In [ ]:
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import numpy as np
import os
import cv2
import tensorflow as tf
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Dense, Dropout, GlobalAveragePooling2D
from tensorflow.keras.applications import MobileNetV2
from tensorflow.keras.optimizers import Adam
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import confusion_matrix, accuracy_score, precision_score, r

# Set directory paths and categories for dataset
data_dir = "C:\\Users\\MONALISA\\Desktop\\BLOOD CANCER DETECTION_AI\\BLOOD CANCE
categories = ["Normal", "Myeloma", "Leukemia", "Lymphoma"]

# Parameters
img_size = 128
data = []
labels = []

# Load and preprocess the data
for category in categories:
    folder_path = os.path.join(data_dir, category)
    label = categories.index(category)

    if not os.path.exists(folder_path):
        print(f"Folder does not exist: {folder_path}")
        continue

    displayed_sample = False
    for img in os.listdir(folder_path):
        try:
            img_path = os.path.join(folder_path, img)
            image = cv2.imread(img_path)
            if image is None:
                print(f"Image not loaded properly: {img_path}")
                continue
            image = cv2.resize(image, (img_size, img_size))
            data.append(image)
            labels.append(label)

            if not displayed_sample:
                plt.imshow(cv2.cvtColor(image, cv2.COLOR_BGR2RGB))
                plt.title(f"Sample Image - {category}")
                plt.axis('off')
                plt.show()
                displayed_sample = True
        except Exception as e:
            print("Error loading image:", e)

# Convert data to NumPy arrays and normalize
data = np.array(data) / 255.0
labels = np.array(labels)
labels = to_categorical(labels, num_classes=len(categories))
```

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# Split the data
x_train, x_val, y_train, y_val = train_test_split(data, labels, test_size=0.2, r

# MobileNetV2 Transfer Learning Model
base_model = MobileNetV2(weights='imagenet', include_top=False, input_shape=(img
base_model.trainable = False

x = base_model.output
x = GlobalAveragePooling2D()(x)
x = Dense(128, activation='relu')(x)
x = Dropout(0.5)(x)
predictions = Dense(len(categories), activation='softmax')(x)

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

model.compile(optimizer=Adam(), loss='categorical_crossentropy', metrics=['accur
model.summary()

# Data augmentation
datagen = ImageDataGenerator(
    rotation_range=20,
    width_shift_range=0.1,
    height_shift_range=0.1,
    horizontal_flip=True
)

# Train the model
history = model.fit(datagen.flow(x_train, y_train, batch_size=32),
                    epochs=10,
                    validation_data=(x_val, y_val))

# Evaluate the model
val_loss, val_accuracy = model.evaluate(x_val, y_val)
print(f"Validation Loss: {val_loss}")
print(f"Validation Accuracy: {val_accuracy}")

# Display sample images in one row
def display_sample_images():
    plt.figure(figsize=(12, 4))
    for i, category in enumerate(categories):
        folder_path = os.path.join(data_dir, category)
        img_path = os.path.join(folder_path, os.listdir(folder_path)[0])
        img = cv2.imread(img_path)
        if img is None:
            print(f"Error: The image file in {category} folder could not be read
            continue
        img_resized = cv2.resize(img, (img_size, img_size))
        plt.subplot(1, 4, i+1)
        plt.imshow(cv2.cvtColor(img_resized, cv2.COLOR_BGR2RGB))
        plt.title(category)
        plt.axis('off')
    plt.show()

display_sample_images()

# Prediction function
def predict_image(image_path):
    img = cv2.imread(image_path)
    if img is None:
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        print("Error: The image file could not be read.")
        return None
    img_resized = cv2.resize(img, (img_size, img_size))
    img_input = img_resized.reshape(1, img_size, img_size, 3) / 255.0
    prediction = model.predict(img_input)
    result_index = np.argmax(prediction)
    result_label = categories[result_index]

    plt.figure(figsize=(10, 4))
    plt.subplot(1, 2, 1)
    plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
    plt.title("TEST SAMPLE")
    plt.axis('off')

    plt.subplot(1, 2, 2)
    plt.imshow(cv2.cvtColor(img_resized, cv2.COLOR_BGR2RGB))
    plt.title(f"Predicted: {result_label}")
    plt.axis('off')

    plt.show()

    return result_label

# Example prediction
prediction_result = predict_image("C:\\Users\\MONALISA\\Desktop\\BLOOD CANCER DE
print(f"Prediction Result: {prediction_result}")

# Plot training history
plt.figure(figsize=(15, 5))
plt.subplot(1, 3, 1)
plt.plot(history.history['loss'], label='Training Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.title('Loss over epochs')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()

plt.subplot(1, 3, 2)
plt.plot(history.history['accuracy'], label='Training Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Accuracy over epochs')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.legend()
plt.show()

# Evaluation metrics
y_val_pred = model.predict(x_val)
y_val_pred_labels = np.argmax(y_val_pred, axis=1)
y_val_true_labels = np.argmax(y_val, axis=1)

conf_matrix = confusion_matrix(y_val_true_labels, y_val_pred_labels)
plt.figure(figsize=(8, 6))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues', xticklabels=categori
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.title("Confusion Matrix")
plt.show()

accuracy = accuracy_score(y_val_true_labels, y_val_pred_labels)
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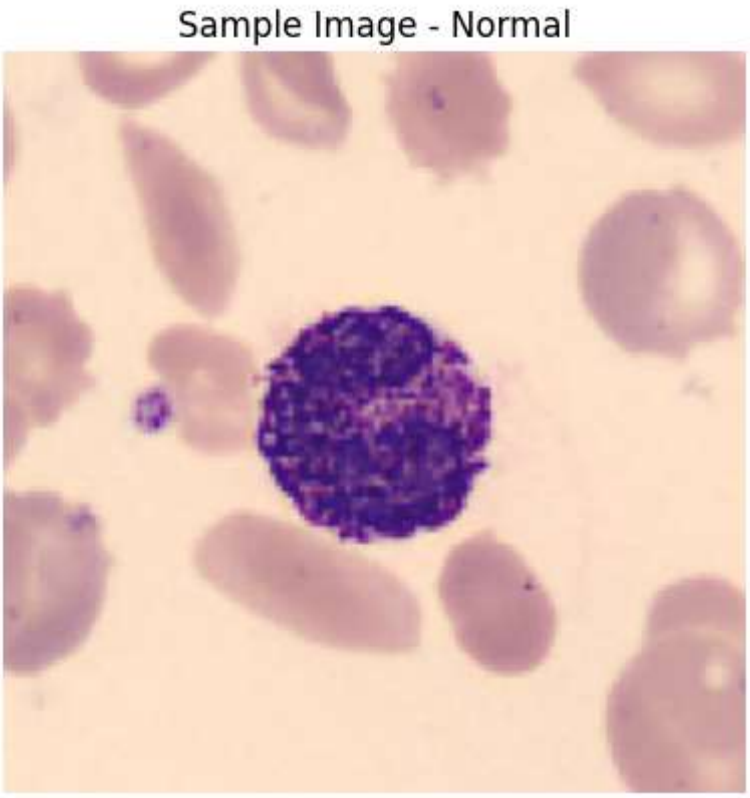
precision = precision_score(y_val_true_labels, y_val_pred_labels, average='weigh
recall = recall_score(y_val_true_labels, y_val_pred_labels, average='weighted',
f1 = f1_score(y_val_true_labels, y_val_pred_labels, average='weighted', zero_div

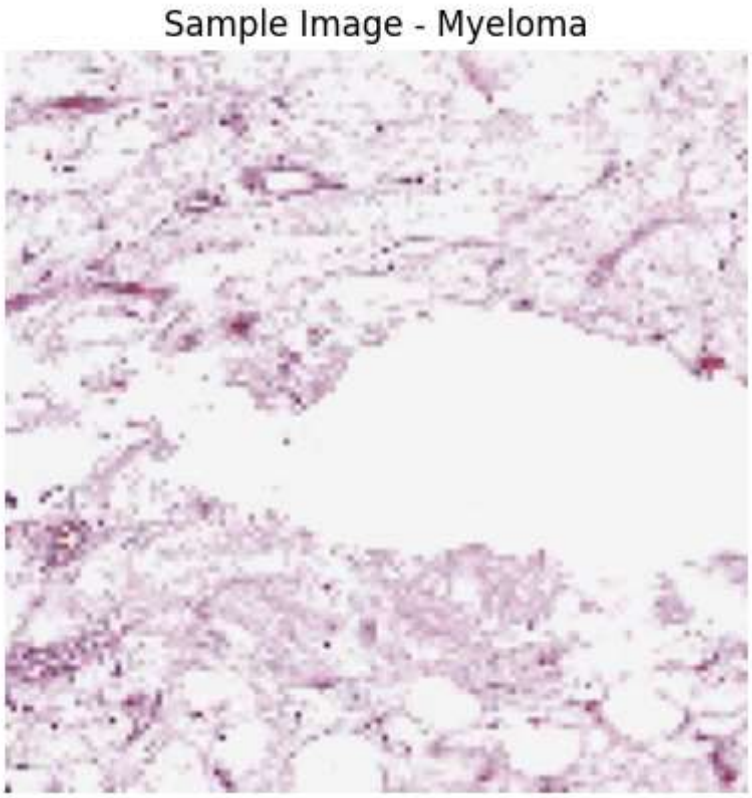
print(f"Accuracy: {accuracy:.2f}")
print(f"Precision: {precision:.2f}")
print(f"Recall: {recall:.2f}")
print(f"F1 Score: {f1:.2f}")

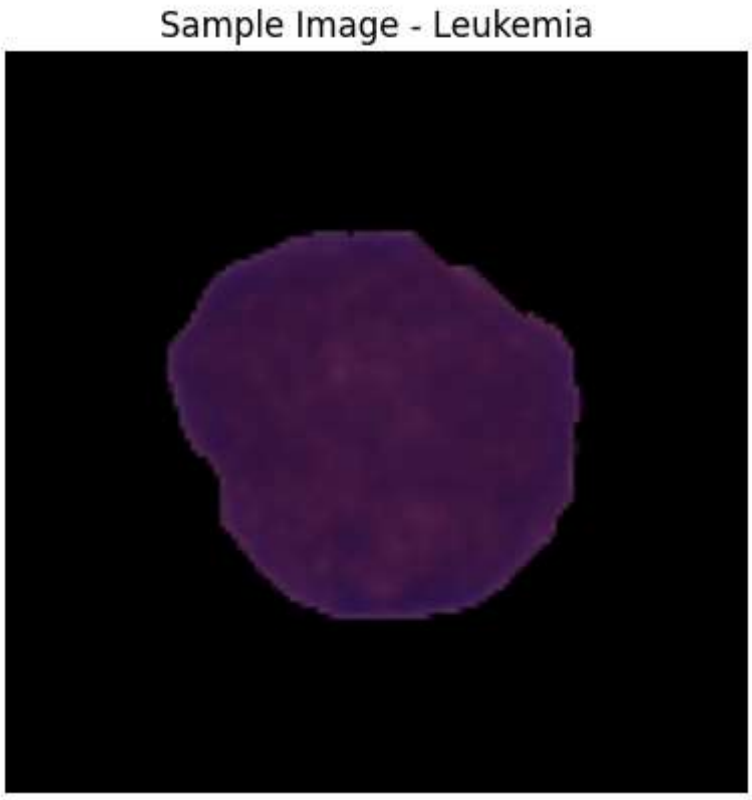
def calculate_tp_tn_fp_fn(conf_matrix):
    tp, tn, fp, fn = [], [], [], []
    for i in range(len(categories)):
        tp.append(conf_matrix[i, i])
        tn.append(np.sum(np.delete(conf_matrix, i, axis=0), axis=0).sum() - tp[i
        fp.append(np.sum(conf_matrix[:, i]) - tp[i])
        fn.append(np.sum(conf_matrix[i, :]) - tp[i])
    return tp, tn, fp, fn

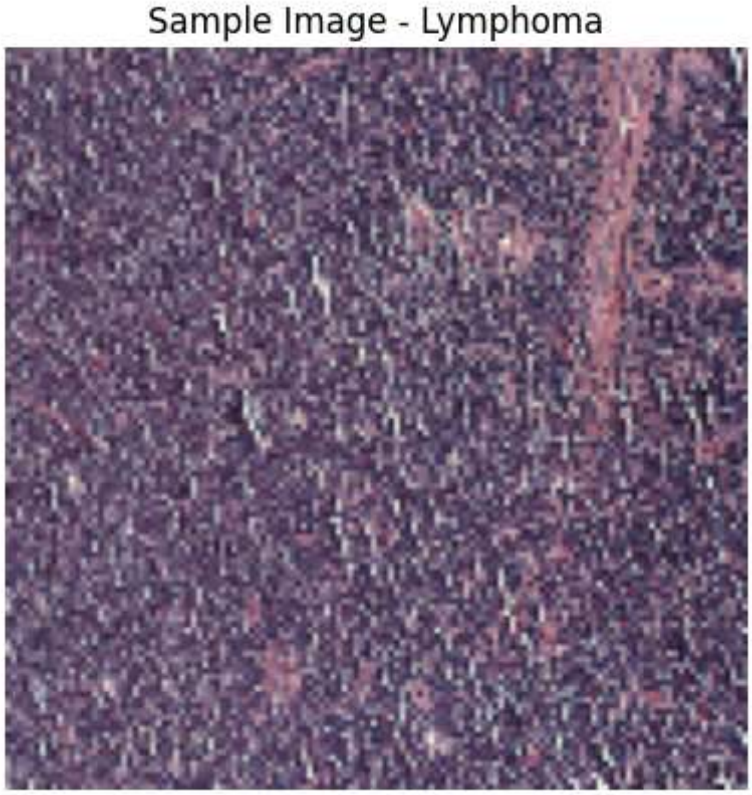
tp, tn, fp, fn = calculate_tp_tn_fp_fn(conf_matrix)

for i, category in enumerate(categories):
    print(f"{category} - TP: {tp[i]}, TN: {tn[i]}, FP: {fp[i]}, FN: {fn[i]}")
```




Sample Image - Myeloma


Sample Image - Leukemia




```
Downloading data from https://storage.googleapis.com/tensorflow/keras-application
s/mobilenet_v2/mobilenet_v2_weights_tf_dim_ordering_tf_kernels_1.0_128_no_top.h5
9406464/9406464 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
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Model: "functional"

Layer (type)	Output Shape	Param #	Connected to
input_layer_1 (InputLayer)	(None, 128, 128, 3)	0	-
Conv1 (Conv2D)	(None, 64, 64, 32)	864	input_layer_1[0]…
bn_Conv1 (BatchNormalizatio…	(None, 64, 64, 32)	128	Conv1[0][0]
Conv1_relu (ReLU)	(None, 64, 64, 32)	0	bn_Conv1[0][0]
expanded_conv_dept… (DepthwiseConv2D)	(None, 64, 64, 32)	288	Conv1_relu[0][0]
expanded_conv_dept… (BatchNormalizatio…	(None, 64, 64, 32)	128	expanded_conv_de…
expanded_conv_dept… (ReLU)	(None, 64, 64, 32)	0	expanded_conv_de…
expanded_conv_proj… (Conv2D)	(None, 64, 64, 16)	512	expanded_conv_de…
expanded_conv_proj… (BatchNormalizatio…	(None, 64, 64, 16)	64	expanded_conv_pr…
block_1_expand (Conv2D)	(None, 64, 64, 96)	1,536	expanded_conv_pr…
block_1_expand_BN (BatchNormalizatio…	(None, 64, 64, 96)	384	block_1_expand[0…
block_1_expand_relu (ReLU)	(None, 64, 64, 96)	0	block_1_expand_B…
block_1_pad (ZeroPadding2D)	(None, 65, 65, 96)	0	block_1_expand_r…
block_1_depthwise (DepthwiseConv2D)	(None, 32, 32, 96)	864	block_1_pad[0][0]
block_1_depthwise_… (BatchNormalizatio…	(None, 32, 32, 96)	384	block_1_depthwis…
block_1_depthwise_… (ReLU)	(None, 32, 32, 96)	0	block_1_depthwis…
block_1_project (Conv2D)	(None, 32, 32, 24)	2,304	block_1_depthwis…
block_1_project_BN (BatchNormalizatio…	(None, 32, 32, 24)	96	block_1_project[…
block_2_expand (Conv2D)	(None, 32, 32, 144)	3,456	block_1_project_…

block_2_expand_BN (BatchNormalizatio…	(None, 32, 32, 144)	576	block_2_expand[0…
block_2_expand_relu (ReLU)	(None, 32, 32, 144)	0	block_2_expand_B…
block_2_depthwise (DepthwiseConv2D)	(None, 32, 32, 144)	1,296	block_2_expand_r…
block_2_depthwise_… (BatchNormalizatio…	(None, 32, 32, 144)	576	block_2_depthwis…
block_2_depthwise_… (ReLU)	(None, 32, 32, 144)	0	block_2_depthwis…
block_2_project (Conv2D)	(None, 32, 32, 24)	3,456	block_2_depthwis…
block_2_project_BN (BatchNormalizatio…	(None, 32, 32, 24)	96	block_2_project[…
block_2_add (Add)	(None, 32, 32, 24)	0	block_1_project_… block_2_project_…
block_3_expand (Conv2D)	(None, 32, 32, 144)	3,456	block_2_add[0][0]
block_3_expand_BN (BatchNormalizatio…	(None, 32, 32, 144)	576	block_3_expand[0…
block_3_expand_relu (ReLU)	(None, 32, 32, 144)	0	block_3_expand_B…
block_3_pad (ZeroPadding2D)	(None, 33, 33, 144)	0	block_3_expand_r…
block_3_depthwise (DepthwiseConv2D)	(None, 16, 16, 144)	1,296	block_3_pad[0][0]
block_3_depthwise_… (BatchNormalizatio…	(None, 16, 16, 144)	576	block_3_depthwis…
block_3_depthwise_… (ReLU)	(None, 16, 16, 144)	0	block_3_depthwis…
block_3_project (Conv2D)	(None, 16, 16, 32)	4,608	block_3_depthwis…
block_3_project_BN (BatchNormalizatio…	(None, 16, 16, 32)	128	block_3_project[…
block_4_expand (Conv2D)	(None, 16, 16, 192)	6,144	block_3_project_…
block_4_expand_BN (BatchNormalizatio…	(None, 16, 16, 192)	768	block_4_expand[0…
block_4_expand_relu (ReLU)	(None, 16, 16, 192)	0	block_4_expand_B…

block_4_depthwise (DepthwiseConv2D)	(None, 16, 16, 192)	1,728	block_4_expand_r…
block_4_depthwise_… (BatchNormalizatio…	(None, 16, 16, 192)	768	block_4_depthwis…
block_4_depthwise_… (ReLU)	(None, 16, 16, 192)	0	block_4_depthwis…
block_4_project (Conv2D)	(None, 16, 16, 32)	6,144	block_4_depthwis…
block_4_project_BN (BatchNormalizatio…	(None, 16, 16, 32)	128	block_4_project[…
block_4_add (Add)	(None, 16, 16, 32)	0	block_3_project_… block_4_project_…
block_5_expand (Conv2D)	(None, 16, 16, 192)	6,144	block_4_add[0][0]
block_5_expand_BN (BatchNormalizatio…	(None, 16, 16, 192)	768	block_5_expand[0…
block_5_expand_relu (ReLU)	(None, 16, 16, 192)	0	block_5_expand_B…
block_5_depthwise (DepthwiseConv2D)	(None, 16, 16, 192)	1,728	block_5_expand_r…
block_5_depthwise_… (BatchNormalizatio…	(None, 16, 16, 192)	768	block_5_depthwis…
block_5_depthwise_… (ReLU)	(None, 16, 16, 192)	0	block_5_depthwis…
block_5_project (Conv2D)	(None, 16, 16, 32)	6,144	block_5_depthwis…
block_5_project_BN (BatchNormalizatio…	(None, 16, 16, 32)	128	block_5_project[…
block_5_add (Add)	(None, 16, 16, 32)	0	block_4_add[0][0… block_5_project_…
block_6_expand (Conv2D)	(None, 16, 16, 192)	6,144	block_5_add[0][0]
block_6_expand_BN (BatchNormalizatio…	(None, 16, 16, 192)	768	block_6_expand[0…
block_6_expand_relu (ReLU)	(None, 16, 16, 192)	0	block_6_expand_B…
block_6_pad (ZeroPadding2D)	(None, 17, 17, 192)	0	block_6_expand_r…
block_6_depthwise (DepthwiseConv2D)	(None, 8, 8, 192)	1,728	block_6_pad[0][0]

block_6_depthwise_… (BatchNormalizatio…	(None, 8, 8, 192)	768	block_6_depthwis…
block_6_depthwise_… (ReLU)	(None, 8, 8, 192)	0	block_6_depthwis…
block_6_project (Conv2D)	(None, 8, 8, 64)	12,288	block_6_depthwis…
block_6_project_BN (BatchNormalizatio…	(None, 8, 8, 64)	256	block_6_project[…
block_7_expand (Conv2D)	(None, 8, 8, 384)	24,576	block_6_project_…
block_7_expand_BN (BatchNormalizatio…	(None, 8, 8, 384)	1,536	block_7_expand[0…
block_7_expand_relu (ReLU)	(None, 8, 8, 384)	0	block_7_expand_B…
block_7_depthwise (DepthwiseConv2D)	(None, 8, 8, 384)	3,456	block_7_expand_r…
block_7_depthwise_… (BatchNormalizatio…	(None, 8, 8, 384)	1,536	block_7_depthwis…
block_7_depthwise_… (ReLU)	(None, 8, 8, 384)	0	block_7_depthwis…
block_7_project (Conv2D)	(None, 8, 8, 64)	24,576	block_7_depthwis…
block_7_project_BN (BatchNormalizatio…	(None, 8, 8, 64)	256	block_7_project[…
block_7_add (Add)	(None, 8, 8, 64)	0	block_6_project_… block_7_project_…
block_8_expand (Conv2D)	(None, 8, 8, 384)	24,576	block_7_add[0][0]
block_8_expand_BN (BatchNormalizatio…	(None, 8, 8, 384)	1,536	block_8_expand[0…
block_8_expand_relu (ReLU)	(None, 8, 8, 384)	0	block_8_expand_B…
block_8_depthwise (DepthwiseConv2D)	(None, 8, 8, 384)	3,456	block_8_expand_r…
block_8_depthwise_… (BatchNormalizatio…	(None, 8, 8, 384)	1,536	block_8_depthwis…
block_8_depthwise_… (ReLU)	(None, 8, 8, 384)	0	block_8_depthwis…
block_8_project (Conv2D)	(None, 8, 8, 64)	24,576	block_8_depthwis…

block_8_project_BN (BatchNormalizatio…	(None, 8, 8, 64)	256	block_8_project[…
block_8_add (Add)	(None, 8, 8, 64)	0	block_7_add[0][0… block_8_project_…
block_9_expand (Conv2D)	(None, 8, 8, 384)	24,576	block_8_add[0][0]
block_9_expand_BN (BatchNormalizatio…	(None, 8, 8, 384)	1,536	block_9_expand[0…
block_9_expand_relu (ReLU)	(None, 8, 8, 384)	0	block_9_expand_B…
block_9_depthwise (DepthwiseConv2D)	(None, 8, 8, 384)	3,456	block_9_expand_r…
block_9_depthwise_… (BatchNormalizatio…	(None, 8, 8, 384)	1,536	block_9_depthwis…
block_9_depthwise_… (ReLU)	(None, 8, 8, 384)	0	block_9_depthwis…
block_9_project (Conv2D)	(None, 8, 8, 64)	24,576	block_9_depthwis…
block_9_project_BN (BatchNormalizatio…	(None, 8, 8, 64)	256	block_9_project[…
block_9_add (Add)	(None, 8, 8, 64)	0	block_8_add[0][0… block_9_project_…
block_10_expand (Conv2D)	(None, 8, 8, 384)	24,576	block_9_add[0][0]
block_10_expand_BN (BatchNormalizatio…	(None, 8, 8, 384)	1,536	block_10_expand[…
block_10_expand_re… (ReLU)	(None, 8, 8, 384)	0	block_10_expand_…
block_10_depthwise (DepthwiseConv2D)	(None, 8, 8, 384)	3,456	block_10_expand_…
block_10_depthwise… (BatchNormalizatio…	(None, 8, 8, 384)	1,536	block_10_depthwi…
block_10_depthwise… (ReLU)	(None, 8, 8, 384)	0	block_10_depthwi…
block_10_project (Conv2D)	(None, 8, 8, 96)	36,864	block_10_depthwi…
block_10_project_BN (BatchNormalizatio…	(None, 8, 8, 96)	384	block_10_project…
block_11_expand (Conv2D)	(None, 8, 8, 576)	55,296	block_10_project…

block_11_expand_BN (BatchNormalizatio…	(None, 8, 8, 576)	2,304	block_11_expand[…
block_11_expand_re… (ReLU)	(None, 8, 8, 576)	0	block_11_expand_…
block_11_depthwise (DepthwiseConv2D)	(None, 8, 8, 576)	5,184	block_11_expand_…
block_11_depthwise… (BatchNormalizatio…	(None, 8, 8, 576)	2,304	block_11_depthwi…
block_11_depthwise… (ReLU)	(None, 8, 8, 576)	0	block_11_depthwi…
block_11_project (Conv2D)	(None, 8, 8, 96)	55,296	block_11_depthwi…
block_11_project_BN (BatchNormalizatio…	(None, 8, 8, 96)	384	block_11_project…
block_11_add (Add)	(None, 8, 8, 96)	0	block_10_project… block_11_project…
block_12_expand (Conv2D)	(None, 8, 8, 576)	55,296	block_11_add[0][…
block_12_expand_BN (BatchNormalizatio…	(None, 8, 8, 576)	2,304	block_12_expand[…
block_12_expand_re… (ReLU)	(None, 8, 8, 576)	0	block_12_expand_…
block_12_depthwise (DepthwiseConv2D)	(None, 8, 8, 576)	5,184	block_12_expand_…
block_12_depthwise… (BatchNormalizatio…	(None, 8, 8, 576)	2,304	block_12_depthwi…
block_12_depthwise… (ReLU)	(None, 8, 8, 576)	0	block_12_depthwi…
block_12_project (Conv2D)	(None, 8, 8, 96)	55,296	block_12_depthwi…
block_12_project_BN (BatchNormalizatio…	(None, 8, 8, 96)	384	block_12_project…
block_12_add (Add)	(None, 8, 8, 96)	0	block_11_add[0][… block_12_project…
block_13_expand (Conv2D)	(None, 8, 8, 576)	55,296	block_12_add[0][…
block_13_expand_BN (BatchNormalizatio…	(None, 8, 8, 576)	2,304	block_13_expand[…
block_13_expand_re… (ReLU)	(None, 8, 8, 576)	0	block_13_expand_…

block_13_pad (ZeroPadding2D)	(None, 9, 9, 576)	0	block_13_expand_…
block_13_depthwise (DepthwiseConv2D)	(None, 4, 4, 576)	5,184	block_13_pad[0][…
block_13_depthwise… (BatchNormalizatio…	(None, 4, 4, 576)	2,304	block_13_depthwi…
block_13_depthwise… (ReLU)	(None, 4, 4, 576)	0	block_13_depthwi…
block_13_project (Conv2D)	(None, 4, 4, 160)	92,160	block_13_depthwi…
block_13_project_BN (BatchNormalizatio…	(None, 4, 4, 160)	640	block_13_project…
block_14_expand (Conv2D)	(None, 4, 4, 960)	153,600	block_13_project…
block_14_expand_BN (BatchNormalizatio…	(None, 4, 4, 960)	3,840	block_14_expand[…
block_14_expand_re… (ReLU)	(None, 4, 4, 960)	0	block_14_expand_…
block_14_depthwise (DepthwiseConv2D)	(None, 4, 4, 960)	8,640	block_14_expand_…
block_14_depthwise… (BatchNormalizatio…	(None, 4, 4, 960)	3,840	block_14_depthwi…
block_14_depthwise… (ReLU)	(None, 4, 4, 960)	0	block_14_depthwi…
block_14_project (Conv2D)	(None, 4, 4, 160)	153,600	block_14_depthwi…
block_14_project_BN (BatchNormalizatio…	(None, 4, 4, 160)	640	block_14_project…
block_14_add (Add)	(None, 4, 4, 160)	0	block_13_project… block_14_project…
block_15_expand (Conv2D)	(None, 4, 4, 960)	153,600	block_14_add[0][…
block_15_expand_BN (BatchNormalizatio…	(None, 4, 4, 960)	3,840	block_15_expand[…
block_15_expand_re… (ReLU)	(None, 4, 4, 960)	0	block_15_expand_…
block_15_depthwise (DepthwiseConv2D)	(None, 4, 4, 960)	8,640	block_15_expand_…
block_15_depthwise… (BatchNormalizatio…	(None, 4, 4, 960)	3,840	block_15_depthwi…

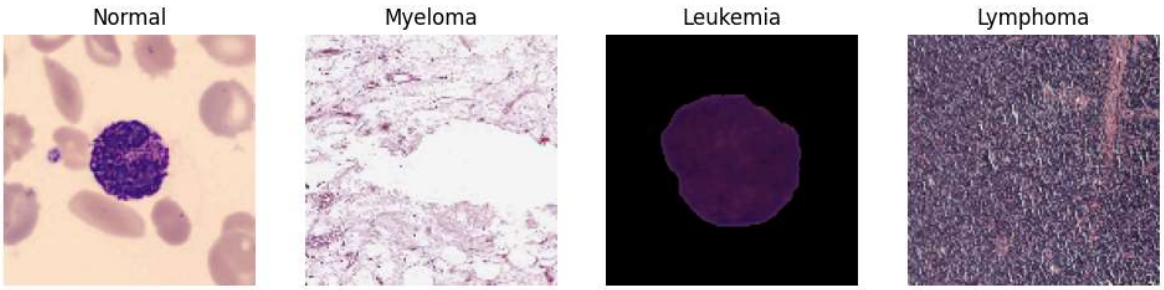
block_15_depthwise… (ReLU)	(None, 4, 4, 960)	0	block_15_depthwi…
block_15_project (Conv2D)	(None, 4, 4, 160)	153,600	block_15_depthwi…
block_15_project_BN (BatchNormalizatio…	(None, 4, 4, 160)	640	block_15_project…
block_15_add (Add)	(None, 4, 4, 160)	0	block_14_add[0][… block_15_project…
block_16_expand (Conv2D)	(None, 4, 4, 960)	153,600	block_15_add[0][…
block_16_expand_BN (BatchNormalizatio…	(None, 4, 4, 960)	3,840	block_16_expand[…
block_16_expand_re… (ReLU)	(None, 4, 4, 960)	0	block_16_expand_…
block_16_depthwise (DepthwiseConv2D)	(None, 4, 4, 960)	8,640	block_16_expand_…
block_16_depthwise… (BatchNormalizatio…	(None, 4, 4, 960)	3,840	block_16_depthwi…
block_16_depthwise… (ReLU)	(None, 4, 4, 960)	0	block_16_depthwi…
block_16_project (Conv2D)	(None, 4, 4, 320)	307,200	block_16_depthwi…
block_16_project_BN (BatchNormalizatio…	(None, 4, 4, 320)	1,280	block_16_project…
Conv_1 (Conv2D)	(None, 4, 4, 1280)	409,600	block_16_project…
Conv_1_bn (BatchNormalizatio…	(None, 4, 4, 1280)	5,120	Conv_1[0][0]
out_relu (ReLU)	(None, 4, 4, 1280)	0	Conv_1_bn[0][0]
global_average_poo… (GlobalAveragePool…	(None, 1280)	0	out_relu[0][0]
dense (Dense)	(None, 128)	163,968	global_average_p…
dropout (Dropout)	(None, 128)	0	dense[0][0]
dense_1 (Dense)	(None, 4)	516	dropout[0][0]

Total params: 2,422,468 (9.24 MB)

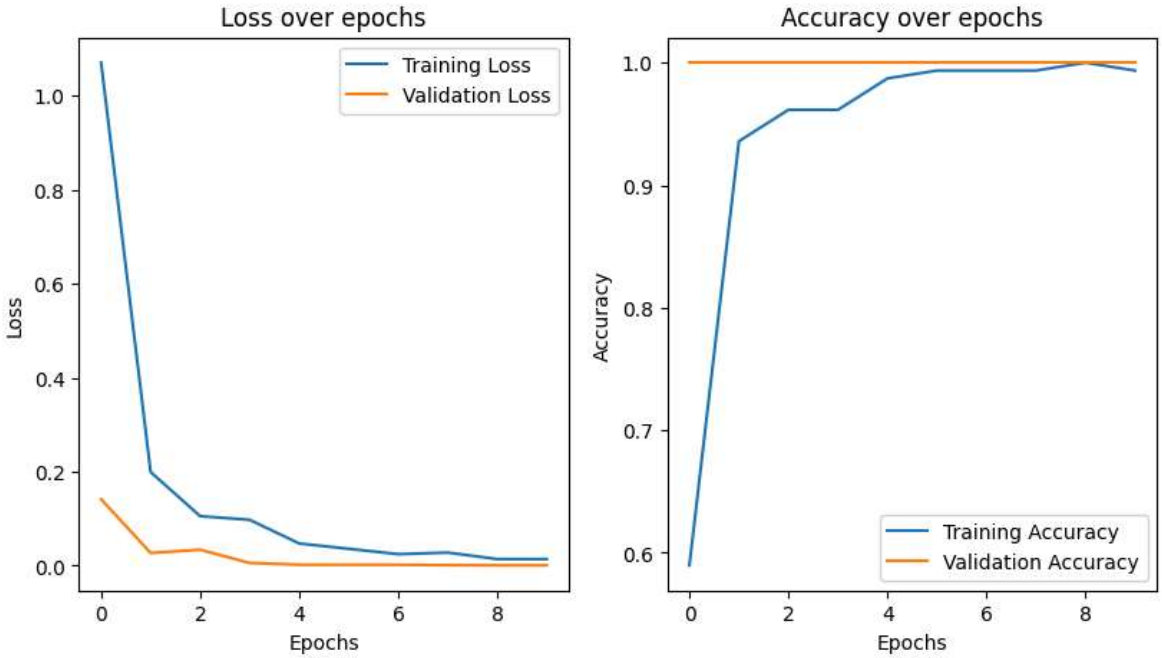
Trainable params: 164,484 (642.52 KB)

Non-trainable params: 2,257,984 (8.61 MB)

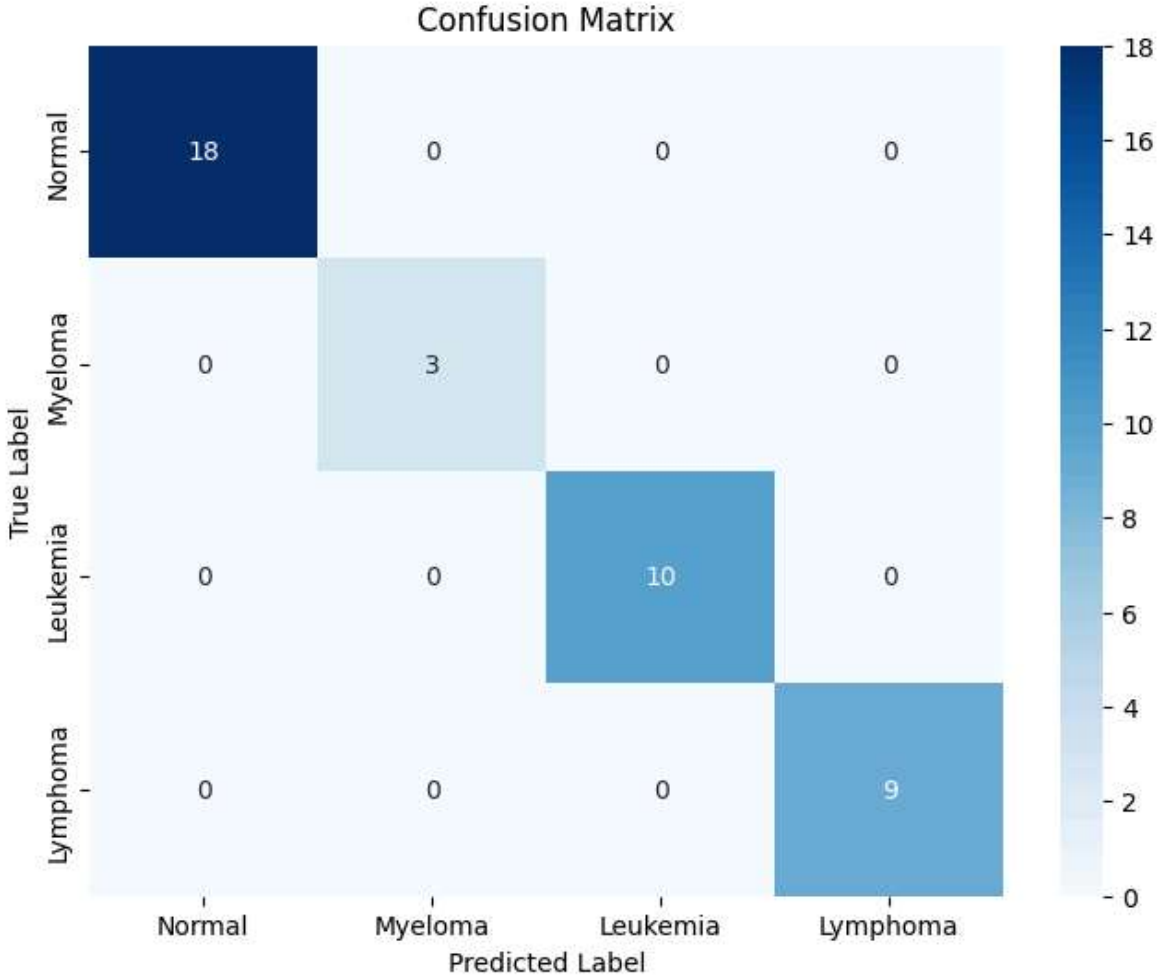
```
Epoch 1/10
c:\Users\MONALISA\AppData\Local\Programs\Python\Python310\lib\site-packages\keras
\src\trainers\data_adapters\py_dataset_adapter.py:122: UserWarning: Your `PyDatas
et` class should call `super().__init__(**kwargs)` in its constructor. `**kwargs`
can include `workers`, `use_multiprocessing`, `max_queue_size`. Do not pass these
arguments to `fit()`, as they will be ignored.
  self._warn_if_super_not_called()
5/5 ━━━━━━━━━━━━━━━━━━━━ 9s 779ms/step - accuracy: 0.4574 - loss: 1.4343 - val_ac
curacy: 1.0000 - val_loss: 0.1412
Epoch 2/10
5/5 ━━━━━━━━━━━━━━━━━━━━ 2s 336ms/step - accuracy: 0.9358 - loss: 0.2038 - val_ac
curacy: 1.0000 - val_loss: 0.0269
Epoch 3/10
5/5 ━━━━━━━━━━━━━━━━━━━━ 2s 294ms/step - accuracy: 0.9736 - loss: 0.0800 - val_ac
curacy: 1.0000 - val_loss: 0.0338
Epoch 4/10
5/5 ━━━━━━━━━━━━━━━━━━━━ 2s 293ms/step - accuracy: 0.9505 - loss: 0.1317 - val_ac
curacy: 1.0000 - val_loss: 0.0056
Epoch 5/10
5/5 ━━━━━━━━━━━━━━━━━━━━ 2s 287ms/step - accuracy: 0.9912 - loss: 0.0364 - val_ac
curacy: 1.0000 - val_loss: 0.0019
Epoch 6/10
5/5 ━━━━━━━━━━━━━━━━━━━━ 2s 289ms/step - accuracy: 0.9870 - loss: 0.0668 - val_ac
curacy: 1.0000 - val_loss: 0.0019
Epoch 7/10
5/5 ━━━━━━━━━━━━━━━━━━━━ 2s 287ms/step - accuracy: 0.9922 - loss: 0.0332 - val_ac
curacy: 1.0000 - val_loss: 0.0017
Epoch 8/10
5/5 ━━━━━━━━━━━━━━━━━━━━ 2s 329ms/step - accuracy: 0.9867 - loss: 0.0401 - val_ac
curacy: 1.0000 - val_loss: 9.6788e-04
Epoch 9/10
5/5 ━━━━━━━━━━━━━━━━━━━━ 2s 286ms/step - accuracy: 1.0000 - loss: 0.0132 - val_ac
curacy: 1.0000 - val_loss: 6.0345e-04
Epoch 10/10
5/5 ━━━━━━━━━━━━━━━━━━━━ 2s 289ms/step - accuracy: 0.9979 - loss: 0.0092 - val_ac
curacy: 1.0000 - val_loss: 5.1769e-04
2/2 ━━━━━━━━━━━━━━━━━━━━ 0s 54ms/step - accuracy: 1.0000 - loss: 5.4940e-04
Validation Loss: 0.0005176906706765294
Validation Accuracy: 1.0
```




```
Error: The image file could not be read.
Prediction Result: None
```



2/2 ━━━━━━━━━━━━━━━━━━━━ **2s** 1s/step




```
Accuracy: 1.00
Precision: 1.00
Recall: 1.00
F1 Score: 1.00
Normal - TP: 18, TN: 4, FP: 0, FN: 0
Myeloma - TP: 3, TN: 34, FP: 0, FN: 0
Leukemia - TP: 10, TN: 20, FP: 0, FN: 0
Lymphoma - TP: 9, TN: 22, FP: 0, FN: 0
```