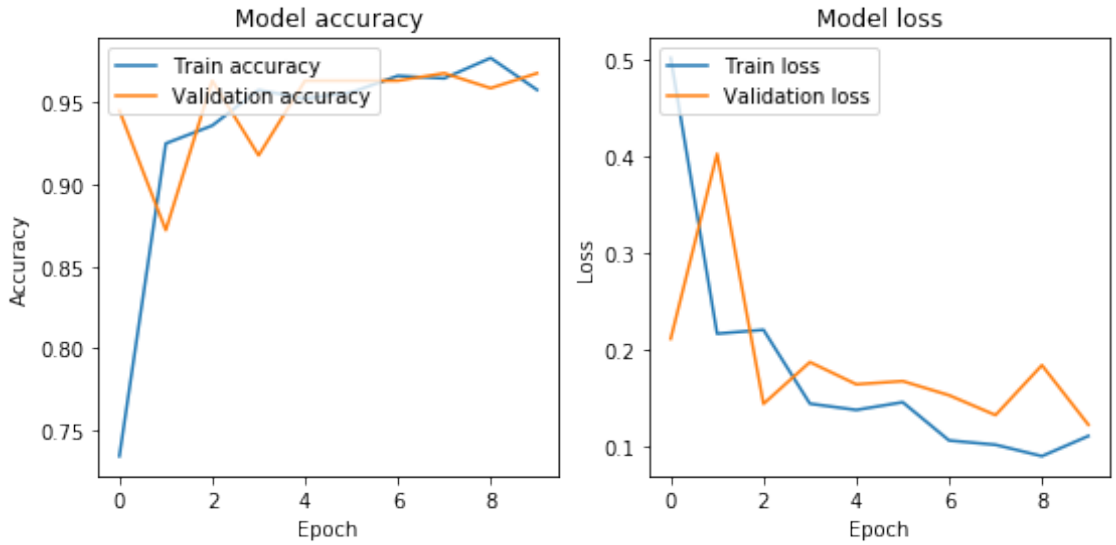

```
310/310 [==============================] - 3s 9ms/step
Test loss: 0.47123505319318465
Test accuracy: 77.10%
[0.56316614]
--------------------------------------------------
mandolin
        TRAIN
              precision    recall  f1-score   support

       False       0.99      0.57      0.72      1215
        True       0.55      0.99      0.71       643

    accuracy                           0.71      1858
   macro avg       0.77      0.78      0.71      1858
weighted avg       0.84      0.71      0.72      1858

True
[0.5705857]
        TEST
              precision    recall  f1-score   support

       False       0.96      0.49      0.65       211
        True       0.47      0.96      0.63        99

    accuracy                           0.64       310
   macro avg       0.72      0.73      0.64       310
weighted avg       0.81      0.64      0.65       310

(1438, 10, 128)
```

```
(1438, 1, 10, 128)
True
Train on 1438 samples, validate on 259 samples
Epoch 1/10
1438/1438 [==============================] - 108s 75ms/step - loss: 0.6263 -
acc: 0.6759 - val_loss: 0.4821 - val_acc: 0.7645
Epoch 2/10
1438/1438 [==============================] - 103s 72ms/step - loss: 0.4587 -
acc: 0.7789 - val_loss: 0.3895 - val_acc: 0.7954
Epoch 3/10
1438/1438 [==============================] - 104s 73ms/step - loss: 0.4078 -
acc: 0.8060 - val_loss: 0.4015 - val_acc: 0.8224
Epoch 4/10
1438/1438 [==============================] - 102s 71ms/step - loss: 0.3733 -
acc: 0.8192 - val_loss: 0.3732 - val_acc: 0.8031
Epoch 5/10
1438/1438 [==============================] - 101s 70ms/step - loss: 0.3605 -
acc: 0.8255 - val_loss: 0.3720 - val_acc: 0.8147
Epoch 6/10
1438/1438 [==============================] - 103s 72ms/step - loss: 0.3486 -
acc: 0.8261 - val_loss: 0.4420 - val_acc: 0.7992
Epoch 7/10
1438/1438 [==============================] - 103s 71ms/step - loss: 0.3406 -
acc: 0.8324 - val_loss: 0.3956 - val_acc: 0.8031
Epoch 8/10
1438/1438 [==============================] - 102s 71ms/step - loss: 0.3104 -
acc: 0.8449 - val_loss: 0.3698 - val_acc: 0.8069
Epoch 9/10
1438/1438 [==============================] - 104s 72ms/step - loss: 0.3042 -
acc: 0.8574 - val_loss: 0.3723 - val_acc: 0.8224
Epoch 10/10
1438/1438 [==============================] - 103s 72ms/step - loss: 0.2861 -
acc: 0.8651 - val_loss: 0.4204 - val_acc: 0.7954
```



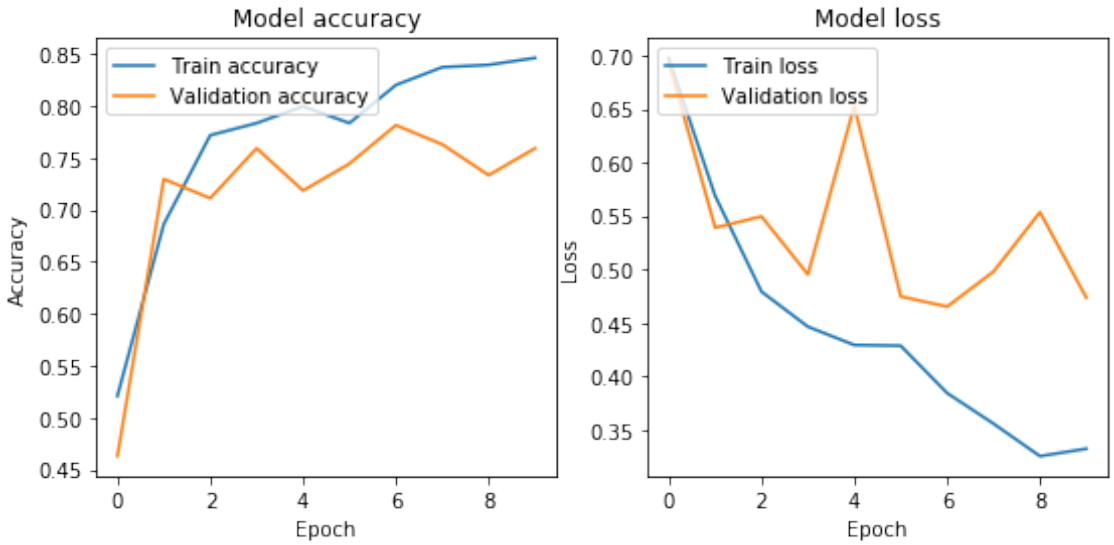

```
193/193 [==============================] - 2s 10ms/step
Test loss: 0.4051659104892009
Test accuracy: 80.83%
[0.7450688]
--------------------------------------------------
organ
        TRAIN
              precision    recall  f1-score   support

       False       0.99      0.86      0.92       972
        True       0.77      0.98      0.86       466

    accuracy                           0.90      1438
   macro avg       0.88      0.92      0.89      1438
weighted avg       0.92      0.90      0.90      1438

True
[0.9714943]
        TEST
              precision    recall  f1-score   support

       False       0.89      0.83      0.86       138
        True       0.63      0.75      0.68        55

    accuracy                           0.80       193
   macro avg       0.76      0.79      0.77       193
weighted avg       0.82      0.80      0.81       193

(1282, 10, 128)
```

```
(1282, 1, 10, 128)
False
Train on 1282 samples, validate on 219 samples
Epoch 1/10
1282/1282 [==============================] - 100s 78ms/step - loss: 0.5013 -
acc: 0.7340 - val_loss: 0.2113 - val_acc: 0.9452
Epoch 2/10
1282/1282 [==============================] - 93s 73ms/step - loss: 0.2166 - acc:
0.9251 - val_loss: 0.4023 - val_acc: 0.8721
Epoch 3/10
1282/1282 [==============================] - 93s 73ms/step - loss: 0.2206 - acc:
0.9360 - val_loss: 0.1442 - val_acc: 0.9635
Epoch 4/10
1282/1282 [==============================] - 94s 73ms/step - loss: 0.1443 - acc:
0.9579 - val_loss: 0.1873 - val_acc: 0.9178
Epoch 5/10
1282/1282 [==============================] - 95s 74ms/step - loss: 0.1379 - acc:
0.9524 - val_loss: 0.1644 - val_acc: 0.9635
Epoch 6/10
1282/1282 [==============================] - 93s 73ms/step - loss: 0.1459 - acc:
0.9563 - val_loss: 0.1676 - val_acc: 0.9635
Epoch 7/10
1282/1282 [==============================] - 92s 72ms/step - loss: 0.1064 - acc:
0.9665 - val_loss: 0.1530 - val_acc: 0.9635
Epoch 8/10
1282/1282 [==============================] - 93s 72ms/step - loss: 0.1019 - acc:
0.9649 - val_loss: 0.1326 - val_acc: 0.9680
Epoch 9/10
1282/1282 [==============================] - 92s 72ms/step - loss: 0.0902 - acc:
0.9774 - val_loss: 0.1841 - val_acc: 0.9589
Epoch 10/10
1282/1282 [==============================] - 93s 73ms/step - loss: 0.1110 - acc:
0.9579 - val_loss: 0.1227 - val_acc: 0.9680
```



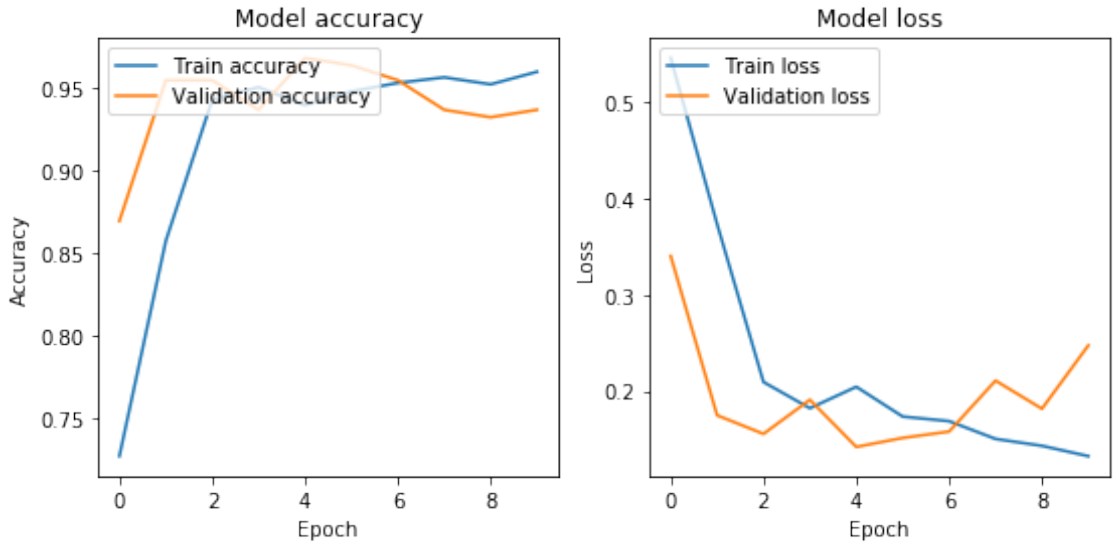

```
219/219 [==============================] - 2s 9ms/step
Test loss: 0.16597979757339443
Test accuracy: 94.52%
[0.0208216]
--------------------------------------------------
piano
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.87      0.93       402
        True       0.94      1.00      0.97       880

    accuracy                           0.96      1282
   macro avg       0.97      0.94      0.95      1282
weighted avg       0.96      0.96      0.96      1282

True
[0.9986913]
        TEST
              precision    recall  f1-score   support

       False       0.98      0.79      0.88        73
        True       0.91      0.99      0.95       146

    accuracy                           0.93       219
   macro avg       0.94      0.89      0.91       219
weighted avg       0.93      0.93      0.92       219

(1801, 10, 128)
```

```
(1801, 1, 10, 128)
False
Train on 1801 samples, validate on 270 samples
Epoch 1/10
1801/1801 [==============================] - 137s 76ms/step - loss: 0.6976 -
acc: 0.5208 - val_loss: 0.6941 - val_acc: 0.4630
Epoch 2/10
1801/1801 [==============================] - 129s 71ms/step - loss: 0.5688 -
acc: 0.6863 - val_loss: 0.5390 - val_acc: 0.7296
Epoch 3/10
1801/1801 [==============================] - 127s 71ms/step - loss: 0.4792 -
acc: 0.7718 - val_loss: 0.5494 - val_acc: 0.7111
Epoch 4/10
1801/1801 [==============================] - 127s 70ms/step - loss: 0.4464 -
acc: 0.7835 - val_loss: 0.4951 - val_acc: 0.7593
Epoch 5/10
1801/1801 [==============================] - 129s 72ms/step - loss: 0.4293 -
acc: 0.7996 - val_loss: 0.6528 - val_acc: 0.7185
Epoch 6/10
1801/1801 [==============================] - 131s 73ms/step - loss: 0.4286 -
acc: 0.7835 - val_loss: 0.4746 - val_acc: 0.7444
Epoch 7/10
1801/1801 [==============================] - 126s 70ms/step - loss: 0.3844 -
acc: 0.8201 - val_loss: 0.4651 - val_acc: 0.7815
Epoch 8/10
1801/1801 [==============================] - 129s 71ms/step - loss: 0.3558 -
acc: 0.8373 - val_loss: 0.4979 - val_acc: 0.7630
Epoch 9/10
1801/1801 [==============================] - 127s 71ms/step - loss: 0.3254 -
acc: 0.8395 - val_loss: 0.5534 - val_acc: 0.7333
Epoch 10/10
1801/1801 [==============================] - 128s 71ms/step - loss: 0.3323 -
acc: 0.8462 - val_loss: 0.4734 - val_acc: 0.7593
```



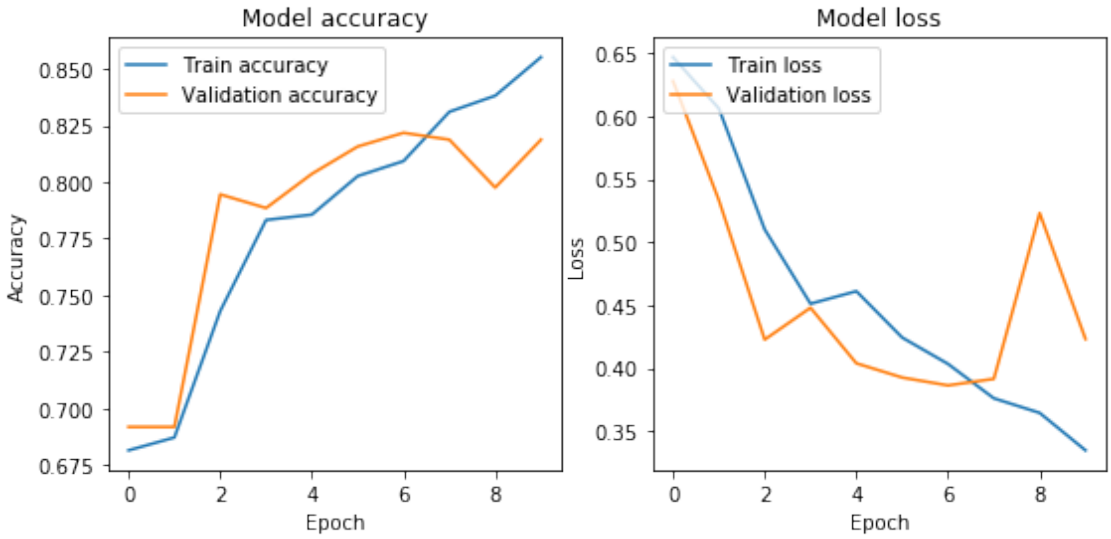

```
294/294 [==============================] - 3s 10ms/step
Test loss: 0.4525670425421527
Test accuracy: 76.87%
[0.00114265]
--------------------------------------------------
saxophone
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.54      0.70       927
        True       0.67      1.00      0.80       874

    accuracy                           0.76      1801
   macro avg       0.83      0.77      0.75      1801
weighted avg       0.84      0.76      0.75      1801

True
[0.54964817]
        TEST
              precision    recall  f1-score   support

       False       0.97      0.44      0.60       158
        True       0.60      0.99      0.75       136

    accuracy                           0.69       294
   macro avg       0.79      0.71      0.67       294
weighted avg       0.80      0.69      0.67       294

(1177, 10, 128)
```

```
(1177, 1, 10, 128)
True
Train on 1177 samples, validate on 222 samples
Epoch 1/10
1177/1177 [==============================] - 90s 77ms/step - loss: 0.5461 - acc:
0.7264 - val_loss: 0.3404 - val_acc: 0.8694
Epoch 2/10
1177/1177 [==============================] - 84s 71ms/step - loss: 0.3736 - acc:
0.8573 - val_loss: 0.1749 - val_acc: 0.9550
Epoch 3/10
1177/1177 [==============================] - 83s 71ms/step - loss: 0.2094 - acc:
0.9431 - val_loss: 0.1556 - val_acc: 0.9550
Epoch 4/10
1177/1177 [==============================] - 83s 71ms/step - loss: 0.1822 - acc:
0.9507 - val_loss: 0.1910 - val_acc: 0.9369
Epoch 5/10
1177/1177 [==============================] - 84s 71ms/step - loss: 0.2045 - acc:
0.9397 - val_loss: 0.1420 - val_acc: 0.9685
Epoch 6/10
1177/1177 [==============================] - 85s 72ms/step - loss: 0.1736 - acc:
0.9482 - val_loss: 0.1514 - val_acc: 0.9640
Epoch 7/10
1177/1177 [==============================] - 85s 72ms/step - loss: 0.1688 - acc:
0.9533 - val_loss: 0.1580 - val_acc: 0.9550
Epoch 8/10
1177/1177 [==============================] - 86s 73ms/step - loss: 0.1504 - acc:
0.9567 - val_loss: 0.2109 - val_acc: 0.9369
Epoch 9/10
1177/1177 [==============================] - 84s 71ms/step - loss: 0.1432 - acc:
0.9524 - val_loss: 0.1817 - val_acc: 0.9324
Epoch 10/10
1177/1177 [==============================] - 86s 73ms/step - loss: 0.1325 - acc:
0.9601 - val_loss: 0.2475 - val_acc: 0.9369
```



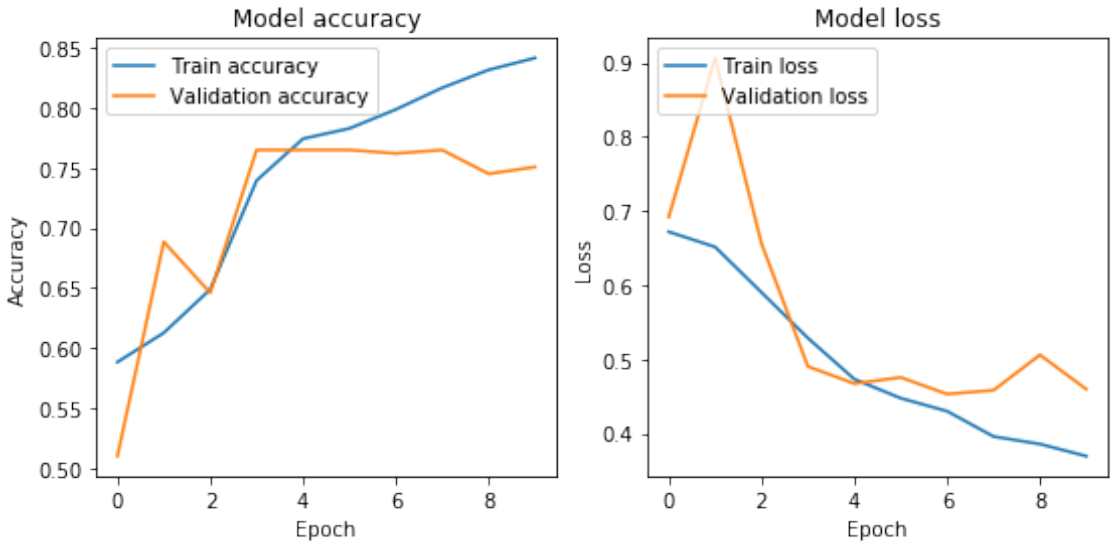

```
203/203 [==============================] - 2s 10ms/step
Test loss: 0.24100707397965962
Test accuracy: 92.61%
[0.9997945]
--------------------------------------------------
synthesizer
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.80      0.89       370
        True       0.91      1.00      0.95       807

    accuracy                           0.94      1177
   macro avg       0.96      0.90      0.92      1177
weighted avg       0.94      0.94      0.93      1177

True
[0.9982294]
        TEST
              precision    recall  f1-score   support

       False       0.97      0.77      0.86        75
        True       0.88      0.98      0.93       128

    accuracy                           0.91       203
   macro avg       0.92      0.88      0.89       203
weighted avg       0.91      0.91      0.90       203

(2113, 10, 128)
```

```
(2113, 1, 10, 128)
False
Train on 2113 samples, validate on 331 samples
Epoch 1/10
2113/2113 [==============================] - 161s 76ms/step - loss: 0.6467 -
acc: 0.6815 - val_loss: 0.6277 - val_acc: 0.6918
Epoch 2/10
2113/2113 [==============================] - 152s 72ms/step - loss: 0.6059 -
acc: 0.6872 - val_loss: 0.5333 - val_acc: 0.6918
Epoch 3/10
2113/2113 [==============================] - 151s 72ms/step - loss: 0.5101 -
acc: 0.7430 - val_loss: 0.4226 - val_acc: 0.7946
Epoch 4/10
2113/2113 [==============================] - 149s 71ms/step - loss: 0.4511 -
acc: 0.7832 - val_loss: 0.4479 - val_acc: 0.7885
Epoch 5/10
2113/2113 [==============================] - 150s 71ms/step - loss: 0.4610 -
acc: 0.7856 - val_loss: 0.4039 - val_acc: 0.8036
Epoch 6/10
2113/2113 [==============================] - 151s 72ms/step - loss: 0.4243 -
acc: 0.8027 - val_loss: 0.3925 - val_acc: 0.8157
Epoch 7/10
2113/2113 [==============================] - 152s 72ms/step - loss: 0.4033 -
acc: 0.8093 - val_loss: 0.3863 - val_acc: 0.8218
Epoch 8/10
2113/2113 [==============================] - 149s 71ms/step - loss: 0.3761 -
acc: 0.8310 - val_loss: 0.3915 - val_acc: 0.8187
Epoch 9/10
2113/2113 [==============================] - 151s 71ms/step - loss: 0.3645 -
acc: 0.8381 - val_loss: 0.5230 - val_acc: 0.7976
Epoch 10/10
2113/2113 [==============================] - 152s 72ms/step - loss: 0.3348 -
acc: 0.8552 - val_loss: 0.4231 - val_acc: 0.8187
```



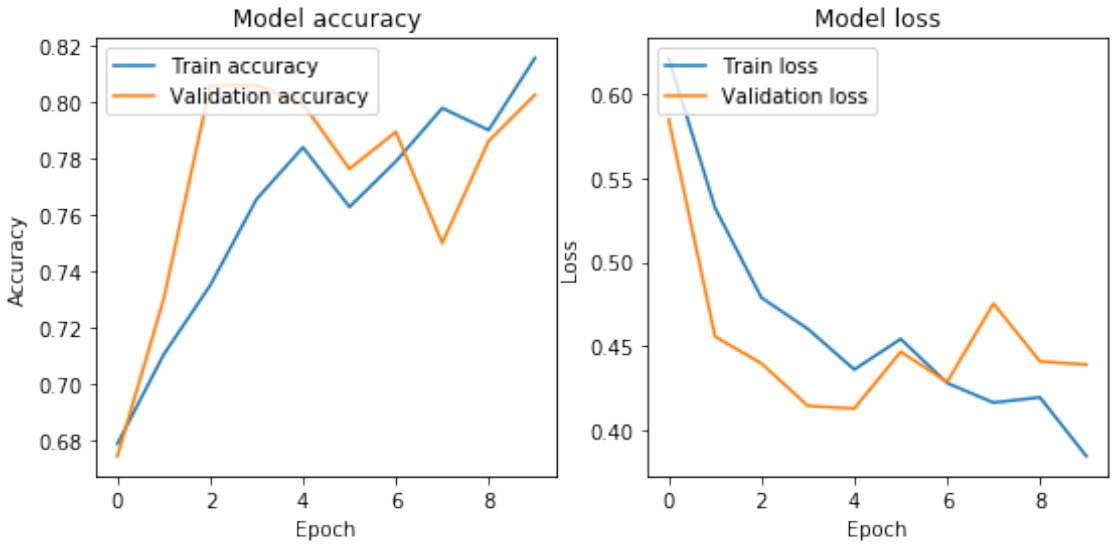

```
316/316 [==============================] - 3s 10ms/step
Test loss: 0.4415015563180175
Test accuracy: 82.59%
[0.00079224]
--------------------------------------------------
trombone
        TRAIN
              precision    recall  f1-score   support

       False       0.99      0.82      0.89      1452
        True       0.71      0.98      0.82       661

    accuracy                           0.87      2113
   macro avg       0.85      0.90      0.86      2113
weighted avg       0.90      0.87      0.87      2113

False
[0.03959638]
        TEST
              precision    recall  f1-score   support

       False       0.94      0.72      0.82       216
        True       0.60      0.90      0.72       100

    accuracy                           0.78       316
   macro avg       0.77      0.81      0.77       316
weighted avg       0.83      0.78      0.79       316

(2215, 10, 128)
```

```
(2215, 1, 10, 128)
False
Train on 2215 samples, validate on 353 samples
Epoch 1/10
2215/2215 [==============================] - 166s 75ms/step - loss: 0.6718 -
acc: 0.5883 - val_loss: 0.6917 - val_acc: 0.5099
Epoch 2/10
2215/2215 [==============================] - 158s 71ms/step - loss: 0.6514 -
acc: 0.6126 - val_loss: 0.9064 - val_acc: 0.6884
Epoch 3/10
2215/2215 [==============================] - 160s 72ms/step - loss: 0.5900 -
acc: 0.6488 - val_loss: 0.6558 - val_acc: 0.6459
Epoch 4/10
2215/2215 [==============================] - 158s 71ms/step - loss: 0.5284 -
acc: 0.7395 - val_loss: 0.4900 - val_acc: 0.7649
Epoch 5/10
2215/2215 [==============================] - 160s 72ms/step - loss: 0.4729 -
acc: 0.7743 - val_loss: 0.4669 - val_acc: 0.7649
Epoch 6/10
2215/2215 [==============================] - 156s 71ms/step - loss: 0.4472 -
acc: 0.7828 - val_loss: 0.4753 - val_acc: 0.7649
Epoch 7/10
2215/2215 [==============================] - 158s 72ms/step - loss: 0.4296 -
acc: 0.7986 - val_loss: 0.4528 - val_acc: 0.7620
Epoch 8/10
2215/2215 [==============================] - 161s 73ms/step - loss: 0.3955 -
acc: 0.8167 - val_loss: 0.4579 - val_acc: 0.7649
Epoch 9/10
2215/2215 [==============================] - 158s 71ms/step - loss: 0.3853 -
acc: 0.8316 - val_loss: 0.5056 - val_acc: 0.7450
Epoch 10/10
2215/2215 [==============================] - 158s 71ms/step - loss: 0.3690 -
acc: 0.8415 - val_loss: 0.4593 - val_acc: 0.7507
```



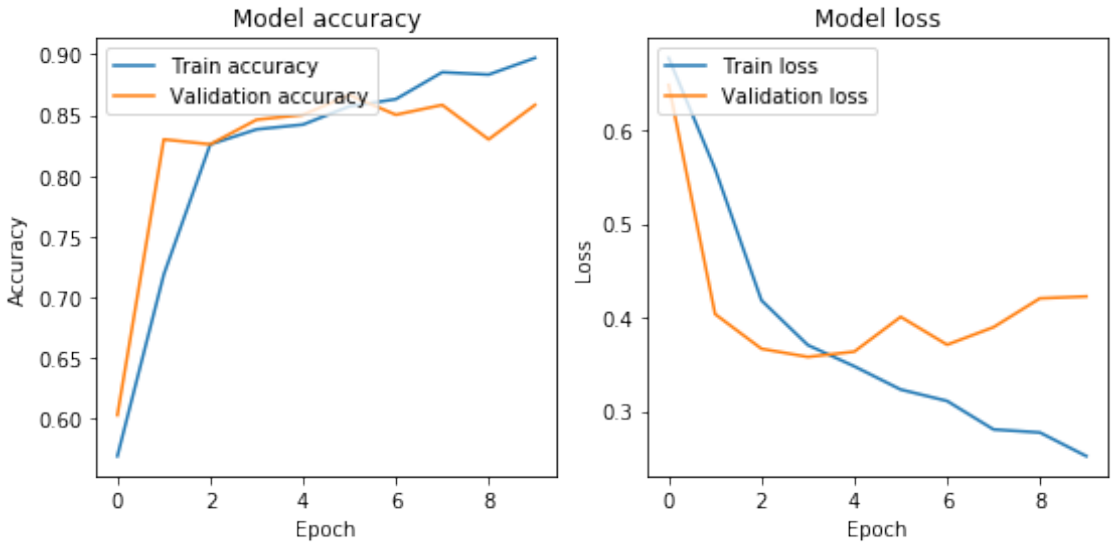

```
348/348 [==============================] - 3s 9ms/step
Test loss: 0.4435253341992696
Test accuracy: 81.03%
[0.10742149]
--------------------------------------------------
trumpet
        TRAIN
              precision    recall  f1-score   support

       False       0.98      0.65      0.78      1347
        True       0.64      0.98      0.78       868

    accuracy                           0.78      2215
   macro avg       0.81      0.82      0.78      2215
weighted avg       0.85      0.78      0.78      2215

False
[0.30723488]
        TEST
              precision    recall  f1-score   support

       False       0.93      0.56      0.69       209
        True       0.58      0.94      0.72       139

    accuracy                           0.71       348
   macro avg       0.76      0.75      0.71       348
weighted avg       0.79      0.71      0.70       348

(1796, 10, 128)
```

```
(1796, 1, 10, 128)
False
Train on 1796 samples, validate on 304 samples
Epoch 1/10
1796/1796 [==============================] - 140s 78ms/step - loss: 0.6214 -
acc: 0.6787 - val_loss: 0.5847 - val_acc: 0.6743
Epoch 2/10
1796/1796 [==============================] - 132s 73ms/step - loss: 0.5322 -
acc: 0.7105 - val_loss: 0.4558 - val_acc: 0.7303
Epoch 3/10
1796/1796 [==============================] - 134s 75ms/step - loss: 0.4789 -
acc: 0.7350 - val_loss: 0.4399 - val_acc: 0.8059
Epoch 4/10
1796/1796 [==============================] - 131s 73ms/step - loss: 0.4604 -
acc: 0.7656 - val_loss: 0.4146 - val_acc: 0.8059
Epoch 5/10
1796/1796 [==============================] - 132s 74ms/step - loss: 0.4362 -
acc: 0.7840 - val_loss: 0.4131 - val_acc: 0.7993
Epoch 6/10
1796/1796 [==============================] - 130s 72ms/step - loss: 0.4544 -
acc: 0.7628 - val_loss: 0.4468 - val_acc: 0.7763
Epoch 7/10
1796/1796 [==============================] - 130s 72ms/step - loss: 0.4282 -
acc: 0.7790 - val_loss: 0.4289 - val_acc: 0.7895
Epoch 8/10
1796/1796 [==============================] - 130s 72ms/step - loss: 0.4166 -
acc: 0.7979 - val_loss: 0.4754 - val_acc: 0.7500
Epoch 9/10
1796/1796 [==============================] - 131s 73ms/step - loss: 0.4197 -
acc: 0.7901 - val_loss: 0.4411 - val_acc: 0.7862
Epoch 10/10
1796/1796 [==============================] - 129s 72ms/step - loss: 0.3848 -
acc: 0.8157 - val_loss: 0.4392 - val_acc: 0.8026
```



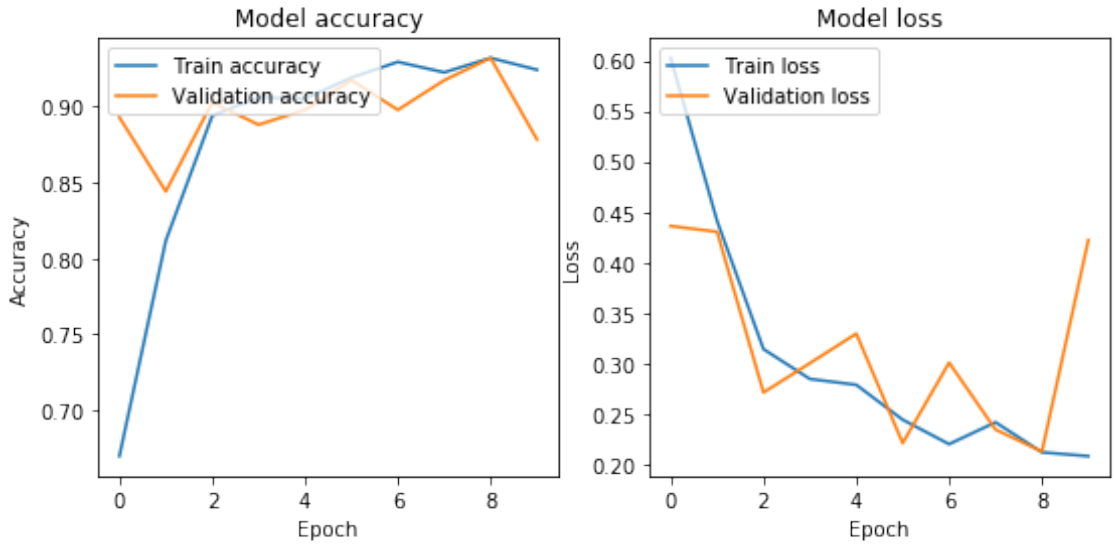

```
325/325 [==============================] - 3s 10ms/step
Test loss: 0.4593540314527658
Test accuracy: 76.00%
[0.3134371]
--------------------------------------------------
ukulele
        TRAIN
              precision    recall  f1-score   support

       False       0.99      0.58      0.73      1255
        True       0.50      0.99      0.67       541

    accuracy                           0.70      1796
   macro avg       0.75      0.78      0.70      1796
weighted avg       0.85      0.70      0.71      1796

True
[0.5016497]
        TEST
              precision    recall  f1-score   support

       False       0.95      0.52      0.67       227
        True       0.46      0.94      0.62        98

    accuracy                           0.65       325
   macro avg       0.70      0.73      0.64       325
weighted avg       0.80      0.65      0.66       325

(1533, 10, 128)
```

```
(1533, 1, 10, 128)
False
Train on 1533 samples, validate on 247 samples
Epoch 1/10
1533/1533 [==============================] - 117s 76ms/step - loss: 0.6766 -
acc: 0.5695 - val_loss: 0.6478 - val_acc: 0.6032
Epoch 2/10
1533/1533 [==============================] - 111s 73ms/step - loss: 0.5582 -
acc: 0.7189 - val_loss: 0.4036 - val_acc: 0.8300
Epoch 3/10
1533/1533 [==============================] - 110s 72ms/step - loss: 0.4181 -
acc: 0.8258 - val_loss: 0.3666 - val_acc: 0.8259
Epoch 4/10
1533/1533 [==============================] - 111s 73ms/step - loss: 0.3705 -
acc: 0.8382 - val_loss: 0.3579 - val_acc: 0.8462
Epoch 5/10
1533/1533 [==============================] - 109s 71ms/step - loss: 0.3479 -
acc: 0.8421 - val_loss: 0.3636 - val_acc: 0.8502
Epoch 6/10
1533/1533 [==============================] - 112s 73ms/step - loss: 0.3231 -
acc: 0.8571 - val_loss: 0.4007 - val_acc: 0.8664
Epoch 7/10
1533/1533 [==============================] - 111s 72ms/step - loss: 0.3110 -
acc: 0.8630 - val_loss: 0.3709 - val_acc: 0.8502
Epoch 8/10
1533/1533 [==============================] - 110s 71ms/step - loss: 0.2806 -
acc: 0.8852 - val_loss: 0.3896 - val_acc: 0.8583
Epoch 9/10
1533/1533 [==============================] - 109s 71ms/step - loss: 0.2774 -
acc: 0.8832 - val_loss: 0.4204 - val_acc: 0.8300
Epoch 10/10
1533/1533 [==============================] - 111s 72ms/step - loss: 0.2522 -
acc: 0.8969 - val_loss: 0.4224 - val_acc: 0.8583
```




```
253/253 [==============================] - 2s 9ms/step
Test loss: 0.43692774358003034
Test accuracy: 79.84%
[0.8562643]
--------------------------------------------------
violin
        TRAIN
              precision    recall  f1-score   support

       False       1.00      0.73      0.84       653
        True       0.83      1.00      0.91       880

    accuracy                           0.88      1533
   macro avg       0.92      0.86      0.88      1533
weighted avg       0.90      0.88      0.88      1533

True
[0.7658575]
        TEST
              precision    recall  f1-score   support

       False       0.94      0.54      0.69       109
        True       0.74      0.97      0.84       144

    accuracy                           0.79       253
   macro avg       0.84      0.76      0.76       253
weighted avg       0.82      0.79      0.77       253

(1157, 10, 128)
```

```
(1157, 1, 10, 128)
True
Train on 1157 samples, validate on 205 samples
Epoch 1/10
1157/1157 [==============================] - 92s 79ms/step - loss: 0.6026 - acc:
0.6698 - val_loss: 0.4360 - val_acc: 0.8927
Epoch 2/10
1157/1157 [==============================] - 84s 72ms/step - loss: 0.4411 - acc:
0.8116 - val_loss: 0.4303 - val_acc: 0.8439
Epoch 3/10
1157/1157 [==============================] - 86s 75ms/step - loss: 0.3140 - acc:
0.8937 - val_loss: 0.2711 - val_acc: 0.9024
Epoch 4/10
1157/1157 [==============================] - 84s 73ms/step - loss: 0.2845 - acc:
0.9058 - val_loss: 0.3001 - val_acc: 0.8878
Epoch 5/10
1157/1157 [==============================] - 84s 72ms/step - loss: 0.2787 - acc:
0.9049 - val_loss: 0.3294 - val_acc: 0.8976
Epoch 6/10
1157/1157 [==============================] - 86s 74ms/step - loss: 0.2441 - acc:
0.9188 - val_loss: 0.2209 - val_acc: 0.9171
Epoch 7/10
1157/1157 [==============================] - 85s 73ms/step - loss: 0.2199 - acc:
0.9291 - val_loss: 0.3007 - val_acc: 0.8976
Epoch 8/10
1157/1157 [==============================] - 85s 73ms/step - loss: 0.2416 - acc:
0.9222 - val_loss: 0.2343 - val_acc: 0.9171
Epoch 9/10
1157/1157 [==============================] - 84s 73ms/step - loss: 0.2118 - acc:
0.9317 - val_loss: 0.2126 - val_acc: 0.9317
Epoch 10/10
1157/1157 [==============================] - 85s 73ms/step - loss: 0.2080 - acc:
0.9239 - val_loss: 0.4221 - val_acc: 0.8780
```




```
202/202 [==============================] - 2s 10ms/step
Test loss: 0.3783179719259243
Test accuracy: 89.60%
[0.9990358]
--------------------------------------------------
voice
        TRAIN
              precision    recall  f1-score   support

       False       0.98      0.62      0.76       434
        True       0.81      0.99      0.89       723

    accuracy                           0.85      1157
   macro avg       0.90      0.80      0.82      1157
weighted avg       0.87      0.85      0.84      1157

True
[0.99848545]
        TEST
              precision    recall  f1-score   support

       False       1.00      0.54      0.70        59
        True       0.84      1.00      0.91       143

    accuracy                           0.87       202
   macro avg       0.92      0.77      0.81       202
weighted avg       0.89      0.87      0.85       202
```

[13]:
```
print(X_train_inst_sklearn)
print(Y_pred_train)
```

```
[[0.921332   0.40947548 0.6402511  ... 0.4017433  0.4174872  1.        ]
 [0.87017375 0.7986464  0.8297372  ... 0.5835975  0.17802285 1.        ]
 [0.8291506  0.02876481 0.5637505  ... 0.08914421 0.35053173 1.        ]
 ...
 [0.9300193  0.76480544 0.7944292  ... 0.16798733 0.1346987  1.        ]
 [0.9329151  0.48223352 0.8422911  ... 0.11568939 0.6384404  1.        ]
 [0.9092664  0.42808798 0.64848965 ... 0.36648178 0.48956284 1.        ]]
[[0.9990358 ]
 [0.99189687]
 [0.0078997 ]
 ...
 [0.9992817 ]
 [0.9992617 ]
 [0.99744934]]
```

[ ]: