

# gesture\_recog\_categorical

September 5, 2020

```
[1]: # gesture_recog.ipynb

# The model is to train the gesture of images with the Leap Motion
# T. Mantecón, C.R. del Blanco, F. Jaureguizar, N. García, "Hand Gesture
  ↳ Recognition using Infrared
# Imagery Provided by Leap Motion Controller", Int. Conf. on Advanced Concepts
  ↳ for Intelligent Vision
# Systems, ACIVS 2016, Lecce, Italy, pp. 47-57, 24-27 Oct. 2016. (doi: 10.1007/
  ↳ 978-3-319-48680-2_5)

# Please download the leapgestrecog dataset from Kaggle.
# https://www.kaggle.com/gti-upm/leapgestrecog
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[2]: import tensorflow as tf
from keras.preprocessing.image import ImageDataGenerator
# -from keras import optimizers
import matplotlib.pyplot as plt
from alexnet import AlexNet
from keras.preprocessing import image

import numpy as np
import datetime
import os
import shutil
from PIL import Image
from numba import cuda
```

```
[3]: # Set up the GPU growth to avoid the sudden runtime error.

gpus = tf.config.experimental.list_physical_devices('GPU')
for gpu in gpus:
    tf.config.experimental.set_memory_growth(gpu, True)
```

```
[4]: # Move the iamges from the original path to the source path

# -import os
# -import shutil
```

```

orig_dir = '/home/mike/Documents/image_gesture/leapgestrecog/leapGestRecog'
src_dir = '/home/mike/Documents/image_gesture/leapgestrecog/src_data'
if not os.path.exists(src_dir):
    os.makedirs(src_dir)

def move_data(orig_dir, src_dir):

    # Conduct three iterations with i, j and k counters
    for i in os.listdir(orig_dir):
        label = 0
        # Get the original category(ca) with i pointing to any folder from 00_
        →to 09
        origca_dir = os.path.join(orig_dir, i)
        print("[MESSAGE] Category %s %s"% (origca_dir,i))

        # The counter j points to any folder from 01_palm to 10_down.
        for j in os.listdir(origca_dir):
            # The label is related to str(label) in the k iterations.
            label = label + 1
            # Create the origcaty_dir and type(ty) represents the type of the_
            →above folders
            origcaty_dir = os.path.join(origca_dir, j)
            print("[MESSAGE] Type %s %s"% (origcaty_dir,j))

            for k in os.listdir(origcaty_dir):
                # origimg_path is the absolute path that holds the images such_
                →as frame_00_7_0001.png
                origimg_path = os.path.join(origcaty_dir, k)
                # Create the diretort for the label with str(label) ranging_
                →from 1 to 10
                srclbl_dir = os.path.join(src_dir, str(label))
                if not os.path.exists(srclbl_dir):
                    os.makedirs(srclbl_dir)
                # Create the absolute path
                srcimg_path = os.path.join(srclbl_dir, k)
                # Move the images
                shutil.move(origimg_path, srcimg_path)

            print("[MESSAGE] Done ", origcaty_dir)

        print("[MESSAGE] All Done!")

if __name__ == '__main__':

    move_data(orig_dir, src_dir)

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[MESSAGE]  
Category /home/mike/Documents/image\_gesture/leapgestrecog/leapGestRecog/06 06  
[MESSAGE] Type  
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[MESSAGE] Done
/home/mike/Documents/image_gesture/leapgestrecog/leapGestRecog/09/07_ok
[MESSAGE] All Done!

```

```

[5]: # Divide the dataset into train, validation and tfile sets.

# -import os
# -import shutil

# Designate source and division datasets
src_dir = '/home/mike/Documents/image_gesture/leapgestrecog/src_data'
dset_dir = '/home/mike/Documents/image_gesture/dset_data'
if not os.path.exists(dset_dir):
    os.makedirs(dset_dir)

# Make three directories for training, validation and tfile(test file)
train_dir = os.path.join(dset_dir, 'train')
if not os.path.exists(train_dir):
    os.mkdir(train_dir)

val_dir = os.path.join(dset_dir, 'validation')
if not os.path.exists(val_dir):
    os.mkdir(val_dir)

tfile_dir = os.path.join(dset_dir, 'tfile')
if not os.path.exists(tfile_dir):

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os.mkdir(tfile_dir)

for num in os.listdir(src_dir):
    # Folder 1~10
    train_idx_dir = os.path.join(train_dir, num)
    if not os.path.exists(train_idx_dir):
        os.mkdir(train_idx_dir)

    val_idx_dir = os.path.join(val_dir, num)
    if not os.path.exists(val_idx_dir):
        os.mkdir(val_idx_dir)

    tfile_idx_dir = os.path.join(tfile_dir, num)
    if not os.path.exists(tfile_idx_dir):
        os.mkdir(tfile_idx_dir)

    # Index is increasing.
    src_idx_dir = os.path.join(src_dir, num)

    # print(src_idx_dir)

    j = 0

    for fname in os.listdir(src_idx_dir):

        if j < 1000: # Copy 1000 images to the train directory
            src = os.path.join(src_idx_dir, fname)
            dst = os.path.join(train_idx_dir, fname)
            shutil.copyfile(src, dst)
        elif (j >= 1000 and j < 1500): # Copy 500 images to the val directory
            src = os.path.join(src_idx_dir, fname)
            dst = os.path.join(val_idx_dir, fname)
            shutil.copyfile(src, dst)
        elif (j >= 1500): # Copy 500 images to the tfile directory
            src = os.path.join(src_idx_dir, fname)
            dst = os.path.join(tfile_idx_dir, fname)
            shutil.copyfile(src, dst)

        j = j + 1

    print("[MESSAGE] Copy completed :", train_idx_dir)
    print("[MESSAGE] Copy completed :", val_idx_dir)
    print("[MESSAGE] Copy completed :", tfile_idx_dir)

print('[MESSAGE] Train folders:', len(os.listdir(train_dir)))

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print('[MESSAGE] Validation folders:', len(os.listdir(val_dir)))
print('[MESSAGE] Tfile folders:', len(os.listdir(tfile_dir)))

print('[MESSAGE] Train images per folder:', len(os.listdir(train_dir+"/1/")))
print('[MESSAGE] Validation images per folder:', len(os.listdir(val_dir+"/1/")))
print('[MESSAGE] Tfile images per folder:', len(os.listdir(tfile_dir+"/1/")))

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[MESSAGE] Copy completed : /home/mike/Documents/image_gesture/dset_data/train/8
[MESSAGE] Copy completed :
/home/mike/Documents/image_gesture/dset_data/validation/8
[MESSAGE] Copy completed : /home/mike/Documents/image_gesture/dset_data/tfile/8

```

```
[MESSAGE] Train folders: 10
[MESSAGE] Validation folders: 10
[MESSAGE] Tfile folders: 10
[MESSAGE] Train images per folder: 1000
[MESSAGE] Validation images per folder: 500
[MESSAGE] Tfile images per folder: 500
```

```
[6]: # Shift the dataset from tfile_dir to test_dir with only one subsidiary folder
```

```
# -import os
# -import shutil

tfile_dir = '/home/mike/Documents/image_gesture/dset_data/tfile'
test_dir = '/home/mike/Documents/image_gesture/dset_data/test'
if not os.path.exists(test_dir):
    os.makedirs(test_dir)

def shift_data(tfile_dir, test_dir):

    for i in os.listdir(tfile_dir):
        tfca_dir = os.path.join(tfile_dir, i)

        for j in os.listdir(tfca_dir):
            tfcaimg_path = os.path.join(tfca_dir, j)
            tfol_dir = os.path.join(test_dir, 'folder')
            if not os.path.exists(tfol_dir):
                os.makedirs(tfol_dir)
            tfoling_path = os.path.join(tfol_dir, j)
            shutil.move(tfcaimg_path, tfoling_path)

if __name__ == '__main__':

    shift_data(tfile_dir, test_dir)
```

```
[7]: # Assign the global constants
```

```
EPOCHS = 32
BATCH_SIZE = 64
image_width = 227
image_height = 227
channels = 3
num_classes = 10
```

```
[8]: # Call the AlexNet model
```

```
model = AlexNet((image_width, image_height, channels), num_classes)
```

```
[9]: # Compile the Model with RMSprop and categorical_crossentropy for ten classes
```

```
model.compile(optimizer=tf.keras.optimizers.Adam(0.001),  
              loss='categorical_crossentropy',  
              metrics=['acc'])
```

```
[10]: # Summary
```

```
model.summary()
```

Model: "alex\_net"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 55, 55, 96)	34944
max_pooling2d (MaxPooling2D)	(None, 27, 27, 96)	0
conv2d_1 (Conv2D)	(None, 27, 27, 256)	614656
max_pooling2d_1 (MaxPooling2D)	(None, 13, 13, 256)	0
conv2d_2 (Conv2D)	(None, 13, 13, 384)	885120
conv2d_3 (Conv2D)	(None, 13, 13, 384)	1327488
conv2d_4 (Conv2D)	(None, 13, 13, 256)	884992
max_pooling2d_2 (MaxPooling2D)	(None, 6, 6, 256)	0
flatten (Flatten)	(None, 9216)	0
dense (Dense)	(None, 4096)	37752832
dropout (Dropout)	(None, 4096)	0
dense_1 (Dense)	(None, 4096)	16781312
dropout_1 (Dropout)	(None, 4096)	0
dense_2 (Dense)	(None, 1000)	4097000
dense_3 (Dense)	(None, 10)	10010

Total params: 62,388,354  
Trainable params: 62,388,354  
Non-trainable params: 0

```
train_datagen = ImageDataGenerator(rescale=1.0/255)

train_generator = train_datagen.flow_from_directory(train_dir,
                                                    target_size=(image_width,image_height),
                                                    batch_size=BATCH_SIZE,
                                                    class_mode='categorical')

train_num = train_generator.samples

test_datagen = ImageDataGenerator(rescale=1.0/255)

val_generator = test_datagen.flow_from_directory(val_dir,
                                                  target_size=(image_width,image_height),
                                                  batch_size=BATCH_SIZE,
                                                  class_mode='categorical')

val_num = val_generator.samples
```

```
for data_batch, label_batch in train_generator:
    print("data batch shape:", data_batch.shape)
    print("label batch shape:", label_batch)

    break
```

14

```

[0. 0. 0. 0. 1. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 1. 0. 0. 0.]
[1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 1. 0.]
[0. 1. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 1. 0. 0. 0.]
[0. 0. 0. 0. 1. 0. 0. 0. 0. 0.]
[0. 0. 0. 1. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 1. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 1. 0.]
[0. 0. 0. 0. 0. 1. 0. 0. 0. 0.]
[0. 1. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 1. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 1.]
[0. 0. 0. 0. 1. 0. 0. 0. 0. 0.]
[1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 1. 0. 0. 0.]
[0. 0. 1. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 1.]
[0. 0. 0. 0. 0. 0. 1. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 1. 0. 0.]
[0. 0. 0. 0. 0. 1. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 1. 0. 0. 0. 0.]
[0. 0. 0. 0. 1. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 1. 0. 0. 0. 0. 0.]
[0. 0. 1. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 1. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 1.]
[0. 0. 0. 0. 0. 0. 1. 0. 0. 0.]
[0. 0. 0. 0. 1. 0. 0. 0. 0. 0.]
[0. 1. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 1. 0. 0.]
[0. 0. 0. 0. 1. 0. 0. 0. 0. 0.]
[0. 1. 0. 0. 0. 0. 0. 0. 0. 0.]
[1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 1. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 1. 0. 0. 0. 0. 0.]
[1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 1. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 1. 0.]
[0. 0. 0. 0. 0. 1. 0. 0. 0. 0.]
[1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 1. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 1. 0.]
[0. 0. 0. 0. 0. 1. 0. 0. 0. 0.]
[0. 1. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 1.]

```

```
[0. 0. 0. 0. 0. 0. 0. 0. 0. 1.]
[1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 1. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 1. 0. 0. 0.]
```

```
[13]: # Train the model
history = model.fit(train_generator,
                    steps_per_epoch=train_num//BATCH_SIZE,
                    epochs=EPOCHS,
                    validation_data=val_generator,
                    validation_steps=val_num//BATCH_SIZE)
```

```
Epoch 1/32
156/156 [=====] - 26s 165ms/step - loss: 1.4621 - acc:
0.6098 - val_loss: 0.1405 - val_acc: 0.9467
Epoch 2/32
156/156 [=====] - 25s 160ms/step - loss: 0.0714 - acc:
0.9750 - val_loss: 0.0201 - val_acc: 0.9944
Epoch 3/32
156/156 [=====] - 25s 160ms/step - loss: 0.0523 - acc:
0.9836 - val_loss: 0.0819 - val_acc: 0.9772
Epoch 4/32
156/156 [=====] - 25s 159ms/step - loss: 0.0522 - acc:
0.9849 - val_loss: 0.0102 - val_acc: 0.9974
Epoch 5/32
156/156 [=====] - 25s 159ms/step - loss: 0.0325 - acc:
0.9915 - val_loss: 0.0484 - val_acc: 0.9848
Epoch 6/32
156/156 [=====] - 25s 159ms/step - loss: 0.0195 - acc:
0.9948 - val_loss: 0.0493 - val_acc: 0.9918
Epoch 7/32
156/156 [=====] - 25s 160ms/step - loss: 0.0580 - acc:
0.9835 - val_loss: 0.0169 - val_acc: 0.9952
Epoch 8/32
156/156 [=====] - 25s 160ms/step - loss: 0.0121 - acc:
0.9962 - val_loss: 0.0119 - val_acc: 0.9950
Epoch 9/32
156/156 [=====] - 25s 160ms/step - loss: 0.0961 - acc:
0.9806 - val_loss: 0.0297 - val_acc: 0.9928
Epoch 10/32
156/156 [=====] - 25s 159ms/step - loss: 0.0437 - acc:
0.9910 - val_loss: 0.0177 - val_acc: 0.9930
Epoch 11/32
156/156 [=====] - 25s 160ms/step - loss: 0.0099 - acc:
0.9976 - val_loss: 0.0025 - val_acc: 0.9996
Epoch 12/32
156/156 [=====] - 25s 161ms/step - loss: 0.0125 - acc:
0.9971 - val_loss: 0.0210 - val_acc: 0.9964
```



Epoch 13/32  
156/156 [=====] - 25s 161ms/step - loss: 0.0301 - acc:  
0.9930 - val\_loss: 0.0146 - val\_acc: 0.9974  
Epoch 14/32  
156/156 [=====] - 25s 161ms/step - loss: 0.0143 - acc:  
0.9958 - val\_loss: 0.0082 - val\_acc: 0.9976  
Epoch 15/32  
156/156 [=====] - 25s 161ms/step - loss: 0.0045 - acc:  
0.9989 - val\_loss: 0.0446 - val\_acc: 0.9910  
Epoch 16/32  
156/156 [=====] - 25s 163ms/step - loss: 0.0359 - acc:  
0.9926 - val\_loss: 0.0100 - val\_acc: 0.9988  
Epoch 17/32  
156/156 [=====] - 25s 162ms/step - loss: 0.0833 - acc:  
0.9831 - val\_loss: 0.0047 - val\_acc: 0.9988  
Epoch 18/32  
156/156 [=====] - 25s 161ms/step - loss: 0.0170 - acc:  
0.9968 - val\_loss: 0.0019 - val\_acc: 0.9994  
Epoch 19/32  
156/156 [=====] - 25s 162ms/step - loss: 0.0240 - acc:  
0.9957 - val\_loss: 0.0307 - val\_acc: 0.9948  
Epoch 20/32  
156/156 [=====] - 25s 161ms/step - loss: 0.0032 - acc:  
0.9992 - val\_loss: 0.0045 - val\_acc: 0.9988  
Epoch 21/32  
156/156 [=====] - 25s 161ms/step - loss: 3.5334e-04 -  
acc: 0.9999 - val\_loss: 0.0025 - val\_acc: 0.9992  
Epoch 22/32  
156/156 [=====] - 25s 161ms/step - loss: 8.7035e-06 -  
acc: 1.0000 - val\_loss: 0.0018 - val\_acc: 0.9996  
Epoch 23/32  
156/156 [=====] - 25s 162ms/step - loss: 1.3492e-05 -  
acc: 1.0000 - val\_loss: 0.0016 - val\_acc: 0.9996  
Epoch 24/32  
156/156 [=====] - 25s 161ms/step - loss: 2.7042e-06 -  
acc: 1.0000 - val\_loss: 0.0016 - val\_acc: 0.9996  
Epoch 25/32  
156/156 [=====] - 25s 162ms/step - loss: 4.2445e-05 -  
acc: 1.0000 - val\_loss: 0.0030 - val\_acc: 0.9992  
Epoch 26/32  
156/156 [=====] - 25s 161ms/step - loss: 2.0889e-05 -  
acc: 1.0000 - val\_loss: 0.0034 - val\_acc: 0.9996  
Epoch 27/32  
156/156 [=====] - 25s 160ms/step - loss: 1.8005e-06 -  
acc: 1.0000 - val\_loss: 0.0037 - val\_acc: 0.9996  
Epoch 28/32  
156/156 [=====] - 25s 160ms/step - loss: 2.4791e-06 -  
acc: 1.0000 - val\_loss: 0.0036 - val\_acc: 0.9996

```

Epoch 29/32
156/156 [=====] - 25s 160ms/step - loss: 1.1898e-06 -
acc: 1.0000 - val_loss: 0.0036 - val_acc: 0.9996
Epoch 30/32
156/156 [=====] - 25s 159ms/step - loss: 2.9850e-07 -
acc: 1.0000 - val_loss: 0.0036 - val_acc: 0.9996
Epoch 31/32
156/156 [=====] - 25s 161ms/step - loss: 5.1813e-07 -
acc: 1.0000 - val_loss: 0.0036 - val_acc: 0.9996
Epoch 32/32
156/156 [=====] - 25s 163ms/step - loss: 2.1199e-06 -
acc: 1.0000 - val_loss: 0.0038 - val_acc: 0.9996

```

```

[14]: # Save the model

model.save('/home/mike/Documents/image_gesture/leapGestRecog_small_categorical.
↪h5')

```

```

[15]: # Evaluate the model with visulizing the result

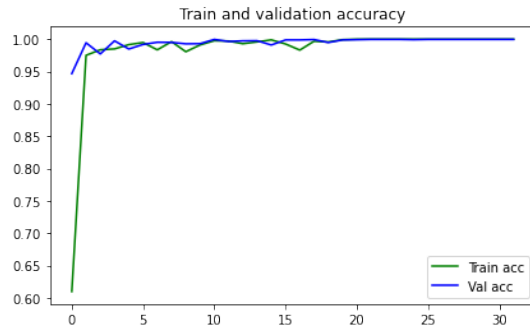
acc = history.history['acc']
val_acc = history.history['val_acc']
loss = history.history['loss']
val_loss = history.history['val_loss']
epochs = range(len(acc))

plt.figure(figsize=(15,4))
plt.subplot(1,2,1)
plt.plot(epochs, acc, 'b', label='Train acc', color='green')
plt.plot(epochs, val_acc, 'b', label='Val acc')
plt.title('Train and validation accuracy')
plt.legend()

plt.subplot(1,2,2)
plt.plot(epochs, loss, 'bo', label='Train loss', color='green')
plt.plot(epochs, val_loss, 'b', label='Val loss')
plt.title('Train and validation loss')
plt.legend()

plt.show()

```



```
[16]: # Release the GPU memory
```

```
cuda.select_device(0)  
cuda.close()
```