InceptionV3

In [1]:
```
import pandas as pd
import numpy as np
from keras.applications.inception_v3 import InceptionV3
from keras.applications.inception_v3 import preprocess_input
from keras.preprocessing.image import ImageDataGenerator, array_to_img
from keras.preprocessing import image
from keras.models import Model, Sequential
from keras.layers import Conv2D, MaxPooling2D, GlobalAveragePooling2D, AveragePooling2D
from keras.layers import Activation, Dropout, Flatten, Dense
from keras.callbacks import ModelCheckpoint, EarlyStopping
from keras.optimizers import SGD
from keras import backend as K
```

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

In [2]:
```
# 影像維度
img_width, img_height = 299, 299

train_data_dir = 'D:/Anaconda3/Scripts/5 上課資料/電腦視覺與人機互動/20191031HW/cats_and_dogs_small/train'
validation_data_dir = 'D:/Anaconda3/Scripts/5 上課資料/電腦視覺與人機互動/20191031HW/cats_and_dogs_small/validation'
nb_train_samples = 2000
nb_validation_samples = 800
batch_size = 2
```

In [3]:
```
if K.image_data_format() == 'channels_first':
    input_shape = (3, img_width, img_height)
else:
    input_shape = (img_width, img_height, 3)
```

In [4]:
```
base_model = InceptionV3(weights='imagenet', include_top=False)

# 添加全域空間平均池化層
x = base_model.output
x = GlobalAveragePooling2D()(x)
# 增加全連階層
x = Dense(1024, activation='relu', name='fc1')(x)
prediction = Dense(2, activation='softmax', name='predictions')(x)
model = Model(inputs=base_model.input, outputs=prediction)
model.summary()
```

```
concatenate_2 (Concatenate)     (None, None, None, 7 0           activation_92[0][0]
                                                                 activation_93[0][0]
__________________________________________________________________________________________________
activation_94 (Activation)      (None, None, None, 1 0           batch_normalization_94[0][0]
__________________________________________________________________________________________________
mixed10 (Concatenate)           (None, None, None, 2 0           activation_86[0][0]
                                                                 mixed9_1[0][0]
                                                                 concatenate_2[0][0]
                                                                 activation_94[0][0]
__________________________________________________________________________________________________
global_average_pooling2d_1 (Glo (None, 2048)         0           mixed10[0][0]
__________________________________________________________________________________________________
fc1 (Dense)                     (None, 1024)         2098176     global_average_pooling2d_1[0][0]
__________________________________________________________________________________________________
predictions (Dense)             (None, 2)            2050        fc1[0][0]
==================================================================================================
Total params: 23,903,010
Trainable params: 23,868,578
Non-trainable params: 34,432
__________________________________________________________________________________________________
```

In [5]:
```
# 凍結所有層(除了Bottleneck Layers以外)來進行微調
for layer in model.layers:
    if layer.name in ['predictions']:
        continue
    layer.trainable = False
```

In [6]:
```
df = pd.DataFrame(([layer.name, layer.trainable] for layer in model.layers), columns=['layer', 'trainable'])
df
```

Out[6]:

	layer	trainable
0	input_1	False
1	conv2d_1	False
2	batch_normalization_1	False
3	activation_1	False
4	conv2d_2	False
5	batch_normalization_2	False
6	activation_2	False
7	conv2d_3	False
8	batch_normalization_3	False
9	activation_3	False
10	max_pooling2d_1	False
11	conv2d_4	False

In [7]:
```
train_datagen = ImageDataGenerator(rotation_range=40,
                                   width_shift_range=0.2,
                                   height_shift_range=0.2,
                                   shear_range=0.2,
                                   zoom_range=0.2,
                                   horizontal_flip=True,
                                   fill_mode='nearest')
train_generator = train_datagen.flow_from_directory(directory='D:/Anaconda3/Scripts/5 上課資料/電腦視覺與人機互動/20191031HW/cat
                                                    target_size=[img_width, img_height],
                                                    batch_size=batch_size,
                                                    class_mode='categorical')

validation_datagen = ImageDataGenerator()
validation_generator = validation_datagen.flow_from_directory(directory='D:/Anaconda3/Scripts/5 上課資料/電腦視覺與人機互動/2019
                                                              target_size=[img_width, img_height],
                                                              batch_size=batch_size,
                                                              class_mode='categorical')
```

```
Found 2000 images belonging to 2 classes.
Found 1000 images belonging to 2 classes.
```

In [8]:
```
model.compile(optimizer = 'rmsprop', loss = 'categorical_crossentropy', metrics = ['accuracy'])
history = model.fit_generator(
        train_generator,
        steps_per_epoch = train_generator.samples // batch_size,
        validation_data = validation_generator,
        validation_steps = validation_generator.samples // batch_size,
        epochs = 20)

model.save('model-inceptionv3-final.h5')
```

```
1000/1000 [==============================] - 131s 131ms/step - loss: 0.4315 - acc: 0.7765 - val_loss: 7.5340 - val_acc: 0.518
0
Epoch 15/20
1000/1000 [==============================] - 132s 132ms/step - loss: 0.4087 - acc: 0.8070 - val_loss: 7.5696 - val_acc: 0.515
00.4
Epoch 16/20
1000/1000 [==============================] - 132s 132ms/step - loss: 0.4517 - acc: 0.7640 - val_loss: 7.7938 - val_acc: 0.511
0
Epoch 17/20
1000/1000 [==============================] - 132s 132ms/step - loss: 0.4343 - acc: 0.7815 - val_loss: 7.7535 - val_acc: 0.511
0
Epoch 18/20
```

```
1000/1000 [==============================] - 131s 131ms/step - loss: 0.4261 - acc: 0.7895 - val_loss: 7.9017 - val_acc: 0.506
0
Epoch 19/20
1000/1000 [==============================] - 131s 131ms/step - loss: 0.4490 - acc: 0.7710 - val_loss: 7.8034 - val_acc: 0.512
0
Epoch 20/20
1000/1000 [==============================] - 131s 131ms/step - loss: 0.4296 - acc: 0.7815 - val_loss: 7.7969 - val_acc: 0.512
0
```

In [9]:

```
for i, layer in enumerate(base_model.layers):
    print(i, layer.name)
for layer in model.layers[:172]:
    layer.trainable = False
for layer in model.layers[172:]:
    layer.trainable = True
```

```
0 input_1
1 conv2d_1
2 batch_normalization_1
3 activation_1
4 conv2d_2
5 batch_normalization_2
6 activation_2
7 conv2d_3
8 batch_normalization_3
9 activation_3
10 max_pooling2d_1
11 conv2d_4
12 batch_normalization_4
13 activation_4
14 conv2d_5
15 batch_normalization_5
16 activation_5
17 max_pooling2d_2
18 conv2d_9
19 batch_normalization_9
```

In [10]:

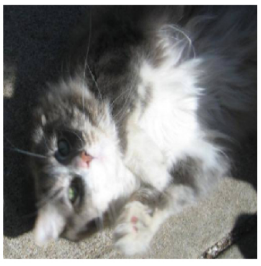
```
from keras.optimizers import SGD
model.compile(optimizer=SGD(lr=0.001, momentum=0.9), loss='categorical_crossentropy', metrics=['accuracy'])
history = model.fit_generator(
        train_generator,
        steps_per_epoch = train_generator.samples // batch_size,
        validation_data = validation_generator,
        validation_steps = validation_generator.samples // batch_size,
        epochs = 20)

model.save('model-inceptionv3-final2.h5')
```

```
Epoch 1/20
1000/1000 [==============================] - 239s 239ms/step - loss: 1.2781 - acc: 0.6990 - val_loss: 7.8385 - val_acc: 0.5100
Epoch 2/20
1000/1000 [==============================] - 232s 232ms/step - loss: 0.3086 - acc: 0.8605 - val_loss: 8.0590 - val_acc: 0.5000
Epoch 3/20
1000/1000 [==============================] - 232s 232ms/step - loss: 0.1861 - acc: 0.9325 - val_loss: 7.8990 - val_acc: 0.5020
Epoch 4/20
1000/1000 [==============================] - 232s 232ms/step - loss: 0.1582 - acc: 0.9355 - val_loss: 6.4260 - val_acc: 0.5210
Epoch 5/20
1000/1000 [==============================] - 232s 232ms/step - loss: 0.1392 - acc: 0.9425 - val_loss: 8.0293 - val_acc: 0.5010
Epoch 6/20
1000/1000 [==============================] - 232s 232ms/step - loss: 0.1198 - acc: 0.9550 - val_loss: 7.4270 - val_acc: 0.5150
Epoch 7/20
1000/1000 [==============================] - 231s 231ms/step - loss: 0.1033 - acc: 0.9585 - val_loss: 8.0533 - val_acc: 0.5000
Epoch 8/20
1000/1000 [==============================] - 231s 231ms/step - loss: 0.1081 - acc: 0.9590 - val_loss: 8.0567 - val_acc: 0.5000
Epoch 9/20
1000/1000 [==============================] - 232s 232ms/step - loss: 0.0858 - acc: 0.9675 - val_loss: 8.0590 - val_acc: 0.5000
Epoch 10/20
1000/1000 [==============================] - 232s 232ms/step - loss: 0.0875 - acc: 0.9670 - val_loss: 8.0590 - val_acc: 0.5000
Epoch 11/20
1000/1000 [==============================] - 232s 232ms/step - loss: 0.0691 - acc: 0.9730 - val_loss: 8.0590 - val_acc: 0.5000
Epoch 12/20
1000/1000 [==============================] - 231s 231ms/step - loss: 0.0698 - acc: 0.9705 - val_loss: 8.0659 - val_acc: 0.4990
Epoch 13/20
1000/1000 [==============================] - 231s 231ms/step - loss: 0.0762 - acc: 0.9720 - val_loss: 7.6983 - val_acc: 0.4990
Epoch 14/20
1000/1000 [==============================] - 231s 231ms/step - loss: 0.0469 - acc: 0.9805 - val_loss: 7.4622 - val_acc: 0.5140
Epoch 15/20
1000/1000 [==============================] - 231s 231ms/step - loss: 0.0530 - acc: 0.9805 - val_loss: 8.0576 - val_acc: 0.5000
Epoch 16/20
1000/1000 [==============================] - 231s 231ms/step - loss: 0.0465 - acc: 0.9810 - val_loss: 6.4573 - val_acc: 0.5450
Epoch 17/20
1000/1000 [==============================] - 231s 231ms/step - loss: 0.0504 - acc: 0.9790 - val_loss: 6.4857 - val_acc: 0.5570
Epoch 18/20
1000/1000 [==============================] - 232s 232ms/step - loss: 0.0435 - acc: 0.9815 - val_loss: 6.9573 - val_acc: 0.5370
Epoch 19/20
1000/1000 [==============================] - 232s 232ms/step - loss: 0.0325 - acc: 0.9875 - val_loss: 7.5819 - val_acc: 0.5080
Epoch 20/20
1000/1000 [==============================] - 231s 231ms/step - loss: 0.0431 - acc: 0.9845 - val_loss: 8.0590 - val_acc: 0.5000
```

In [11]:

```
from IPython.display import display
import matplotlib.pyplot as plt

X_val_sample, _ = next(validation_generator)
y_pred = model.predict(X_val_sample)

nb_sample = 4
for x, y in zip(X_val_sample[:nb_sample], y_pred[:nb_sample]):
    s = pd.Series({'Cat': 1-np.max(y), 'Dog': np.max(y)})
    axes = s.plot(kind='bar')
    axes.set_xlabel('Class')
    axes.set_ylabel('Probability')
    axes.set_ylim([0, 1])
    plt.show()

    img = array_to_img(x)
    display(img)
```

```
<Figure size 640x480 with 1 Axes>
```



```
<Figure size 640x480 with 1 Axes>
```

In [12]:

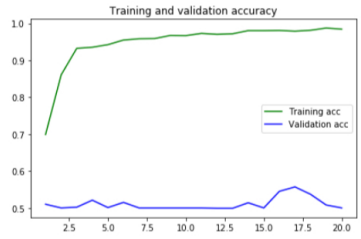
```
scores = model.evaluate_generator(generator=validation_generator, steps=validation_generator.samples // batch_size)
print("\nLoss: %.2f, Accuracy: %.2f%%" % (scores[0]/100, scores[1]*100))
```

```
Loss: 0.08, Accuracy: 50.00%
```

In [13]:

```python
modelname = 'Inceptionv3'

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)

metrics = 'acc'
filename = 'image/'+ modelname + '_' + metrics
plt.plot(epochs, acc, 'g', label='Training acc')
plt.plot(epochs, val_acc, 'b', label='Validation acc')
plt.title('Training and validation accuracy')
plt.legend(loc='best')
plt.tight_layout()
plt.savefig(filename, dpi=300)
print('Save',filename)
plt.figure()

metrics = 'loss'
filename = 'image/'+ modelname + '_' + metrics
plt.plot(epochs, loss, 'g', label='Training loss')
plt.plot(epochs, val_loss, 'b', label='Validation loss')
plt.title('Training and validation loss')
plt.legend(loc='best')
plt.tight_layout()
plt.savefig(filename, dpi=300)
print('Save',filename)
plt.show()
```

```
Save image/Inceptionv3_acc
Save image/Inceptionv3_loss
```



In [ ]:

```python
```