```
In [2]: %matplotlib inline
        %config InlineBackend.figure_format = 'retina'

        import matplotlib.pyplot as plt
        import matplotlib.image as mpimg
        import random
        import os, shutil
        from tqdm import tqdm
        import pickle

        from keras.applications.resnet50 import ResNet50
        from keras.preprocessing import image
        from keras.applications.resnet50 import preprocess_input, decode_predictions
        from keras.layers import GlobalAveragePooling2D, Dense, Dropout, Flatten
        from keras.models import Model, Sequential, load_model
        from keras import optimizers
        from keras.callbacks import ModelCheckpoint, EarlyStopping

        import numpy as np
        import pandas as pd
```
Using TensorFlow backend.
/home/ubuntu/anaconda3/envs/tensorflow_p36/lib/python3.6/importlib/_bootstrap.py:219: RuntimeWarning:
  return f(*args, **kwds)

```
In [3]: data_dir = './{}/'
        nb_class = len(os.listdir(data_dir.format('train')))
        data = {}
        for i in ['train', 'valid']:
            data[i] = {x: os.listdir(data_dir.format(i)+x) for x in os.listdir(data_dir.format(i))}
        nb_train_samples = sum([len(data['train'][x]) for x in data['train'].keys()])
        nb_valid_samples = sum([len(data['valid'][x]) for x in data['train'].keys()])

In [4]: print(any([data['valid']['cat'][x] in data['train']['cat'] for x in range(len(data['valid']['ca
        print(any([data['valid']['dog'][x] in data['train']['dog'] for x in range(len(data['valid']['d
```
False
False

https://zhuanlan.zhihu.com/p/26693647

```
In [5]: datagen = {'train': image.ImageDataGenerator(
            preprocessing_function=preprocess_input,
            rotation_range=30,
            width_shift_range=0.2,
            height_shift_range=0.2,
```

```
                shear_range=0.2,
                zoom_range=0.2,
                horizontal_flip=True,
                vertical_flip=True
        ),
                    'valid':image.ImageDataGenerator(
                preprocessing_function=preprocess_input
        )
                }
```

preprocess_input()rescale

https://stackoverflow.com/questions/47555829/preprocess-input-method-in-keras

```
In [6]: im_width, im_height = 224, 224
        batch_size = 64

        generator = {x: datagen[x].flow_from_directory(
            data_dir.format(x),
            target_size=(im_width, im_height),
            batch_size=batch_size,
            seed = 0,
            class_mode = 'binary'
        ) for x in datagen.keys()}
```

```
Found 16662 images belonging to 2 classes.
Found 8208 images belonging to 2 classes.
```

```
In [7]: model_base = ResNet50(weights='imagenet', include_top=False, input_shape = (im_width, im_heigh
```

```
In [8]: model_base.summary()
```

Layer (type)	Output Shape	Param #	Connected to
input_1 (InputLayer)	(None, 224, 224, 3)	0	
conv1 (Conv2D)	(None, 112, 112, 64)	9472	input_1[0][0]
bn_conv1 (BatchNormalization)	(None, 112, 112, 64)	256	conv1[0][0]
activation_1 (Activation)	(None, 112, 112, 64)	0	bn_conv1[0][0]
max_pooling2d_1 (MaxPooling2D)	(None, 55, 55, 64)	0	activation_1[0][0]
res2a_branch2a (Conv2D)	(None, 55, 55, 64)	4160	max_pooling2d_1[0][0]
bn2a_branch2a (BatchNormalizati	(None, 55, 55, 64)	256	res2a_branch2a[0][0]

```
activation_2 (Activation)        (None, 55, 55, 64)    0          bn2a_branch2a[0][0]
--------------------------------------------------------------------------------------------------
res2a_branch2b (Conv2D)          (None, 55, 55, 64)    36928      activation_2[0][0]
--------------------------------------------------------------------------------------------------
bn2a_branch2b (BatchNormalizati (None, 55, 55, 64)     256        res2a_branch2b[0][0]
--------------------------------------------------------------------------------------------------
activation_3 (Activation)        (None, 55, 55, 64)    0          bn2a_branch2b[0][0]
--------------------------------------------------------------------------------------------------
res2a_branch2c (Conv2D)          (None, 55, 55, 256)   16640      activation_3[0][0]
--------------------------------------------------------------------------------------------------
res2a_branch1 (Conv2D)           (None, 55, 55, 256)   16640      max_pooling2d_1[0][0]
--------------------------------------------------------------------------------------------------
bn2a_branch2c (BatchNormalizati (None, 55, 55, 256)    1024       res2a_branch2c[0][0]
--------------------------------------------------------------------------------------------------
bn2a_branch1 (BatchNormalizatio (None, 55, 55, 256)    1024       res2a_branch1[0][0]
--------------------------------------------------------------------------------------------------
add_1 (Add)                      (None, 55, 55, 256)   0          bn2a_branch2c[0][0]
                                                                  bn2a_branch1[0][0]
--------------------------------------------------------------------------------------------------
activation_4 (Activation)        (None, 55, 55, 256)   0          add_1[0][0]
--------------------------------------------------------------------------------------------------
res2b_branch2a (Conv2D)          (None, 55, 55, 64)    16448      activation_4[0][0]
--------------------------------------------------------------------------------------------------
bn2b_branch2a (BatchNormalizati (None, 55, 55, 64)     256        res2b_branch2a[0][0]
--------------------------------------------------------------------------------------------------
activation_5 (Activation)        (None, 55, 55, 64)    0          bn2b_branch2a[0][0]
--------------------------------------------------------------------------------------------------
res2b_branch2b (Conv2D)          (None, 55, 55, 64)    36928      activation_5[0][0]
--------------------------------------------------------------------------------------------------
bn2b_branch2b (BatchNormalizati (None, 55, 55, 64)     256        res2b_branch2b[0][0]
--------------------------------------------------------------------------------------------------
activation_6 (Activation)        (None, 55, 55, 64)    0          bn2b_branch2b[0][0]
--------------------------------------------------------------------------------------------------
res2b_branch2c (Conv2D)          (None, 55, 55, 256)   16640      activation_6[0][0]
--------------------------------------------------------------------------------------------------
bn2b_branch2c (BatchNormalizati (None, 55, 55, 256)    1024       res2b_branch2c[0][0]
--------------------------------------------------------------------------------------------------
add_2 (Add)                      (None, 55, 55, 256)   0          bn2b_branch2c[0][0]
                                                                  activation_4[0][0]
--------------------------------------------------------------------------------------------------
activation_7 (Activation)        (None, 55, 55, 256)   0          add_2[0][0]
--------------------------------------------------------------------------------------------------
res2c_branch2a (Conv2D)          (None, 55, 55, 64)    16448      activation_7[0][0]
--------------------------------------------------------------------------------------------------
bn2c_branch2a (BatchNormalizati (None, 55, 55, 64)     256        res2c_branch2a[0][0]
--------------------------------------------------------------------------------------------------
activation_8 (Activation)        (None, 55, 55, 64)    0          bn2c_branch2a[0][0]
--------------------------------------------------------------------------------------------------
res2c_branch2b (Conv2D)          (None, 55, 55, 64)    36928      activation_8[0][0]
--------------------------------------------------------------------------------------------------
bn2c_branch2b (BatchNormalizati (None, 55, 55, 64)     256        res2c_branch2b[0][0]
--------------------------------------------------------------------------------------------------
```

Layer (type)	Output Shape	Param #	Connected to
activation_9 (Activation)	(None, 55, 55, 64)	0	bn2c_branch2b[0][0]
res2c_branch2c (Conv2D)	(None, 55, 55, 256)	16640	activation_9[0][0]
bn2c_branch2c (BatchNormalizati	(None, 55, 55, 256)	1024	res2c_branch2c[0][0]
add_3 (Add)	(None, 55, 55, 256)	0	bn2c_branch2c[0][0] activation_7[0][0]
activation_10 (Activation)	(None, 55, 55, 256)	0	add_3[0][0]
res3a_branch2a (Conv2D)	(None, 28, 28, 128)	32896	activation_10[0][0]
bn3a_branch2a (BatchNormalizati	(None, 28, 28, 128)	512	res3a_branch2a[0][0]
activation_11 (Activation)	(None, 28, 28, 128)	0	bn3a_branch2a[0][0]
res3a_branch2b (Conv2D)	(None, 28, 28, 128)	147584	activation_11[0][0]
bn3a_branch2b (BatchNormalizati	(None, 28, 28, 128)	512	res3a_branch2b[0][0]
activation_12 (Activation)	(None, 28, 28, 128)	0	bn3a_branch2b[0][0]
res3a_branch2c (Conv2D)	(None, 28, 28, 512)	66048	activation_12[0][0]
res3a_branch1 (Conv2D)	(None, 28, 28, 512)	131584	activation_10[0][0]
bn3a_branch2c (BatchNormalizati	(None, 28, 28, 512)	2048	res3a_branch2c[0][0]
bn3a_branch1 (BatchNormalizatio	(None, 28, 28, 512)	2048	res3a_branch1[0][0]
add_4 (Add)	(None, 28, 28, 512)	0	bn3a_branch2c[0][0] bn3a_branch1[0][0]
activation_13 (Activation)	(None, 28, 28, 512)	0	add_4[0][0]
res3b_branch2a (Conv2D)	(None, 28, 28, 128)	65664	activation_13[0][0]
bn3b_branch2a (BatchNormalizati	(None, 28, 28, 128)	512	res3b_branch2a[0][0]
activation_14 (Activation)	(None, 28, 28, 128)	0	bn3b_branch2a[0][0]
res3b_branch2b (Conv2D)	(None, 28, 28, 128)	147584	activation_14[0][0]
bn3b_branch2b (BatchNormalizati	(None, 28, 28, 128)	512	res3b_branch2b[0][0]
activation_15 (Activation)	(None, 28, 28, 128)	0	bn3b_branch2b[0][0]
res3b_branch2c (Conv2D)	(None, 28, 28, 512)	66048	activation_15[0][0]
bn3b_branch2c (BatchNormalizati	(None, 28, 28, 512)	2048	res3b_branch2c[0][0]

add_5 (Add)	(None, 28, 28, 512)	0	bn3b_branch2c[0][0]
			activation_13[0][0]
activation_16 (Activation)	(None, 28, 28, 512)	0	add_5[0][0]
res3c_branch2a (Conv2D)	(None, 28, 28, 128)	65664	activation_16[0][0]
bn3c_branch2a (BatchNormalizati	(None, 28, 28, 128)	512	res3c_branch2a[0][0]
activation_17 (Activation)	(None, 28, 28, 128)	0	bn3c_branch2a[0][0]
res3c_branch2b (Conv2D)	(None, 28, 28, 128)	147584	activation_17[0][0]
bn3c_branch2b (BatchNormalizati	(None, 28, 28, 128)	512	res3c_branch2b[0][0]
activation_18 (Activation)	(None, 28, 28, 128)	0	bn3c_branch2b[0][0]
res3c_branch2c (Conv2D)	(None, 28, 28, 512)	66048	activation_18[0][0]
bn3c_branch2c (BatchNormalizati	(None, 28, 28, 512)	2048	res3c_branch2c[0][0]
add_6 (Add)	(None, 28, 28, 512)	0	bn3c_branch2c[0][0]
			activation_16[0][0]
activation_19 (Activation)	(None, 28, 28, 512)	0	add_6[0][0]
res3d_branch2a (Conv2D)	(None, 28, 28, 128)	65664	activation_19[0][0]
bn3d_branch2a (BatchNormalizati	(None, 28, 28, 128)	512	res3d_branch2a[0][0]
activation_20 (Activation)	(None, 28, 28, 128)	0	bn3d_branch2a[0][0]
res3d_branch2b (Conv2D)	(None, 28, 28, 128)	147584	activation_20[0][0]
bn3d_branch2b (BatchNormalizati	(None, 28, 28, 128)	512	res3d_branch2b[0][0]
activation_21 (Activation)	(None, 28, 28, 128)	0	bn3d_branch2b[0][0]
res3d_branch2c (Conv2D)	(None, 28, 28, 512)	66048	activation_21[0][0]
bn3d_branch2c (BatchNormalizati	(None, 28, 28, 512)	2048	res3d_branch2c[0][0]
add_7 (Add)	(None, 28, 28, 512)	0	bn3d_branch2c[0][0]
			activation_19[0][0]
activation_22 (Activation)	(None, 28, 28, 512)	0	add_7[0][0]
res4a_branch2a (Conv2D)	(None, 14, 14, 256)	131328	activation_22[0][0]
bn4a_branch2a (BatchNormalizati	(None, 14, 14, 256)	1024	res4a_branch2a[0][0]
activaon_23 (Activation)	(None, 14, 14, 256)	0	bn4a_branch2a[0][0]

Layer (type)	Output Shape	Param #	Connected to
res4a_branch2b (Conv2D)	(None, 14, 14, 256)	590080	activation_23[0][0]
bn4a_branch2b (BatchNormalizati	(None, 14, 14, 256)	1024	res4a_branch2b[0][0]
activation_24 (Activation)	(None, 14, 14, 256)	0	bn4a_branch2b[0][0]
res4a_branch2c (Conv2D)	(None, 14, 14, 1024)	263168	activation_24[0][0]
res4a_branch1 (Conv2D)	(None, 14, 14, 1024)	525312	activation_22[0][0]
bn4a_branch2c (BatchNormalizati	(None, 14, 14, 1024)	4096	res4a_branch2c[0][0]
bn4a_branch1 (BatchNormalizatio	(None, 14, 14, 1024)	4096	res4a_branch1[0][0]
add_8 (Add)	(None, 14, 14, 1024)	0	bn4a_branch2c[0][0] bn4a_branch1[0][0]
activation_25 (Activation)	(None, 14, 14, 1024)	0	add_8[0][0]
res4b_branch2a (Conv2D)	(None, 14, 14, 256)	262400	activation_25[0][0]
bn4b_branch2a (BatchNormalizati	(None, 14, 14, 256)	1024	res4b_branch2a[0][0]
activation_26 (Activation)	(None, 14, 14, 256)	0	bn4b_branch2a[0][0]
res4b_branch2b (Conv2D)	(None, 14, 14, 256)	590080	activation_26[0][0]
bn4b_branch2b (BatchNormalizati	(None, 14, 14, 256)	1024	res4b_branch2b[0][0]
activation_27 (Activation)	(None, 14, 14, 256)	0	bn4b_branch2b[0][0]
res4b_branch2c (Conv2D)	(None, 14, 14, 1024)	263168	activation_27[0][0]
bn4b_branch2c (BatchNormalizati	(None, 14, 14, 1024)	4096	res4b_branch2c[0][0]
add_9 (Add)	(None, 14, 14, 1024)	0	bn4b_branch2c[0][0] activation_25[0][0]
activation_28 (Activation)	(None, 14, 14, 1024)	0	add_9[0][0]
res4c_branch2a (Conv2D)	(None, 14, 14, 256)	262400	activation_28[0][0]
bn4c_branch2a (BatchNormalizati	(None, 14, 14, 256)	1024	res4c_branch2a[0][0]
activation_29 (Activation)	(None, 14, 14, 256)	0	bn4c_branch2a[0][0]
res4c_branch2b (Conv2D)	(None, 14, 14, 256)	590080	activation_29[0][0]
bn4c_branch2b (BatchNormalizati	(None, 14, 14, 256)	1024	res4c_branch2b[0][0]
activation_30 (Activation)	(None, 14, 14, 256)	0	bn4c_branch2b[0][0]

```
----------------------------------------------------------------------------------------------------
res4c_branch2c (Conv2D)        (None, 14, 14, 1024) 263168     activation_30[0][0]
----------------------------------------------------------------------------------------------------
bn4c_branch2c (BatchNormalizati (None, 14, 14, 1024) 4096      res4c_branch2c[0][0]
----------------------------------------------------------------------------------------------------
add_10 (Add)                   (None, 14, 14, 1024) 0          bn4c_branch2c[0][0]
                                                               activation_28[0][0]
----------------------------------------------------------------------------------------------------
activation_31 (Activation)     (None, 14, 14, 1024) 0          add_10[0][0]
----------------------------------------------------------------------------------------------------
res4d_branch2a (Conv2D)        (None, 14, 14, 256)  262400     activation_31[0][0]
----------------------------------------------------------------------------------------------------
bn4d_branch2a (BatchNormalizati (None, 14, 14, 256)  1024      res4d_branch2a[0][0]
----------------------------------------------------------------------------------------------------
activation_32 (Activation)     (None, 14, 14, 256)  0          bn4d_branch2a[0][0]
----------------------------------------------------------------------------------------------------
res4d_branch2b (Conv2D)        (None, 14, 14, 256)  590080     activation_32[0][0]
----------------------------------------------------------------------------------------------------
bn4d_branch2b (BatchNormalizati (None, 14, 14, 256)  1024      res4d_branch2b[0][0]
----------------------------------------------------------------------------------------------------
activation_33 (Activation)     (None, 14, 14, 256)  0          bn4d_branch2b[0][0]
----------------------------------------------------------------------------------------------------
res4d_branch2c (Conv2D)        (None, 14, 14, 1024) 263168     activation_33[0][0]
----------------------------------------------------------------------------------------------------
bn4d_branch2c (BatchNormalizati (None, 14, 14, 1024) 4096      res4d_branch2c[0][0]
----------------------------------------------------------------------------------------------------
add_11 (Add)                   (None, 14, 14, 1024) 0          bn4d_branch2c[0][0]
                                                               activation_31[0][0]
----------------------------------------------------------------------------------------------------
activation_34 (Activation)     (None, 14, 14, 1024) 0          add_11[0][0]
----------------------------------------------------------------------------------------------------
res4e_branch2a (Conv2D)        (None, 14, 14, 256)  262400     activation_34[0][0]
----------------------------------------------------------------------------------------------------
bn4e_branch2a (BatchNormalizati (None, 14, 14, 256)  1024      res4e_branch2a[0][0]
----------------------------------------------------------------------------------------------------
activation_35 (Activation)     (None, 14, 14, 256)  0          bn4e_branch2a[0][0]
----------------------------------------------------------------------------------------------------
res4e_branch2b (Conv2D)        (None, 14, 14, 256)  590080     activation_35[0][0]
----------------------------------------------------------------------------------------------------
bn4e_branch2b (BatchNormalizati (None, 14, 14, 256)  1024      res4e_branch2b[0][0]
----------------------------------------------------------------------------------------------------
activation_36 (Activation)     (None, 14, 14, 256)  0          bn4e_branch2b[0][0]
----------------------------------------------------------------------------------------------------
res4e_branch2c (Conv2D)        (None, 14, 14, 1024) 263168     activation_36[0][0]
----------------------------------------------------------------------------------------------------
bn4e_branch2c (BatchNormalizati (None, 14, 14, 1024) 4096      res4e_branch2c[0][0]
----------------------------------------------------------------------------------------------------
add_12 (Add)                   (None, 14, 14, 1024) 0          bn4e_branch2c[0][0]
                                                               activation_34[0][0]
----------------------------------------------------------------------------------------------------
activation_37 (Activation)     (None, 14, 14, 1024) 0          add_12[0][0]
----------------------------------------------------------------------------------------------------
```

res4f_branch2a (Conv2D)	(None, 14, 14, 256)	262400	activation_37[0][0]
bn4f_branch2a (BatchNormalizati	(None, 14, 14, 256)	1024	res4f_branch2a[0][0]
activation_38 (Activation)	(None, 14, 14, 256)	0	bn4f_branch2a[0][0]
res4f_branch2b (Conv2D)	(None, 14, 14, 256)	590080	activation_38[0][0]
bn4f_branch2b (BatchNormalizati	(None, 14, 14, 256)	1024	res4f_branch2b[0][0]
activation_39 (Activation)	(None, 14, 14, 256)	0	bn4f_branch2b[0][0]
res4f_branch2c (Conv2D)	(None, 14, 14, 1024)	263168	activation_39[0][0]
bn4f_branch2c (BatchNormalizati	(None, 14, 14, 1024)	4096	res4f_branch2c[0][0]
add_13 (Add)	(None, 14, 14, 1024)	0	bn4f_branch2c[0][0] activation_37[0][0]
activation_40 (Activation)	(None, 14, 14, 1024)	0	add_13[0][0]
res5a_branch2a (Conv2D)	(None, 7, 7, 512)	524800	activation_40[0][0]
bn5a_branch2a (BatchNormalizati	(None, 7, 7, 512)	2048	res5a_branch2a[0][0]
activation_41 (Activation)	(None, 7, 7, 512)	0	bn5a_branch2a[0][0]
res5a_branch2b (Conv2D)	(None, 7, 7, 512)	2359808	activation_41[0][0]
bn5a_branch2b (BatchNormalizati	(None, 7, 7, 512)	2048	res5a_branch2b[0][0]
activation_42 (Activation)	(None, 7, 7, 512)	0	bn5a_branch2b[0][0]
res5a_branch2c (Conv2D)	(None, 7, 7, 2048)	1050624	activation_42[0][0]
res5a_branch1 (Conv2D)	(None, 7, 7, 2048)	2099200	activation_40[0][0]
bn5a_branch2c (BatchNormalizati	(None, 7, 7, 2048)	8192	res5a_branch2c[0][0]
bn5a_branch1 (BatchNormalizatio	(None, 7, 7, 2048)	8192	res5a_branch1[0][0]
add_14 (Add)	(None, 7, 7, 2048)	0	bn5a_branch2c[0][0] bn5a_branch1[0][0]
activation_43 (Activation)	(None, 7, 7, 2048)	0	add_14[0][0]
res5b_branch2a (Conv2D)	(None, 7, 7, 512)	1049088	activation_43[0][0]
bn5b_branch2a (BatchNormalizati	(None, 7, 7, 512)	2048	res5b_branch2a[0][0]
activation_44 (Activation)	(None, 7, 7, 512)	0	bn5b_branch2a[0][0]

```
res5b_branch2b (Conv2D)         (None, 7, 7, 512)    2359808    activation_44[0][0]
--------------------------------------------------------------------------------------------
bn5b_branch2b (BatchNormalizati (None, 7, 7, 512)    2048       res5b_branch2b[0][0]
--------------------------------------------------------------------------------------------
activation_45 (Activation)      (None, 7, 7, 512)    0          bn5b_branch2b[0][0]
--------------------------------------------------------------------------------------------
res5b_branch2c (Conv2D)         (None, 7, 7, 2048)   1050624    activation_45[0][0]
--------------------------------------------------------------------------------------------
bn5b_branch2c (BatchNormalizati (None, 7, 7, 2048)   8192       res5b_branch2c[0][0]
--------------------------------------------------------------------------------------------
add_15 (Add)                    (None, 7, 7, 2048)   0          bn5b_branch2c[0][0]
                                                                activation_43[0][0]
--------------------------------------------------------------------------------------------
activation_46 (Activation)      (None, 7, 7, 2048)   0          add_15[0][0]
--------------------------------------------------------------------------------------------
res5c_branch2a (Conv2D)         (None, 7, 7, 512)    1049088    activation_46[0][0]
--------------------------------------------------------------------------------------------
bn5c_branch2a (BatchNormalizati (None, 7, 7, 512)    2048       res5c_branch2a[0][0]
--------------------------------------------------------------------------------------------
activation_47 (Activation)      (None, 7, 7, 512)    0          bn5c_branch2a[0][0]
--------------------------------------------------------------------------------------------
res5c_branch2b (Conv2D)         (None, 7, 7, 512)    2359808    activation_47[0][0]
--------------------------------------------------------------------------------------------
bn5c_branch2b (BatchNormalizati (None, 7, 7, 512)    2048       res5c_branch2b[0][0]
--------------------------------------------------------------------------------------------
activation_48 (Activation)      (None, 7, 7, 512)    0          bn5c_branch2b[0][0]
--------------------------------------------------------------------------------------------
res5c_branch2c (Conv2D)         (None, 7, 7, 2048)   1050624    activation_48[0][0]
--------------------------------------------------------------------------------------------
bn5c_branch2c (BatchNormalizati (None, 7, 7, 2048)   8192       res5c_branch2c[0][0]
--------------------------------------------------------------------------------------------
add_16 (Add)                    (None, 7, 7, 2048)   0          bn5c_branch2c[0][0]
                                                                activation_46[0][0]
--------------------------------------------------------------------------------------------
activation_49 (Activation)      (None, 7, 7, 2048)   0          add_16[0][0]
--------------------------------------------------------------------------------------------
avg_pool (AveragePooling2D)     (None, 1, 1, 2048)   0          activation_49[0][0]
============================================================================================
Total params: 23,587,712
Trainable params: 23,534,592
Non-trainable params: 53,120
--------------------------------------------------------------------------------------------


In [9]: model = Sequential()
        model.add(model_base)
        model.add(Flatten())
        model.add(Dense(1024, activation='relu'))
        model.add(Dropout(0.3))
        model.add(Dense(500, activation='relu'))
        model.add(Dropout(0.3))
```

```python
        model.add(Dense(1, activation='sigmoid'))
```

```
In [10]: model.summary()
```

```
_____
Layer (type)                 Output Shape              Param #
=================================================================
resnet50 (Model)             (None, 1, 1, 2048)        23587712
_____
flatten_1 (Flatten)          (None, 2048)              0
_____
dense_1 (Dense)              (None, 1024)              2098176
_____
dropout_1 (Dropout)          (None, 1024)              0
_____
dense_2 (Dense)              (None, 500)               512500
_____
dropout_2 (Dropout)          (None, 500)               0
_____
dense_3 (Dense)              (None, 1)                 501
=================================================================
Total params: 26,198,889
Trainable params: 26,145,769
Non-trainable params: 53,120
_____
```

```python
In [11]: print('Number of trainable weights befor freezing the model_base:', len(model.trainable_weigh
         model_base.trainable = False
         print('Number of trainable weights after freezing the model_base:', len(model.trainable_weigh
```

```
Number of trainable weights befor freezing the model_base: 218
Number of trainable weights after freezing the model_base: 6
```

```python
In [12]: lr = 0.0005
         # from keras.utils import multi_gpu_model
         # model = multi_gpu_model(model_base, gpus=8)
         model.compile(loss = "binary_crossentropy", optimizer = optimizers.SGD(lr=lr, momentum=0.9),
```

```python
In [ ]: epochs = 20
        history = model.fit_generator(generator['train'],
                                      steps_per_epoch=nb_train_samples // batch_size,
                                      epochs=epochs,
                                      validation_data=generator['valid'],
                                      validation_steps=nb_valid_samples // batch_size)
```

```
Epoch 1/20
108/260 [==========>...] - ETA: 1:37 - loss: 0.5767 - acc: 0.6905
```

checkpoint

```
In [ ]: model.save_weights('model_binary_wieghts.h5')
        model.save('model_binary.h5')
```

```
In [ ]: # model = load_model('model_binary.h5')
```

```
In [ ]: #get the details form the history object
        acc = history.history['acc']
        val_acc = history.history['val_acc']
        loss = history.history['loss']
        val_loss = history.history['val_loss']

        epochs = range(1, len(acc) + 1)

        #Train and validation accuracy
        plt.figure(figsize = [15, 7])
        plt.subplot(1,2,1)
        plt.plot(epochs, acc, 'b', label='Training accurarcy')
        plt.plot(epochs, val_acc, 'r', label='Validation accurarcy')
        plt.title('Training and Validation accurarcy')
        plt.legend()

        plt.subplot(1,2,2)
        #Train and validation loss
        plt.plot(epochs, loss, 'b', label='Training loss')
        plt.plot(epochs, val_loss, 'r', label='Validation loss')
        plt.title('Training and Validation loss')
        plt.legend()
        plt.savefig('loss and acc.jpg', bbox_inches = 'tight')
        plt.show()
```

```
In [ ]: test_imgs = os.listdir(data_dir.format('test'))
        img_path = data_dir.format('test') + test_imgs[3]
        # img_path = './test04.jpg'
        img = image.load_img(img_path, target_size=(im_width, im_height))
        x = image.img_to_array(img)
        x = np.expand_dims(x, axis=0)
        x = preprocess_input(x)

        preds = model.predict(x)[0][0]
        print(preds)
        img_show = mpimg.imread(img_path)
        plt.imshow(img_show)
        plt.title('This is a {}'.format('dog' if preds > 0.5 else 'cat'))
        plt.suptitle('probability: {} percent'.format(round(preds, 3)*100) if preds > 0.5 else round(1
```

csv

```
In [ ]: test_imgs = os.listdir(data_dir.format('test'))
        ids = []
        label = []
        for i in tqdm(test_imgs):
            img = image.load_img(data_dir.format('test') + i, target_size=(im_width, im_height))
            x = image.img_to_array(img)
            x = np.expand_dims(x, axis=0)
            x = preprocess_input(x)
            label.append(model.predict(x)[0][0])
            ids.append(int(i.split('.')[0]))

In [ ]: sub = pd.DataFrame({'id': ids, 'label': label}).sort_values('id',axis = 0, ascending = True)
        sub.to_csv('submission.csv', index = False)
```

- https://zhuanlan.zhihu.com/p/26693647
- https://medium.com/@14prakash/transfer-learning-using-keras-d804b2e04ef8
- https://www.kaggle.com/risingdeveloper/transfer-learning-in-keras-on-dogs-vs-cats