卷積神經網路 Convolutional Neural Network
&
電腦視覺 Computer Vision
Part3

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「版權聲明頁」

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課程內容

本日課程:

1. CNN實戰 in Keras
2. Generator(Data Augmentation)

延伸閱讀 (Optional):

1. What does CNN learn?

本次課程結束後你 (妳) 應該會什麼?

- **軟實力**
  - 理解data augmentation技法
  - 了解CNN實際學到的內容是什麼(optional)
- **硬底子**
  - 使用 Keras 寫出基本的 CNN
  - 用Simpson dataset練習CNN與data augmentation
  - 學會手刻generator或使用Keras內建的generator

CNN in Keras

[實戰演練]CNN in Keras:

CNN 的訓練技巧

- Data augmentation

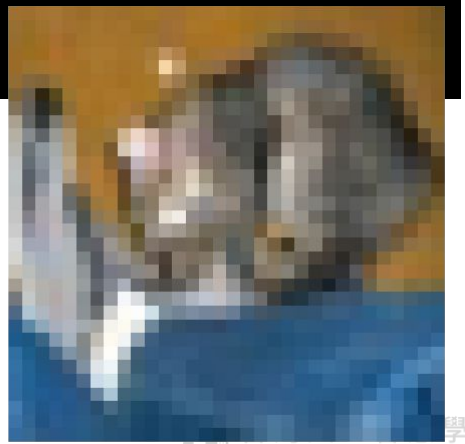
How to Load CIFAR-10 Dataset by Keras

- This reading function is provided from the Keras

```
# this function is provided from the official site
from keras.datasets import cifar10

# read train/test data
(x_train, y_train), (x_test, y_test) = cifar10.load_data()

# check the data shape
print("x_train shape:", x_train.shape)
print("numbers of training smaples:", x_train.shape[0])
print("numbers of testing smaples:", x_test.shape[0])
```

Show the images

```
import matplotlib.pyplot as plt
%matplotlib inline

# show the first image of training data
plt.imshow(x_train[0])

# show the first image of testing data
plt.imshow(x_test[0])
```



Building CNN model

32 個 3x3 filters

'valid' : without padding
'same': perform padding
default value is zero

```
'''CNN model'''
model = Sequential()
model.add(                                                    CNN
        Convolution2D(32, 3, 3, padding='same',
                      input_shape=x_train[0].shape)
        )
model.add(Activation('relu'))
model.add(Convolution2D(32, 3, 3))
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.25))

model.add(Flatten())
model.add(Dense(512))                                         DNN
model.add(Activation('relu'))
model.add(Dropout(0.5))
model.add(Dense(10))
model.add(Activation('softmax'))
```

Model Compilation

```
'''setting optimizer'''

# define the optimizer
optimizer = Adam()

# Let's compile our model
model.compile(loss='categorical_crossentropy', optimizer= optimizer,
metrics=['accuracy'])
```

Number of Parameters of Each Layer

- Only one function

```
# check parameters of every layers
model.summary()
```

- Total parameters

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
convolution2d_5 (Convolution2D)  (None, 32, 32, 32)    896
_________________________________________________________________
convolution2d_6 (Convolution2D)  (None, 30, 30, 32)    9248
_________________________________________________________________
maxpooling2d_3 (MaxPooling2D)    (None, 15, 15, 32)    0
_________________________________________________________________
dropout_5 (Dropout)          (None, 15, 15, 32)    0
_________________________________________________________________
flatten_3 (Flatten)          (None, 7200)          0
_________________________________________________________________
dense_5 (Dense)              (None, 512)           3686912
_________________________________________________________________
dropout_6 (Dropout)          (None, 512)           0
_________________________________________________________________
dense_6 (Dense)              (None, 10)            5130
=================================================================
Total params: 3702186
```

Number of Parameters of Each Layer

Layer (type)	Output Shape	Param #
convolution2d_1 (Convolution2D)	(None, 32, 32, 32)	896
activation_1 (Activation)	(None, 32, 32, 32)	0
convolution2d_2 (Convolution2D)	(None, 30, 30, 32)	9248
activation_2 (Activation)	(None, 30, 30, 32)	0
maxpooling2d_1 (MaxPooling2D)	(None, 15, 15, 32)	0
dropout_1 (Dropout)	(None, 15, 15, 32)	0
flatten_1 (Flatten)	(None, 7200)	0
dense_1 (Dense)	(None, 512)	3686912
activation_3 (Activation)	(None, 512)	0
dropout_2 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 10)	5130
activation_4 (Activation)	(None, 10)	0

Total params: 3702186

3*3*3*32 + 32

32*3*3*32 + 32

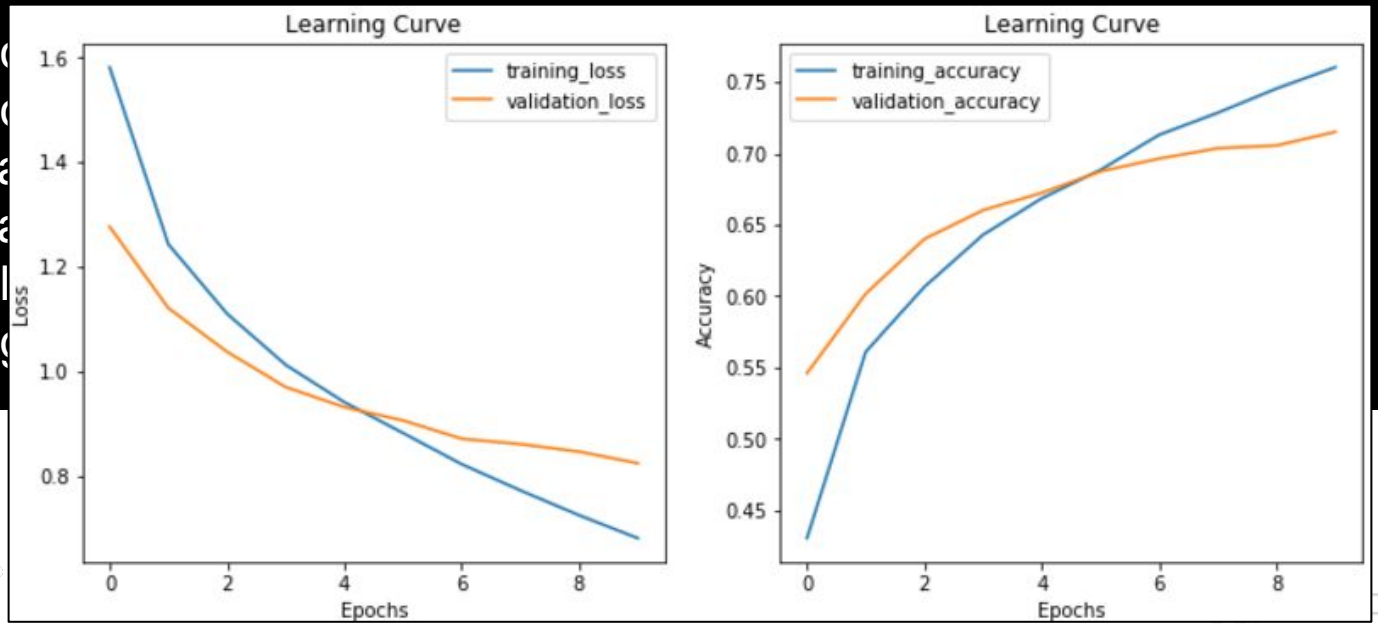
7200*512 + 512

Let’s Start Training

```
# define batch size and # of epoch
batch_size = 32 or 64 or 128
epoch = 10

# [2] validation data comes from testing data
model_history = model.fit(x_train, y_train, batch_size=batch_size,
epochs=epoch, shuffle=True,
validation_data=(x_test, y_test))
```

Plot Training History

```
# get learning loss from model_history.history
training_loss = model_history.history['loss']
testing_loss = model_history.history['val_loss']

plt.plo
plt.plo
plt.xla
plt.yla
plt.titl
plt.leg
```



Model Saving and Prediction

- Saving/loading the whole CNN model

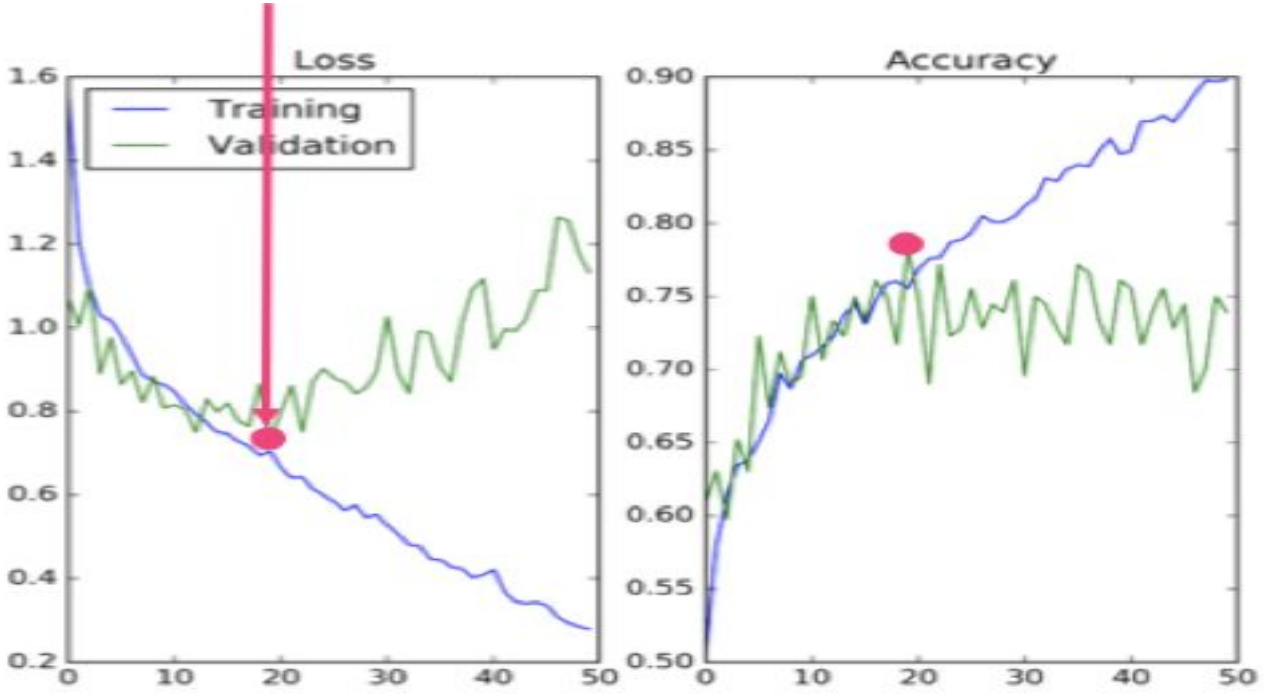
```
'''saving model'''
from keras.models import load_model
model.save('cifar10.h5')
del model

'''loading model'''
model = load_model('cifar10.h5')
```

- Predicting the classes with new image samples

```
'''prediction'''
y_pred = model.predict_classes(x_test, batch_size, verbose=0)
```

CNN 的訓練技巧

- Early Stopping



CNN 的訓練技巧

- Data augmentation

Data augmentation in Keras

```
from keras.preprocessing.image import ImageDataGenerator
datagen = ImageDataGenerator(
                rotation_range=30,
                width_shift_range=0.1,
                height_shift_range=0.1,
                horizontal_flip=True,
                     vertical_flip=False)
model.fit_generator(datagen.flow(x_train, y_train))
```

Earlystop in Keras

```
from keras.callbacks  import EarlyStopping
earlystop = EarlyStopping(
                        monitor=”val_loss”,
                      patience=5)
model.fit_generator(datagen.flow(x_train, y_train),
                      callbacks=earlystop)
```

Data Augmentation

What is data augmentation？

在資料有限的情況下，以數據處理的方式來增加大量資料。以圖片的資料增強來說，對圖片進行翻轉、旋轉、放大縮小、平移、明暗度或色調的改變，都是資料增強的一種手法。

Why data augmentation？

通常來說，無論是機器學習或者是深度學習，都會希望是有效的訓練資料是越多越好，能夠讓所訓練的模型更強健。而在實務上一個被拍到的物體或是動物，實際上的認知並不會因為在照片上的大小、位置、角度各種狀況，在學習資料不足的情況下就視為不同的東西，而透過資料增強的方式，能夠有效的解決。

How to do data augmentation？

最直接土法煉鋼的方式，就是透過Open Computer Vision(OpenCV)的API，對圖片進行放大縮小翻轉平移，甚至模糊處理，這些方式都能夠過OpenCV實現。

而在Keras之下有提供更為方便資料增量的API (ImageDataGenerator)。

Keras-ImageDataGenerator

所需套件

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

from glob import glob
import matplotlib.pyplot as plt
import cv2
import numpy as np
```

常用

```
datagen = ImageDataGenerator(
                    rotation_range=45,              #旋轉
                    width_shift_range=0.1,                  #寬度縮放
                    height_shift_range=0.1,                 #高度縮放
                    rescale=1./255,                                 #重新縮放
                    shear_range=0.4,                            #斷開位移(
                    zoom_range=0.3,                             #局部放大
                    horizontal_flip=True,                   #平移
                    channel_shift_range=50,             #色調變形
                    fill_mode='nearest') #當圖片扭曲時所產生的空白邊界進行填充。
```

更詳細請參考

https://keras.io/preprocessing/image/

範例

```
for batch in datagen.flow(x,batch_size=1,save_to_dir='./datagen', #產生的資料保存的位置
        save_prefix='cat',save_format='png'):

    i +=1
    plt.subplot(5,4,1-1+ i)
    plt.axis("off")
    augImg = batch[0]
    plt.imshow(augImg)
    if i > 7 :
        break
```

batch_size 為一次所產生的圖片數量，若最後沒設定break則會不停的產生圖片。

常見疑問

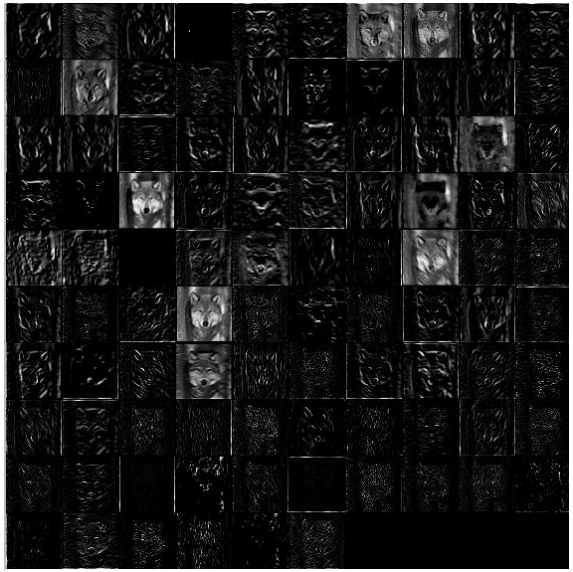
如果同學們有使用過CNN課程part1的範例，會看到下列這兩部分的程式碼

```
datagen = ImageDataGenerator(
    rotation_range=30,  # randomly rotate images in the range (degrees, 0 to 180)
    width_shift_range=0.1,  # randomly shift images horizontally (fraction of total width)
    height_shift_range=0.1,  # randomly shift images vertically (fraction of total height)
    horizontal_flip=True,  # randomly flip images
    vertical_flip=False)  # randomly flip images

model_history = model.fit_generator(datagen.flow(x_train, y_train,
                                    batch_size=batch_size),
                epochs=epochs,
                validation_data=(x_test, y_test),
                workers=4,
                callbacks=[earlystop])
```

而到底做了什麼呢？
簡單來說，就是每個Epoch從train data中隨機抽出不同的data並進行資料增強後一次吐出batch_size數量的圖片。
而不是將data增加數倍數量放在那邊再給神經網路學習，這邊很容易造成同學們誤會。

CNN 的架構建議

- 建議使用 3x3 的 filter size
- filter 數量應該要越來越多 64 -> 128 -> 256
- 盡量別做太多的 Maxpooling 以免丟失過多訊息
- 使用 Data-augmentation 增加資料量
- 使用 Earlystop 避免 Overfitting
- 若嚴重 Overfitting 可嘗試 dropout, L2 regularization

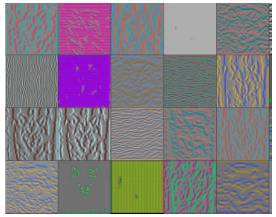


延伸閱讀-1

What does CNN learn?

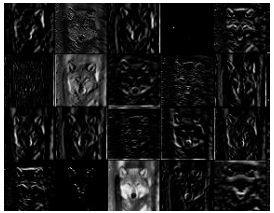
CNN到底看到了什麼，又學了什麼？

- 我們在訓練完CNN後得到的feature map到底長什麼樣子？ ->



- 餵圖片給訓練完之後的CNN，經過第一層的feature map後原圖變成什麼樣子？

  ->



[實作範例](Optional)

- 在part3/03_feature_map_optional 資料夾中
- 檔案都已經下載好，但仍需在terminal中執行以下指令，才能呼叫模組使用。
  1. **cd 你複製的資料夾位置**
  2. **cd feature_map_optional**
  3. **python setup.py install**
- 接下來在example中就有範例囉，若有興趣可以在以下的Reference中找到更多資訊。
- Reference: SourceCode來源與介紹