```
# -*- coding: utf-8 -*-
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
import numpy as np
import tensorflow as tf
from tensorflow.keras.applications import DenseNet121
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Dense, GlobalAveragePooling2D, Dropout
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.callbacks import EarlyStopping, ReduceLROnPlateau
from sklearn.utils import class_weight
import os
```

```
# Set random seed
tf.random.set_seed(42)
np.random.seed(42)

# === Data Paths ===
train_dir = '/content/drive/MyDrive/train'
val_dir = '/content/drive/MyDrive/val'
test_dir = '/content/drive/MyDrive/val'
img_size = (224, 224)
batch_size = 32
```

```
# === Data Augmentation ===
train_datagen = ImageDataGenerator(
    rescale=1./255,
    rotation_range=25,
    width_shift_range=0.2,
    height_shift_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    vertical_flip=True
)

val_datagen = ImageDataGenerator(rescale=1./255)
test_datagen = ImageDataGenerator(rescale=1./255)

train_gen = train_datagen.flow_from_directory(
    train_dir,
    target_size=img_size,
    batch_size=batch_size,
    class_mode='categorical'
)

val_gen = val_datagen.flow_from_directory(
    val_dir,
    target_size=img_size,
    batch_size=batch_size,
    class_mode='categorical'
)

test_gen = test_datagen.flow_from_directory(
    test_dir,
    target_size=img_size,
    batch_size=1,
    class_mode='categorical',
    shuffle=False
)
```

```
Found 697 images belonging to 9 classes.
Found 181 images belonging to 9 classes.
Found 181 images belonging to 9 classes.
```

```
# === Class Weights ===
labels = train_gen.classes
class_weights = class_weight.compute_class_weight(
    class_weight='balanced',
    classes=np.unique(labels),
    y=labels
)
class_weights = dict(enumerate(class_weights))
```

```
# === Build Model ===
base_model = DenseNet121(include_top=False, weights='imagenet', input_shape=(224, 224, 3))
```

```
base_model.trainable = True  # Unfreeze all layers

x = base_model.output
x = GlobalAveragePooling2D()(x)
x = Dropout(0.4)(x)
predictions = Dense(train_gen.num_classes, activation='softmax')(x)

model = Model(inputs=base_model.input, outputs=predictions)

model.compile(
    optimizer=tf.keras.optimizers.Adam(learning_rate=1e-4),
    loss='categorical_crossentropy',
    metrics=['accuracy']
)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/densenet/densenet121_weights_tf_dim_ordering_tf_
29084464/29084464 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
```

```
# === Callbacks ===
early_stop = EarlyStopping(monitor='val_loss', patience=5, restore_best_weights=True)
reduce_lr = ReduceLROnPlateau(monitor='val_loss', patience=3, factor=0.2, min_lr=1e-6)
```

```
# === Train ===
history = model.fit(
    train_gen,
    epochs=30,
    validation_data=val_gen,
    class_weight=class_weights,
    callbacks=[early_stop, reduce_lr]
)
```

```
/usr/local/lib/python3.11/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:121: UserWarning: Your `PyDataset` c
  self._warn_if_super_not_called()
Epoch 1/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 720s 28s/step - accuracy: 0.2113 - loss: 2.4315 - val_accuracy: 0.4144 - val_loss: 1.6041 - learning_rate
Epoch 2/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 546s 25s/step - accuracy: 0.6306 - loss: 1.1169 - val_accuracy: 0.5249 - val_loss: 1.3003 - learning_rate
Epoch 3/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 571s 26s/step - accuracy: 0.7561 - loss: 0.6954 - val_accuracy: 0.6077 - val_loss: 1.1616 - learning_rate
Epoch 4/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 537s 25s/step - accuracy: 0.7746 - loss: 0.6048 - val_accuracy: 0.6409 - val_loss: 1.0738 - learning_rate
Epoch 5/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 535s 24s/step - accuracy: 0.8429 - loss: 0.4714 - val_accuracy: 0.6740 - val_loss: 0.9532 - learning_rate
Epoch 6/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 533s 24s/step - accuracy: 0.8786 - loss: 0.3715 - val_accuracy: 0.7182 - val_loss: 0.8194 - learning_rate
Epoch 7/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 564s 25s/step - accuracy: 0.8820 - loss: 0.3274 - val_accuracy: 0.7514 - val_loss: 0.6590 - learning_rate
Epoch 8/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 536s 24s/step - accuracy: 0.9233 - loss: 0.2161 - val_accuracy: 0.7956 - val_loss: 0.5665 - learning_rate
Epoch 9/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 538s 25s/step - accuracy: 0.9063 - loss: 0.2668 - val_accuracy: 0.8177 - val_loss: 0.5197 - learning_rate
Epoch 10/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 536s 24s/step - accuracy: 0.9441 - loss: 0.2051 - val_accuracy: 0.8066 - val_loss: 0.6335 - learning_rate
Epoch 11/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 584s 25s/step - accuracy: 0.9294 - loss: 0.1917 - val_accuracy: 0.8066 - val_loss: 0.6492 - learning_rate
Epoch 12/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 542s 25s/step - accuracy: 0.9618 - loss: 0.1271 - val_accuracy: 0.7790 - val_loss: 0.6988 - learning_rate
Epoch 13/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 528s 24s/step - accuracy: 0.9377 - loss: 0.1798 - val_accuracy: 0.7956 - val_loss: 0.5992 - learning_rate
Epoch 14/30
22/22 ━━━━━━━━━━━━━━━━━━━━ 542s 25s/step - accuracy: 0.9642 - loss: 0.1104 - val_accuracy: 0.7956 - val_loss: 0.5550 - learning_rate
```

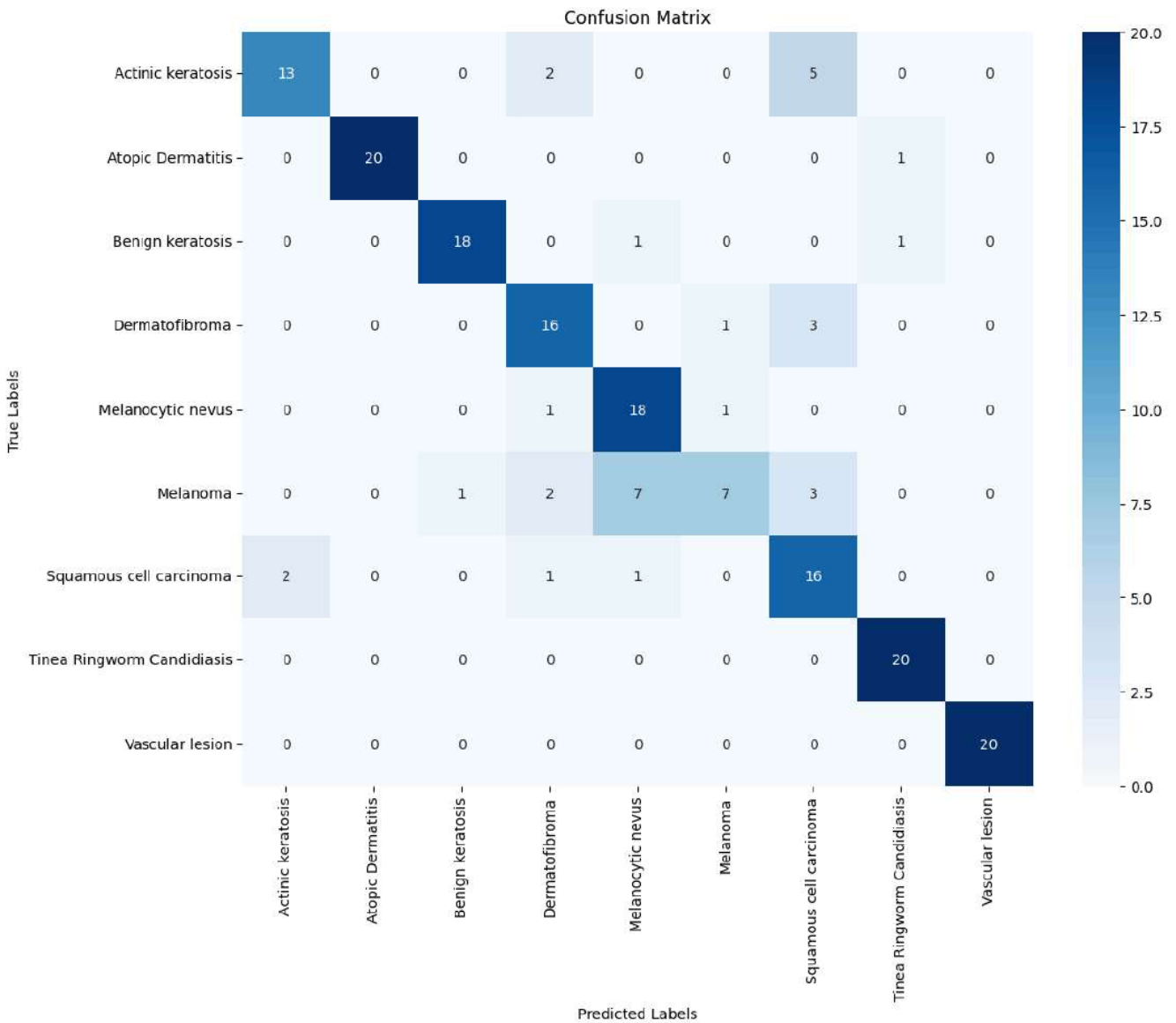
```
# === Evaluate ===
loss, acc = model.evaluate(test_gen)
print(f"Final Test Accuracy: {acc * 100:.2f}%")
```

```
181/181 ━━━━━━━━━━━━━━━━━━━━ 30s 167ms/step - accuracy: 0.7827 - loss: 0.6292
Final Test Accuracy: 81.77%
```

```
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import classification_report, confusion_matrix

# Step 1: Get predictions
Y_pred = model.predict(test_gen, steps=test_gen.samples)
y_pred = np.argmax(Y_pred, axis=1)

# Step 2: True labels
y_true = test_gen.classes
```

```
# Step 3: Confusion Matrix
cm = confusion_matrix(y_true, y_pred)
class_names = list(test_gen.class_indices.keys())

# Step 4: Plot confusion matrix
plt.figure(figsize=(12, 10))
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues',
            xticklabels=class_names,
            yticklabels=class_names)
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.title('Confusion Matrix')
plt.tight_layout()
plt.show()

# Optional: Classification Report
print("Classification Report:\n")
print(classification_report(y_true, y_pred, target_names=class_names))
```

```
181/181 ━━━━━━━━━━━━━━━━━━━━ 39s 168ms/step
```



Classification Report:

	precision	recall	f1-score	support
Actinic keratosis	0.87	0.65	0.74	20
Melanocytic nevus	0.67	0.90	0.77	20
Melanoma	0.78	0.35	0.48	20
Squamous cell carcinoma	0.59	0.80	0.68	20
Tinea Ringworm Candidiasis	0.91	1.00	0.95	20
accuracy			0.82	181
macro avg	0.83	0.82	0.81	181
weighted avg	0.83	0.82	0.81	181

```
# === Save Model ===
model.save('/content/drive/MyDrive/final_project/DenseNet_81PercentageAccuracy.h5')
```

```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`. This file format is c
```

```
Start coding or generate with AI.
```