hw06

用其他模型完成图像分类任务

In [1]:

```
from keras.applications.resnet50 import ResNet50
# from keras.applications.inception_v3 import InceptionV3
# from keras.applications.vgg19 import VGG19
```

```
C:\Users\Ian\Anaconda3\lib\site-packages\h5py\__init__.py:36: Futur
eWarning: Conversion of the second argument of issubdtype from `flo
at` to `np.floating` is deprecated. In future, it will be treated a
s `np.float64 == np.dtype(float).type`.
  from ._conv import register_converters as _register_converters
Using TensorFlow backend.
```

In [6]:

```
from keras.preprocessing import image
from keras.applications.vgg16 import preprocess_input
import numpy as np
from keras.preprocessing.image import ImageDataGenerator
from keras.utils import np_utils
from keras.models import Sequential
from keras.layers import Dropout, Flatten, Dense
from keras.optimizers import Adam
```

In [3]:

```
ResNet50_model = ResNet50(weights='imagenet', include_top=False, input_shape=(20
0,200,3))
# InceptionV3_model = InceptionV3(weights='imagenet', include_top=False, input_s
hape=(150,150,3))
# VGG19_model = VGG19(weights='imagenet', include_top=False, input_shape=(150,15
0,3))
```

```
Downloading data from https://github.com/fchollet/deep-learning-mod
els/releases/download/v0.2/resnet50_weights_tf_dim_ordering_tf_kern
els_notop.h5
94658560/94653016 [==============================] - 45s 0us/step
```

In [4]:

```
ResNet50_model.summary()
```

```
__________________________________________________________________________
_____________________________________
Layer (type)                 Output Shape              Param #     Co
nnected to
==========================================================================
==============================
input_1 (InputLayer)         (None, 200, 200, 3)       0

__________________________________________________________________________
_____________________________________
conv1_pad (ZeroPadding2D)    (None, 206, 206, 3)       0           in
put_1[0][0]
__________________________________________________________________________
_____________________________________
conv1 (Conv2D)               (None, 100, 100, 64)      9472        co
nv1_pad[0][0]
__________________________________________________________________________
_____________________________________
bn_conv1 (BatchNormalization) (None, 100, 100, 64)     256         co
nv1[0][0]
__________________________________________________________________________
_____________________________________
activation_1 (Activation)    (None, 100, 100, 64)      0           bn
_conv1[0][0]
__________________________________________________________________________
_____________________________________
max_pooling2d_1 (MaxPooling2D) (None, 49, 49, 64)      0           ac
tivation_1[0][0]
__________________________________________________________________________
_____________________________________
res2a_branch2a (Conv2D)      (None, 49, 49, 64)        4160        ma
x_pooling2d_1[0][0]
__________________________________________________________________________
_____________________________________
bn2a_branch2a (BatchNormalizati (None, 49, 49, 64)     256         re
s2a_branch2a[0][0]
__________________________________________________________________________
_____________________________________
activation_2 (Activation)    (None, 49, 49, 64)        0           bn
2a_branch2a[0][0]
__________________________________________________________________________
_____________________________________
res2a_branch2b (Conv2D)      (None, 49, 49, 64)        36928       ac
tivation_2[0][0]
__________________________________________________________________________
_____________________________________
bn2a_branch2b (BatchNormalizati (None, 49, 49, 64)     256         re
s2a_branch2b[0][0]
__________________________________________________________________________
_____________________________________
activation_3 (Activation)    (None, 49, 49, 64)        0           bn
2a_branch2b[0][0]
__________________________________________________________________________
_____________________________________
res2a_branch2c (Conv2D)      (None, 49, 49, 256)       16640       ac
tivation_3[0][0]
__________________________________________________________________________
_____________________________________
res2a_branch1 (Conv2D)       (None, 49, 49, 256)       16640       ma
x_pooling2d_1[0][0]
__________________________________________________________________________
```

```
__________________________________
bn2a_branch2c (BatchNormalizati (None, 49, 49, 256)  1024        re
s2a_branch2c[0][0]
__________________________________________________________________
__________________________________
bn2a_branch1 (BatchNormalizatio (None, 49, 49, 256)  1024        re
s2a_branch1[0][0]
__________________________________________________________________
__________________________________
add_1 (Add)                     (None, 49, 49, 256)  0           bn
2a_branch2c[0][0]
                                                                 bn
2a_branch1[0][0]
__________________________________________________________________
__________________________________
activation_4 (Activation)       (None, 49, 49, 256)  0           ad
d_1[0][0]
__________________________________________________________________
__________________________________
res2b_branch2a (Conv2D)         (None, 49, 49, 64)   16448       ac
tivation_4[0][0]
__________________________________________________________________
__________________________________
bn2b_branch2a (BatchNormalizati (None, 49, 49, 64)   256         re
s2b_branch2a[0][0]
__________________________________________________________________
__________________________________
activation_5 (Activation)       (None, 49, 49, 64)   0           bn
2b_branch2a[0][0]
__________________________________________________________________
__________________________________
res2b_branch2b (Conv2D)         (None, 49, 49, 64)   36928       ac
tivation_5[0][0]
__________________________________________________________________
__________________________________
bn2b_branch2b (BatchNormalizati (None, 49, 49, 64)   256         re
s2b_branch2b[0][0]
__________________________________________________________________
__________________________________
activation_6 (Activation)       (None, 49, 49, 64)   0           bn
2b_branch2b[0][0]
__________________________________________________________________
__________________________________
res2b_branch2c (Conv2D)         (None, 49, 49, 256)  16640       ac
tivation_6[0][0]
__________________________________________________________________
__________________________________
bn2b_branch2c (BatchNormalizati (None, 49, 49, 256)  1024        re
s2b_branch2c[0][0]
__________________________________________________________________
__________________________________
add_2 (Add)                     (None, 49, 49, 256)  0           bn
2b_branch2c[0][0]
                                                                 ac
tivation_4[0][0]
__________________________________________________________________
__________________________________
activation_7 (Activation)       (None, 49, 49, 256)  0           ad
d_2[0][0]
__________________________________________________________________
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```

```
res2c_branch2a (Conv2D)          (None, 49, 49, 64)   16448       ac
tivation_7[0][0]
__________________________________________________________________________
_____
bn2c_branch2a (BatchNormalizati (None, 49, 49, 64)   256         re
s2c_branch2a[0][0]
__________________________________________________________________________
_____
activation_8 (Activation)        (None, 49, 49, 64)   0           bn
2c_branch2a[0][0]
__________________________________________________________________________
_____
res2c_branch2b (Conv2D)          (None, 49, 49, 64)   36928       ac
tivation_8[0][0]
__________________________________________________________________________
_____
bn2c_branch2b (BatchNormalizati (None, 49, 49, 64)   256         re
s2c_branch2b[0][0]
__________________________________________________________________________
_____
activation_9 (Activation)        (None, 49, 49, 64)   0           bn
2c_branch2b[0][0]
__________________________________________________________________________
_____
res2c_branch2c (Conv2D)          (None, 49, 49, 256)  16640       ac
tivation_9[0][0]
__________________________________________________________________________
_____
bn2c_branch2c (BatchNormalizati (None, 49, 49, 256)  1024        re
s2c_branch2c[0][0]
__________________________________________________________________________
_____
add_3 (Add)                      (None, 49, 49, 256)  0           bn
2c_branch2c[0][0]
                                                                  ac
tivation_7[0][0]
__________________________________________________________________________
_____
activation_10 (Activation)       (None, 49, 49, 256)  0           ad
d_3[0][0]
__________________________________________________________________________
_____
res3a_branch2a (Conv2D)          (None, 25, 25, 128)  32896       ac
tivation_10[0][0]
__________________________________________________________________________
_____
bn3a_branch2a (BatchNormalizati (None, 25, 25, 128)  512         re
s3a_branch2a[0][0]
__________________________________________________________________________
_____
activation_11 (Activation)       (None, 25, 25, 128)  0           bn
3a_branch2a[0][0]
__________________________________________________________________________
_____
res3a_branch2b (Conv2D)          (None, 25, 25, 128)  147584      ac
tivation_11[0][0]
__________________________________________________________________________
_____
bn3a_branch2b (BatchNormalizati (None, 25, 25, 128)  512         re
s3a_branch2b[0][0]
__________________________________________________________________________
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__________________________________
activation_12 (Activation)      (None, 25, 25, 128)  0           bn
3a_branch2b[0][0]
__________________________________________________________________
__________________________________
res3a_branch2c (Conv2D)         (None, 25, 25, 512)  66048       ac
tivation_12[0][0]
__________________________________________________________________
__________________________________
res3a_branch1 (Conv2D)          (None, 25, 25, 512)  131584      ac
tivation_10[0][0]
__________________________________________________________________
__________________________________
bn3a_branch2c (BatchNormalizati (None, 25, 25, 512)  2048        re
s3a_branch2c[0][0]
__________________________________________________________________
__________________________________
bn3a_branch1 (BatchNormalizatio (None, 25, 25, 512)  2048        re
s3a_branch1[0][0]
__________________________________________________________________
__________________________________
add_4 (Add)                     (None, 25, 25, 512)  0           bn
3a_branch2c[0][0]
                                                                 bn
3a_branch1[0][0]
__________________________________________________________________
__________________________________
activation_13 (Activation)      (None, 25, 25, 512)  0           ad
d_4[0][0]
__________________________________________________________________
__________________________________
res3b_branch2a (Conv2D)         (None, 25, 25, 128)  65664       ac
tivation_13[0][0]
__________________________________________________________________
__________________________________
bn3b_branch2a (BatchNormalizati (None, 25, 25, 128)  512         re
s3b_branch2a[0][0]
__________________________________________________________________
__________________________________
activation_14 (Activation)      (None, 25, 25, 128)  0           bn
3b_branch2a[0][0]
__________________________________________________________________
__________________________________
res3b_branch2b (Conv2D)         (None, 25, 25, 128)  147584      ac
tivation_14[0][0]
__________________________________________________________________
__________________________________
bn3b_branch2b (BatchNormalizati (None, 25, 25, 128)  512         re
s3b_branch2b[0][0]
__________________________________________________________________
__________________________________
activation_15 (Activation)      (None, 25, 25, 128)  0           bn
3b_branch2b[0][0]
__________________________________________________________________
__________________________________
res3b_branch2c (Conv2D)         (None, 25, 25, 512)  66048       ac
tivation_15[0][0]
__________________________________________________________________
__________________________________
bn3b_branch2c (BatchNormalizati (None, 25, 25, 512)  2048        re
s3b_branch2c[0][0]
```

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__________________________________________________________________________________________________
____________________________________
add_5 (Add)                     (None, 25, 25, 512)  0           bn
3b_branch2c[0][0]
                                                                 ac
tivation_13[0][0]
__________________________________________________________________________________________________
____________________________________
activation_16 (Activation)      (None, 25, 25, 512)  0           ad
d_5[0][0]
__________________________________________________________________________________________________
____________________________________
res3c_branch2a (Conv2D)         (None, 25, 25, 128)  65664       ac
tivation_16[0][0]
__________________________________________________________________________________________________
____________________________________
bn3c_branch2a (BatchNormalizati (None, 25, 25, 128)  512         re
s3c_branch2a[0][0]
__________________________________________________________________________________________________
____________________________________
activation_17 (Activation)      (None, 25, 25, 128)  0           bn
3c_branch2a[0][0]
__________________________________________________________________________________________________
____________________________________
res3c_branch2b (Conv2D)         (None, 25, 25, 128)  147584      ac
tivation_17[0][0]
__________________________________________________________________________________________________
____________________________________
bn3c_branch2b (BatchNormalizati (None, 25, 25, 128)  512         re
s3c_branch2b[0][0]
__________________________________________________________________________________________________
____________________________________
activation_18 (Activation)      (None, 25, 25, 128)  0           bn
3c_branch2b[0][0]
__________________________________________________________________________________________________
____________________________________
res3c_branch2c (Conv2D)         (None, 25, 25, 512)  66048       ac
tivation_18[0][0]
__________________________________________________________________________________________________
____________________________________
bn3c_branch2c (BatchNormalizati (None, 25, 25, 512)  2048        re
s3c_branch2c[0][0]
__________________________________________________________________________________________________
____________________________________
add_6 (Add)                     (None, 25, 25, 512)  0           bn
3c_branch2c[0][0]
                                                                 ac
tivation_16[0][0]
__________________________________________________________________________________________________
____________________________________
activation_19 (Activation)      (None, 25, 25, 512)  0           ad
d_6[0][0]
__________________________________________________________________________________________________
____________________________________
res3d_branch2a (Conv2D)         (None, 25, 25, 128)  65664       ac
tivation_19[0][0]
__________________________________________________________________________________________________
____________________________________
bn3d_branch2a (BatchNormalizati (None, 25, 25, 128)  512         re
s3d_branch2a[0][0]
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____________________________________
activation_20 (Activation)       (None, 25, 25, 128)  0           bn
3d_branch2a[0][0]
____________________________________________________________________________________
____________________________________
res3d_branch2b (Conv2D)          (None, 25, 25, 128)  147584      ac
tivation_20[0][0]
____________________________________________________________________________________
____________________________________
bn3d_branch2b (BatchNormalizati (None, 25, 25, 128)  512         re
s3d_branch2b[0][0]
____________________________________________________________________________________
____________________________________
activation_21 (Activation)       (None, 25, 25, 128)  0           bn
3d_branch2b[0][0]
____________________________________________________________________________________
____________________________________
res3d_branch2c (Conv2D)          (None, 25, 25, 512)  66048       ac
tivation_21[0][0]
____________________________________________________________________________________
____________________________________
bn3d_branch2c (BatchNormalizati (None, 25, 25, 512)  2048        re
s3d_branch2c[0][0]
____________________________________________________________________________________
____________________________________
add_7 (Add)                      (None, 25, 25, 512)  0           bn
3d_branch2c[0][0]
                                                                  ac
tivation_19[0][0]
____________________________________________________________________________________
____________________________________
activation_22 (Activation)       (None, 25, 25, 512)  0           ad
d_7[0][0]
____________________________________________________________________________________
____________________________________
res4a_branch2a (Conv2D)          (None, 13, 13, 256)  131328      ac
tivation_22[0][0]
____________________________________________________________________________________
____________________________________
bn4a_branch2a (BatchNormalizati (None, 13, 13, 256)  1024        re
s4a_branch2a[0][0]
____________________________________________________________________________________
____________________________________
activation_23 (Activation)       (None, 13, 13, 256)  0           bn
4a_branch2a[0][0]
____________________________________________________________________________________
____________________________________
res4a_branch2b (Conv2D)          (None, 13, 13, 256)  590080      ac
tivation_23[0][0]
____________________________________________________________________________________
____________________________________
bn4a_branch2b (BatchNormalizati (None, 13, 13, 256)  1024        re
s4a_branch2b[0][0]
____________________________________________________________________________________
____________________________________
activation_24 (Activation)       (None, 13, 13, 256)  0           bn
4a_branch2b[0][0]
____________________________________________________________________________________
____________________________________
res4a_branch2c (Conv2D)          (None, 13, 13, 1024) 263168      ac
tivation_24[0][0]
```

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__________________________________________________________________________________________________
____________________________________
res4a_branch1 (Conv2D)          (None, 13, 13, 1024) 525312      ac
tivation_22[0][0]
__________________________________________________________________________________________________
____________________________________
bn4a_branch2c (BatchNormalizati (None, 13, 13, 1024) 4096        re
s4a_branch2c[0][0]
__________________________________________________________________________________________________
____________________________________
bn4a_branch1 (BatchNormalizatio (None, 13, 13, 1024) 4096        re
s4a_branch1[0][0]
__________________________________________________________________________________________________
____________________________________
add_8 (Add)                     (None, 13, 13, 1024) 0           bn
4a_branch2c[0][0]
                                                                 bn
4a_branch1[0][0]
__________________________________________________________________________________________________
____________________________________
activation_25 (Activation)      (None, 13, 13, 1024) 0           ad
d_8[0][0]
__________________________________________________________________________________________________
____________________________________
res4b_branch2a (Conv2D)         (None, 13, 13, 256)  262400      ac
tivation_25[0][0]
__________________________________________________________________________________________________
____________________________________
bn4b_branch2a (BatchNormalizati (None, 13, 13, 256)  1024        re
s4b_branch2a[0][0]
__________________________________________________________________________________________________
____________________________________
activation_26 (Activation)      (None, 13, 13, 256)  0           bn
4b_branch2a[0][0]
__________________________________________________________________________________________________
____________________________________
res4b_branch2b (Conv2D)         (None, 13, 13, 256)  590080      ac
tivation_26[0][0]
__________________________________________________________________________________________________
____________________________________
bn4b_branch2b (BatchNormalizati (None, 13, 13, 256)  1024        re
s4b_branch2b[0][0]
__________________________________________________________________________________________________
____________________________________
activation_27 (Activation)      (None, 13, 13, 256)  0           bn
4b_branch2b[0][0]
__________________________________________________________________________________________________
____________________________________
res4b_branch2c (Conv2D)         (None, 13, 13, 1024) 263168      ac
tivation_27[0][0]
__________________________________________________________________________________________________
____________________________________
bn4b_branch2c (BatchNormalizati (None, 13, 13, 1024) 4096        re
s4b_branch2c[0][0]
__________________________________________________________________________________________________
____________________________________
add_9 (Add)                     (None, 13, 13, 1024) 0           bn
4b_branch2c[0][0]
                                                                 ac
tivation_25[0][0]
__________________________________________________________________________________________________
```

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__________________________________
activation_28 (Activation)      (None, 13, 13, 1024) 0           ad
d_9[0][0]
__________________________________________________________________
__________________________________
res4c_branch2a (Conv2D)         (None, 13, 13, 256)  262400      ac
tivation_28[0][0]
__________________________________________________________________
__________________________________
bn4c_branch2a (BatchNormalizati (None, 13, 13, 256)  1024        re
s4c_branch2a[0][0]
__________________________________________________________________
__________________________________
activation_29 (Activation)      (None, 13, 13, 256)  0           bn
4c_branch2a[0][0]
__________________________________________________________________
__________________________________
res4c_branch2b (Conv2D)         (None, 13, 13, 256)  590080      ac
tivation_29[0][0]
__________________________________________________________________
__________________________________
bn4c_branch2b (BatchNormalizati (None, 13, 13, 256)  1024        re
s4c_branch2b[0][0]
__________________________________________________________________
__________________________________
activation_30 (Activation)      (None, 13, 13, 256)  0           bn
4c_branch2b[0][0]
__________________________________________________________________
__________________________________
res4c_branch2c (Conv2D)         (None, 13, 13, 1024) 263168      ac
tivation_30[0][0]
__________________________________________________________________
__________________________________
bn4c_branch2c (BatchNormalizati (None, 13, 13, 1024) 4096        re
s4c_branch2c[0][0]
__________________________________________________________________
__________________________________
add_10 (Add)                    (None, 13, 13, 1024) 0           bn
4c_branch2c[0][0]
                                                                 ac
tivation_28[0][0]
__________________________________________________________________
__________________________________
activation_31 (Activation)      (None, 13, 13, 1024) 0           ad
d_10[0][0]
__________________________________________________________________
__________________________________
res4d_branch2a (Conv2D)         (None, 13, 13, 256)  262400      ac
tivation_31[0][0]
__________________________________________________________________
__________________________________
bn4d_branch2a (BatchNormalizati (None, 13, 13, 256)  1024        re
s4d_branch2a[0][0]
__________________________________________________________________
__________________________________
activation_32 (Activation)      (None, 13, 13, 256)  0           bn
4d_branch2a[0][0]
__________________________________________________________________
__________________________________
res4d_branch2b (Conv2D)         (None, 13, 13, 256)  590080      ac
tivation_32[0][0]
```

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__________________________________________________________________________________________________
____________________________________
bn4d_branch2b (BatchNormalizati (None, 13, 13, 256)  1024        re
s4d_branch2b[0][0]
__________________________________________________________________________________________________
____________________________________
activation_33 (Activation)      (None, 13, 13, 256)  0           bn
4d_branch2b[0][0]
__________________________________________________________________________________________________
____________________________________
res4d_branch2c (Conv2D)         (None, 13, 13, 1024) 263168      ac
tivation_33[0][0]
__________________________________________________________________________________________________
____________________________________
bn4d_branch2c (BatchNormalizati (None, 13, 13, 1024) 4096        re
s4d_branch2c[0][0]
__________________________________________________________________________________________________
____________________________________
add_11 (Add)                    (None, 13, 13, 1024) 0           bn
4d_branch2c[0][0]
                                                                 ac
tivation_31[0][0]
__________________________________________________________________________________________________
____________________________________
activation_34 (Activation)      (None, 13, 13, 1024) 0           ad
d_11[0][0]
__________________________________________________________________________________________________
____________________________________
res4e_branch2a (Conv2D)         (None, 13, 13, 256)  262400      ac
tivation_34[0][0]
__________________________________________________________________________________________________
____________________________________
bn4e_branch2a (BatchNormalizati (None, 13, 13, 256)  1024        re
s4e_branch2a[0][0]
__________________________________________________________________________________________________
____________________________________
activation_35 (Activation)      (None, 13, 13, 256)  0           bn
4e_branch2a[0][0]
__________________________________________________________________________________________________
____________________________________
res4e_branch2b (Conv2D)         (None, 13, 13, 256)  590080      ac
tivation_35[0][0]
__________________________________________________________________________________________________
____________________________________
bn4e_branch2b (BatchNormalizati (None, 13, 13, 256)  1024        re
s4e_branch2b[0][0]
__________________________________________________________________________________________________
____________________________________
activation_36 (Activation)      (None, 13, 13, 256)  0           bn
4e_branch2b[0][0]
__________________________________________________________________________________________________
____________________________________
res4e_branch2c (Conv2D)         (None, 13, 13, 1024) 263168      ac
tivation_36[0][0]
__________________________________________________________________________________________________
____________________________________
bn4e_branch2c (BatchNormalizati (None, 13, 13, 1024) 4096        re
s4e_branch2c[0][0]
__________________________________________________________________________________________________
____________________________________
add_12 (Add)                    (None, 13, 13, 1024) 0           bn
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4e_branch2c[0][0]
                                                                  ac
tivation_34[0][0]
__________________________________________________________________________________
_____________________________________
activation_37 (Activation)      (None, 13, 13, 1024) 0           ad
d_12[0][0]
__________________________________________________________________________________
_____________________________________
res4f_branch2a (Conv2D)         (None, 13, 13, 256)  262400      ac
tivation_37[0][0]
__________________________________________________________________________________
_____________________________________
bn4f_branch2a (BatchNormalizati (None, 13, 13, 256)  1024        re
s4f_branch2a[0][0]
__________________________________________________________________________________
_____________________________________
activation_38 (Activation)      (None, 13, 13, 256)  0           bn
4f_branch2a[0][0]
__________________________________________________________________________________
_____________________________________
res4f_branch2b (Conv2D)         (None, 13, 13, 256)  590080      ac
tivation_38[0][0]
__________________________________________________________________________________
_____________________________________
bn4f_branch2b (BatchNormalizati (None, 13, 13, 256)  1024        re
s4f_branch2b[0][0]
__________________________________________________________________________________
_____________________________________
activation_39 (Activation)      (None, 13, 13, 256)  0           bn
4f_branch2b[0][0]
__________________________________________________________________________________
_____________________________________
res4f_branch2c (Conv2D)         (None, 13, 13, 1024) 263168      ac
tivation_39[0][0]
__________________________________________________________________________________
_____________________________________
bn4f_branch2c (BatchNormalizati (None, 13, 13, 1024) 4096        re
s4f_branch2c[0][0]
__________________________________________________________________________________
_____________________________________
add_13 (Add)                    (None, 13, 13, 1024) 0           bn
4f_branch2c[0][0]
                                                                  ac
tivation_37[0][0]
__________________________________________________________________________________
_____________________________________
activation_40 (Activation)      (None, 13, 13, 1024) 0           ad
d_13[0][0]
__________________________________________________________________________________
_____________________________________
res5a_branch2a (Conv2D)         (None, 7, 7, 512)    524800      ac
tivation_40[0][0]
__________________________________________________________________________________
_____________________________________
bn5a_branch2a (BatchNormalizati (None, 7, 7, 512)    2048        re
s5a_branch2a[0][0]
__________________________________________________________________________________
_____________________________________
activation_41 (Activation)      (None, 7, 7, 512)    0           bn
5a_branch2a[0][0]
```

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__________________________________________________________________________________________________
____________________________________
res5a_branch2b (Conv2D)          (None, 7, 7, 512)    2359808     ac
tivation_41[0][0]
__________________________________________________________________________________________________
____________________________________
bn5a_branch2b (BatchNormalizati (None, 7, 7, 512)    2048        re
s5a_branch2b[0][0]
__________________________________________________________________________________________________
____________________________________
activation_42 (Activation)       (None, 7, 7, 512)    0           bn
5a_branch2b[0][0]
__________________________________________________________________________________________________
____________________________________
res5a_branch2c (Conv2D)          (None, 7, 7, 2048)   1050624     ac
tivation_42[0][0]
__________________________________________________________________________________________________
____________________________________
res5a_branch1 (Conv2D)           (None, 7, 7, 2048)   2099200     ac
tivation_40[0][0]
__________________________________________________________________________________________________
____________________________________
bn5a_branch2c (BatchNormalizati (None, 7, 7, 2048)   8192        re
s5a_branch2c[0][0]
__________________________________________________________________________________________________
____________________________________
bn5a_branch1 (BatchNormalizatio (None, 7, 7, 2048)   8192        re
s5a_branch1[0][0]
__________________________________________________________________________________________________
____________________________________
add_14 (Add)                     (None, 7, 7, 2048)   0           bn
5a_branch2c[0][0]
                                                                  bn
5a_branch1[0][0]
__________________________________________________________________________________________________
____________________________________
activation_43 (Activation)       (None, 7, 7, 2048)   0           ad
d_14[0][0]
__________________________________________________________________________________________________
____________________________________
res5b_branch2a (Conv2D)          (None, 7, 7, 512)    1049088     ac
tivation_43[0][0]
__________________________________________________________________________________________________
____________________________________
bn5b_branch2a (BatchNormalizati (None, 7, 7, 512)    2048        re
s5b_branch2a[0][0]
__________________________________________________________________________________________________
____________________________________
activation_44 (Activation)       (None, 7, 7, 512)    0           bn
5b_branch2a[0][0]
__________________________________________________________________________________________________
____________________________________
res5b_branch2b (Conv2D)          (None, 7, 7, 512)    2359808     ac
tivation_44[0][0]
__________________________________________________________________________________________________
____________________________________
bn5b_branch2b (BatchNormalizati (None, 7, 7, 512)    2048        re
s5b_branch2b[0][0]
__________________________________________________________________________________________________
____________________________________
activation_45 (Activation)       (None, 7, 7, 512)    0           bn
```

```
5b_branch2b[0][0]
__________________________________________________________________________
_____________________________________
res5b_branch2c (Conv2D)          (None, 7, 7, 2048)   1050624     ac
tivation_45[0][0]
__________________________________________________________________________
_____________________________________
bn5b_branch2c (BatchNormalizati (None, 7, 7, 2048)   8192        re
s5b_branch2c[0][0]
__________________________________________________________________________
_____________________________________
add_15 (Add)                     (None, 7, 7, 2048)   0           bn
5b_branch2c[0][0]
                                                                  ac
tivation_43[0][0]
__________________________________________________________________________
_____________________________________
activation_46 (Activation)       (None, 7, 7, 2048)   0           ad
d_15[0][0]
__________________________________________________________________________
_____________________________________
res5c_branch2a (Conv2D)          (None, 7, 7, 512)    1049088     ac
tivation_46[0][0]
__________________________________________________________________________
_____________________________________
bn5c_branch2a (BatchNormalizati (None, 7, 7, 512)    2048        re
s5c_branch2a[0][0]
__________________________________________________________________________
_____________________________________
activation_47 (Activation)       (None, 7, 7, 512)    0           bn
5c_branch2a[0][0]
__________________________________________________________________________
_____________________________________
res5c_branch2b (Conv2D)          (None, 7, 7, 512)    2359808     ac
tivation_47[0][0]
__________________________________________________________________________
_____________________________________
bn5c_branch2b (BatchNormalizati (None, 7, 7, 512)    2048        re
s5c_branch2b[0][0]
__________________________________________________________________________
_____________________________________
activation_48 (Activation)       (None, 7, 7, 512)    0           bn
5c_branch2b[0][0]
__________________________________________________________________________
_____________________________________
res5c_branch2c (Conv2D)          (None, 7, 7, 2048)   1050624     ac
tivation_48[0][0]
__________________________________________________________________________
_____________________________________
bn5c_branch2c (BatchNormalizati (None, 7, 7, 2048)   8192        re
s5c_branch2c[0][0]
__________________________________________________________________________
_____________________________________
add_16 (Add)                     (None, 7, 7, 2048)   0           bn
5c_branch2c[0][0]
                                                                  ac
tivation_46[0][0]
__________________________________________________________________________
_____________________________________
activation_49 (Activation)       (None, 7, 7, 2048)   0           ad
d_16[0][0]
```

```
__________________________________________________________________________________
_____________________________________
avg_pool (AveragePooling2D)      (None, 1, 1, 2048)    0           ac
tivation_49[0][0]
==================================================================================
==============================
Total params: 23,587,712
Trainable params: 23,534,592
Non-trainable params: 53,120

__________________________________________________________________________________
_____________________________________
```

In [7]:

```
datagen = ImageDataGenerator(
        rotation_range = 40,       # 随机旋转角度
        width_shift_range = 0.2,   # 随机水平平移
        height_shift_range = 0.2, # 随机竖直平移
        rescale = 1./255,          # 数值归一化
        shear_range = 0.2,         # 随机裁剪
        zoom_range  =0.2,          # 随机放大
        horizontal_flip = True,    # 水平翻转
        fill_mode='nearest')       # 填充方式
```

In [21]:

```
batch_size = 32
#
train_steps = int((4002 +  batch_size - 1)/batch_size)*10
test_steps = int((1000 +  batch_size - 1)/batch_size)*10
generator = datagen.flow_from_directory(
        'image/train',
        target_size=(200, 200),
        batch_size=batch_size,
        class_mode=None,  # 不生成标签
        shuffle=False)    # 不随机打乱
```

```
Found 4002 images belonging to 2 classes.
```

In [22]:

```
# 得到训练集数据
bottleneck_features_train = ResNet50_model.predict_generator(generator, train_st
eps)
print(bottleneck_features_train.shape)
# 保存训练集bottleneck结果
np.save(open('bottleneck_features_train.npy', 'wb'), bottleneck_features_train)
```

```
(40020, 1, 1, 2048)
```

In [23]:

```
generator = datagen.flow_from_directory(
        'image/test',
        target_size=(200, 200),
        batch_size=batch_size,
        class_mode=None, # 不生成标签
        shuffle=False)  # 不随机打乱
# 得到预测集数据
bottleneck_features_test = ResNet50_model.predict_generator(generator, test_step
s)
print(bottleneck_features_test.shape)
# 保存测试集bottleneck结果
np.save(open('bottleneck_features_test.npy', 'wb'), bottleneck_features_test)
```

```
Found 1000 images belonging to 2 classes.
(10000, 1, 1, 2048)
```

In [24]:

```
train_data = np.load(open('bottleneck_features_train.npy','rb'))
# the features were saved in order, so recreating the labels is easy
labels = np.array([0] * 2001 + [1] * 2001)
train_labels = np.array([])
for _ in range(10):
    train_labels=np.concatenate((train_labels,labels))

test_data = np.load(open('bottleneck_features_test.npy','rb'))
labels = np.array([0] * 500 + [1] * 500)
test_labels = np.array([])
for _ in range(10):
    test_labels=np.concatenate((test_labels,labels))

train_labels = np_utils.to_categorical(train_labels,num_classes=2)
test_labels = np_utils.to_categorical(test_labels,num_classes=2)
```

In [25]:

```
model = Sequential()
model.add(Flatten(input_shape=train_data.shape[1:]))
model.add(Dense(256, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(2, activation='softmax'))

# 定义优化器
adam = Adam(lr=1e-4)

# 定义优化器，loss function，训练过程中计算准确率
model.compile(optimizer=adam,loss='categorical_crossentropy',metrics=
['accuracy'])

model.fit(train_data, train_labels,
          epochs=20, batch_size=batch_size,
          validation_data=(test_data, test_labels))

model.save_weights('bottleneck_fc_model.h5')
```

```
Train on 40020 samples, validate on 10000 samples
Epoch 1/20
40020/40020 [==============================] - 12s 296us/step - los
s: 0.6940 - acc: 0.5438 - val_loss: 0.6790 - val_acc: 0.5971
Epoch 2/20
40020/40020 [==============================] - 10s 262us/step - los
s: 0.6832 - acc: 0.5611 - val_loss: 0.6775 - val_acc: 0.5738
Epoch 3/20
40020/40020 [==============================] - 10s 261us/step - los
s: 0.6789 - acc: 0.5672 - val_loss: 0.6731 - val_acc: 0.6023
Epoch 4/20
40020/40020 [==============================] - 10s 261us/step - los
s: 0.6737 - acc: 0.5844 - val_loss: 0.6674 - val_acc: 0.6011
Epoch 5/20
40020/40020 [==============================] - 10s 262us/step - los
s: 0.6707 - acc: 0.5894 - val_loss: 0.6624 - val_acc: 0.6122
Epoch 6/20
40020/40020 [==============================] - 10s 262us/step - los
s: 0.6678 - acc: 0.5955 - val_loss: 0.6615 - val_acc: 0.6208
Epoch 7/20
40020/40020 [==============================] - 10s 262us/step - los
s: 0.6654 - acc: 0.6029 - val_loss: 0.6551 - val_acc: 0.6201
Epoch 8/20
40020/40020 [==============================] - 10s 262us/step - los
s: 0.6627 - acc: 0.6063 - val_loss: 0.6568 - val_acc: 0.6009
Epoch 9/20
40020/40020 [==============================] - 11s 262us/step - los
s: 0.6619 - acc: 0.6057 - val_loss: 0.6521 - val_acc: 0.6142
Epoch 10/20
40020/40020 [==============================] - 11s 264us/step - los
s: 0.6602 - acc: 0.6106 - val_loss: 0.6563 - val_acc: 0.6020
Epoch 11/20
40020/40020 [==============================] - 11s 263us/step - los
s: 0.6585 - acc: 0.6117 - val_loss: 0.6501 - val_acc: 0.6297
Epoch 12/20
40020/40020 [==============================] - 11s 263us/step - los
s: 0.6577 - acc: 0.6141 - val_loss: 0.6467 - val_acc: 0.6361
Epoch 13/20
40020/40020 [==============================] - 11s 263us/step - los
s: 0.6563 - acc: 0.6147 - val_loss: 0.6470 - val_acc: 0.6253
Epoch 14/20
40020/40020 [==============================] - 11s 263us/step - los
s: 0.6559 - acc: 0.6162 - val_loss: 0.6432 - val_acc: 0.6306
Epoch 15/20
40020/40020 [==============================] - 11s 265us/step - los
s: 0.6551 - acc: 0.6170 - val_loss: 0.6446 - val_acc: 0.6377
Epoch 16/20
40020/40020 [==============================] - 11s 263us/step - los
s: 0.6533 - acc: 0.6187 - val_loss: 0.6391 - val_acc: 0.6410
Epoch 17/20
40020/40020 [==============================] - 11s 264us/step - los
s: 0.6519 - acc: 0.6194 - val_loss: 0.6419 - val_acc: 0.6383
Epoch 18/20
40020/40020 [==============================] - 11s 263us/step - los
s: 0.6515 - acc: 0.6202 - val_loss: 0.6379 - val_acc: 0.6397
Epoch 19/20
40020/40020 [==============================] - 11s 263us/step - los
s: 0.6514 - acc: 0.6182 - val_loss: 0.6353 - val_acc: 0.6403
Epoch 20/20
40020/40020 [==============================] - 11s 263us/step - los
s: 0.6503 - acc: 0.6224 - val_loss: 0.6356 - val_acc: 0.6409
```

In [15]:

```
len(model.layers)
```

Out[15]:

4