CNN-FCT-30E-13L-shift-test-03

March 24, 2021

1 Are Relations Relevant in CNNs? *A Study Based on a Facial Dataset*

1.1 Testing CNN with Features Closer Together *(30 Epochs - 13 Layers)*

1.1.1 Imports, Seed, GPU integration

[1]:
```
import numpy as np
import random
import tensorflow as tf
```

[2]:
```
# Seeds for better reproducibility
seed = 42
np.random.seed(seed)
random.seed(seed)
tf.random.set_seed(seed)
```

[3]:
```
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from sklearn.metrics import confusion_matrix
import itertools
import matplotlib.pyplot as plt
import warnings
warnings.simplefilter(action='ignore', category=FutureWarning)
%matplotlib inline
```

[4]:
```
physical_devices = tf.config.experimental.list_physical_devices('GPU')
print("Num GPUs Available: ", len(physical_devices))
tf.config.experimental.set_memory_growth(physical_devices[0], True)
```

```
Num GPUs Available:  1
```

1.1.2 Data preparation

[5]:
```
test_path = '../../../picasso_dataset/FCT-data/shifted/test'
```

[6]:
```
test_batches = ImageDataGenerator(preprocessing_function=tf.keras.applications.
 ↪vgg16.preprocess_input) \
    .flow_from_directory(directory=test_path, target_size=(224,224),␣
↪classes=['no_face', 'face'], batch_size=10, shuffle=False)
```

```
Found 3000 images belonging to 2 classes.
```

[7]:
```
assert test_batches.n == 3000
assert test_batches.num_classes == 2
```

1.1.3 Loading the trained CNN

[8]:
```
filename='../models/CNN-FCT-30E-13L-03.h5'
loaded_model = load_model(filename)
```

1.1.4 Accuracy and loss of the trained model

[9]:
```
scores = loaded_model.evaluate(test_batches, verbose=2)
print("Accuracy: %.2f%%" % (scores[1]*100))
print("Loss: %.2f%%" % (scores[0]*100))
```

```
300/300 - 7s - loss: 0.9893 - accuracy: 0.8043
Accuracy: 80.43%
Loss: 98.93%
```

1.1.5 Testing the CNN

[10]:
```
predictions = loaded_model.predict(x=test_batches, steps=len(test_batches),␣
↪verbose=0)
```

1.1.6 Index of wrongly predicted pictures

[11]:
```
y_true=test_batches.classes
y_pred=np.argmax(predictions, axis=-1)
cm = confusion_matrix(y_true = y_true, y_pred = y_pred)
```

[12]:
```
face_but_predicted_no_face=[]
no_face_but_predicted_face=[]

for i in range(len(predictions)):
        if y_true[i] != y_pred[i]:
            if y_true[i] == 1:
                face_but_predicted_no_face.append(i+8001-1500) #Index of file␣
↪on disk
            else:
                no_face_but_predicted_face.append(i+8001) #Index of file on disk
```

```
print("Data from class 'face', that was wrongly predicted as 'no-face' [",␣
 ↪len(face_but_predicted_no_face), "] :")
print(face_but_predicted_no_face)
print("---------------------------------------------------------------------------------------
print("Data from class 'no-face', that was wrongly predicted as 'face' [",␣
 ↪len(no_face_but_predicted_face), "] :")
print(no_face_but_predicted_face)
```

```
Data from class 'face', that was wrongly predicted as 'no-face' [ 474 ] :
[8001, 8005, 8010, 8012, 8017, 8019, 8020, 8022, 8023, 8026, 8028, 8032, 8034,
8035, 8036, 8039, 8040, 8047, 8049, 8054, 8059, 8061, 8065, 8068, 8075, 8082,
8090, 8093, 8095, 8108, 8113, 8121, 8122, 8130, 8133, 8135, 8136, 8137, 8141,
8142, 8156, 8160, 8169, 8172, 8174, 8179, 8184, 8186, 8187, 8188, 8193, 8194,
8195, 8197, 8200, 8202, 8207, 8217, 8219, 8224, 8225, 8231, 8234, 8237, 8239,
8249, 8250, 8251, 8254, 8256, 8257, 8262, 8266, 8267, 8269, 8280, 8293, 8298,
8299, 8302, 8304, 8305, 8308, 8312, 8319, 8325, 8326, 8327, 8331, 8336, 8343,
8345, 8348, 8349, 8354, 8356, 8359, 8362, 8366, 8368, 8369, 8370, 8371, 8372,
8375, 8376, 8378, 8380, 8382, 8384, 8385, 8391, 8396, 8397, 8399, 8402, 8404,
8406, 8408, 8411, 8412, 8420, 8426, 8428, 8431, 8435, 8436, 8439, 8440, 8442,
8449, 8450, 8453, 8457, 8461, 8462, 8465, 8468, 8471, 8473, 8475, 8476, 8478,
8479, 8483, 8484, 8486, 8489, 8500, 9002, 9006, 9007, 9008, 9009, 9010, 9014,
9016, 9017, 9018, 9019, 9020, 9022, 9023, 9025, 9027, 9029, 9032, 9034, 9035,
9038, 9039, 9040, 9041, 9043, 9044, 9045, 9046, 9047, 9048, 9049, 9052, 9053,
9055, 9060, 9064, 9065, 9066, 9067, 9071, 9072, 9073, 9074, 9076, 9077, 9078,
9080, 9083, 9085, 9087, 9088, 9095, 9097, 9098, 9100, 9101, 9102, 9103, 9104,
9105, 9107, 9108, 9113, 9115, 9116, 9118, 9119, 9120, 9121, 9122, 9123, 9125,
9126, 9128, 9129, 9131, 9132, 9133, 9134, 9135, 9136, 9137, 9139, 9140, 9141,
9142, 9143, 9144, 9145, 9147, 9149, 9152, 9155, 9156, 9158, 9161, 9165, 9166,
9167, 9168, 9169, 9170, 9172, 9173, 9174, 9175, 9176, 9177, 9178, 9179, 9181,
9182, 9183, 9184, 9186, 9189, 9190, 9191, 9192, 9195, 9196, 9198, 9199, 9200,
9201, 9202, 9203, 9206, 9208, 9210, 9211, 9213, 9215, 9216, 9218, 9219, 9220,
9223, 9224, 9227, 9228, 9230, 9231, 9232, 9233, 9234, 9235, 9236, 9237, 9239,
9240, 9243, 9244, 9246, 9247, 9248, 9249, 9250, 9251, 9252, 9253, 9254, 9256,
9257, 9259, 9261, 9262, 9263, 9264, 9265, 9266, 9267, 9268, 9269, 9270, 9271,
9272, 9275, 9277, 9279, 9280, 9281, 9282, 9283, 9284, 9285, 9286, 9287, 9289,
9290, 9291, 9293, 9295, 9297, 9299, 9300, 9301, 9302, 9304, 9305, 9308, 9309,
9310, 9311, 9312, 9313, 9315, 9319, 9320, 9321, 9322, 9325, 9326, 9327, 9328,
9331, 9332, 9333, 9334, 9338, 9339, 9340, 9341, 9342, 9344, 9345, 9347, 9349,
9352, 9356, 9360, 9362, 9363, 9365, 9366, 9367, 9368, 9369, 9370, 9372, 9373,
9376, 9377, 9378, 9379, 9380, 9381, 9382, 9383, 9384, 9385, 9386, 9388, 9389,
9390, 9391, 9392, 9394, 9395, 9396, 9397, 9398, 9399, 9402, 9403, 9404, 9405,
9406, 9407, 9411, 9412, 9413, 9415, 9418, 9419, 9422, 9424, 9427, 9429, 9430,
9431, 9432, 9433, 9434, 9435, 9436, 9437, 9439, 9440, 9442, 9444, 9445, 9446,
9447, 9449, 9450, 9453, 9454, 9456, 9458, 9459, 9460, 9461, 9462, 9463, 9464,
9467, 9468, 9469, 9471, 9472, 9473, 9476, 9477, 9478, 9482, 9484, 9487, 9491,
9493, 9494, 9496, 9497, 9498, 9499]
--------------------------------------------------------------------------------
```

```
--------------
Data from class 'no-face', that was wrongly predicted as 'face' [ 113 ] :
[8002, 8007, 8013, 8024, 8041, 8054, 8057, 8077, 8079, 8082, 8085, 8091, 8101,
8102, 8121, 8130, 8131, 8145, 8146, 8154, 8164, 8167, 8182, 8185, 8188, 8191,
8195, 8202, 8211, 8220, 8255, 8266, 8276, 8281, 8282, 8285, 8288, 8289, 8295,
8297, 8301, 8328, 8358, 8360, 8361, 8362, 8364, 8392, 8394, 8403, 8414, 8419,
8423, 8459, 8472, 8487, 8493, 9003, 9015, 9023, 9034, 9039, 9041, 9046, 9061,
9062, 9066, 9078, 9095, 9098, 9110, 9116, 9123, 9128, 9133, 9138, 9139, 9148,
9153, 9173, 9177, 9190, 9194, 9196, 9197, 9231, 9262, 9264, 9268, 9272, 9278,
9316, 9318, 9321, 9334, 9338, 9350, 9361, 9365, 9367, 9423, 9436, 9443, 9447,
9450, 9457, 9459, 9461, 9464, 9472, 9477, 9491, 9500]
```

1.1.7 Confusion matrix

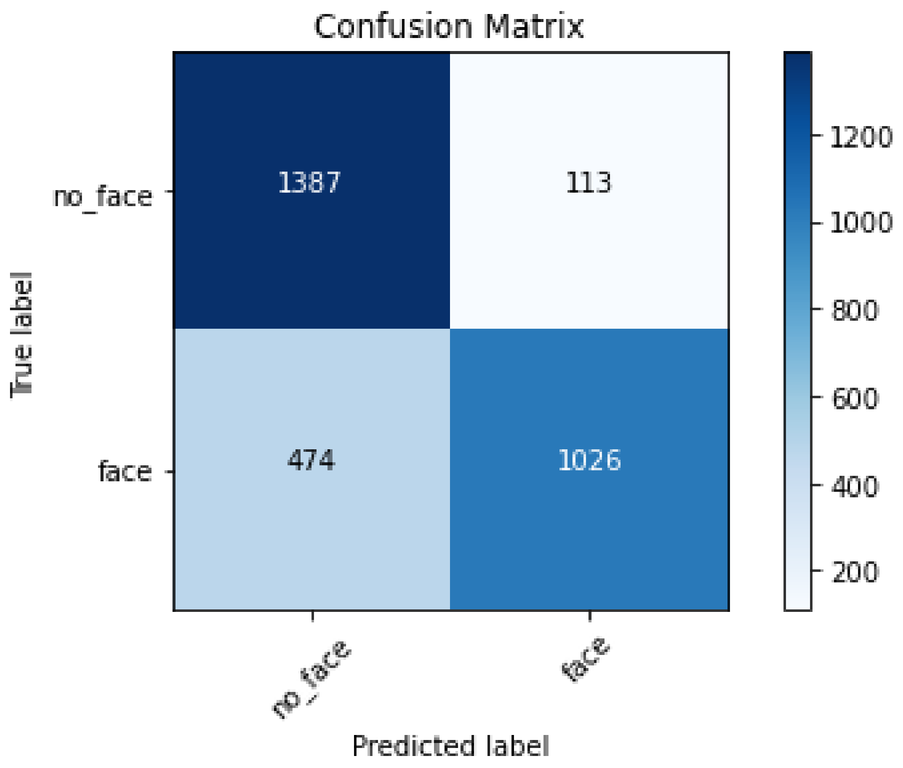
[13]:
```
def plot_confusion_matrix(cm, classes,
                          normalize=False,
                          title='Confusion matrix',
                          cmap=plt.cm.Blues):

    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=45)
    plt.yticks(tick_marks, classes)

    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
        print("Normalized confusion matrix")
    else:
        print('Confusion matrix, without normalization')

    print(cm)

    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, cm[i, j],
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
```

[14]:
```
test_batches.class_indices
```

[14]:
```
{'no_face': 0, 'face': 1}
```

```
[15]: cm_plot_labels = ['no_face','face']
      plot_confusion_matrix(cm=cm, classes=cm_plot_labels, title='Confusion Matrix')
```

```
Confusion matrix, without normalization
[[1387  113]
 [ 474 1026]]
```


Confusion Matrix
True label
no_face
face
Predicted label
no_face
face