

# 水果辨識及價格

## 一、資料介紹

使用網站 Zenodo 裡面的 [Fruit Recognition dataset \(https://zenodo.org/record/1310165#XtYnRzozZPY\)](https://zenodo.org/record/1310165#XtYnRzozZPY) 作為訓練資料。該網站資料集提供蘋果、蓮霧、楊桃等水果總計14種，每種水果三千張照片，總計四萬多筆，並且已經將每種水果的照片按照資料夾放好，我們從每個水果的資料夾中挑出300張照片做為測試集，剩下的作為訓練集(約莫9:1)。

## 二、動機

隨著健康意識的抬頭，許多人開始注意飲食均衡，為了在平常食物攝取中能保持營養均衡而購買水果，但很多人在購買水果時無法妥善的分辨水果與其合理時價而導致荷包受損，尤其是吃米不知米價的大學生們。因此我們想製作一個模型來辨識水果後能報上此水果的時價，讓大家可以輕鬆使用與用合理時價購買。

## 三、問題發想

利用 Zenodo Fruit Recognition dataset 的資料建立並訓練模型，能夠判斷水果種類之後，再結合爬蟲從twfood網站上爬取該水果合理價錢，此外，為了方便消費者查詢，將此程式做成 APP 的形式，我們選擇使用 MobileNet 作為模型。

## 四、程式實作

### 0. MobileNet

1. MobileNet 是基於 Depthwise separable convolution 構建的網絡，希望在不影響輸出結構的狀況下減少運算量，基本上可以拆成兩部分：

深度卷積(depthwise convolution) 和逐點卷積(pointwise convolution)

- Depthwise convolution 和標準卷積不同，標準卷積其卷積核是用在所有的輸入通道上，而 Depthwise convolution 針對每個輸入通道採用不同的捲積核，就是說一個卷積核對應一個輸入通道
- Pointwise convolution 其實就是普通的卷積，只不過其採用1x1的卷積

2. 這樣子的作法有什麼好處呢？

假設輸入尺寸為  $D_F \times D_F \times M$ ，strides 為1且 padding 為1 也就是做完一次卷積之後圖片大小還是一樣  $D_F \times D_F$

(1)採用標準卷積核進行卷積：標準卷積核的尺寸為  $D_K \times D_K \times M \times N$ ，那麼輸出尺寸應該為  $D_F \times D_F \times N$ ，計算量為  $D_F \times D_F \times M \times N \times D_K \times D_K$

(2)採用 Depthwise separable convolution 的方式進行卷積：

- 先使用 M 個Depthwise Convolution 對輸入的M個通道分別進行卷積得到尺寸為  $D_F \times D_F \times M$ ，這一步的計算量為  $D_F \times D_F \times M \times D_K \times D_K$
- 再使用 N 個Pointwise convolution  $1 \times 1 \times M$  的卷積核進行逐點卷積得到輸出尺寸為  $D_F \times D_F \times M \times N$ ，這一步的計算量為  $D_F \times D_F \times M \times N$   
故總的計算量為  $D_F \times D_F \times M \times D_K \times D_K + D_F \times D_F \times M \times N$

最後再將兩者合併，可以看出 Depthwise separable convolution 的輸入和輸出結果量是可以跟一般卷積計算一樣的。

(3)Depthwise separable convolution 的計算量與標準卷積相比：

$$\frac{D_F \times D_F \times M \times N \times D_K \times D_K}{D_F \times D_F \times M \times D_K \times D_K + D_F \times D_F \times M \times N} = \frac{1}{N} + \frac{1}{D_K^2}$$

可以看到當 N (卷積核的數目) 及  $D_K$  (卷積核的大小) 越大時，兩者的運算量就差越多

3. MobileNet 及 Inception 比較

- MobileNet 及 Inception 皆是可以運行在TFLite 框架下的模型
- 可以看到MobileNet 在損失一點準確率的情況下，將模型大小縮小了好幾倍

4. 為甚麼選擇MobileNet？

- 手機的硬體並不像電腦一樣強大，例如：CPU、記憶體
- MobileNet 在準確率及模型大小取得良好的平衡
- TFLite 是 Tensorflow 提供給創作者可以將模型放到移動裝置上運行的解決方案，MobileNet便是少數的模型之一

## 1. 匯入套件及模型

In [2]:

```
import tensorflow as tf
from tensorflow.keras.preprocessing import image
from tensorflow.keras.applications import imagenet_utils
from tensorflow.keras.applications.mobilenet import preprocess_input
from tensorflow.keras.applications import MobileNet, MobileNetV2
from tensorflow.keras.layers import Activation, GlobalAveragePooling2D, Dense
from tensorflow.keras.models import Model, Sequential
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.layers import Input
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import requests
from bs4 import BeautifulSoup
from ipywidgets import interact_manual
```

In [2]:

```
# 只選取其中和圖片有關的，並將輸入層改為(320, 258, 3)，因為訓練圖片大小是這樣
mobile = MobileNetV2(weights='imagenet', include_top=False, input_shape = (320, 258, 3))
```

In [106]:

```
mobile.summary()
```

Model: "mobilenetv2\_1.00\_224"

Layer (type)	Output Shape	Param #	Connected to
=====			
input_4 (InputLayer)	[(None, 320, 258, 3)]	0	
Conv1_pad (ZeroPadding2D)	(None, 321, 259, 3)	0	input_4
Conv1 (Conv2D)	(None, 160, 129, 32)	864	Conv1_pad[0][0]
bn_Conv1 (BatchNormalization)	(None, 160, 129, 32)	128	Conv1[0]
Conv1_relu (ReLU)	(None, 160, 129, 32)	0	bn_Conv1[0][0]
expanded_conv_depthwise (Depthwise Conv2D)	(None, 160, 129, 32)	288	Conv1_relu[0][0]
expanded_conv_depthwise_BN (Batch Normalization)	(None, 160, 129, 32)	128	expanded_conv_depthwise[0][0]
expanded_conv_depthwise_relu (ReLU)	(None, 160, 129, 32)	0	expanded_conv_depthwise_BN[0][0]
expanded_conv_project (Conv2D)	(None, 160, 129, 16)	512	expanded_conv_depthwise_relu[0][0]
expanded_conv_project_BN (Batch Normalization)	(None, 160, 129, 16)	64	expanded_conv_project[0][0]
block_1_expand (Conv2D)	(None, 160, 129, 96)	1536	expanded_conv_project_BN[0][0]
block_1_expand_BN (Batch Normalization)	(None, 160, 129, 96)	384	block_1_expand[0][0]
block_1_expand_relu (ReLU)	(None, 160, 129, 96)	0	block_1_expand_BN[0][0]
block_1_pad (ZeroPadding2D)	(None, 161, 131, 96)	0	block_1_expand_relu[0][0]

block_1_depthwise (DepthwiseCon	(None, 80, 65, 96)	864	block_1_p
ad[0][0]			
block_1_depthwise_BN (BatchNorm	(None, 80, 65, 96)	384	block_1_d
epthwise[0][0]			
block_1_depthwise_relu (ReLU)	(None, 80, 65, 96)	0	block_1_d
epthwise_BN[0][0]			
block_1_project (Conv2D)	(None, 80, 65, 24)	2304	block_1_d
epthwise_relu[0][0]			
block_1_project_BN (BatchNormal	(None, 80, 65, 24)	96	block_1_p
roject[0][0]			
block_2_expand (Conv2D)	(None, 80, 65, 144)	3456	block_1_p
roject_BN[0][0]			
block_2_expand_BN (BatchNormali	(None, 80, 65, 144)	576	block_2_e
xpand[0][0]			
block_2_expand_relu (ReLU)	(None, 80, 65, 144)	0	block_2_e
xpand_BN[0][0]			
block_2_depthwise (DepthwiseCon	(None, 80, 65, 144)	1296	block_2_e
xpand_relu[0][0]			
block_2_depthwise_BN (BatchNorm	(None, 80, 65, 144)	576	block_2_d
epthwise[0][0]			
block_2_depthwise_relu (ReLU)	(None, 80, 65, 144)	0	block_2_d
epthwise_BN[0][0]			
block_2_project (Conv2D)	(None, 80, 65, 24)	3456	block_2_d
epthwise_relu[0][0]			
block_2_project_BN (BatchNormal	(None, 80, 65, 24)	96	block_2_p
roject[0][0]			
block_2_add (Add)	(None, 80, 65, 24)	0	block_1_p
roject_BN[0][0]			block_2_p
roject_BN[0][0]			
block_3_expand (Conv2D)	(None, 80, 65, 144)	3456	block_2_a
dd[0][0]			

block_3_expand_BN (BatchNormali xpad[0][0])	(None, 80, 65, 144)	576	block_3_e
block_3_expand_relu (ReLU) xpad_BN[0][0])	(None, 80, 65, 144)	0	block_3_e
block_3_pad (ZeroPadding2D) xpad_relu[0][0])	(None, 81, 67, 144)	0	block_3_e
block_3_depthwise (DepthwiseCon ad[0][0])	(None, 40, 33, 144)	1296	block_3_p
block_3_depthwise_BN (BatchNorm epthwise[0][0])	(None, 40, 33, 144)	576	block_3_d
block_3_depthwise_relu (ReLU) epthwise_BN[0][0])	(None, 40, 33, 144)	0	block_3_d
block_3_project (Conv2D) epthwise_relu[0][0])	(None, 40, 33, 32)	4608	block_3_d
block_3_project_BN (BatchNormal roject[0][0])	(None, 40, 33, 32)	128	block_3_p
block_4_expand (Conv2D) roject_BN[0][0])	(None, 40, 33, 192)	6144	block_3_p
block_4_expand_BN (BatchNormali xpad[0][0])	(None, 40, 33, 192)	768	block_4_e
block_4_expand_relu (ReLU) xpad_BN[0][0])	(None, 40, 33, 192)	0	block_4_e
block_4_depthwise (DepthwiseCon xpad_relu[0][0])	(None, 40, 33, 192)	1728	block_4_e
block_4_depthwise_BN (BatchNorm epthwise[0][0])	(None, 40, 33, 192)	768	block_4_d
block_4_depthwise_relu (ReLU) epthwise_BN[0][0])	(None, 40, 33, 192)	0	block_4_d
block_4_project (Conv2D) epthwise_relu[0][0])	(None, 40, 33, 32)	6144	block_4_d

block_4_project_BN (BatchNormal project[0][0])	(None, 40, 33, 32)	128	block_4_p
block_4_add (Add) project_BN[0][0]	(None, 40, 33, 32)	0	block_3_p
project_BN[0][0]			block_4_p
block_5_expand (Conv2D) dd[0][0]	(None, 40, 33, 192)	6144	block_4_a
block_5_expand_BN (BatchNormali xpad[0][0])	(None, 40, 33, 192)	768	block_5_e
block_5_expand_relu (ReLU) xpad_BN[0][0]	(None, 40, 33, 192)	0	block_5_e
block_5_depthwise (DepthwiseCon xpad_relu[0][0])	(None, 40, 33, 192)	1728	block_5_e
block_5_depthwise_BN (BatchNorm epthwise[0][0])	(None, 40, 33, 192)	768	block_5_d
block_5_depthwise_relu (ReLU) epthwise_BN[0][0]	(None, 40, 33, 192)	0	block_5_d
block_5_project (Conv2D) epthwise_relu[0][0]	(None, 40, 33, 32)	6144	block_5_d
block_5_project_BN (BatchNormal project[0][0])	(None, 40, 33, 32)	128	block_5_p
block_5_add (Add) dd[0][0]	(None, 40, 33, 32)	0	block_4_a
project_BN[0][0]			block_5_p
block_6_expand (Conv2D) dd[0][0]	(None, 40, 33, 192)	6144	block_5_a
block_6_expand_BN (BatchNormali xpad[0][0])	(None, 40, 33, 192)	768	block_6_e
block_6_expand_relu (ReLU) xpad_BN[0][0]	(None, 40, 33, 192)	0	block_6_e



block_6_pad (ZeroPadding2D)	(None, 41, 35, 192)	0	block_6_e
xpad_relu[0][0]			
block_6_depthwise (DepthwiseCon	(None, 20, 17, 192)	1728	block_6_p
ad[0][0]			
block_6_depthwise_BN (BatchNorm	(None, 20, 17, 192)	768	block_6_d
epthwise[0][0]			
block_6_depthwise_relu (ReLU)	(None, 20, 17, 192)	0	block_6_d
epthwise_BN[0][0]			
block_6_project (Conv2D)	(None, 20, 17, 64)	12288	block_6_d
epthwise_relu[0][0]			
block_6_project_BN (BatchNormal	(None, 20, 17, 64)	256	block_6_p
roject[0][0]			
block_7_expand (Conv2D)	(None, 20, 17, 384)	24576	block_6_p
roject_BN[0][0]			
block_7_expand_BN (BatchNormali	(None, 20, 17, 384)	1536	block_7_e
xpand[0][0]			
block_7_expand_relu (ReLU)	(None, 20, 17, 384)	0	block_7_e
xpand_BN[0][0]			
block_7_depthwise (DepthwiseCon	(None, 20, 17, 384)	3456	block_7_e
xpand_relu[0][0]			
block_7_depthwise_BN (BatchNorm	(None, 20, 17, 384)	1536	block_7_d
epthwise[0][0]			
block_7_depthwise_relu (ReLU)	(None, 20, 17, 384)	0	block_7_d
epthwise_BN[0][0]			
block_7_project (Conv2D)	(None, 20, 17, 64)	24576	block_7_d
epthwise_relu[0][0]			
block_7_project_BN (BatchNormal	(None, 20, 17, 64)	256	block_7_p
roject[0][0]			
block_7_add (Add)	(None, 20, 17, 64)	0	block_6_p
roject_BN[0][0]			block_7_p
roject_BN[0][0]			

block_8_expand (Conv2D) dd[0][0]	(None, 20, 17, 384)	24576	block_7_a
block_8_expand_BN (BatchNormali xpad[0][0]	(None, 20, 17, 384)	1536	block_8_e
block_8_expand_relu (ReLU) xpad_BN[0][0]	(None, 20, 17, 384)	0	block_8_e
block_8_depthwise (DepthwiseCon xpad_relu[0][0]	(None, 20, 17, 384)	3456	block_8_e
block_8_depthwise_BN (BatchNorm epthwise[0][0]	(None, 20, 17, 384)	1536	block_8_d
block_8_depthwise_relu (ReLU) epthwise_BN[0][0]	(None, 20, 17, 384)	0	block_8_d
block_8_project (Conv2D) epthwise_relu[0][0]	(None, 20, 17, 64)	24576	block_8_d
block_8_project_BN (BatchNormal roject[0][0]	(None, 20, 17, 64)	256	block_8_p
block_8_add (Add) dd[0][0]	(None, 20, 17, 64)	0	block_7_a
roject_BN[0][0]			block_8_p
block_9_expand (Conv2D) dd[0][0]	(None, 20, 17, 384)	24576	block_8_a
block_9_expand_BN (BatchNormali xpad[0][0]	(None, 20, 17, 384)	1536	block_9_e
block_9_expand_relu (ReLU) xpad_BN[0][0]	(None, 20, 17, 384)	0	block_9_e
block_9_depthwise (DepthwiseCon xpad_relu[0][0]	(None, 20, 17, 384)	3456	block_9_e
block_9_depthwise_BN (BatchNorm epthwise[0][0]	(None, 20, 17, 384)	1536	block_9_d
block_9_depthwise_relu (ReLU) epthwise_BN[0][0]	(None, 20, 17, 384)	0	block_9_d

block_9_project (Conv2D) epthwise_relu[0][0]	(None, 20, 17, 64)	24576	block_9_d
block_9_project_BN (BatchNormal project[0][0])	(None, 20, 17, 64)	256	block_9_p
block_9_add (Add) dd[0][0]	(None, 20, 17, 64)	0	block_8_a
			block_9_p
block_10_expand (Conv2D) dd[0][0]	(None, 20, 17, 384)	24576	block_9_a
block_10_expand_BN (BatchNormal expand[0][0])	(None, 20, 17, 384)	1536	block_10_
block_10_expand_relu (ReLU) expand_BN[0][0]	(None, 20, 17, 384)	0	block_10_
block_10_depthwise (DepthwiseCo expand_relu[0][0])	(None, 20, 17, 384)	3456	block_10_
block_10_depthwise_BN (BatchNor depthwise[0][0])	(None, 20, 17, 384)	1536	block_10_
block_10_depthwise_relu (ReLU) depthwise_BN[0][0]	(None, 20, 17, 384)	0	block_10_
block_10_project (Conv2D) depthwise_relu[0][0]	(None, 20, 17, 96)	36864	block_10_
block_10_project_BN (BatchNorma project[0][0])	(None, 20, 17, 96)	384	block_10_
block_11_expand (Conv2D) project_BN[0][0]	(None, 20, 17, 576)	55296	block_10_
block_11_expand_BN (BatchNormal expand[0][0])	(None, 20, 17, 576)	2304	block_11_
block_11_expand_relu (ReLU) expand_BN[0][0]	(None, 20, 17, 576)	0	block_11_
block_11_depthwise (DepthwiseCo expand_relu[0][0])	(None, 20, 17, 576)	5184	block_11_

expand\_relu[0][0]

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block_11_depthwise_BN (BatchNor	(None, 20, 17, 576)	2304	block_11_
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depthwise[0][0]

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block_11_depthwise_relu (ReLU)	(None, 20, 17, 576)	0	block_11_
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depthwise\_BN[0][0]

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block_11_project (Conv2D)	(None, 20, 17, 96)	55296	block_11_
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depthwise\_relu[0][0]

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block_11_project_BN (BatchNorma	(None, 20, 17, 96)	384	block_11_
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project[0][0]

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block_11_add (Add)	(None, 20, 17, 96)	0	block_10_
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project\_BN[0][0]

project\_BN[0][0]

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block_12_expand (Conv2D)	(None, 20, 17, 576)	55296	block_11_
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add[0][0]

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block_12_expand_BN (BatchNormal	(None, 20, 17, 576)	2304	block_12_
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expand[0][0]

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block_12_expand_relu (ReLU)	(None, 20, 17, 576)	0	block_12_
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expand\_BN[0][0]

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block_12_depthwise (DepthwiseCo	(None, 20, 17, 576)	5184	block_12_
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expand\_relu[0][0]

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block_12_depthwise_BN (BatchNor	(None, 20, 17, 576)	2304	block_12_
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depthwise[0][0]

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block_12_depthwise_relu (ReLU)	(None, 20, 17, 576)	0	block_12_
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depthwise\_BN[0][0]

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block_12_project (Conv2D)	(None, 20, 17, 96)	55296	block_12_
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depthwise\_relu[0][0]

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block_12_project_BN (BatchNorma	(None, 20, 17, 96)	384	block_12_
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project[0][0]

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block_12_add (Add)	(None, 20, 17, 96)	0	block_11_
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add[0][0]

project\_BN[0][0]

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block_13_expand (Conv2D) add[0][0]	(None, 20, 17, 576)	55296	block_12_
block_13_expand_BN (BatchNormal expand[0][0])	(None, 20, 17, 576)	2304	block_13_
block_13_expand_relu (ReLU) expand_BN[0][0]	(None, 20, 17, 576)	0	block_13_
block_13_pad (ZeroPadding2D) expand_relu[0][0]	(None, 21, 19, 576)	0	block_13_
block_13_depthwise (DepthwiseCo pad[0][0])	(None, 10, 9, 576)	5184	block_13_
block_13_depthwise_BN (BatchNor depthwise[0][0])	(None, 10, 9, 576)	2304	block_13_
block_13_depthwise_relu (ReLU) depthwise_BN[0][0]	(None, 10, 9, 576)	0	block_13_
block_13_project (Conv2D) depthwise_relu[0][0]	(None, 10, 9, 160)	92160	block_13_
block_13_project_BN (BatchNorma project[0][0])	(None, 10, 9, 160)	640	block_13_
block_14_expand (Conv2D) project_BN[0][0]	(None, 10, 9, 960)	153600	block_13_
block_14_expand_BN (BatchNormal expand[0][0])	(None, 10, 9, 960)	3840	block_14_
block_14_expand_relu (ReLU) expand_BN[0][0]	(None, 10, 9, 960)	0	block_14_
block_14_depthwise (DepthwiseCo expand_relu[0][0])	(None, 10, 9, 960)	8640	block_14_
block_14_depthwise_BN (BatchNor depthwise[0][0])	(None, 10, 9, 960)	3840	block_14_
block_14_depthwise_relu (ReLU) depthwise_BN[0][0]	(None, 10, 9, 960)	0	block_14_

block_14_project (Conv2D) depthwise_relu[0][0]	(None, 10, 9, 160)	153600	block_14_
block_14_project_BN (BatchNorma project[0][0]	(None, 10, 9, 160)	640	block_14_
block_14_add (Add) project_BN[0][0]	(None, 10, 9, 160)	0	block_13_ block_14_
block_15_expand (Conv2D) add[0][0]	(None, 10, 9, 960)	153600	block_14_
block_15_expand_BN (BatchNormal expand[0][0]	(None, 10, 9, 960)	3840	block_15_
block_15_expand_relu (ReLU) expand_BN[0][0]	(None, 10, 9, 960)	0	block_15_
block_15_depthwise (DepthwiseCo expand_relu[0][0]	(None, 10, 9, 960)	8640	block_15_
block_15_depthwise_BN (BatchNor depthwise[0][0]	(None, 10, 9, 960)	3840	block_15_
block_15_depthwise_relu (ReLU) depthwise_BN[0][0]	(None, 10, 9, 960)	0	block_15_
block_15_project (Conv2D) depthwise_relu[0][0]	(None, 10, 9, 160)	153600	block_15_
block_15_project_BN (BatchNorma project[0][0]	(None, 10, 9, 160)	640	block_15_
block_15_add (Add) add[0][0]	(None, 10, 9, 160)	0	block_14_ block_15_
block_16_expand (Conv2D) add[0][0]	(None, 10, 9, 960)	153600	block_15_
block_16_expand_BN (BatchNormal expand[0][0]	(None, 10, 9, 960)	3840	block_16_

block_16_expand_relu (ReLU)	(None, 10, 9, 960)	0	block_16_expand_BN[0][0]
block_16_depthwise (DepthwiseCo	(None, 10, 9, 960)	8640	block_16_expand_relu[0][0]
block_16_depthwise_BN (BatchNor	(None, 10, 9, 960)	3840	block_16_depthwise[0][0]
block_16_depthwise_relu (ReLU)	(None, 10, 9, 960)	0	block_16_depthwise_BN[0][0]
block_16_project (Conv2D)	(None, 10, 9, 320)	307200	block_16_depthwise_relu[0][0]
block_16_project_BN (BatchNorma	(None, 10, 9, 320)	1280	block_16_project[0][0]
Conv_1 (Conv2D)	(None, 10, 9, 1280)	409600	block_16_project_BN[0][0]
Conv_1_bn (BatchNormalization)	(None, 10, 9, 1280)	5120	Conv_1[0][0]
out_relu (ReLU)	(None, 10, 9, 1280)	0	Conv_1_bn[0][0]
=====			
Total params: 2,257,984			
Trainable params: 886,400			
Non-trainable params: 1,371,584			

## 2. 資料處理

In [3]:

```
# 將訓練資料以Generator形式呈現並經過前置處理
train_datagen=image.ImageDataGenerator(preprocessing_function=preprocess_input)
train_generator=train_datagen.flow_from_directory(r"C:\Users\j3192\Desktop\Jupyter Note
book\計算機程式\fruit_data\train",
                                                    target_size=(320,258),
                                                    color_mode='rgb',
                                                    batch_size=50,
                                                    class_mode='categorical',
                                                    shuffle=True)
```

Found 38039 images belonging to 14 classes.

In [4]:

```
# 將測試資料以Generator形式呈現並經過前置處理
test_datagen = image.ImageDataGenerator(preprocessing_function = preprocess_input)
test_generator = test_datagen.flow_from_directory(r'C:\Users\j3192\Desktop\Jupyter Note
book\計算機程式\fruit_data\test',
                                                target_size = (320,258),
                                                color_mode = 'rgb',
                                                batch_size = 50,
                                                class_mode = 'categorical',
                                                shuffle = True)
```

Found 4200 images belonging to 14 classes.

### 3. 建立模型

In [38]:

```
# 將MobileNet前面幾層凍結只訓練後面13層
for layer in mobile.layers[:-13]:
    layer.trainable = False
```

In [39]:

```
# 因為原本MobileNet可以辨識1000種類的東西，但我們只有14種水果，因此將最後一層刪除並新增一層 Dense
輸出為14維度
x = mobile.layers[-1].output
x = GlobalAveragePooling2D()(x)
pre = Dense(14, activation='softmax')(x)
new_model = Model(mobile.input, pre)
```

In [40]:

```
new_model.compile(optimizer='Adam', loss='categorical_crossentropy', metrics = ['accuracy'])
```



In [46]:

```
new_model.summary()
```

Model: "model\_10"

Layer (type)	Output Shape	Param #	Connected to
=====			
input_4 (InputLayer)	[(None, 320, 258, 3)]	0	
Conv1_pad (ZeroPadding2D)	(None, 321, 259, 3)	0	input_4
Conv1 (Conv2D)	(None, 160, 129, 32)	864	Conv1_pad
bn_Conv1 (BatchNormalization)	(None, 160, 129, 32)	128	Conv1[0]
Conv1_relu (ReLU)	(None, 160, 129, 32)	0	bn_Conv1
expanded_conv_depthwise (Depthwise Conv2D)	(None, 160, 129, 32)	288	Conv1_relu
expanded_conv_depthwise_BN (Batch Normalization)	(None, 160, 129, 32)	128	expanded_conv_depthwise
expanded_conv_depthwise_relu (ReLU)	(None, 160, 129, 32)	0	expanded_conv_depthwise_BN
expanded_conv_project (Conv2D)	(None, 160, 129, 16)	512	expanded_conv_depthwise_relu
expanded_conv_project_BN (Batch Normalization)	(None, 160, 129, 16)	64	expanded_conv_project
block_1_expand (Conv2D)	(None, 160, 129, 96)	1536	expanded_conv_project_BN
block_1_expand_BN (Batch Normalization)	(None, 160, 129, 96)	384	block_1_expand
block_1_expand_relu (ReLU)	(None, 160, 129, 96)	0	block_1_expand_BN
block_1_pad (ZeroPadding2D)	(None, 161, 131, 96)	0	block_1_expand_relu

block_1_depthwise (DepthwiseCon	(None, 80, 65, 96)	864	block_1_p
ad[0][0]			
block_1_depthwise_BN (BatchNorm	(None, 80, 65, 96)	384	block_1_d
epthwise[0][0]			
block_1_depthwise_relu (ReLU)	(None, 80, 65, 96)	0	block_1_d
epthwise_BN[0][0]			
block_1_project (Conv2D)	(None, 80, 65, 24)	2304	block_1_d
epthwise_relu[0][0]			
block_1_project_BN (BatchNormal	(None, 80, 65, 24)	96	block_1_p
roject[0][0]			
block_2_expand (Conv2D)	(None, 80, 65, 144)	3456	block_1_p
roject_BN[0][0]			
block_2_expand_BN (BatchNormali	(None, 80, 65, 144)	576	block_2_e
xpand[0][0]			
block_2_expand_relu (ReLU)	(None, 80, 65, 144)	0	block_2_e
xpand_BN[0][0]			
block_2_depthwise (DepthwiseCon	(None, 80, 65, 144)	1296	block_2_e
xpand_relu[0][0]			
block_2_depthwise_BN (BatchNorm	(None, 80, 65, 144)	576	block_2_d
epthwise[0][0]			
block_2_depthwise_relu (ReLU)	(None, 80, 65, 144)	0	block_2_d
epthwise_BN[0][0]			
block_2_project (Conv2D)	(None, 80, 65, 24)	3456	block_2_d
epthwise_relu[0][0]			
block_2_project_BN (BatchNormal	(None, 80, 65, 24)	96	block_2_p
roject[0][0]			
block_2_add (Add)	(None, 80, 65, 24)	0	block_1_p
roject_BN[0][0]			block_2_p
roject_BN[0][0]			
block_3_expand (Conv2D)	(None, 80, 65, 144)	3456	block_2_a
dd[0][0]			

block_3_expand_BN (BatchNormali	(None, 80, 65, 144)	576	block_3_e
xpand[0][0]			
block_3_expand_relu (ReLU)	(None, 80, 65, 144)	0	block_3_e
xpand_BN[0][0]			
block_3_pad (ZeroPadding2D)	(None, 81, 67, 144)	0	block_3_e
xpand_relu[0][0]			
block_3_depthwise (DepthwiseCon	(None, 40, 33, 144)	1296	block_3_p
ad[0][0]			
block_3_depthwise_BN (BatchNorm	(None, 40, 33, 144)	576	block_3_d
epthwise[0][0]			
block_3_depthwise_relu (ReLU)	(None, 40, 33, 144)	0	block_3_d
epthwise_BN[0][0]			
block_3_project (Conv2D)	(None, 40, 33, 32)	4608	block_3_d
epthwise_relu[0][0]			
block_3_project_BN (BatchNormal	(None, 40, 33, 32)	128	block_3_p
roject[0][0]			
block_4_expand (Conv2D)	(None, 40, 33, 192)	6144	block_3_p
roject_BN[0][0]			
block_4_expand_BN (BatchNormali	(None, 40, 33, 192)	768	block_4_e
xpand[0][0]			
block_4_expand_relu (ReLU)	(None, 40, 33, 192)	0	block_4_e
xpand_BN[0][0]			
block_4_depthwise (DepthwiseCon	(None, 40, 33, 192)	1728	block_4_e
xpand_relu[0][0]			
block_4_depthwise_BN (BatchNorm	(None, 40, 33, 192)	768	block_4_d
epthwise[0][0]			
block_4_depthwise_relu (ReLU)	(None, 40, 33, 192)	0	block_4_d
epthwise_BN[0][0]			
block_4_project (Conv2D)	(None, 40, 33, 32)	6144	block_4_d
epthwise_relu[0][0]			

block_4_project_BN (BatchNormal project[0][0])	(None, 40, 33, 32)	128	block_4_p
block_4_add (Add) project_BN[0][0]	(None, 40, 33, 32)	0	block_3_p
project_BN[0][0]			block_4_p
block_5_expand (Conv2D) dd[0][0]	(None, 40, 33, 192)	6144	block_4_a
block_5_expand_BN (BatchNormali xpad[0][0])	(None, 40, 33, 192)	768	block_5_e
block_5_expand_relu (ReLU) xpad_BN[0][0]	(None, 40, 33, 192)	0	block_5_e
block_5_depthwise (DepthwiseCon xpad_relu[0][0])	(None, 40, 33, 192)	1728	block_5_e
block_5_depthwise_BN (BatchNorm epthwise[0][0])	(None, 40, 33, 192)	768	block_5_d
block_5_depthwise_relu (ReLU) epthwise_BN[0][0]	(None, 40, 33, 192)	0	block_5_d
block_5_project (Conv2D) epthwise_relu[0][0]	(None, 40, 33, 32)	6144	block_5_d
block_5_project_BN (BatchNormal project[0][0])	(None, 40, 33, 32)	128	block_5_p
block_5_add (Add) dd[0][0]	(None, 40, 33, 32)	0	block_4_a
project_BN[0][0]			block_5_p
block_6_expand (Conv2D) dd[0][0]	(None, 40, 33, 192)	6144	block_5_a
block_6_expand_BN (BatchNormali xpad[0][0])	(None, 40, 33, 192)	768	block_6_e
block_6_expand_relu (ReLU) xpad_BN[0][0]	(None, 40, 33, 192)	0	block_6_e

block_6_pad (ZeroPadding2D)	(None, 41, 35, 192)	0	block_6_e
xpad_relu[0][0]			
block_6_depthwise (DepthwiseCon	(None, 20, 17, 192)	1728	block_6_p
ad[0][0]			
block_6_depthwise_BN (BatchNorm	(None, 20, 17, 192)	768	block_6_d
epthwise[0][0]			
block_6_depthwise_relu (ReLU)	(None, 20, 17, 192)	0	block_6_d
epthwise_BN[0][0]			
block_6_project (Conv2D)	(None, 20, 17, 64)	12288	block_6_d
epthwise_relu[0][0]			
block_6_project_BN (BatchNormal	(None, 20, 17, 64)	256	block_6_p
roject[0][0]			
block_7_expand (Conv2D)	(None, 20, 17, 384)	24576	block_6_p
roject_BN[0][0]			
block_7_expand_BN (BatchNormali	(None, 20, 17, 384)	1536	block_7_e
xpand[0][0]			
block_7_expand_relu (ReLU)	(None, 20, 17, 384)	0	block_7_e
xpand_BN[0][0]			
block_7_depthwise (DepthwiseCon	(None, 20, 17, 384)	3456	block_7_e
xpand_relu[0][0]			
block_7_depthwise_BN (BatchNorm	(None, 20, 17, 384)	1536	block_7_d
epthwise[0][0]			
block_7_depthwise_relu (ReLU)	(None, 20, 17, 384)	0	block_7_d
epthwise_BN[0][0]			
block_7_project (Conv2D)	(None, 20, 17, 64)	24576	block_7_d
epthwise_relu[0][0]			
block_7_project_BN (BatchNormal	(None, 20, 17, 64)	256	block_7_p
roject[0][0]			
block_7_add (Add)	(None, 20, 17, 64)	0	block_6_p
roject_BN[0][0]			block_7_p
roject_BN[0][0]			

block_8_expand (Conv2D) dd[0][0]	(None, 20, 17, 384)	24576	block_7_a
block_8_expand_BN (BatchNormali xpad[0][0]	(None, 20, 17, 384)	1536	block_8_e
block_8_expand_relu (ReLU) xpad_BN[0][0]	(None, 20, 17, 384)	0	block_8_e
block_8_depthwise (DepthwiseCon xpad_relu[0][0]	(None, 20, 17, 384)	3456	block_8_e
block_8_depthwise_BN (BatchNorm epthwise[0][0]	(None, 20, 17, 384)	1536	block_8_d
block_8_depthwise_relu (ReLU) epthwise_BN[0][0]	(None, 20, 17, 384)	0	block_8_d
block_8_project (Conv2D) epthwise_relu[0][0]	(None, 20, 17, 64)	24576	block_8_d
block_8_project_BN (BatchNormal roject[0][0]	(None, 20, 17, 64)	256	block_8_p
block_8_add (Add) dd[0][0]	(None, 20, 17, 64)	0	block_7_a
roject_BN[0][0]			block_8_p
block_9_expand (Conv2D) dd[0][0]	(None, 20, 17, 384)	24576	block_8_a
block_9_expand_BN (BatchNormali xpad[0][0]	(None, 20, 17, 384)	1536	block_9_e
block_9_expand_relu (ReLU) xpad_BN[0][0]	(None, 20, 17, 384)	0	block_9_e
block_9_depthwise (DepthwiseCon xpad_relu[0][0]	(None, 20, 17, 384)	3456	block_9_e
block_9_depthwise_BN (BatchNorm epthwise[0][0]	(None, 20, 17, 384)	1536	block_9_d
block_9_depthwise_relu (ReLU) epthwise_BN[0][0]	(None, 20, 17, 384)	0	block_9_d

block_9_project (Conv2D) epthwise_relu[0][0]	(None, 20, 17, 64)	24576	block_9_d
block_9_project_BN (BatchNormal project[0][0])	(None, 20, 17, 64)	256	block_9_p
block_9_add (Add) dd[0][0]	(None, 20, 17, 64)	0	block_8_a
block_9_project_BN[0][0]			block_9_p
block_10_expand (Conv2D) dd[0][0]	(None, 20, 17, 384)	24576	block_9_a
block_10_expand_BN (BatchNormal expand[0][0])	(None, 20, 17, 384)	1536	block_10_
block_10_expand_relu (ReLU) expand_BN[0][0]	(None, 20, 17, 384)	0	block_10_
block_10_depthwise (DepthwiseCo expand_relu[0][0])	(None, 20, 17, 384)	3456	block_10_
block_10_depthwise_BN (BatchNor depthwise[0][0])	(None, 20, 17, 384)	1536	block_10_
block_10_depthwise_relu (ReLU) depthwise_BN[0][0]	(None, 20, 17, 384)	0	block_10_
block_10_project (Conv2D) depthwise_relu[0][0]	(None, 20, 17, 96)	36864	block_10_
block_10_project_BN (BatchNorma project[0][0])	(None, 20, 17, 96)	384	block_10_
block_11_expand (Conv2D) project_BN[0][0]	(None, 20, 17, 576)	55296	block_10_
block_11_expand_BN (BatchNormal expand[0][0])	(None, 20, 17, 576)	2304	block_11_
block_11_expand_relu (ReLU) expand_BN[0][0]	(None, 20, 17, 576)	0	block_11_
block_11_depthwise (DepthwiseCo expand_relu[0][0])	(None, 20, 17, 576)	5184	block_11_



expand\_relu[0][0]

---

block_11_depthwise_BN (BatchNor	(None, 20, 17, 576)	2304	block_11_
---------------------------------	---------------------	------	-----------

depthwise[0][0]

---



---

block_11_depthwise_relu (ReLU)	(None, 20, 17, 576)	0	block_11_
--------------------------------	---------------------	---	-----------

depthwise\_BN[0][0]

---



---

block_11_project (Conv2D)	(None, 20, 17, 96)	55296	block_11_
---------------------------	--------------------	-------	-----------

depthwise\_relu[0][0]

---



---

block_11_project_BN (BatchNorma	(None, 20, 17, 96)	384	block_11_
---------------------------------	--------------------	-----	-----------

project[0][0]

---



---

block_11_add (Add)	(None, 20, 17, 96)	0	block_10_
--------------------	--------------------	---	-----------

project\_BN[0][0]

block\_11\_

project\_BN[0][0]

---



---

block_12_expand (Conv2D)	(None, 20, 17, 576)	55296	block_11_
--------------------------	---------------------	-------	-----------

add[0][0]

---



---

block_12_expand_BN (BatchNormal	(None, 20, 17, 576)	2304	block_12_
---------------------------------	---------------------	------	-----------

expand[0][0]

---



---

block_12_expand_relu (ReLU)	(None, 20, 17, 576)	0	block_12_
-----------------------------	---------------------	---	-----------

expand\_BN[0][0]

---



---

block_12_depthwise (DepthwiseCo	(None, 20, 17, 576)	5184	block_12_
---------------------------------	---------------------	------	-----------

expand\_relu[0][0]

---



---

block_12_depthwise_BN (BatchNor	(None, 20, 17, 576)	2304	block_12_
---------------------------------	---------------------	------	-----------

depthwise[0][0]

---



---

block_12_depthwise_relu (ReLU)	(None, 20, 17, 576)	0	block_12_
--------------------------------	---------------------	---	-----------

depthwise\_BN[0][0]

---



---

block_12_project (Conv2D)	(None, 20, 17, 96)	55296	block_12_
---------------------------	--------------------	-------	-----------

depthwise\_relu[0][0]

---



---

block_12_project_BN (BatchNorma	(None, 20, 17, 96)	384	block_12_
---------------------------------	--------------------	-----	-----------

project[0][0]

---



---

block_12_add (Add)	(None, 20, 17, 96)	0	block_11_
--------------------	--------------------	---	-----------

add[0][0]

block\_12\_

project\_BN[0][0]

---

block_13_expand (Conv2D) add[0][0]	(None, 20, 17, 576)	55296	block_12_
block_13_expand_BN (BatchNormal expand[0][0])	(None, 20, 17, 576)	2304	block_13_
block_13_expand_relu (ReLU) expand_BN[0][0]	(None, 20, 17, 576)	0	block_13_
block_13_pad (ZeroPadding2D) expand_relu[0][0]	(None, 21, 19, 576)	0	block_13_
block_13_depthwise (DepthwiseCo pad[0][0])	(None, 10, 9, 576)	5184	block_13_
block_13_depthwise_BN (BatchNor depthwise[0][0])	(None, 10, 9, 576)	2304	block_13_
block_13_depthwise_relu (ReLU) depthwise_BN[0][0]	(None, 10, 9, 576)	0	block_13_
block_13_project (Conv2D) depthwise_relu[0][0]	(None, 10, 9, 160)	92160	block_13_
block_13_project_BN (BatchNorma project[0][0])	(None, 10, 9, 160)	640	block_13_
block_14_expand (Conv2D) project_BN[0][0]	(None, 10, 9, 960)	153600	block_13_
block_14_expand_BN (BatchNormal expand[0][0])	(None, 10, 9, 960)	3840	block_14_
block_14_expand_relu (ReLU) expand_BN[0][0]	(None, 10, 9, 960)	0	block_14_
block_14_depthwise (DepthwiseCo expand_relu[0][0])	(None, 10, 9, 960)	8640	block_14_
block_14_depthwise_BN (BatchNor depthwise[0][0])	(None, 10, 9, 960)	3840	block_14_
block_14_depthwise_relu (ReLU) depthwise_BN[0][0]	(None, 10, 9, 960)	0	block_14_

block_14_project (Conv2D) depthwise_relu[0][0]	(None, 10, 9, 160)	153600	block_14_
block_14_project_BN (BatchNorma project[0][0]	(None, 10, 9, 160)	640	block_14_
block_14_add (Add) project_BN[0][0]	(None, 10, 9, 160)	0	block_13_ block_14_
block_15_expand (Conv2D) add[0][0]	(None, 10, 9, 960)	153600	block_14_
block_15_expand_BN (BatchNormal expand[0][0]	(None, 10, 9, 960)	3840	block_15_
block_15_expand_relu (ReLU) expand_BN[0][0]	(None, 10, 9, 960)	0	block_15_
block_15_depthwise (DepthwiseCo expand_relu[0][0]	(None, 10, 9, 960)	8640	block_15_
block_15_depthwise_BN (BatchNor depthwise[0][0]	(None, 10, 9, 960)	3840	block_15_
block_15_depthwise_relu (ReLU) depthwise_BN[0][0]	(None, 10, 9, 960)	0	block_15_
block_15_project (Conv2D) depthwise_relu[0][0]	(None, 10, 9, 160)	153600	block_15_
block_15_project_BN (BatchNorma project[0][0]	(None, 10, 9, 160)	640	block_15_
block_15_add (Add) add[0][0]	(None, 10, 9, 160)	0	block_14_ block_15_
block_16_expand (Conv2D) add[0][0]	(None, 10, 9, 960)	153600	block_15_
block_16_expand_BN (BatchNormal expand[0][0]	(None, 10, 9, 960)	3840	block_16_

block_16_expand_relu (ReLU)	(None, 10, 9, 960)	0	block_16_expand_BN[0][0]
block_16_depthwise (DepthwiseCo	(None, 10, 9, 960)	8640	block_16_expand_relu[0][0]
block_16_depthwise_BN (BatchNor	(None, 10, 9, 960)	3840	block_16_depthwise[0][0]
block_16_depthwise_relu (ReLU)	(None, 10, 9, 960)	0	block_16_depthwise_BN[0][0]
block_16_project (Conv2D)	(None, 10, 9, 320)	307200	block_16_depthwise_relu[0][0]
block_16_project_BN (BatchNorma	(None, 10, 9, 320)	1280	block_16_project[0][0]
Conv_1 (Conv2D)	(None, 10, 9, 1280)	409600	block_16_project_BN[0][0]
Conv_1_bn (BatchNormalization)	(None, 10, 9, 1280)	5120	Conv_1[0][0]
out_relu (ReLU)	(None, 10, 9, 1280)	0	Conv_1_bn[0][0]
global_average_pooling2d_3 (Glo	(None, 1280)	0	out_relu[0][0]
dense_10 (Dense)	(None, 14)	17934	global_av
erage_pooling2d_3[0][0]			
=====			
Total params: 2,275,918			
Trainable params: 904,334			
Non-trainable params: 1,371,584			

#### 4. 訓練資料

In [42]:

```
# 若訓練超過8次以上 val_accuracy 沒有增加超過0.005則提前停止訓練
early_stopping = EarlyStopping(monitor='val_accuracy', min_delta=0.005, mode='max', patience = 8 )
history3 = new_model.fit_generator(generator = train_generator,
                                   epochs = 25,
                                   callbacks = [early_stopping],
                                   validation_data = test_generator)
```

WARNING:tensorflow:sample\_weight modes were coerced from

```
...  
to  
['...']
```

WARNING:tensorflow:sample\_weight modes were coerced from

```
...  
to  
['...']
```

Train for 761 steps, validate for 84 steps

Epoch 1/25

761/761 [=====] - 642s 844ms/step - loss: 0.0542  
- accuracy: 0.9831 - val\_loss: 7.7220 - val\_accuracy: 0.5133

Epoch 2/25

761/761 [=====] - 637s 837ms/step - loss: 0.0084  
- accuracy: 0.9973 - val\_loss: 4.1708 - val\_accuracy: 0.6440

Epoch 3/25

761/761 [=====] - 637s 837ms/step - loss: 0.0081  
- accuracy: 0.9976 - val\_loss: 1.8179 - val\_accuracy: 0.8019

Epoch 4/25

761/761 [=====] - 636s 836ms/step - loss: 0.0115  
- accuracy: 0.9968 - val\_loss: 3.0550 - val\_accuracy: 0.7343

Epoch 5/25

761/761 [=====] - 636s 836ms/step - loss: 0.0126  
- accuracy: 0.9965 - val\_loss: 7.6127 - val\_accuracy: 0.5776

Epoch 6/25

761/761 [=====] - 636s 836ms/step - loss: 0.0048  
- accuracy: 0.9988 - val\_loss: 2.5146 - val\_accuracy: 0.8002

Epoch 7/25

761/761 [=====] - 637s 838ms/step - loss: 0.0075  
- accuracy: 0.9977 - val\_loss: 1.8953 - val\_accuracy: 0.8150

Epoch 8/25

761/761 [=====] - 637s 837ms/step - loss: 0.0013  
- accuracy: 0.9995 - val\_loss: 1.6855 - val\_accuracy: 0.8083

Epoch 9/25

761/761 [=====] - 637s 837ms/step - loss: 1.9219e  
-04 - accuracy: 0.9999 - val\_loss: 1.1725 - val\_accuracy: 0.8390

Epoch 10/25

761/761 [=====] - 637s 837ms/step - loss: 0.0149  
- accuracy: 0.9957 - val\_loss: 2.7073 - val\_accuracy: 0.7979

Epoch 11/25

761/761 [=====] - 637s 837ms/step - loss: 0.0050  
- accuracy: 0.9988 - val\_loss: 3.2025 - val\_accuracy: 0.7457

Epoch 12/25

761/761 [=====] - 639s 839ms/step - loss: 0.0041  
- accuracy: 0.9990 - val\_loss: 0.9156 - val\_accuracy: 0.8955

Epoch 13/25

761/761 [=====] - 637s 838ms/step - loss: 3.2392e  
-04 - accuracy: 0.9999 - val\_loss: 0.6089 - val\_accuracy: 0.9145

Epoch 14/25

761/761 [=====] - 637s 837ms/step - loss: 2.1914e  
-05 - accuracy: 1.0000 - val\_loss: 0.6386 - val\_accuracy: 0.9093

Epoch 15/25

761/761 [=====] - 637s 838ms/step - loss: 9.6240e  
-06 - accuracy: 1.0000 - val\_loss: 0.6034 - val\_accuracy: 0.9133

Epoch 16/25

761/761 [=====] - 637s 837ms/step - loss: 6.5843e  
-06 - accuracy: 1.0000 - val\_loss: 0.6063 - val\_accuracy: 0.9131

Epoch 17/25

761/761 [=====] - 637s 837ms/step - loss: 4.7139e  
-06 - accuracy: 1.0000 - val\_loss: 0.6069 - val\_accuracy: 0.9129

Epoch 18/25

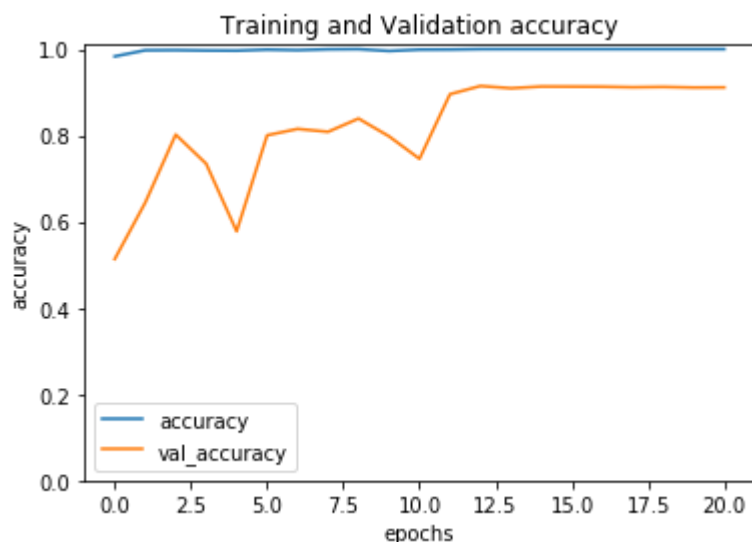
```
761/761 [=====] - 639s 840ms/step - loss: 3.3877e-06 - accuracy: 1.0000 - val_loss: 0.6147 - val_accuracy: 0.9117
Epoch 19/25
761/761 [=====] - 640s 841ms/step - loss: 2.4376e-06 - accuracy: 1.0000 - val_loss: 0.6124 - val_accuracy: 0.9124
Epoch 20/25
761/761 [=====] - 640s 841ms/step - loss: 1.7427e-06 - accuracy: 1.0000 - val_loss: 0.6221 - val_accuracy: 0.9110
Epoch 21/25
761/761 [=====] - 642s 843ms/step - loss: 1.2404e-06 - accuracy: 1.0000 - val_loss: 0.6273 - val_accuracy: 0.9112
```

In [61]:

```
plt.plot(history3.history['accuracy'], label = 'accuracy')
plt.plot(history3.history['val_accuracy'], label = 'val_accuracy')
plt.xlabel('epochs')
plt.ylabel('accuracy')
plt.ylim(0, 1.01)
plt.title('Training and Validation accuracy')
plt.legend()
```

Out[61]:

<matplotlib.legend.Legend at 0x28e5cb4fb88>

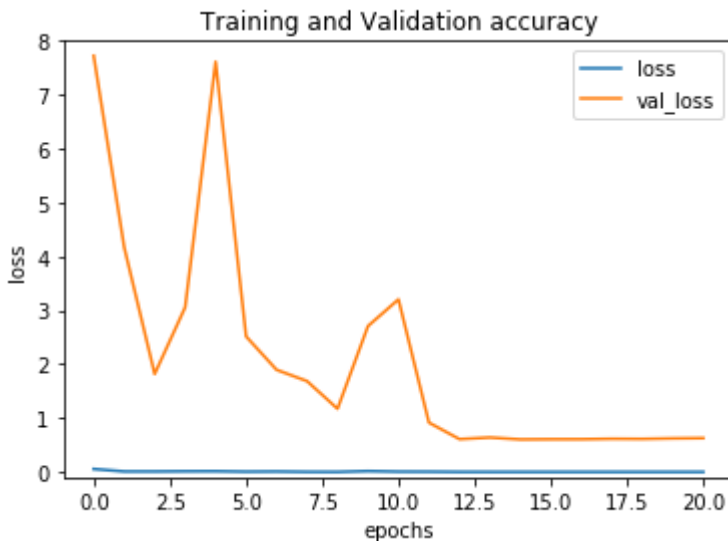


In [62]:

```
plt.plot(history3.history['loss'], label='loss')
plt.plot(history3.history['val_loss'], label = 'val_loss')
plt.xlabel('epochs')
plt.ylabel('loss')
plt.ylim(-0.1, 8)
plt.title('Training and Validation accuracy')
plt.legend()
```

Out[62]:

&lt;matplotlib.legend.Legend at 0x28e4d5e4d88&gt;



## 5. 網路爬蟲水果價格

In [6]:

```
# 爬取網站上所有的水果種類的價格並儲存成 DataFrame
df = pd.DataFrame({})
L = ['熱帶水果', '硬核類', '高山類', '厚皮類', '薄皮類', '瓜類', '柑橘柚類']
for category in L:
    res = requests.get(f'https://www.twfood.cc/topic/fruit/{category}')
    soup = BeautifulSoup(res.text, 'html.parser')
    fruit = soup.select('#vege_chart > div.col-xs-12.col-sm-12.col-md-3.widget.to_animate.animated.fadeInLeft > div > div.col-xs-6.col-sm-6.col-md-12.vege_price')
    names = soup.select('#vege_chart > div.col-xs-12.col-sm-12.col-md-3.widget.to_animate.animated.fadeInLeft > div > div.col-xs-6.col-sm-6.col-md-12.vege_price > h4 > a')
    num = len(fruit)
    for i in range(num):
        name = names[i].text.replace(" ", "").replace(f'推薦No:{i+1}', '').strip()
        estimated_price = fruit[i].find_all('span', {'class': 'text-price'})[3].text
        ser = pd.Series({"estimated_price": estimated_price}, name = name)
        df = df.append(ser)
df = df.astype('float64')
```



In [7]:

```
# 因為有些水果並沒有分類，所以要以輸入關鍵字的方式搜尋
def search(search):
    res = requests.get(f'https://www.twfood.cc/search?q={search}')
    soup = BeautifulSoup(res.text, 'html.parser')
    fruit = soup.find_all('div', {'class': 'row_search_result'})[0]
    name = fruit.find_all({'a': 'href'})[0].text.strip()
    new_url = 'https://www.twfood.cc' + fruit.find_all('a')[0]['href']
    new_res = requests.get(new_url)
    new_soup = BeautifulSoup(new_res.text, 'html.parser')
    estimated_price = new_soup.find_all('span', {'class': 'text-price'})[3].text
    return float(estimated_price)
```

In [8]:

```
# 找尋所有同種水果的價格並將其平均
class_names = ['蘋果', '香蕉', '楊桃', '芭樂', '奇異果', '芒果', '甜瓜', '橘子', '桃子',
               '梨', '柿子', '火龍果', '李', '番茄']
price = []
for cls in class_names:
    L = []
    for name in df.index:
        if (cls + '-' in name) or (f'({cls})' in name):
            L.append(df.loc[name, 'estimated_price'])
    price.append(search(cls)) if len(L) == 0 else price.append(np.array(L).mean().round(
))
```

In [9]:

```
# 將水果名稱和價錢放在一起並用 utf-8 的方式寫入避免產生亂碼
name_price = [combination for combination in zip(class_names, price)]
name_price = [f'{item[0]} ${item[1]}\n'.encode('utf-8') for item in name_price]
```

In [10]:

```
# 將標籤寫成檔案
with open(r"C:\Users\j3192\Desktop\TFLite_example\lite\examples\image_classification\an
droid\app\src\main\assets\labels.txt", 'wb') as f:
    f.writelines(name_price)
```

## 6. 測試

In [13]:

```
new_model = tf.keras.models.load_model('fruit_model3.h5')
```

In [14]:

```
result = new_model.predict(test_generator)
```

In [18]:

```
# 因為 array 一次不能儲存那麼大的資料所以分批 reshape再合起來
x_test = []
for j in range(3):
    if 30*(j+1)*50 < len(result):
        L = [test_generator[i][0] for i in range(30*j, 30*(j+1))]
        res = list(np.array(L).reshape(1500, 320, 258, 3))
        print(np.array(L).shape)
    else:
        L = [test_generator[i][0] for i in range(30*j, int(len(result)/50))]
        res = list(np.array(L).reshape(len(result) - 30*j*50, 320, 258, 3))
        print(np.array(L).shape)

    x_test.extend(res)
```

(30, 50, 320, 258, 3)

(30, 50, 320, 258, 3)

(24, 50, 320, 258, 3)

In [22]:

```
# 簡單觀察一下訓練結果
def show(n):
    plt.imshow(x_test[n] + 0.5)
    print("預測:", class_names[np.where(result[n] == result[n].max())[0][0]])
    print('合理價格為:', price[np.where(result[n] == result[n].max())[0][0]])
```

In [23]:

```
interact_manual(show, n = (0, 4200))
```

Out[23]:

&lt;function \_\_main\_\_.show(n)&gt;

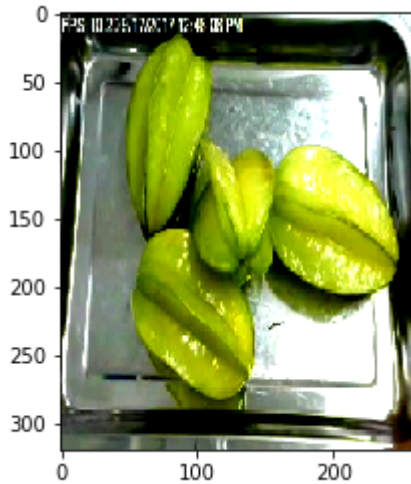
In [26]:

```
show(2197)
```

Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers).

預測： 楊桃

合理價格為： 36.0



## 7. 儲存並轉成TFLite

In [43]:

```
new_model.save('fruit_model3.h5')
```

In [44]:

```
converter = tf.lite.TFLiteConverter.from_keras_model(new_model)
tflite_model = converter.convert()
open('fruit3.tflite', 'wb').write(tflite_model)
```

Out[44]:

8923956

## 8. 匯出成一個APP

1. 尋找Git Hub上的Demo並下載
2. 利用Android Studio匯入檔案
3. 將內建的model及labels改成我們的
4. Build並匯出成APP ( [https://github.com/bookbnnbnn/TFLite\\_example](https://github.com/bookbnnbnn/TFLite_example) ([https://github.com/bookbnnbnn/TFLite\\_example](https://github.com/bookbnnbnn/TFLite_example)) )

## 9. 結果與討論

優點：

- 可以看出圖片的辨識度都蠻高的且運算速度相當快

缺點：

- 沒有訓練關於食物的剖面圖
- 沒有辦法辨識同種水果但品種不同，畢竟價格可能相差很多
- 沒辦法即時更新最新的合理價格

## 五、心得感想

大家都第一次接觸深度學習，從老師身上學到了很多，但每次作業的資料都是從 **keras** 的套件中讀取，一行程式碼就輕鬆解決，以為 **CNN** 就是很簡單的幾步驟，自己從頭去做才知道原來從資料的找尋、資料的讀取及前置作業是如此的繁雜，資料準備好之後，模型的選擇也相當重要，這次沒有老師要求要用什麼模型去做，於是開始反問自己，我們對模型的要求是什麼？由於我們最終的目標是將模型放入手機中運行，手機的硬體設備不像電腦一樣那麼強大，**Tensorflow** 對於這方面有支援的模型也不多，因此我們開始搜尋許多相關資訊，了解各個模型的特性，找出速度快同時精準度也不錯的模型，在完成模型的選擇及訓練之後，要如何將模型以 **APP** 的形式在手機上運行又是一個相當大的難題，對於編寫 **Android** 的 **Java** 又是一個全新的難題，但當成品做出來的時候，還是有滿滿的感動，並且讓我們有機會了解自身的不足並能夠加以補足。

In [ ]: