Proyek Klasifikasi Gambar: facemask44k

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Import Semua Packages/Library yang Digunakan

```
# Sering digunakan
import os, shutil, zipfile, random, pathlib
from random import sample
from shutil import copyfile
from pathlib import Path
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from tqdm.notebook import tqdm as tq
```

```
# Pemrosesan data gambar
import cv2
from PIL import Image

import skimage
from skimage import io, img_as_ubyte
from skimage.transform import resize, rotate, AffineTransform, warp
from skimage.exposure import adjust_gamma
from skimage.util import random_noise
```

```
# Membangun model
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix, classification_report

import keras
import tensorflow as tf
from tensorflow.keras import Model, layers
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator, img_to_array, load_img
from tensorflow.keras.models import Sequential, Model
from tensorflow.keras.layers import InputLayer, Conv2D, SeparableConv2D, MaxPooling2D, MaxPool2D, Dense, Flatten, Dropout, Ba
from tensorflow.keras.applications import MobileNet
from tensorflow.keras.applications.densenet import DenseNet121
from tensorflow.keras.optimizers import Adam, RMSprop, SGD
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.callbacks import ModelCheckpoint, Callback, EarlyStopping, ReduceLROnPlateau
```

```
import warnings
warnings.simplefilter(action='ignore', category=FutureWarning)
```

Data Preparation

Data Loading

```
# Mount Google Drive
from google.colab import drive
drive.mount('/content/drive')
```

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

```
!mkdir -p ~/.kaggle
!cp /content/drive/MyDrive/kaggle.json ~/.kaggle/
!chmod 600 ~/.kaggle/kaggle.json
!kaggle datasets download -d istiakhasan/facemask44k
!unzip facemask44k.zip
```

Show hidden output

```
def print_images_resolution(directory):
    unique_sizes = set()
    total_images = 0
```

```
    image_files = [f for f in os.listdir(directory) if os.path.isfile(os.path.join(directory, f))]
    num_images = len(image_files)
    print(f"{directory}: {num_images}")
    total_images += num_images

    for img_file in image_files:
        img_path = os.path.join(directory, img_file)
        with Image.open(img_path) as img:
            unique_sizes.add(img.size)

    for size in unique_sizes:
        print(f"- {size}")

    print(f"\nTotal: {total_images}")
```

```
# Jumlah gambar beserta resolusinya
print('DATA WITH: ')
print_images_resolution('/content/Facemask-44k/dataset/with_mask')
print('\nDATA WITHOUT: ')
print_images_resolution('/content/Facemask-44k/dataset/without_mask')
```

```
DATA WITH:
/content/Facemask-44k/dataset/with_mask: 22471
- (224, 224)

Total: 22471

DATA WITHOUT:
/content/Facemask-44k/dataset/without_mask: 22479
- (224, 224)

Total: 22479
```

```
from PIL import ImageFile
ImageFile.LOAD_TRUNCATED_IMAGES = True
```

```
# Direktori untuk data train dan test
with_dir = '/content/Facemask-44k/dataset/with_mask'
without_dir = '/content/Facemask-44k/dataset/without_mask'

# Direktori data gabungan
combined_dir = 'dataset/'
os.makedirs(combined_dir, exist_ok=True)
```

```
# Menyalin file dari with
for category in os.listdir(with_dir):
    category_dir = os.path.join(with_dir, category)
    if os.path.isdir(category_dir):
        shutil.copytree(category_dir, os.path.join(combined_dir, category), dirs_exist_ok=True)

# Menyalin file dari without
for category in os.listdir(without_dir):
    category_dir = os.path.join(without_dir, category)
    if os.path.isdir(category_dir):
        shutil.copytree(category_dir, os.path.join(combined_dir, category), dirs_exist_ok=True)
```

```
# Membuat kamus yang menyimpan gambar untuk setiap kelas dalam data
cifake_image = {}
path = "/content/Facemask-44k/dataset"

for i in os.listdir(path):
    # path diubah dari path ke path agar sesuai
    cifake_image[i] = os.listdir(os.path.join(path, i))

# Menampilkan secara acak 5 gambar di bawah setiap kelas dari dataset
fig, axs = plt.subplots(len(cifake_image.keys()), 5, figsize=(15, 15))

for i, class_name in enumerate(os.listdir(path)):
    images = np.random.choice(cifake_image[class_name], 5, replace=False)

    for j, image_name in enumerate(images):
        img_path = os.path.join(path, class_name, image_name)
        img = Image.open(img_path).convert("L")  # Konversi menjadi skala keabuan
        axs[i, j].imshow(img, cmap='gray')
        axs[i, j].set(xlabel=class_name, xticks=[], yticks=[])


fig.tight_layout()
```

Data Preprocessing

Split Dataset

```
# Memanggil path yang menampung dataset gambar
mypath = "/content/Facemask-44k/dataset"
file_name = []
labels = []
full_path = []

for path, subdirs, files in os.walk(mypath):
    for name in files:
        full_path.append(os.path.join(path, name))
        labels.append(path.split('/')[-1])
        file_name.append(name)

# Memasukkan variabel yang sudah dikumpulkan menjadi sebuah dataframe
df = pd.DataFrame({"path":full_path, 'file_name':file_name, "labels":labels})
df.groupby(['labels']).size()
```

labels	0
with_mask	22471
without_mask	22479

dtype: int64

```
# Inisialisasi variabel X dan y
X = df['path']
y = df['labels']

# Split dataset
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

```
df_train = pd.DataFrame({'path':X_train, 'labels':y_train, 'set':'train'})
df_test = pd.DataFrame({'path':X_test, 'labels':y_test, 'set':'test'})

df_all = pd.concat([df_train, df_test], ignore_index=True)
```

```
dataset_awal = "/content/Facemask-44k/dataset"
dataset_final = "Dataset_Final/"

for index, row in tq(df_all.iterrows()):
    # Deteksi filepath
    file_path = row['path']
    if os.path.exists(file_path) == False:
            file_path = os.path.join(dataset_awal,row['labels'],row['image'].split('.')[0])

    # Buat direktori tujuan folder
    if os.path.exists(os.path.join(dataset_final,row['set'],row['labels'])) == False:
        os.makedirs(os.path.join(dataset_final,row['set'],row['labels']))

    # Tentukan tujuan file
    destination_file_name = file_path.split('/')[-1]
    file_dest = os.path.join(dataset_final,row['set'],row['labels'],destination_file_name)

    # Salin file dari sumber ke tujuan
    if os.path.exists(file_dest) == False:
        shutil.copy2(file_path,file_dest)
```

```
 44950/? [00:23<00:00, 1139.34it/s]
```

```
# Definisikan direktori training dan test
TRAIN_DIR = "Dataset_Final/train/"
TEST_DIR = "Dataset_Final/test/"

train_without = os.path.join(TRAIN_DIR + 'without_mask')
train_with = os.path.join(TRAIN_DIR + 'with_mask')
test_without = os.path.join(TEST_DIR + 'without_mask')
test_with = os.path.join(TEST_DIR + 'with_mask')

print("Total without mask training set: ",len(os.listdir(train_without)))
print("Total with mask training set: ",len(os.listdir(train_with)))
print("Total without mask test set: ",len(os.listdir(test_without)))
print("Total with mask test set: ",len(os.listdir(test_with)))
```

```
Total without mask training set:  18020
Total with mask training set:  17940
Total without mask test set:  4459
Total with mask test set:  4531
```

```
# Normaliasai data menggunakan ImageDataGenerator
datagen = ImageDataGenerator(rescale=1/255.,
                             validation_split=0.2,)
test_datagen = ImageDataGenerator(rescale=1./255)

train_generator = datagen.flow_from_directory(TRAIN_DIR,
                                              batch_size=32,
                                              target_size=(150,150),
                                              color_mode='grayscale',
                                              class_mode='binary',
                                              subset='training',
                                              shuffle=True)

validation_generator = datagen.flow_from_directory(TRAIN_DIR,
                                              batch_size=32,
                                              target_size=(150,150),
                                              color_mode='grayscale',
                                              class_mode='binary',
                                              subset='validation',
                                              shuffle=True)

test_generator = test_datagen.flow_from_directory(TEST_DIR,
                                              batch_size=1,
                                              target_size=(150,150),
                                              color_mode='grayscale',
                                              class_mode='binary',
                                              shuffle=True)
```

```
Found 28768 images belonging to 2 classes.
Found 7192 images belonging to 2 classes.
Found 8990 images belonging to 2 classes.
```

Modelling

```
# Menggunakan convolution, batch normalization, dan max pooling layer sebanyak 3 kali
model = Sequential([
    Conv2D(32,(3,3), padding='same', activation='relu', input_shape=(150,150,1)),
    BatchNormalization(),
    MaxPool2D(2,2),

    Conv2D(32,(4,4), padding='same', activation='relu'),
    BatchNormalization(),
    MaxPool2D(2,2),

    Conv2D(32,(7,7), padding='same', activation='relu'),
    BatchNormalization(),
    MaxPool2D(2,2),

    Flatten(), # Flatten layer
    Dense(128, activation='relu'), # Dense 1
    Dropout(0.5), # Dropout 1
    Dense(64, activation='relu'), # Dense 2
    Dropout(0.3), # Dropout 2
    Dense(1, activation='sigmoid')
])

# Compile model
model.compile(optimizer=tf.keras.optimizers.Adam(learning_rate=0.001),
              loss='binary_crossentropy',
              metrics=['accuracy'])

print(model.summary())
```

```
/usr/local/lib/python3.12/dist-packages/keras/src/layers/convolutional/base_conv.py:113: UserWarning: Do not pass an `input_sha
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
Model: "sequential"
```

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 150, 150, 32)	320
batch_normalization (BatchNormalization)	(None, 150, 150, 32)	128
max_pooling2d (MaxPooling2D)	(None, 75, 75, 32)	0
conv2d_1 (Conv2D)	(None, 75, 75, 32)	16,416
batch_normalization_1 (BatchNormalization)	(None, 75, 75, 32)	128
max_pooling2d_1 (MaxPooling2D)	(None, 37, 37, 32)	0
conv2d_2 (Conv2D)	(None, 37, 37, 32)	50,208
batch_normalization_2 (BatchNormalization)	(None, 37, 37, 32)	128
max_pooling2d_2 (MaxPooling2D)	(None, 18, 18, 32)	0
flatten (Flatten)	(None, 10368)	0
dense (Dense)	(None, 128)	1,327,232
dropout (Dropout)	(None, 128)	0
dense_1 (Dense)	(None, 64)	8,256
dropout_1 (Dropout)	(None, 64)	0
dense_2 (Dense)	(None, 1)	65

```
 Total params: 1,402,881 (5.35 MB)
 Trainable params: 1,402,689 (5.35 MB)
 Non-trainable params: 192 (768.00 B)
None
```

```
# Hitung class weight
count_with = len(os.listdir(os.path.join(TRAIN_DIR, 'with_mask')))
count_without = len(os.listdir(os.path.join(TRAIN_DIR, 'without_mask')))
total = count_with + count_without
class_weight = {
    0: (1 / count_with) * total / 2.0,
    1: (1 / count_without) * total / 2.0
}
```

```
# Callbacks
callbacks = [
    EarlyStopping(monitor='val_loss', patience=5, restore_best_weights=True),
    ReduceLROnPlateau(factor=0.2, patience=3, min_lr=1e-6),
    ModelCheckpoint('best_model.h5', save_best_only=True)
]
```

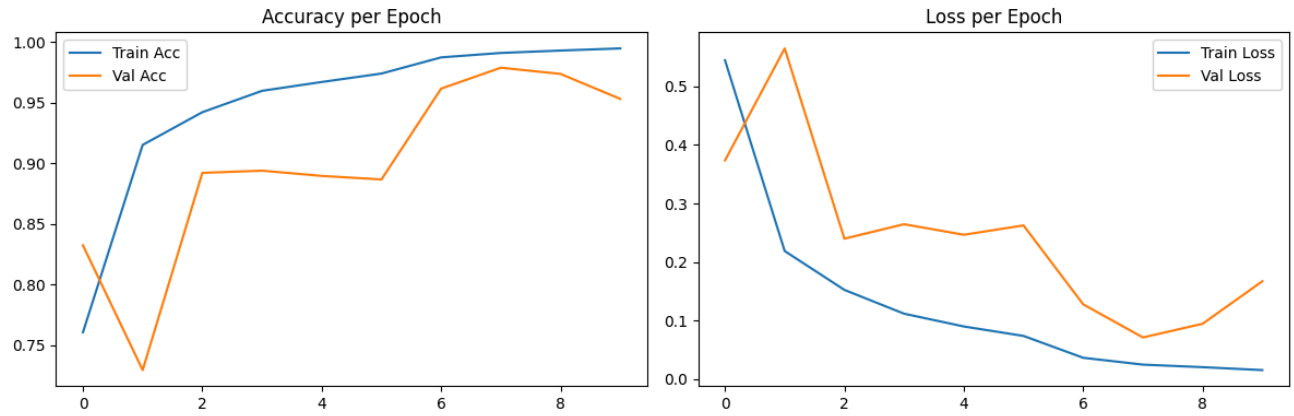
Evaluasi dan Visualisasi

```
# Train model
history = model.fit(train_generator,
                    epochs=10,
                    validation_data=validation_generator,
                    class_weight=class_weight,
                    callbacks=callbacks)
```

```
Epoch 1/10
/usr/local/lib/python3.12/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:121: UserWarning: Your `PyDataset
  self._warn_if_super_not_called()
899/899 ━━━━━━━━━━━━━━━━━━━━ 0s 88ms/step - accuracy: 0.6715 - loss: 0.8015WARNING:absl:You are saving your model as an HDF5 fi
899/899 ━━━━━━━━━━━━━━━━━━━━ 111s 111ms/step - accuracy: 0.6716 - loss: 0.8012 - val_accuracy: 0.8322 - val_loss: 0.3736 - lear
Epoch 2/10
899/899 ━━━━━━━━━━━━━━━━━━━━ 130s 108ms/step - accuracy: 0.9053 - loss: 0.2463 - val_accuracy: 0.7293 - val_loss: 0.5652 - lear
Epoch 3/10
899/899 ━━━━━━━━━━━━━━━━━━━━ 0s 90ms/step - accuracy: 0.9372 - loss: 0.1635WARNING:absl:You are saving your model as an HDF5 fi
899/899 ━━━━━━━━━━━━━━━━━━━━ 99s 111ms/step - accuracy: 0.9372 - loss: 0.1635 - val_accuracy: 0.8920 - val_loss: 0.2398 - learn
Epoch 4/10
899/899 ━━━━━━━━━━━━━━━━━━━━ 99s 110ms/step - accuracy: 0.9604 - loss: 0.1092 - val_accuracy: 0.8938 - val_loss: 0.2645 - learn
Epoch 5/10
899/899 ━━━━━━━━━━━━━━━━━━━━ 102s 113ms/step - accuracy: 0.9676 - loss: 0.0890 - val_accuracy: 0.8895 - val_loss: 0.2465 - lear
Epoch 6/10
899/899 ━━━━━━━━━━━━━━━━━━━━ 101s 112ms/step - accuracy: 0.9751 - loss: 0.0704 - val_accuracy: 0.8865 - val_loss: 0.2624 - lear
Epoch 7/10
899/899 ━━━━━━━━━━━━━━━━━━━━ 0s 89ms/step - accuracy: 0.9853 - loss: 0.0418WARNING:absl:You are saving your model as an HDF5 fi
899/899 ━━━━━━━━━━━━━━━━━━━━ 98s 109ms/step - accuracy: 0.9853 - loss: 0.0417 - val_accuracy: 0.9615 - val_loss: 0.1275 - learn
Epoch 8/10
899/899 ━━━━━━━━━━━━━━━━━━━━ 0s 89ms/step - accuracy: 0.9910 - loss: 0.0228WARNING:absl:You are saving your model as an HDF5 fi
899/899 ━━━━━━━━━━━━━━━━━━━━ 97s 108ms/step - accuracy: 0.9910 - loss: 0.0228 - val_accuracy: 0.9787 - val_loss: 0.0709 - learn
Epoch 9/10
899/899 ━━━━━━━━━━━━━━━━━━━━ 96s 107ms/step - accuracy: 0.9928 - loss: 0.0199 - val_accuracy: 0.9736 - val_loss: 0.0942 - learn
Epoch 10/10
899/899 ━━━━━━━━━━━━━━━━━━━━ 97s 108ms/step - accuracy: 0.9951 - loss: 0.0141 - val_accuracy: 0.9530 - val_loss: 0.1669 - learn
```

```
# Plot akurasi dan loss tiap epoch
plt.figure(figsize=(12, 4))
plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Train Acc')
plt.plot(history.history['val_accuracy'], label='Val Acc')
plt.title('Accuracy per Epoch')
plt.legend()

plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Train Loss')
plt.plot(history.history['val_loss'], label='Val Loss')
plt.title('Loss per Epoch')
plt.legend()
plt.tight_layout()
plt.show()
```



```
test_loss, test_acc = model.evaluate(test_generator)
print("Test Accuracy:", test_acc)
print("Test Loss:", test_loss)
```

```
8990/8990 ━━━━━━━━━━━━━━━━━━━━ 40s 4ms/step - accuracy: 0.9795 - loss: 0.0654
Test Accuracy: 0.9797552824020386
Test Loss: 0.06475349515676498
```

Konversi Model

```
# Menyimpan model menggunakan saved_model
save_path = 'mymodel/'
# Use the native Keras format for saving the model
model.save('my_model.keras')
```

```
# Menyimpan model dalam bentuk TF-Lite
# Use the native Keras model for TFLite conversion
converter = tf.lite.TFLiteConverter.from_keras_model(model)
tflite_model = converter.convert()

tflite_model_file = pathlib.Path('model.tflite')
tflite_model_file.write_bytes(tflite_model)
```

Show hidden output

```
# TFJS
# Save the model in the native Keras format before converting to TFJS
model.save("my_model.keras")

# Install tensorflowjs
!pip install tensorflowjs

# Convert model.h5 to model
# Convert the native Keras model to TFJS
!tensorflowjs_converter --input_format=keras my_model.keras tfjs_model
```

Show hidden output

Inference Photos

```
import requests

image_urls = [
    "https://raw.githubusercontent.com/RifaldiAchmad/Face-Mask-Detection-Using-CNN/main/image/people_1.png",
    "https://raw.githubusercontent.com/RifaldiAchmad/Face-Mask-Detection-Using-CNN/main/image/people_2.jpg"
]

for image_url in image_urls:
    image_filename = image_url.split("/")[-1]
    response = requests.get(image_url, stream=True)
    if response.status_code == 200:
        with open(image_filename, 'wb') as out_file:
            out_file.write(response.content)
        print(f"Downloaded {image_filename}")
    else:
        print(f"Failed to download image {image_filename}. Status code: {response.status_code}")
```

```
Downloaded people_1.png
Downloaded people_2.jpg
```

```
from PIL import Image
import matplotlib.pyplot as plt

image_filenames = ["people_1.png", "people_2.jpg"]

for image_filename in image_filenames:
    try:
        img = Image.open(image_filename)
        plt.imshow(img)
        plt.title(image_filename)
        plt.axis('off') # Hide axes
        plt.show()
    except FileNotFoundError:
        print(f"Error: {image_filename} not found. Please make sure you have downloaded the images.")
```

people_1.png

people_2.jpg

```
# Load TFLite model
interpreter = tf.lite.Interpreter(model_path='model.tflite')
interpreter.allocate_tensors()

# Dapatkan detail input/output
input_details = interpreter.get_input_details()
output_details = interpreter.get_output_details()
```

Show hidden output

```
# Fungsi preprocessing gambar
def preprocess_image(image_path, target_size=(150, 150)):
    img = Image.open(image_path).convert('L').resize(target_size)
    img_array = np.array(img, dtype=np.float32) / 255.0
    img_array = np.expand_dims(img_array, axis=0)     # (1, 150, 150)
    img_array = np.expand_dims(img_array, axis=-1)    # (1, 150, 150, 1)
    return img_array.astype(np.float32)
```

```
# @title
# Load gambar dan preprocess gambar people_1
img_array = preprocess_image('/content/people_1.png')
interpreter.set_tensor(input_details[0]['index'], img_array) # Set input
interpreter.invoke() # Run inference

# Ambil output prediksi
pred = interpreter.get_tensor(output_details[0]['index'])[0][0]

# Tampilkan hasil prediksi
print(f"Predicted class: {'without_mask' if pred > 0.5 else 'with_mask'} | Confidence: {pred:.6f}")
```

```
Predicted class: without_mask | Confidence: 1.000000
```

```
# Load gambar dan preprocess gambar people_2
img_array_2 = preprocess_image('/content/people_2.jpg')
interpreter.set_tensor(input_details[0]['index'], img_array_2) # Set input
interpreter.invoke() # Run inference

# Ambil output prediksi
pred_2 = interpreter.get_tensor(output_details[0]['index'])[0][0]
```

```
# Tampilkan hasil prediksi
print(f"Predicted class: {'without_mask' if pred_2 > 0.5 else 'with_mask'} | Confidence: {pred:.6f}")
```

```
Predicted class: with_mask | Confidence: 1.000000
```