In [24]:
```
!pip install keras
```

```
Requirement already satisfied: keras in /opt/anaconda/envs/wmlce/lib/python3.
6/site-packages (2.3.1)
Requirement already satisfied: numpy>=1.9.1 in /opt/anaconda/envs/wmlce/lib/py
thon3.6/site-packages (from keras) (1.17.4)
Requirement already satisfied: keras-applications>=1.0.6 in /opt/anaconda/env
s/wmlce/lib/python3.6/site-packages (from keras) (1.0.8)
Requirement already satisfied: pyyaml in /opt/anaconda/envs/wmlce/lib/python3.
6/site-packages (from keras) (5.4.1)
Requirement already satisfied: scipy>=0.14 in /opt/anaconda/envs/wmlce/lib/pyt
hon3.6/site-packages (from keras) (1.3.1)
Requirement already satisfied: keras-preprocessing>=1.0.5 in /opt/anaconda/env
s/wmlce/lib/python3.6/site-packages (from keras) (1.1.0)
Requirement already satisfied: h5py in /opt/anaconda/envs/wmlce/lib/python3.6/
site-packages (from keras) (2.8.0)
Requirement already satisfied: six>=1.9.0 in /opt/anaconda/envs/wmlce/lib/pyth
on3.6/site-packages (from keras) (1.13.0)
```

In [25]:
```
!pip install seaborn
```

```
Requirement already satisfied: seaborn in /opt/anaconda/envs/wmlce/lib/python
3.6/site-packages (0.11.2)
Requirement already satisfied: scipy>=1.0 in /opt/anaconda/envs/wmlce/lib/pyth
on3.6/site-packages (from seaborn) (1.3.1)
Requirement already satisfied: numpy>=1.15 in /opt/anaconda/envs/wmlce/lib/pyt
hon3.6/site-packages (from seaborn) (1.17.4)
Requirement already satisfied: pandas>=0.23 in /opt/anaconda/envs/wmlce/lib/py
thon3.6/site-packages (from seaborn) (1.1.5)
Requirement already satisfied: matplotlib>=2.2 in /opt/anaconda/envs/wmlce/li
b/python3.6/site-packages (from seaborn) (3.3.2)
Requirement already satisfied: pillow>=6.2.0 in /opt/anaconda/envs/wmlce/lib/p
ython3.6/site-packages (from matplotlib>=2.2->seaborn) (7.1.2)
Requirement already satisfied: kiwisolver>=1.0.1 in /opt/anaconda/envs/wmlce/l
ib/python3.6/site-packages (from matplotlib>=2.2->seaborn) (1.3.1)
Requirement already satisfied: cycler>=0.10 in /opt/anaconda/envs/wmlce/lib/py
thon3.6/site-packages (from matplotlib>=2.2->seaborn) (0.10.0)
Requirement already satisfied: certifi>=2020.06.20 in /opt/anaconda/envs/wmlc
e/lib/python3.6/site-packages (from matplotlib>=2.2->seaborn) (2021.5.30)
Requirement already satisfied: python-dateutil>=2.1 in /opt/anaconda/envs/wmlc
e/lib/python3.6/site-packages (from matplotlib>=2.2->seaborn) (2.8.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.3 in /op
t/anaconda/envs/wmlce/lib/python3.6/site-packages (from matplotlib>=2.2->seabo
rn) (2.4.7)
Requirement already satisfied: six in /opt/anaconda/envs/wmlce/lib/python3.6/s
ite-packages (from cycler>=0.10->matplotlib>=2.2->seaborn) (1.13.0)
Requirement already satisfied: pytz>=2017.2 in /opt/anaconda/envs/wmlce/lib/py
thon3.6/site-packages (from pandas>=0.23->seaborn) (2021.1)
```

In [26]:
```
!pip install keras==2.3.1
```

```
Requirement already satisfied: keras==2.3.1 in /opt/anaconda/envs/wmlce/lib/py
thon3.6/site-packages (2.3.1)
Requirement already satisfied: six>=1.9.0 in /opt/anaconda/envs/wmlce/lib/pyth
on3.6/site-packages (from keras==2.3.1) (1.13.0)
Requirement already satisfied: keras-applications>=1.0.6 in /opt/anaconda/env
s/wmlce/lib/python3.6/site-packages (from keras==2.3.1) (1.0.8)
Requirement already satisfied: keras-preprocessing>=1.0.5 in /opt/anaconda/env
s/wmlce/lib/python3.6/site-packages (from keras==2.3.1) (1.1.0)
Requirement already satisfied: h5py in /opt/anaconda/envs/wmlce/lib/python3.6/
site-packages (from keras==2.3.1) (2.8.0)
Requirement already satisfied: scipy>=0.14 in /opt/anaconda/envs/wmlce/lib/pyt
hon3.6/site-packages (from keras==2.3.1) (1.3.1)
Requirement already satisfied: numpy>=1.9.1 in /opt/anaconda/envs/wmlce/lib/py
thon3.6/site-packages (from keras==2.3.1) (1.17.4)
```

```
Requirement already satisfied: pyyaml in /opt/anaconda/envs/wmlce/lib/python3.
6/site-packages (from keras==2.3.1) (5.4.1)
```

In [27]:
```
!pip install tensorflow
```

```
Requirement already satisfied: tensorflow in /opt/anaconda/envs/wmlce/lib/pyth
on3.6/site-packages (2.1.3)
Requirement already satisfied: tensorboard<2.2.0,>=2.1.0 in /opt/anaconda/env
s/wmlce/lib/python3.6/site-packages (from tensorflow) (2.1.1)
Requirement already satisfied: opt-einsum>=2.3.2 in /opt/anaconda/envs/wmlce/l
ib/python3.6/site-packages (from tensorflow) (3.1.0)
Requirement already satisfied: astor>=0.6.0 in /opt/anaconda/envs/wmlce/lib/py
thon3.6/site-packages (from tensorflow) (0.8.0)
Requirement already satisfied: wrapt>=1.11.1 in /opt/anaconda/envs/wmlce/lib/p
ython3.6/site-packages (from tensorflow) (1.11.2)
Requirement already satisfied: wheel>=0.26 in /opt/anaconda/envs/wmlce/lib/pyt
hon3.6/site-packages (from tensorflow) (0.36.2)
Requirement already satisfied: absl-py>=0.7.0 in /opt/anaconda/envs/wmlce/lib/
python3.6/site-packages (from tensorflow) (0.8.1)
Requirement already satisfied: grpcio>=1.8.6 in /opt/anaconda/envs/wmlce/lib/p
ython3.6/site-packages (from tensorflow) (1.16.1)
Requirement already satisfied: gast==0.2.2 in /opt/anaconda/envs/wmlce/lib/pyt
hon3.6/site-packages (from tensorflow) (0.2.2)
Requirement already satisfied: numpy<1.19.0,>=1.16.0 in /opt/anaconda/envs/wml
ce/lib/python3.6/site-packages (from tensorflow) (1.17.4)
Requirement already satisfied: keras-applications>=1.0.8 in /opt/anaconda/env
s/wmlce/lib/python3.6/site-packages (from tensorflow) (1.0.8)
Requirement already satisfied: google-pasta>=0.1.6 in /opt/anaconda/envs/wmlc
e/lib/python3.6/site-packages (from tensorflow) (0.1.8)
Requirement already satisfied: keras-preprocessing==1.1.0 in /opt/anaconda/env
s/wmlce/lib/python3.6/site-packages (from tensorflow) (1.1.0)
Requirement already satisfied: protobuf>=3.8.0 in /opt/anaconda/envs/wmlce/li
b/python3.6/site-packages (from tensorflow) (3.8.0)
Requirement already satisfied: h5py<=2.10.0 in /opt/anaconda/envs/wmlce/lib/py
thon3.6/site-packages (from tensorflow) (2.8.0)
Requirement already satisfied: six>=1.12.0 in /opt/anaconda/envs/wmlce/lib/pyt
hon3.6/site-packages (from tensorflow) (1.13.0)
Requirement already satisfied: termcolor>=1.1.0 in /opt/anaconda/envs/wmlce/li
b/python3.6/site-packages (from tensorflow) (1.1.0)
Requirement already satisfied: tensorflow-estimator<2.2.0,>=2.1.0rc0 in /opt/a
naconda/envs/wmlce/lib/python3.6/site-packages (from tensorflow) (2.1.0)
Requirement already satisfied: setuptools in /opt/anaconda/envs/wmlce/lib/pyth
on3.6/site-packages (from protobuf>=3.8.0->tensorflow) (52.0.0.post20210125)
Requirement already satisfied: requests<3,>=2.21.0 in /opt/anaconda/envs/wmlc
e/lib/python3.6/site-packages (from tensorboard<2.2.0,>=2.1.0->tensorflow) (2.
22.0)
Requirement already satisfied: markdown>=2.6.8 in /opt/anaconda/envs/wmlce/li
b/python3.6/site-packages (from tensorboard<2.2.0,>=2.1.0->tensorflow) (3.1.1)
Requirement already satisfied: werkzeug>=0.11.15 in /opt/anaconda/envs/wmlce/l
ib/python3.6/site-packages (from tensorboard<2.2.0,>=2.1.0->tensorflow) (0.16.
1)
Requirement already satisfied: chardet<3.1.0,>=3.0.2 in /opt/anaconda/envs/wml
ce/lib/python3.6/site-packages (from requests<3,>=2.21.0->tensorboard<2.2.0,>=
2.1.0->tensorflow) (3.0.4)
Requirement already satisfied: certifi>=2017.4.17 in /opt/anaconda/envs/wmlce/
lib/python3.6/site-packages (from requests<3,>=2.21.0->tensorboard<2.2.0,>=2.
1.0->tensorflow) (2021.5.30)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /op
t/anaconda/envs/wmlce/lib/python3.6/site-packages (from requests<3,>=2.21.0->t
ensorboard<2.2.0,>=2.1.0->tensorflow) (1.25.11)
Requirement already satisfied: idna<2.9,>=2.5 in /opt/anaconda/envs/wmlce/lib/
python3.6/site-packages (from requests<3,>=2.21.0->tensorboard<2.2.0,>=2.1.0->
tensorflow) (2.8)
```

In [28]:
```
!pip install notebook
```

```
Requirement already satisfied: notebook in /opt/anaconda/envs/wmlce/lib/python
3.6/site-packages (6.4.3)
```

```
Requirement already satisfied: nbconvert in /opt/anaconda/envs/wmlce/lib/pytho
n3.6/site-packages (from notebook) (6.0.7)
Requirement already satisfied: ipython-genutils in /opt/anaconda/envs/wmlce/li
b/python3.6/site-packages (from notebook) (0.2.0)
Requirement already satisfied: argon2-cffi in /opt/anaconda/envs/wmlce/lib/pyt
hon3.6/site-packages (from notebook) (20.1.0)
Requirement already satisfied: ipykernel in /opt/anaconda/envs/wmlce/lib/pytho
n3.6/site-packages (from notebook) (5.3.4)
Requirement already satisfied: Send2Trash>=1.5.0 in /opt/anaconda/envs/wmlce/l
ib/python3.6/site-packages (from notebook) (1.8.0)
Requirement already satisfied: jinja2 in /opt/anaconda/envs/wmlce/lib/python3.
6/site-packages (from notebook) (2.11.3)
Requirement already satisfied: prometheus-client in /opt/anaconda/envs/wmlce/l
ib/python3.6/site-packages (from notebook) (0.11.0)
Requirement already satisfied: pyzmq>=17 in /opt/anaconda/envs/wmlce/lib/pytho
n3.6/site-packages (from notebook) (22.2.1)
Requirement already satisfied: terminado>=0.8.3 in /opt/anaconda/envs/wmlce/li
b/python3.6/site-packages (from notebook) (0.9.4)
Requirement already satisfied: jupyter-client>=5.3.4 in /opt/anaconda/envs/wml
ce/lib/python3.6/site-packages (from notebook) (7.0.1)
Requirement already satisfied: traitlets>=4.2.1 in /opt/anaconda/envs/wmlce/li
b/python3.6/site-packages (from notebook) (4.3.3)
Requirement already satisfied: tornado>=6.1 in /opt/anaconda/envs/wmlce/lib/py
thon3.6/site-packages (from notebook) (6.1)
Requirement already satisfied: nbformat in /opt/anaconda/envs/wmlce/lib/python
3.6/site-packages (from notebook) (5.1.3)
Requirement already satisfied: jupyter-core>=4.6.1 in /opt/anaconda/envs/wmlc
e/lib/python3.6/site-packages (from notebook) (4.8.1)
Requirement already satisfied: entrypoints in /opt/anaconda/envs/wmlce/lib/pyt
hon3.6/site-packages (from jupyter-client>=5.3.4->notebook) (0.3)
Requirement already satisfied: python-dateutil>=2.1 in /opt/anaconda/envs/wmlc
e/lib/python3.6/site-packages (from jupyter-client>=5.3.4->notebook) (2.8.1)
Requirement already satisfied: nest-asyncio>=1.5 in /opt/anaconda/envs/wmlce/l
ib/python3.6/site-packages (from jupyter-client>=5.3.4->notebook) (1.5.1)
Requirement already satisfied: six>=1.5 in /opt/anaconda/envs/wmlce/lib/python
3.6/site-packages (from python-dateutil>=2.1->jupyter-client>=5.3.4->notebook)
(1.13.0)
Requirement already satisfied: ptyprocess in /opt/anaconda/envs/wmlce/lib/pyth
on3.6/site-packages (from terminado>=0.8.3->notebook) (0.7.0)
Requirement already satisfied: decorator in /opt/anaconda/envs/wmlce/lib/pytho
n3.6/site-packages (from traitlets>=4.2.1->notebook) (4.4.2)
Requirement already satisfied: cffi>=1.0.0 in /opt/anaconda/envs/wmlce/lib/pyt
hon3.6/site-packages (from argon2-cffi->notebook) (1.14.4)
Requirement already satisfied: pycparser in /opt/anaconda/envs/wmlce/lib/pytho
n3.6/site-packages (from cffi>=1.0.0->argon2-cffi->notebook) (2.20)
Requirement already satisfied: ipython>=5.0.0 in /opt/anaconda/envs/wmlce/lib/
python3.6/site-packages (from ipykernel->notebook) (7.16.1)
Requirement already satisfied: pickleshare in /opt/anaconda/envs/wmlce/lib/pyt
hon3.6/site-packages (from ipython>=5.0.0->ipykernel->notebook) (0.7.5)
Requirement already satisfied: pygments in /opt/anaconda/envs/wmlce/lib/python
3.6/site-packages (from ipython>=5.0.0->ipykernel->notebook) (2.10.0)
Requirement already satisfied: pexpect in /opt/anaconda/envs/wmlce/lib/python
3.6/site-packages (from ipython>=5.0.0->ipykernel->notebook) (4.8.0)
Requirement already satisfied: setuptools>=18.5 in /opt/anaconda/envs/wmlce/li
b/python3.6/site-packages (from ipython>=5.0.0->ipykernel->notebook) (52.0.0.p
ost20210125)
Requirement already satisfied: prompt-toolkit!=3.0.0,!=3.0.1,<3.1.0,>=2.0.0 in
/opt/anaconda/envs/wmlce/lib/python3.6/site-packages (from ipython>=5.0.0->ipy
kernel->notebook) (3.0.20)
Requirement already satisfied: jedi>=0.10 in /opt/anaconda/envs/wmlce/lib/pyth
on3.6/site-packages (from ipython>=5.0.0->ipykernel->notebook) (0.17.0)
Requirement already satisfied: backcall in /opt/anaconda/envs/wmlce/lib/python
3.6/site-packages (from ipython>=5.0.0->ipykernel->notebook) (0.2.0)
Requirement already satisfied: parso>=0.7.0 in /opt/anaconda/envs/wmlce/lib/py
thon3.6/site-packages (from jedi>=0.10->ipython>=5.0.0->ipykernel->notebook)
(0.8.2)
Requirement already satisfied: wcwidth in /opt/anaconda/envs/wmlce/lib/python
3.6/site-packages (from prompt-toolkit!=3.0.0,!=3.0.1,<3.1.0,>=2.0.0->ipython>
=5.0.0->ipykernel->notebook) (0.2.5)
```

```
Requirement already satisfied: MarkupSafe>=0.23 in /opt/anaconda/envs/wmlce/li
b/python3.6/site-packages (from jinja2->notebook) (1.1.1)
Requirement already satisfied: bleach in /opt/anaconda/envs/wmlce/lib/python3.
6/site-packages (from nbconvert->notebook) (4.0.0)
Requirement already satisfied: defusedxml in /opt/anaconda/envs/wmlce/lib/pyth
on3.6/site-packages (from nbconvert->notebook) (0.7.1)
Requirement already satisfied: jupyterlab-pygments in /opt/anaconda/envs/wmlc
e/lib/python3.6/site-packages (from nbconvert->notebook) (0.1.2)
Requirement already satisfied: pandocfilters>=1.4.1 in /opt/anaconda/envs/wmlc
e/lib/python3.6/site-packages (from nbconvert->notebook) (1.4.3)
Requirement already satisfied: mistune<2,>=0.8.1 in /opt/anaconda/envs/wmlce/l
ib/python3.6/site-packages (from nbconvert->notebook) (0.8.4)
Requirement already satisfied: nbclient<0.6.0,>=0.5.0 in /opt/anaconda/envs/wm
lce/lib/python3.6/site-packages (from nbconvert->notebook) (0.5.3)
Requirement already satisfied: testpath in /opt/anaconda/envs/wmlce/lib/python
3.6/site-packages (from nbconvert->notebook) (0.5.0)
Requirement already satisfied: async-generator in /opt/anaconda/envs/wmlce/li
b/python3.6/site-packages (from nbclient<0.6.0,>=0.5.0->nbconvert->notebook)
(1.10)
Requirement already satisfied: jsonschema!=2.5.0,>=2.4 in /opt/anaconda/envs/w
mlce/lib/python3.6/site-packages (from nbformat->notebook) (3.2.0)
Requirement already satisfied: attrs>=17.4.0 in /opt/anaconda/envs/wmlce/lib/p
ython3.6/site-packages (from jsonschema!=2.5.0,>=2.4->nbformat->notebook) (20.
3.0)
Requirement already satisfied: pyrsistent>=0.14.0 in /opt/anaconda/envs/wmlce/
lib/python3.6/site-packages (from jsonschema!=2.5.0,>=2.4->nbformat->notebook)
(0.17.3)
Requirement already satisfied: importlib-metadata in /opt/anaconda/envs/wmlce/
lib/python3.6/site-packages (from jsonschema!=2.5.0,>=2.4->nbformat->notebook)
(2.0.0)
Requirement already satisfied: packaging in /opt/anaconda/envs/wmlce/lib/pytho
n3.6/site-packages (from bleach->nbconvert->notebook) (20.9)
Requirement already satisfied: webencodings in /opt/anaconda/envs/wmlce/lib/py
thon3.6/site-packages (from bleach->nbconvert->notebook) (0.5.1)
Requirement already satisfied: zipp>=0.5 in /opt/anaconda/envs/wmlce/lib/pytho
n3.6/site-packages (from importlib-metadata->jsonschema!=2.5.0,>=2.4->nbformat
->notebook) (3.4.0)
Requirement already satisfied: pyparsing>=2.0.2 in /opt/anaconda/envs/wmlce/li
b/python3.6/site-packages (from packaging->bleach->nbconvert->notebook) (2.4.
7)
```

In [29]:

```
import os
```

In [30]:

```
import numpy as np # linear algebra
import pandas as pd
import sys
import seaborn as sns
import os
import keras
from keras.applications.vgg16 import VGG16
from keras_applications import vgg16
from numpy import load
from matplotlib import pyplot
from sklearn.model_selection import train_test_split
from keras import backend
from keras.layers import Dense
from keras.layers import Flatten
from keras.models import Sequential
from keras.layers import Conv2D,MaxPooling2D
from keras.optimizers import SGD
from keras.models import Model
from keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.preprocessing.image import load_img
#from tensorflow.keras.utils import load_img
from tensorflow.keras.preprocessing.image import img_to_array
```

```
from keras.layers import Dropout
from tensorflow.keras.layers import BatchNormalization
```

In [31]:
```
traindir = "train"
validdir = "valid"
testdir = "test"
```

In [32]:
```
td = os.listdir(traindir)
len(td)
```

Out[32]: 39

In [33]:
```
vd = os.listdir(validdir)
len(vd)
```

Out[33]: 38

In [34]:
```
tdd = os.listdir(testdir)
len(tdd)
```

Out[34]: 33

In [12]:
```
train_datagen = ImageDataGenerator(rescale=1./255,
                                   shear_range=0.2,
                                   zoom_range=0.2,
                                   width_shift_range=0.2,
                                   height_shift_range=0.2,
                                   fill_mode='nearest')
```

In [13]:
```
valid_datagen = ImageDataGenerator(rescale=1./255)
```

In [14]:
```
batch_size = 128
training_set = train_datagen.flow_from_directory(traindir,
                                                 target_size=(224, 224),
                                                 batch_size=batch_size,
                                                 class_mode='categorical')

valid_set = valid_datagen.flow_from_directory(validdir,
                                              target_size=(224, 224),
                                              batch_size=batch_size,
                                              class_mode='categorical')
```

```
Found 70295 images belonging to 38 classes.
Found 17572 images belonging to 38 classes.
```

In [15]:
```
class_dict = training_set.class_indices
print(class_dict)
```

```
{'Apple___Apple_scab': 0, 'Apple___Black_rot': 1, 'Apple___Cedar_apple_rust':
2, 'Apple___healthy': 3, 'Blueberry___healthy': 4, 'Cherry_(including_sour)___
Powdery_mildew': 5, 'Cherry_(including_sour)___healthy': 6, 'Corn_(maize)___Ce
rcospora_leaf_spot Gray_leaf_spot': 7, 'Corn_(maize)___Common_rust_': 8, 'Corn
_(maize)___Northern_Leaf_Blight': 9, 'Corn_(maize)___healthy': 10, 'Grape___Bl
ack_rot': 11, 'Grape___Esca_(Black_Measles)': 12, 'Grape___Leaf_blight_(Isario
psis_Leaf_Spot)': 13, 'Grape___healthy': 14, 'Orange___Haunglongbing_(Citrus_g
```

```
reening)': 15, 'Peach___Bacterial_spot': 16, 'Peach___healthy': 17, 'Pepper,_b
ell___Bacterial_spot': 18, 'Pepper,_bell___healthy': 19, 'Potato___Early_bligh
t': 20, 'Potato___Late_blight': 21, 'Potato___healthy': 22, 'Raspberry___healt
hy': 23, 'Soybean___healthy': 24, 'Squash___Powdery_mildew': 25, 'Strawberry__
_Leaf_scorch': 26, 'Strawberry___healthy': 27, 'Tomato___Bacterial_spot': 28,
'Tomato___Early_blight': 29, 'Tomato___Late_blight': 30, 'Tomato___Leaf_Mold':
31, 'Tomato___Septoria_leaf_spot': 32, 'Tomato___Spider_mites Two-spotted_spid
er_mite': 33, 'Tomato___Target_Spot': 34, 'Tomato___Tomato_Yellow_Leaf_Curl_Vi
rus': 35, 'Tomato___Tomato_mosaic_virus': 36, 'Tomato___healthy': 37}
```

In [16]:
```
li = list(class_dict.keys())
print(li)
```

```
['Apple___Apple_scab', 'Apple___Black_rot', 'Apple___Cedar_apple_rust', 'Apple
___healthy', 'Blueberry___healthy', 'Cherry_(including_sour)___Powdery_milde
w', 'Cherry_(including_sour)___healthy', 'Corn_(maize)___Cercospora_leaf_spot
Gray_leaf_spot', 'Corn_(maize)___Common_rust_', 'Corn_(maize)___Northern_Leaf_
Blight', 'Corn_(maize)___healthy', 'Grape___Black_rot', 'Grape___Esca_(Black_M
easles)', 'Grape___Leaf_blight_(Isariopsis_Leaf_Spot)', 'Grape___healthy', 'Or
ange___Haunglongbing_(Citrus_greening)', 'Peach___Bacterial_spot', 'Peach___he
althy', 'Pepper,_bell___Bacterial_spot', 'Pepper,_bell___healthy', 'Potato___E
arly_blight', 'Potato___Late_blight', 'Potato___healthy', 'Raspberry___health
y', 'Soybean___healthy', 'Squash___Powdery_mildew', 'Strawberry___Leaf_scorc
h', 'Strawberry___healthy', 'Tomato___Bacterial_spot', 'Tomato___Early_bligh
t', 'Tomato___Late_blight', 'Tomato___Leaf_Mold', 'Tomato___Septoria_leaf_spo
t', 'Tomato___Spider_mites Two-spotted_spider_mite', 'Tomato___Target_Spot',
'Tomato___Tomato_Yellow_Leaf_Curl_Virus', 'Tomato___Tomato_mosaic_virus', 'Tom
ato___healthy']
```

In [17]:
```
li = list(class_dict.keys())
print(li)
```

In [54]:
```
model = Sequential()
```

In [55]:
```
model.add(Conv2D(input_shape=(224,224,3),filters=64,kernel_size=(3,3),padding
```

In [56]:
```
model.add(Conv2D(filters=64,kernel_size=(3,3),padding="same", activation="rel
```

In [59]:
```
model.add(MaxPool2D(pool_size=(2,2),strides=(2,2)))
```

In [58]:
```
import keras,os
from keras.models import Sequential
from keras.layers import Dense, Conv2D, MaxPool2D , Flatten
```

In [60]:
```
model.add(Conv2D(filters=128, kernel_size=(3,3), padding="same", activation="
```

In [61]:
```
model.add(Conv2D(filters=128, kernel_size=(3,3), padding="same", activation="
```

In [62]:
```
model.add(MaxPool2D(pool_size=(2,2),strides=(2,2)))
```

In [63]:
```
model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same", activation="
```

In [64]:
```
model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same", activation="
```

In [65]:
```
model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same", activation="
```

In [66]:
```
model.add(MaxPool2D(pool_size=(2,2),strides=(2,2)))
```

In [67]:
```
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="
```

In [68]:
```
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="
```

In [69]:
```
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="
```

In [70]:
```
model.add(MaxPool2D(pool_size=(2,2),strides=(2,2)))
```

In [71]:
```
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="
```

In [72]:
```
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="
```

In [73]:
```
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="
```

In [74]:
```
model.add(MaxPool2D(pool_size=(2,2),strides=(2,2)))
```

In [75]:
```
model.add(Flatten())
```

In [76]:
```
model.add(Dense(units=4096,activation="relu"))
```

In [77]:
```
model.add(Dense(units=4096,activation="relu"))
```

In [78]:
```
model.add(Dense(units=2, activation="softmax"))
```

In [79]:
```
from keras.optimizers import Adam
opt = Adam(lr=0.001)
model.compile(optimizer=opt, loss=keras.losses.categorical_crossentropy, metr
```

In [80]:
```
model.summary()
```

```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 224, 224, 64)      1792
_________________________________________________________________
```

```
conv2d_2 (Conv2D)            (None, 224, 224, 64)      36928
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 112, 112, 64)      0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 112, 112, 128)     73856
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 112, 112, 128)     147584
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 56, 56, 128)       0
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 56, 56, 256)       295168
_________________________________________________________________
conv2d_6 (Conv2D)            (None, 56, 56, 256)       590080
_________________________________________________________________
conv2d_7 (Conv2D)            (None, 56, 56, 256)       590080
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 28, 28, 256)       0
_________________________________________________________________
conv2d_8 (Conv2D)            (None, 28, 28, 512)       1180160
_________________________________________________________________
conv2d_9 (Conv2D)            (None, 28, 28, 512)       2359808
_________________________________________________________________
conv2d_10 (Conv2D)           (None, 28, 28, 512)       2359808
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 14, 14, 512)       0
_________________________________________________________________
conv2d_11 (Conv2D)           (None, 14, 14, 512)       2359808
_________________________________________________________________
conv2d_12 (Conv2D)           (None, 14, 14, 512)       2359808
_________________________________________________________________
conv2d_13 (Conv2D)           (None, 14, 14, 512)       2359808
_________________________________________________________________
max_pooling2d_5 (MaxPooling2 (None, 7, 7, 512)         0
_________________________________________________________________
flatten_2 (Flatten)          (None, 25088)             0
_________________________________________________________________
dense_2 (Dense)              (None, 4096)              102764544
_________________________________________________________________
dense_3 (Dense)              (None, 4096)              16781312
_________________________________________________________________
dense_4 (Dense)              (None, 2)                 8194
=================================================================
Total params: 134,268,738
Trainable params: 134,268,738
Non-trainable params: 0
_________________________________________________________________
```

In [81]:

```
from keras.callbacks import ModelCheckpoint, EarlyStopping
checkpoint = ModelCheckpoint("vgg16_1.h5", monitor='val_acc', verbose=1, save
early = EarlyStopping(monitor='val_acc', min_delta=0, patience=20, verbose=1,
```

In [90]:

```
classifier.compile(optimizer='adam',
              loss='categorical_crossentropy',
              metrics=['accuracy'])
```

In [91]:

```
#fitting images to CNN
history = classifier.fit(training_set,
                         steps_per_epoch=train_num//batch_size,
                         validation_data=valid_set,
                         epochs=5,
                         validation_steps=valid_num//batch_size,
                         )
```

```
Epoch 1/5
549/549 [==============================] - 4267s 8s/step - loss: 0.3428 - accu
racy: 0.8894 - val_loss: 0.2594 - val_accuracy: 0.9251
Epoch 2/5
549/549 [==============================] - 4253s 8s/step - loss: 0.2984 - accu
racy: 0.9046 - val_loss: 0.3559 - val_accuracy: 0.9070
Epoch 3/5
549/549 [==============================] - 4263s 8s/step - loss: 0.2883 - accu
racy: 0.9094 - val_loss: 0.3366 - val_accuracy: 0.9222
Epoch 4/5
549/549 [==============================] - 4253s 8s/step - loss: 0.2641 - accu
racy: 0.9187 - val_loss: 0.2196 - val_accuracy: 0.9119
Epoch 5/5
549/549 [==============================] - 4257s 8s/step - loss: 0.2538 - accu
racy: 0.9217 - val_loss: 0.1507 - val_accuracy: 0.9303
```

In [92]:

```
#Saving our model
filepath="Mymodel.h5"
classifier.save(filepath)
```

In [93]:

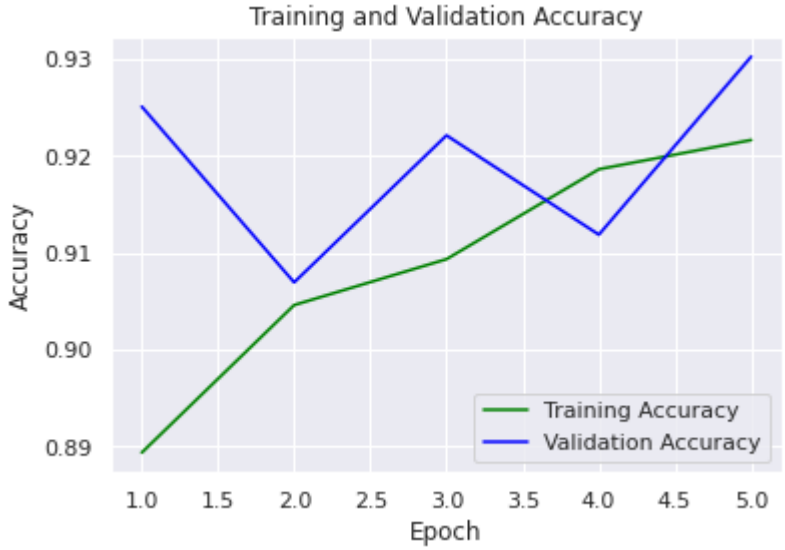
```
#Visualizing the Accuracy
import matplotlib.pyplot as plt
import seaborn as sns
sns.set()

acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
loss = history.history['loss']
val_loss = history.history['val_loss']
epochs = range(1, len(loss) + 1)

#accuracy plot
plt.plot(epochs, acc, color='green', label='Training Accuracy')
plt.plot(epochs, val_acc, color='blue', label='Validation Accuracy')
plt.title('Training and Validation Accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend()

plt.figure()
#loss plot
plt.plot(epochs, loss, color='pink', label='Training Loss')
plt.plot(epochs, val_loss, color='red', label='Validation Loss')
plt.title('Training and Validation Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()

plt.show()
```



In [94]:

```
#predicting an image
from keras.preprocessing import image
import numpy as np
image_path = "test/TomatoHealthy1.JPG"
new_img = image.load_img(image_path, target_size=(224, 224))
img = image.img_to_array(new_img)
img = np.expand_dims(img, axis=0)
img = img/255

print("Following is our prediction:")
prediction = classifier.predict(img)
# decode the results into a list of tuples (class, description, probability)
# (one such list for each sample in the batch)
d = prediction.flatten()
j = d.max()
for index,item in enumerate(d):
    if item == j:
        class_name = li[index]

#ploting image with predicted class name
plt.figure(figsize = (4,4))
plt.imshow(new_img)
plt.axis('off')
plt.title(class_name)
plt.show()
```

```
Following is our prediction:
```

In [96]:

```
#predicting an image
from keras.preprocessing import image
import numpy as np
image_path = "test/AppleCedarRust3.JPG"
new_img = image.load_img(image_path, target_size=(224, 224))
img = image.img_to_array(new_img)
img = np.expand_dims(img, axis=0)
img = img/255

print("Following is our prediction:")
prediction = classifier.predict(img)
# decode the results into a list of tuples (class, description, probability)
# (one such list for each sample in the batch)
d = prediction.flatten()
j = d.max()
for index,item in enumerate(d):
    if item == j:
        class_name = li[index]

#ploting image with predicted class name
plt.figure(figsize = (4,4))
plt.imshow(new_img)
plt.axis('off')
plt.title(class_name)
plt.show()
```

```
Following is our prediction:
```

In [97]:

```
#predicting an image
from keras.preprocessing import image
import numpy as np
```

```
image_path = "test/CornCommonRust1.JPG"
new_img = image.load_img(image_path, target_size=(224, 224))
img = image.img_to_array(new_img)
img = np.expand_dims(img, axis=0)
img = img/255

print("Following is our prediction:")
prediction = classifier.predict(img)
# decode the results into a list of tuples (class, description, probability)
# (one such list for each sample in the batch)
d = prediction.flatten()
j = d.max()
for index,item in enumerate(d):
    if item == j:
        class_name = li[index]

#ploting image with predicted class name
plt.figure(figsize = (4,4))
plt.imshow(new_img)
plt.axis('off')
plt.title(class_name)
plt.show()
```

```
Following is our prediction:
```

In [98]:

```
#predicting an image
from keras.preprocessing import image
import numpy as np
image_path = "test/AppleScab1.JPG"
new_img = image.load_img(image_path, target_size=(224, 224))
img = image.img_to_array(new_img)
img = np.expand_dims(img, axis=0)
img = img/255

print("Following is our prediction:")
prediction = classifier.predict(img)
# decode the results into a list of tuples (class, description, probability)
# (one such list for each sample in the batch)
d = prediction.flatten()
j = d.max()
for index,item in enumerate(d):
    if item == j:
        class_name = li[index]

#ploting image with predicted class name
plt.figure(figsize = (4,4))
plt.imshow(new_img)
plt.axis('off')
```

```
plt.title(class_name)
plt.show()
```

```
Following is our prediction:
```

In [ ]: