College of Electrical & Mechanical Engineering, NUST

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

44 CE A

AI Decision Support Sys

LAB 11

NAME	**REG NO**	**Syndicate**
Syed Shaheer Suhaib	429292	A

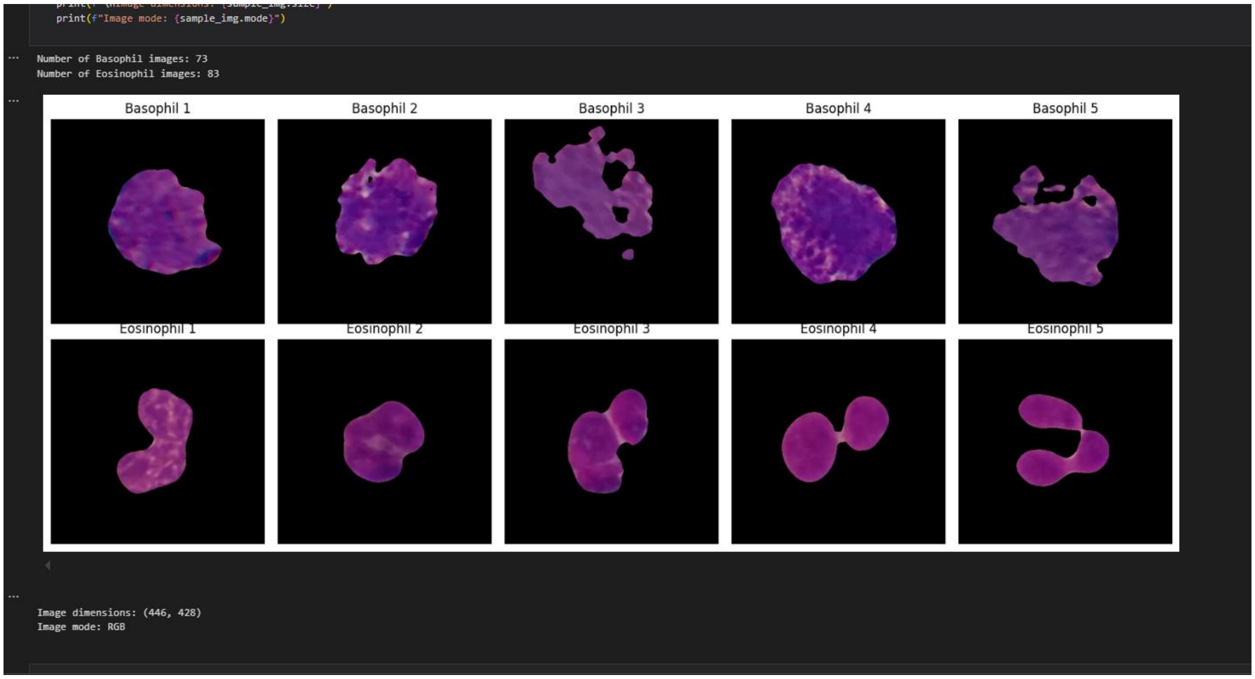
Contents

Importing images.

```python
import numpy as np
import matplotlib.pyplot as plt
from PIL import Image
import glob


basophil_path = '/content/dip_data/Basophil'
eosinophil_path = '/content/dip_data/Eosinophil'

basophil_images = sorted(glob.glob(f'{basophil_path}/*.jpg'))
eosinophil_images = sorted(glob.glob(f'{eosinophil_path}/*.jpg'))

print(f"Number of Basophil images: {len(basophil_images)}")
print(f"Number of Eosinophil images: {len(eosinophil_images)}")


fig, axes = plt.subplots(2, 5, figsize=(15, 6))

for i in range(5):
    # Basophil
    img = Image.open(basophil_images[i])
    axes[0, i].imshow(img)
    axes[0, i].set_title(f'Basophil {i+1}')
    axes[0, i].axis('off')

    # Eosinophil
    img = Image.open(eosinophil_images[i])
    axes[1, i].imshow(img)
    axes[1, i].set_title(f'Eosinophil {i+1}')
    axes[1, i].axis('off')

plt.tight_layout()
plt.show()

# Check image dimensions
sample_img = Image.open(basophil_images[0])
```

```
print(f"\nImage dimensions: {sample_img.size}")
print(f"Image mode: {sample_img.mode}")
```

Output



```
print(f"\nImage dimensions: {sample_img.size}")
print(f"Image mode: {sample_img.mode}")
```

```
Number of Basophil images: 73
Number of Eosinophil images: 83
```

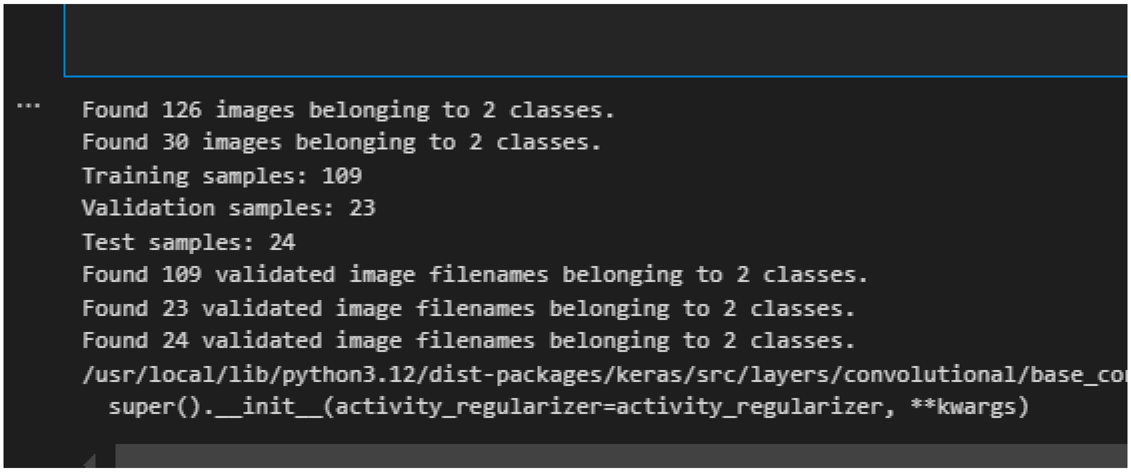
```
Image dimensions: (446, 428)
Image mode: RGB
```

Prepare dataset.

```
import tensorflow as tf
from tensorflow.keras.preprocessing.image import ImageDataGenerator


img_height = 446
img_width = 428
batch_size = 15


train_datagen = ImageDataGenerator(
    rescale=1./255,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    validation_split=0.2
)


train_generator = train_datagen.flow_from_directory(
    extract_path,
    target_size=(img_height, img_width),
    batch_size=batch_size,
    class_mode='binary',
    subset='training'
)

validation_generator = train_datagen.flow_from_directory(
    extract_path,
    target_size=(img_height, img_width),
    batch_size=batch_size,
    class_mode='binary',
    subset='validation'
)


test_datagen = ImageDataGenerator(rescale=1./255)

all_images = basophil_images + eosinophil_images
all_labels = [0] * len(basophil_images) + [1] * len(eosinophil_images)

from sklearn.model_selection import train_test_split
import pandas as pd


df_images = pd.DataFrame({'filepath': all_images, 'label': all_labels})


train_df, temp_df = train_test_split(df_images, test_size=0.3, random_state=42,
stratify=df_images['label'])

val_df, test_df = train_test_split(temp_df, test_size=0.5, random_state=42,
stratify=temp_df['label'])

print(f"Training samples: {len(train_df)}")
print(f"Validation samples: {len(val_df)}")
print(f"Test samples: {len(test_df)}")
```

```
train_df['label'] = train_df['label'].astype(str)
val_df['label'] = val_df['label'].astype(str)
test_df['label'] = test_df['label'].astype(str)


train_generator_df = train_datagen.flow_from_dataframe(
    dataframe=train_df,
    x_col='filepath',
    y_col='label',
    target_size=(img_height, img_width),
    batch_size=batch_size,
    class_mode='binary',
    seed=42
)

validation_generator_df = train_datagen.flow_from_dataframe(
    dataframe=val_df,
    x_col='filepath',
    y_col='label',
    target_size=(img_height, img_width),
    batch_size=batch_size,
    class_mode='binary',
    seed=42
)

test_generator_df = test_datagen.flow_from_dataframe(
    dataframe=test_df,
    x_col='filepath',
    y_col='label',
    target_size=(img_height, img_width),
    batch_size=batch_size,
    class_mode='binary',
    shuffle=False,
    seed=42
)
```

OUTPUT:

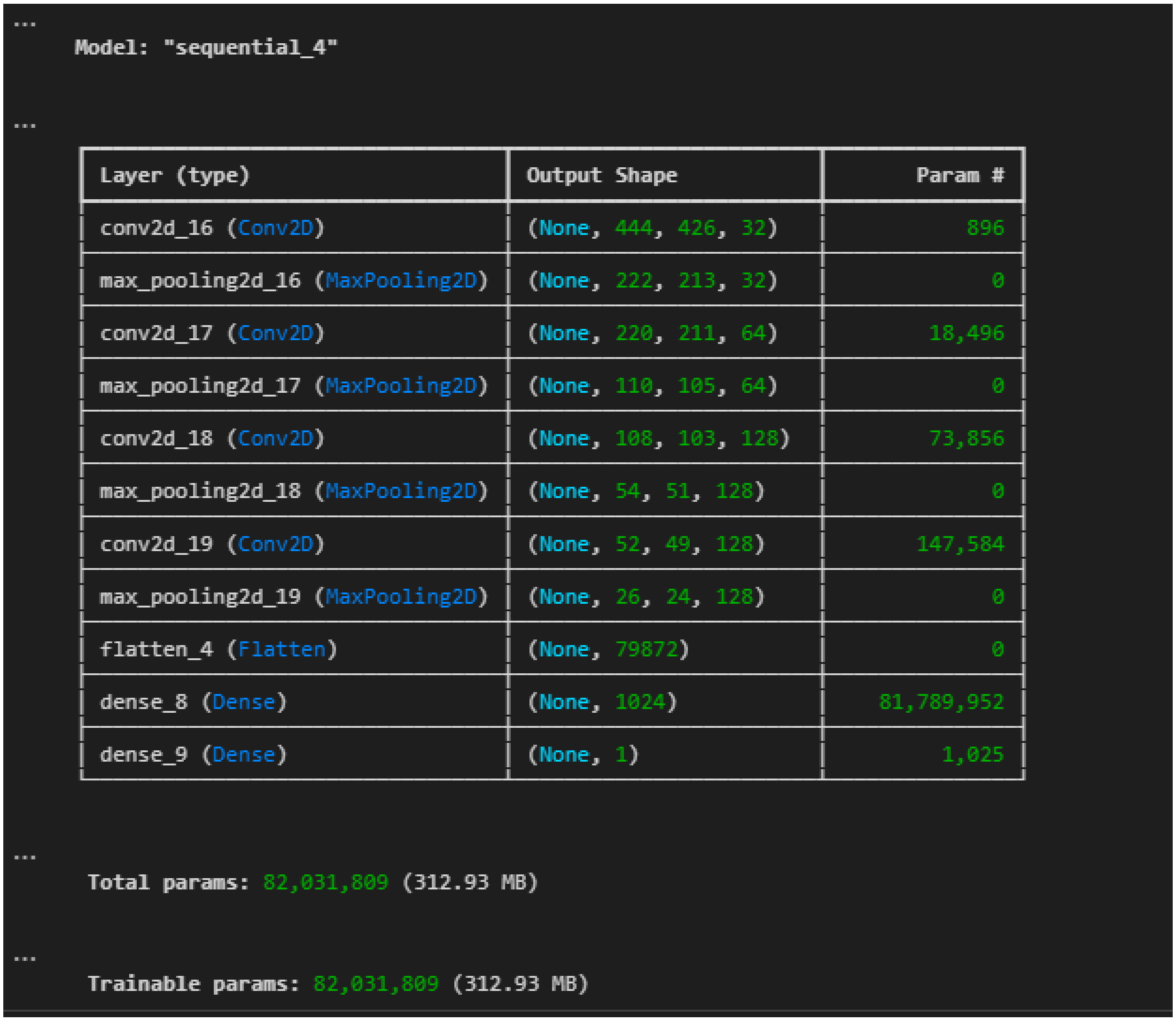


```
Found 126 images belonging to 2 classes.
Found 30 images belonging to 2 classes.
Training samples: 109
Validation samples: 23
Test samples: 24
Found 109 validated image filenames belonging to 2 classes.
Found 23 validated image filenames belonging to 2 classes.
Found 24 validated image filenames belonging to 2 classes.
/usr/local/lib/python3.12/dist-packages/keras/src/layers/convolutional/base_co
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

Model Architecture

```python
from tensorflow.keras import layers, models

# model
model = models.Sequential([
    layers.Conv2D(32, (3, 3), activation='relu', input_shape=(446, 428, 3)),
    layers.MaxPooling2D((2, 2)),

    layers.Conv2D(64, (3, 3), activation='relu'),
    layers.MaxPooling2D((2, 2)),

    layers.Conv2D(128, (3, 3), activation='relu'),
    layers.MaxPooling2D((2, 2)),

    layers.Conv2D(128, (3, 3), activation='relu'),
    layers.MaxPooling2D((2, 2)),
    layers.Flatten(),

    layers.Dense(1024, activation='relu'),
    layers.Dense(1, activation='sigmoid')
])

model.summary()
model.compile(
    loss='binary_crossentropy',
    optimizer='adam',
    metrics=['accuracy']
)


epochs = 7
history = model.fit(
    train_generator_df,
    steps_per_epoch=train_generator_df.samples // batch_size,
    epochs=epochs,
    validation_data=validation_generator_df,
    validation_steps=validation_generator_df.samples // batch_size
)
```

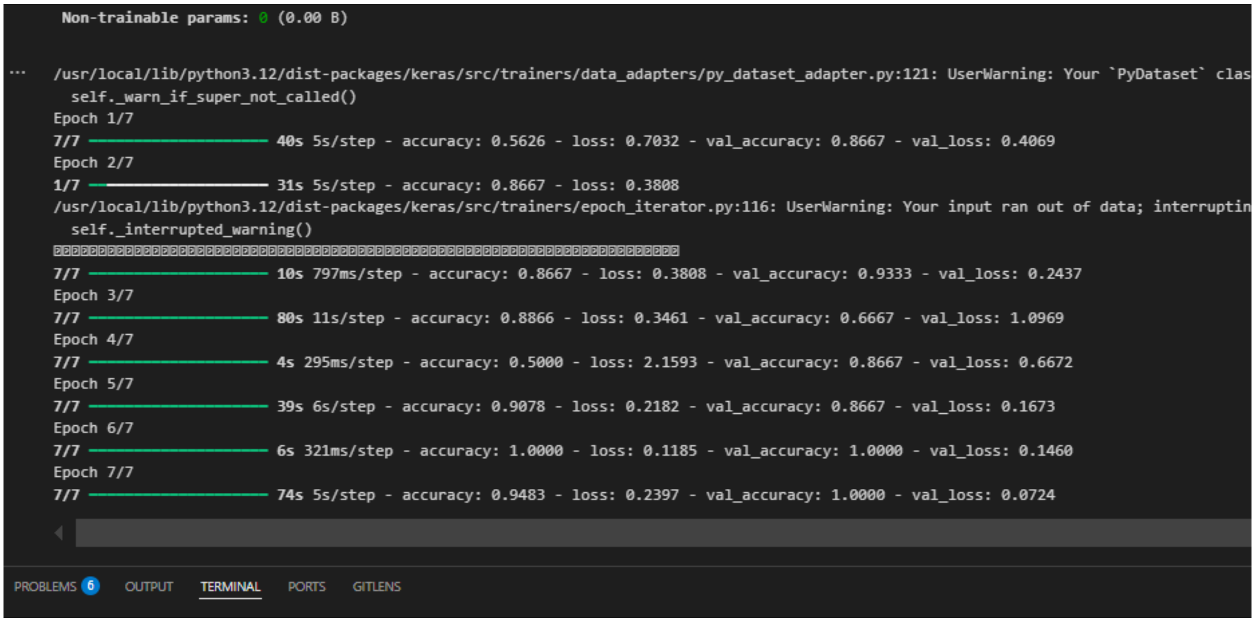
OUTPUT:



```
...
    Model: "sequential_4"

...
    ┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━┓
    ┃ Layer (type)                    ┃ Output Shape           ┃       Param # ┃
    ┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━┩
    │ conv2d_16 (Conv2D)              │ (None, 444, 426, 32)   │           896 │
    ├─────────────────────────────────┼────────────────────────┼───────────────┤
    │ max_pooling2d_16 (MaxPooling2D) │ (None, 222, 213, 32)   │             0 │
    ├─────────────────────────────────┼────────────────────────┼───────────────┤
    │ conv2d_17 (Conv2D)              │ (None, 220, 211, 64)   │        18,496 │
    ├─────────────────────────────────┼────────────────────────┼───────────────┤
    │ max_pooling2d_17 (MaxPooling2D) │ (None, 110, 105, 64)   │             0 │
    ├─────────────────────────────────┼────────────────────────┼───────────────┤
    │ conv2d_18 (Conv2D)              │ (None, 108, 103, 128)  │        73,856 │
    ├─────────────────────────────────┼────────────────────────┼───────────────┤
    │ max_pooling2d_18 (MaxPooling2D) │ (None, 54, 51, 128)    │             0 │
    ├─────────────────────────────────┼────────────────────────┼───────────────┤
    │ conv2d_19 (Conv2D)              │ (None, 52, 49, 128)    │       147,584 │
    ├─────────────────────────────────┼────────────────────────┼───────────────┤
    │ max_pooling2d_19 (MaxPooling2D) │ (None, 26, 24, 128)    │             0 │
    ├─────────────────────────────────┼────────────────────────┼───────────────┤
    │ flatten_4 (Flatten)             │ (None, 79872)          │             0 │
    ├─────────────────────────────────┼────────────────────────┼───────────────┤
    │ dense_8 (Dense)                 │ (None, 1024)           │    81,789,952 │
    ├─────────────────────────────────┼────────────────────────┼───────────────┤
    │ dense_9 (Dense)                 │ (None, 1)              │         1,025 │
    └─────────────────────────────────┴────────────────────────┴───────────────┘

...
     Total params: 82,031,809 (312.93 MB)

...
     Trainable params: 82,031,809 (312.93 MB)
```

Model Train

OUTPUT:

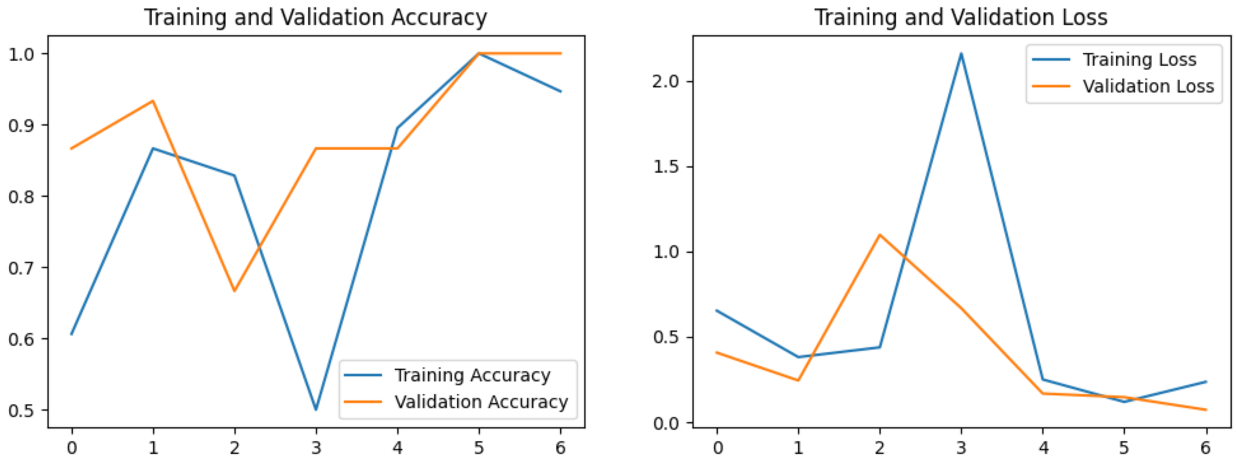


```
 Non-trainable params: 0 (0.00 B)

…   /usr/local/lib/python3.12/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:121: UserWarning: Your `PyDataset` clas
      self._warn_if_super_not_called()
    Epoch 1/7
    7/7 ━━━━━━━━━━━━━━━━━━━━ 40s 5s/step - accuracy: 0.5626 - loss: 0.7032 - val_accuracy: 0.8667 - val_loss: 0.4069
    Epoch 2/7
    1/7 ━━━━━━━━━━━━━━━━━━━━ 31s 5s/step - accuracy: 0.8667 - loss: 0.3808
    /usr/local/lib/python3.12/dist-packages/keras/src/trainers/epoch_iterator.py:116: UserWarning: Your input ran out of data; interruptin
      self._interrupted_warning()
    ▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯
    7/7 ━━━━━━━━━━━━━━━━━━━━ 10s 797ms/step - accuracy: 0.8667 - loss: 0.3808 - val_accuracy: 0.9333 - val_loss: 0.2437
    Epoch 3/7
    7/7 ━━━━━━━━━━━━━━━━━━━━ 80s 11s/step - accuracy: 0.8866 - loss: 0.3461 - val_accuracy: 0.6667 - val_loss: 1.0969
    Epoch 4/7
    7/7 ━━━━━━━━━━━━━━━━━━━━ 4s 295ms/step - accuracy: 0.5000 - loss: 2.1593 - val_accuracy: 0.8667 - val_loss: 0.6672
    Epoch 5/7
    7/7 ━━━━━━━━━━━━━━━━━━━━ 39s 6s/step - accuracy: 0.9078 - loss: 0.2182 - val_accuracy: 0.8667 - val_loss: 0.1673
    Epoch 6/7
    7/7 ━━━━━━━━━━━━━━━━━━━━ 6s 321ms/step - accuracy: 1.0000 - loss: 0.1185 - val_accuracy: 1.0000 - val_loss: 0.1460
    Epoch 7/7
    7/7 ━━━━━━━━━━━━━━━━━━━━ 74s 5s/step - accuracy: 0.9483 - loss: 0.2397 - val_accuracy: 1.0000 - val_loss: 0.0724
```

Training and Validation loss:

```
import matplotlib.pyplot as plt

acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
loss = history.history['loss']
val_loss = history.history['val_loss']

epochs_range = range(epochs)

plt.figure(figsize=(12, 4))
plt.subplot(1, 2, 1)
plt.plot(epochs_range, acc, label='Training Accuracy')
plt.plot(epochs_range, val_acc, label='Validation Accuracy')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy')

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


test_loss, test_acc = model.evaluate(
    test_generator_df,
    steps=test_generator_df.samples // batch_size
)

print(f"\nTest Loss: {test_loss:.4f}")
print(f"Test Accuracy: {test_acc:.4f}")
```

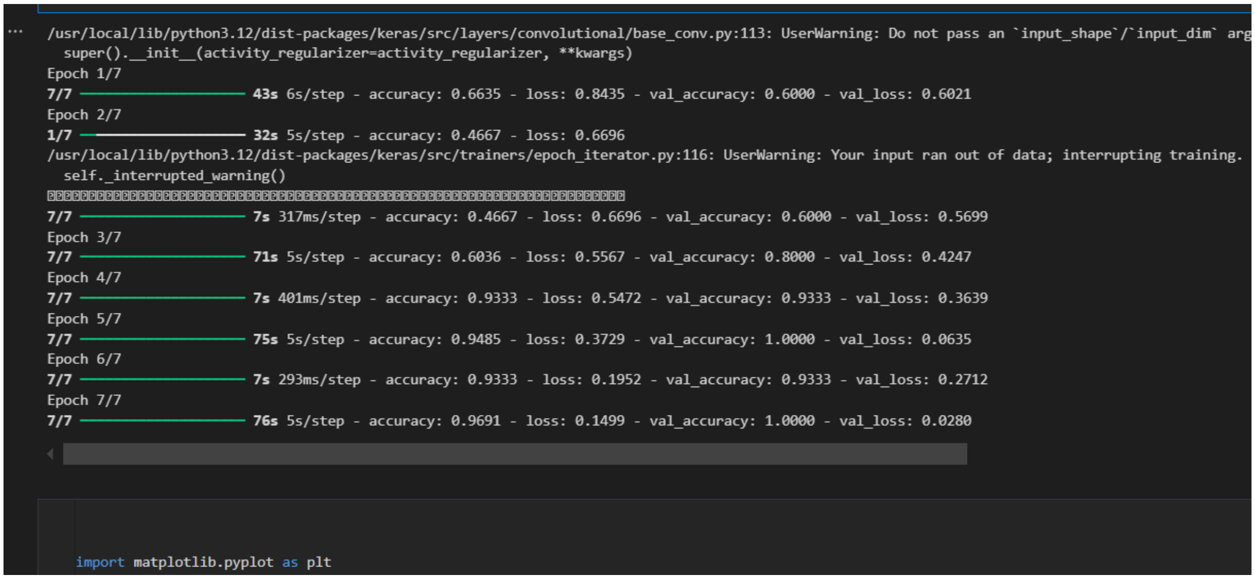
OUTPUT:



Dropout:

```
model = models.Sequential([
    layers.Conv2D(32, (3, 3), activation='relu', input_shape=(446, 428, 3)),
    layers.MaxPooling2D((2, 2)),

    layers.Conv2D(64, (3, 3), activation='relu'),
    layers.MaxPooling2D((2, 2)),

    layers.Conv2D(128, (3, 3), activation='relu'),
    layers.MaxPooling2D((2, 2)),

    layers.Conv2D(128, (3, 3), activation='relu'),
    layers.MaxPooling2D((2, 2)),
    layers.Flatten(),

    layers.Dropout(0.80),
    layers.Dense(1024, activation='relu'),

    layers.Dense(1, activation='sigmoid')
])
model.compile(
    loss='binary_crossentropy',
    optimizer='adam',
    metrics=['accuracy']
)

epochs = 7
history = model.fit(
    train_generator_df,
    steps_per_epoch=train_generator_df.samples // batch_size,
    epochs=epochs,
    validation_data=validation_generator_df,
    validation_steps=validation_generator_df.samples // batch_size
)
```

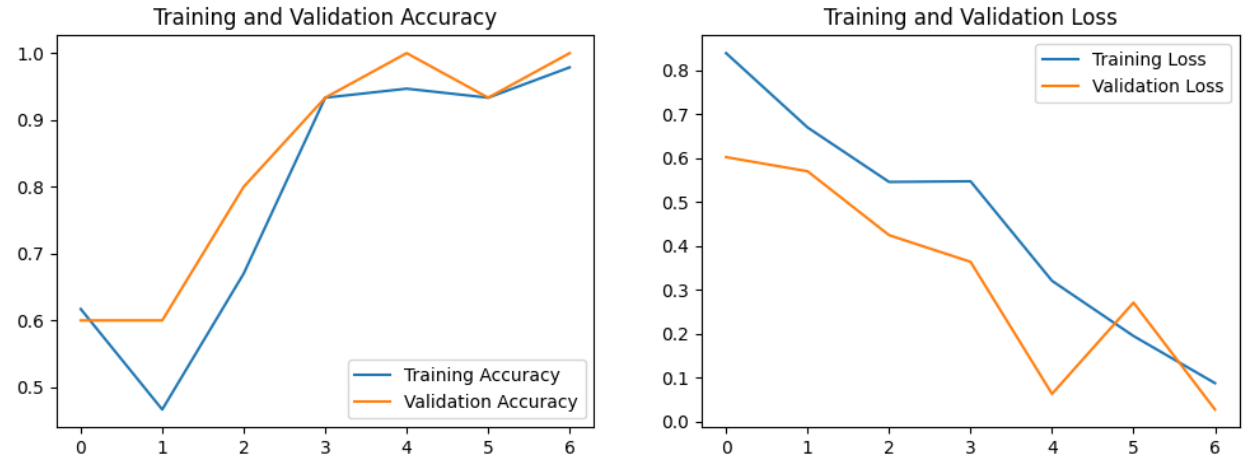
OUTPUT:



```
/usr/local/lib/python3.12/dist-packages/keras/src/layers/convolutional/base_conv.py:113: UserWarning: Do not pass an `input_shape`/`input_dim` arg
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
Epoch 1/7
7/7 ━━━━━━━━━━━━━━━━━━━━ 43s 6s/step - accuracy: 0.6635 - loss: 0.8435 - val_accuracy: 0.6000 - val_loss: 0.6021
Epoch 2/7
1/7 ━━━━━━━━━━━━━━━━━━━━ 32s 5s/step - accuracy: 0.4667 - loss: 0.6696
/usr/local/lib/python3.12/dist-packages/keras/src/trainers/epoch_iterator.py:116: UserWarning: Your input ran out of data; interrupting training.
  self._interrupted_warning()
□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
7/7 ━━━━━━━━━━━━━━━━━━━━ 7s 317ms/step - accuracy: 0.4667 - loss: 0.6696 - val_accuracy: 0.6000 - val_loss: 0.5699
Epoch 3/7
7/7 ━━━━━━━━━━━━━━━━━━━━ 71s 5s/step - accuracy: 0.6036 - loss: 0.5567 - val_accuracy: 0.8000 - val_loss: 0.4247
Epoch 4/7
7/7 ━━━━━━━━━━━━━━━━━━━━ 7s 401ms/step - accuracy: 0.9333 - loss: 0.5472 - val_accuracy: 0.9333 - val_loss: 0.3639
Epoch 5/7
7/7 ━━━━━━━━━━━━━━━━━━━━ 75s 5s/step - accuracy: 0.9485 - loss: 0.3729 - val_accuracy: 1.0000 - val_loss: 0.0635
Epoch 6/7
7/7 ━━━━━━━━━━━━━━━━━━━━ 7s 293ms/step - accuracy: 0.9333 - loss: 0.1952 - val_accuracy: 0.9333 - val_loss: 0.2712
Epoch 7/7
7/7 ━━━━━━━━━━━━━━━━━━━━ 76s 5s/step - accuracy: 0.9691 - loss: 0.1499 - val_accuracy: 1.0000 - val_loss: 0.0280
```

```
import matplotlib.pyplot as plt
```

Loss with dropuout:



performance before and after adding dropout:

Dropout stabilized learning

Reduced volatility in early training

Training and validation curves are more aligned

Without dropout: unstable and noisy learning

Metric	**Without Dropout**	**With Dropout**
Training Stability	Unstable, large spikes	Stable, smooth curves
Validation Stability	High volatility	Smooth, consistent
Overfitting	Moderate–High	Strong reduction
Accuracy Trend	Irregular jumps	Steady upward progression
Loss Behavior	Sudden spikes	Controlled decrease
Generalization	❌ Poor/Unstable	Improved significantly