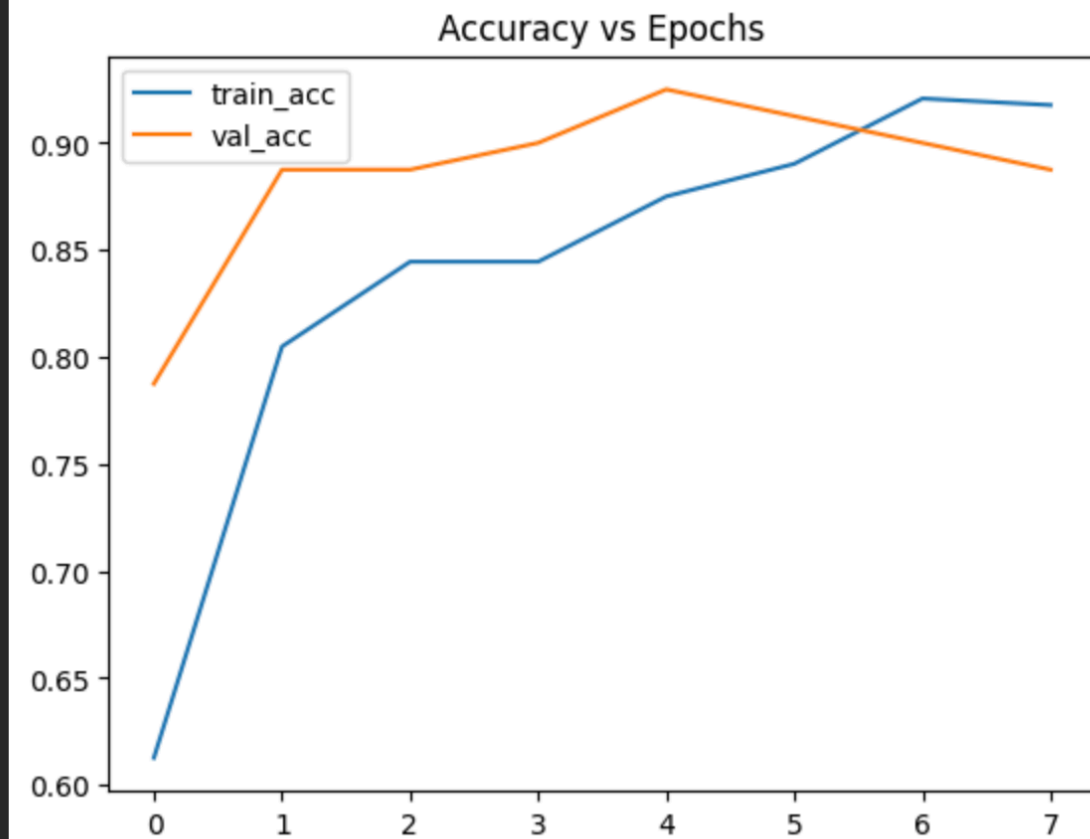# Outputs:

```
...  Found 328 images belonging to 2 classes.
     Found 80 images belonging to 2 classes.
     /usr/local/lib/python3.12/dist-packages/keras/src/layers/convolutional/base_conv.py:113: 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

     /usr/local/lib/python3.12/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:121: UserWarning:

     Your `PyDataset` class should call `super().__init__(**kwargs)` in its constructor. `**kwargs` can include `workers`, `use_multiprocessing`, `max_queue

     Epoch 1/8
     21/21 ———————————— 14s 516ms/step - accuracy: 0.5649 - loss: 1.2850 - val_accuracy: 0.7875 - val_loss: 0.4635
     Epoch 2/8
     21/21 ———————————— 11s 539ms/step - accuracy: 0.8278 - loss: 0.4354 - val_accuracy: 0.8875 - val_loss: 0.3550
     Epoch 3/8
     21/21 ———————————— 11s 521ms/step - accuracy: 0.8409 - loss: 0.3842 - val_accuracy: 0.8875 - val_loss: 0.3082
     Epoch 4/8
     21/21 ———————————— 11s 530ms/step - accuracy: 0.8752 - loss: 0.3292 - val_accuracy: 0.9000 - val_loss: 0.3324
     Epoch 5/8
     21/21 ———————————— 11s 491ms/step - accuracy: 0.8735 - loss: 0.2853 - val_accuracy: 0.9250 - val_loss: 0.3319
     Epoch 6/8
     21/21 ———————————— 11s 536ms/step - accuracy: 0.8867 - loss: 0.2730 - val_accuracy: 0.9125 - val_loss: 0.3199
     Epoch 7/8
     21/21 ———————————— 11s 540ms/step - accuracy: 0.9337 - loss: 0.1619 - val_accuracy: 0.9000 - val_loss: 0.3442
     Epoch 8/8
     21/21 ———————————— 12s 559ms/step - accuracy: 0.9131 - loss: 0.1813 - val_accuracy: 0.8875 - val_loss: 0.3452
```
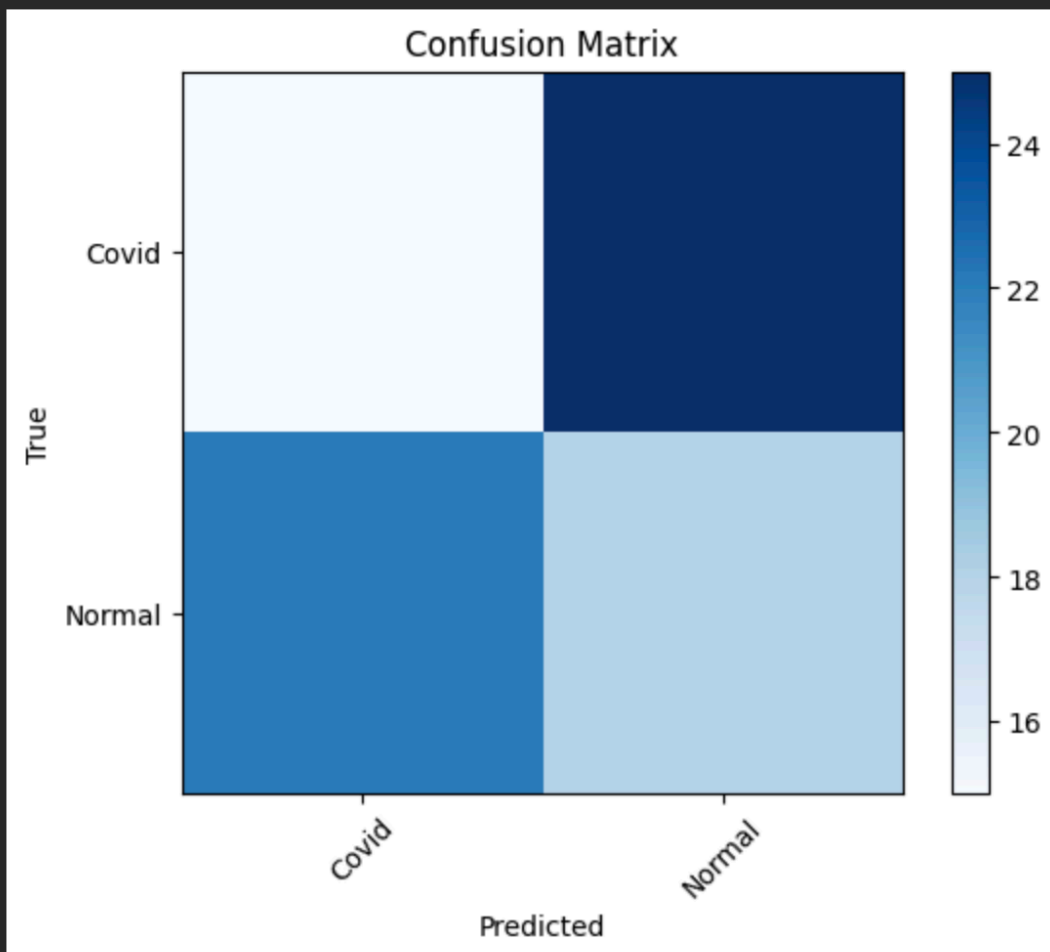


```
5/5 ———————————— 1s 207ms/step
```

```
✅ Validation Accuracy: 41.25%

Confusion Matrix:
 [[15 25]
 [22 18]]

Classification Report:
              precision    recall  f1-score   support

       Covid       0.41      0.38      0.39        40
      Normal       0.42      0.45      0.43        40

    accuracy                           0.41        80
   macro avg       0.41      0.41      0.41        80
weighted avg       0.41      0.41      0.41        80
```
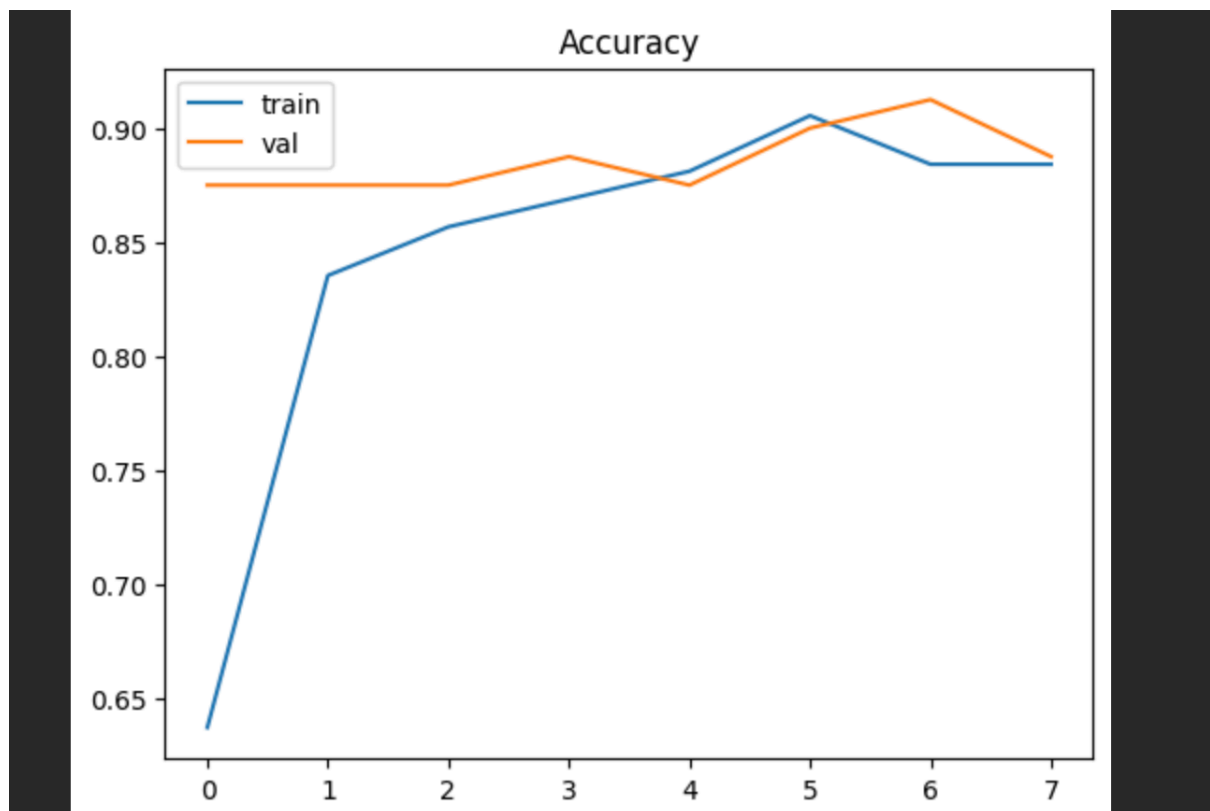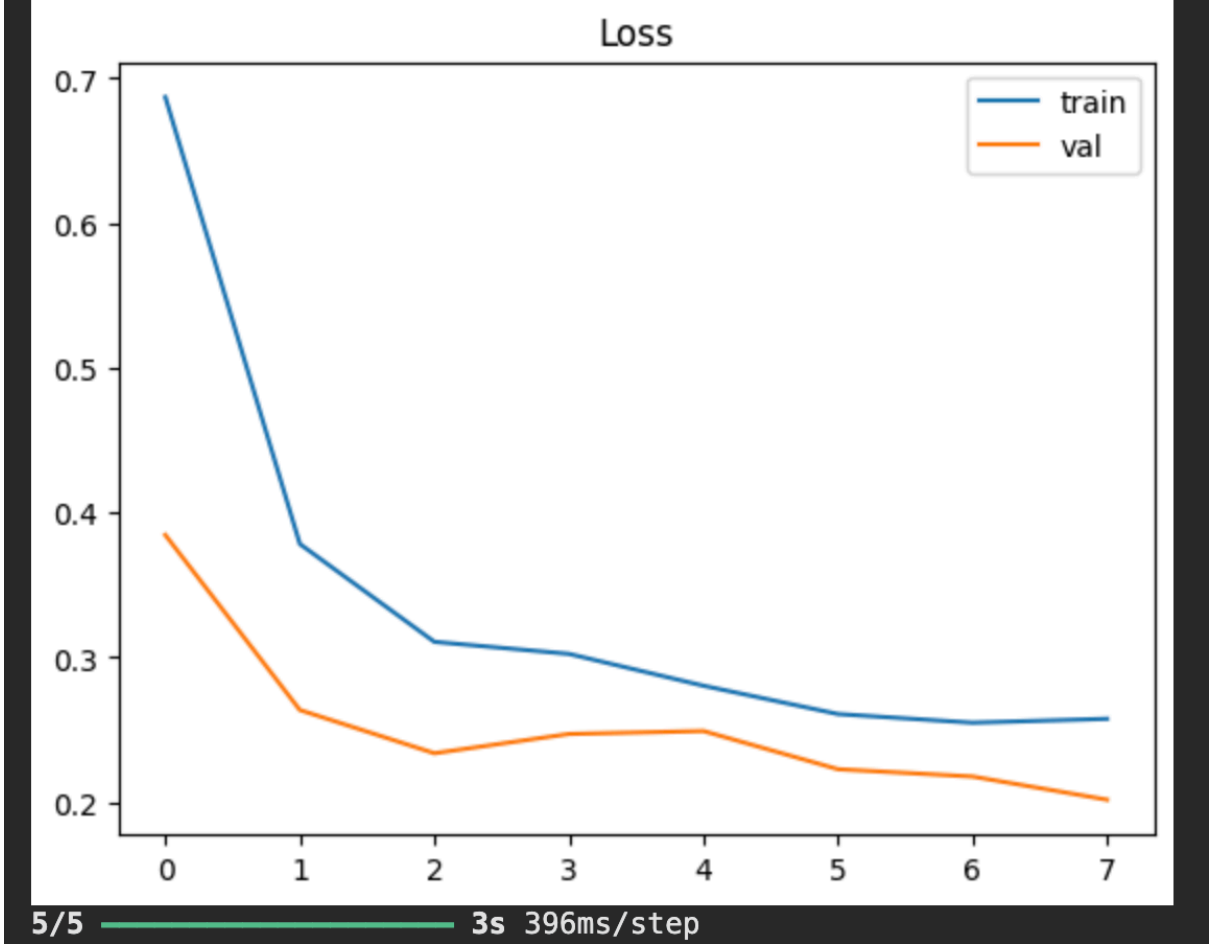

Confusion Matrix

Found 328 images belonging to 2 classes.
Found 80 images belonging to 2 classes.
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/mobilenet_v2/mobilenet_v2_weights_tf_dim_ordering_tf_kernels_1.0_160_no_
9406464/9406464 ━━━━━━━━━━━━━━━ 0s 0us/step
/usr/local/lib/python3.12/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:121: UserWarning:

Your `PyDataset` class should call `super().__init__(**kwargs)` in its constructor. `**kwargs` can include `workers`, `use_multiprocessing`, `max_queue_siz

Epoch 1/8
21/21 ━━━━━━━━━━━━━━━ 21s 755ms/step - accuracy: 0.5175 - loss: 0.8582 - val_accuracy: 0.8750 - val_loss: 0.3846 - learning_rate: 0.0010
Epoch 2/8
21/21 ━━━━━━━━━━━━━━━ 13s 590ms/step - accuracy: 0.8387 - loss: 0.3867 - val_accuracy: 0.8750 - val_loss: 0.2637 - learning_rate: 0.0010
Epoch 3/8
21/21 ━━━━━━━━━━━━━━━ 13s 601ms/step - accuracy: 0.8591 - loss: 0.3215 - val_accuracy: 0.8750 - val_loss: 0.2338 - learning_rate: 0.0010
Epoch 4/8
21/21 ━━━━━━━━━━━━━━━ 13s 628ms/step - accuracy: 0.8449 - loss: 0.3459 - val_accuracy: 0.8875 - val_loss: 0.2471 - learning_rate: 0.0010
Epoch 5/8
21/21 ━━━━━━━━━━━━━━━ 0s 491ms/step - accuracy: 0.8840 - loss: 0.2886
Epoch 5: ReduceLROnPlateau reducing learning rate to 0.0005000000237487257.
21/21 ━━━━━━━━━━━━━━━ 13s 598ms/step - accuracy: 0.8839 - loss: 0.2883 - val_accuracy: 0.8750 - val_loss: 0.2492 - learning_rate: 0.0010
Epoch 6/8
21/21 ━━━━━━━━━━━━━━━ 14s 671ms/step - accuracy: 0.8997 - loss: 0.2866 - val_accuracy: 0.9000 - val_loss: 0.2228 - learning_rate: 5.0000e-04
Epoch 7/8
21/21 ━━━━━━━━━━━━━━━ 13s 618ms/step - accuracy: 0.8963 - loss: 0.2273 - val_accuracy: 0.9125 - val_loss: 0.2178 - learning_rate: 5.0000e-04
Epoch 8/8
21/21 ━━━━━━━━━━━━━━━ 13s 595ms/step - accuracy: 0.8761 - loss: 0.2560 - val_accuracy: 0.8875 - val_loss: 0.2018 - learning_rate: 5.0000e-04
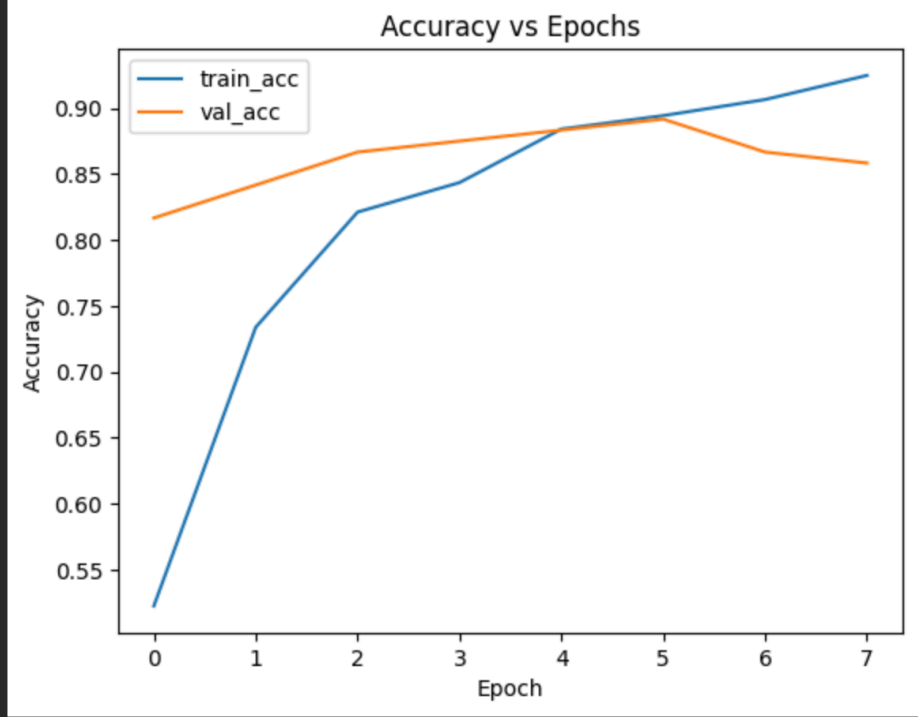
Loss

5/5 ━━━━━━━━━━━━━━━━━━━━ 3s 396ms/step

```
...
✅ Validation Accuracy (frozen base): 86.25%
Epoch 1/5
21/21 ━━━━━━━━━━━━━━━━━━━━ 27s 793ms/step – accuracy: 0.8435 – loss: 0.4313 – val_accuracy: 0.9125 – val_loss: 0.1718 – learning_rate: 1.0000e-04
Epoch 2/5
21/21 ━━━━━━━━━━━━━━━━━━━━ 14s 684ms/step – accuracy: 0.9551 – loss: 0.1377 – val_accuracy: 0.9000 – val_loss: 0.1737 – learning_rate: 1.0000e-04
Epoch 3/5
21/21 ━━━━━━━━━━━━━━━━━━━━ 15s 715ms/step – accuracy: 0.9681 – loss: 0.1039 – val_accuracy: 0.9500 – val_loss: 0.1424 – learning_rate: 1.0000e-04
Epoch 4/5
21/21 ━━━━━━━━━━━━━━━━━━━━ 15s 697ms/step – accuracy: 0.9798 – loss: 0.0696 – val_accuracy: 0.9375 – val_loss: 0.1981 – learning_rate: 1.0000e-04
Epoch 5/5
21/21 ━━━━━━━━━━━━━━━━━━━━ 0s 585ms/step – accuracy: 0.9932 – loss: 0.0502
Epoch 5: ReduceLROnPlateau reducing learning rate to 4.999999873689376e-05.
21/21 ━━━━━━━━━━━━━━━━━━━━ 15s 691ms/step – accuracy: 0.9931 – loss: 0.0503 – val_accuracy: 0.8750 – val_loss: 0.3489 – learning_rate: 1.0000e-04
5/5 ━━━━━━━━━━━━━━━━━━━━ 5s 510ms/step
✅ Validation Accuracy (after fine-tuning): 95.00%

Confusion Matrix:
 [[37  3]
 [ 1 39]]

Classification Report:
              precision    recall  f1-score   support

       Covid       0.97      0.93      0.95        40
      Normal       0.93      0.97      0.95        40

    accuracy                           0.95        80
   macro avg       0.95      0.95      0.95        80
weighted avg       0.95      0.95      0.95        80
```

Accuracy vs Epochs

✅ Overall Validation Accuracy: 85.83%
✅ Macro F1-score: 0.860

Normalized Confusion Matrix