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# -*- coding: utf-8 -*-
"""
Created on Wed Apr 28 17:46:50 2021

@author: User
"""

# -*- coding: utf-8 -*-
"""
Created on Thu Apr 15 13:11:21 2021

@author: User
"""

import scipy.io
import matplotlib.pyplot as plt

import tensorflow as tf
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay

import numpy as np
import numpy
import tensorflow.keras as keras
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelBinarizer
from sklearn.metrics import confusion_matrix
from tensorflow.keras.preprocessing.image import ImageDataGenerator

from tensorflow.keras.utils import to_categorical
import seaborn as sns

from keras.preprocessing.image import ImageDataGenerator, array_to_img, img_to_array, load_img

if __name__=="__main__":

    #import data
    test_data = scipy.io.loadmat('CAB420_Assessment_1B_Data\Data\Q1\q1_test.mat')
    train_data = scipy.io.loadmat('CAB420_Assessment_1B_Data\Data\Q1\q1_train.mat')

    # Load images and labels
    test_Y = np.array(test_data['test_Y'])
    test_X = np.array(test_data['test_X'])  /255.0

    train_Y = np.array(train_data['train_Y'])
    train_X = np.array(train_data['train_X']) /255.0

    # Check the shape of the data
    print(test_X.shape)
    print(train_X.shape)

    # Fix the axes of the images
    test_X = np.moveaxis(test_X, -1, 0)
    train_X = np.moveaxis(train_X, -1, 0)

    print(test_X.shape)
    print(train_X.shape)
```

```
# Plot a random image and its label

plt.imshow(train_X[350])
plt.show()
print(train_Y[350])

#reshape train Y to vector format
print(test_Y)

#replace 10 to 0s in ys
train_Y = np.where(train_Y==10, 0, train_Y)
test_Y = np.where(test_Y==10, 0, test_Y)

a = 5

print(test_Y[a])
print(test_Y[a+1])

def unique(list1):
    x = np.array(list1)
    print(np.unique(x))

print("unique")

unique(test_Y)




def build_model(num_classes, output_activation=None):#week 4 lec/week 5 prac
    # our model, input in an image shape
    inputs = keras.Input(shape=(32, 32, 3,))

    # run pairs of conv layers, all 3s3 kernels
    x = keras.layers.Conv2D(filters=32, kernel_size=(3,3), padding='same',
    activation=None)(inputs)
    x = keras.layers.Conv2D(filters=32, kernel_size=(3,3), padding='same',
    activation=None)(x)
    x = keras.layers.BatchNormalization()(x)
    x = keras.layers.SpatialDropout2D(0.2)(x)
    x = keras.layers.MaxPool2D(pool_size=(2, 2))(x)

    # rinse and repeat with 2D convs, batch norm, dropout and max pool
    x = keras.layers.Conv2D(filters=64, kernel_size=(3,3), padding='same',
    activation=None)(x)
    x = keras.layers.Conv2D(filters=64, kernel_size=(3,3), padding='same',
    activation=None)(x)
    x = keras.layers.BatchNormalization()(x)
    x = keras.layers.SpatialDropout2D(0.2)(x)
    x = keras.layers.MaxPool2D(pool_size=(2, 2))(x)

    # final conv2d, batch norm and spatial dropout
    x = keras.layers.Conv2D(filters=128, kernel_size=(3,3), padding='same',
    activation=None)(x)
    x = keras.layers.Conv2D(filters=128, kernel_size=(3,3), padding='same',
    activation=None)(x)
    x = keras.layers.BatchNormalization()(x)
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    x = keras.layers.SpatialDropout2D(0.2)(x)
    x = keras.layers.MaxPool2D(pool_size=(2, 2))(x)

    # flatten layer
    x = keras.layers.Flatten()(x)
    # we'll use a couple of dense layers here, mainly so that we can show what another
    dropout layer looks like
    # in the middle
    x = keras.layers.Dense(128, activation='relu')(x)
    x = keras.layers.Dense(128, activation='relu')(x)
    x = keras.layers.Dense(128, activation='relu')(x)
    x = keras.layers.Dense(64, activation='relu')(x)
    # the output
    outputs = keras.layers.Dense(num_classes, activation=output_activation)(x)

    # build the model, and print a summary
    model_cnn = keras.Model(inputs=inputs, outputs=outputs, name='cnn_model')

    return model_cnn

model = build_model(10)
model.summary()

model.compile(loss=keras.losses.SparseCategoricalCrossentropy(from_logits=True),
          optimizer=keras.optimizers.Adam(),
          metrics=['accuracy'])
#Data augmentations

datagen = ImageDataGenerator(
                        rotation_range=10,
                        zoom_range=[0.9, 1.1],
                        height_shift_range=0.10,
                        shear_range=0.15,
                        #channel_shift_range=100,
                        #brightness_range=(0.3,0.9)
                        )



#model.fit(train_X,train_Y,batch_size = 32,epochs=50)
his = model.fit_generator(datagen.flow(train_X, train_Y, batch_size=40),epochs=250)
print("--------------")
#print(his.history)
print("--------------")

predictions = model.predict(test_X)

a = 5

print(predictions[a])
print(test_Y[a])
print(predictions[a+1])
print(test_Y[a+1])
print(predictions[a+2])
print(test_Y[a+2])
```

```
    def eval_model(model, x_test, y_test):
        test_scores = model.evaluate(x_test, y_test, verbose=2)
        print('Test loss:', test_scores[0])
        print('Test accuracy:', test_scores[1])

        pred = model.predict(x_test);
        indexes = tf.argmax(pred, axis=1)

        cm = confusion_matrix(y_test, indexes)
        fig = plt.figure(figsize=[20, 6])
        ax = fig.add_subplot(1, 2, 1)
        c = ConfusionMatrixDisplay(cm, display_labels=range(len(numpy.unique(y_test))))
        c.plot(ax = ax)

        ax = fig.add_subplot(1, 2, 2)
        ax.hist(y_test, bins=len(numpy.diagonal(cm)), rwidth=0.95)
        ax.plot(numpy.diagonal(cm))

    eval_model(model, train_X, train_Y)
    eval_model(model, test_X, test_Y)

    pred = model.predict(test_X);
    indexes = tf.argmax(pred, axis=1)
    count = 0
    print("_check_")
    print(test_Y[9])
    print(indexes[9].numpy())
    print("____test")
    for i in range(10000):
        if test_Y[i] == indexes[i].numpy():
            count = count + 1
    print(count)
    print(len(indexes))
    print((count/len(indexes))*100)
    print("____train")
    pred = model.predict(train_X);
    indexes = tf.argmax(pred, axis=1)
    count = 0
    for i in range(1000):
        if train_Y[i] == indexes[i].numpy():
            count = count + 1
    print(count)
    print(len(indexes))
    print((count/len(indexes))*100)

    print("count elements")
    print(np.count_nonzero(test_Y == 0))
    print(np.count_nonzero(test_Y == 1))
    print(np.count_nonzero(test_Y == 2))
    print(np.count_nonzero(test_Y == 3))
    print(np.count_nonzero(test_Y == 4))
    print(np.count_nonzero(test_Y == 5))
    print(np.count_nonzero(test_Y == 6))
    print(np.count_nonzero(test_Y == 7))
    print(np.count_nonzero(test_Y == 8))
    print(np.count_nonzero(test_Y == 9))
```