# Potato Disease Detection

Potato health Potato early blight Potato late blight

```
import numpy as np
import pandas as pd
import os

base_path = "/kaggle/input/potato-disease-detection-dataset/"
categories = ["Potato___Early_blight","Potato___Late_blight",
"Potato___healthy"]

image_paths = []
labels = []

for category in categories:
    category_path = os.path.join(base_path, category)
    for image_name in os.listdir(category_path):
        image_path = os.path.join(category_path, image_name)
        image_paths.append(image_path)
        labels.append(category)

df = pd.DataFrame({
    "image_path": image_paths,
    "label": labels
})

df.head()

                                          image_path                  label
0  /kaggle/input/potato-disease-detection-dataset...  Potato___Early_blight
1  /kaggle/input/potato-disease-detection-dataset...  Potato___Early_blight
2  /kaggle/input/potato-disease-detection-dataset...  Potato___Early_blight
3  /kaggle/input/potato-disease-detection-dataset...  Potato___Early_blight
4  /kaggle/input/potato-disease-detection-dataset...  Potato___Early_blight

df.tail()
```

```
                                             image_path             label
2147  /kaggle/input/potato-disease-detection-dataset...  Potato___healthy
2148  /kaggle/input/potato-disease-detection-dataset...  Potato___healthy
2149  /kaggle/input/potato-disease-detection-dataset...  Potato___healthy
2150  /kaggle/input/potato-disease-detection-dataset...  Potato___healthy
2151  /kaggle/input/potato-disease-detection-dataset...  Potato___healthy
```

```
df.shape
```

```
(2152, 2)
```

```
df.columns
```

```
Index(['image_path', 'label'], dtype='object')
```

```
df.duplicated().sum()
```

```
0
```

```
df.isnull().sum()
```

```
image_path    0
label         0
dtype: int64
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2152 entries, 0 to 2151
Data columns (total 2 columns):
 #   Column      Non-Null Count  Dtype 
---  ------      --------------  ----- 
 0   image_path  2152 non-null   object
 1   label       2152 non-null   object
dtypes: object(2)
memory usage: 33.8+ KB
```

```
df['label'].unique()
```

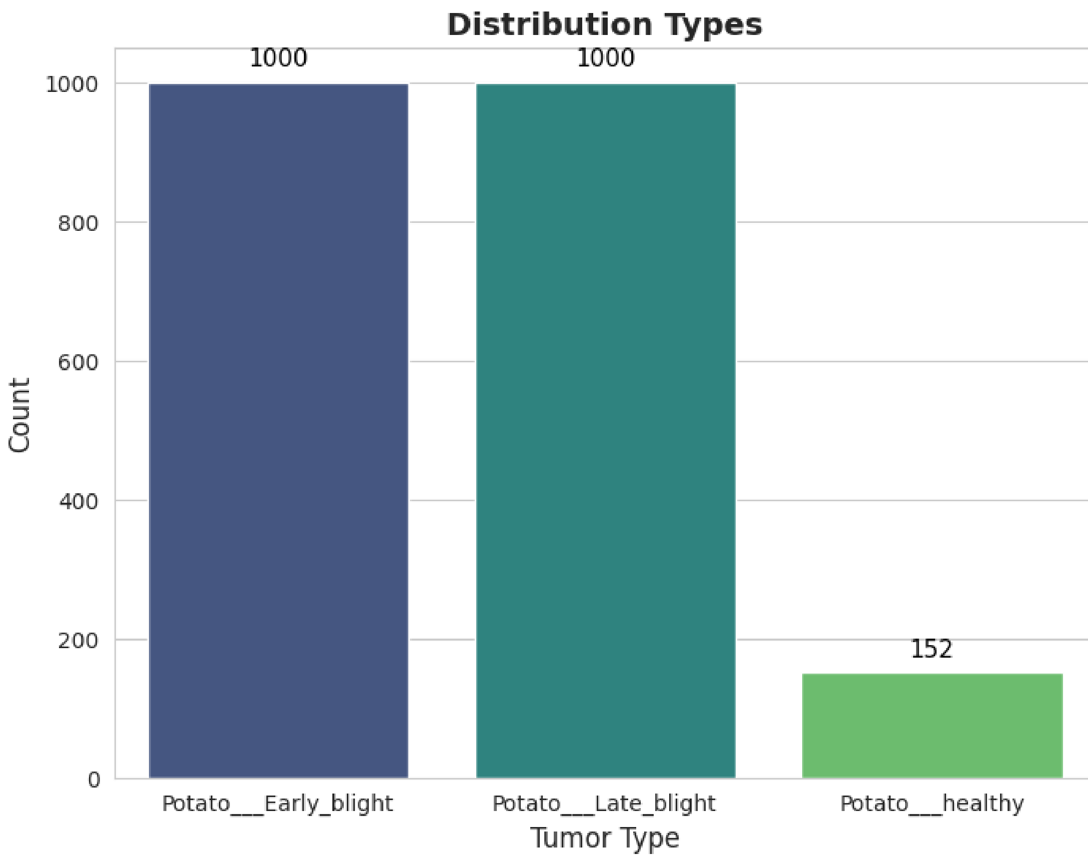
```
array(['Potato___Early_blight', 'Potato___Late_blight',
       'Potato___healthy'], dtype=object)
```

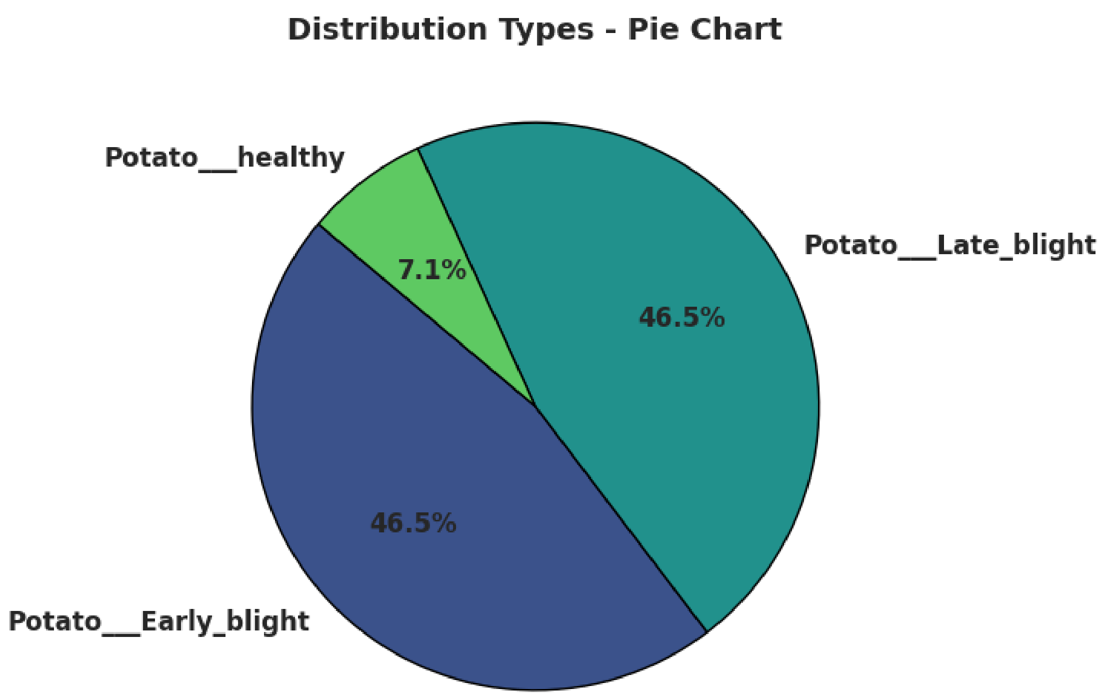
```
df['label'].value_counts()
```

```
label
Potato___Early_blight    1000
Potato___Late_blight     1000
Potato___healthy          152
Name: count, dtype: int64
```

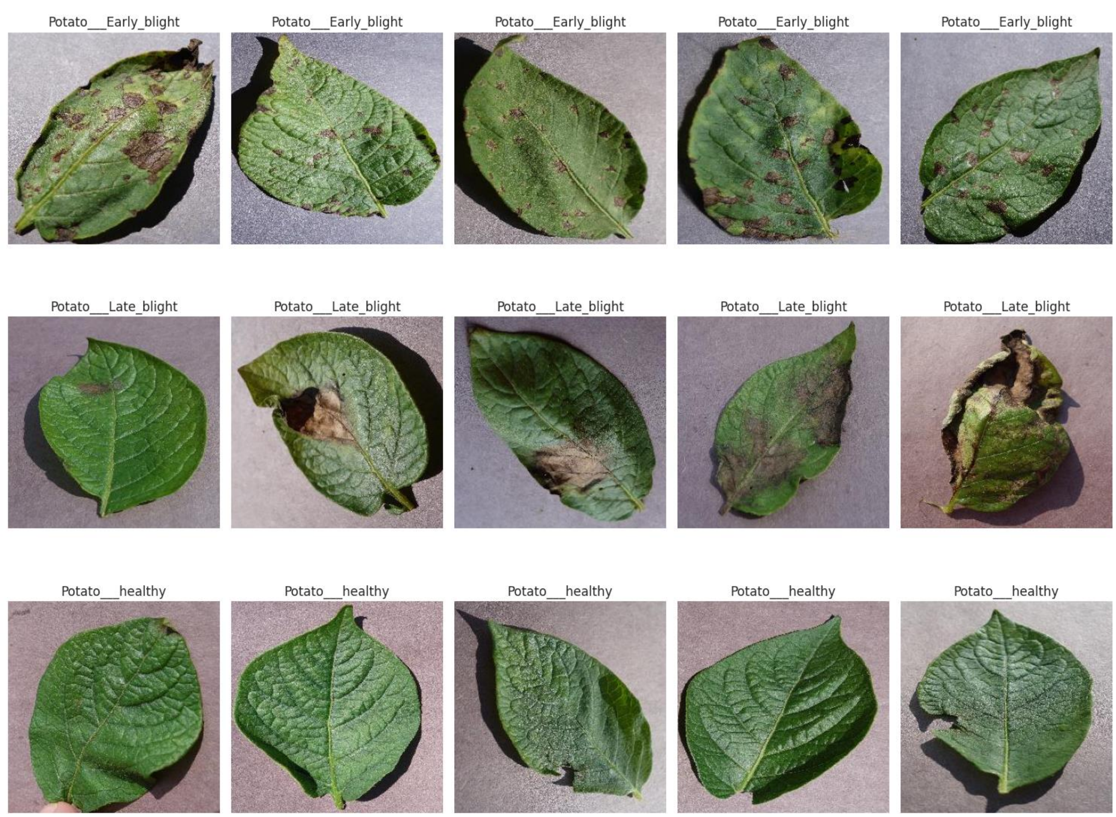
```
import seaborn as sns
import matplotlib.pyplot as plt
```

```
sns.set_style("whitegrid")

fig, ax = plt.subplots(figsize=(8, 6))
sns.countplot(data=df, x="label", palette="viridis", ax=ax)

ax.set_title("Distribution Types", fontsize=14, fontweight='bold')
ax.set_xlabel("Tumor Type", fontsize=12)
ax.set_ylabel("Count", fontsize=12)

for p in ax.patches:
    ax.annotate(f'{int(p.get_height())}',
                (p.get_x() + p.get_width() / 2., p.get_height()),
                ha='center', va='bottom', fontsize=11, color='black',
                xytext=(0, 5), textcoords='offset points')

plt.show()

label_counts = df["label"].value_counts()

fig, ax = plt.subplots(figsize=(8, 6))
colors = sns.color_palette("viridis", len(label_counts))

ax.pie(label_counts, labels=label_counts.index, autopct='%1.1f%%',
       startangle=140, colors=colors, textprops={'fontsize': 12, 'weight':
'bold'},
       wedgeprops={'edgecolor': 'black', 'linewidth': 1})

ax.set_title("Distribution Types - Pie Chart", fontsize=14,
fontweight='bold')

plt.show()
```


Distribution Types
1000
1000
152
1000
800
600
400
200
0
Count
Potato___Early_blight
Potato___Late_blight
Potato___healthy
Tumor Type


Distribution Types - Pie Chart
Potato___healthy
7.1%
Potato___Late_blight
46.5%
46.5%
Potato___Early_blight

```python
import cv2

num_images = 5

plt.figure(figsize=(15, 12))

for i, category in enumerate(categories):
    category_images = df[df['label'] ==
category]['image_path'].iloc[:num_images]

    for j, img_path in enumerate(category_images):

        img = cv2.imread(img_path)
        img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)

        plt.subplot(len(categories), num_images, i * num_images + j + 1)
        plt.imshow(img)
        plt.axis('off')
        plt.title(category)

plt.tight_layout()
plt.show()
```




```python
from sklearn.preprocessing import LabelEncoder
```

```python
label_encoder = LabelEncoder()

df['category_encoded'] = label_encoder.fit_transform(df['label'])

df = df[['image_path', 'category_encoded']]

from sklearn.utils import resample

max_count = df['category_encoded'].value_counts().max()

dfs = []
for category in df['category_encoded'].unique():
    class_subset = df[df['category_encoded'] == category]
    class_upsampled = resample(class_subset,
                               replace=True,
                               n_samples=max_count,
                               random_state=42)
    dfs.append(class_upsampled)

df_balanced = pd.concat(dfs).sample(frac=1,
random_state=42).reset_index(drop=True)

df_balanced['category_encoded'].value_counts()
```

```
category_encoded
1    1000
0    1000
2    1000
Name: count, dtype: int64
```

```python
df_resampled = df_balanced

df_resampled['category_encoded'] =
df_resampled['category_encoded'].astype(str)

import time
import shutil
import pathlib
import itertools
from PIL import Image

import cv2
import seaborn as sns
sns.set_style('darkgrid')
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix, classification_report

import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.models import Sequential
```

```
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense,
Activation, Dropout, BatchNormalization
from tensorflow.keras import regularizers

import warnings
warnings.filterwarnings("ignore")

print ('check')
```

```
2025-06-04 12:50:59.118080: E
external/local_xla/xla/stream_executor/cuda/cuda_fft.cc:477] Unable to
register cuFFT factory: Attempting to register factory for plugin cuFFT when
one has already been registered
WARNING: All log messages before absl::InitializeLog() is called are written
to STDERR
E0000 00:00:1749041459.595664      35 cuda_dnn.cc:8310] Unable to register
cuDNN factory: Attempting to register factory for plugin cuDNN when one has
already been registered
E0000 00:00:1749041459.728633      35 cuda_blas.cc:1418] Unable to register
cuBLAS factory: Attempting to register factory for plugin cuBLAS when one has
already been registered

check
```

```
train_df_new, temp_df_new = train_test_split(
    df_resampled,
    train_size=0.8,
    shuffle=True,
    random_state=42,
    stratify=df_resampled['category_encoded']
)

valid_df_new, test_df_new = train_test_split(
    temp_df_new,
    test_size=0.5,
    shuffle=True,
    random_state=42,
    stratify=temp_df_new['category_encoded']
)

from tensorflow.keras.preprocessing.image import ImageDataGenerator

batch_size = 16
img_size = (224, 224)
channels = 3
img_shape = (img_size[0], img_size[1], channels)

tr_gen = ImageDataGenerator(
```

```python
    rescale=1./255
)

ts_gen = ImageDataGenerator(rescale=1./255)

train_gen_new = tr_gen.flow_from_dataframe(
    train_df_new,
    x_col='image_path',
    y_col='category_encoded',
    target_size=img_size,
    class_mode='sparse',
    color_mode='rgb',
    shuffle=True,
    batch_size=batch_size
)

valid_gen_new = ts_gen.flow_from_dataframe(
    valid_df_new,
    x_col='image_path',
    y_col='category_encoded',
    target_size=img_size,
    class_mode='sparse',
    color_mode='rgb',
    shuffle=True,
    batch_size=batch_size
)

test_gen_new = ts_gen.flow_from_dataframe(
    test_df_new,
    x_col='image_path',
    y_col='category_encoded',
    target_size=img_size,
    class_mode='sparse',
    color_mode='rgb',
    shuffle=False,
    batch_size=batch_size
)
```

```
Found 2400 validated image filenames belonging to 3 classes.
Found 300 validated image filenames belonging to 3 classes.
Found 300 validated image filenames belonging to 3 classes.
```

```python
print("Num GPUs Available: ", len(tf.config.list_physical_devices('GPU')))
```

```
Num GPUs Available:  2
```

```python
gpus = tf.config.list_physical_devices('GPU')
if gpus:
    try:
        for gpu in gpus:
```

```
            tf.config.experimental.set_memory_growth(gpu, True)
        print("GPU is set for TensorFlow")
    except RuntimeError as e:
        print(e)
```

```
GPU is set for TensorFlow
```

```
import tensorflow as tf
from tensorflow.keras.layers import (Input, Lambda, Conv2D, MaxPooling2D,
Flatten,
                                     Dense, Reshape, Concatenate,
GlobalAveragePooling1D, Softmax, Multiply)
from tensorflow.keras.models import Model

img_size = (224, 224)
channels = 3
img_shape = (224, 224, 3)
num_classes = len(train_df_new['category_encoded'].unique())

def split_image(image):
    upper_half = image[:, :img_size[0]//2, :, :]
    lower_half = image[:, img_size[0]//2:, :, :]
    return upper_half, lower_half

def flip_lower_half(lower_half):
    return tf.image.flip_left_right(lower_half)

input_layer = Input(shape=img_shape)

upper_half, lower_half = Lambda(split_image)(input_layer)
lower_half_flipped = Lambda(flip_lower_half)(lower_half)

upper = Conv2D(32, (3, 3), activation='relu', padding='same')(upper_half)
upper = MaxPooling2D((2, 2))(upper)
upper = Conv2D(64, (3, 3), activation='relu', padding='same')(upper)
upper = MaxPooling2D((2, 2))(upper)
upper = Conv2D(128, (3, 3), activation='relu', padding='same')(upper)
upper = MaxPooling2D((2, 2))(upper)
upper = Flatten()(upper)
upper_dense = Dense(512, activation='relu')(upper)
upper_reshape = Reshape((1, 512))(upper_dense)

lower = Conv2D(32, (3, 3), activation='relu',
padding='same')(lower_half_flipped)
lower = MaxPooling2D((2, 2))(lower)
lower = Conv2D(64, (3, 3), activation='relu', padding='same')(lower)
lower = MaxPooling2D((2, 2))(lower)
lower = Conv2D(128, (3, 3), activation='relu', padding='same')(lower)
lower = MaxPooling2D((2, 2))(lower)
lower = Flatten()(lower)
```

```
lower_dense = Dense(512, activation='relu')(lower)
lower_reshape = Reshape((1, 512))(lower_dense)

concat_seq = Concatenate(axis=1)([upper_reshape, lower_reshape])

similarity_scores = tf.keras.layers.Dot(axes=-1,
normalize=True)([upper_reshape, lower_reshape])  # (None, 1, 1)
attention_weights = Softmax(axis=1)(similarity_scores)

attended = Multiply()([attention_weights, upper_reshape])

combined = Concatenate(axis=-1)([attended, lower_reshape])  #
combined = Reshape((1024,))(combined)

fc1 = Dense(256, activation='relu')(combined)
fc2 = Dense(128, activation='relu')(fc1)
output = Dense(num_classes, activation='softmax')(fc2)

model = Model(inputs=input_layer, outputs=output)
model.compile(optimizer='adam', loss='sparse_categorical_crossentropy',
metrics=['accuracy'])

model.summary()
```

```
I0000 00:00:1749041840.967212      35 gpu_device.cc:2022] Created device
/job:localhost/replica:0/task:0/device:GPU:0 with 13942 MB memory:  ->
device: 0, name: Tesla T4, pci bus id: 0000:00:04.0, compute capability: 7.5
I0000 00:00:1749041840.968011      35 gpu_device.cc:2022] Created device
/job:localhost/replica:0/task:0/device:GPU:1 with 13942 MB memory:  ->
device: 1, name: Tesla T4, pci bus id: 0000:00:05.0, compute capability: 7.5

Model: "functional"

┏━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━┳━━━━━━━
━━━━━━━━━━━━━━━━━━━┓
┃ Layer (type)              ┃ Output Shape           ┃        Param # ┃
Connected to          ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━╇━━━━━━━
━━━━━━━━━━━━━━━━━━━┩
│ input_layer (InputLayer)  │ (None, 224, 224, 3)    │              0 │ -
│
├───────────────────────────┼────────────────────────┼────────────────┼───────
───────────────────┤
│ lambda (Lambda)           │ [(None, 112, 224, 3),  │              0 │
input_layer[0][0]         │
│                           │ (None, 112, 224, 3)]   │                │
│
├───────────────────────────┼────────────────────────┼────────────────┼───────
───────────────────┤
│ lambda_1 (Lambda)         │ (None, 112, 224, 3)    │              0 │
```

```
lambda[0][1]            │
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
──────────────────┤
│ conv2d (Conv2D)            │ (None, 112, 224, 32)    │             896 │
lambda[0][0]            │
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
──────────────────┤
│ conv2d_3 (Conv2D)          │ (None, 112, 224, 32)    │             896 │
lambda_1[0][0]          │
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
──────────────────┤
│ max_pooling2d              │ (None, 56, 112, 32)     │               0 │
conv2d[0][0]            │
│ (MaxPooling2D)             │                         │                 │
│
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
──────────────────┤
│ max_pooling2d_3            │ (None, 56, 112, 32)     │               0 │
conv2d_3[0][0]          │
│ (MaxPooling2D)             │                         │                 │
│
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
──────────────────┤
│ conv2d_1 (Conv2D)          │ (None, 56, 112, 64)     │          18,496 │
max_pooling2d[0][0]     │
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
──────────────────┤
│ conv2d_4 (Conv2D)          │ (None, 56, 112, 64)     │          18,496 │
max_pooling2d_3[0][0]   │
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
──────────────────┤
│ max_pooling2d_1            │ (None, 28, 56, 64)      │               0 │
conv2d_1[0][0]          │
│ (MaxPooling2D)             │                         │                 │
│
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
──────────────────┤
│ max_pooling2d_4            │ (None, 28, 56, 64)      │               0 │
conv2d_4[0][0]          │
│ (MaxPooling2D)             │                         │                 │
│
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
──────────────────┤
│ conv2d_2 (Conv2D)          │ (None, 28, 56, 128)     │          73,856 │
max_pooling2d_1[0][0]   │
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
──────────────────┤
│ conv2d_5 (Conv2D)          │ (None, 28, 56, 128)     │          73,856 │
max_pooling2d_4[0][0]   │
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
```

```
───────────────────┤
│ max_pooling2d_2           │ (None, 14, 28, 128)       │              0 │
conv2d_2[0][0]          │
│ (MaxPooling2D)            │                           │                │
│
├───────────────────────────┼───────────────────────────┼────────────────┼──────
───────────────────┤
│ max_pooling2d_5           │ (None, 14, 28, 128)       │              0 │
conv2d_5[0][0]          │
│ (MaxPooling2D)            │                           │                │
│
├───────────────────────────┼───────────────────────────┼────────────────┼──────
───────────────────┤
│ flatten (Flatten)         │ (None, 50176)             │              0 │
max_pooling2d_2[0][0]   │
├───────────────────────────┼───────────────────────────┼────────────────┼──────
───────────────────┤
│ flatten_1 (Flatten)       │ (None, 50176)             │              0 │
max_pooling2d_5[0][0]   │
├───────────────────────────┼───────────────────────────┼────────────────┼──────
───────────────────┤
│ dense (Dense)             │ (None, 512)               │     25,690,624 │
flatten[0][0]           │
├───────────────────────────┼───────────────────────────┼────────────────┼──────
───────────────────┤
│ dense_1 (Dense)           │ (None, 512)               │     25,690,624 │
flatten_1[0][0]         │
├───────────────────────────┼───────────────────────────┼────────────────┼──────
───────────────────┤
│ reshape (Reshape)         │ (None, 1, 512)            │              0 │
dense[0][0]             │
├───────────────────────────┼───────────────────────────┼────────────────┼──────
───────────────────┤
│ reshape_1 (Reshape)       │ (None, 1, 512)            │              0 │
dense_1[0][0]           │
├───────────────────────────┼───────────────────────────┼────────────────┼──────
───────────────────┤
│ dot (Dot)                 │ (None, 1, 1)              │              0 │
reshape[0][0],          │
│                           │                           │                │
reshape_1[0][0]         │
├───────────────────────────┼───────────────────────────┼────────────────┼──────
───────────────────┤
│ softmax (Softmax)         │ (None, 1, 1)              │              0 │
dot[0][0]               │
├───────────────────────────┼───────────────────────────┼────────────────┼──────
───────────────────┤
│ multiply (Multiply)       │ (None, 1, 512)            │              0 │
softmax[0][0],          │
│                           │                           │                │
```

```
reshape[0][0]              │
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
───────────────────┤
│ concatenate_1              │ (None, 1, 1024)         │               0 │
multiply[0][0],            │
│ (Concatenate)              │                         │                 │
reshape_1[0][0]            │
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
───────────────────┤
│ reshape_2 (Reshape)        │ (None, 1024)            │               0 │
concatenate_1[0][0]        │
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
───────────────────┤
│ dense_2 (Dense)            │ (None, 256)             │         262,400 │
reshape_2[0][0]            │
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
───────────────────┤
│ dense_3 (Dense)            │ (None, 128)             │          32,896 │
dense_2[0][0]              │
├────────────────────────────┼─────────────────────────┼─────────────────┼──────
───────────────────┤
│ dense_4 (Dense)            │ (None, 3)               │             387 │
dense_3[0][0]              │
└────────────────────────────┴─────────────────────────┴─────────────────┴──────
───────────────────┘

 Total params: 51,863,427 (197.84 MB)

 Trainable params: 51,863,427 (197.84 MB)

 Non-trainable params: 0 (0.00 B)
```

```python
from tensorflow.keras.utils import plot_model

plot_model(model,
           to_file='/kaggle/working/model.png',
           show_shapes=False,
           show_dtype=False,
           show_layer_names=False,
           dpi=300)
```

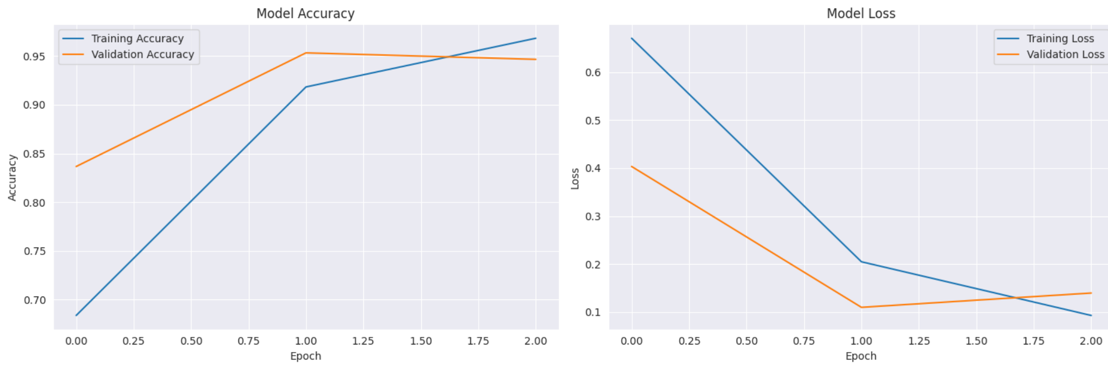
---

```python
history = model.fit(
    train_gen_new,
    validation_data=valid_gen_new,
    epochs=3,
    batch_size=batch_size
)
```

```
Epoch 1/3
```

```
WARNING: All log messages before absl::InitializeLog() is called are written
to STDERR
I0000 00:00:1749041902.649802     105 service.cc:148] XLA service
0x7b0678008160 initialized for platform CUDA (this does not guarantee that
XLA will be used). Devices:
I0000 00:00:1749041902.651550     105 service.cc:156]   StreamExecutor device
(0): Tesla T4, Compute Capability 7.5
I0000 00:00:1749041902.651574     105 service.cc:156]   StreamExecutor device
(1): Tesla T4, Compute Capability 7.5
I0000 00:00:1749041903.381011     105 cuda_dnn.cc:529] Loaded cuDNN version
90300

  1/150 ━━━━━━━━━━━━━━━━━━━━27:50 11s/step - accuracy: 0.3750 - loss: 1.1035

I0000 00:00:1749041908.827985     105 device_compiler.h:188] Compiled cluster
using XLA!  This line is logged at most once for the lifetime of the process.

150/150 ━━━━━━━━━━━━━━━━━━━━29s 116ms/step - accuracy: 0.5030 - loss: 1.0529
- val_accuracy: 0.8367 - val_loss: 0.4034
Epoch 2/3
150/150 ━━━━━━━━━━━━━━━━━━━━8s 50ms/step - accuracy: 0.8986 - loss: 0.2389 -
val_accuracy: 0.9533 - val_loss: 0.1101
Epoch 3/3
150/150 ━━━━━━━━━━━━━━━━━━━━7s 49ms/step - accuracy: 0.9691 - loss: 0.0918 -
val_accuracy: 0.9467 - val_loss: 0.1399
```

```python
def plot_training_history(history):

    fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(15, 5))

    ax1.plot(history.history['accuracy'], label='Training Accuracy')
    ax1.plot(history.history['val_accuracy'], label='Validation Accuracy')
    ax1.set_title('Model Accuracy')
    ax1.set_xlabel('Epoch')
    ax1.set_ylabel('Accuracy')
    ax1.legend()
    ax1.grid(True)

    ax2.plot(history.history['loss'], label='Training Loss')
    ax2.plot(history.history['val_loss'], label='Validation Loss')
    ax2.set_title('Model Loss')
    ax2.set_xlabel('Epoch')
    ax2.set_ylabel('Loss')
    ax2.legend()
    ax2.grid(True)

    plt.tight_layout()
    plt.show()

plot_training_history(history)
```



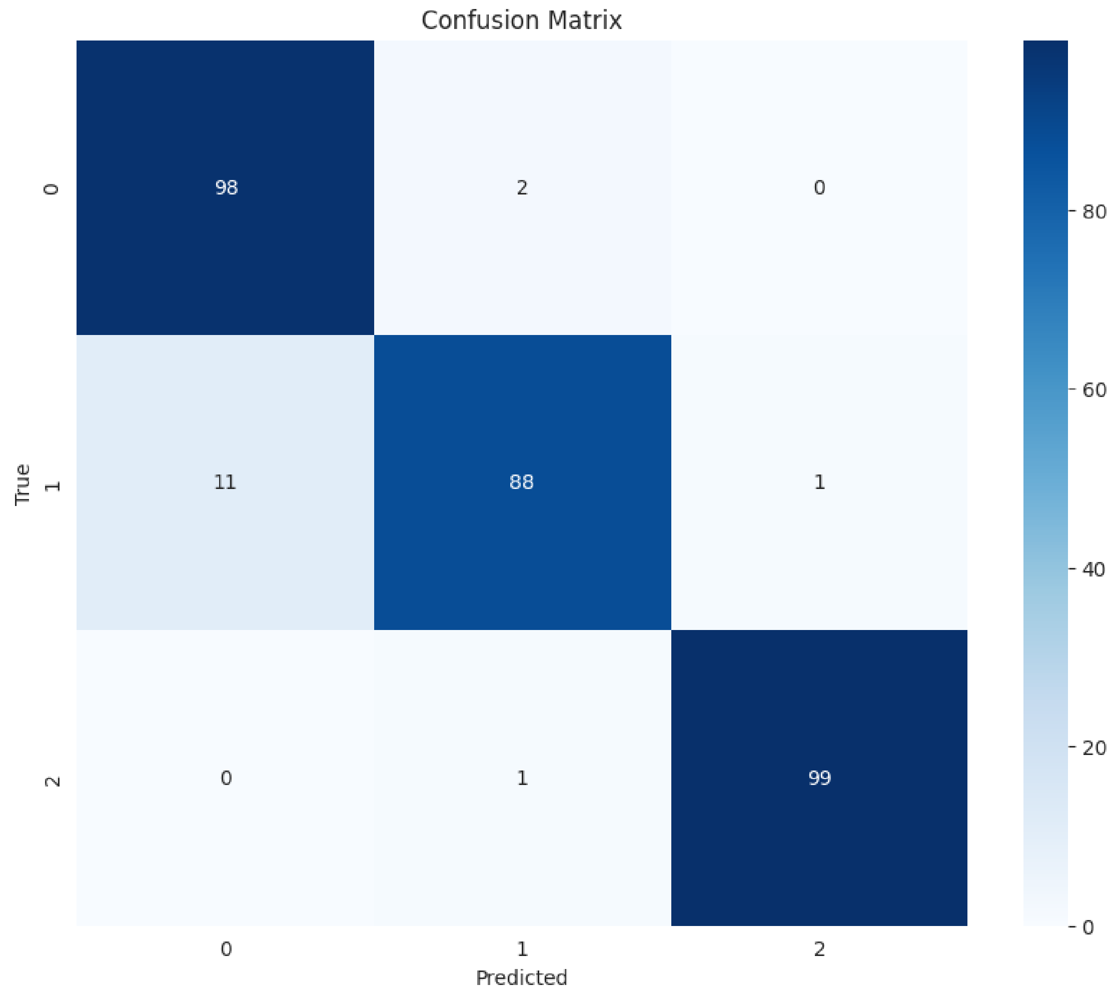

```
test_loss, test_accuracy = model.evaluate(test_gen_new)
print(f"Test Accuracy: {test_accuracy:.4f}, Test Loss: {test_loss:.4f}")
```

```
19/19 ━━━━━━━━━━━━━━━━━━━━1s 65ms/step - accuracy: 0.9640 - loss: 0.1056
Test Accuracy: 0.9500, Test Loss: 0.1269
```

```
from sklearn.metrics import confusion_matrix, classification_report

test_gen_new.reset()
y_pred = model.predict(test_gen_new)
y_pred_classes = np.argmax(y_pred, axis=1)
y_true = test_gen_new.classes
```

```
19/19 ━━━━━━━━━━━━━━━━━━━━2s 97ms/step
```

```
class_names = list(test_gen_new.class_indices.keys())

cm = confusion_matrix(y_true, y_pred_classes)

plt.figure(figsize=(10, 8))
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', xticklabels=class_names,
yticklabels=class_names)
plt.title('Confusion Matrix')
plt.xlabel('Predicted')
plt.ylabel('True')
plt.show()
```




```
print("\nClassification Report:")
print(classification_report(y_true, y_pred_classes,
target_names=class_names))
```

```
Classification Report:
              precision    recall  f1-score   support

           0       0.90      0.98      0.94       100
           1       0.97      0.88      0.92       100
           2       0.99      0.99      0.99       100

    accuracy                           0.95       300
   macro avg       0.95      0.95      0.95       300
weighted avg       0.95      0.95      0.95       300
```