Import dan Load Data

In [ ]:
```
import tensorflow as tf
import cv2
import numpy as np
from matplotlib import pyplot as plt

data_dir = r"D:\Logo GK dan UAJY\TUbes vgg16\Train_Data_Tubes"



data = tf.keras.utils.image_dataset_from_directory(data_dir, seed = 123, image_size=(180,180), batch_size=16)
print(data.class_names)

class_names = data.class_names
```

```
Found 300 files belonging to 3 classes.
['Beras', 'Gandum', 'Sorgum']
```

Load Dataset dari direktori

In [14]:
```
img_size = 180
batch = 32
validation_split = 0.1
dataset = tf.keras.utils.image_dataset_from_directory(
    data_dir,
    seed = 123,
    image_size = (img_size, img_size),
    batch_size = batch,
)
```

```
Found 300 files belonging to 3 classes.
```

Datset split

In [15]:
```
total_count = len (dataset)
val_count = int(total_count * validation_split)
train_count = total_count - val_count

print("Total Images: ", total_count)
print("Train Images: ", train_count)
print("Validation Images: ", val_count)

train_ds = dataset.take(train_count)
val_ds = dataset.skip(train_count)
```

```
Total Images:  10
Train Images:  9
Validation Images:  1
```

Visualisasi Gambar

In [17]:
```
import matplotlib.pyplot as plt

i = 0
plt.figure(figsize=(10,10))


for images, labels in train_ds.take(1):
    for i in range(9):
        plt.subplot(3,3, i+1)
        plt.imshow(images[i].numpy().astype('uint8'))
        plt.axis('off')
```

Melakukan augmentasi data

In [ ]:
```
from tensorflow.keras import layers
from tensorflow.keras.models import Sequential, load_model

Tuner = tf.data.AUTOTUNE
train_ds = train_ds.cache().shuffle(1000).prefetch(buffer_size = Tuner)
val_ds = val_ds.cache().shuffle(1000).prefetch(buffer_size = Tuner)



data_augmentation = Sequential([
    layers.RandomFlip('horizontal', input_shape = (img_size,img_size,3)),
    layers.RandomRotation(0.1),
    layers.RandomZoom(0.1)
])

i = 0
plt.figure(figsize=(10,10))

for images, labels in train_ds.take(69):
    for i in range(9):
        images = data_augmentation(images)
        plt.subplot(3,3, i+1)
        plt.imshow(images[0].numpy().astype('uint8'))
        plt.axis('off')
```

Buat Model VGG-16 Manual

In [19]:
```
import tensorflow as tf
from keras.models import Model
from keras.layers import Input, Conv2D, MaxPool2D, Flatten, Dense, Dropout

def vgg16(input_shape, n_classes):
    input = Input(input_shape)


    x = Conv2D(64, (3, 3), activation='relu', padding='same')(input)
    x = Conv2D(64, (3, 3), activation='relu', padding='same')(x)
    x = MaxPool2D((2, 2), strides=2)(x)


    x = Conv2D(128, (3, 3), activation='relu', padding='same')(x)
    x = Conv2D(128, (3, 3), activation='relu', padding='same')(x)
    x = MaxPool2D((2, 2), strides=2)(x)


    x = Conv2D(256, (3, 3), activation='relu', padding='same')(x)
    x = Conv2D(256, (3, 3), activation='relu', padding='same')(x)
    x = Conv2D(256, (3, 3), activation='relu', padding='same')(x)
    x = MaxPool2D((2, 2), strides=2)(x)


    x = Conv2D(512, (3, 3), activation='relu', padding='same')(x)
    x = Conv2D(512, (3, 3), activation='relu', padding='same')(x)
    x = Conv2D(512, (3, 3), activation='relu', padding='same')(x)
    x = MaxPool2D((2, 2), strides=2)(x)


    x = Conv2D(512, (3, 3), activation='relu', padding='same')(x)
    x = Conv2D(512, (3, 3), activation='relu', padding='same')(x)
    x = Conv2D(512, (3, 3), activation='relu', padding='same')(x)
```

```
    x = MaxPool2D((2, 2), strides=2)(x)


    x = Flatten()(x)
    x = Dense(512, activation='relu')(x)
    x = Dropout(0.5)(x)
    x = Dense(256, activation='relu')(x)
    x = Dropout(0.5)(x)
    output = Dense(n_classes, activation='softmax')(x)

    model = Model(input, output)
    return model


input_shape = (180, 180, 3)
n_classes = 3


model = vgg16(input_shape, n_classes)


model.summary()
```

Model: "functional_4"

Layer (type)	Output Shape	Param #
input_layer_4 (InputLayer)	(None, 180, 180, 3)	0
conv2d_26 (Conv2D)	(None, 180, 180, 64)	1,792
conv2d_27 (Conv2D)	(None, 180, 180, 64)	36,928
max_pooling2d_10 (MaxPooling2D)	(None, 90, 90, 64)	0
conv2d_28 (Conv2D)	(None, 90, 90, 128)	73,856
conv2d_29 (Conv2D)	(None, 90, 90, 128)	147,584
max_pooling2d_11 (MaxPooling2D)	(None, 45, 45, 128)	0
conv2d_30 (Conv2D)	(None, 45, 45, 256)	295,168
conv2d_31 (Conv2D)	(None, 45, 45, 256)	590,080
conv2d_32 (Conv2D)	(None, 45, 45, 256)	590,080
max_pooling2d_12 (MaxPooling2D)	(None, 22, 22, 256)	0
conv2d_33 (Conv2D)	(None, 22, 22, 512)	1,180,160
conv2d_34 (Conv2D)	(None, 22, 22, 512)	2,359,808
conv2d_35 (Conv2D)	(None, 22, 22, 512)	2,359,808
max_pooling2d_13 (MaxPooling2D)	(None, 11, 11, 512)	0
conv2d_36 (Conv2D)	(None, 11, 11, 512)	2,359,808
conv2d_37 (Conv2D)	(None, 11, 11, 512)	2,359,808
conv2d_38 (Conv2D)	(None, 11, 11, 512)	2,359,808
max_pooling2d_14 (MaxPooling2D)	(None, 5, 5, 512)	0
flatten_2 (Flatten)	(None, 12800)	0
dense_6 (Dense)	(None, 512)	6,554,112
dropout_4 (Dropout)	(None, 512)	0
dense_7 (Dense)	(None, 256)	131,328
dropout_5 (Dropout)	(None, 256)	0
dense_8 (Dense)	(None, 3)	771

Total params: 21,400,899 (81.64 MB)

Trainable params: 21,400,899 (81.64 MB)

Non-trainable params: 0 (0.00 B)

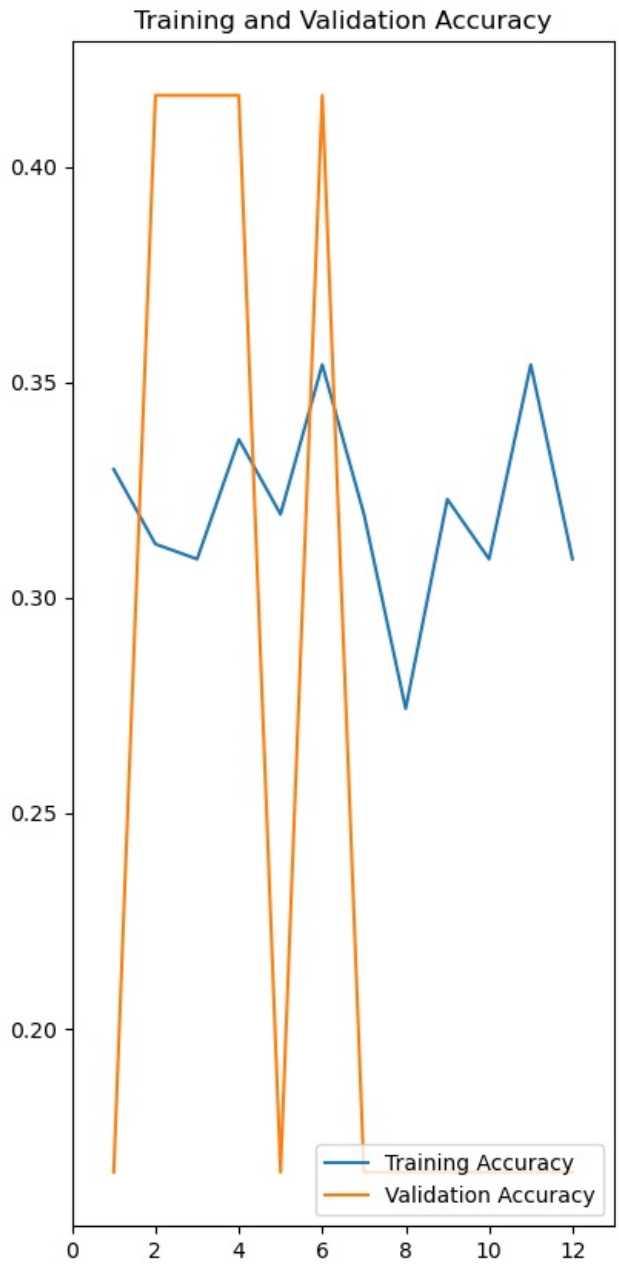
Melatih Data

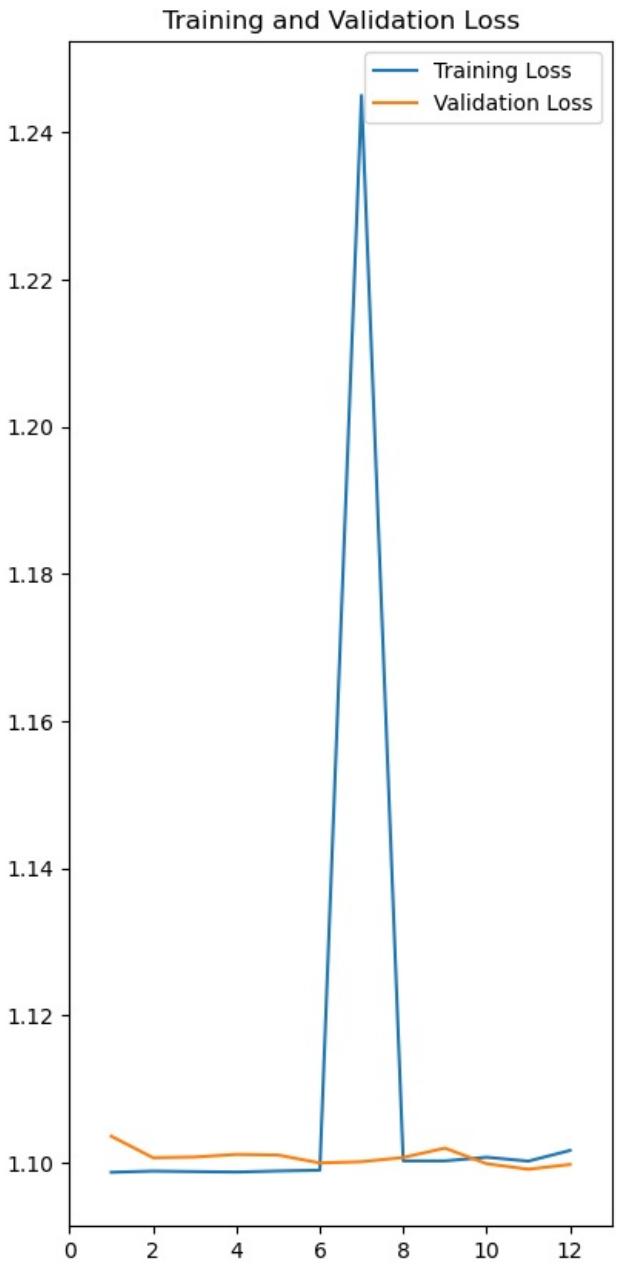
In [ ]:
```
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.optimizers import Adam


model.compile(
    optimizer=Adam(),
    loss='sparse_categorical_crossentropy',
    metrics=['accuracy']
)

early_stopping = EarlyStopping(monitor='val_accuracy',
                               patience=10,
                               mode='max')

history= model.fit(train_ds,
                   epochs=50,
                   validation_data=val_ds,
                   callbacks=[early_stopping])
```

```
Epoch 1/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 103s 9s/step - accuracy: 0.3482 - loss: 1.0977 - val_accuracy: 0.1667 - val_loss: 1.103
6
Epoch 2/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 76s 8s/step - accuracy: 0.3196 - loss: 1.0987 - val_accuracy: 0.4167 - val_loss: 1.1007
Epoch 3/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 72s 8s/step - accuracy: 0.3145 - loss: 1.0983 - val_accuracy: 0.4167 - val_loss: 1.1008
Epoch 4/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 74s 8s/step - accuracy: 0.3433 - loss: 1.0981 - val_accuracy: 0.4167 - val_loss: 1.1011
Epoch 5/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 84s 9s/step - accuracy: 0.3290 - loss: 1.0989 - val_accuracy: 0.1667 - val_loss: 1.1010
Epoch 6/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 87s 10s/step - accuracy: 0.3807 - loss: 1.0986 - val_accuracy: 0.4167 - val_loss: 1.100
0
Epoch 7/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 93s 10s/step - accuracy: 0.3475 - loss: 1.1625 - val_accuracy: 0.1667 - val_loss: 1.100
1
Epoch 8/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 90s 10s/step - accuracy: 0.2998 - loss: 1.0996 - val_accuracy: 0.1667 - val_loss: 1.100
7
Epoch 9/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 86s 9s/step - accuracy: 0.3628 - loss: 1.1000 - val_accuracy: 0.1667 - val_loss: 1.1020
Epoch 10/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 85s 9s/step - accuracy: 0.3102 - loss: 1.1004 - val_accuracy: 0.1667 - val_loss: 1.0999
Epoch 11/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 77s 8s/step - accuracy: 0.3445 - loss: 1.0996 - val_accuracy: 0.1667 - val_loss: 1.0991
Epoch 12/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 73s 8s/step - accuracy: 0.3234 - loss: 1.1003 - val_accuracy: 0.1667 - val_loss: 1.0998
```

Memvisualisasikan Hasil Pelatihan Data

In [30]:
```
ephocs_range = range(1, len(history.history['loss']) + 1)

plt.figure(figsize=(10, 10))


plt.subplot(1, 2, 1)
plt.plot(ephocs_range, history.history['accuracy'], label='Training Accuracy')
plt.plot(ephocs_range, history.history['val_accuracy'], label='Validation Accuracy')
plt.legend(loc='lower right')
plt.xlim(0, 13)
plt.title('Training and Validation Accuracy')


plt.subplot(1, 2, 2)
plt.plot(ephocs_range, history.history['loss'], label='Training Loss')
plt.plot(ephocs_range, history.history['val_loss'], label='Validation Loss')
plt.legend(loc='upper right')
plt.xlim(0, 13)
plt.title('Training and Validation Loss')
plt.show()
```





Save Model

In [31]:
```
model.save('vgg-16.h5')
```

```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`. T
his file format is considered legacy. We recommend using instead the native Keras format, e.g. `model.save('my_m
odel.keras')` or `keras.saving.save_model(model, 'my_model.keras')`.
```

Test Klasifikasikan Gambar

In [32]:
```
import tensorflow as tf
import numpy as np
import matplotlib.pyplot as plt
from tensorflow.keras.models import load_model
from PIL import Image


model_path = r'D:\Logo GK dan UAJY\TUbes vgg16\vgg-16.h5'
model = load_model(model_path)
print("Model loaded successfully.")


class_names = ['Beras', 'Gandum', 'Sorgum']
print("Class names:", class_names)


def classify_images(image_path, save_path='predicted_image.jpg'):
    try:

        input_image = tf.keras.utils.load_img(image_path, target_size=(180, 180))
        input_image_array = tf.keras.utils.img_to_array(input_image)
        input_image_array = input_image_array / 255.0
        input_image_exp_dim = tf.expand_dims(input_image_array, 0)
```

```
        print(f"Input image shape: {input_image_array.shape}")
        print(f"Image normalized: Min={np.min(input_image_array)}, Max={np.max(input_image_array)}")


        predictions = model.predict(input_image_exp_dim)
        print(f"Raw predictions: {predictions}")


        class_idx = np.argmax(predictions[0])
        confidence = np.max(predictions[0]) * 100


        print(f"Prediksi: {class_names[class_idx]}")
        print(f"Confidence: {confidence:.2f}%")


        input_image = Image.open(image_path)
        input_image.save(save_path)
        print(f"Original image saved to {save_path}")


        return f"Prediksi: {class_names[class_idx]} dengan confidence {confidence:.2f}%. Gambar asli disimpan di
    except Exception as e:
        return f"Terjadi kesalahan: {e}"


image_path = r'D:\Logo GK dan UAJY\TUbes vgg16\Train_Data_Tubes\Beras\Beras 2.jpg'
save_path = 'Beras_2_predicted.jpg'
result = classify_images(image_path, save_path=save_path)
print(result)
```

```
WARNING:absl:Compiled the loaded model, but the compiled metrics have yet to be built. `model.compile_metrics` w
ill be empty until you train or evaluate the model.
Model loaded successfully.
Class names: ['Beras', 'Gandum', 'Sorgum']
Input image shape: (180, 180, 3)
Image normalized: Min=0.0, Max=0.9882352948188782
1/1 ━━━━━━━━━━━━━━━━━━━━ 2s 2s/step
Raw predictions: [[0.3329767  0.33194458 0.33507863]]
Prediksi: Sorgum
Confidence: 33.51%
Original image saved to Beras_2_predicted.jpg
Prediksi: Sorgum dengan confidence 33.51%. Gambar asli disimpan di Beras_2_predicted.jpg.
```

Confusion Matrix

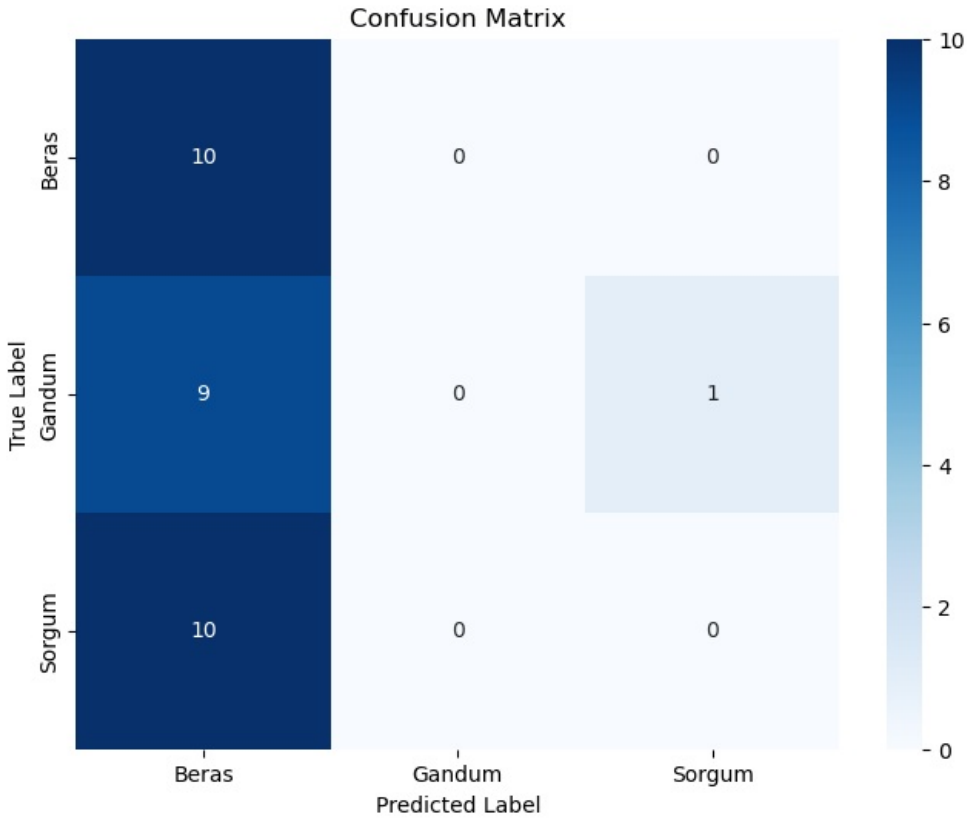
In [ ]:
```
import tensorflow as tf
from tensorflow.keras.models import load_model
import seaborn as sns
import matplotlib.pyplot as plt


test_data = tf.keras.preprocessing.image_dataset_from_directory(
    r'D:\Logo GK dan UAJY\TUbes vgg16\Test_Data_Tubes',
    labels='inferred',
    label_mode='categorical',
    batch_size=32,
    image_size=(180, 180)
)


y_pred = model.predict(test_data)
y_pred_class = tf.argmax(y_pred, axis=1)


true_labels = []
for _, labels in test_data:
    true_labels.extend(tf.argmax(labels, axis=1).numpy())
true_labels = tf.convert_to_tensor(true_labels)


conf_mat = tf.math.confusion_matrix(true_labels, y_pred_class)


accuracy = tf.reduce_sum(tf.linalg.diag_part(conf_mat)) / tf.reduce_sum(conf_mat)
precision = tf.linalg.diag_part(conf_mat) / tf.reduce_sum(conf_mat, axis=0)
recall = tf.linalg.diag_part(conf_mat) / tf.reduce_sum(conf_mat, axis=1)
f1_score = 2 * (precision * recall) / (precision + recall)


plt.figure(figsize=(8, 6))
```

```
sns.heatmap(conf_mat.numpy(),
            annot=True,
            fmt='d',
            cmap='Blues',
            xticklabels=["Beras", "Gandum", "Sorgum"],
            yticklabels=["Beras", "Gandum", "Sorgum"])
plt.title('Confusion Matrix')
plt.xlabel('Predicted Label')
plt.ylabel('True Label')
plt.show()


print("\nEvaluation Metrics:")
print("==================")
print("Confusion Matrix:\n", conf_mat.numpy())
print("\nAccuracy:", accuracy.numpy())
print("\nPrecision for each class:", precision.numpy())
print("Recall for each class:", recall.numpy())
print("F1 Score for each class:", f1_score.numpy())


class_accuracies = tf.linalg.diag_part(conf_mat) / tf.reduce_sum(conf_mat, axis=1)
print("\nClass-specific accuracies:")
for i, class_name in enumerate(["Beras", "Gandum", "Sorgum"]):
    print(f"{class_name}: {class_accuracies[i].numpy():.4f}")
```

```
Found 30 files belonging to 3 classes.
WARNING:tensorflow:5 out of the last 9 calls to <function TensorFlowTrainer.make_predict_function.<locals>.one_step_on_data_distributed at 0x0000022E68F12200> triggered tf.function retracing. Tracing is expensive and the excessive number of tracings could be due to (1) creating @tf.function repeatedly in a loop, (2) passing tensors with different shapes, (3) passing Python objects instead of tensors. For (1), please define your @tf.function outside of the loop. For (2), @tf.function has reduce_retracing=True option that can avoid unnecessary retracing. For (3), please refer to https://www.tensorflow.org/guide/function#controlling_retracing and https://www.tensorflow.org/api_docs/python/tf/function for  more details.
```


```
WARNING:tensorflow:5 out of the last 9 calls to <function TensorFlowTrainer.make_predict_function.<locals>.one_step_on_data_distributed at 0x0000022E68F12200> triggered tf.function retracing. Tracing is expensive and the excessive number of tracings could be due to (1) creating @tf.function repeatedly in a loop, (2) passing tensors with different shapes, (3) passing Python objects instead of tensors. For (1), please define your @tf.function outside of the loop. For (2), @tf.function has reduce_retracing=True option that can avoid unnecessary retracing. For (3), please refer to https://www.tensorflow.org/guide/function#controlling_retracing and https://www.tensorflow.org/api_docs/python/tf/function for  more details.
```


```
1/1 ━━━━━━━━━━━━━━━━━━━━ 5s 5s/step
```



```
Evaluation Metrics:
==================
Confusion Matrix:
 [[10  0  0]
 [ 9  0  1]
 [10  0  0]]

Accuracy: 0.3333333333333333


Precision for each class: [0.34482759        nan 0.        ]
Recall for each class: [1. 0. 0.]
F1 Score for each class: [0.51282051        nan        nan]

Class-specific accuracies:
Beras: 1.0000
Gandum: 0.0000
Sorgum: 0.0000
```

```
In [25]: import os
         import numpy as np

         import tensorflow as tf
         from tensorflow.keras import layers
         from tensorflow.keras.preprocessing.image import load_img, ImageDataGenerator
         from tensorflow.keras.models import Sequential, load_model
         from tensorflow.keras.layers import Conv2D, MaxPooling2D, Dense, Dropout, Flatte
```

```
In [27]: count = 0
         dirs = os.listdir(r'Train_Data_Tubes')
         for dir in dirs:
             files = list(os.listdir(r'Train_Data_Tubes/'+dir))
             print(dir + ' Folder has ' + str(len(files)) + ' Images')
             count = count + len(files)
         print('Images Folder has ' + str(count) + ' Images')
```

```
Gandum Folder has 101 Images
Sorgum Folder has 101 Images
Beras Folder has 101 Images
Images Folder has 303 Images
```

```
In [28]: # Parameter
         base_dir = r'Train_Data_Tubes'
         img_size = 180
         batch = 32
         validation_split = 0.1
```

```
In [29]: dataset = tf.keras.utils.image_dataset_from_directory(
             base_dir,
             seed=123,
             image_size=(img_size, img_size),
             batch_size=batch,
         )
```

```
Found 310 files belonging to 3 classes.
```

```
In [30]: class_names = dataset.class_names
         print("Class Names:", class_names)
```

```
Class Names: ['Beras', 'Gandum', 'Sorgum']
```

```
In [31]: total_count =len(dataset)
         val_count = int(total_count * validation_split)
         train_count = total_count - val_count

         print("Total Images:", total_count)
         print("Train Images:", train_count)
         print("Validation Images:", val_count)
```

```
Total Images: 10
Train Images: 9
Validation Images: 1
```

```
In [32]: train_ds = dataset.take(train_count)
         val_ds = dataset.skip(train_count)
```

```
In [33]: import matplotlib.pyplot as plt

         i = 0
         plt.figure(figsize=(10,10))

         for images, labels in train_ds.take(1):
           for i in range(9):
             plt.subplot(3,3, i+1)
             plt.imshow(images[i].numpy().astype('uint8'))
             plt.title(class_names[labels[i]])
             plt.axis('off')
```


```
In [34]: import numpy as np

         for images, labels in train_ds.take(1):
             images_array = np.array(images)
             print(images_array.shape)
```

```
(32, 180, 180, 3)
```

```
In [35]: AUTOTUNE = tf.data.AUTOTUNE
```

```
In [36]: train_ds = train_ds.cache().shuffle(1000).prefetch(buffer_size = AUTOTUNE)
```

```
In [37]: val_ds = val_ds.cache().shuffle(1000).prefetch(buffer_size = AUTOTUNE)
```

```
In [38]: data_augmentation = Sequential([
             layers.RandomFlip("horizontal", input_shape = (img_size,img_size,3)),
             layers.RandomRotation(0.1),
             layers.RandomZoom(0.1)
         ])
```

```
/opt/tljh/user/envs/dltf/lib/python3.10/site-packages/keras/src/layers/preprocess
ing/tf_data_layer.py:19: UserWarning: Do not pass an `input_shape`/`input_dim` ar
gument to a layer. When using Sequential models, prefer using an `Input(shape)` o
bject as the first layer in the model instead.
  super().__init__(**kwargs)
```

```
In [39]: i = 0
         plt.figure(figsize=(10,10))

         for images, labels in train_ds.take(1):
             for i in range(9):
                 images = data_augmentation(images)
                 plt.subplot(3,3, i+1)
                 plt.imshow(images[0].numpy().astype('uint8'))
                 plt.axis('off')
```

```
In [40]: from tensorflow.keras.applications import MobileNet
         from tensorflow.keras.models import Model

         base_model = MobileNet(include_top=False, input_shape=(img_size, img_size, 3))

         base_model.trainable = True
         fine_tune_at = len(base_model.layers) // 2
         for layer in base_model.layers[:fine_tune_at]:
             layer.trainable = False

         model = Sequential([
             data_augmentation,
             layers.Rescaling(1./255),
             base_model,
             layers.GlobalAveragePooling2D(),
             Dense(128, activation='relu'),
             Dropout(0.3),
             Dense(len(class_names), activation='softmax')
         ])
```

```
/tmp/ipykernel_2823050/952645268.py:4: UserWarning: `input_shape` is undefined or
non-square, or `rows` is not in [128, 160, 192, 224]. Weights for input shape (22
4, 224) will be loaded as the default.
  base_model = MobileNet(include_top=False, input_shape=(img_size, img_size, 3))
```

```
In [41]: from tensorflow.keras.optimizers import Adam

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

```
In [42]: model.summary()
```

Model: "sequential_3"

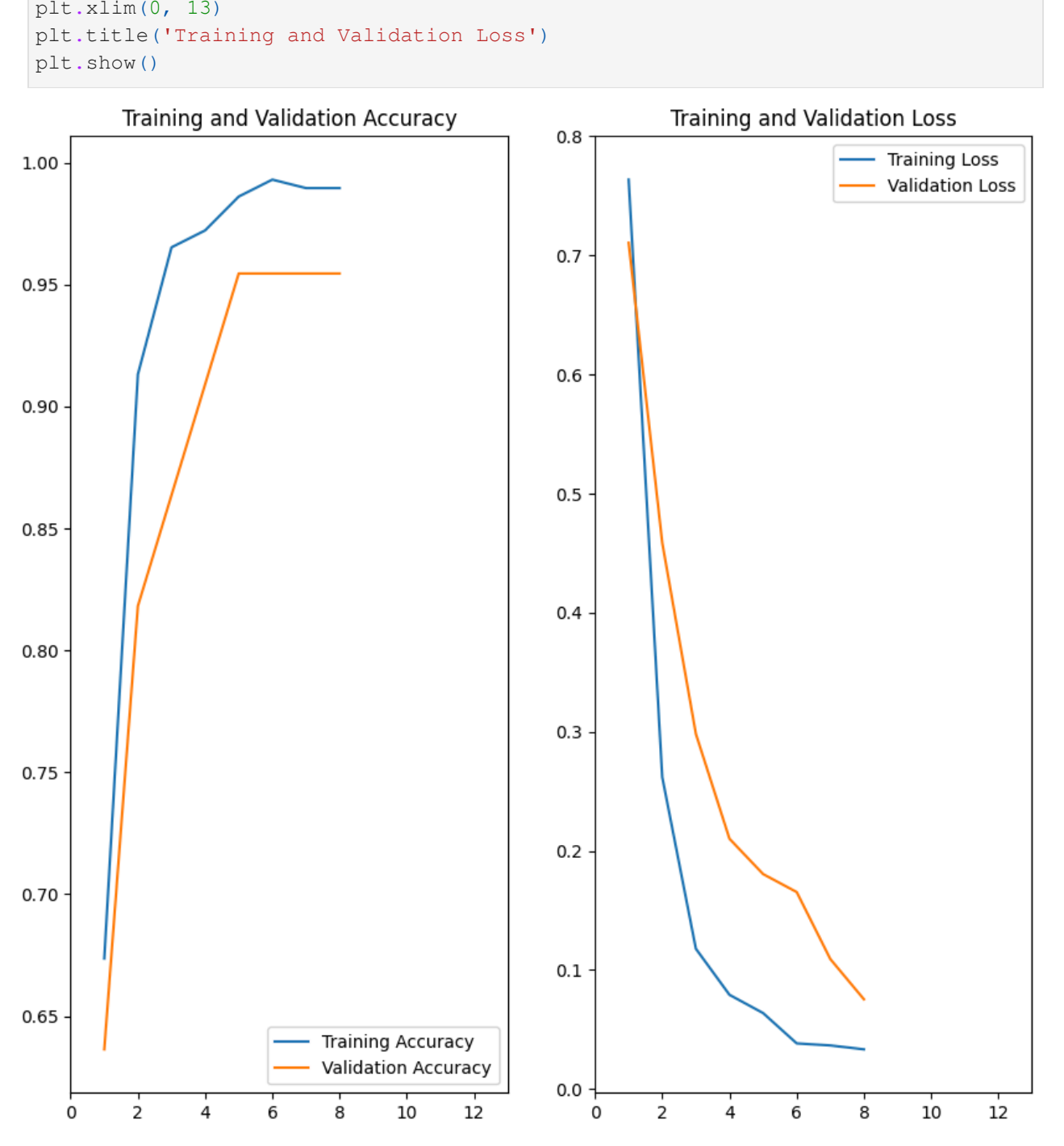
Layer (type)	Output Shape	Param
sequential_2 (Sequential)	(None, 180, 180, 3)	0
rescaling_1 (Rescaling)	(None, 180, 180, 3)	0
mobilenet_1.00_224 (Functional)	(None, 5, 5, 1024)	3,228,864
global_average_pooling2d_1 (GlobalAveragePooling2D)	(None, 1024)	0
dense_2 (Dense)	(None, 128)	131,200
dropout_1 (Dropout)	(None, 128)	0
dense_3 (Dense)	(None, 3)	387

Total params: 3,360,451 (12.82 MB)
Trainable params: 3,069,443 (11.71 MB)
Non-trainable params: 291,008 (1.11 MB)

```
In [43]: from tensorflow.keras.callbacks import EarlyStopping

         early_stopping = EarlyStopping(monitor='val_accuracy',
                                        patience=3,
                                        mode='max')

         history= model.fit(train_ds,
                            epochs=50,
                            validation_data=val_ds,
                            callbacks=[early_stopping])
```

```
Epoch 1/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 8s 223ms/step - accuracy: 0.5556 - loss:
0.9623 - val_accuracy: 0.6364 - val_loss: 0.7106
Epoch 2/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 1s 127ms/step - accuracy: 0.8904 - loss:
0.3034 - val_accuracy: 0.8182 - val_loss: 0.4587
Epoch 3/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 1s 128ms/step - accuracy: 0.9603 - loss:
0.1270 - val_accuracy: 0.8636 - val_loss: 0.2982
Epoch 4/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 1s 125ms/step - accuracy: 0.9727 - loss:
0.0760 - val_accuracy: 0.9091 - val_loss: 0.2101
Epoch 5/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 1s 125ms/step - accuracy: 0.9752 - loss:
0.0795 - val_accuracy: 0.9545 - val_loss: 0.1805
Epoch 6/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 1s 126ms/step - accuracy: 0.9893 - loss:
0.0465 - val_accuracy: 0.9545 - val_loss: 0.1653
Epoch 7/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 1s 126ms/step - accuracy: 0.9894 - loss:
0.0377 - val_accuracy: 0.9545 - val_loss: 0.1091
Epoch 8/50
9/9 ━━━━━━━━━━━━━━━━━━━━ 1s 126ms/step - accuracy: 0.9953 - loss:
0.0253 - val_accuracy: 0.9545 - val_loss: 0.0753
```

```
In [44]: ephocs_range = range(1, len(history.history['loss']) + 1)

         plt.figure(figsize=(10, 10))

         plt.subplot(1, 2, 1)
         plt.plot(ephocs_range, history.history['accuracy'], label='Training Accuracy')
         plt.plot(ephocs_range, history.history['val_accuracy'], label='Validation Accura
         plt.legend(loc='lower right')
         plt.xlim(0, 13)
         plt.title('Training and Validation Accuracy')

         plt.subplot(1, 2, 2)
         plt.plot(ephocs_range, history.history['loss'], label='Training Loss')
         plt.plot(ephocs_range, history.history['val_loss'], label='Validation Loss')
         plt.legend(loc='upper right')
         plt.xlim(0, 13)
         plt.title('Training and Validation Loss')
         plt.show()
```




```
In [45]: model.save('Model_MobileNet.h5')
```

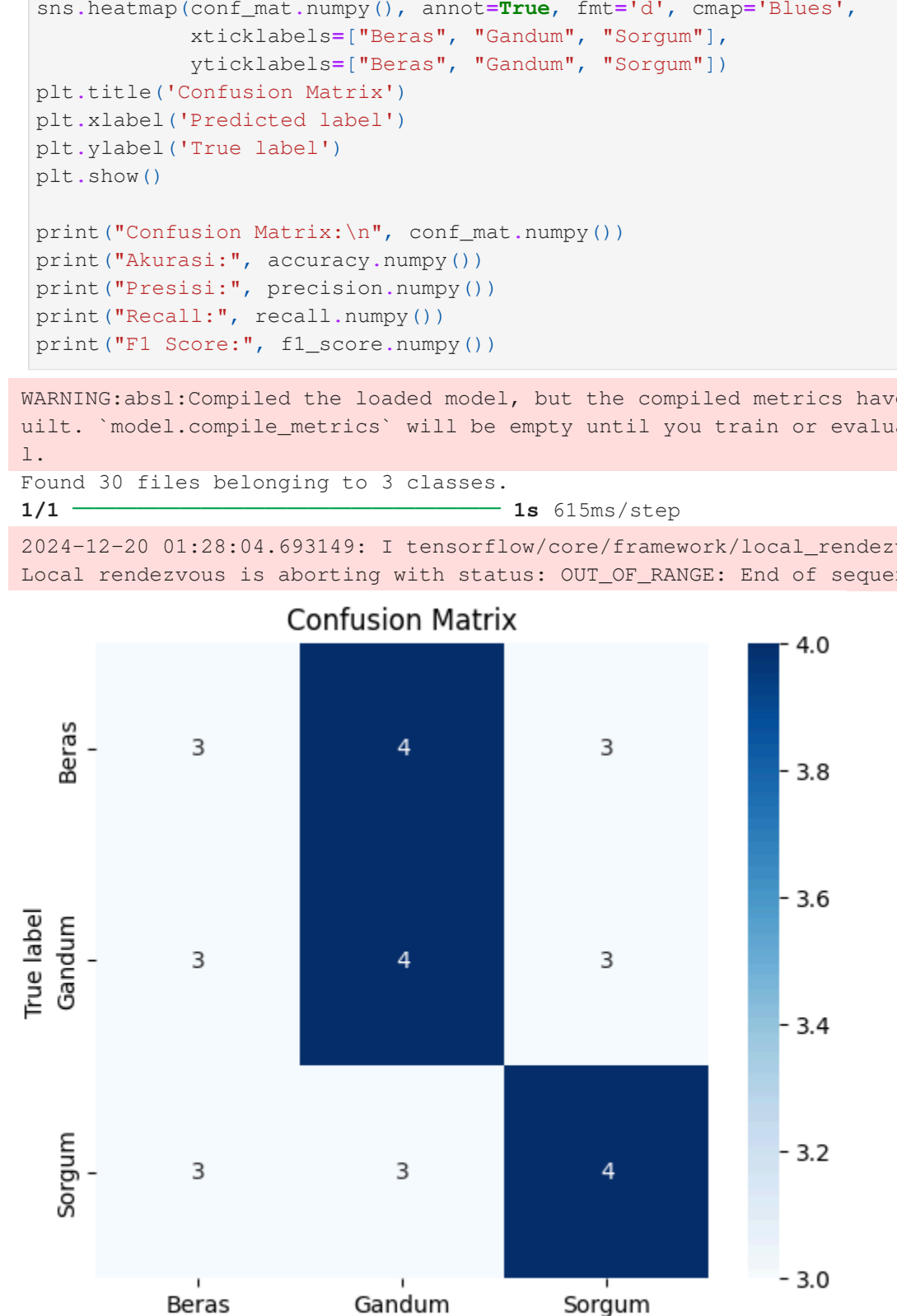
```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `ker
as.saving.save_model(model)`. This file format is considered legacy. We recommend
using instead the native Keras format, e.g. `model.save('my_model.keras')` or `ke
ras.saving.save_model(model, 'my_model.keras')`.
```

```
In [46]: import tensorflow as tf
         import numpy as np
         import matplotlib.pyplot as plt
         from tensorflow.keras.models import load_model
         from PIL import Image

         model = load_model(r'Model_MobileNet.h5')
         class_names = ['Beras', 'Gandum', 'Sorgum']

         def classify_images(image_path, save_path='predicted_image.jpg'):
             try:
                 input_image = tf.keras.utils.load_img(image_path, target_size=(180, 180)
                 input_image_array = tf.keras.utils.img_to_array(input_image)
                 input_image_exp_dim = tf.expand_dims(input_image_array, 0)

                 predictions = model.predict(input_image_exp_dim)
                 result = tf.nn.softmax(predictions[0])
                 class_idx = np.argmax(result)
                 confidence = np.max(result) * 100

                 print(f"Prediksi: {class_names[class_idx]}")
                 print(f"Confidence: {confidence:.2f}%")

                 input_image = Image.open(image_path)
                 input_image.save(save_path)

                 return f"Prediksi: {class_names[class_idx]} dengan confidence {confidenc
             except Exception as e:
                 return f"Terjadi kesalahan: {e}"

         result = classify_images(r'Train_Data_Tubes/Beras/Beras 99.jpg', save_path='Bera
         print(result)
```

```
WARNING:absl:Compiled the loaded model, but the compiled metrics have yet to be b
uilt. `model.compile_metrics` will be empty until you train or evaluate the mode
l.
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 568ms/step
Prediksi: Beras
Confidence: 57.61%
Prediksi: Beras dengan confidence 57.61%. Gambar asli disimpan di Beras2.jpg.
```

```
In [55]: import tensorflow as tf
         from tensorflow.keras.models import load_model
         import seaborn as sns
         import matplotlib.pyplot as plt

         mobileNet_model = load_model(r'Model_MobileNet.h5')

         test_data = tf.keras.preprocessing.image_dataset_from_directory(
             r'Test_Data_Tubes',
             labels='inferred',
             label_mode='categorical',
             batch_size=32,
             image_size=(180, 180)
         )

         y_pred = mobileNet_model.predict(test_data)
         y_pred_class = tf.argmax(y_pred, axis=1)

         true_labels = []
         for _, labels in test_data:
             true_labels.extend(tf.argmax(labels, axis=1).numpy())
         true_labels = tf.convert_to_tensor(true_labels)

         conf_mat = tf.math.confusion_matrix(true_labels, y_pred_class)

         accuracy = tf.reduce_sum(tf.linalg.diag_part(conf_mat)) / tf.reduce_sum(conf_mat

         precision = tf.linalg.diag_part(conf_mat) / tf.reduce_sum(conf_mat, axis=0)
         recall = tf.linalg.diag_part(conf_mat) / tf.reduce_sum(conf_mat, axis=1)

         f1_score = 2 * (precision * recall) / (precision + recall)

         plt.figure(figsize=(6, 5))
         sns.heatmap(conf_mat.numpy(), annot=True, fmt='d', cmap='Blues',
                     xticklabels=["Beras", "Gandum", "Sorgum"],
                     yticklabels=["Beras", "Gandum", "Sorgum"])
         plt.title('Confusion Matrix')
         plt.xlabel('Predicted label')
         plt.ylabel('True label')
         plt.show()

         print("Confusion Matrix:\n", conf_mat.numpy())
         print("Akurasi:", accuracy.numpy())
         print("Presisi:", precision.numpy())
         print("Recall:", recall.numpy())
         print("F1 Score:", f1_score.numpy())
```

```
WARNING:absl:Compiled the loaded model, but the compiled metrics have yet to be b
uilt. `model.compile_metrics` will be empty until you train or evaluate the mode
l.
Found 30 files belonging to 3 classes.
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 615ms/step
2024-12-20 01:28:04.693149: I tensorflow/core/framework/local_rendezvous.cc:405]
Local rendezvous is aborting with status: OUT_OF_RANGE: End of sequence
```




```
Confusion Matrix:
 [[3 4 3]
 [3 4 3]
 [3 3 4]]
Akurasi: 0.36666666666666664
Presisi: [0.33333333 0.36363636 0.4       ]
Recall: [0.3 0.4 0.4]
F1 Score: [0.31578947 0.38095238 0.4       ]
```

```
In [ ]:
```

Import library

Bagian Baru

[1]
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).
```

[2]
```
import tensorflow as tf
import keras
import cv2
import os
import numpy as np
import matplotlib
from matplotlib import pyplot as plt

from tensorflow.keras.models import Model
from tensorflow.keras.layers import Input, Dense, Conv2D
from tensorflow.keras.layers import Flatten, MaxPool2D, AvgPool2D
from tensorflow.keras.layers import BatchNormalization, Dropout
from tensorflow.keras.layers import concatenate, load_model
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.optimizers import Adam
```

Load Data set

[3]
```
data_dir = '/content/drive/MyDrive/Colab Notebooks/Tubes alexnet/Train_Data_Tubes'
data = tf.keras.utils.image_dataset_from_directory(
    data_dir,
    seed=23,
    image_size=(227,227),
    batch_size=32
)

print("inilah yang terdeteksi:")
print(data.class_names)

class_names = data.class_names
img_size = 227
batch = 32

dataset = tf.keras.utils.image_dataset_from_directory(
    data_dir,
    seed=23,
    image_size=(img_size, img_size),
    batch_size=batch,
)

total_count = len(dataset)

train_count = int(total_count * 0.8)
val_count = int(total_count * 0.1)
test_count = total_count - train_count - val_count

print("\nPembagian Dataset:")
print("Total Images (Batches): ", total_count)
print("Training Images (Batches): ", train_count)
print("Validation Images (Batches): ", val_count)
print("Test Images (Batches): ", test_count)

train_ds = dataset.take(train_count)
val_ds = dataset.skip(train_count).take(val_count)
test_ds = remaining_ds.take(val_count)

Tuner = tf.data.AUTOTUNE
val_ds = val_ds.cache().shuffle(1000).prefetch(buffer_size=Tuner)
test_ds = test_ds.cache().shuffle(1000).prefetch(buffer_size=Tuner)
```

```
Found 305 files belonging to 3 classes.
Relax yang terdeteksi:
['Beras', 'Gandum', 'Sorgum']
Found 305 files belonging to 3 classes.

Pembagian Dataset:
Total Images (Batches):  10
Train Images (Batches):  8
Validation Images (Batches):  1
Test Images (Batches):  1
```

Augmentasi

[23]
```
data_augmentation = tf.keras.Sequential([
    tf.keras.layers.RandomFlip("horizontal_and_vertical", input_shape=(img_size, img_size, 3)),
    tf.keras.layers.RandomRotation(0.2),
    tf.keras.layers.RandomZoom(0.2),
    tf.keras.layers.RandomBrightness(0.2),
    tf.keras.layers.RandomContrast(0.2)
])

i = 0
plt.figure(figsize=(15,10))

for images, labels in train_ds.take(1):
    for i in range(9):
        ax = plt.subplot(3, 3, i+1)
        plt.imshow(images[i].numpy().astype("uint8"))
        plt.title(class_names[labels[i]])
        plt.axis("off")

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

```
Output hidden; open in https://colab.research.google.com to view.
```

[24]
```
for images, labels in train_ds.take(1):
    images_array = np.array(images)
    print(images_array.shape)
```

```
(32, 227, 227, 3)
```

[25]
```
from tensorflow.keras import layers
from tensorflow.keras.models import Sequential

Tuner = tf.data.AUTOTUNE
train_ds = train_ds.cache().shuffle(1000).prefetch(buffer_size = Tuner)
val_ds = val_ds.cache().shuffle(1000).prefetch(buffer_size = Tuner)


img_size = 227

data_augmentation = Sequential([
    layers.RandomFlip("horizontal", input_shape=(img_size, img_size, 3)),
    layers.RandomRotation(0.1),
    layers.RandomZoom(0.1)
])

i = 0
plt.figure(figsize=(10,10))

for images, labels in train_ds.take(1):
    for i in range(9):
        augmented_images = data_augmentation(images)
        ax = plt.subplot(3, 3, i + 1)
        plt.imshow(augmented_images[0].numpy().astype("uint8"))
        plt.axis("off")

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

```
Output hidden; open in https://colab.research.google.com to view.
```

AlexNet

[26]
```
from tensorflow.keras.layers import Input, Conv2D, MaxPool2D, Flatten, Dense, Dropout
from tensorflow.keras.models import Model
import tensorflow.keras.backend as K

def alexnet(input_shape, n_classes):

    input = Input(input_shape)
    x = Conv2D(96, 11, strides=4, activation='relu', padding='valid')(input)
    x = MaxPool2D(3, strides=2)(x)
    x = Conv2D(256, 5, activation='relu', padding='same')(x)
    x = MaxPool2D(3, strides=2)(x)
    x = Conv2D(384, 3, activation='relu', padding='same')(x)
    x = Conv2D(384, 3, activation='relu', padding='same')(x)
    x = Conv2D(256, 3, activation='relu', padding='same')(x)
    x = MaxPool2D(3, strides=2)(x)
    x = Flatten()(x)
    x = Dense(4096, activation='relu')(x)
    x = Dropout(0.5)(x)
    x = Dense(4096, activation='relu')(x)
    x = Dropout(0.5)(x)

    output = Dense(n_classes, activation='softmax')(x)
    model = Model(input, output)
    return model

input_shape = (227, 227, 3)
n_classes = len(class_names)

K.clear_session()
model = alexnet(input_shape, n_classes)

initial_learning_rate = 0.001
decay_steps = 100
decay_rate = 0.9

lr_schedule = tf.keras.optimizers.schedules.ExponentialDecay(
    initial_learning_rate,
    decay_steps=decay_steps,
    decay_rate=decay_rate,
    staircase=True
)

optimizer = tf.keras.optimizers.Adam(learning_rate=lr_schedule)

model.compile(
    optimizer=optimizer,
    loss='sparse_categorical_crossentropy',
    metrics=["accuracy"]
)

print("\nArsitektur Model: ")
model.summary()
```

```
Arsitektur Model:
Model: "functional"
```

Layer (type)	Output Shape	Param #
input_layer (InputLayer)	(None, 227, 227, 3)	0
conv2d (Conv2D)	(None, 55, 55, 96)	34,944
max_pooling2d (MaxPooling2D)	(None, 27, 27, 96)	0
conv2d_1 (Conv2D)	(None, 27, 27, 256)	614,656
max_pooling2d_1 (MaxPooling2D)	(None, 13, 13, 256)	0
conv2d_2 (Conv2D)	(None, 13, 13, 384)	885,120
conv2d_3 (Conv2D)	(None, 13, 13, 384)	1,327,488
conv2d_4 (Conv2D)	(None, 13, 13, 256)	884,992
max_pooling2d_2 (MaxPooling2D)	(None, 6, 6, 256)	0
flatten (Flatten)	(None, 9216)	0
dense (Dense)	(None, 4096)	37,752,832
dropout (Dropout)	(None, 4096)	0
dense_1 (Dense)	(None, 4096)	16,781,312
dropout_1 (Dropout)	(None, 4096)	0
dense_2 (Dense)	(None, 3)	12,291

```
Total params: 58,293,635 (222.37 MB)
Trainable params: 58,293,635 (222.37 MB)
Non-trainable params: 0 (0.00 B)
```

training

[29]
```
print("\nMemulai proses training...")

model.compile(
    optimizer=Adam(),
    loss='sparse_categorical_crossentropy',
    metrics=["accuracy"]
)

early_stopping = EarlyStopping(monitor="val_accuracy",
                               patience=5,
                               mode='max')

epochs = 50

history = model.fit(
    train_ds,
    validation_data=val_ds,
    epochs=epochs,
    callbacks=[early_stopping]
)
```

```
Memulai proses training...
Epoch 1/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 63s 7s/step - accuracy: 0.3625 - loss: 1023.7187 - val_accuracy: 0.3182 - val_loss: 1.1404
Epoch 2/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 51s 7s/step - accuracy: 0.3572 - loss: 1.1539 - val_accuracy: 0.3182 - val_loss: 1.1333
Epoch 3/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 54s 7s/step - accuracy: 0.3669 - loss: 1.1353 - val_accuracy: 0.3182 - val_loss: 1.1130
Epoch 4/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 52s 6s/step - accuracy: 0.3058 - loss: 1.1098 - val_accuracy: 0.3636 - val_loss: 1.1018
Epoch 5/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 83s 7s/step - accuracy: 0.3337 - loss: 1.1023 - val_accuracy: 0.3864 - val_loss: 1.0916
Epoch 6/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 80s 6s/step - accuracy: 0.3871 - loss: 1.0968 - val_accuracy: 0.3864 - val_loss: 1.0881
Epoch 7/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 82s 6s/step - accuracy: 0.3215 - loss: 1.0887 - val_accuracy: 0.3636 - val_loss: 1.0816
Epoch 8/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 58s 6s/step - accuracy: 0.4089 - loss: 1.0808 - val_accuracy: 0.4318 - val_loss: 1.0358
Epoch 9/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 82s 6s/step - accuracy: 0.5288 - loss: 0.9915 - val_accuracy: 0.3636 - val_loss: 1.1049
Epoch 10/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 82s 6s/step - accuracy: 0.3241 - loss: 1.1243 - val_accuracy: 0.3636 - val_loss: 1.1322
Epoch 11/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 56s 6s/step - accuracy: 0.3872 - loss: 1.0959 - val_accuracy: 0.4091 - val_loss: 1.0580
Epoch 12/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 50s 6s/step - accuracy: 0.4750 - loss: 1.0305 - val_accuracy: 0.5682 - val_loss: 0.8994
Epoch 13/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 53s 6s/step - accuracy: 0.5729 - loss: 0.9035 - val_accuracy: 0.4773 - val_loss: 1.0702
Epoch 14/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 51s 6s/step - accuracy: 0.5080 - loss: 1.0683 - val_accuracy: 0.5227 - val_loss: 0.9156
Epoch 15/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 54s 6s/step - accuracy: 0.6559 - loss: 0.8447 - val_accuracy: 0.6818 - val_loss: 0.7939
Epoch 16/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 80s 7s/step - accuracy: 0.5738 - loss: 0.9527 - val_accuracy: 0.5909 - val_loss: 0.7276
Epoch 17/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 51s 6s/step - accuracy: 0.5590 - loss: 0.7659 - val_accuracy: 0.5909 - val_loss: 0.9155
Epoch 18/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 83s 7s/step - accuracy: 0.6506 - loss: 0.7165 - val_accuracy: 0.7500 - val_loss: 0.5363
Epoch 19/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 54s 7s/step - accuracy: 0.8692 - loss: 0.7022 - val_accuracy: 0.7500 - val_loss: 0.5257
Epoch 20/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 80s 6s/step - accuracy: 0.6672 - loss: 0.6499 - val_accuracy: 0.7273 - val_loss: 0.5601
Epoch 21/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 52s 6s/step - accuracy: 0.7245 - loss: 0.6215 - val_accuracy: 0.7500 - val_loss: 0.5173
Epoch 22/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 83s 7s/step - accuracy: 0.6792 - loss: 0.6313 - val_accuracy: 0.6818 - val_loss: 0.6216
Epoch 23/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 79s 6s/step - accuracy: 0.7294 - loss: 0.5728 - val_accuracy: 0.8182 - val_loss: 0.4833
Epoch 24/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 82s 6s/step - accuracy: 0.4731 - loss: 0.5773 - val_accuracy: 0.7955 - val_loss: 0.4552
Epoch 25/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 55s 6s/step - accuracy: 0.7493 - loss: 0.5633 - val_accuracy: 0.8773 - val_loss: 0.3808
Epoch 26/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 53s 7s/step - accuracy: 0.6847 - loss: 0.7691 - val_accuracy: 0.8864 - val_loss: 0.7022
Epoch 27/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 50s 6s/step - accuracy: 0.5925 - loss: 0.7098 - val_accuracy: 0.6591 - val_loss: 0.6654
Epoch 28/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 50s 6s/step - accuracy: 0.6608 - loss: 0.6723 - val_accuracy: 0.6591 - val_loss: 0.5962
```

graph accuracy

[30]
```
epochs_range = range(1, len(history.history['loss']) + 1)

plt.figure(figsize=(15, 10))

plt.subplot(1, 2, 1)
plt.plot(epochs_range, history.history['accuracy'], label='Training Accuracy')
plt.plot(epochs_range, history.history['val_accuracy'], label='Validation Accuracy')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy')

plt.subplot(1, 2, 2)
plt.plot(epochs_range, history.history['loss'], label='Training Loss')
plt.plot(epochs_range, history.history['val_loss'], label='Validation Loss')
plt.legend(loc='upper right')
plt.title('Training and Validation Loss')

plt.show()
```

[31]
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).
```

[32]
```
model.save('/content/drive/MyDrive/alexnet_model.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 considered legacy. We recommend using instead the native Keras format, e.g. `model.save('my_model.keras')` or `keras.saving.save_model(model, 'my_model.keras')`.
```

[33]
```
import tensorflow as tf
import numpy as np
import matplotlib.pyplot as plt
from tensorflow.keras.models import load_model
from PIL import Image
from google.colab import drive

drive.mount('/content/drive')

model_path = '/content/drive/MyDrive/alexnet_model.h5'
model = load_model(model_path)

class_names = ['Beras', 'Gandum', 'Sorgum']

def classify_images(image_path, save_path='predicted_image.jpg'):
    try:
        input_image = tf.keras.utils.load_img(image_path, target_size=(227, 227))
        input_image_array = tf.keras.utils.img_to_array(input_image)
        input_image_exp_dim = tf.expand_dims(input_image_array, 0) # Add batch dimension

        predictions = model.predict(input_image_exp_dim)
        result = tf.nn.softmax(predictions[0])
        class_idx = np.argmax(result)
        confidence = np.max(result) * 100

        print(f"Prediksi: {class_names[class_idx]}")
        print(f"Confidence: {confidence:.2f}%")

        input_image = Image.open(image_path)
        input_image.save(save_path)

        return f"Prediksi: {class_names[class_idx]} dengan confidence {confidence:.2f}%. Gambar asli disimpan di {save_path}."
    except Exception as e:
        return f"Error: {e}"

result = classify_images('/content/drive/MyDrive/Colab Notebooks/Tubes alexnet/Test_data_tubes/Beras/Beras (3).jpg', save_path='/content/drive/MyDrive/beras.jpg')
print(result)
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).
WARNING:absl:Compiled the loaded model, but the compiled metrics have yet to be built. `model.compile_metrics` will be empty until you train or evaluate the model.
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 175ms/step
Prediksi: Beras
Confidence: 54.59%
Prediksi Beras dengan confidence 54.59%. Gambar asli disimpan di /content/drive/MyDrive/beras.jpg.
```

Import library

```
In [12]: import tensorflow as tf
import keras
import cv2
import numpy as np
import pandas as pd
from matplotlib import pyplot as plt

import keras._tf_keras.keras.backend as K
from keras._tf_keras.keras.models import Model
from keras._tf_keras.keras.layers import Input, Dense, Conv2D
from keras._tf_keras.keras.layers import Flatten, MaxPool2D, AvgPool2D
from keras._tf_keras.keras.layers import Concatenate, Dropout
from keras._tf_keras.keras.models import load_model
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.optimizers import Adam
```

Load Data set

```
In [13]: data_dir = r"C:\Users\rdali\Downloads\Tubes googlenet+strealit done\Train_data_tubes"
data = tf.keras.utils.image_dataset_from_directory(
    data_dir,
    seed=123,
    image_size=(180,180),
    batch_size=32
)

print("\nKelas yang terdeteksi:")
print(data.class_names)


class_names = data.class_names
img_size = 180
batch = 32


dataset = tf.keras.utils.image_dataset_from_directory(
    data_dir,
    seed=123,
    image_size=(img_size, img_size),
    batch_size=batch,
)


total_count = len(dataset)


train_count = int(total_count * 0.8)
val_count = int(total_count * 0.1)
test_count = total_count - train_count - val_count

print("\nPembagian Dataset:")
print("Total Images (Batches): ", total_count)
print("Train Images (Batches): ", train_count)
print("Validation Images (Batches): ", val_count)
print("Test Images (Batches): ", test_count)


train_ds = dataset.take(train_count)
remaining_ds = dataset.skip(train_count)
val_ds = remaining_ds.take(val_count)
test_ds = remaining_ds.skip(val_count)


Tuner = tf.data.AUTOTUNE
train_ds = dataset.take(train_count)
val_ds = dataset.skip(train_count)
```

```
Found 300 files belonging to 3 classes.

Kelas yang terdeteksi:
['Beras', 'Gandum', 'Sorgum']
Found 300 files belonging to 3 classes.

Pembagian Dataset:
Total Images (Batches):  10
Train Images (Batches):  8
Validation Images (Batches):  1
Test Images (Batches):  1
```

Augmentasi

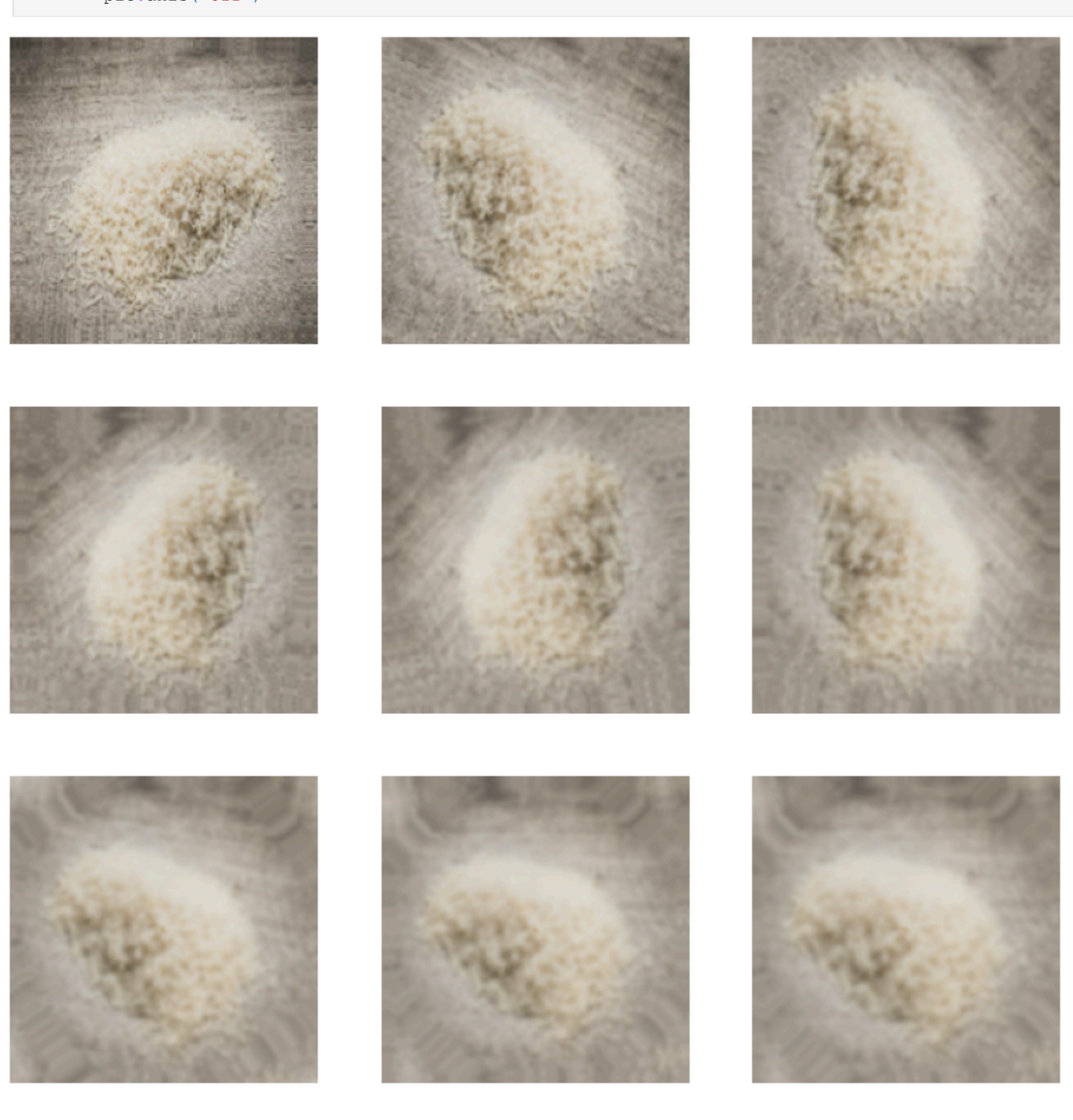
```
In [14]: data_augmentation = tf.keras.Sequential([
    tf.keras.layers.RandomFlip("horizontal_and_vertical", input_shape=(img_size,img_size,3)),
    tf.keras.layers.RandomRotation(0.2),
    tf.keras.layers.RandomZoom(0.2),
    tf.keras.layers.RandomBrightness(0.2),
    tf.keras.layers.RandomContrast(0.2)
])

i = 0
plt.figure(figsize=(10,10))


for images, labels in train_ds.take(1):
    for i in range(9):
        plt.subplot(3,3, i+1)
        plt.imshow(images[i].numpy().astype('uint8'))
        plt.title(class_names[labels[i]])
        plt.axis('off')

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

```
c:\Users\rdali\anaconda3\Lib\site-packages\keras\src\layers\preprocessing\tf_data_layer.py:19: UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` obje
ct as the first layer in the model instead.
  super().__init__(**kwargs)
```


```
In [15]: for images, labels in train_ds.take(1):
    images_array = np.array(images)
    print(images_array.shape)
```

```
(32, 180, 180, 3)
```

```
In [16]: from tensorflow.keras import layers
from tensorflow.keras.models import Sequential, load_model

Tuner = tf.data.AUTOTUNE
train_ds = train_ds.cache().shuffle(1000).prefetch(buffer_size = Tuner)
val_ds = val_ds.cache().shuffle(1000).prefetch(buffer_size = Tuner)



data_augmentation = Sequential([
    layers.RandomFlip("horizontal", input_shape = (img_size,img_size,3)),
    layers.RandomRotation(0.1),
    layers.RandomZoom(0.1)
])

i = 0
plt.figure(figsize=(10,10))

for images, labels in train_ds.take(69):
    for i in range(9):
        images = data_augmentation(images)
        plt.subplot(3,3, i+1)
        plt.imshow(images[0].numpy().astype('uint8'))
        plt.axis('off')
```



googlenet

```
In [17]: def googlenet(input_shape, n_classes):
    def inception_block(x, f):

        t1 = Conv2D(f[0], 1, activation='relu')(x)


        t2 = Conv2D(f[1], 1, activation='relu')(x)
        t2 = Conv2D(f[2], 3, padding='same', activation='relu')(t2)


        t3 = Conv2D(f[3], 1, activation='relu')(x)
        t3 = Conv2D(f[4], 5, padding='same', activation='relu')(t3)


        t4 = MaxPool2D(3, strides=1, padding='same')(x)
        t4 = Conv2D(f[5], 1, activation='relu')(t4)


        output = Concatenate()([t1, t2, t3, t4])
        return output


    input = Input(input_shape)


    x = Conv2D(32, 7, strides=2, padding='same', activation='relu')(input)
    x = MaxPool2D(3, strides=2, padding='same')(x)

    x = Conv2D(32, 1, activation='relu')(x)
    x = Conv2D(64, 3, padding='same', activation='relu')(x)
    x = MaxPool2D(3, strides=2)(x)


    x = inception_block(x, [32, 48, 64, 8, 16, 16])
    x = inception_block(x, [64, 64, 128, 16, 32, 32])
    x = MaxPool2D(3, strides=2, padding='same')(x)

    x = inception_block(x, [64, 96, 128, 16, 32, 32])
    x = inception_block(x, [96, 96, 192, 32, 48, 48])
    x = MaxPool2D(3, strides=2, padding='same')(x)

    x = inception_block(x, [128, 128, 256, 32, 64, 64])
    x = inception_block(x, [160, 160, 320, 64, 96, 96])


    x = AvgPool2D(pool_size=3, strides=1, padding='valid')(x)
    x = Dropout(0.5)(x)


    x = Flatten()(x)
    output = Dense(n_classes, activation='softmax')(x)


    model = Model(input, output)
    return model

input_shape = (180, 180, 3)
n_classes = len(class_names)


K.clear_session()


model = googlenet(input_shape, n_classes)

initial_learning_rate = 0.001
decay_steps = 1000
decay_rate = 0.9

lr_schedule = tf.keras.optimizers.schedules.ExponentialDecay(
    initial_learning_rate,
    decay_steps=decay_steps,
    decay_rate=decay_rate,
    staircase=True
)

optimizer = tf.keras.optimizers.Adam(learning_rate=lr_schedule)

model.compile(
    optimizer=optimizer,
    loss='sparse_categorical_crossentropy',
    metrics=['accuracy']
)


print("\nArsitektur Model:")
model.summary()
```

Arsitektur Model:
Model: "functional"

Layer (type)	Output Shape	Param #	Connected to
input_layer (InputLayer)	(None, 180, 180, 3)	0	-
conv2d (Conv2D)	(None, 90, 90, 32)	4,736	input_layer[0][0]
max_pooling2d (MaxPooling2D)	(None, 45, 45, 32)	0	conv2d[0][0]
conv2d_1 (Conv2D)	(None, 45, 45, 32)	1,056	max_pooling2d[0]…
conv2d_2 (Conv2D)	(None, 45, 45, 64)	18,496	conv2d_1[0][0]
max_pooling2d_1 (MaxPooling2D)	(None, 22, 22, 64)	0	conv2d_2[0][0]
conv2d_4 (Conv2D)	(None, 22, 22, 48)	3,120	max_pooling2d_1[…
conv2d_6 (Conv2D)	(None, 22, 22, 8)	520	max_pooling2d_1[…
max_pooling2d_2 (MaxPooling2D)	(None, 22, 22, 64)	0	max_pooling2d_1[…
conv2d_3 (Conv2D)	(None, 22, 22, 32)	2,080	max_pooling2d_1[…
conv2d_5 (Conv2D)	(None, 22, 22, 64)	27,712	conv2d_4[0][0]
conv2d_7 (Conv2D)	(None, 22, 22, 16)	3,216	conv2d_6[0][0]
conv2d_8 (Conv2D)	(None, 22, 22, 16)	1,040	max_pooling2d_2[…
concatenate (Concatenate)	(None, 22, 22, 128)	0	conv2d_3[0][0], conv2d_5[0][0], conv2d_7[0][0], conv2d_8[0][0]
conv2d_10 (Conv2D)	(None, 22, 22, 64)	8,256	concatenate[0][0]
conv2d_12 (Conv2D)	(None, 22, 22, 16)	2,064	concatenate[0][0]
max_pooling2d_3 (MaxPooling2D)	(None, 22, 22, 128)	0	concatenate[0][0]
conv2d_9 (Conv2D)	(None, 22, 22, 64)	8,256	concatenate[0][0]
conv2d_11 (Conv2D)	(None, 22, 22, 128)	73,856	conv2d_10[0][0]
conv2d_13 (Conv2D)	(None, 22, 22, 32)	12,832	conv2d_12[0][0]
conv2d_14 (Conv2D)	(None, 22, 22, 32)	4,128	max_pooling2d_3[…
concatenate_1 (Concatenate)	(None, 22, 22, 256)	0	conv2d_9[0][0], conv2d_11[0][0], conv2d_13[0][0], conv2d_14[0][0]
max_pooling2d_4 (MaxPooling2D)	(None, 11, 11, 256)	0	concatenate_1[0]…
conv2d_16 (Conv2D)	(None, 11, 11, 96)	24,672	max_pooling2d_4[…
conv2d_18 (Conv2D)	(None, 11, 11, 16)	4,112	max_pooling2d_4[…
max_pooling2d_5 (MaxPooling2D)	(None, 11, 11, 256)	0	max_pooling2d_4[…
conv2d_15 (Conv2D)	(None, 11, 11, 64)	16,448	max_pooling2d_4[…
conv2d_17 (Conv2D)	(None, 11, 11, 128)	110,720	conv2d_16[0][0]
conv2d_19 (Conv2D)	(None, 11, 11, 32)	12,832	conv2d_18[0][0]
conv2d_20 (Conv2D)	(None, 11, 11, 32)	8,224	max_pooling2d_5[…
concatenate_2 (Concatenate)	(None, 11, 11, 256)	0	conv2d_15[0][0], conv2d_17[0][0], conv2d_19[0][0], conv2d_20[0][0]
conv2d_22 (Conv2D)	(None, 11, 11, 96)	24,672	concatenate_2[0]…
conv2d_24 (Conv2D)	(None, 11, 11, 32)	8,224	concatenate_2[0]…
max_pooling2d_6 (MaxPooling2D)	(None, 11, 11, 256)	0	concatenate_2[0]…
conv2d_21 (Conv2D)	(None, 11, 11, 96)	24,672	concatenate_2[0]…
conv2d_23 (Conv2D)	(None, 11, 11, 192)	166,080	conv2d_22[0][0]
conv2d_25 (Conv2D)	(None, 11, 11, 48)	38,448	conv2d_24[0][0]
conv2d_26 (Conv2D)	(None, 11, 11, 48)	12,336	max_pooling2d_6[…
concatenate_3 (Concatenate)	(None, 11, 11, 384)	0	conv2d_21[0][0], conv2d_23[0][0], conv2d_25[0][0], conv2d_26[0][0]
max_pooling2d_7 (MaxPooling2D)	(None, 6, 6, 384)	0	concatenate_3[0]…
conv2d_28 (Conv2D)	(None, 6, 6, 128)	49,280	max_pooling2d_7[…
conv2d_30 (Conv2D)	(None, 6, 6, 32)	12,320	max_pooling2d_7[…
max_pooling2d_8 (MaxPooling2D)	(None, 6, 6, 384)	0	max_pooling2d_7[…
conv2d_27 (Conv2D)	(None, 6, 6, 128)	49,280	max_pooling2d_7[…
conv2d_29 (Conv2D)	(None, 6, 6, 256)	295,168	conv2d_28[0][0]
conv2d_31 (Conv2D)	(None, 6, 6, 64)	51,264	conv2d_30[0][0]
conv2d_32 (Conv2D)	(None, 6, 6, 64)	24,640	max_pooling2d_8[…
concatenate_4 (Concatenate)	(None, 6, 6, 512)	0	conv2d_27[0][0], conv2d_29[0][0], conv2d_31[0][0], conv2d_32[0][0]
conv2d_34 (Conv2D)	(None, 6, 6, 160)	82,080	concatenate_4[0]…
conv2d_36 (Conv2D)	(None, 6, 6, 64)	32,832	concatenate_4[0]…
max_pooling2d_9 (MaxPooling2D)	(None, 6, 6, 512)	0	concatenate_4[0]…
conv2d_33 (Conv2D)	(None, 6, 6, 160)	82,080	concatenate_4[0]…
conv2d_35 (Conv2D)	(None, 6, 6, 320)	461,120	conv2d_34[0][0]
conv2d_37 (Conv2D)	(None, 6, 6, 96)	153,696	conv2d_36[0][0]
conv2d_38 (Conv2D)	(None, 6, 6, 96)	49,248	max_pooling2d_9[…
concatenate_5 (Concatenate)	(None, 6, 6, 672)	0	conv2d_33[0][0], conv2d_35[0][0], conv2d_37[0][0], conv2d_38[0][0]
average_pooling2d (AveragePooling2D)	(None, 4, 4, 672)	0	concatenate_5[0]…
dropout (Dropout)	(None, 4, 4, 672)	0	average_pooling2…
flatten (Flatten)	(None, 10752)	0	dropout[0][0]
dense (Dense)	(None, 3)	32,259	flatten[0][0]

Total params: 1,998,075 (7.62 MB)
Trainable params: 1,998,075 (7.62 MB)
Non-trainable params: 0 (0.00 B)

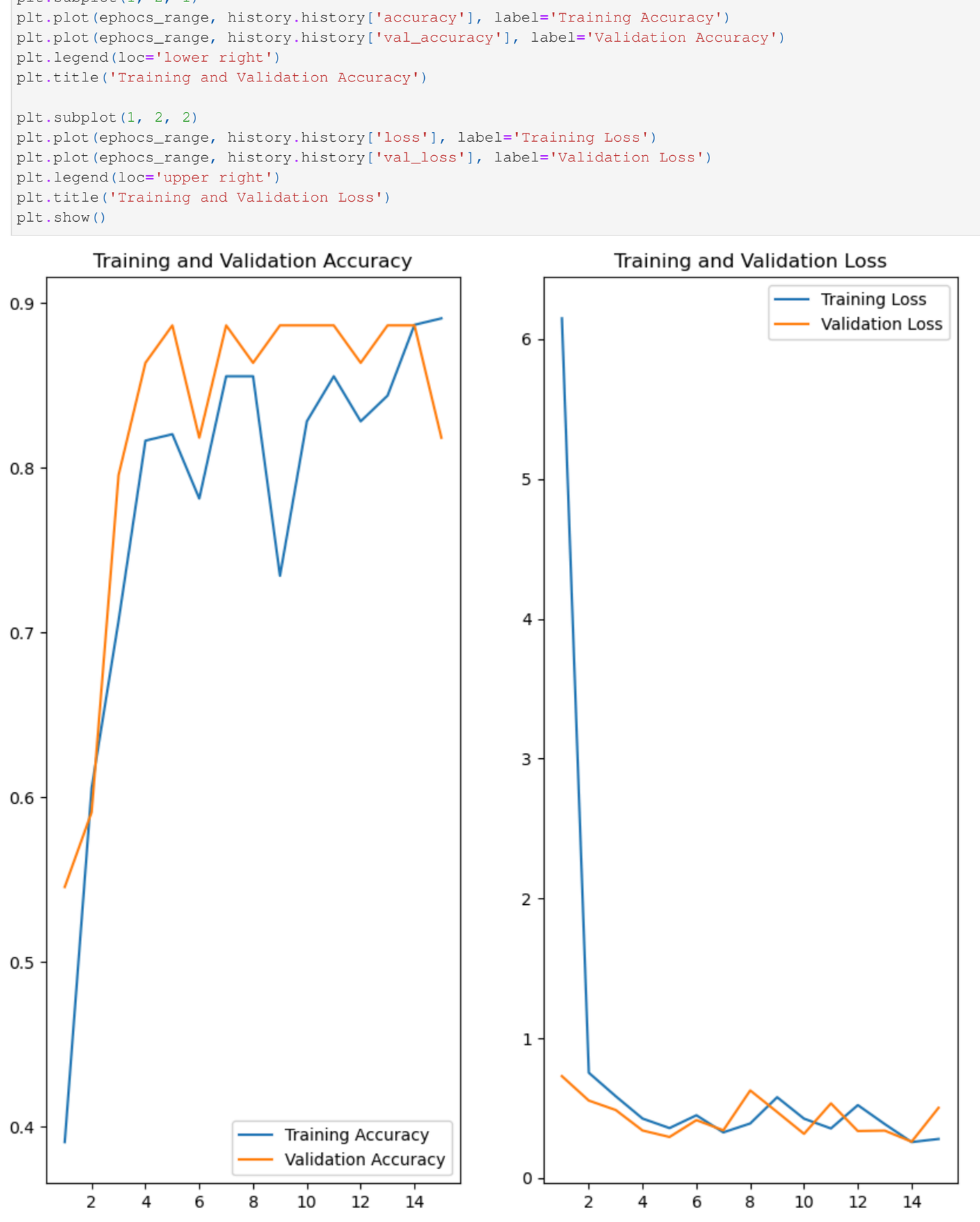
training

```
In [18]: print("\nMemulai proses training...")
model.compile(
    optimizer=Adam(),
    loss='sparse_categorical_crossentropy',
    metrics=['accuracy']
)

early_stopping = EarlyStopping(monitor='val_accuracy',
                               patience=10,
                               mode='max')

epochs = 50
history = model.fit(
    train_ds,
    validation_data=val_ds,
    epochs=epochs,
    callbacks=[early_stopping]
)
```

```
Memulai proses training...
Epoch 1/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 18s 458ms/step - accuracy: 0.3568 - loss: 9.6081 - val_accuracy: 0.5455 - val_loss: 0.7287
Epoch 2/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 296ms/step - accuracy: 0.5715 - loss: 0.7971 - val_accuracy: 0.5909 - val_loss: 0.5541
Epoch 3/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 281ms/step - accuracy: 0.7162 - loss: 0.5423 - val_accuracy: 0.7955 - val_loss: 0.4865
Epoch 4/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 284ms/step - accuracy: 0.7925 - loss: 0.4488 - val_accuracy: 0.8636 - val_loss: 0.3398
Epoch 5/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 286ms/step - accuracy: 0.8029 - loss: 0.3740 - val_accuracy: 0.8864 - val_loss: 0.2936
Epoch 6/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 291ms/step - accuracy: 0.7973 - loss: 0.4248 - val_accuracy: 0.8182 - val_loss: 0.4143
Epoch 7/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 278ms/step - accuracy: 0.8226 - loss: 0.3611 - val_accuracy: 0.8864 - val_loss: 0.3416
Epoch 8/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 281ms/step - accuracy: 0.8709 - loss: 0.3149 - val_accuracy: 0.8636 - val_loss: 0.6265
Epoch 9/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 282ms/step - accuracy: 0.7177 - loss: 0.5833 - val_accuracy: 0.8864 - val_loss: 0.4724
Epoch 10/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 280ms/step - accuracy: 0.7955 - loss: 0.4589 - val_accuracy: 0.8864 - val_loss: 0.3161
Epoch 11/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 280ms/step - accuracy: 0.8706 - loss: 0.3287 - val_accuracy: 0.8864 - val_loss: 0.5338
Epoch 12/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 281ms/step - accuracy: 0.8153 - loss: 0.6210 - val_accuracy: 0.8636 - val_loss: 0.3360
Epoch 13/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 294ms/step - accuracy: 0.8483 - loss: 0.3765 - val_accuracy: 0.8864 - val_loss: 0.3392
Epoch 14/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 286ms/step - accuracy: 0.8634 - loss: 0.2791 - val_accuracy: 0.8864 - val_loss: 0.2600
Epoch 15/50
8/8 ━━━━━━━━━━━━━━━━━━━━ 2s 284ms/step - accuracy: 0.9065 - loss: 0.2534 - val_accuracy: 0.8182 - val_loss: 0.5025
```

graph accuracy

```
In [19]: ephocs_range = range(1, len(history.history['loss']) + 1)
plt.figure(figsize=(10, 10))
plt.subplot(1, 2, 1)
plt.plot(ephocs_range, history.history['accuracy'], label='Training Accuracy')
plt.plot(ephocs_range, history.history['val_accuracy'], label='Validation Accuracy')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy')

plt.subplot(1, 2, 2)
plt.plot(ephocs_range, history.history['loss'], label='Training Loss')
plt.plot(ephocs_range, history.history['val_loss'], label='Validation Loss')
plt.legend(loc='upper right')
plt.title('Training and Validation Loss')
plt.show()
```




```
In [20]: model.save('googlenet.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 considered legacy. We recommend using instead the native Keras format, e.g. `model.save('my_model.kera
s')` or `keras.saving.save_model(model, 'my_model.keras')`.
```

test model

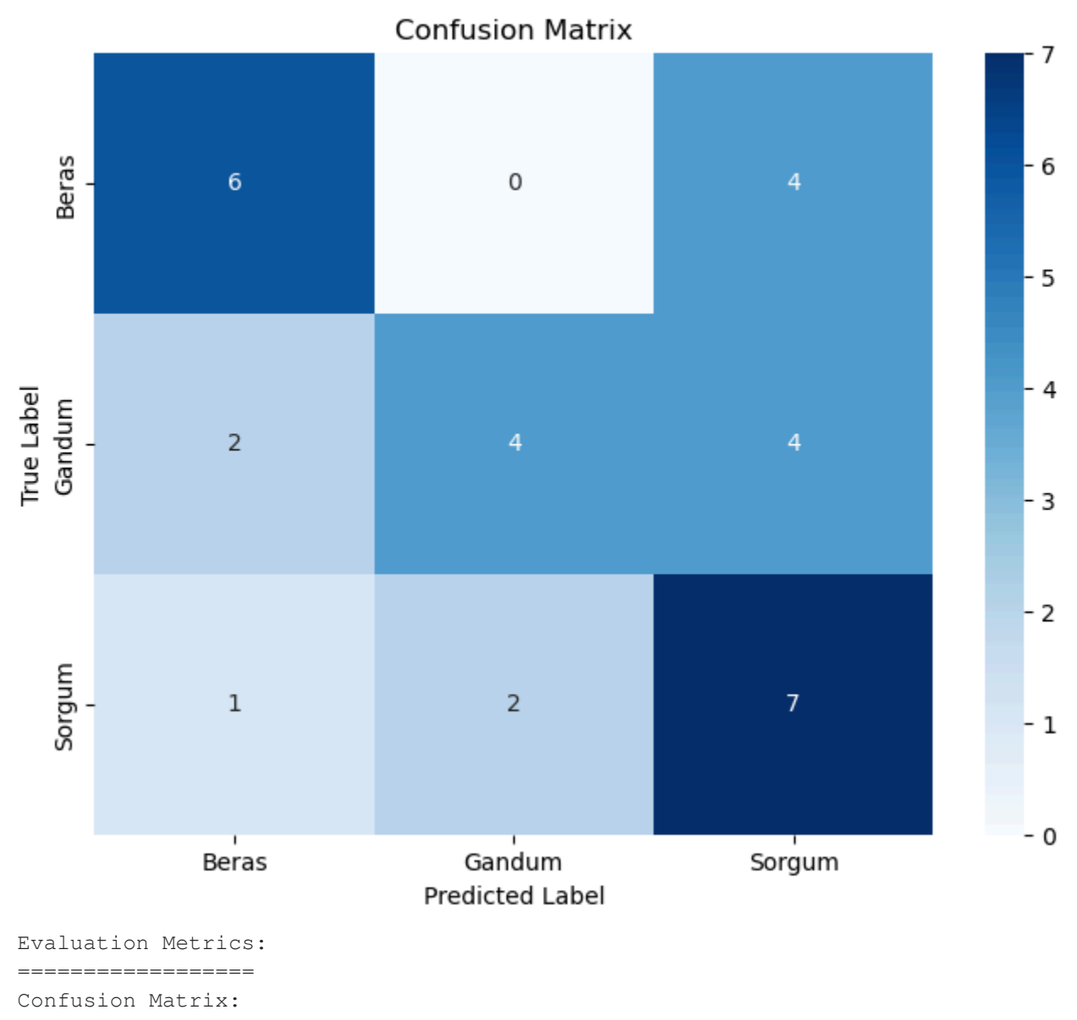
```
In [21]: import tensorflow as tf
import numpy as np
import matplotlib.pyplot as plt
from tensorflow.keras.models import load_model
from PIL import Image

model = load_model(r'C:\Users\rdali\Downloads\Tubes googlenet+strealit done\googlenet.h5')
class_names = ['Beras', 'Gandum', 'Sorgum']

def classify_images(image_path, save_path='predicted_image.jpg'):
    try:

        input_image = tf.keras.utils.load_img(image_path, target_size=(180, 180))
        input_image_array = tf.keras.utils.img_to_array(input_image)
        input_image_exp_dim = tf.expand_dims(input_image_array, 0)


        predictions = model.predict(input_image_exp_dim)
        result = tf.nn.softmax(predictions[0])
        class_idx = np.argmax(result)
        confidence = np.max(result) * 100


        print(f"Prediksi: {class_names[class_idx]}")
        print(f"Confidence: {confidence:.2f}%")


        input_image = Image.open(image_path)
        input_image.save(save_path)

        return f"Prediksi: {class_names[class_idx]} dengan confidence {confidence:.2f}%. Gambar asli disimpan di {save_path}."
    except Exception as e:
        return f"Terjadi kesalahan: {e}"



result = classify_images(r'C:\Users\rdali\Downloads\Tubes googlenet+strealit done\Test_data_tubes\Sorgum\Sorgum 6.jpg', save_path = 'sorgum.jpg')
print(result)
```

```
WARNING:absl:Compiled the loaded model, but the compiled metrics have yet to be built. `model.compile_metrics` will be empty until you train or evaluate the model.
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 1s/step
Prediksi: Sorgum
Confidence: 57.61%
Prediksi: Sorgum dengan confidence 57.61%. Gambar asli disimpan di sorgum.jpg.
```

Confussion Matrix

```
In [71]: import tensorflow as tf
from tensorflow.keras.models import load_model
import seaborn as sns
import matplotlib.pyplot as plt


test_data = tf.keras.preprocessing.image_dataset_from_directory(
    r'C:\Users\rdali\Downloads\Tubes googlenet+strealit done\Test_data_tubes',
    labels='inferred',
    label_mode='categorical',
    batch_size=32,
    image_size=(180, 180)
)


y_pred = model.predict(test_data)
y_pred_class = tf.argmax(y_pred, axis=1)


true_labels = []
for _, labels in test_data:
    true_labels.extend(tf.argmax(labels, axis=1).numpy())
true_labels = tf.convert_to_tensor(true_labels)


conf_mat = tf.math.confusion_matrix(true_labels, y_pred_class)


accuracy = tf.reduce_sum(tf.linalg.diag_part(conf_mat)) / tf.reduce_sum(conf_mat)
precision = tf.linalg.diag_part(conf_mat) / tf.reduce_sum(conf_mat, axis=0)
recall = tf.linalg.diag_part(conf_mat) / tf.reduce_sum(conf_mat, axis=1)
f1_score = 2 * (precision * recall) / (precision + recall)


plt.figure(figsize=(8, 6))
sns.heatmap(conf_mat.numpy(),
            annot=True,
            fmt='d',
            cmap='Blues',
            xticklabels=["Beras", "Gandum", "Sorgum"],
            yticklabels=["Beras", "Gandum", "Sorgum"])
plt.title('Confusion Matrix')
plt.xlabel('Predicted Label')
plt.ylabel('True Label')
plt.show()


print("\nEvaluation Metrics:")
print("==================")
print("Confusion Matrix:\n", conf_mat.numpy())
print("\nAccuracy:", accuracy.numpy())
print("\nPrecision for each class:", precision.numpy())
print("Recall for each class:", recall.numpy())
print("F1 Score for each class:", f1_score.numpy())


class_accuracies = tf.linalg.diag_part(conf_mat) / tf.reduce_sum(conf_mat, axis=1)
print("\nClass-specific accuracies:")
for i, class_name in enumerate(["Beras", "Gandum", "Sorgum"]):
    print(f"{class_name}: {class_accuracies[i].numpy():.4f}")
```

```
Found 30 files belonging to 3 classes.
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 131ms/step
```




```
Evaluation Metrics:
==================
Confusion Matrix:
 [[6 0 4]
 [2 4 4]
 [1 2 7]]

Accuracy: 0.5666666666666667

Precision for each class: [0.66666667 0.66666667 0.46666667]
Recall for each class: [0.6 0.4 0.7]
F1 Score for each class: [0.63157895 0.5        0.56      ]

Class-specific accuracies:
```

Accuracy: 0.9167
Number: 11 items
Accepted: 11 items