potato-leaf-disease-final95

March 7, 2024

IMPORTING REQUIRED LIBRARIES

[1]:
```
import pandas as pd
import numpy as np
import os
import cv2
import matplotlib.pyplot as plt
import keras
import seaborn as sns
import pathlib
from pathlib import Path
import glob
import tensorflow as tf
from sklearn.model_selection import train_test_split
from tensorflow.keras.utils  import to_categorical
from keras.preprocessing.image import ImageDataGenerator
```

[2]:
```
data_dir='/kaggle/input/potato-leaf-disease'
root_dir='/kaggle/working/'
```

[3]:
```
def countfiles(root_dir):
    for path in pathlib.Path(root_dir).iterdir():
        if path.is_dir():
             print( str(len([name for name in os.listdir(path) \
            if os.path.isfile(os.path.join(path, name))])) + " files inside the␣
↪" + \
            str(path.name),'class')
countfiles(data_dir)
```

```
1000 files inside the Potato___healthy class
1000 files inside the Potato___Late_blight class
1000 files inside the Potato___Early_blight class
```

DATASET PREPARATION

[11]:
```
def data_categories(d_path):
    categories=[]    #listdir-->used to get the list of all files and␣
↪directories in the specified directory
```

```
    for folder_name in os.listdir(d_path):  #os.path.isdir()--->used to check␣
↪whether the specified path is an existing directory or not.
        if os.path.isdir(os.path.join(d_path,folder_name)):
            no_of_files=len(glob.glob(os.path.join(d_path, folder_name)+"/*.
↪JPG"))
            categories.append(np.array([folder_name,no_of_files]))
    categories.sort(key=lambda a:a[0])
    cat=np.array(categories)
    return list(cat[:, 0]),list(cat[:,1])
categories,no_of_files = data_categories("/kaggle/input/potato-leaf-disease")
print(categories)
```

```
['Potato___Early_blight', 'Potato___Late_blight', 'Potato___healthy']
```

[12]:
```
print("number of categories: ", len(categories))
```

```
number of categories:  3
```

[13]:
```
df = pd.DataFrame({"category": categories, "number of files": no_of_files})
df
```

[13]:

	category	number of files
0	Potato___Early_blight	1000
1	Potato___Late_blight	1000
2	Potato___healthy	1000

[14]:
```
def dataset(data_path, categories, width, height):
    x = []
    y = []
    for category_idx, category in enumerate(categories):
        path = os.path.join(data_path, category)
        count = 0
        for img in os.listdir(path):
            img_array = cv2.imread(os.path.join(path,img))
            img_size = cv2.resize(img_array, (width, height))
            x.append(img_size)
            y.append(category_idx)
            count += 1
        print(f"Number of images in class {category_idx}: {count}")
    y = np.array(y)
    x = np.array(x).reshape(y.shape[0], width, height, 3)
    return x, y

x, y = dataset(data_path=data_dir, categories=['Potato___Early_blight',␣
↪'Potato___Late_blight', 'Potato___healthy'], width=100,height=100)
```

```
Number of images in class 0: 1000
Number of images in class 1: 1000
```

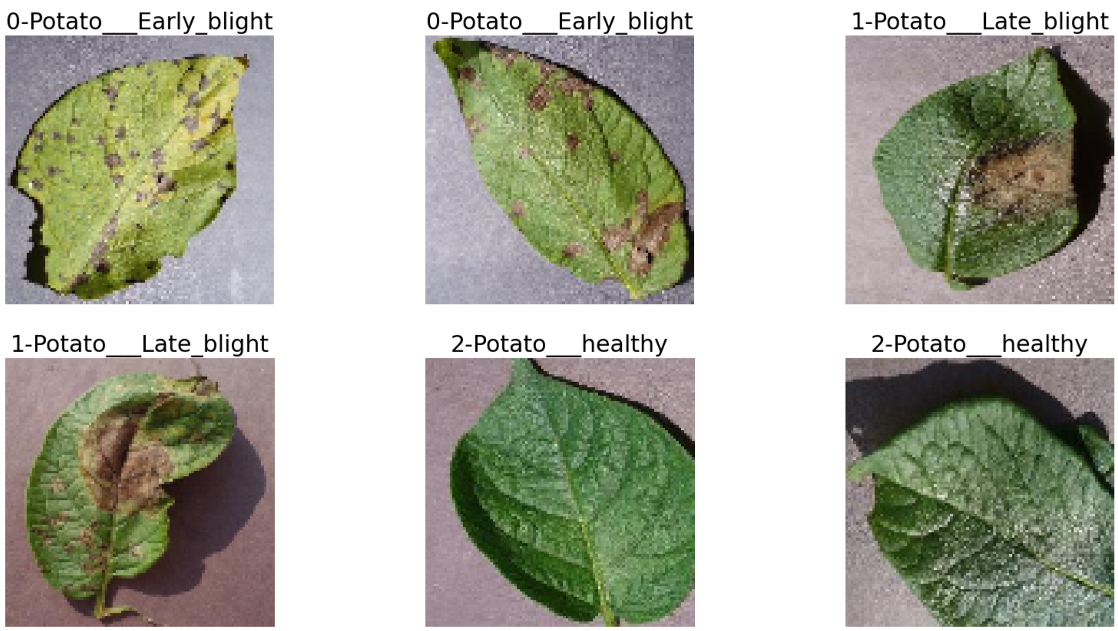
```
Number of images in class 2: 1000
```

[15]:
```python
print(f'x shape:{x.shape}')
print(f"y shape: {y.shape}")
```

```
x shape:(3000, 100, 100, 3)
y shape: (3000,)
```

IMAGES FROM CLASSES

[18]:
```python
plt.figure(figsize=(20, 10))
st, end = 0,500
for i in range(6):
    plt.subplot(2, 3, i + 1)
    idx = np.random.randint(st, end)
    st = end + 1
    end = (i + 2) * 500
    plt.rcParams.update({'font.size':18})
    plt.imshow(x[idx][:, :, ::-1])
    plt.title(f"{y[idx]}-{categories[y[idx]]}")
    plt.axis("off")
plt.show()
```



DATASET SPLITTING FOR TRAIN/VAL/TEST SETS

[19]:
```python
y=np.reshape(y,(len(y),1))
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.
↪1,random_state=42)
```

```
print(f"x_train: {x_train.shape}")
print(f"y_train: {y_train.shape}")
print(f"x_test: {x_test.shape}")
print(f"y_test: {y_test.shape}")
```

```
x_train: (2700, 100, 100, 3)
y_train: (2700, 1)
x_test: (300, 100, 100, 3)
y_test: (300, 1)
```

[20]:
```
x_train,x_val,y_train,y_val=train_test_split(x_train,y_train,train_size=0.70)
x_test=x_test

print(f"x_train:{x_train.shape},y_train:{y_train.shape}")
print(f"x_val: {x_val.shape},y_val:{y_val.shape}")        #70-20-10
print(f"x_test:{x_test.shape},y_test:{y_test.shape}")
```

```
x_train:(1889, 100, 100, 3),y_train:(1889, 1)
x_val: (811, 100, 100, 3),y_val:(811, 1)
x_test:(300, 100, 100, 3),y_test:(300, 1)
```

[21]:
```
y_train = to_categorical(y_train)
y_val = to_categorical(y_val)
y_test = to_categorical(y_test)

print(f"x_train:{x_train.shape},  y_train:{y_train.shape}")
print(f"x_val:{x_val.shape},  y_val:{y_val.shape}")
print(f"x_test:{x_test.shape},  y_test:{y_test.shape}")
```

```
x_train:(1889, 100, 100, 3),  y_train:(1889, 3)
x_val:(811, 100, 100, 3),  y_val:(811, 3)
x_test:(300, 100, 100, 3),  y_test:(300, 3)
```

DATA PREPROCESSING

[22]:
```
train_generator=ImageDataGenerator(rescale=1./255,
                                    rotation_range=2,
                                   horizontal_flip=True,
                                    shear_range=0.5,
                                   zoom_range=0.7)
val_generator=ImageDataGenerator(rescale=1./255,
                                 rotation_range=2,
                                 horizontal_flip=True,
                                 shear_range=0.5,
                                 zoom_range=0.1)
test_generator=ImageDataGenerator(rotation_range=2,
                                 horizontal_flip=True,
                                 zoom_range=0.1)
```

```
train_generator.fit(x_train)
val_generator.fit(x_val)
test_generator.fit(x_test)
```

MODEL BUILDING-CNN

[23]:
```
from keras.models import Sequential, load_model
from keras.layers import Flatten, Dense
```

[42]:
```
model = keras.Sequential([
    # Convolutional layers
                  #kernels,  #filters ,  #activation function,           #input
    tf.keras.layers.Conv2D(32, (3,3), activation='relu',␣
 ↪input_shape=(100,100,3)),
    tf.keras.layers.Conv2D(32, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D((2,2)),
    tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
    tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D((2,2)),
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D((2,2)),
    tf.keras.layers.Flatten(),
    tf.keras.layers.Dense(512, activation='relu'),
    tf.keras.layers.Dense(3, activation='softmax')

])
```

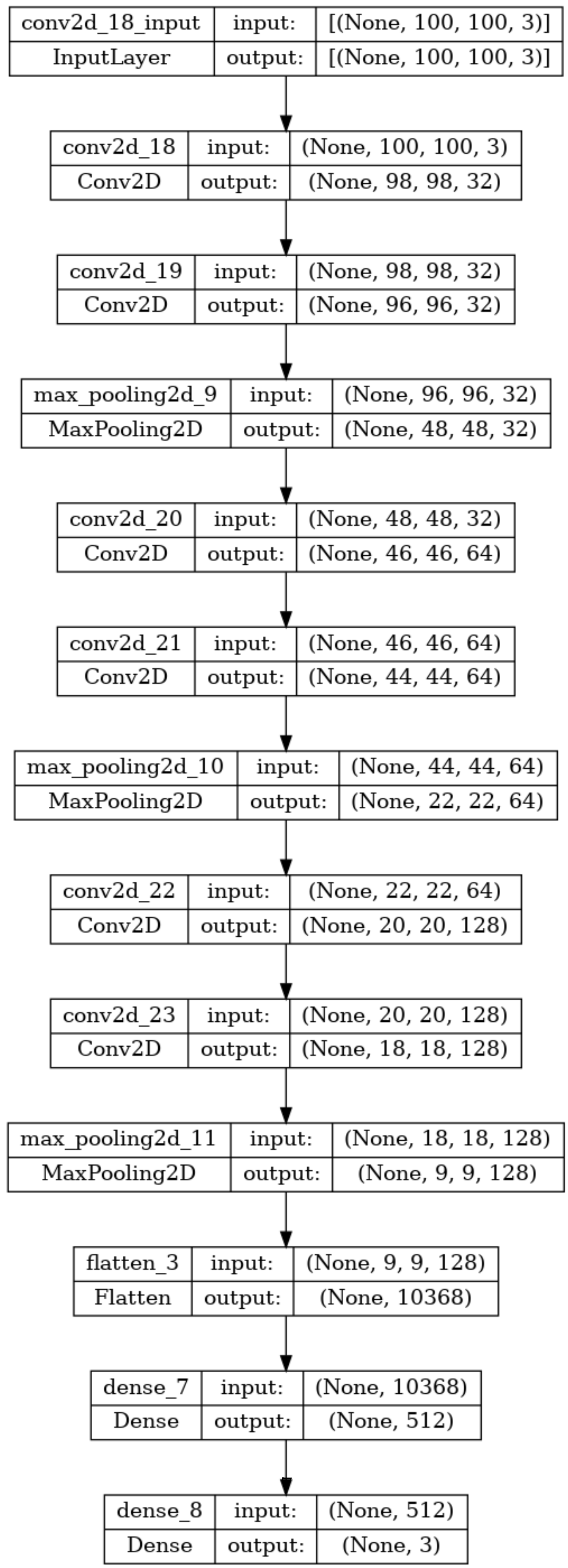
[43]:
```
model.summary()
```

```
Model: "sequential_3"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_18 (Conv2D)          (None, 98, 98, 32)        896

 conv2d_19 (Conv2D)          (None, 96, 96, 32)        9248

 max_pooling2d_9 (MaxPooling  (None, 48, 48, 32)       0
 2D)

 conv2d_20 (Conv2D)          (None, 46, 46, 64)        18496

 conv2d_21 (Conv2D)          (None, 44, 44, 64)        36928

 max_pooling2d_10 (MaxPoolin  (None, 22, 22, 64)       0
 g2D)
```

```
 conv2d_22 (Conv2D)          (None, 20, 20, 128)       73856

 conv2d_23 (Conv2D)          (None, 18, 18, 128)       147584

 max_pooling2d_11 (MaxPoolin  (None, 9, 9, 128)        0
 g2D)

 flatten_3 (Flatten)         (None, 10368)             0

 dense_7 (Dense)             (None, 512)               5308928

 dense_8 (Dense)             (None, 3)                 1539

=================================================================
Total params: 5,597,475
Trainable params: 5,597,475
Non-trainable params: 0
_________________________________________________________________
```

[44]:
```python
from tensorflow.keras.utils import plot_model
plot_model(model,show_shapes=True,to_file='3class model.png')
```

[44]:


conv2d_18_input | input: | [(None, 100, 100, 3)]
InputLayer | output: | [(None, 100, 100, 3)]
conv2d_18 | input: | (None, 100, 100, 3)
Conv2D | output: | (None, 98, 98, 32)
conv2d_19 | input: | (None, 98, 98, 32)
Conv2D | output: | (None, 96, 96, 32)
max_pooling2d_9 | input: | (None, 96, 96, 32)
MaxPooling2D | output: | (None, 48, 48, 32)
conv2d_20 | input: | (None, 48, 48, 32)
Conv2D | output: | (None, 46, 46, 64)
conv2d_21 | input: | (None, 46, 46, 64)
Conv2D | output: | (None, 44, 44, 64)
max_pooling2d_10 | input: | (None, 44, 44, 64)
MaxPooling2D | output: | (None, 22, 22, 64)
conv2d_22 | input: | (None, 22, 22, 64)
Conv2D | output: | (None, 20, 20, 128)
conv2d_23 | input: | (None, 20, 20, 128)
Conv2D | output: | (None, 18, 18, 128)
max_pooling2d_11 | input: | (None, 18, 18, 128)
MaxPooling2D | output: | (None, 9, 9, 128)
flatten_3 | input: | (None, 9, 9, 128)
Flatten | output: | (None, 10368)
dense_7 | input: | (None, 10368)
Dense | output: | (None, 512)
dense_8 | input: | (None, 512)
Dense | output: | (None, 3)

[45]:
```
from keras.metrics import Precision,Recall
import tensorflow_addons as tfa
```

[46]:
```
model.compile(optimizer='adam',
              loss='categorical_crossentropy',
             ␣
↪metrics=['accuracy',Precision(name='precision'),Recall(name='Recall'),tfa.
↪metrics.F1Score(num_classes=3)])
```

[47]:
```
history = model.fit(x_train,y_train, epochs=30,batch_size=100,
                    validation_data = val_generator.
↪flow(x_val,y_val,batch_size=100),
                   validation_steps=200,
                   verbose=1)
history=history.history
model.save('/kaggle/working/3c_model.h5')
```

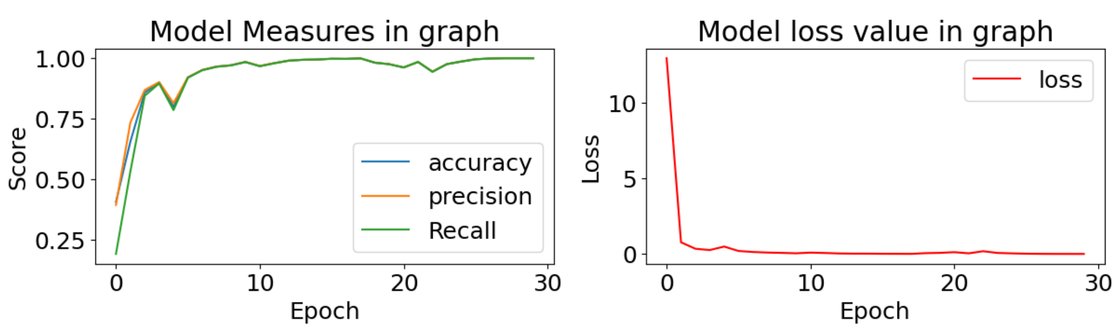
```
Epoch 1/30
19/19 [==============================] - 6s 170ms/step - loss: 12.9609 -
accuracy: 0.4060 - precision: 0.3937 - Recall: 0.1911 - f1_score: 0.4050 -
val_loss: 1.0986 - val_accuracy: 0.3354 - val_precision: 0.0000e+00 -
val_Recall: 0.0000e+00 - val_f1_score: 0.1674
Epoch 2/30
19/19 [==============================] - 1s 36ms/step - loss: 0.7701 - accuracy:
0.6548 - precision: 0.7339 - Recall: 0.5315 - f1_score: 0.6531
Epoch 3/30
19/19 [==============================] - 1s 36ms/step - loss: 0.3436 - accuracy:
0.8581 - precision: 0.8688 - Recall: 0.8449 - f1_score: 0.8569
Epoch 4/30
19/19 [==============================] - 1s 36ms/step - loss: 0.2577 - accuracy:
0.8999 - precision: 0.9014 - Recall: 0.8957 - f1_score: 0.8995
Epoch 5/30
19/19 [==============================] - 1s 36ms/step - loss: 0.4892 - accuracy:
0.7988 - precision: 0.8145 - Recall: 0.7856 - f1_score: 0.7963
Epoch 6/30
19/19 [==============================] - 1s 36ms/step - loss: 0.1956 - accuracy:
0.9201 - precision: 0.9215 - Recall: 0.9195 - f1_score: 0.9199
Epoch 7/30
19/19 [==============================] - 1s 36ms/step - loss: 0.1285 - accuracy:
0.9508 - precision: 0.9518 - Recall: 0.9508 - f1_score: 0.9508
Epoch 8/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0910 - accuracy:
0.9656 - precision: 0.9656 - Recall: 0.9645 - f1_score: 0.9656
Epoch 9/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0704 - accuracy:
```

```
0.9709 - precision: 0.9714 - Recall: 0.9704 - f1_score: 0.9709
Epoch 10/30
19/19 [==============================] - 1s 39ms/step - loss: 0.0428 - accuracy:
0.9846 - precision: 0.9846 - Recall: 0.9841 - f1_score: 0.9847
Epoch 11/30
19/19 [==============================] - 1s 40ms/step - loss: 0.0872 - accuracy:
0.9672 - precision: 0.9682 - Recall: 0.9672 - f1_score: 0.9671
Epoch 12/30
19/19 [==============================] - 1s 37ms/step - loss: 0.0625 - accuracy:
0.9799 - precision: 0.9799 - Recall: 0.9788 - f1_score: 0.9800
Epoch 13/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0305 - accuracy:
0.9899 - precision: 0.9899 - Recall: 0.9899 - f1_score: 0.9899
Epoch 14/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0197 - accuracy:
0.9936 - precision: 0.9936 - Recall: 0.9936 - f1_score: 0.9937
Epoch 15/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0202 - accuracy:
0.9947 - precision: 0.9947 - Recall: 0.9947 - f1_score: 0.9947
Epoch 16/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0105 - accuracy:
0.9979 - precision: 0.9979 - Recall: 0.9979 - f1_score: 0.9979
Epoch 17/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0082 - accuracy:
0.9974 - precision: 0.9974 - Recall: 0.9974 - f1_score: 0.9974
Epoch 18/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0050 - accuracy:
0.9995 - precision: 0.9995 - Recall: 0.9995 - f1_score: 0.9995
Epoch 19/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0512 - accuracy:
0.9815 - precision: 0.9820 - Recall: 0.9815 - f1_score: 0.9814
Epoch 20/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0711 - accuracy:
0.9756 - precision: 0.9756 - Recall: 0.9751 - f1_score: 0.9756
Epoch 21/30
19/19 [==============================] - 1s 36ms/step - loss: 0.1155 - accuracy:
0.9619 - precision: 0.9619 - Recall: 0.9619 - f1_score: 0.9618
Epoch 22/30
19/19 [==============================] - 1s 35ms/step - loss: 0.0400 - accuracy:
0.9846 - precision: 0.9846 - Recall: 0.9846 - f1_score: 0.9847
Epoch 23/30
19/19 [==============================] - 1s 36ms/step - loss: 0.1789 - accuracy:
0.9444 - precision: 0.9449 - Recall: 0.9439 - f1_score: 0.9445
Epoch 24/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0652 - accuracy:
0.9756 - precision: 0.9756 - Recall: 0.9756 - f1_score: 0.9757
Epoch 25/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0375 - accuracy:
```

```
0.9862 - precision: 0.9868 - Recall: 0.9862 - f1_score: 0.9863
Epoch 26/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0155 - accuracy:
0.9958 - precision: 0.9958 - Recall: 0.9958 - f1_score: 0.9958
Epoch 27/30
19/19 [==============================] - 1s 37ms/step - loss: 0.0063 - accuracy:
0.9989 - precision: 0.9989 - Recall: 0.9989 - f1_score: 0.9989
Epoch 28/30
19/19 [==============================] - 1s 36ms/step - loss: 0.0017 - accuracy:
1.0000 - precision: 1.0000 - Recall: 1.0000 - f1_score: 1.0000
Epoch 29/30
19/19 [==============================] - 1s 36ms/step - loss: 8.3512e-04 -
accuracy: 1.0000 - precision: 1.0000 - Recall: 1.0000 - f1_score: 1.0000
Epoch 30/30
19/19 [==============================] - 1s 36ms/step - loss: 5.4360e-04 -
accuracy: 1.0000 - precision: 1.0000 - Recall: 1.0000 - f1_score: 1.0000
```

CNN MODEL EVALUATION

[55]:
```
fig = plt.figure(figsize=(14, 3))
ax1 = fig.add_subplot(1, 2, 1)
ax1.plot(history['accuracy'])
ax1.plot(history['precision'])
ax1.plot(history["Recall"])
ax1.legend(['accuracy','precision','Recall'])
ax1.set_title('Model Measures in graph')
ax1.set_xlabel('Epoch')
ax1.set_ylabel('Score')

ax2 = fig.add_subplot(1, 2, 2)
ax2.plot(history['loss'],color='red')
ax2.legend(['loss'])
ax2.set_title('Model loss value in graph')
ax2.set_xlabel('Epoch')
ax2.set_ylabel('Loss')

plt.savefig('graph.png')
plt.show()
```



TEST SET

[56]:
```
testscore=model.evaluate(x_test,y_test)
testscore
```

```
10/10 [==============================] - 0s 7ms/step - loss: 0.2006 - accuracy:
0.9567 - precision: 0.9567 - Recall: 0.9567 - f1_score: 0.9570
```

[56]:
```
[0.20064330101013184,
 0.9566666483879089,
 0.9566666483879089,
 0.9566666483879089,
 array([0.9626168, 0.9353234, 0.972973 ], dtype=float32)]
```

[50]:
```
print('TEST DATA')
print('')
print(f"Accuracy: {round(testscore[1]*100,2)}%")
print(f"Precision: {round(testscore[2]*100,2)}%")
print(f"Recall: {round(testscore[3]*100,2)}%")
print(f"F1_score: {testscore[4]}")
print(f"Loss: {testscore[0]}")
```

```
TEST DATA

Accuracy: 95.67%
Precision: 95.67%
Recall: 95.67%
F1_score: [0.9626168 0.9353234 0.972973 ]
Loss: 0.20064330101013184
```

[51]:
```
from sklearn.metrics import classification_report,confusion_matrix
from sklearn.metrics import ConfusionMatrixDisplay
```

[57]:
```
y_pred=np.argmax(model.predict(x_test),axis=1)
y_true=np.argmax(y_test,axis=1)
```

```
10/10 [==============================] - 0s 4ms/step
```

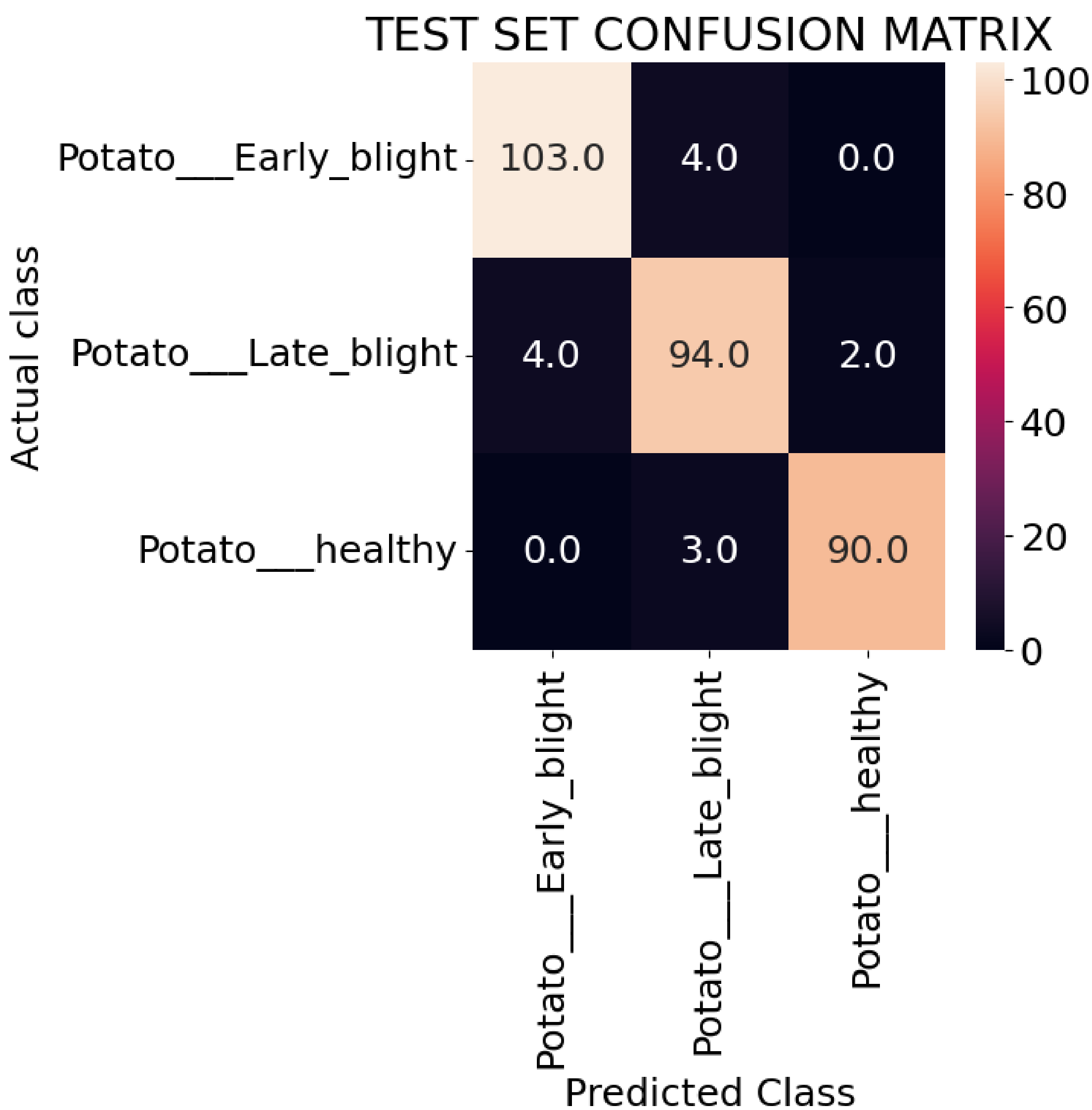
[58]:
```
c_test=confusion_matrix(y_true,y_pred)
c_test
```

[58]:
```
array([[103,   4,   0],
       [  4,  94,   2],
       [  0,   3,  90]])
```

[59]:
```python
print(classification_report(y_true,y_pred,target_names=['Potato___Early_blight',␣
↪'Potato___Late_blight', 'Potato___healthy']))
```

```
                       precision    recall  f1-score   support

Potato___Early_blight       0.96      0.96      0.96       107
 Potato___Late_blight       0.93      0.94      0.94       100
     Potato___healthy       0.98      0.97      0.97        93

             accuracy                           0.96       300
            macro avg       0.96      0.96      0.96       300
         weighted avg       0.96      0.96      0.96       300
```

[60]:
```python
class_names=['Potato___Early_blight', 'Potato___Late_blight',␣
↪'Potato___healthy']
plt.figure(figsize=(5,5))
sns.
↪heatmap(c_test,annot=True,xticklabels=class_names,yticklabels=class_names,fmt='.
↪1f')
plt.title('TEST SET CONFUSION MATRIX')
plt.xlabel("Predicted Class")
plt.ylabel("Actual class")
plt.savefig('cm test.png')
plt.show()
```



[61]:
```python
print(f"TEST SET")
print('')
for i in range(3):
    tp = c_test[i, i]
    tn = np.sum(c_test) - np.sum(c_test[i, :]) - np.sum(c_test[:, i]) +␣
 ↪c_test[i, i]
    fp = np.sum(c_test[:, i]) - c_test[i, i]
    fn = np.sum(c_test[i, :]) - c_test[i, i]
    print(f"Class {i}: TP={tp}, TN={tn}, FP={fp}, FN={fn}")
```

```
TEST SET

Class 0: TP=103, TN=189, FP=4, FN=4
```

```
Class 1: TP=94, TN=193, FP=7, FN=6
Class 2: TP=90, TN=205, FP=2, FN=3
```

VALIDATION SET ANALYSIS

[62]:
```
valscore=model.evaluate(x_val,y_val)
valscore
```

```
26/26 [==============================] - 0s 8ms/step - loss: 0.1532 - accuracy:
0.9593 - precision: 0.9593 - Recall: 0.9593 - f1_score: 0.9591
```

[62]:
```
[0.1532370150089264,
 0.9593095183372498,
 0.9593095183372498,
 0.9593095183372498,
 array([0.9726776 , 0.93761814, 0.9669118 ], dtype=float32)]
```

[63]:
```
print('VALIDATION DATA')
print('')
print(f"Accuracy: {round(valscore[1]*100,2)}%")
print(f"Precision: {round(valscore[2]*100,2)}%")
print(f"Recall: {round(valscore[3]*100,2)}%")
print(f"F1_score: {valscore[4]}")
print(f"Loss: {valscore[0]}")
```

```
VALIDATION DATA

Accuracy: 95.93%
Precision: 95.93%
Recall: 95.93%
F1_score: [0.9726776  0.93761814 0.9669118 ]
Loss: 0.1532370150089264
```

[64]:
```
yv_pred=np.argmax(model.predict(x_val),axis=1)
yv_true=np.argmax(y_val,axis=1)
```

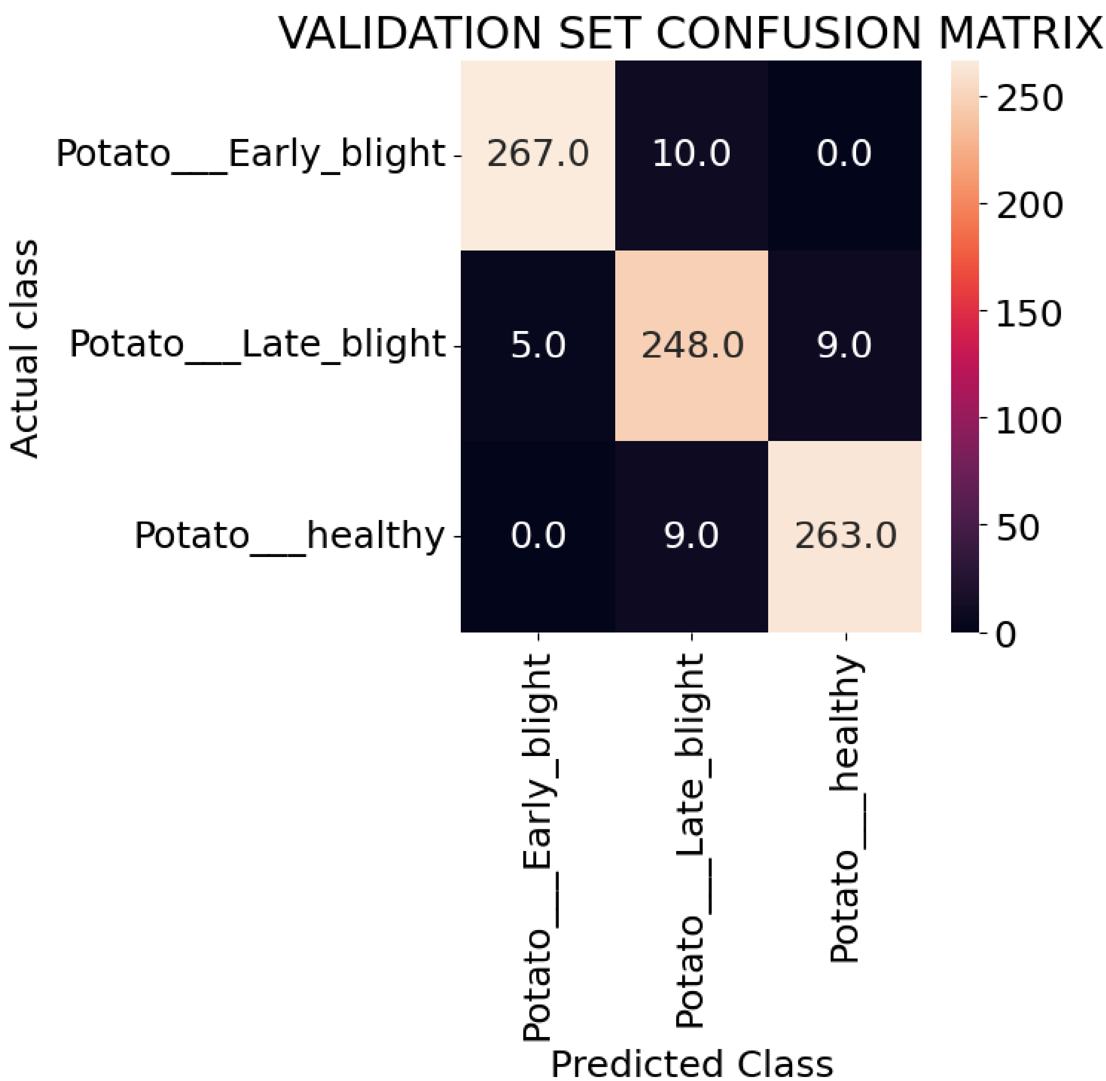
```
26/26 [==============================] - 0s 4ms/step
```

[65]:
```
c_val=confusion_matrix(yv_true,yv_pred)
c_val
```

[65]:
```
array([[267,  10,   0],
       [  5, 248,   9],
       [  0,   9, 263]])
```

[66]:
```
plt.figure(figsize=(5,5))
sns.
 ↪heatmap(c_val,annot=True,xticklabels=class_names,yticklabels=class_names,fmt='.
 ↪1f')
```

```
plt.title('VALIDATION SET CONFUSION MATRIX')
plt.xlabel("Predicted Class")
plt.ylabel("Actual class")
plt.savefig('cm VAL.png')
plt.show()
```



[68]:
```
print(classification_report(yv_true,yv_pred,target_names=class_names))
```

```
                       precision    recall  f1-score   support

Potato___Early_blight       0.98      0.96      0.97       277
 Potato___Late_blight       0.93      0.95      0.94       262
     Potato___healthy       0.97      0.97      0.97       272
```

```
    accuracy                           0.96       811
   macro avg       0.96      0.96      0.96       811
weighted avg       0.96      0.96      0.96       811
```

[69]:
```
print(f"VALIDATION SET")
print('')
for i in range(3):
    tp = c_val[i, i]
    tn = np.sum(c_val) - np.sum(c_val[i, :]) - np.sum(c_val[:, i]) + c_val[i, i]
    fp = np.sum(c_val[:, i]) - c_val[i, i]
    fn = np.sum(c_val[i, :]) - c_val[i, i]
    print(f"Class {i}: TP={tp}, TN={tn}, FP={fp}, FN={fn}")
```

```
VALIDATION SET

Class 0: TP=267, TN=529, FP=5, FN=10
Class 1: TP=248, TN=530, FP=19, FN=14
Class 2: TP=263, TN=530, FP=9, FN=9
```

IMAGE PREDICTIONS WITH PERCENTAGES

[71]:
```
plt.figure(figsize=(30, 30))
plt.subplots_adjust(wspace=0.3, hspace=0.3)
for i in range(20):
    idx = np.random.randint(len(y))
    img, true_class = x[idx], categories[y[idx].squeeze()]

    # predict class probabilities for the current image
    probs = model.predict(img[None, :, :, :])[0]
    pred_class = categories[np.argmax(probs)]
    max_prob = np.max(probs)*100
    plt.rcParams.update({'font.size':18})
    plt.subplot(5, 4, i + 1)
    plt.imshow(img[:, :, ::-1])
    plt.title(f"Predicted: {pred_class}\nActual: {true_class}\n␣
↪matching_Percentage: {round(max_prob)}%")
    plt.axis("off")
plt.show()
```

```
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 21ms/step
1/1 [==============================] - 0s 19ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 19ms/step
1/1 [==============================] - 0s 25ms/step
1/1 [==============================] - 0s 23ms/step
1/1 [==============================] - 0s 19ms/step
1/1 [==============================] - 0s 19ms/step
```

```
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 19ms/step
1/1 [==============================] - 0s 22ms/step
1/1 [==============================] - 0s 22ms/step
1/1 [==============================] - 0s 21ms/step
1/1 [==============================] - 0s 22ms/step
1/1 [==============================] - 0s 21ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 20ms/step
1/1 [==============================] - 0s 38ms/step
```