```python
import tensorflow as tf
from tensorflow.keras.applications import MobileNetV2
from tensorflow.keras.layers import Dense, GlobalAveragePooling2D,
Dropout
from tensorflow.keras.models import Model
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import matplotlib.pyplot as plt

# Define a callback to store loss & accuracy after each epoch
class PerformancePlotCallback(tf.keras.callbacks.Callback):
    def on_train_begin(self, logs=None):
        self.epochs = []
        self.train_loss = []
        self.val_loss = []
        self.train_acc = []
        self.val_acc = []

    def on_epoch_end(self, epoch, logs=None):
        self.epochs.append(epoch)
        self.train_loss.append(logs["loss"])
        self.val_loss.append(logs["val_loss"])
        self.train_acc.append(logs["accuracy"])
        self.val_acc.append(logs["val_accuracy"])

        # Plot loss & accuracy
        plt.figure(figsize=(12, 5))

        # Loss Plot
        plt.subplot(1, 2, 1)
        plt.plot(self.epochs, self.train_loss, label="Training Loss",
marker='o')
        plt.plot(self.epochs, self.val_loss, label="Validation Loss",
marker='o')
        plt.xlabel("Epochs")
        plt.ylabel("Loss")
        plt.title("Loss Over Epochs")
        plt.legend()

        # Accuracy Plot
        plt.subplot(1, 2, 2)
        plt.plot(self.epochs, self.train_acc, label="Training
Accuracy", marker='o')
        plt.plot(self.epochs, self.val_acc, label="Validation
Accuracy", marker='o')
        plt.xlabel("Epochs")
        plt.ylabel("Accuracy")
        plt.title("Accuracy Over Epochs")
        plt.legend()

        plt.show()
```

```python
# Add callback to the training process
plot_callback = PerformancePlotCallback()

# Load MobileNetV2
base_model = MobileNetV2(weights="imagenet", include_top=False,
input_shape=(224, 224, 3))
base_model.trainable = False  # Freeze pretrained layers

# Add new classification layers
x = base_model.output
x = GlobalAveragePooling2D()(x)
x = Dense(128, activation="relu")(x)
x = Dropout(0.3)(x)  # Prevent overfitting
output = Dense(5, activation="softmax")(x)  # 5 categories

model = Model(inputs=base_model.input, outputs=output)
model.compile(optimizer="adam", loss="categorical_crossentropy",
metrics=["accuracy"])

# Augment dataset
datagen = ImageDataGenerator(
    rescale=1.0/255,
    validation_split=0.2,  # 80% training, 20% validation
    rotation_range=20,
    width_shift_range=0.2,
    height_shift_range=0.2,
    horizontal_flip=True,
    brightness_range=[0.7, 1.3],
    zoom_range=0.2
)

train_generator = datagen.flow_from_directory("dataset",
target_size=(224, 224), batch_size=32, subset="training")
val_generator = datagen.flow_from_directory("dataset",
target_size=(224, 224), batch_size=32, subset="validation")

# Train Model
model.fit(train_generator, validation_data=val_generator, epochs=15,
callbacks=[plot_callback] )
```

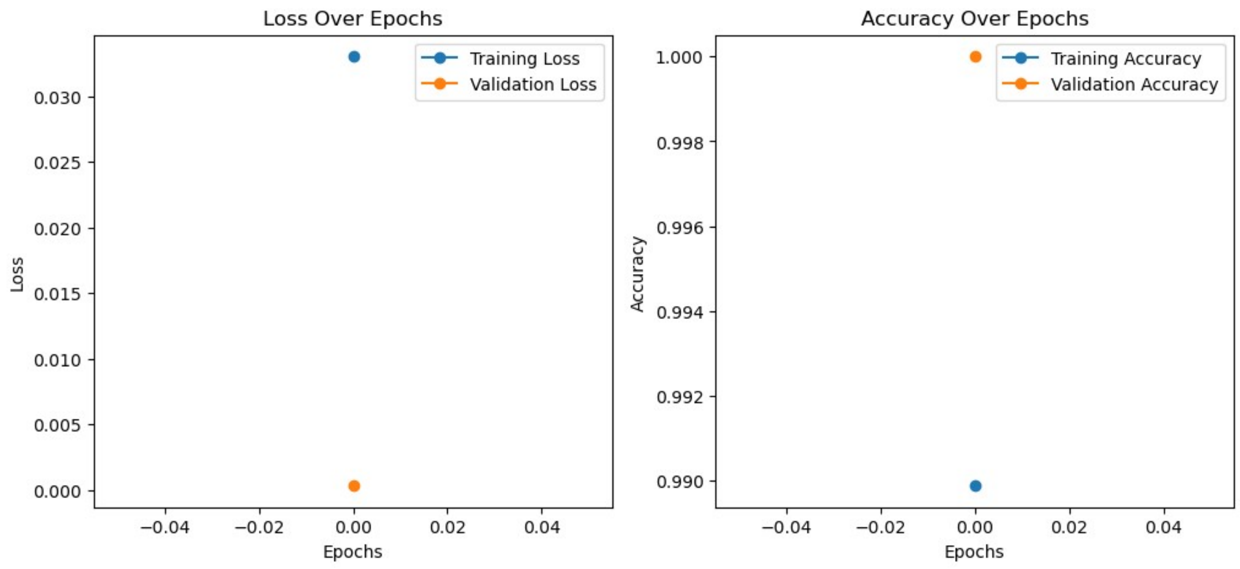
```
Downloading data from https://storage.googleapis.com/tensorflow/keras-
applications/mobilenet_v2/
mobilenet_v2_weights_tf_dim_ordering_tf_kernels_1.0_224_no_top.h5
9406464/9406464 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
Found 8010 images belonging to 5 classes.
Found 2000 images belonging to 5 classes.

C:\Users\ENVY\anaconda3\envs\ocv\Lib\site-packages\keras\src\trainers\
data_adapters\py_dataset_adapter.py:121: UserWarning: Your `PyDataset`
```

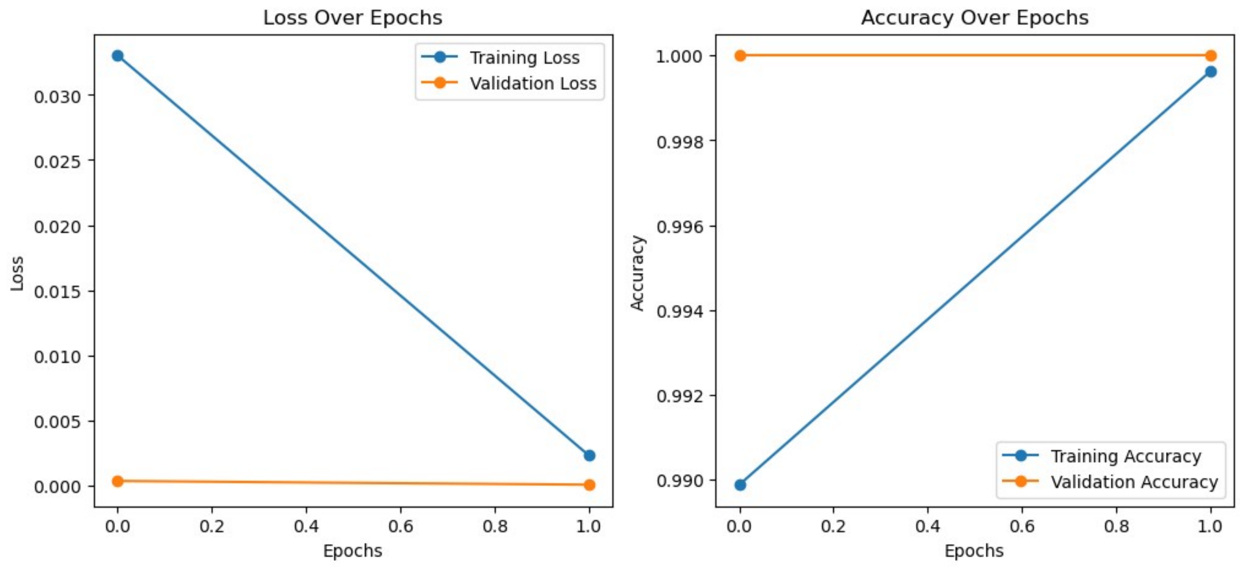
```
class should call `super().__init__(**kwargs)` in its constructor.
`**kwargs` can include `workers`, `use_multiprocessing`,
`max_queue_size`. Do not pass these arguments to `fit()`, as they will
be ignored.
  self._warn_if_super_not_called()

Epoch 1/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 1s/step - accuracy: 0.9503 - loss:
0.1449

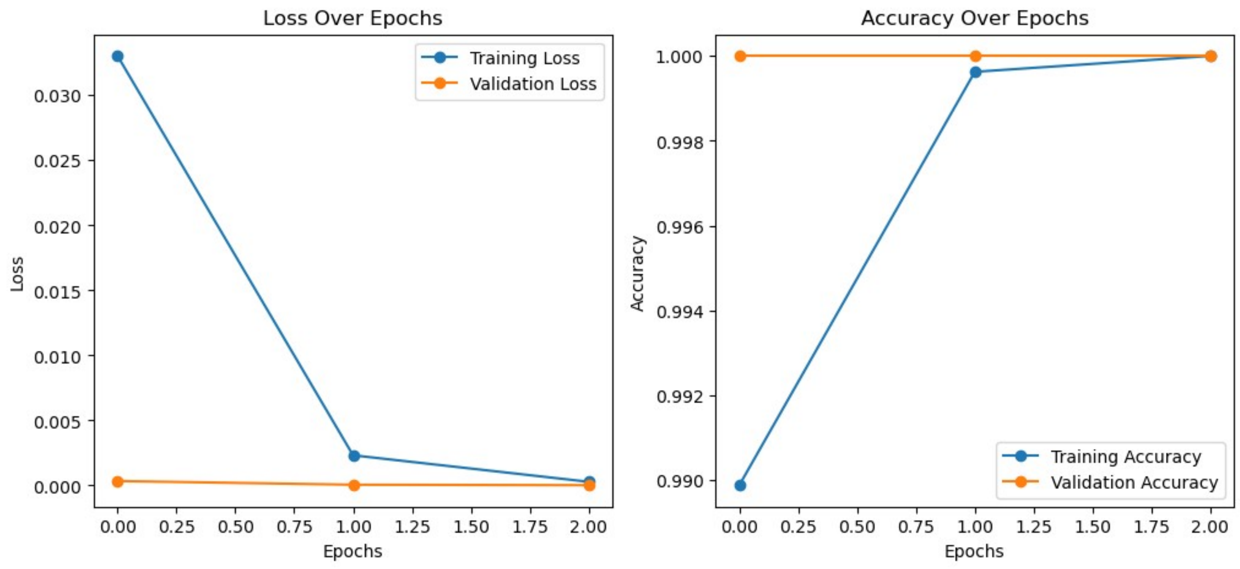
C:\Users\ENVY\anaconda3\envs\ocv\Lib\site-packages\keras\src\trainers\
data_adapters\py_dataset_adapter.py:121: UserWarning: Your `PyDataset`
class should call `super().__init__(**kwargs)` in its constructor.
`**kwargs` can include `workers`, `use_multiprocessing`,
`max_queue_size`. Do not pass these arguments to `fit()`, as they will
be ignored.
  self._warn_if_super_not_called()
```



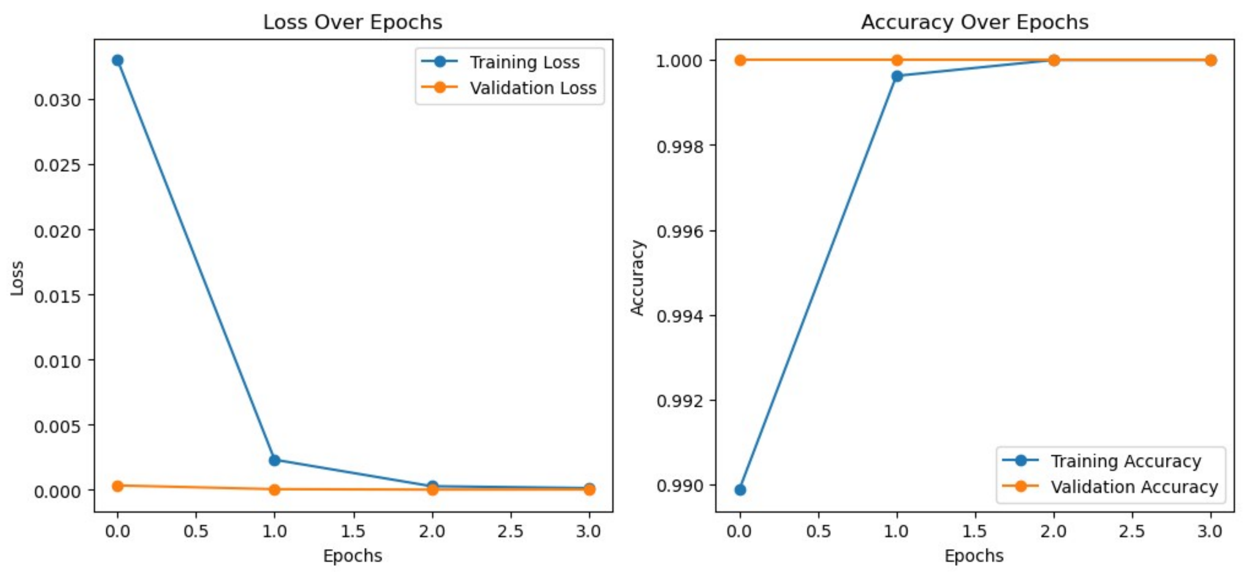
```
251/251 ━━━━━━━━━━━━━━━━━━━━ 414s 2s/step - accuracy: 0.9504 - loss:
0.1445 - val_accuracy: 1.0000 - val_loss: 3.4167e-04
Epoch 2/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 955ms/step - accuracy: 0.9994 - loss:
0.0045
```



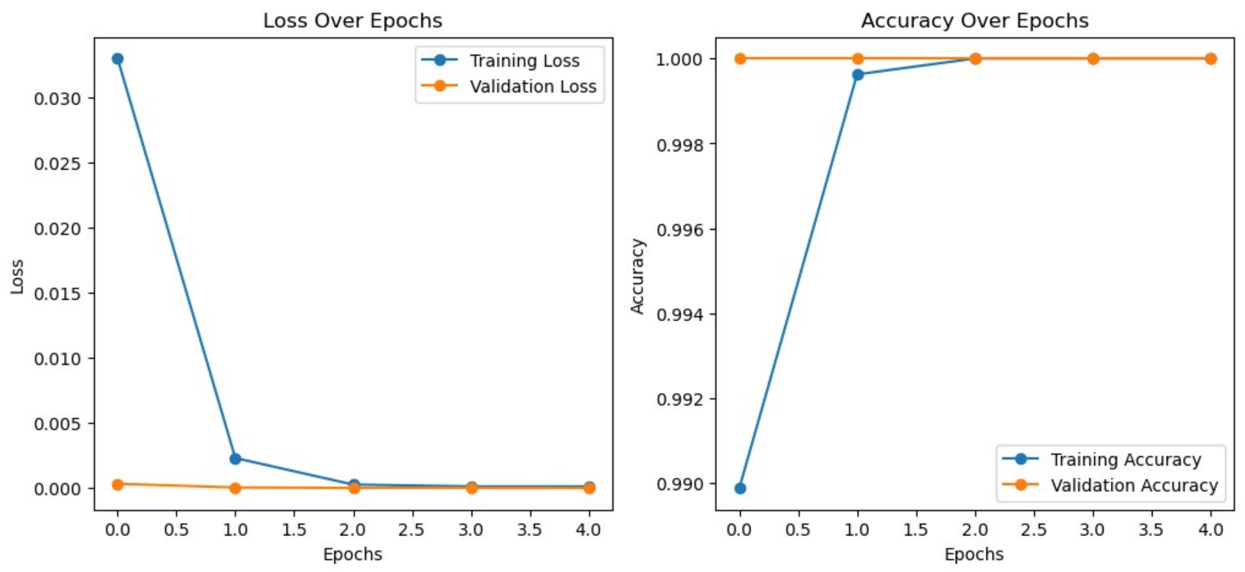
```
251/251 ━━━━━━━━━━━━━━━━━━━━ 298s 1s/step - accuracy: 0.9994 - loss:
0.0045 - val_accuracy: 1.0000 - val_loss: 5.6569e-05
Epoch 3/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 971ms/step - accuracy: 1.0000 - loss:
2.9934e-04
```



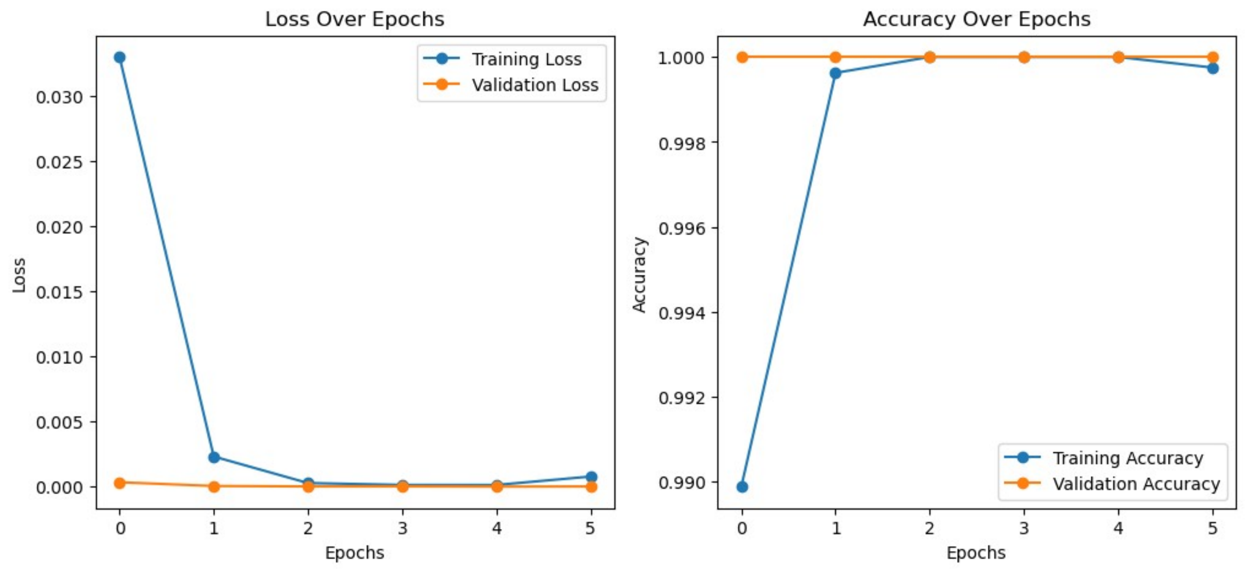
```
251/251 ━━━━━━━━━━━━━━━━━━━━ 306s 1s/step - accuracy: 1.0000 - loss:
2.9928e-04 - val_accuracy: 1.0000 - val_loss: 2.1595e-05
Epoch 4/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 940ms/step - accuracy: 1.0000 - loss:
1.4407e-04
```



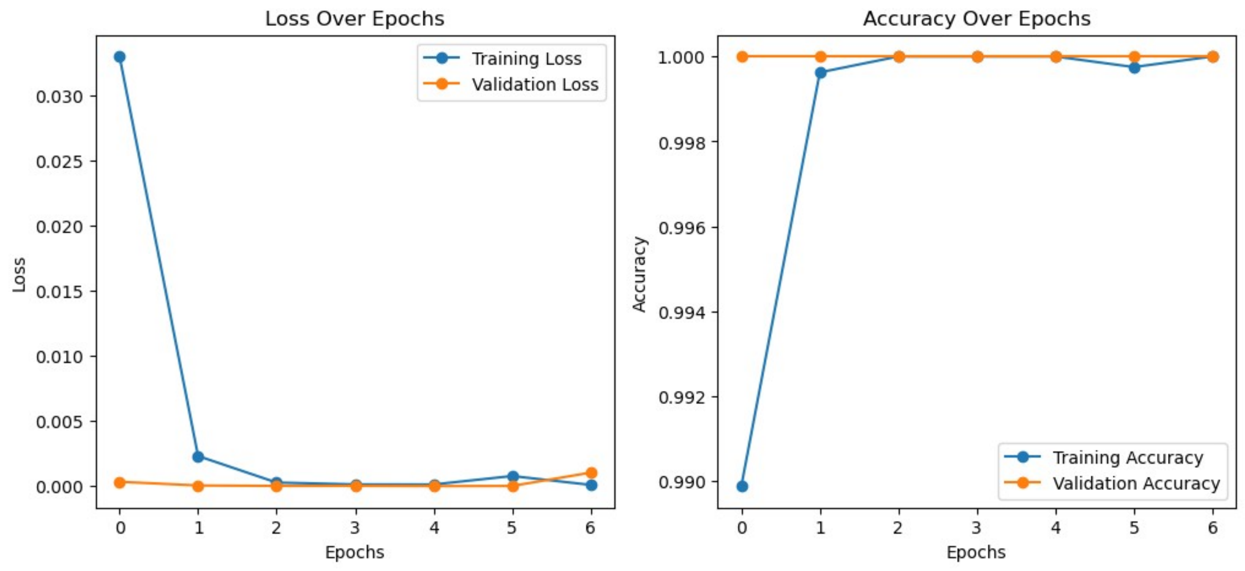
```
251/251 ━━━━━━━━━━━━━━━━━━━━ 298s 1s/step - accuracy: 1.0000 - loss:
1.4405e-04 - val_accuracy: 1.0000 - val_loss: 2.6954e-05
Epoch 5/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 953ms/step - accuracy: 1.0000 - loss:
1.5038e-04
```



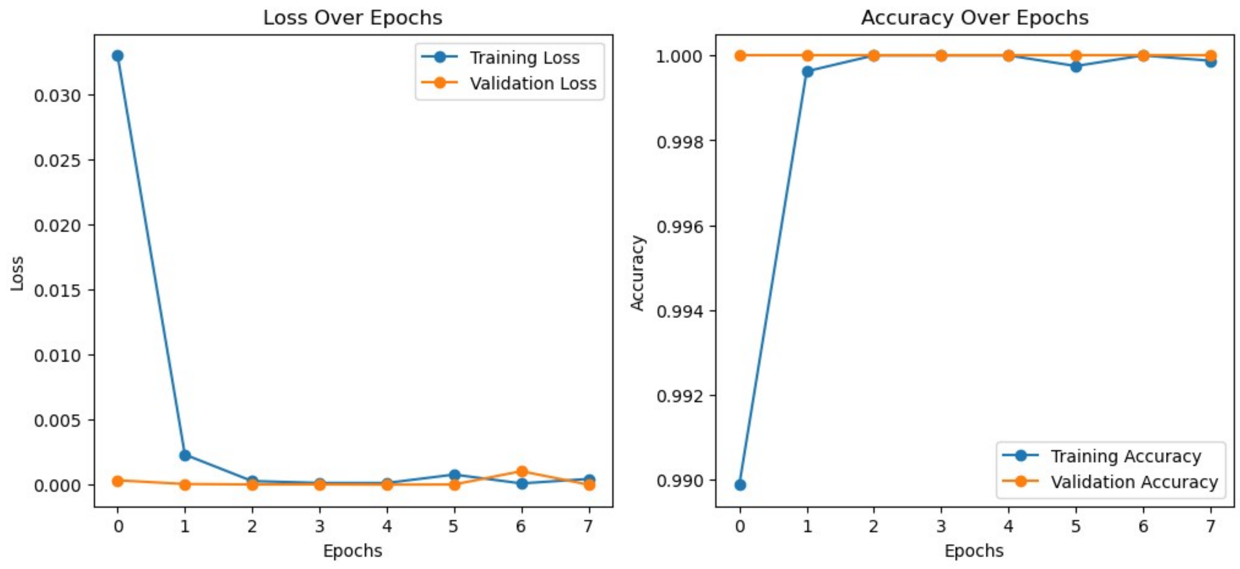
```
251/251 ━━━━━━━━━━━━━━━━━━━━ 298s 1s/step - accuracy: 1.0000 - loss:
1.5032e-04 - val_accuracy: 1.0000 - val_loss: 8.2568e-06
Epoch 6/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 953ms/step - accuracy: 0.9997 - loss:
7.6511e-04
```



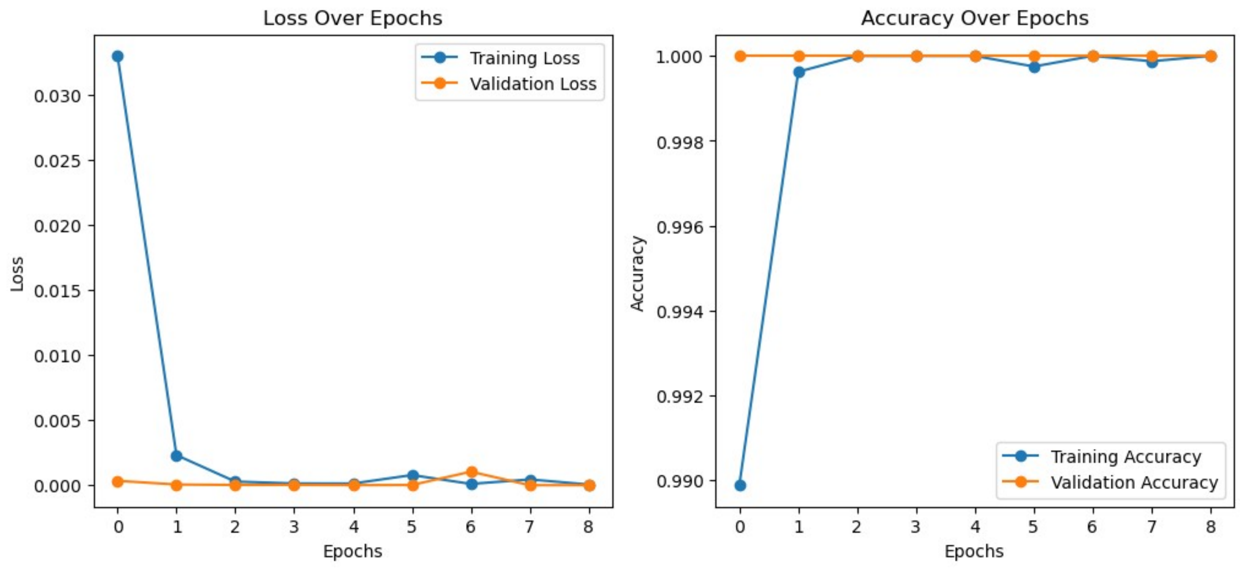
```
251/251 ━━━━━━━━━━━━━━━━━━━━ 299s 1s/step - accuracy: 0.9997 - loss:
7.6518e-04 - val_accuracy: 1.0000 - val_loss: 1.9682e-05
Epoch 7/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 951ms/step - accuracy: 1.0000 - loss:
7.4388e-05
```



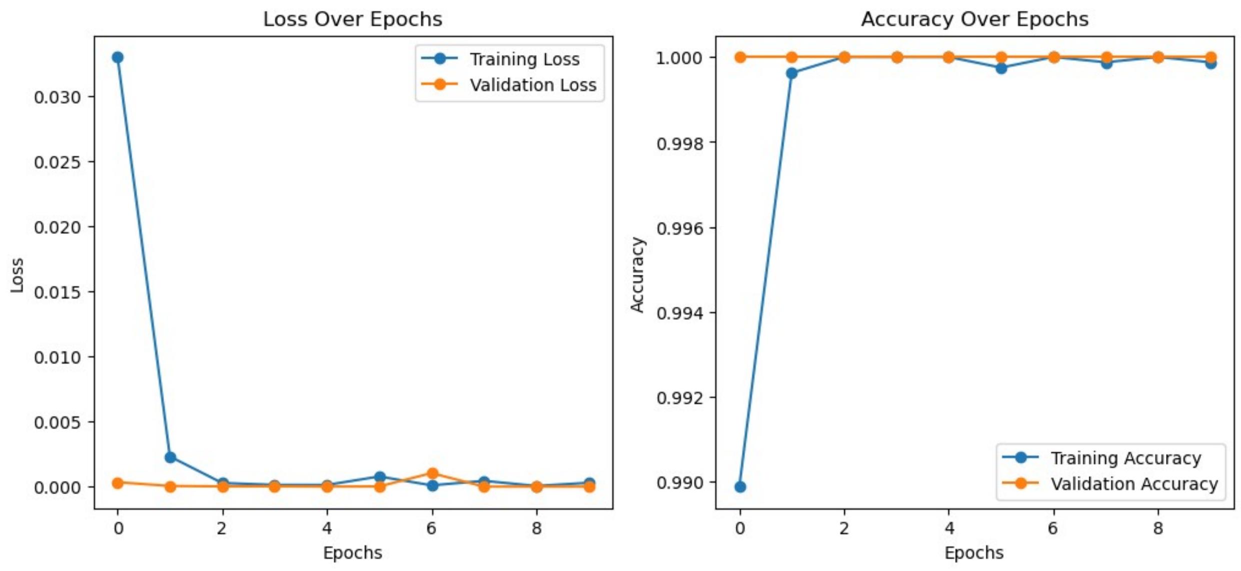
```
251/251 ━━━━━━━━━━━━━━━━━━━━ 298s 1s/step - accuracy: 1.0000 - loss:
7.4503e-05 - val_accuracy: 1.0000 - val_loss: 0.0010
Epoch 8/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 935ms/step - accuracy: 0.9994 - loss:
0.0015
```



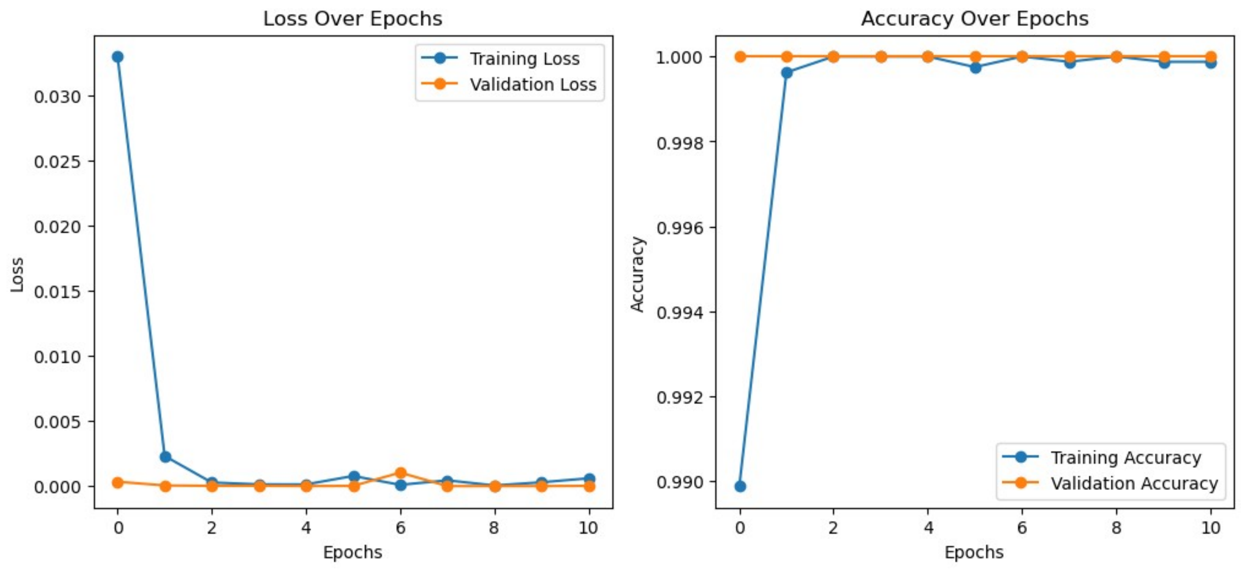
```
251/251 ━━━━━━━━━━━━━━━━━━━━ 294s 1s/step - accuracy: 0.9994 - loss:
0.0015 - val_accuracy: 1.0000 - val_loss: 4.7252e-06
Epoch 9/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 952ms/step - accuracy: 1.0000 - loss:
4.7576e-05
```



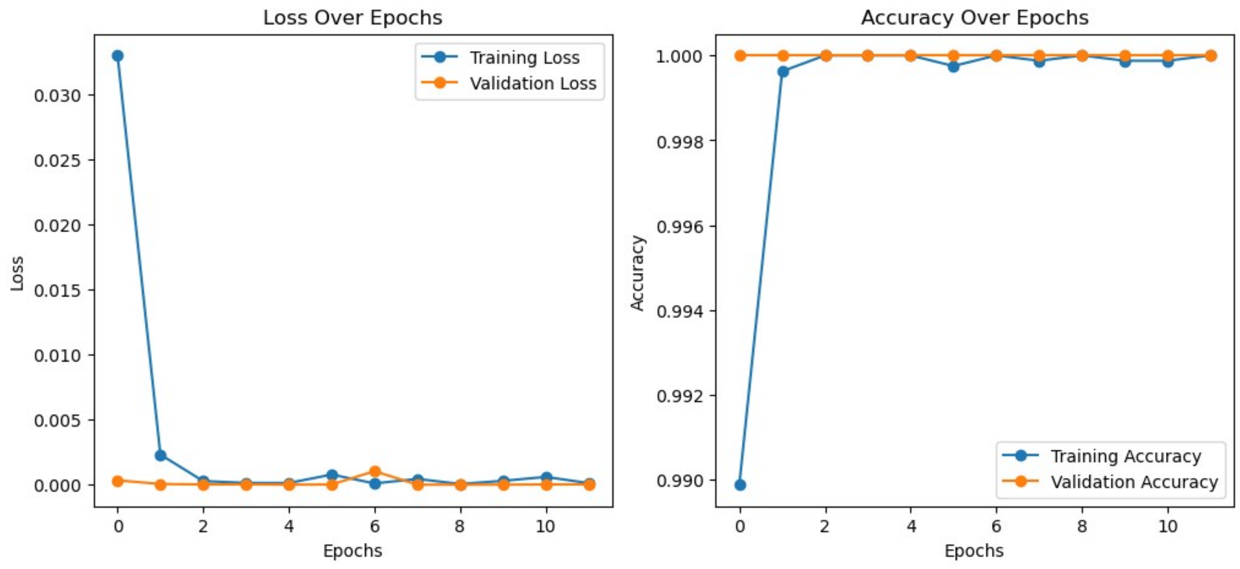
```
251/251 ━━━━━━━━━━━━━━━━━━━━ 297s 1s/step - accuracy: 1.0000 - loss:
4.7610e-05 - val_accuracy: 1.0000 - val_loss: 4.6969e-06
Epoch 10/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 965ms/step - accuracy: 1.0000 - loss:
5.0045e-05
```



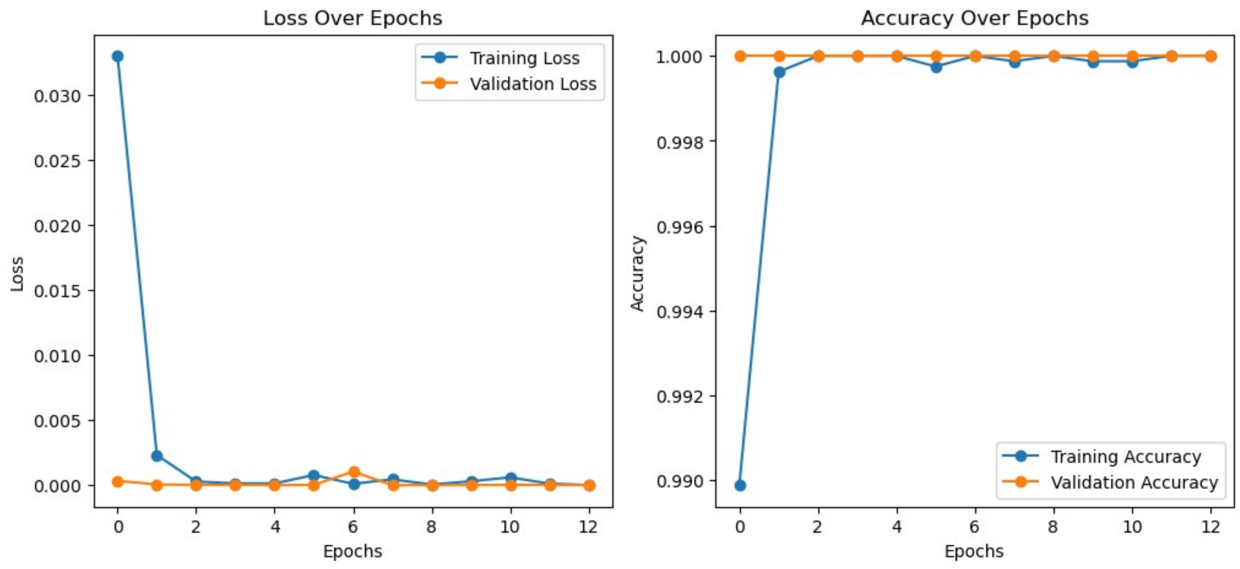
```
251/251 ━━━━━━━━━━━━━━━━━━━━ 302s 1s/step - accuracy: 1.0000 - loss:
5.1033e-05 - val_accuracy: 1.0000 - val_loss: 5.6234e-06
Epoch 11/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 947ms/step - accuracy: 1.0000 - loss:
1.8032e-04
```



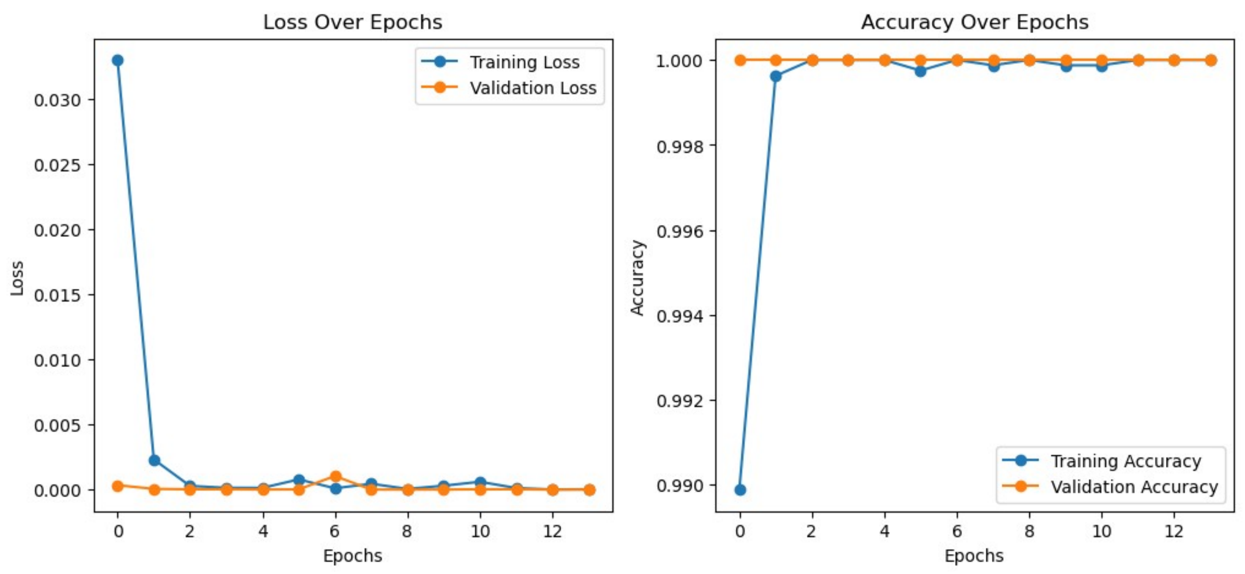
```
251/251 ━━━━━━━━━━━━━━━━━━━━ 296s 1s/step - accuracy: 1.0000 - loss:
1.8200e-04 - val_accuracy: 1.0000 - val_loss: 2.4058e-05
Epoch 12/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 946ms/step - accuracy: 1.0000 - loss:
1.8922e-04
```



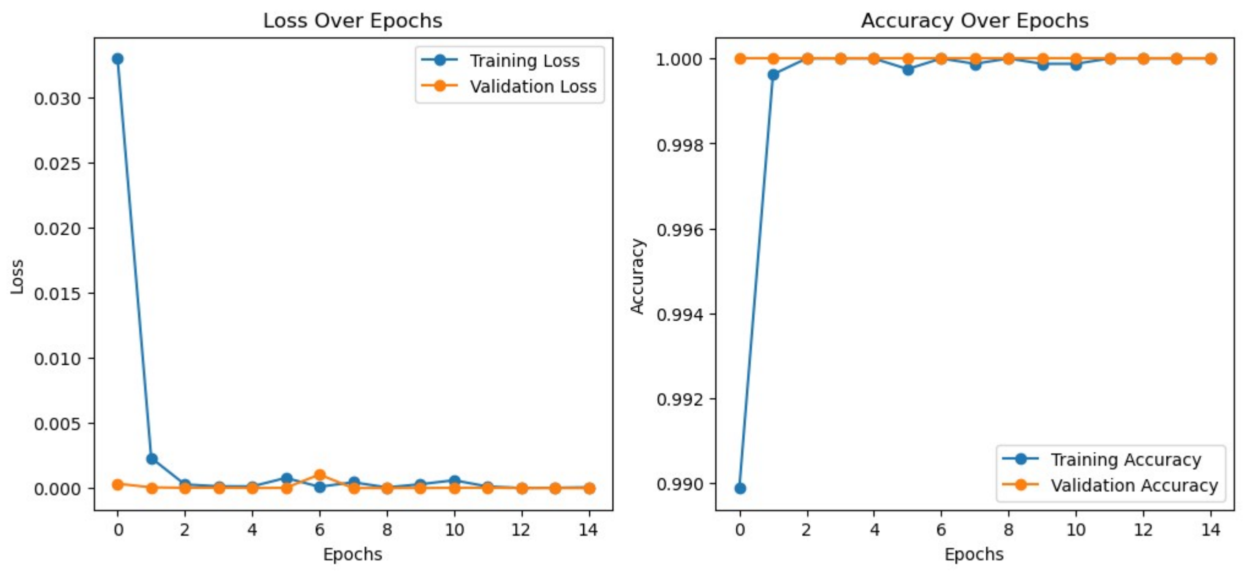
```
251/251 ━━━━━━━━━━━━━━━━━━━━ 299s 1s/step - accuracy: 1.0000 - loss:
1.8895e-04 - val_accuracy: 1.0000 - val_loss: 2.5982e-05
Epoch 13/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 941ms/step - accuracy: 1.0000 - loss:
9.7957e-06
```



```
251/251 ━━━━━━━━━━━━━━━━━━━━ 295s 1s/step - accuracy: 1.0000 - loss:
9.7939e-06 - val_accuracy: 1.0000 - val_loss: 3.0064e-07
Epoch 14/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 934ms/step - accuracy: 1.0000 - loss:
2.1941e-05
```



```
251/251 ━━━━━━━━━━━━━━━━━━━━ 293s 1s/step - accuracy: 1.0000 - loss:
2.1953e-05 - val_accuracy: 1.0000 - val_loss: 3.5717e-07
Epoch 15/15
251/251 ━━━━━━━━━━━━━━━━━━━━ 0s 973ms/step - accuracy: 1.0000 - loss:
1.3655e-04
```



```
251/251 ━━━━━━━━━━━━━━━━━━━━ 305s 1s/step - accuracy: 1.0000 - loss:
1.3625e-04 - val_accuracy: 1.0000 - val_loss: 5.1163e-07

<keras.src.callbacks.history.History at 0x213c24bb6d0>

# Save Model
model.save("object_detector.h5")
print("Model trained and saved successfully!")
```

```
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')`.

Model trained and saved successfully!
```

```
model.save("mymodel.keras")
print("Model trained and saved successfully!")
```

```
Model trained and saved successfully!
```

```
import tensorflow as tf

# Load trained model
model = tf.keras.models.load_model("object_detector.h5")
# Check validation accuracy
val_loss, val_acc = model.evaluate(val_generator)
print(f"Validation Accuracy: {val_acc * 100:.2f}%")
print(f"Validation Loss: {val_loss:.4f}")
```

```
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.

63/63 ━━━━━━━━━━━━━━━━━━━━ 68s 1s/step - accuracy: 1.0000 - loss:
3.4388e-06
Validation Accuracy: 100.00%
Validation Loss: 0.0000
```

```
converter = tf.lite.TFLiteConverter.from_keras_model(model)
tflite_model = converter.convert()

# Save the model
with open("object_detector.tflite", "wb") as f:
    f.write(tflite_model)

print("Model converted to TensorFlow Lite successfully!")
```

```
INFO:tensorflow:Assets written to: C:\Users\ENVY\AppData\Local\Temp\
tmpy67pxpe4\assets

INFO:tensorflow:Assets written to: C:\Users\ENVY\AppData\Local\Temp\
tmpy67pxpe4\assets

Saved artifact at 'C:\Users\ENVY\AppData\Local\Temp\tmpy67pxpe4'. The
following endpoints are available:

* Endpoint 'serve'
  args_0 (POSITIONAL_ONLY): TensorSpec(shape=(None, 224, 224, 3),
dtype=tf.float32, name='input_layer')
```

```
Output Type:
  TensorSpec(shape=(None, 5), dtype=tf.float32, name=None)
Captures:
  2282798880848: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798881808: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798882000: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798881616: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798880080: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798882384: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798883728: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798883920: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798883536: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798882768: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798884304: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798885648: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798885840: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798885456: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798884688: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798886224: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798887568: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798887760: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798887376: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798886608: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798888144: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798889488: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798889680: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798889296: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798888528: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798890064: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828316944: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828317712: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798880464: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282798890448: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828317520: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828319056: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828319248: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828318864: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828318096: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828319632: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828320976: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828321168: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828320784: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828320016: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828321552: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828322896: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828323088: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828322704: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828321936: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828323472: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828324816: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828325008: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828324624: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828323856: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828325392: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828326736: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828326928: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828326544: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828325776: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828327312: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828328656: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828328848: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828328464: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828327696: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828329232: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828330576: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828330768: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828330384: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828329616: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828331152: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828332496: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828331920: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828332304: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828331536: TensorSpec(shape=(), dtype=tf.resource, name=None)
  2282828332688: TensorSpec(shape=(), dtype=tf.resource, name=None)
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Model converted to TensorFlow Lite successfully!
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