image_classification

March 27, 2020

Project created during the Deep Learning Specialization course on www.coursera.org

1 Classification of hand gestures with resNet

[1]:
```
import numpy as np
import h5py
```

1.1 Data preparation

[2]:
```
# Load the dataset

def load_dataset():
    train_dataset = h5py.File('./data/train_signs.h5', "r")
    train_set_x_orig = np.array(train_dataset["train_set_x"][:])
    train_set_y_orig = np.array(train_dataset["train_set_y"][:])

    test_dataset = h5py.File('./data/test_signs.h5', "r")
    test_set_x_orig = np.array(test_dataset["test_set_x"][:])
    test_set_y_orig = np.array(test_dataset["test_set_y"][:])

    classes = np.array(test_dataset["list_classes"][:])

    train_set_y_orig = train_set_y_orig.reshape((1, train_set_y_orig.shape[0]))
    test_set_y_orig = test_set_y_orig.reshape((1, test_set_y_orig.shape[0]))

    return train_set_x_orig, train_set_y_orig, test_set_x_orig, test_set_y_orig,␣
↪classes
```

[3]:
```
X_train_orig, Y_train_orig, X_test_orig, Y_test_orig, classes = load_dataset()

# Normalize data
X_train = X_train_orig/255.
X_test = X_test_orig/255.

# Convert training and test labels to one-hot encoded matrices
Y_train = np.eye(6)[Y_train_orig.reshape(-1)]
```

```
Y_test = np.eye(6)[Y_test_orig.reshape(-1)]
```

1.2 Model architecture

[4]:
```
from keras import layers
from keras.layers import Input, Add, Dense, Activation, ZeroPadding2D,␣
 ↪BatchNormalization, Flatten, Conv2D, AveragePooling2D, MaxPooling2D
from keras.models import Model, load_model
from keras.preprocessing import image
from keras.initializers import glorot_uniform
```

```
Using TensorFlow backend.
```

[5]:
```
# Create ResNet identity block

def identity_block(X, f, filters, stage, block):

    # Defining name basis
    conv_name_base = 'res' + str(stage) + block + '_branch'
    bn_name_base = 'bn' + str(stage) + block + '_branch'

    # Retrieve filters size
    F1, F2, F3 = filters

    # Build identity block
    X_shortcut = X

    X = Conv2D(filters = F1, kernel_size = (1, 1), strides = (1,1), padding =␣
 ↪'valid', name = conv_name_base + '2a', kernel_initializer =␣
 ↪glorot_uniform(seed=0))(X)
    X = BatchNormalization(axis = 3, name = bn_name_base + '2a')(X)
    X = Activation('relu')(X)

    X = Conv2D(filters=F2, kernel_size=(f, f), strides=(1, 1), padding='same',␣
 ↪name=conv_name_base + '2b', kernel_initializer=glorot_uniform(seed=0))(X)
    X = BatchNormalization(axis=3, name=bn_name_base + '2b')(X)
    X = Activation('relu')(X)

    X = Conv2D(filters=F3, kernel_size=(1,1), strides=(1,1), padding='valid',␣
 ↪name=conv_name_base + '2c', kernel_initializer=glorot_uniform(seed=0))(X)
    X = BatchNormalization(axis=3, name=bn_name_base + '2c')(X)

    X = Add()([X, X_shortcut])
    X = Activation('relu')(X)

    return X
```

[6]:
```
# Create ResNet convolutional block

def convolutional_block(X, f, filters, stage, block, s = 2):

    # Define name basis
    conv_name_base = 'res' + str(stage) + block + '_branch'
    bn_name_base = 'bn' + str(stage) + block + '_branch'

    # Retrieve filters size
    F1, F2, F3 = filters

    # Build convolutional block
    X_shortcut = X

    X = Conv2D(F1, (1, 1), strides = (s,s), padding='valid', name =␣
↪conv_name_base + '2a', kernel_initializer = glorot_uniform(seed=0))(X)
    X = BatchNormalization(axis = 3, name = bn_name_base + '2a')(X)
    X = Activation('relu')(X)

    X = Conv2D(F2, (f, f), strides=(1,1), padding='same', name=conv_name_base +␣
↪'2b', kernel_initializer=glorot_uniform(seed=0))(X)
    X = BatchNormalization(axis=3, name=bn_name_base + '2b')(X)
    X = Activation('relu')(X)

    X = Conv2D(F3, (1,1), strides=(1,1), padding='valid', name=conv_name_base +␣
↪'2c', kernel_initializer=glorot_uniform(seed=0))(X)
    X = BatchNormalization(axis=3, name=bn_name_base + '2c')(X)

    X_shortcut = Conv2D(F3, (1,1), strides=(s,s), padding='valid',␣
↪name=conv_name_base + '1',␣
↪kernel_initializer=glorot_uniform(seed=0))(X_shortcut)
    X_shortcut = BatchNormalization(axis=3, name=bn_name_base +'1')(X_shortcut)

    X = Add()([X_shortcut, X])
    X = Activation('relu')(X)

    return X
```

[7]:
```
# Build ResNet model

def ResNet50(input_shape = (64, 64, 3), classes = 6):

    X_input = Input(input_shape)

    X = ZeroPadding2D((3, 3))(X_input)
```

```
    X = Conv2D(64, (7, 7), strides = (2, 2), name = 'conv1', kernel_initializer␣
↪= glorot_uniform(seed=0))(X)
    X = BatchNormalization(axis = 3, name = 'bn_conv1')(X)
    X = Activation('relu')(X)
    X = MaxPooling2D((3, 3), strides=(2, 2))(X)

    X = convolutional_block(X, f = 3, filters = [64, 64, 256], stage = 2,␣
↪block='a', s = 1)
    X = identity_block(X, 3, [64, 64, 256], stage=2, block='b')
    X = identity_block(X, 3, [64, 64, 256], stage=2, block='c')

    X = convolutional_block(X, f=3, filters=[128, 128, 512], stage=3, block='a',␣
↪s=2)
    X = identity_block(X, f=3, filters=[128, 128, 512], stage=3, block='b')
    X = identity_block(X, f=3, filters=[128, 128, 512], stage=3, block='c')
    X = identity_block(X, f=3, filters=[128, 128, 512], stage=3, block='d')

    X = convolutional_block(X, f=3, filters=[256, 256, 1024], stage=4, block='a')
    X = identity_block(X, f=3, filters=[256, 256, 1024], stage=4, block='b')
    X = identity_block(X, f=3, filters=[256, 256, 1024], stage=4, block='c')
    X = identity_block(X, f=3, filters=[256, 256, 1024], stage=4, block='d')
    X = identity_block(X, f=3, filters=[256, 256, 1024], stage=4, block='e')
    X = identity_block(X, f=3, filters=[256, 256, 1024], stage=4, block='f')

    X = convolutional_block(X, f=3, filters=[512, 512, 2048], stage=5, block='a')
    X = identity_block(X, f=3, filters=[512, 512, 2048], stage=5, block='b')
    X = identity_block(X, f=3, filters=[512, 512, 2048], stage=5, block='c')

    X = AveragePooling2D(pool_size=(2,2), name='avg_pool')(X)

    X = Flatten()(X)
    X = Dense(classes, activation='softmax', name='fc' + str(classes),␣
↪kernel_initializer = glorot_uniform(seed=0))(X)

    model = Model(inputs = X_input, outputs = X, name='ResNet50')

    return model
```

[8]:
```
model = ResNet50(input_shape = (64, 64, 3), classes = 6)
```

1.3 Training and testing

[9]:
```
# Compile the model
model.compile(optimizer='adam', loss='categorical_crossentropy',␣
 ↪metrics=['accuracy'])
```

[10]:
```
# Train the model
model.fit(X_train, Y_train, epochs = 2, batch_size = 32)
```

```
Epoch 1/2
1080/1080 [==============================] - 71s 66ms/step - loss: 1.7110 -
accuracy: 0.4750
Epoch 2/2
1080/1080 [==============================] - 60s 56ms/step - loss: 0.5836 -
accuracy: 0.7972
```

[10]:
```
<keras.callbacks.callbacks.History at 0x654621be0>
```

[11]:
```
# Evaluate the model on the test set
preds = model.evaluate(X_test, Y_test)
print ("Loss = " + str(preds[0]))
print ("Test Accuracy = " + str(preds[1]))
```

```
120/120 [==============================] - 2s 16ms/step
Loss = 3.9948134740193684
Test Accuracy = 0.1666666716337204
```

1.4 Testing on pretrained model

[12]:
```
# Load pretrained model (found here: https://github.com/kotestyle/
↪deep-learning-coursera)
model = load_model('./models/ResNet50.h5')
```

```
/Applications/anaconda3/lib/python3.6/site-packages/keras/engine/saving.py:384:
UserWarning: Error in loading the saved optimizer state. As a result, your model
is starting with a freshly initialized optimizer.
  warnings.warn('Error in loading the saved optimizer '
```

[13]:
```
# Evaluate pretrained model on the test set
preds = model.evaluate(X_test, Y_test)
print ("Loss = " + str(preds[0]))
print ("Test Accuracy = " + str(preds[1]))
```

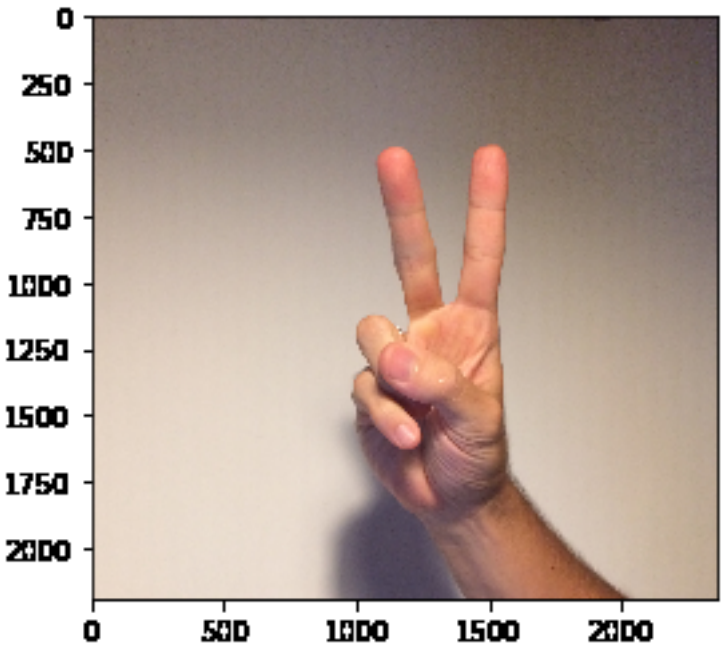
```
120/120 [==============================] - 2s 21ms/step
Loss = 0.5301785508791605
Test Accuracy = 0.8666666746139526
```

[14]:
```
from matplotlib.pyplot import imshow
import scipy.misc
from PIL import Image
%matplotlib inline
```

[15]:
```
def inference(path):
    # Load the image
    my_image = Image.open(path)
    imshow(my_image)

    # Preprocess the image to coincide with model input size
    img = image.load_img(path, target_size=(64, 64))
    x = image.img_to_array(img)
    x = np.expand_dims(x, axis=0)
    x = x / 255.0

    # Predict the class
    predictions = model.predict(x)

    print('\nPredicted class: ', np.argmax(predictions))
```

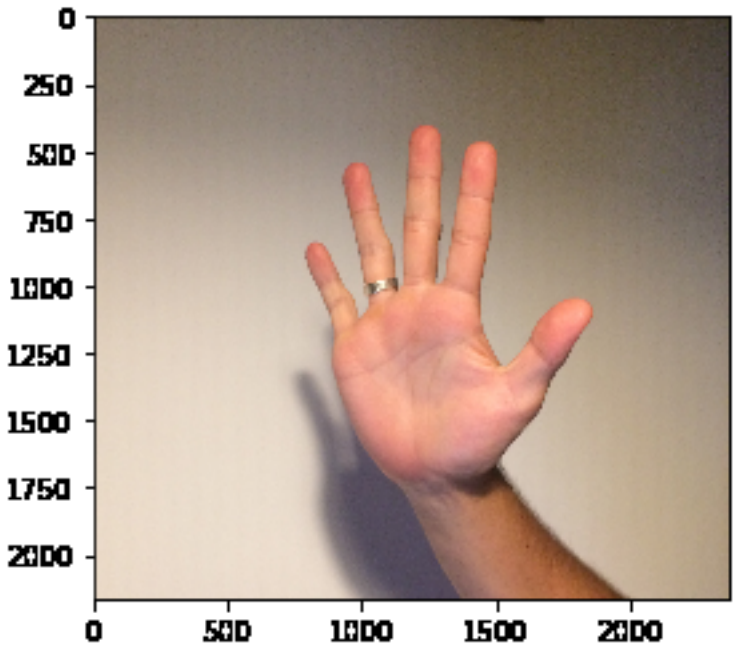
[16]:
```
inference('./test/2.jpg')
```

```
Predicted class:  2
```



[17]:
```
inference('./test/5.jpg')
```

```
Predicted class:  5
```


0
250
500
750
1000
1250
1500
1750
2000
0
500
1000
1500
2000

[ ]: