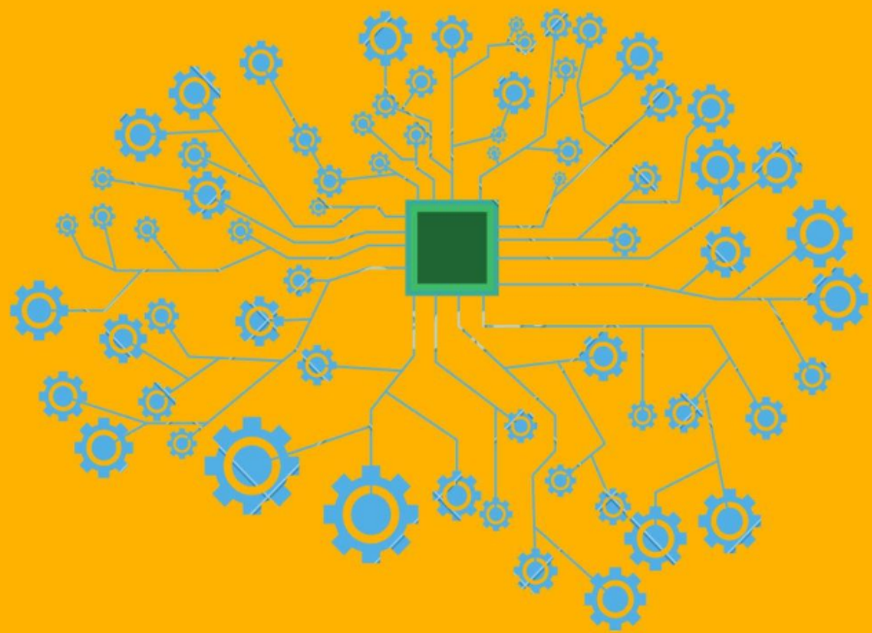

PEMBELAJARAN MESIN DAN
PEMBELAJARAN MENDALAM

Modul 6
Convolutional Neural Network

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Tugas Modul Convolutional Neural Network

MobileNet

Import Library

- Tahap pertama adalah import seluruh library yang dibutuhkan

In [ ]:
```
#Import library
import os
import numpy as np

#Import library tensorflow dan modul keras yang diperlukan
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, Flatten

#Penjelasan
# layers digunakan untuk menambahkan lapisan ke dalam model
# load_img digunakan untuk memuat gambar
# ImageDataGenerator digunakan untuk melakukan augmentasi pada gambar
# Sequential digunakan untuk membuat model secara berurutan
# Conv2D digunakan untuk membuat lapisan konvolusi
# MaxPooling2D digunakan untuk melakukan pooling pada lapisan konvolusi
# Dense digunakan untuk membuat lapisan fully connected
# Dropout digunakan untuk menghindari overfitting
# Flatten digunakan untuk membuat lapisan menjadi flat (rata) menjadi vektor 1 dimensi
```

Load Data

- Load dataset berdasarkan path dimana dataset disimpan

In [ ]:
```
count = 0 #digunakan untuk menghitung jumlah gambar
dirs = os.listdir(r'D:\SURYA\UAJY\Semester 5\Asdos Machine Learning\Pemegang Modul\Modul CNN\Notebook2\train_data')
for dir in dirs:
    files = list(os.listdir(r'D:\SURYA\UAJY\Semester 5\Asdos Machine Learning\Pemegang Modul\Modul CNN\Notebook2\train_data/'+dir))
    print(dir + ' Folder has ' + str(len(files)) + ' Images')
    count = count + len(files)
print('Images Folder has ' + str(count) + ' Images')
```

```
Matang Folder has 800 Images
Mentah Folder has 800 Images
Images Folder has 1600 Images
```

Load Images into Arrays as Dataset

- Membuat dataset dari gambar yang ada di direktori

In [ ]:
```
# Parameter
base_dir = r'D:\SURYA\UAJY\Semester 5\Asdos Machine Learning\Pemegang Modul\Modul CNN\Notebook2\train_data' #direktori folder dataset
img_size = 180 #mengubah ukuran gambar menjadi 180
batch = 32 #jumlah sample (gambar) yang akan diproses pada satu kali iterasi
validation_split = 0.1 #data pelatihan yang akan digunakan sebagai data validasi
```

- Memasukkan parameter yang telah di definisikan tadi untuk membuat dataset dari gambar di direktori

In [ ]:
```
dataset = tf.keras.utils.image_dataset_from_directory(
    base_dir, #path direktori, subfolder dianggap sebagai label
    seed=123, #untuk memastikan proses pemisahan data selalu konsisten (random_state)
    image_size=(img_size, img_size), #ukuran gambar diubah (resize) menjadi 180x180 pixel
    batch_size=batch, #jumlah gambar yang akan dikelompokkan
)
```

```
Found 1600 files belonging to 2 classes.
```

In [ ]:
```
#mendapatkan nama kelas dari dataset
class_names = dataset.class_names #dataset.class_names akan mengambil daftar nama kelas berdasarkan subfolder di dalam direktori
print("Class Names:", class_names)
```

```
Class Names: ['Matang', 'Mentah']
```

Train-Validation-Test Split

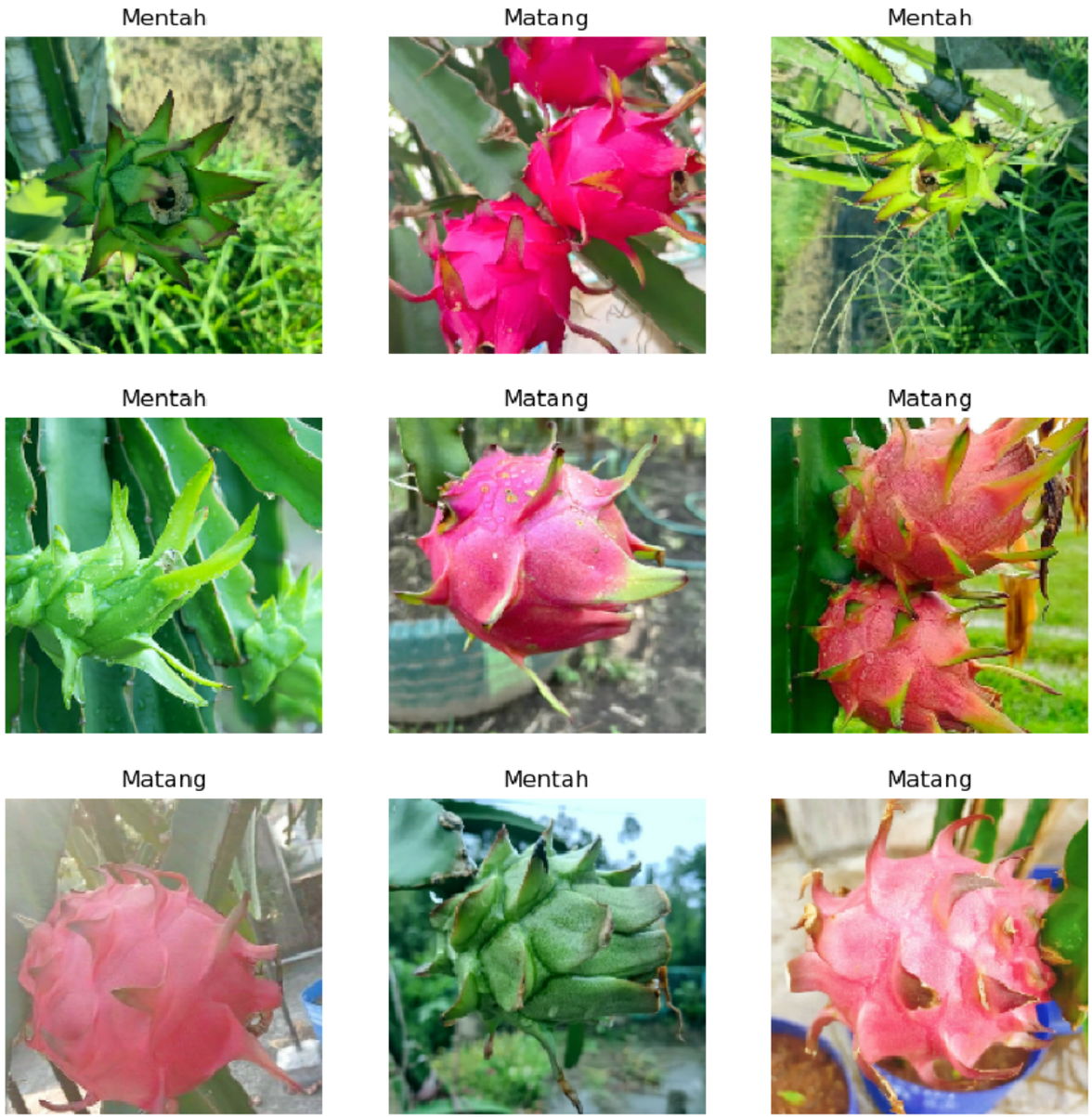
- Membagi dataset menjadi tiga subset yaitu train, validation, dan test
  - Train, digunakan untuk melatih model agar mengenali pola dalam data
  - Validation, digunakan untuk mengevaluasi performa model selama pelatihan
  - Test, digunakan untuk menguji model setelah pelatihan

In [ ]:
```
total_count = len(dataset) #menghitung jumlah total gambar dalam dataset
val_count = int(total_count * validation_split) #menghitung jumlah gambar untuk validasi
train_count = total_count - val_count # menghitung jumlah gambar untuk train

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

```
Total Images: 50
Train Images: 45
Validation Images: 5
```

In [ ]:
```
train_ds = dataset.take(train_count) #digunakan untuk mengambil (take) sejumlah batch sebanyak 'train_count' yang pertama dari dataset
val_ds = dataset.skip(train_count) #digunakan untuk melewati (skip) sejumlah batch sebanyak 'train_count' yang pertama dari dataset
```

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

i = 0
plt.figure(figsize=(10,10)) #membuat figure dengan ukuran 10x10 inchi untuk menampilkan gambar

for images, labels in train_ds.take(1): #mengambil 1 batch pertama dari train_ds
    for i in range(9): #iterasi untuk menampilkan 9 gambar pertama dalam batch
        plt.subplot(3,3, i+1) #menyiapkan subplot dengan grid 3x3 dan menempatkan gambar pada posisi i+1
        plt.imshow(images[i].numpy().astype('uint8')) #menampilkan gambar dan mengonversi ke tipe uint8
        plt.title(class_names[labels[i]]) #menampilkan judul gambar sesuai dengan nama kelas
        plt.axis('off') #menonaktifkan sumbu pada gambar agar tidak terlihat
```



In [ ]:
```
import numpy as np

# Tampilkan gambar dengan shape (32, 180, 180, 3)
for images, labels in train_ds.take(1):
    images_array = np.array(images)
    print(images_array.shape)  # Output: (32, 180, 180, 3)
    #32: Jumlah gambar dalam batch.
    #180: Lebar gambar dalam piksel
    #180: Tinggi gambar dalam piksel
    #3: Jumlah channel gambar (RGB)
```

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

In [ ]:
```
#Mengatur AUTOTUNE untuk pemrosesan data otomatis oleh tensorflow
#AUTOTUNE digunakan untuk memungkinkan tensorflow mengoptimalkan jumlah thread secara otomatis saat memproses data
AUTOTUNE = tf.data.AUTOTUNE
```

In [ ]:
```
#mengoptimalkan dataset pelatihan (train_ds)
train_ds = train_ds.cache().shuffle(1000).prefetch(buffer_size = AUTOTUNE)
#cache digunakan untuk menyimpan dataser di memori agar lebih cepat diakses
#shuffle mengacak data dalam batch agar model tidak terlalu terlatih pada urutan tertentu
#prefetch untuk menyiapkan data batch berikutnya secara otomatis
```

In [ ]:
```
#mengoptimalkan dataset validasi (val_ds)
val_ds = val_ds.cache().shuffle(1000).prefetch(buffer_size = AUTOTUNE)
```

Data Augmentation

- Digunakan untuk menambah variasi data pelatihan dengan membuat gambar baru dari yang sudah ada seperti dengan rotasi, flipping, zooming, dan sebagainy
- Untuk mengurangi overfitting dan memperbesar dataset tanpa mengumpulkan data baru

In [ ]:
```
data_augmentation = Sequential([
    layers.RandomFlip("horizontal", input_shape = (img_size,img_size,3)), #membalik gambar secara horizontal
    layers.RandomRotation(0.1), #merotasi gambar secara acak dalam kisaran 0°-36° (0.1 * 360)
    layers.RandomZoom(0.1) #melakukan zoom in/zoom out secara acak dengan rentang 10%
])
```

```
C:\Users\HP\AppData\Roaming\Python\Python312\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)` object as the first layer in the model instead.
  super().__init__(**kwargs)
```

In [ ]:
```
#sama seperti sebelumnya, code ini digunakan untuk menampilkan gambar dari data_augmentation
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')
```

MobileNet

- Salah satu algoritma yang dirancang untuk perangkat dengan keterbatasan sumber daya seperti smartphone

In [ ]:
```python
#import library yang dibutuhkan
from tensorflow.keras.applications import MobileNet #digunakan untuk memanfaatkan model yang sudah dilatih sebelumnya untuk pengenalan gambar
from tensorflow.keras.models import Model #digunakan untuk membuat dan mengonfigurasi arsitektur model

#membuat model dengan bobot yang telah dilatih sebelumnya
#include_top=False berarti tidak menggunakan lapisan klasifikasi dari mobilenet hanya bagian ekstraksi fitur
base_model = MobileNet(include_top=False, input_shape=(img_size, img_size, 3))

#membuka (unfreeze beberapa lapisan untuk proses fine tuning)
base_model.trainable = True #seluruh model bisa dilatih
fine_tune_at = len(base_model.layers) // 2  #menentukan bahwa setengah lapisan terakhir akan di unfreeze
for layer in base_model.layers[:fine_tune_at]:
    layer.trainable = False #mengunci (freeze) lapisan pertama hingga setengah bagian pertama agar tidak dilatih kembali

#membuat model akhir dengan lapisan tambahan
model = Sequential([ #sequential berarti lapisan diterapkan secara berurutan
    data_augmentation,  #data augmentasi untuk memperbanyak data latih
    layers.Rescaling(1./255),  #menormalisasi gambar, mengubah nilai pixel dari rentang [0, 255] menjadi [0, 1]
    base_model,  #mobileNet sebagai dasar ekstraksi fitur
    layers.GlobalAveragePooling2D(),  #Lapisan pooling untuk meratakan hasil fitur dan mengurangi dimensi
    Dense(128, activation='relu'),  #lapisan dense dengan 128 neuron dan aktivasi relu untuk pembelajaran non linear
    Dropout(0.3),  #dropout dengan 30% neuron yang dihilangkan secara acak selama pelatihan
    Dense(len(class_names), activation='softmax')  #Lapisan output dengan jumlah neuron sesuai dengan jumlah kelas yang ingin diprediksi
                                                   #aktivasi softmax untuk klasifikasi multi kelas
])
```

```
C:\Users\HP\AppData\Local\Temp\ipykernel_22236\2739304275.py:5: UserWarning: `input_shape` is undefined or non-square, or `rows` is not in [128, 160, 192, 224]. Weights
for input shape (224, 224) will be loaded as the default.
  base_model = MobileNet(include_top=False, input_shape=(img_size, img_size, 3))
```

In [ ]:
```python
from tensorflow.keras.optimizers import Adam #untuk mengoptimalkan proses pelatihan model

#mengkompilasi model dengan optimizer, loss function, dan metrics
model.compile(
    optimizer=Adam(learning_rate=1e-4), #menggunakan optimizer Adam dengan learning rate 0.0001
    loss='sparse_categorical_crossentropy', #untuk klasifikasi multi-kelas
    metrics=['accuracy'] #akurasi digunakan sebagai metrik evaluasi
)
```

In [ ]:
```
#menampilkan ringkasan dari model
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, 2)	258

Total params: 3,360,322 (12.82 MB)

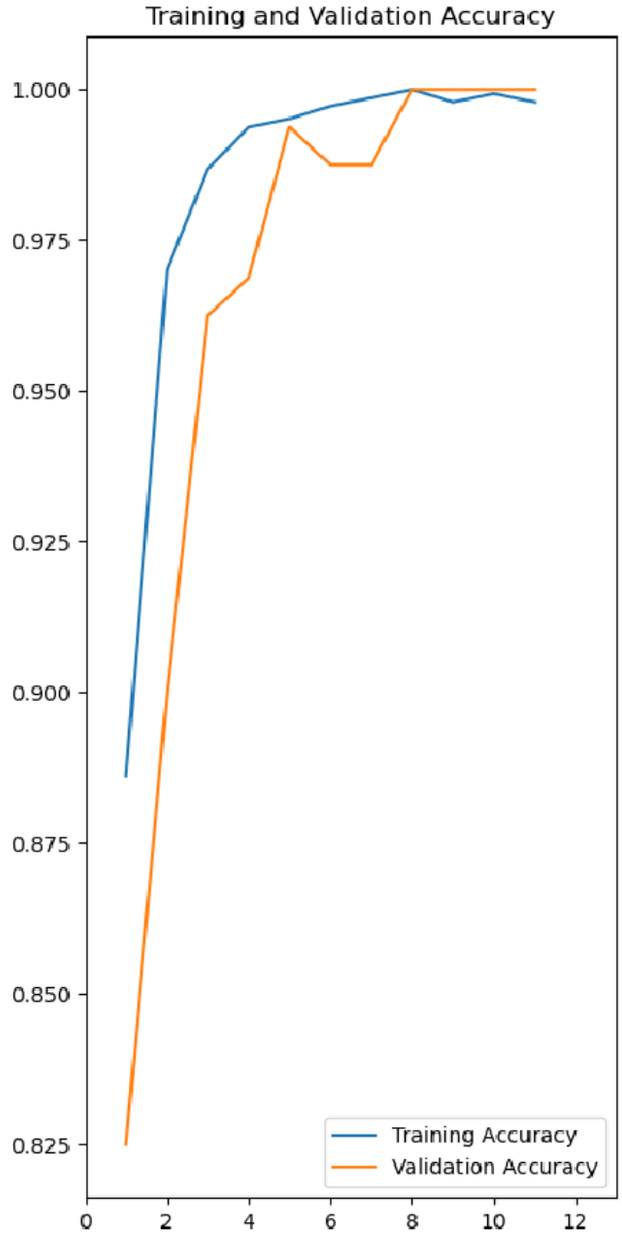
Trainable params: 3,069,314 (11.71 MB)

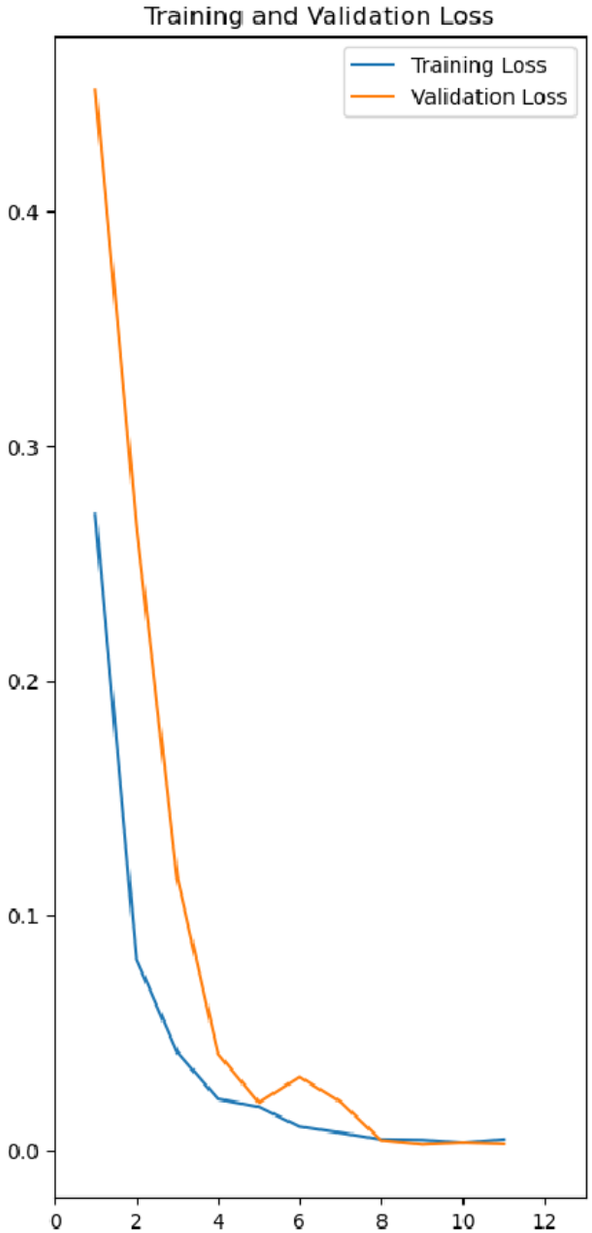
Non-trainable params: 291,008 (1.11 MB)

In [ ]:
```python
#early stopping digunakan untuk menghentikan pelatihan lebih awal jika model tidak ada peningkatan
from tensorflow.keras.callbacks import EarlyStopping

early_stopping = EarlyStopping(monitor='val_accuracy', #memantau val_accuracy untuk menentukan kapan pelatihan dihentikan
                               patience=3,  #jumlah epoch berturut-turut tanpa peningkatan 'val_accuracy' sebelum dihentikan
                               mode='max') #pelatihan berhenti ketika 'val_accuracy' tidak meningkat (nilai lebih besar diinginkan)

#melatih model menggunakan data latih dan validasi dengan early stopping
history= model.fit(train_ds, #data pelatihan yang telah disiapkan
                   epochs=30, # jumlah maksimal epoch
                   validation_data=val_ds,  #data validasi untuk mengevaluasi model pada setiap epoch
                   callbacks=[early_stopping]) #menambahkan early stopping ke dalam callback untuk pelatihan
```

```
Epoch 1/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 31s 463ms/step - accuracy: 0.8128 - loss: 0.4182 - val_accuracy: 0.8250 - val_loss: 0.4521
Epoch 2/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 19s 426ms/step - accuracy: 0.9647 - loss: 0.0970 - val_accuracy: 0.9000 - val_loss: 0.2666
Epoch 3/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 18s 410ms/step - accuracy: 0.9858 - loss: 0.0462 - val_accuracy: 0.9625 - val_loss: 0.1162
Epoch 4/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 18s 410ms/step - accuracy: 0.9922 - loss: 0.0258 - val_accuracy: 0.9688 - val_loss: 0.0412
Epoch 5/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 18s 407ms/step - accuracy: 0.9928 - loss: 0.0166 - val_accuracy: 0.9937 - val_loss: 0.0203
Epoch 6/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 19s 412ms/step - accuracy: 0.9983 - loss: 0.0110 - val_accuracy: 0.9875 - val_loss: 0.0312
Epoch 7/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 18s 411ms/step - accuracy: 0.9987 - loss: 0.0060 - val_accuracy: 0.9875 - val_loss: 0.0206
Epoch 8/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 18s 407ms/step - accuracy: 1.0000 - loss: 0.0038 - val_accuracy: 1.0000 - val_loss: 0.0041
Epoch 9/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 18s 405ms/step - accuracy: 0.9991 - loss: 0.0046 - val_accuracy: 1.0000 - val_loss: 0.0024
Epoch 10/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 18s 408ms/step - accuracy: 0.9999 - loss: 0.0033 - val_accuracy: 1.0000 - val_loss: 0.0032
Epoch 11/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 18s 407ms/step - accuracy: 0.9979 - loss: 0.0037 - val_accuracy: 1.0000 - val_loss: 0.0026
```

In [ ]:
```
#membuat range untuk epoch berdasarkan panjang data loss dari pelatihan
ephocs_range = range(1, len(history.history['loss']) + 1)

plt.figure(figsize=(10, 10)) #membuat figure dengan ukuran 10x10 untuk menampilkan 2 grafik (Training and Validation Accuracy dan Loss)

#grafik pertama (Training and Validation Accuracy)
plt.subplot(1, 2, 1) #membuat subplot pertama dalam layout 1 baris dan 2 kolom
plt.plot(ephocs_range, history.history['accuracy'], label='Training Accuracy') #plot akurasi pelatihan
plt.plot(ephocs_range, history.history['val_accuracy'], label='Validation Accuracy') #plot akurasi validasi
plt.legend(loc='lower right') #membuat legenda (informasi elemen visual) di sudut kanan bawah
plt.xlim(0, 13) #mengatur batas nilai pada sumbu x dari epoch 1 sampai 13
plt.title('Training and Validation Accuracy') #memberi judul grafik

#grafik kedua (Training and Validation Loss)
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 [ ]:
```
#menyimpan model yang telah dilatih
model.save('model_mobilenet.h5')
```

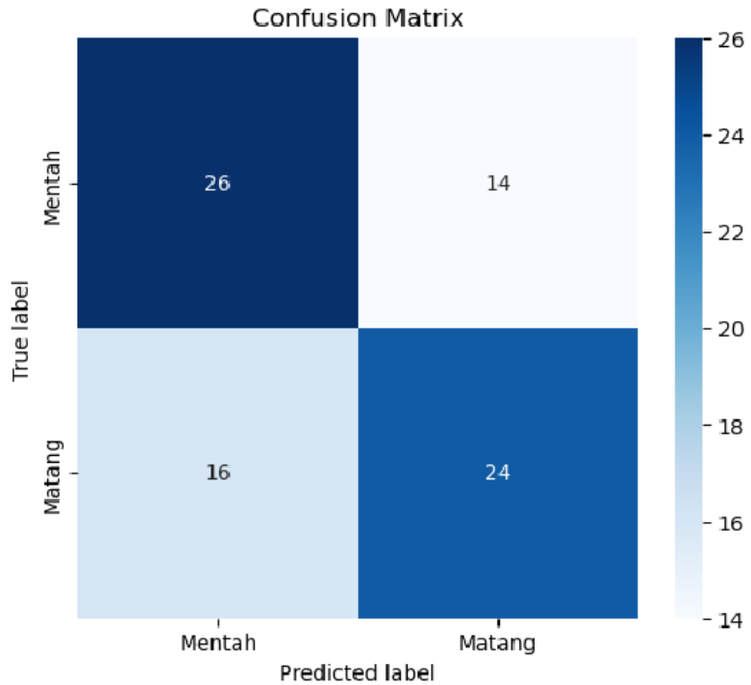
```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`. This file format is considered legacy. We recommend using
instead the native Keras format, e.g. `model.save('my_model.keras')` or `keras.saving.save_model(model, 'my_model.keras')`.
```

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

#memuat model yang sudah dilatih
model = load_model(r'D:\SURYA\UAJY\Semester 5\Asdos Machine Learning\Pemegang Modul\Modul CNN\Notebook2\model_mobilenet.h5')  # Ganti dengan path model Anda
class_names = ['Matang', 'Mentah'] #kelas yang ada pada model

#fungsi untuk mengklasifikasikan gambar dan menyimpan gambar asli
def classify_images(image_path, save_path='predicted_image.jpg'):
    try:
        #memuat dan mempersiapkan gambar untuk prediksi
        input_image = tf.keras.utils.load_img(image_path, target_size=(180, 180)) #membuat gambar dari path dan mnegubah ukurannya menjadi 180x180 pixel
        input_image_array = tf.keras.utils.img_to_array(input_image) #mengubah gambar jadi array numpy agar bisa di proses model
        input_image_exp_dim = tf.expand_dims(input_image_array, 0)  #menambahkan dimensi batch agar sesuai dengan input model
                                                                    #dimensi menjadi (1, 180, 180, 3)

        #melakukan prediksi
        predictions = model.predict(input_image_exp_dim) #melakukan prediksi pada gambar yang telah diproses
        result = tf.nn.softmax(predictions[0]) #menghitung hasil prediksi menggunakan softmax untuk mendapatkan probabilitas tiap kelas
        class_idx = np.argmax(result) #menemukan indeks kelas dengan probabilitas tertinggi
        confidence = np.max(result) * 100 #menghitung confidence dalam persentase

        #menampilkan hasil prediksi dan confidence
        print(f"Prediksi: {class_names[class_idx]}") #menampilkan nama kelas yang diprediksi
        print(f"Confidence: {confidence:.2f}%") #menampilkan nilai confidence

        #menyimpan gambar asli tanpa teks
        input_image = Image.open(image_path) #membuka gambar yang ada di path
        input_image.save(save_path) #menyimpan gambar asli ke dalam path yang telah ditentukan

        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}"

#contoh penggunaan fungsi
result = classify_images(r'test_data/Matang/Mature_Dragon_Original_Data0007.jpg', save_path='matang.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 988ms/step
Prediksi: Matang
Confidence: 73.11%
Prediksi: Matang dengan confidence 73.11%. Gambar asli disimpan di matang.jpg.
```

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

#memuat model yang telah dilatih sebelumnya
mobileNet_model = load_model(r'D:\SURYA\UAJY\Semester 5\Asdos Machine Learning\Pemegang Modul\Modul CNN\Notebook2\model_mobilenet.h5')

#memuat data test yang sebenarnya
test_data = tf.keras.preprocessing.image_dataset_from_directory(
    r'test_data', #direktori data uji
    labels='inferred', #Label otomatis dari subfolder yang ada
    label_mode='categorical',  #menghasilkan label dalam bentuk one-hot encoding
    batch_size=32, #ukuran batch untuk pemrosesan
    image_size=(180, 180) #ukuran gambar yang akan diproses
)

#prediksi model
y_pred = mobileNet_model.predict(test_data)
y_pred_class = tf.argmax(y_pred, axis=1)  #konversi ke kelas prediksi

#ekstrak label sebenarnya dari test_data dan konversi ke bentuk indeks kelas
true_labels = [] #menyimpan label asli dalam bentuk indeks
for _, labels in test_data:
    true_labels.extend(tf.argmax(labels, axis=1).numpy())  #konversi one-hot ke indeks kelas
true_labels = tf.convert_to_tensor(true_labels) #mengkonversi list ke tensor untuk perhitungan

#membuat confusion matrix untuk evaluasi
conf_mat = tf.math.confusion_matrix(true_labels, y_pred_class)

#menghitung akurasi berdasarkan confusion matrix
accuracy = tf.reduce_sum(tf.linalg.diag_part(conf_mat)) / tf.reduce_sum(conf_mat)

#mnghitung presisi dan recall dari confusion matrix
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)

#menghitung F1 Score
f1_score = 2 * (precision * recall) / (precision + recall)

#visualisasi Confusion Matrix
plt.figure(figsize=(6, 5)) #mengatur ukuran gambar
sns.heatmap(conf_mat.numpy(), annot=True, fmt='d', cmap='Blues', #annot=True untuk menampilkan angka di dalam setiap sel matriks
                                                                 #fmt='d' untuk menampilkan bilangan bulat tanpa desimal
            xticklabels=["Mentah", "Matang"], yticklabels=["Mentah", "Matang"])
plt.title('Confusion Matrix')
plt.xlabel('Predicted label')
plt.ylabel('True label')
plt.show()

# Menampilkan hasil
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 built. `model.compile_metrics` will be empty until you train or evaluate the model.

Found 80 files belonging to 2 classes.
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 448ms/step
```



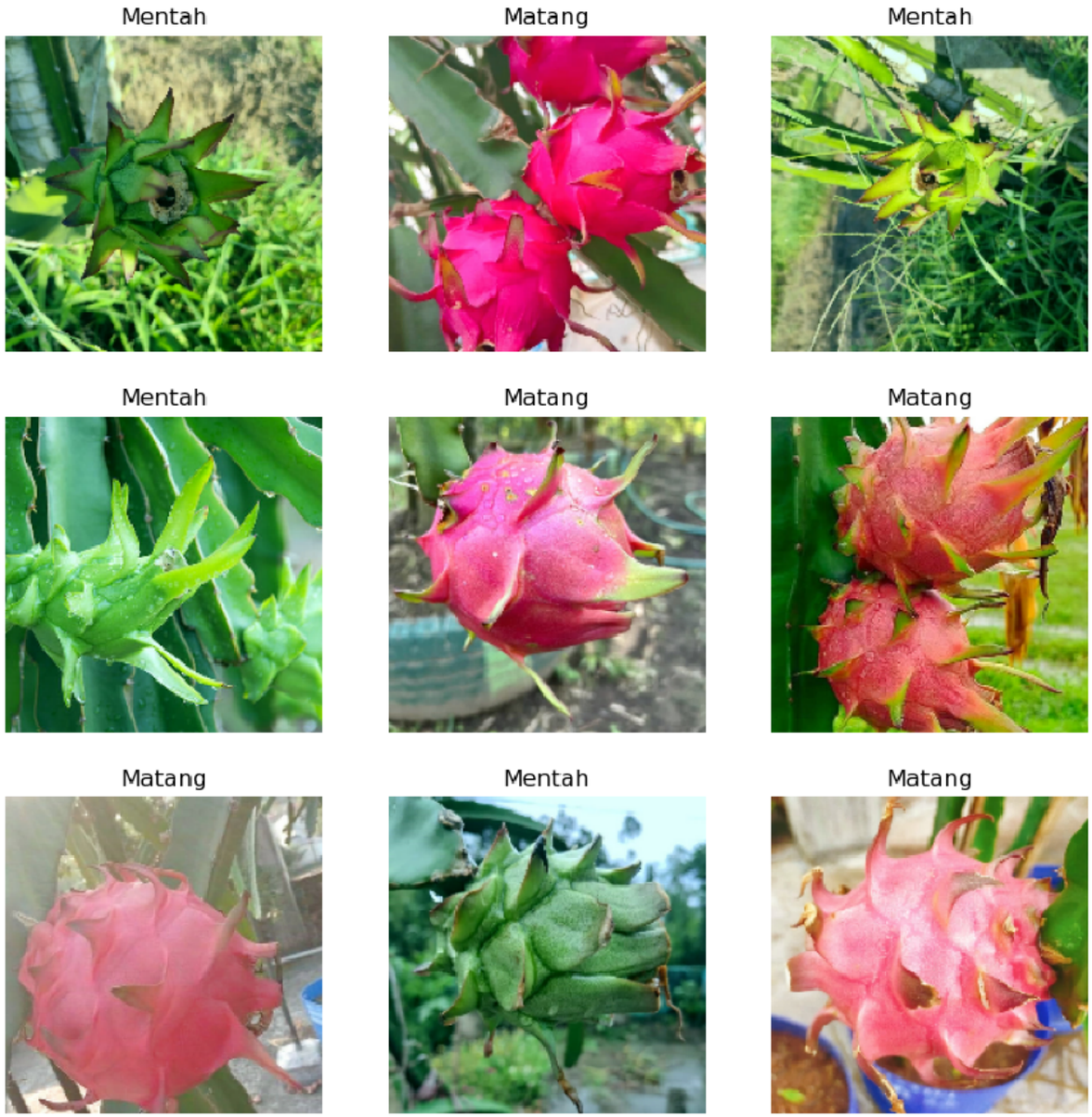

```
Confusion Matrix:
 [[26 14]
 [16 24]]
Akurasi: 0.625
Presisi: [0.61904762 0.63157895]
Recall: [0.65 0.6 ]
F1 Score: [0.63414634 0.61538462]
```

GoogleNet

In [ ]:
```
import tensorflow as tf
import cv2
import numpy as np
from matplotlib import pyplot as plt
#Load data
data_dir = r"C:\Kuliah\ASDOS ML\CNN Part 2\train_data"
#Randomize data yang telah di load sekaligus resize menjadi 180 x 180
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 1600 files belonging to 2 classes.
['Matang', 'Mentah']
```

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

i = 0
plt.figure(figsize=(10,10))
#tampilkan untuk memastikan data sudah di load
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 [5]:
```
for images, labels in train_ds.take(1):
    images_array = np.array(images)
    print(images_array.shape)

#Loop untuk mengecek atribut gambar(jumlah, tinggi, lebar, dan channel(RGB))
```

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

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)

#Augmentasi data dengan menggunakan Sequential
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))
#Lihat data setelah di augmentasi
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')
```

```
c:\Users\jppjo\anaconda3\Lib\site-packages\keras\src\layers\preprocessing\tf_data_layer.py:18: UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
  super().__init__(**kwargs)
```









In [ ]:
```
import tensorflow as tf
import keras

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

#membuat model from scratch
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, 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(64, 7, strides=2, padding='same', activation='relu')(input)
    x = MaxPool2D(3, strides=2, padding='same')(x)

    x = Conv2D(64, 1, activation='relu')(x)
    x = Conv2D(192, 3, padding='same', activation='relu')(x)
    x = MaxPool2D(3, strides=2)(x)

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

    x = inception_block(x, [192, 96, 208, 16, 48, 64])
    x = inception_block(x, [160, 112, 224, 24, 64, 64])
    x = inception_block(x, [128, 128, 256, 24, 64, 64])
    x = inception_block(x, [112, 144, 288, 32, 64, 64])
    x = inception_block(x, [256, 160, 320, 32, 128, 128])
    x = MaxPool2D(3, strides=2, padding='same')(x)

    x = inception_block(x, [256, 160, 320, 32, 128, 128])
    x = inception_block(x, [384, 192, 384, 48, 128, 128])

    x = AvgPool2D(3, strides=1)(x)
    x = Dropout(0.4)(x)

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

    model = Model(input, output)
    return model
#Pastikan input shae dan jumlah kelas sesuai
input_shape = 180, 180, 3
n_classes = 2
```

```
#Clear Cache Keras menggunakan clear session
K.clear_session()
#buat model dengan
model = googlenet(input_shape, n_classes)
model.summary()
```

```
WARNING:tensorflow:From c:\Users\jppjo\anaconda3\Lib\site-packages\keras\src\backend\common\global_state.py:82: The name tf.reset_default_graph is deprecated. Please use
tf.compat.v1.reset_default_graph instead.


Model: "functional_1"
```

Layer (type)	Output Shape	Param #	Connected to
input_layer (InputLayer)	(None, 180, 180, 3)	0	-
conv2d (Conv2D)	(None, 90, 90, 64)	9,472	input_layer[0][0]
max_pooling2d (MaxPooling2D)	(None, 45, 45, 64)	0	conv2d[0][0]
conv2d_1 (Conv2D)	(None, 45, 45, 64)	4,160	max_pooling2d[0]…
conv2d_2 (Conv2D)	(None, 45, 45, 192)	110,784	conv2d_1[0][0]
max_pooling2d_1 (MaxPooling2D)	(None, 22, 22, 192)	0	conv2d_2[0][0]
conv2d_4 (Conv2D)	(None, 22, 22, 96)	18,528	max_pooling2d_1[…
conv2d_6 (Conv2D)	(None, 22, 22, 16)	3,088	max_pooling2d_1[…
max_pooling2d_2 (MaxPooling2D)	(None, 22, 22, 192)	0	max_pooling2d_1[…
conv2d_3 (Conv2D)	(None, 22, 22, 64)	12,352	max_pooling2d_1[…
conv2d_5 (Conv2D)	(None, 22, 22, 128)	110,720	conv2d_4[0][0]
conv2d_7 (Conv2D)	(None, 22, 22, 32)	12,832	conv2d_6[0][0]
conv2d_8 (Conv2D)	(None, 22, 22, 32)	6,176	max_pooling2d_2[…
concatenate (Concatenate)	(None, 22, 22, 256)	0	conv2d_3[0][0], conv2d_5[0][0], conv2d_7[0][0], conv2d_8[0][0]
conv2d_10 (Conv2D)	(None, 22, 22, 128)	32,896	concatenate[0][0]
conv2d_12 (Conv2D)	(None, 22, 22, 32)	8,224	concatenate[0][0]
max_pooling2d_3 (MaxPooling2D)	(None, 22, 22, 256)	0	concatenate[0][0]
conv2d_9 (Conv2D)	(None, 22, 22, 128)	32,896	concatenate[0][0]
conv2d_11 (Conv2D)	(None, 22, 22, 192)	221,376	conv2d_10[0][0]
conv2d_13 (Conv2D)	(None, 22, 22, 96)	76,896	conv2d_12[0][0]

conv2d_14 (Conv2D)	(None, 22, 22, 64)	16,448	max_pooling2d_3[…
concatenate_1 (Concatenate)	(None, 22, 22, 480)	0	conv2d_9[0][0], conv2d_11[0][0], conv2d_13[0][0], conv2d_14[0][0]
max_pooling2d_4 (MaxPooling2D)	(None, 11, 11, 480)	0	concatenate_1[0]…
conv2d_16 (Conv2D)	(None, 11, 11, 96)	46,176	max_pooling2d_4[…
conv2d_18 (Conv2D)	(None, 11, 11, 16)	7,696	max_pooling2d_4[…
max_pooling2d_5 (MaxPooling2D)	(None, 11, 11, 480)	0	max_pooling2d_4[…
conv2d_15 (Conv2D)	(None, 11, 11, 192)	92,352	max_pooling2d_4[…
conv2d_17 (Conv2D)	(None, 11, 11, 208)	179,920	conv2d_16[0][0]
conv2d_19 (Conv2D)	(None, 11, 11, 48)	19,248	conv2d_18[0][0]
conv2d_20 (Conv2D)	(None, 11, 11, 64)	30,784	max_pooling2d_5[…
concatenate_2 (Concatenate)	(None, 11, 11, 512)	0	conv2d_15[0][0], conv2d_17[0][0], conv2d_19[0][0], conv2d_20[0][0]
conv2d_22 (Conv2D)	(None, 11, 11, 112)	57,456	concatenate_2[0]…
conv2d_24 (Conv2D)	(None, 11, 11, 24)	12,312	concatenate_2[0]…
max_pooling2d_6 (MaxPooling2D)	(None, 11, 11, 512)	0	concatenate_2[0]…
conv2d_21 (Conv2D)	(None, 11, 11, 160)	82,080	concatenate_2[0]…
conv2d_23 (Conv2D)	(None, 11, 11, 224)	226,016	conv2d_22[0][0]
conv2d_25 (Conv2D)	(None, 11, 11, 64)	38,464	conv2d_24[0][0]
conv2d_26 (Conv2D)	(None, 11, 11, 64)	32,832	max_pooling2d_6[…
concatenate_3 (Concatenate)	(None, 11, 11, 512)	0	conv2d_21[0][0], conv2d_23[0][0], conv2d_25[0][0], conv2d_26[0][0]
conv2d_28 (Conv2D)	(None, 11, 11, 128)	65,664	concatenate_3[0]…

conv2d_30 (Conv2D)	(None, 11, 11, 24)	12,312	concatenate_3[0]…
max_pooling2d_7 (MaxPooling2D)	(None, 11, 11, 512)	0	concatenate_3[0]…
conv2d_27 (Conv2D)	(None, 11, 11, 128)	65,664	concatenate_3[0]…
conv2d_29 (Conv2D)	(None, 11, 11, 256)	295,168	conv2d_28[0][0]
conv2d_31 (Conv2D)	(None, 11, 11, 64)	38,464	conv2d_30[0][0]
conv2d_32 (Conv2D)	(None, 11, 11, 64)	32,832	max_pooling2d_7[…
concatenate_4 (Concatenate)	(None, 11, 11, 512)	0	conv2d_27[0][0], conv2d_29[0][0], conv2d_31[0][0], conv2d_32[0][0]
conv2d_34 (Conv2D)	(None, 11, 11, 144)	73,872	concatenate_4[0]…
conv2d_36 (Conv2D)	(None, 11, 11, 32)	16,416	concatenate_4[0]…
max_pooling2d_8 (MaxPooling2D)	(None, 11, 11, 512)	0	concatenate_4[0]…
conv2d_33 (Conv2D)	(None, 11, 11, 112)	57,456	concatenate_4[0]…
conv2d_35 (Conv2D)	(None, 11, 11, 288)	373,536	conv2d_34[0][0]
conv2d_37 (Conv2D)	(None, 11, 11, 64)	51,264	conv2d_36[0][0]
conv2d_38 (Conv2D)	(None, 11, 11, 64)	32,832	max_pooling2d_8[…
concatenate_5 (Concatenate)	(None, 11, 11, 528)	0	conv2d_33[0][0], conv2d_35[0][0], conv2d_37[0][0], conv2d_38[0][0]
conv2d_40 (Conv2D)	(None, 11, 11, 160)	84,640	concatenate_5[0]…
conv2d_42 (Conv2D)	(None, 11, 11, 32)	16,928	concatenate_5[0]…
max_pooling2d_9 (MaxPooling2D)	(None, 11, 11, 528)	0	concatenate_5[0]…
conv2d_39 (Conv2D)	(None, 11, 11, 256)	135,424	concatenate_5[0]…
conv2d_41 (Conv2D)	(None, 11, 11, 320)	461,120	conv2d_40[0][0]

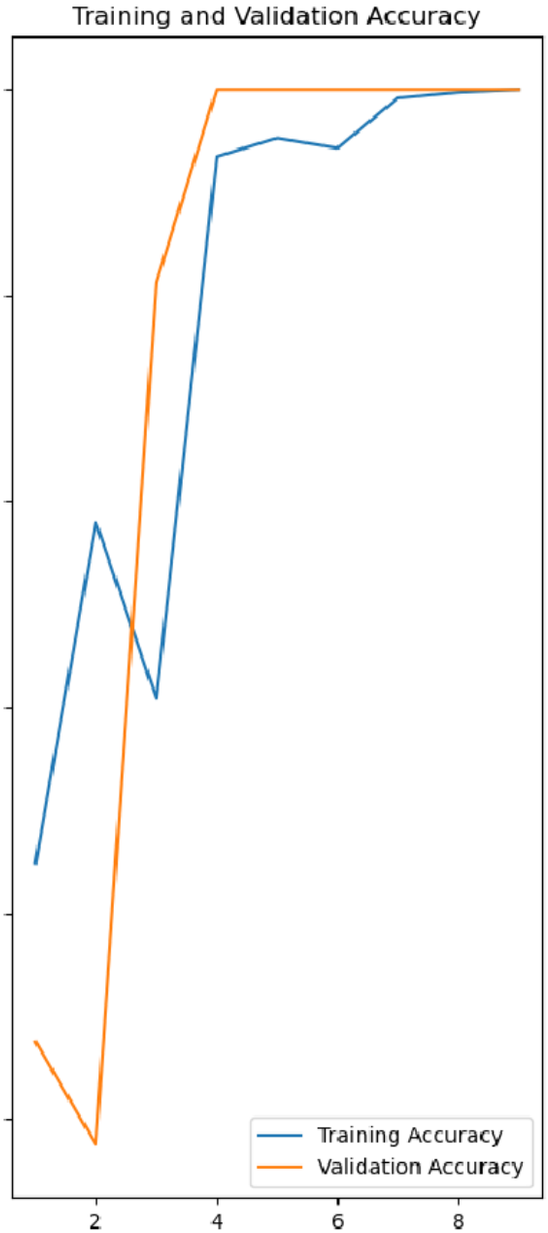
conv2d_43 (Conv2D)	(None, 11, 11, 128)	102,528	conv2d_42[0][0]
conv2d_44 (Conv2D)	(None, 11, 11, 128)	67,712	max_pooling2d_9[…
concatenate_6 (Concatenate)	(None, 11, 11, 832)	0	conv2d_39[0][0], conv2d_41[0][0], conv2d_43[0][0], conv2d_44[0][0]
max_pooling2d_10 (MaxPooling2D)	(None, 6, 6, 832)	0	concatenate_6[0]…
conv2d_46 (Conv2D)	(None, 6, 6, 160)	133,280	max_pooling2d_10…
conv2d_48 (Conv2D)	(None, 6, 6, 32)	26,656	max_pooling2d_10…
max_pooling2d_11 (MaxPooling2D)	(None, 6, 6, 832)	0	max_pooling2d_10…
conv2d_45 (Conv2D)	(None, 6, 6, 256)	213,248	max_pooling2d_10…
conv2d_47 (Conv2D)	(None, 6, 6, 320)	461,120	conv2d_46[0][0]
conv2d_49 (Conv2D)	(None, 6, 6, 128)	102,528	conv2d_48[0][0]
conv2d_50 (Conv2D)	(None, 6, 6, 128)	106,624	max_pooling2d_11…
concatenate_7 (Concatenate)	(None, 6, 6, 832)	0	conv2d_45[0][0], conv2d_47[0][0], conv2d_49[0][0], conv2d_50[0][0]
conv2d_52 (Conv2D)	(None, 6, 6, 192)	159,936	concatenate_7[0]…
conv2d_54 (Conv2D)	(None, 6, 6, 48)	39,984	concatenate_7[0]…
max_pooling2d_12 (MaxPooling2D)	(None, 6, 6, 832)	0	concatenate_7[0]…
conv2d_51 (Conv2D)	(None, 6, 6, 384)	319,872	concatenate_7[0]…
conv2d_53 (Conv2D)	(None, 6, 6, 384)	663,936	conv2d_52[0][0]
conv2d_55 (Conv2D)	(None, 6, 6, 128)	153,728	conv2d_54[0][0]
conv2d_56 (Conv2D)	(None, 6, 6, 128)	106,624	max_pooling2d_12…
concatenate_8 (Concatenate)	(None, 6, 6, 1024)	0	conv2d_51[0][0], conv2d_53[0][0], conv2d_55[0][0], conv2d_56[0][0]
average_pooling2d (AveragePooling2D)	(None, 4, 4, 1024)	0	concatenate_8[0]…
dropout (Dropout)	(None, 4, 4, 1024)	0	average_pooling2…
flatten (Flatten)	(None, 16384)	0	dropout[0][0]
dense (Dense)	(None, 2)	32,770	flatten[0][0]

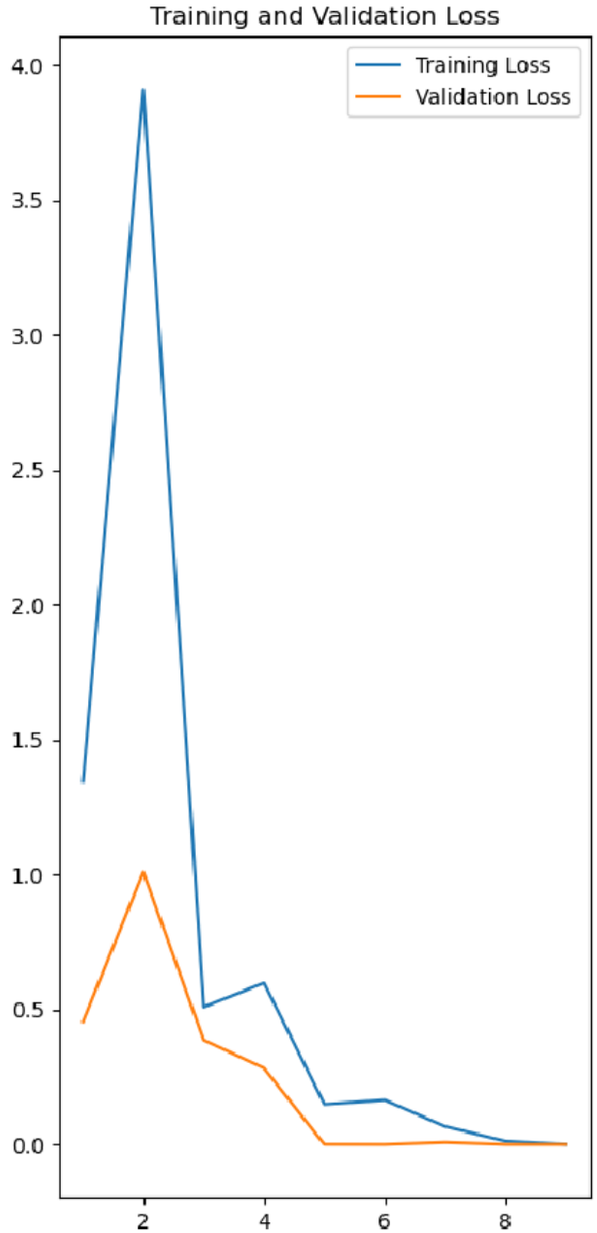
```
Total params: 6,006,322 (22.91 MB)

Trainable params: 6,006,322 (22.91 MB)

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

In [ ]:
```python
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.optimizers import Adam
#Coimpile dengan optimizer adam
model.compile(
    optimizer=Adam(),
    loss='sparse_categorical_crossentropy',
    metrics=['accuracy']
)

#buat early stopping
early_stopping = EarlyStopping(monitor='val_accuracy',
                               patience=5,
                               mode='max')
#fit validation data ke dalam model
history= model.fit(train_ds,
                   epochs=30,
                   validation_data=val_ds,
                   callbacks=[early_stopping])
```

```
Epoch 1/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 45s 722ms/step - accuracy: 0.5372 - loss: 2.7571 - val_accuracy: 0.5375 - val_loss: 0.4554
Epoch 2/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 31s 685ms/step - accuracy: 0.8222 - loss: 1.7091 - val_accuracy: 0.4875 - val_loss: 1.0099
Epoch 3/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 31s 686ms/step - accuracy: 0.5750 - loss: 0.6798 - val_accuracy: 0.9062 - val_loss: 0.3879
Epoch 4/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 31s 690ms/step - accuracy: 0.9669 - loss: 0.2555 - val_accuracy: 1.0000 - val_loss: 0.2833
Epoch 5/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 34s 756ms/step - accuracy: 0.9597 - loss: 0.2722 - val_accuracy: 1.0000 - val_loss: 4.5508e-04
Epoch 6/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 34s 745ms/step - accuracy: 0.9780 - loss: 0.1443 - val_accuracy: 1.0000 - val_loss: 2.4184e-06
Epoch 7/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 33s 728ms/step - accuracy: 0.9952 - loss: 0.0831 - val_accuracy: 1.0000 - val_loss: 0.0083
Epoch 8/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 33s 730ms/step - accuracy: 0.9976 - loss: 0.0321 - val_accuracy: 1.0000 - val_loss: 2.2500e-05
Epoch 9/30
45/45 ━━━━━━━━━━━━━━━━━━━━ 33s 726ms/step - accuracy: 1.0000 - loss: 9.5568e-04 - val_accuracy: 1.0000 - val_loss: 1.0728e-05
```

In [ ]:
```
#buat plot dengan menggunakan history supaya jumlahnya sesuai epoch yang dilakukan
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 [10]:
```
model.save('gugelnet.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')`.
```

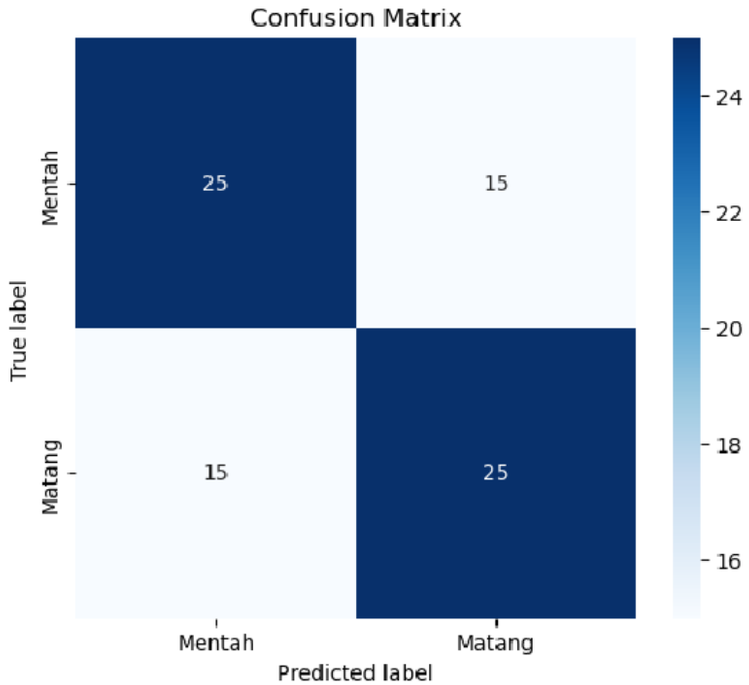
In [11]:

```python
import tensorflow as tf
import numpy as np
import matplotlib.pyplot as plt
from tensorflow.keras.models import load_model
from PIL import Image

# Load the trained model
model = load_model(r'C:\Kuliah\ASDOS ML\CNN Part 2\gugelnet.h5')  # Ganti dengan path model Anda
class_names = ['Matang', 'Mentah']

# Function to classify images and save the original image
def classify_images(image_path, save_path='predicted_image.jpg'):
    try:
        # Load and preprocess the image
        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)  # Add batch dimension

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

        # Display prediction and confidence in notebook
        print(f"Prediksi: {class_names[class_idx]}")
        print(f"Confidence: {confidence:.2f}%")

        # Save the original image (without text)
        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}"

# Contoh penggunaan fungsi
result = classify_images(r'test_data\Mentah\Immature_Dragon_Original_Data0012.jpg', save_path='mentah2.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 511ms/step
Prediksi: Mentah
Confidence: 73.11%
Prediksi: Mentah dengan confidence 73.11%. Gambar asli disimpan di mentah2.jpg.
```

In [17]:
```
import tensorflow as tf
from tensorflow.keras.models import load_model
import seaborn as sns
import matplotlib.pyplot as plt

# Muat data test yang sebenarnya
test_data = tf.keras.preprocessing.image_dataset_from_directory(
    r'test_data',
    labels='inferred',
    label_mode='categorical',  # Menghasilkan label dalam bentuk one-hot encoding
    batch_size=32,
    image_size=(180, 180)
)

# Prediksi model
y_pred = model.predict(test_data)
y_pred_class = tf.argmax(y_pred, axis=1)  # Konversi ke kelas prediksi

# Ekstrak label sebenarnya dari test_data dan konversi ke bentuk indeks kelas
true_labels = []
for _, labels in test_data:
    true_labels.extend(tf.argmax(labels, axis=1).numpy())  # Konversi one-hot ke indeks kelas
true_labels = tf.convert_to_tensor(true_labels)

# Membuat matriks kebingungan
conf_mat = tf.math.confusion_matrix(true_labels, y_pred_class)

# Menghitung akurasi
accuracy = tf.reduce_sum(tf.linalg.diag_part(conf_mat)) / tf.reduce_sum(conf_mat)

# Menghitung presisi dan recall
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)

# Menghitung F1 Score
f1_score = 2 * (precision * recall) / (precision + recall)

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

# Menampilkan hasil
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())
```

```
Found 80 files belonging to 2 classes.
3/3 ━━━━━━━━━━━━━━━━━━━━ 1s 192ms/step
```




```
Confusion Matrix:
 [[25 15]
 [15 25]]
Akurasi: 0.625
Presisi: [0.625 0.625]
Recall: [0.625 0.625]
F1 Score: [0.625 0.625]
```

Streamlit

- Buat file baru dengan ekstensi Python (.py) untuk membuat streamlit

In [ ]:
```python
import streamlit as st
import tensorflow as tf
import numpy as np
from tensorflow.keras.models import load_model
from PIL import Image

# Load the pre-trained model
# Sesuaikan dengan path model Anda (model terbaik yang di dump dalam format .h5)
model = load_model(r'D:\SURYA\UAJY\Semester 5\Asdos Machine Learning\Pemegang Modul\Modul CNN\Notebook2\model_mobilenet.h5')
class_names = ['Matang', 'Mentah']

# Function to preprocess and classify image
def classify_image(image_path):
    try:
        # Load and preprocess the image
        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)

        # Predict using the model
        predictions = model.predict(input_image_exp_dim)
        result = tf.nn.softmax(predictions[0])  # Apply softmax for probability

        # Get class with highest confidence
        class_idx = np.argmax(result)
        confidence_scores = result.numpy()
        return class_names[class_idx], confidence_scores
    except Exception as e:
        return "Error", str(e)

# Function to create a custom progress bar
def custom_progress_bar(confidence, color1, color2):
    percentage1 = confidence[0] * 100  # Confidence for class 0 (Matang)
    percentage2 = confidence[1] * 100  # Confidence for class 1 (Mentah)
    progress_html = f"""
    <div style="border: 1px solid #ddd; border-radius: 5px; overflow: hidden; width: 100%; font-size: 14px;">
        <div style="width: {percentage1:.2f}%; background: {color1}; color: white; text-align: center; height: 24px; float: left;">
            {percentage1:.2f}%
        </div>
        <div style="width: {percentage2:.2f}%; background: {color2}; color: white; text-align: center; height: 24px; float: left;">
            {percentage2:.2f}%
        </div>
    </div>
    """
    st.sidebar.markdown(progress_html, unsafe_allow_html=True)

# Streamlit UI
st.title("Prediksi Kematangan Buah Naga - XXXX")  # 4 digit npm terakhir

# Upload multiple files in the main page
uploaded_files = st.file_uploader("Unggah Gambar (Beberapa diperbolehkan)", type=["jpg", "png", "jpeg"], accept_multiple_files=True)

# Sidebar for prediction button and results
if st.sidebar.button("Prediksi"):
    if uploaded_files:
        st.sidebar.write("### Hasil Prediksi")
        for uploaded_file in uploaded_files:
            with open(uploaded_file.name, "wb") as f:
                f.write(uploaded_file.getbuffer())

            # Perform prediction
            label, confidence = classify_image(uploaded_file.name)

            if label != "Error":
                # Define colors for the bar and label
```

```
                primary_color = "#007BFF"  # Blue for "Matang"
                secondary_color = "#FF4136"  # Red for "Mentah"
                label_color = primary_color if label == "Matang" else secondary_color

                # Display prediction results
                st.sidebar.write(f"**Nama File:** {uploaded_file.name}")
                st.sidebar.markdown(f"<h4 style='color: {label_color};'>Prediksi: {label}</h4>", unsafe_allow_html=True)

                # Display confidence scores
                st.sidebar.write("**Confidence:**")
                for i, class_name in enumerate(class_names):
                    st.sidebar.write(f"- {class_name}: {confidence[i] * 100:.2f}%")

                # Display custom progress bar
                custom_progress_bar(confidence, primary_color, secondary_color)

                st.sidebar.write("---")
            else:
                st.sidebar.error(f"Kesalahan saat memproses gambar {uploaded_file.name}: {confidence}")
    else:
        st.sidebar.error("Silakan unggah setidaknya satu gambar untuk diprediksi.")

# Preview images in the main page
if uploaded_files:
    st.write("### Preview Gambar")
    for uploaded_file in uploaded_files:
        image = Image.open(uploaded_file)
        st.image(image, caption=f"{uploaded_file.name}", use_column_width=True)
```