dicoding

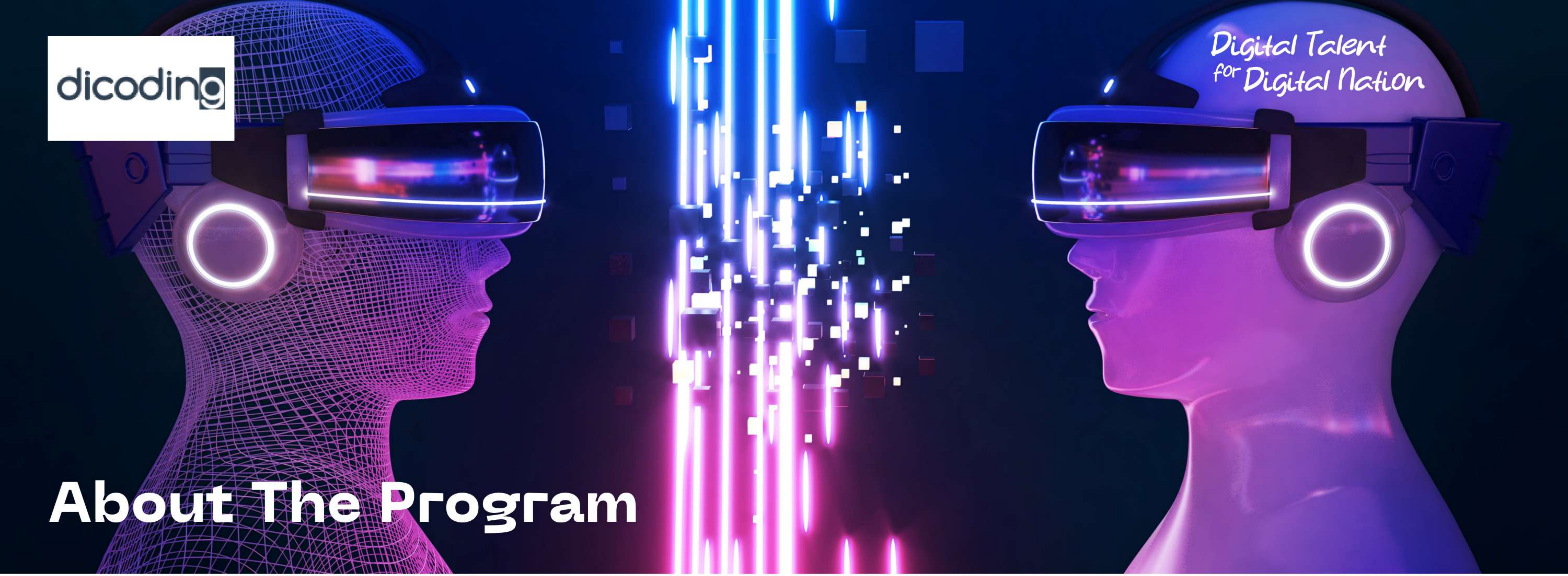
DBS Foundation

FINAL PROJECT:
Rock Paper Scissors Classification Using CNN Sequential Model

DBS Foundation Coding Camp 2024

by: Rendika N.S.

24 - 01 - 2024



About The Program

DBS Foundation Coding Camp adalah inisiatif pelatihan coding online yang bertujuan meningkatkan kompetensi masyarakat Indonesia di bidang teknologi informasi. Sebagai bagian dari DBS Foundation, yang fokus pada menciptakan dampak positif melalui kewirausahaan sosial, program ini telah sukses memberikan lebih dari 52.000 beasiswa coding kepada talenta digital Indonesia pada tahun 2023. Pada tahun 2024, DBS Foundation Coding Camp akan melanjutkan misinya dengan menyediakan puluhan ribu beasiswa pelatihan coding online dalam alur belajar Front-End Web Developer dan Machine Learning Developer. Beasiswa ini mencakup berbagai level, mulai dari Dasar hingga Mahir, sehingga memberikan peluang bagi peserta untuk mengembangkan keterampilan literasi keuangan dan digital yang dibutuhkan untuk masa depan yang lebih baik.

Overview

FINAL PROJECT IMAGE CLASSIFICATION

USING TENSORFLOW TO CLASSIFY IMAGES OF SCISSORS, ROCK AND PAPER GET PERFECT GRADES IN THE ASSESSMENT AND SUCCESSFULLY COMPLETE THE TASK PERFECTLY AND AS SOON AS POSSIBLE

Proyek Akhir : Klasifikasi Gambar

Aktivitas Terbaru

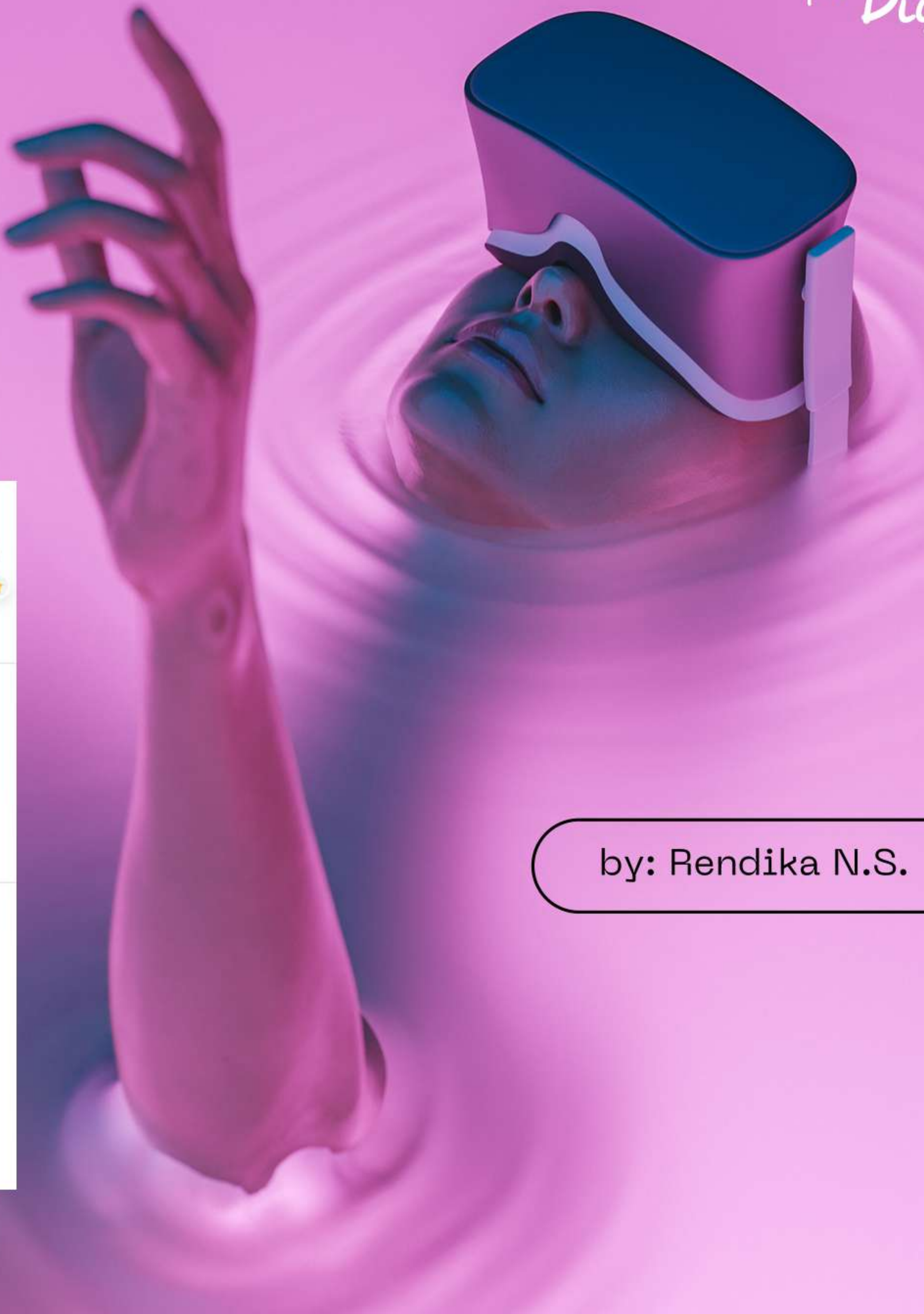
Upload — Review selesai — Diterima

Submission info

Student Name	RENDIKA NURHARTANTO SUHARTO (rendika7)	Submission ID	2818858
Course	Belajar Machine Learning untuk Pemula	Dikirim pada	24-Jan-2024 01:34:55
Submission	Proyek Akhir : Klasifikasi Gambar	Tipe Enrollment	Token: DBS Foundation Coding Camp 2024: Machine Learning Developer

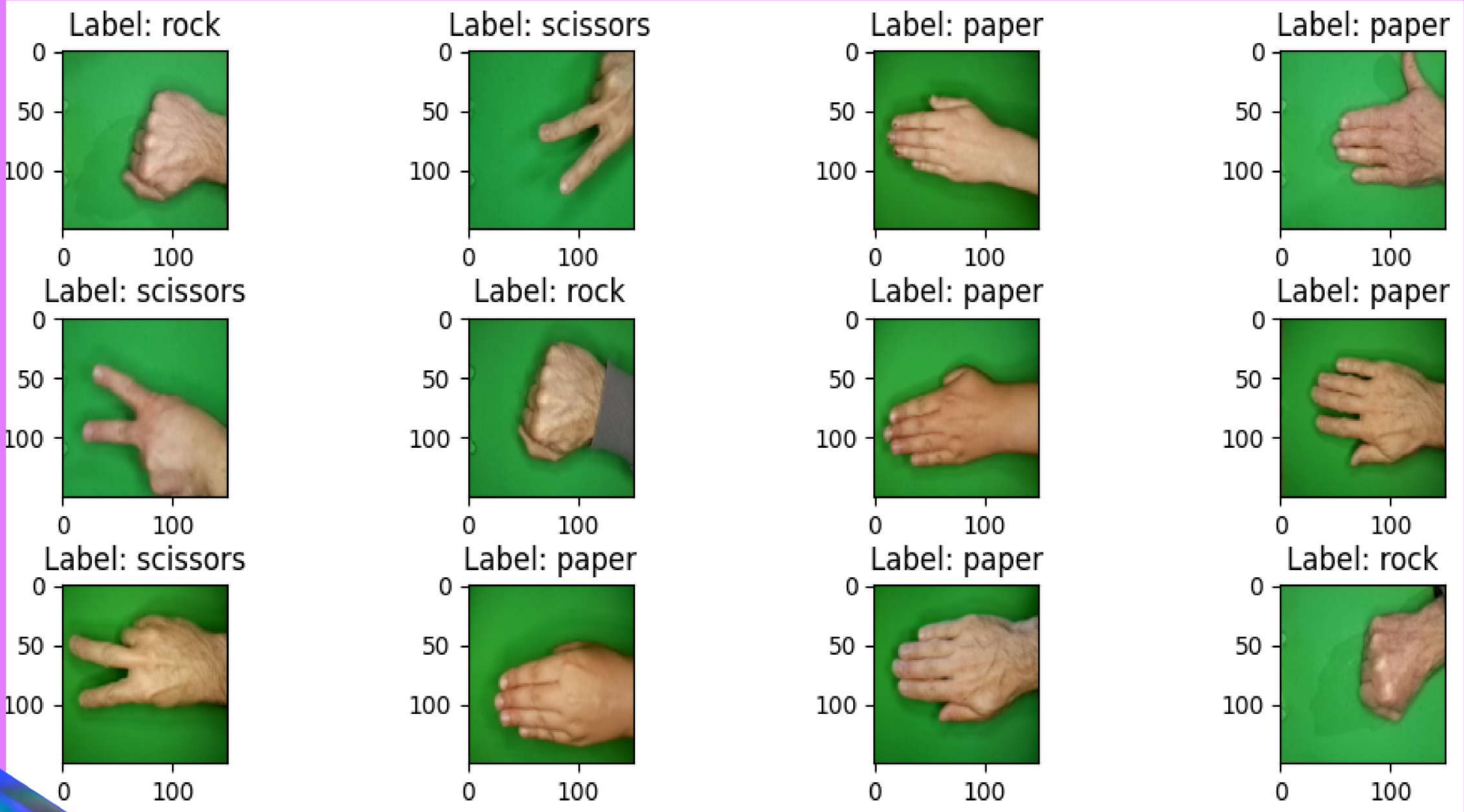
DBS Foundation

Digital Talent for Digital Nation



by: Rendika N.S.

TAKE A LOOK **DATA SETS**



1312
DATA TRAIN

879
DATA TEST

750
Scissors

726
Rock

712
Paper

2188
Total Data

DBS Foundation

MY ACCURACY

97.7%

How can I get that accuracy

Let's Check It Out

by: Rendika N.S.

AUGMENTATION IMAGE

No Need to Augmentation our validation data

Data augmentasi dilakukan hanya pada data train karena data dibuat lebih banyak untuk melatih model, bukan untuk melakukan evaluasi model. Jika data augmentation dilakukan di data tes maka dapat menghasilkan evaluasi model yang bias.

IMAGE AUGMENTATION

```
train_datagenerator = ImageDataGenerator(
                      rescale=1./255,
                      horizontal_flip=True, #horizontal flip untuk p
                      vertical_flip=True,
                      rotation_range=20, #random rotation antara 0-9
                      width_shift_range=0.2, #prosentasi width untuk
                      height_shift_range=0.2, #prosentasi height unt
                      zoom_range = 0.2,
                      shear_range=0.1,
                      fill_mode = 'nearest')

validation_datagenerator = ImageDataGenerator(
                      rescale=1./255,
                      fill_mode = 'nearest')
```

Sumber:

https://shorturl.at/erzA9

CNN ARCHITECTURE

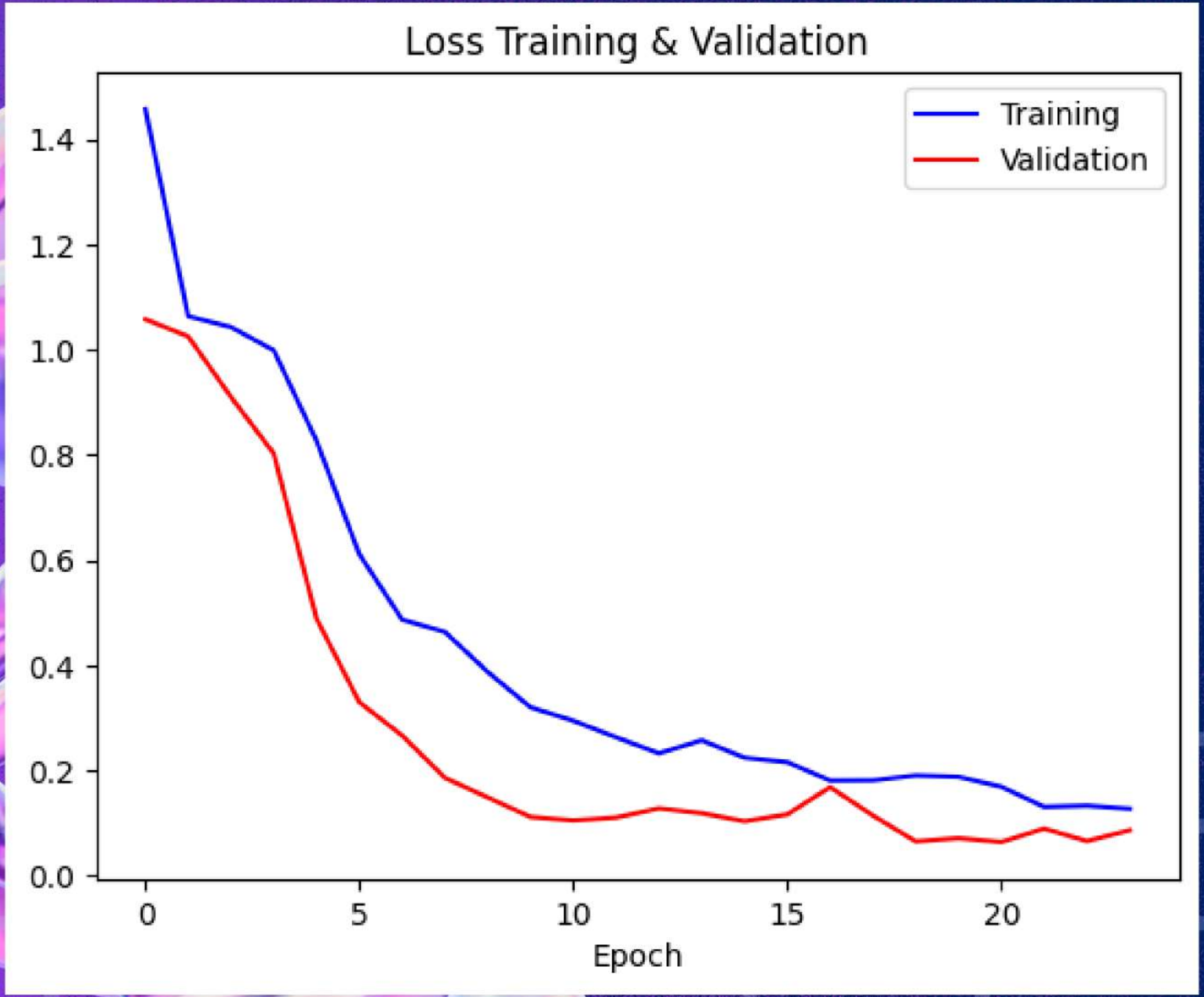
Model sederhana Deep Learning 2 Conv dan 2 Fully Connected Layer (dense layer) #Jadi, terdapat dua lapisan konvolusi, satu lapisan Flatten, satu lapisan Dropout, dan dua lapisan Dense (fully connected) dalam model ini.

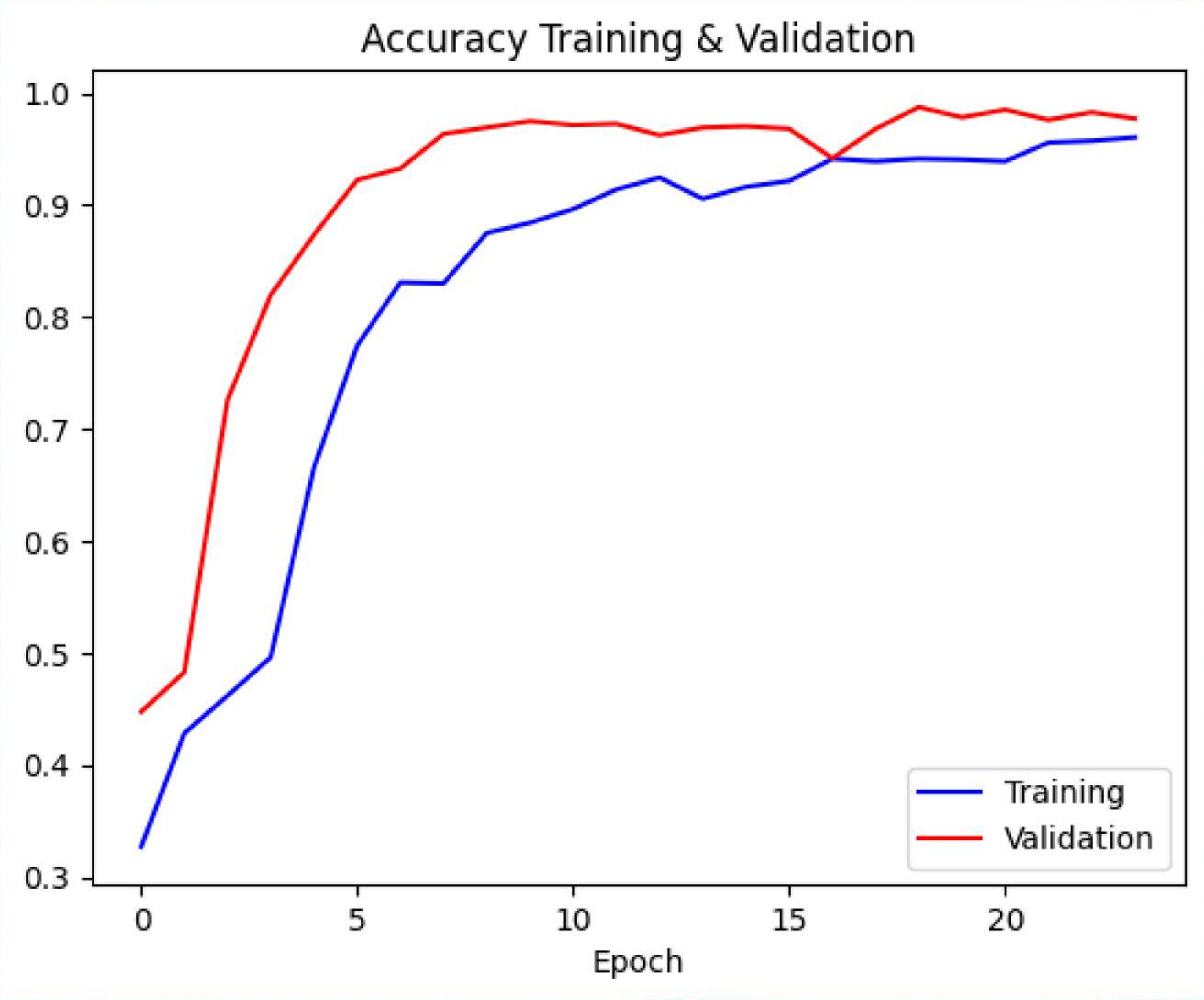
MODEL CNN SEQUENTIAL

```
model = tf.keras.models.Sequential([
  tf.keras.layers.Conv2D(32, (3,3), activation='relu', input_shape=(150, 150, 3)),
  tf.keras.layers.MaxPooling2D(2, 2),
  tf.keras.layers.Conv2D(32, (3,3), activation='relu'),
  tf.keras.layers.MaxPooling2D(2,2),

  tf.keras.layers.Flatten(),
  tf.keras.layers.Dropout(0.3), #melakukan dropout(mematikan neuron) pada 30% layer
sebelumnya
  tf.keras.layers.Dense(512, activation='relu'),
  tf.keras.layers.Dense(3, activation='softmax') #3 kelas
])
```

Loss Training & Validation

Accuracy Training & Validation





THANK YOU!

Don’t hesitate to contact me or comment down below

DBS Foundation

Here the code:

bit.ly/ML-DBSxDicoding

submission

January 24, 2024

[1]:
```
!pip install opencv-python matplotlib
```

```
Requirement already satisfied: opencv-python in /usr/local/lib/python3.10/dist-
packages (4.8.0.76)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.10/dist-
packages (3.7.1)
Requirement already satisfied: numpy>=1.21.2 in /usr/local/lib/python3.10/dist-
packages (from opencv-python) (1.23.5)
Requirement already satisfied: contourpy>=1.0.1 in
/usr/local/lib/python3.10/dist-packages (from matplotlib) (1.2.0)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.10/dist-
packages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in
/usr/local/lib/python3.10/dist-packages (from matplotlib) (4.47.2)
Requirement already satisfied: kiwisolver>=1.0.1 in
/usr/local/lib/python3.10/dist-packages (from matplotlib) (1.4.5)
Requirement already satisfied: packaging>=20.0 in
/usr/local/lib/python3.10/dist-packages (from matplotlib) (23.2)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.10/dist-
packages (from matplotlib) (9.4.0)
Requirement already satisfied: pyparsing>=2.3.1 in
/usr/local/lib/python3.10/dist-packages (from matplotlib) (3.1.1)
Requirement already satisfied: python-dateutil>=2.7 in
/usr/local/lib/python3.10/dist-packages (from matplotlib) (2.8.2)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-
packages (from python-dateutil>=2.7->matplotlib) (1.16.0)
```

[2]:
```
pip install split-folders
```

```
Collecting split-folders
  Downloading split_folders-0.5.1-py3-none-any.whl (8.4 kB)
Installing collected packages: split-folders
Successfully installed split-folders-0.5.1
```

[12]:
```
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import splitfolders
import os, os.path
```

```python
from PIL import Image
import time
import numpy as np
from google.colab import files
import keras.utils as image
import random
import shutil
from keras.preprocessing import image
```

[13]:
```python
import tensorflow as tf
import numpy as np
import pandas as pd
from tensorflow import keras

print("the version of tensorflow that use in this session is " + tf.__version__)
```

```
the version of tensorflow that use in this session is 2.15.0
```

[16]:
```python
import tensorflow as tf
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.python.keras.models import Sequential
from tensorflow.keras.preprocessing.image import load_img, img_to_array
from tensorflow.python.keras.layers import Dense, Flatten,␣
 ↪GlobalAveragePooling2D, Conv2D, MaxPooling2D
from tensorflow.python.keras.callbacks import ModelCheckpoint, EarlyStopping
```

1 Load File

[5]:
```python
# path joining version for other paths - Banyaknya data yang dimiliki
paper_dir = '/content/drive/MyDrive/Colab Notebooks/Machine Learning | DFS␣
 ↪Foundation X Dicoding/rockpaperscissors/Data RockPaperScissors/paper'
print ("Paper:", sum(len(files) for _, _, files in os.walk(paper_dir)))
rock_dir = '/content/drive/MyDrive/Colab Notebooks/Machine Learning | DFS␣
 ↪Foundation X Dicoding/rockpaperscissors/Data RockPaperScissors/rock'
print ("Rock:", sum(len(files) for _, _, files in os.walk(rock_dir)))
scissors_dir = '/content/drive/MyDrive/Colab Notebooks/Machine Learning | DFS␣
 ↪Foundation X Dicoding/rockpaperscissors/Data RockPaperScissors/scissors'
print ("Scissors:", sum(len(files) for _, _, files in os.walk(scissors_dir)))

main_dir = '/content/drive/MyDrive/Colab Notebooks/Machine Learning | DFS␣
 ↪Foundation X Dicoding/rockpaperscissors/Data RockPaperScissors'
print ("Total Data:", sum(len(files) for _, _, files in os.walk(main_dir)))
```

```
Paper: 712
Rock: 726
Scissors: 750
```

```
Total Data: 2188
```

[6]:
```
# Definisikan path untuk direktori data train dan validation
train_dir = '/content/drive/MyDrive/Colab Notebooks/Machine Learning | DFS␣
↪Foundation X Dicoding/rockpaperscissors/Data_train'
validation_dir = '/content/drive/MyDrive/Colab Notebooks/Machine Learning | DFS␣
↪Foundation X Dicoding/rockpaperscissors/Data_validation'
# test_dir = '/content/drive/MyDrive/Colab Notebooks/Dicoding - IDCamp/Machine␣
↪Learning/rockpaperscissors/testing images'


# # Buat direktori train dan validation untuk menampung data yang di split
os.makedirs(train_dir, exist_ok=True)
os.makedirs(validation_dir, exist_ok=True)
```

[7]:
```
# Fungsi untuk membagi data menjadi train dan validation
def split_data(source, train, validation, split_size):
    files = os.listdir(source)
    random.sample(files, len(files))  # Acak urutan file untuk memastikan␣
↪pemilihan acak

    train_files = files[:int(len(files) * split_size)]
    validation_files = files[int(len(files) * split_size):]

    os.makedirs(train, exist_ok=True)  # Buat direktori train jika belum ada
    os.makedirs(validation, exist_ok=True)  # Buat direktori validation jika␣
↪belum ada

    for file in train_files:
        shutil.copy(os.path.join(source, file), os.path.join(train, file))

    for file in validation_files:
        shutil.copy(os.path.join(source, file), os.path.join(validation, file))

# Bagi data untuk setiap kategori
split_data(paper_dir, train_dir + '/paper', validation_dir + '/paper', 0.6)
split_data(rock_dir, train_dir + '/rock', validation_dir + '/rock', 0.6)
split_data(scissors_dir, train_dir + '/scissors', validation_dir + '/scissors',␣
↪0.6)
```

[8]:
```
# Hitung total data train dan validation
total_train = sum(len(files) for _, _, files in os.walk(train_dir))
total_validation = sum(len(files) for _, _, files in os.walk(validation_dir))


print(f"Total Data Train: {total_train}")
print(f"Total Data Validation: {total_validation}")
```

```
Total Data Train: 1312
Total Data Validation: 876
```

2 Checking Data

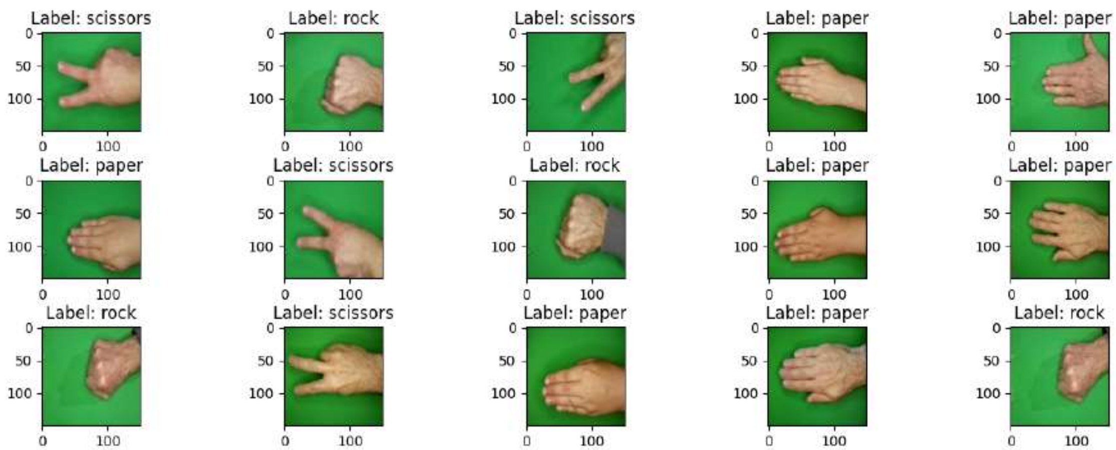
[10]:
```
labels = ['paper','scissors','rock']
nb = len(labels)
```

[9]:
```
def input_target_split(train_dir,labels):
    dataset = []
    count = 0
    for label in labels:
        folder = os.path.join(train_dir,label)
        for image in os.listdir(folder):
            img=load_img(os.path.join(folder,image), target_size=(150,150))
            img=img_to_array(img)
            img=img/255.0
            dataset.append((img,count))
        print(f'\rCompleted: {label}',end='')
        count+=1
    random.shuffle(dataset)
    X, y = zip(*dataset)

    return np.array(X),np.array(y)
```

[17]:
```
X, y = input_target_split(main_dir,labels)
```

```
Completed: rock
```

[18]:
```
plt.figure(figsize = (15 , 9))
n = 0
for i in range(15):
    n+=1
    plt.subplot(5 , 5, n)
    plt.subplots_adjust(hspace = 0.5 , wspace = 0.3)
    plt.imshow(X[i])
    plt.title(f'Label: {labels[y[i]]}')
```



3 Image Generator + Augmentation Image

[20]:
```
# Image augmentation
train_datagenerator = ImageDataGenerator(
                    rescale=1./255,
                    horizontal_flip=True, #horizontal flip untuk posisi tangan horizontal
                    vertical_flip=True,
                    rotation_range=20, #random rotation antara 0-90 derajat
                    width_shift_range=0.2, #prosentasi width untuk random shift
                    height_shift_range=0.2, #prosentasi height untuk random shift
                    zoom_range = 0.2,
                    shear_range=0.1,
                    fill_mode = 'nearest')

validation_datagenerator = ImageDataGenerator(
                    rescale=1./255,
                    fill_mode = 'nearest')
```

[21]:
```
#Persiapan Data Training dan Validasi Generator

train_generator = train_datagenerator.flow_from_directory(
        train_dir,  # direktori data latih
        target_size=(150, 150),  # mengubah resolusi seluruh gambar menjadi 150x150 piksel
        class_mode='categorical', # Klasifikasi Multi-Class (>2)
        batch_size=50,
        shuffle = True,
        seed = 7)
```

```
validation_generator = validation_datagenerator.flow_from_directory(
        validation_dir, # direktori data validasi
        target_size=(150, 150), # mengubah resolusi seluruh gambar menjadi␣
 ↪150x150 piksel
        batch_size=50,
        class_mode='categorical', # Klasifikasi Multi-Class (>2)
        shuffle = True,
        # subset = "training", # Training berarti data validasi dibagi␣
 ↪sedemikian rupa, dan yang ini digunakan untuk menguji performa model dengan␣
 ↪validasi
        seed = 7)
```

```
Found 1312 images belonging to 3 classes.
Found 876 images belonging to 3 classes.
```

4 Callback for monitoring the accuracy

[45]:
```
#Penggunaan Callback untuk menghentikan proses training sesuai akurasi yang␣
 ↪diinginkan

class myCallback(tf.keras.callbacks.Callback):
    def on_epoch_end(self, epoch, logs={}):
        val_accuracy = logs.get('val_accuracy')
        accuracy = logs.get('accuracy')

        if val_accuracy is not None and accuracy is not None:
            if val_accuracy > 0.96 and accuracy > 0.96:
                print("\nSudah >96% nih akurasinya jadi diberhentikan saja!")
                self.model.stop_training = True
            else:
                print("\nBelum mencapai akurasi >96%, lanjutkan training.")
        else:
            print("\nNilai akurasi tidak tersedia. Lanjutkan training.")


callbacks = myCallback()
```

5 Deep learning Arsitektur sequential model

[46]:
```
#Model sederhana Deep Learning 2 Conv dan 2 Fully Connected Layer (dense layer)
model = tf.keras.models.Sequential([ #Menggunakan model Sequential
  tf.keras.layers.Conv2D(32, (3,3), activation='relu', input_shape=(150, 150,␣
 ↪3)),
  tf.keras.layers.MaxPooling2D(2, 2),
```

```
  tf.keras.layers.Conv2D(32, (3,3), activation='relu'),
  tf.keras.layers.MaxPooling2D(2,2),

  tf.keras.layers.Flatten(),
  tf.keras.layers.Dropout(0.3), #melakukan dropout(mematikan neuron) pada 30%␣
↪layer sebelumnya
  tf.keras.layers.Dense(512, activation='relu'),
  tf.keras.layers.Dense(3, activation='softmax') #3 kelas
])

#Jadi, terdapat dua lapisan konvolusi, satu lapisan Flatten, satu lapisan␣
↪Dropout, dan dua lapisan Dense (fully connected) dalam model ini.
```

[47]:
```
# Meng-compile model dengan Adam Optimizer dengan loss Categorical_Crossentropy␣
↪karena multiclass classification
model.compile(loss='categorical_crossentropy',
              optimizer=tf.optimizers.Adam(learning_rate = 0.001),
              metrics=['accuracy'])
```

[48]:
```
model.summary()
```

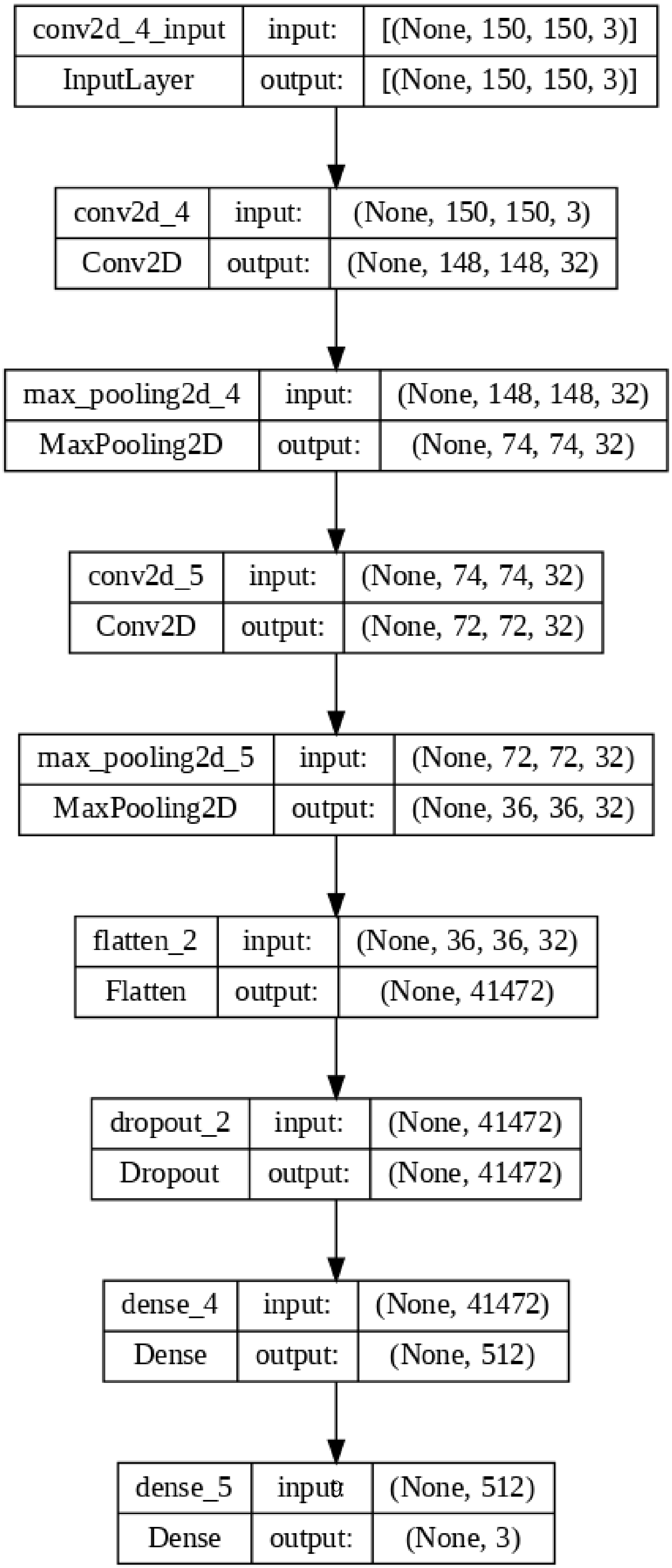
```
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_4 (Conv2D)           (None, 148, 148, 32)      896

 max_pooling2d_4 (MaxPoolin  (None, 74, 74, 32)        0
 g2D)

 conv2d_5 (Conv2D)           (None, 72, 72, 32)        9248

 max_pooling2d_5 (MaxPoolin  (None, 36, 36, 32)        0
 g2D)

 flatten_2 (Flatten)         (None, 41472)             0

 dropout_2 (Dropout)         (None, 41472)             0

 dense_4 (Dense)             (None, 512)               21234176

 dense_5 (Dense)             (None, 3)                 1539

=================================================================
Total params: 21245859 (81.05 MB)
Trainable params: 21245859 (81.05 MB)
Non-trainable params: 0 (0.00 Byte)
```

----

6 Visualize of my model architecture

[49]:
```
model_viz = tf.keras.utils.plot_model(model,
                                      # to_file='model.png',
                                      show_shapes=True,
                                      show_layer_names=True,
                                      rankdir='TB',
                                      expand_nested=True,
                                      dpi=100)
model_viz
```

[49]:


conv2d_4_input
InputLayer
input:
output:
[(None, 150, 150, 3)]
[(None, 150, 150, 3)]
conv2d_4
Conv2D
input:
output:
(None, 150, 150, 3)
(None, 148, 148, 32)
max_pooling2d_4
MaxPooling2D
input:
output:
(None, 148, 148, 32)
(None, 74, 74, 32)
conv2d_5
Conv2D
input:
output:
(None, 74, 74, 32)
(None, 72, 72, 32)
max_pooling2d_5
MaxPooling2D
input:
output:
(None, 72, 72, 32)
(None, 36, 36, 32)
flatten_2
Flatten
input:
output:
(None, 36, 36, 32)
(None, 41472)
dropout_2
Dropout
input:
output:
(None, 41472)
(None, 41472)
dense_4
Dense
input:
output:
(None, 41472)
(None, 512)
dense_5
Dense
input:
output:
(None, 512)
(None, 3)

7 Let's Train The Model Now

7.0.1 Assign the initial parameter values for Training Model

[50]:
```
# Jumlah data dalam train_generator
total_train_data = train_generator.n
print("Total data di train_generator:", total_train_data)

# Jumlah data dalam validation_generator
total_validation_data = validation_generator.n
print("Total data di validation_generator:", total_validation_data)
```

```
Total data di train_generator: 1312
Total data di validation_generator: 876
```

[51]:
```
epoh = 100 # Tentukan banyaknya model melakukan satu putaran penuh terhadap␣
 ↪seluruh dataset training.
batch_size = 50 # seberapa banyak model membagi data train pada setiap epoch␣
 ↪yang dilakukan

# Hitung steps_per_epoch dan validation_steps
steps_per_epoch = int(np.ceil(total_train_data / batch_size)) # ini tergantung␣
 ↪pada banyak data dan jumlah batch_sizenya
validation_steps = int(np.ceil(total_validation_data / batch_size))  # ini␣
 ↪tergantung pada banyak data dan jumlah batch_sizenya
```

[52]:
```
from tensorflow.keras.callbacks import EarlyStopping

# Tentukan kondisi EarlyStopping
early_stopping = EarlyStopping(
    monitor='val_accuracy',  # Monitor akurasi pada data validasi (nilai ini␣
 ↪yang diperhatikan)
    patience=10,  # Toleransi untuk tidak ada peningkatan (10 iterasi jika␣
 ↪akurasi menunjukkan nilai-nilai yang homogen maka stop)
    restore_best_weights=True,  # Kembalikan bobot terbaik ketika berhenti
    verbose=1
)
```

[53]:
```
start_time = time.time()
history = model.fit(
    train_generator,  # Data generator untuk data latih
    steps_per_epoch=steps_per_epoch,  # Jumlah iterasi dalam setiap epoch␣
 ↪(dihitung dari total data latih dan batch size)
    epochs=epoh,  # Jumlah epoch yang akan dilakukan selama proses pelatihan
```

```
    validation_data=validation_generator,  # Data generator untuk data validasi
    validation_steps=validation_steps,  # Jumlah iterasi dalam setiap epoch␣
↪saat melakukan validasi
    callbacks=[callbacks, early_stopping],  # Daftar callbacks yang akan␣
↪digunakan selama pelatihan
    verbose=2  # Level kejelasan pesan yang akan ditampilkan selama pelatihan␣
↪(informasi lebih detail)
)

print("--- Waktu training adalah %s menit ---" % ((time.time() - start_time)/
↪60))
```

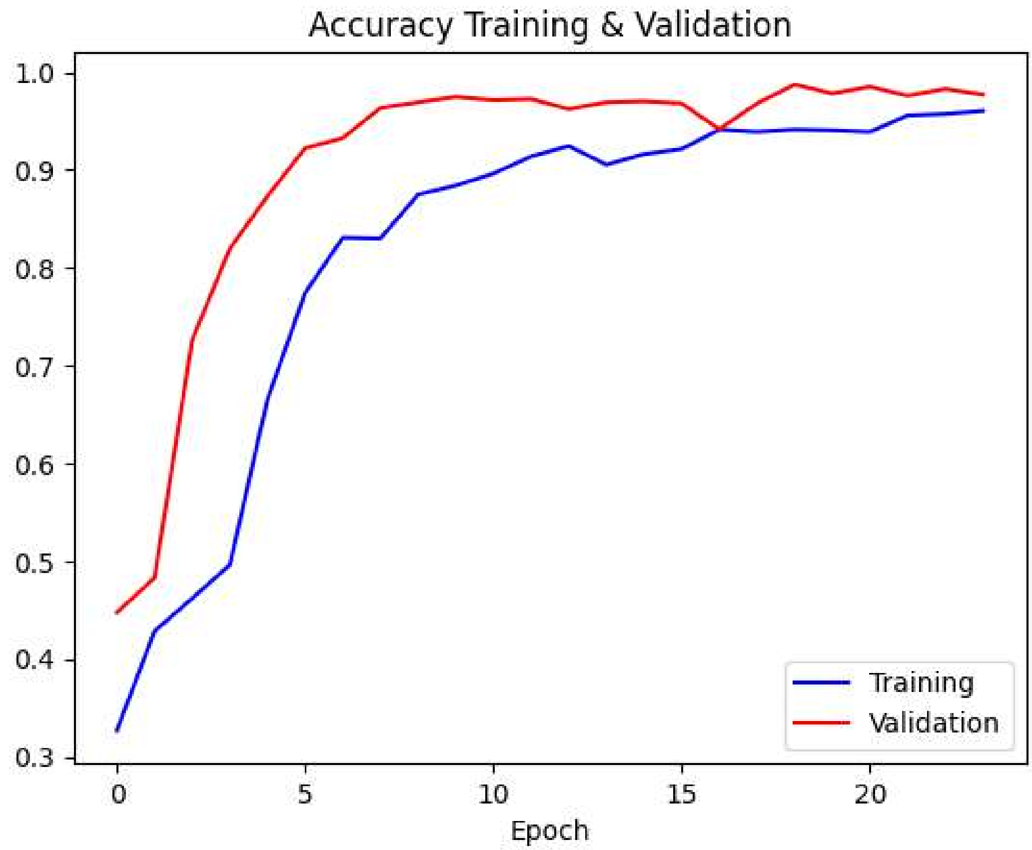
```
Epoch 1/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 16s - loss: 1.4568 - accuracy: 0.3270 - val_loss: 1.0576 - val_accuracy:
0.4475 - 16s/epoch - 607ms/step
Epoch 2/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 1.0634 - accuracy: 0.4284 - val_loss: 1.0251 - val_accuracy:
0.4829 - 15s/epoch - 568ms/step
Epoch 3/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 1.0429 - accuracy: 0.4619 - val_loss: 0.9101 - val_accuracy:
0.7260 - 15s/epoch - 548ms/step
Epoch 4/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.9988 - accuracy: 0.4962 - val_loss: 0.8024 - val_accuracy:
0.8196 - 15s/epoch - 562ms/step
Epoch 5/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.8266 - accuracy: 0.6654 - val_loss: 0.4887 - val_accuracy:
0.8733 - 15s/epoch - 567ms/step
Epoch 6/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 16s - loss: 0.6109 - accuracy: 0.7744 - val_loss: 0.3297 - val_accuracy:
0.9224 - 16s/epoch - 580ms/step
Epoch 7/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.4868 - accuracy: 0.8308 - val_loss: 0.2666 - val_accuracy:
0.9326 - 15s/epoch - 568ms/step
```

```
Epoch 8/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.4635 - accuracy: 0.8300 - val_loss: 0.1861 - val_accuracy:
0.9635 - 15s/epoch - 556ms/step
Epoch 9/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.3873 - accuracy: 0.8750 - val_loss: 0.1488 - val_accuracy:
0.9692 - 15s/epoch - 560ms/step
Epoch 10/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.3202 - accuracy: 0.8841 - val_loss: 0.1118 - val_accuracy:
0.9749 - 15s/epoch - 560ms/step
Epoch 11/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.2947 - accuracy: 0.8963 - val_loss: 0.1051 - val_accuracy:
0.9715 - 15s/epoch - 562ms/step
Epoch 12/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.2632 - accuracy: 0.9139 - val_loss: 0.1107 - val_accuracy:
0.9726 - 15s/epoch - 564ms/step
Epoch 13/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.2328 - accuracy: 0.9245 - val_loss: 0.1280 - val_accuracy:
0.9623 - 15s/epoch - 560ms/step
Epoch 14/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.2576 - accuracy: 0.9055 - val_loss: 0.1190 - val_accuracy:
0.9692 - 15s/epoch - 562ms/step
Epoch 15/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.2245 - accuracy: 0.9162 - val_loss: 0.1035 - val_accuracy:
0.9703 - 15s/epoch - 556ms/step
Epoch 16/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.2159 - accuracy: 0.9215 - val_loss: 0.1166 - val_accuracy:
0.9680 - 15s/epoch - 563ms/step
Epoch 17/100

Belum mencapai akurasi >96%, lanjutkan training.
```

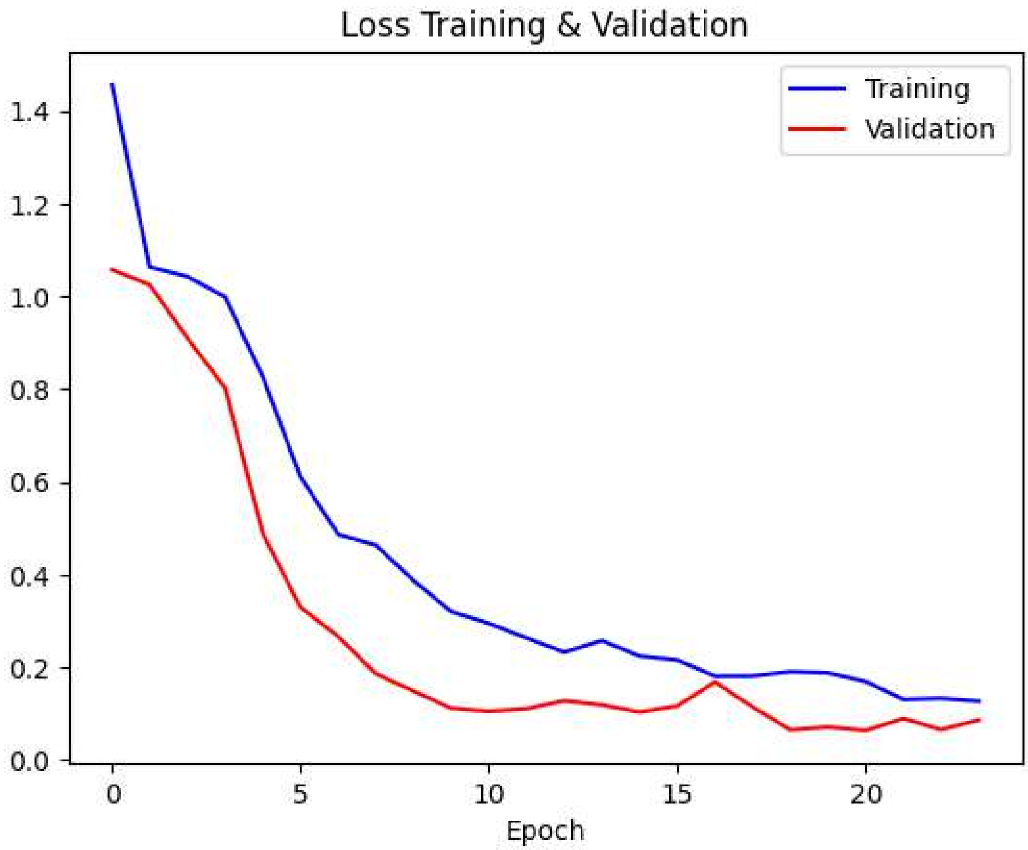
```
27/27 - 15s - loss: 0.1810 - accuracy: 0.9413 - val_loss: 0.1684 - val_accuracy:
0.9418 - 15s/epoch - 560ms/step
Epoch 18/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.1813 - accuracy: 0.9390 - val_loss: 0.1145 - val_accuracy:
0.9680 - 15s/epoch - 565ms/step
Epoch 19/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.1905 - accuracy: 0.9413 - val_loss: 0.0654 - val_accuracy:
0.9874 - 15s/epoch - 567ms/step
Epoch 20/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.1880 - accuracy: 0.9405 - val_loss: 0.0715 - val_accuracy:
0.9783 - 15s/epoch - 558ms/step
Epoch 21/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.1693 - accuracy: 0.9390 - val_loss: 0.0642 - val_accuracy:
0.9852 - 15s/epoch - 563ms/step
Epoch 22/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.1309 - accuracy: 0.9558 - val_loss: 0.0897 - val_accuracy:
0.9760 - 15s/epoch - 560ms/step
Epoch 23/100

Belum mencapai akurasi >96%, lanjutkan training.
27/27 - 15s - loss: 0.1332 - accuracy: 0.9573 - val_loss: 0.0661 - val_accuracy:
0.9829 - 15s/epoch - 562ms/step
Epoch 24/100

Sudah >96% nih akurasinya jadi diberhentikan saja!
27/27 - 15s - loss: 0.1273 - accuracy: 0.9604 - val_loss: 0.0865 - val_accuracy:
0.9772 - 15s/epoch - 562ms/step
--- Waktu training adalah 6.106248525778453 menit ---
```

8 Evaluasi Model

[54]:
```
plt.plot(history.history['accuracy'], label='Training', color='blue')
plt.plot(history.history['val_accuracy'], label='Validation', color='red')
plt.title('Accuracy Training & Validation')
plt.xlabel('Epoch')
plt.legend(loc="lower right")
plt.show()
```



[55]:
```
plt.plot(history.history['loss'], label='Training', color='blue')
plt.plot(history.history['val_loss'], label='Validation', color='red')
plt.title('Loss Training & Validation')
plt.xlabel('Epoch')
plt.legend(loc="upper right")
plt.show()
```



[56]:
```
# Melakukan evaluasi terhadap model menggunakan data validasi
evaluation = model.evaluate(validation_generator, steps=validation_steps,␣
↪verbose=1)

# Menampilkan hasil evaluasi
print(f"Loss: {evaluation[0]}")
print(f"Accuracy: {evaluation[1]}")
```

```
18/18 [==============================] - 4s 214ms/step - loss: 0.0865 -
accuracy: 0.9772
Loss: 0.08651537448167801
Accuracy: 0.9771689772605896
```

9 Save the model

[57]:
```
# #'model' akan di save ke local file
# model.save('/content/drive/MyDrive/Colab Notebooks/Machine Learning | DFS␣
↪Foundation X Dicoding/RockPaperScissors_model')  # Replace␣
↪'path_to_save_model' with your desired path
```

[58]:
```python
from tensorflow.keras.models import load_model

# Load the saved model
loaded_model = load_model("/content/drive/MyDrive/Colab Notebooks/Machine␣
↪Learning | DFS Foundation X Dicoding/RockPaperScissors_model")  # Replace␣
↪'path_to_save_model' with the saved model's path
```

[59]:
```python
# Melakukan evaluasi terhadap model menggunakan data validasi
evaluation = loaded_model.evaluate(validation_generator,␣
↪steps=validation_steps, verbose=1)

# Menampilkan hasil evaluasi
print(f"Loss: {evaluation[0]}")
print(f"Accuracy: {evaluation[1]}")
```

```
18/18 [==============================] - 4s 220ms/step - loss: 0.0865 -
accuracy: 0.9772
Loss: 0.08651537448167801
Accuracy: 0.9771689772605896
```

10 My model has *97.7%* Accuracy

11 Try to predict here

[72]:
```python
from tensorflow.keras.preprocessing import image
import numpy as np

# Step 1: Load and Preprocess Test Images
test_folder_path = "/content/drive/MyDrive/Colab Notebooks/Machine Learning |␣
↪DFS Foundation X Dicoding/rockpaperscissors/Data_testing"
img_size = (150, 150)

def preprocess_image(image_path):
    img = image.load_img(image_path, target_size=img_size)
    img_array = image.img_to_array(img)
    img_array = np.expand_dims(img_array, axis=0)
    return img_array

# Step 2: Make Predictions
def make_predictions(model, image_path):
    img_array = preprocess_image(image_path)
    predictions = model.predict(img_array)
    return predictions

# Step 3: Post-process Predictions
def interpret_predictions(predictions, class_labels):
```

```
    predicted_class_index = np.argmax(predictions)
    predicted_class_label = class_labels[predicted_class_index]
    return predicted_class_label

# List of class labels used during training
class_labels = ['Kertas', 'Batu', 'Gunting']

# Iterate through images in the testing folder
for filename in os.listdir(test_folder_path):
    if filename.endswith(".png"):  # Assuming images are in JPG format
        image_path = os.path.join(test_folder_path, filename)

        # Make predictions
        predictions = make_predictions(loaded_model, image_path)

        # Interpret predictions
        predicted_label = interpret_predictions(predictions, class_labels)

        # Display results or save them as needed
        print(f"Image: {filename}, Predicted Class: {predicted_label}")
```

```
1/1 [==============================] - 0s 25ms/step
Image: Batu_01.png, Predicted Class: Batu
1/1 [==============================] - 0s 20ms/step
Image: Batu_02.png, Predicted Class: Batu
1/1 [==============================] - 0s 20ms/step
Image: Gunting_02.png, Predicted Class: Gunting
1/1 [==============================] - 0s 20ms/step
Image: Gunting_01.png, Predicted Class: Gunting
1/1 [==============================] - 0s 20ms/step
Image: Kertas_02.png, Predicted Class: Kertas
1/1 [==============================] - 0s 20ms/step
Image: Kertas_01.png, Predicted Class: Kertas
```

[73]:
```
from keras.preprocessing import image
import numpy as np
from google.colab import files
import matplotlib.pyplot as plt

class_names = ['Kertas', 'Batu', 'Gunting']  # List nama kelas

# Fungsi untuk memprediksi gambar yang diunggah
def predict_uploaded_image(file_path, model):
    img = image.load_img(file_path, target_size=(150, 150))
    x = image.img_to_array(img)
    x = np.expand_dims(x, axis=0)
    images = np.vstack([x])
```

```python
    classes = model.predict(images, batch_size=10)
    return classes

# Menerima file gambar yang diunggah
uploaded = files.upload()

# Lakukan prediksi pada setiap file yang diunggah
for file_name in uploaded.keys():
    file_path = file_name
    result = predict_uploaded_image(file_path, loaded_model)
    print(result)
    predicted_class_index = np.argmax(result)
    predicted_class_name = class_names[predicted_class_index]  # Sesuaikan␣
 ↪dengan nama kelas Anda
    print(f"File: {file_name}, Predicted Class: {predicted_class_name}")

    # Tampilkan gambar
    img = image.load_img(file_path, target_size=(150, 150))
    plt.imshow(img)
    plt.title(f"Predicted Class: {predicted_class_name}")
    plt.axis('off')  # Hilangkan sumbu x dan y
    plt.show()
```

```
<IPython.core.display.HTML object>
```

```
Saving paper_7.jpg to paper_7.jpg
1/1 [==============================] - 0s 24ms/step
[[1. 0. 0.]]
File: paper_7.jpg, Predicted Class: Kertas
```

Predicted Class: Kertas