```python
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Rescaling , GlobalAveragePooling2D
from tensorflow.keras import layers, optimizers, callbacks
from sklearn.utils.class_weight import compute_class_weight
from tensorflow.keras.applications import EfficientNetV2B2
from sklearn.metrics import confusion_matrix, classification_report
import gradio as gr
```

Python

```python
dataset_dir= r"C:\Users\kolle\Downloads\archive (2)\TrashType_Image_Dataset"
image_size = (124, 124)
batch_size = 32
seed = 42
```

Python

```python
train_ds = tf.keras.utils.image_dataset_from_directory(
    dataset_dir,
    validation_split=0.2,
    subset="training",
    seed=seed,
    shuffle=True,
    image_size=image_size,
    batch_size=batch_size
)
```

Installing ipykernel

Source: Jupyter

```
Found 2527 files belonging to 6 classes.
Using 2022 files for training.
```

```python
val_ds = tf.keras.utils.image_dataset_from_directory(
    dataset_dir,
    validation_split=0.2,
    subset="validation",
    seed=seed,
    shuffle=True,
    image_size=image_size,
    batch_size=batch_size
)
val_class= val_ds.class_names
```

Python

```
Found 2527 files belonging to 6 classes.
Using 505 files for validation.
```

```python
val_batches = tf.data.experimental.cardinality(val_ds)
test_ds = val_ds.take(val_batches // 2)
val_dat = val_ds.skip(val_batches // 2)
test_ds_eval = test_ds.cache().prefetch(tf.data.AUTOTUNE)
```

Python

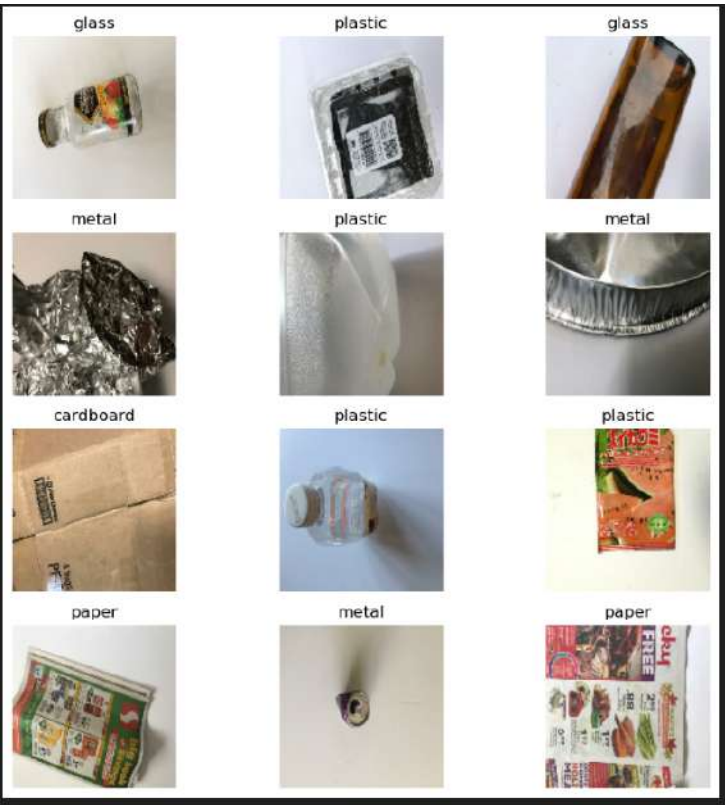
```python
print(train_ds.class_names)
print(val_class)
print(len(train_ds.class_names))
```

Python

```
'cardboard', 'glass', 'metal', 'paper', 'plastic', 'trash']
'cardboard', 'glass', 'metal', 'paper', 'plastic', 'trash']
6
```

```python
import matplotlib.pyplot as plt

plt.figure(figsize=(10, 10))
for images, labels in train_ds.take(1):
    for i in range(12):
        ax = plt.subplot(4, 3, i + 1)
        plt.imshow(images[i].numpy().astype("uint8"))
        plt.title(train_ds.class_names[labels[i]])
        plt.axis("off")
```

Python


glass
plastic
glass
metal
plastic
metal
cardboard
plastic
plastic
paper
metal
paper

```python
def count_distribution(dataset, class_names):
    total = 0
    counts = {name: 0 for name in class_name}

    for _, labels in dataset:
        for label in labels.numpy():
            class_name = class_names[label]
            counts[class_name] +=1
            total +=1
    for k in counts:
        counts[k] = round((counts[k] / total) *100, 2)
        return counts
```

[ ]

Python

Generate + Code + Markdown

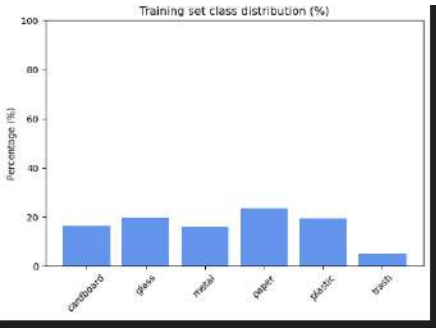
```python
def simple_bar_plot(dist, title):
    plt.bar(dist.keys(), dist.values(), color='cornflowerblue')
    plt.title(title)
    plt.ylabel('Percentage (%)')
    plt.xticks(rotation=45)
    plt.ylim(0, 100)
    plt.tight_layout()
    plt.show()
```

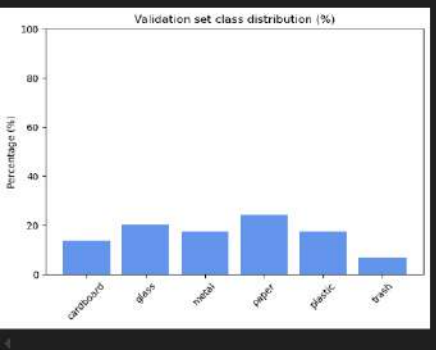
Python

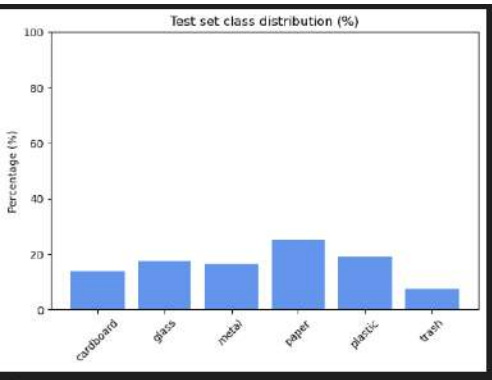
```python
class_names = train_ds.class_names

def get_distribution(dataset, class_names):
    counts = {k: 0 for k in class_names}
    total = 0
    for images, labels in dataset:
        for label in labels:
            class_name = class_names[int(label)]
            counts[class_name] += 1
            total += 1

    if total == 0:
        return counts
    for  k in counts:
        counts[k] = round((counts[k] / total) *100, 2)
    return counts

train_dist = get_distribution(train_ds, class_names)
val_dist = get_distribution(val_ds, class_names)
test_dist = get_distribution(test_ds, class_names)

overall_dist = {}
for k in class_names:
    overall_dist[k] = round((train_dist.get(k, 0) + val_dist.get(k, 0)) / 2)

# Print results
print("Train Distribution:", train_dist)
print("Validation Distribution:", val_dist)
print("Test Distribution:", test_dist)
```

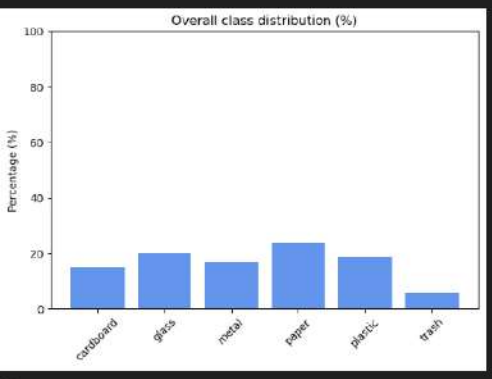
```
Train Distribution: {'cardboard': 16.52, 'glass': 19.73, 'metal': 15.92, 'paper': 23.29, 'plastic': 19.44, 'trash': 5.09}
Validation Distribution: {'cardboard': 13.66, 'glass': 20.2, 'metal': 17.43, 'paper': 24.36, 'plastic': 17.62, 'trash': 6.73}
Test Distribution: {'cardboard': 11.72, 'glass': 19.14, 'metal': 20.7, 'paper': 25.78, 'plastic': 15.62, 'trash': 7.03}
```

```
    simple_bar_plot(train_dist, "Training set class distribution (%)")
    simple_bar_plot(val_dist, "Validation set class distribution (%)")
    simple_bar_plot(test_dist, "Test set class distribution (%)")
    simple_bar_plot(overall_dist, "Overall class distribution (%)")
```


Training set class distribution (%)
Percentage (%)
0
20
40
60
80
100
cardboard
glass
metal
paper
plastic
trash


Validation set class distribution (%)
Percentage (%)
0
20
40
60
80
100
cardboard
glass
metal
paper
plastic
trash


Test set class distribution (%)
Percentage (%)
100
80
60
40
20
0
cardboard
glass
metal
paper
plastic
trash


Overall class distribution (%)
Percentage (%)
100
80
60
40
20
0
cardboard
glass
metal
paper
plastic
trash

```python
import numpy as np
from sklearn.utils.class_weight import compute_class_weight

class_counts = {i: 0 for i in range(len(class_names))}
all_labels = []

for images, labels in train_ds:
    for label in labels.numpy():
        if isinstance(label, np.ndarray):
            label = np.argmax(label)
        class_counts[label] += 1
        all_labels.append(label)

class_weight_array = compute_class_weight(
    class_weight='balanced',
    classes=np.unique(all_labels),
    y=all_labels
)

class_weights = {i: w for i, w in zip(np.unique(all_labels), class_weight_array)}
```

```
print("Class Counts:", class_counts)
print("Class Weights:", class_weights)
```

```
Class Counts: {0: 334, 1: 399, 2: 322, 3: 471, 4: 393, 5: 103}
Class Weights: {0: 1.0089820359281436, 1: 0.8446115288220551, 2: 1.046583850931677, 3: 0.7154989384288747, 4: 0.8575063613231552, 5: 3.2718446601941746}
```

```
data_augmentation = Sequential([
    layers.RandomFlip("horizontal"),
    layers.RandomFlip(0.1),
    layers.RandomZoom(0.1),
    layers.RandomContrast(0.1),
])
```

```
base_model = EfficientNetV2B2(include_top=False, input_shape=(124,124,3), include_preprocessing=True, weights='imagenet')

base_model.trainable = True
for layer in base_model.layers[:100]:
    layer.trainable = False
```

```python
model = Sequential([
    layers.Input(shape=(124, 124, 3)),
    data_augmentation,
    base_model,
    GlobalAveragePooling2D(),
    layers.Dropout(0.3),
    layers.Dense(6, activation='softmax')
])
```

Python

```python
model.compile(
    optimizer=optimizers.Adam(learning_rate=1e-4),
    loss='sparse_categorical_crossentropy',
    metrics=['accuracy']
)
```

Python

```python
early = tf.keras.callbacks.EarlyStopping(
    monitor='val_loss',
    patience=3,
    restore_best_weights=True
)
```

Python

Generate + Code + Markdown

```python
label_mapping = {label: idx for idx, label in enumerate(sorted(set(all_labels)))}
mapped_labels = [label_mapping[label] for label in all_labels]

from sklearn.utils.class_weight import compute_class_weight

class_weight_array = compute_class_weight(
    class_weight='balanced',
    classes=np.arange(len(label_mapping)),
    y=mapped_labels
)
class_weights = {i: w for i,w in enumerate(class_weight_array)}
```

Python

```python
model.summary()
```

Python

```
Model: "sequential_1"
```

```python
model.summary()
```

Python

```
Model: "sequential_1"
```

Layer (type)	Output Shape	Param #
sequential (Sequential)	(None, 124, 124, 3)	0
efficientnetv2-b2 (Functional)	(None, 4, 4, 1408)	8,769,374
global_average_pooling2d (GlobalAveragePooling2D)	(None, 1408)	0
dropout (Dropout)	(None, 1408)	0
dense (Dense)	(None, 6)	8,454

```
Total params: 8,777,828 (33.48 MB)

Trainable params: 7,974,642 (30.42 MB)

Non-trainable params: 803,186 (3.06 MB)
```

```python
base_model.summary()
```

Python

Model: "efficientnetv2-b2"

Layer (type)	Output Shape	Param #	Connected to
input_layer (InputLayer)	(None, 124, 124, 3)	0	-
rescaling (Rescaling)	(None, 124, 124, 3)	0	input_layer[0][0]
normalization (Normalization)	(None, 124, 124, 3)	0	rescaling[0][0]
stem_conv (Conv2D)	(None, 62, 62, 32)	864	normalization[0][0]
stem_bn (BatchNormalization)	(None, 62, 62, 32)	128	stem_conv[0][0]
stem_activation (Activation)	(None, 62, 62, 32)	0	stem_bn[0][0]
block1a_project_conv (Conv2D)	(None, 62, 62, 16)	4,608	stem_activation[0][0]
block1a_project_bn (BatchNormalization)	(None, 62, 62, 16)	64	block1a_project_conv[0][0]
block1a_project_activation (Activation)	(None, 62, 62, 16)	0	block1a_project_bn[0][0]
block1b_project_conv (Conv2D)	(None, 62, 62, 16)	2,304	block1a_project_activatio…
block1b_project_bn (BatchNormalization)	(None, 62, 62, 16)	64	block1b_project_conv[0][0]
block1b_project_activation (Activation)	(None, 62, 62, 16)	0	block1b_project_bn[0][0]
block1b_drop (Dropout)	(None, 62, 62, 16)	0	block1b_project_activatio…
block1b_add (Add)	(None, 62, 62, 16)	0	block1b_drop[0][0], block1a_project_activatio…
block2a_expand_conv (Conv2D)	(None, 31, 31, 64)	9,216	block1b_add[0][0]
block2a_expand_bn (BatchNormalization)	(None, 31, 31, 64)	256	block2a_expand_conv[0][0]
block2a_expand_activation (Activation)	(None, 31, 31, 64)	0	block2a_expand_bn[0][0]

block2a_project_conv (Conv2D)	(None, 31, 31, 32)	2,048	block2a_expand_activation…
block2a_project_bn (BatchNormalization)	(None, 31, 31, 32)	128	block2a_project_conv[0][0]
block2b_expand_conv (Conv2D)	(None, 31, 31, 128)	36,864	block2a_project_bn[0][0]
block2b_expand_bn (BatchNormalization)	(None, 31, 31, 128)	512	block2b_expand_conv[0][0]
block2b_expand_activation (Activation)	(None, 31, 31, 128)	0	block2b_expand_bn[0][0]
block2b_project_conv (Conv2D)	(None, 31, 31, 32)	4,096	block2b_expand_activation…
block2b_project_bn (BatchNormalization)	(None, 31, 31, 32)	128	block2b_project_conv[0][0]
block2b_drop (Dropout)	(None, 31, 31, 32)	0	block2b_project_bn[0][0]
block2b_add (Add)	(None, 31, 31, 32)	0	block2b_drop[0][0], block2a_project_bn[0][0]
block2c_expand_conv (Conv2D)	(None, 31, 31, 128)	36,864	block2b_add[0][0]
block2c_expand_bn (BatchNormalization)	(None, 31, 31, 128)	512	block2c_expand_conv[0][0]
block2c_expand_activation (Activation)	(None, 31, 31, 128)	0	block2c_expand_bn[0][0]
block2c_project_conv (Conv2D)	(None, 31, 31, 32)	4,096	block2c_expand_activation…
block2c_project_bn (BatchNormalization)	(None, 31, 31, 32)	128	block2c_project_conv[0][0]
block2c_drop (Dropout)	(None, 31, 31, 32)	0	block2c_project_bn[0][0]
block2c_add (Add)	(None, 31, 31, 32)	0	block2c_drop[0][0], block2b_add[0][0]
block3a_expand_conv (Conv2D)	(None, 16, 16, 128)	36,864	block2c_add[0][0]
block3a_expand_bn (BatchNormalization)	(None, 16, 16, 128)	512	block3a_expand_conv[0][0]

block3a_expand_activation (Activation)	(None, 16, 16, 128)	0	block3a_expand_bn[0][0]
block3a_project_conv (Conv2D)	(None, 16, 16, 56)	7,168	block3a_expand_activation…
block3a_project_bn (BatchNormalization)	(None, 16, 16, 56)	224	block3a_project_conv[0][0]
block3b_expand_conv (Conv2D)	(None, 16, 16, 224)	112,896	block3a_project_bn[0][0]
block3b_expand_bn (BatchNormalization)	(None, 16, 16, 224)	896	block3b_expand_conv[0][0]
block3b_expand_activation (Activation)	(None, 16, 16, 224)	0	block3b_expand_bn[0][0]
block3b_project_conv (Conv2D)	(None, 16, 16, 56)	12,544	block3b_expand_activation…
block3b_project_bn (BatchNormalization)	(None, 16, 16, 56)	224	block3b_project_conv[0][0]
block3b_drop (Dropout)	(None, 16, 16, 56)	0	block3b_project_bn[0][0]
block3b_add (Add)	(None, 16, 16, 56)	0	block3b_drop[0][0], block3a_project_bn[0][0]
block3c_expand_conv (Conv2D)	(None, 16, 16, 224)	112,896	block3b_add[0][0]
block3c_expand_bn (BatchNormalization)	(None, 16, 16, 224)	896	block3c_expand_conv[0][0]
block3c_expand_activation (Activation)	(None, 16, 16, 224)	0	block3c_expand_bn[0][0]
block3c_project_conv (Conv2D)	(None, 16, 16, 56)	12,544	block3c_expand_activation…
block3c_project_bn (BatchNormalization)	(None, 16, 16, 56)	224	block3c_project_conv[0][0]
block3c_drop (Dropout)	(None, 16, 16, 56)	0	block3c_project_bn[0][0]
block3c_add (Add)	(None, 16, 16, 56)	0	block3c_drop[0][0], block3b_add[0][0]
block4a_expand_conv (Conv2D)	(None, 16, 16, 224)	12,544	block3c_add[0][0]
block4a_expand_bn (BatchNormalization)	(None, 16, 16, 224)	896	block4a_expand_conv[0][0]

block4a_expand_activation (Activation)	(None, 16, 16, 224)	0	block4a_expand_bn[0][0]
block4a_dwconv2 (DepthwiseConv2D)	(None, 8, 8, 224)	2,016	block4a_expand_activation…
block4a_bn (BatchNormalization)	(None, 8, 8, 224)	896	block4a_dwconv2[0][0]
block4a_activation (Activation)	(None, 8, 8, 224)	0	block4a_bn[0][0]
block4a_se_squeeze (GlobalAveragePooling2D)	(None, 224)	0	block4a_activation[0][0]
block4a_se_reshape (Reshape)	(None, 1, 1, 224)	0	block4a_se_squeeze[0][0]
block4a_se_reduce (Conv2D)	(None, 1, 1, 14)	3,150	block4a_se_reshape[0][0]
block4a_se_expand (Conv2D)	(None, 1, 1, 224)	3,360	block4a_se_reduce[0][0]
block4a_se_excite (Multiply)	(None, 8, 8, 224)	0	block4a_activation[0][0], block4a_se_expand[0][0]
block4a_project_conv (Conv2D)	(None, 8, 8, 104)	23,296	block4a_se_excite[0][0]
block4a_project_bn (BatchNormalization)	(None, 8, 8, 104)	416	block4a_project_conv[0][0]
block4b_expand_conv (Conv2D)	(None, 8, 8, 416)	43,264	block4a_project_bn[0][0]
block4b_expand_bn (BatchNormalization)	(None, 8, 8, 416)	1,664	block4b_expand_conv[0][0]
block4b_expand_activation (Activation)	(None, 8, 8, 416)	0	block4b_expand_bn[0][0]
block4b_dwconv2 (DepthwiseConv2D)	(None, 8, 8, 416)	3,744	block4b_expand_activation…
block4b_bn (BatchNormalization)	(None, 8, 8, 416)	1,664	block4b_dwconv2[0][0]
block4b_activation (Activation)	(None, 8, 8, 416)	0	block4b_bn[0][0]
block4b_se_squeeze (GlobalAveragePooling2D)	(None, 416)	0	block4b_activation[0][0]

block4b_se_reshape (Reshape)	(None, 1, 1, 416)	0	block4b_se_squeeze[0][0]
block4b_se_reduce (Conv2D)	(None, 1, 1, 26)	10,842	block4b_se_reshape[0][0]
block4b_se_expand (Conv2D)	(None, 1, 1, 416)	11,232	block4b_se_reduce[0][0]
block4b_se_excite (Multiply)	(None, 8, 8, 416)	0	block4b_activation[0][0], block4b_se_expand[0][0]
block4b_project_conv (Conv2D)	(None, 8, 8, 104)	43,264	block4b_se_excite[0][0]
block4b_project_bn (BatchNormalization)	(None, 8, 8, 104)	416	block4b_project_conv[0][0]
block4b_drop (Dropout)	(None, 8, 8, 104)	0	block4b_project_bn[0][0]
block4b_add (Add)	(None, 8, 8, 104)	0	block4b_drop[0][0], block4a_project_bn[0][0]
block4c_expand_conv (Conv2D)	(None, 8, 8, 416)	43,264	block4b_add[0][0]
block4c_expand_bn (BatchNormalization)	(None, 8, 8, 416)	1,664	block4c_expand_conv[0][0]
block4c_expand_activation (Activation)	(None, 8, 8, 416)	0	block4c_expand_bn[0][0]
block4c_dwconv2 (DepthwiseConv2D)	(None, 8, 8, 416)	3,744	block4c_expand_activation…
block4c_bn (BatchNormalization)	(None, 8, 8, 416)	1,664	block4c_dwconv2[0][0]
block4c_activation (Activation)	(None, 8, 8, 416)	0	block4c_bn[0][0]
block4c_se_squeeze (GlobalAveragePooling2D)	(None, 416)	0	block4c_activation[0][0]
block4c_se_reshape (Reshape)	(None, 1, 1, 416)	0	block4c_se_squeeze[0][0]
block4c_se_reduce (Conv2D)	(None, 1, 1, 26)	10,842	block4c_se_reshape[0][0]
block4c_se_expand (Conv2D)	(None, 1, 1, 416)	11,232	block4c_se_reduce[0][0]
block4c_se_excite (Multiply)	(None, 8, 8, 416)	0	block4c_activation[0][0], block4c_se_expand[0][0]

block4c_project_conv (Conv2D)	(None, 8, 8, 104)	43,264	block4c_se_excite[0][0]
block4c_project_bn (BatchNormalization)	(None, 8, 8, 104)	416	block4c_project_conv[0][0]
block4c_drop (Dropout)	(None, 8, 8, 104)	0	block4c_project_bn[0][0]
block4c_add (Add)	(None, 8, 8, 104)	0	block4c_drop[0][0], block4b_add[0][0]
block4d_expand_conv (Conv2D)	(None, 8, 8, 416)	43,264	block4c_add[0][0]
block4d_expand_bn (BatchNormalization)	(None, 8, 8, 416)	1,664	block4d_expand_conv[0][0]
block4d_expand_activation (Activation)	(None, 8, 8, 416)	0	block4d_expand_bn[0][0]
block4d_dwconv2 (DepthwiseConv2D)	(None, 8, 8, 416)	3,744	block4d_expand_activation…
block4d_bn (BatchNormalization)	(None, 8, 8, 416)	1,664	block4d_dwconv2[0][0]
block4d_activation (Activation)	(None, 8, 8, 416)	0	block4d_bn[0][0]
block4d_se_squeeze (GlobalAveragePooling2D)	(None, 416)	0	block4d_activation[0][0]
block4d_se_reshape (Reshape)	(None, 1, 1, 416)	0	block4d_se_squeeze[0][0]
block4d_se_reduce (Conv2D)	(None, 1, 1, 26)	10,842	block4d_se_reshape[0][0]
block4d_se_expand (Conv2D)	(None, 1, 1, 416)	11,232	block4d_se_reduce[0][0]
block4d_se_excite (Multiply)	(None, 8, 8, 416)	0	block4d_activation[0][0], block4d_se_expand[0][0]
block4d_project_conv (Conv2D)	(None, 8, 8, 104)	43,264	block4d_se_excite[0][0]
block4d_project_bn (BatchNormalization)	(None, 8, 8, 104)	416	block4d_project_conv[0][0]
block4d_drop (Dropout)	(None, 8, 8, 104)	0	block4d_project_bn[0][0]
block4d_add (Add)	(None, 8, 8, 104)	0	block4d_drop[0][0], block4c_add[0][0]

block5a_expand_conv (Conv2D)	(None, 8, 8, 624)	64,896	block4d_add[0][0]
block5a_expand_bn (BatchNormalization)	(None, 8, 8, 624)	2,496	block5a_expand_conv[0][0]
block5a_expand_activation (Activation)	(None, 8, 8, 624)	0	block5a_expand_bn[0][0]
block5a_dwconv2 (DepthwiseConv2D)	(None, 8, 8, 624)	5,616	block5a_expand_activation…
block5a_bn (BatchNormalization)	(None, 8, 8, 624)	2,496	block5a_dwconv2[0][0]
block5a_activation (Activation)	(None, 8, 8, 624)	0	block5a_bn[0][0]
block5a_se_squeeze (GlobalAveragePooling2D)	(None, 624)	0	block5a_activation[0][0]
block5a_se_reshape (Reshape)	(None, 1, 1, 624)	0	block5a_se_squeeze[0][0]
block5a_se_reduce (Conv2D)	(None, 1, 1, 26)	16,250	block5a_se_reshape[0][0]
block5a_se_expand (Conv2D)	(None, 1, 1, 624)	16,848	block5a_se_reduce[0][0]
block5a_se_excite (Multiply)	(None, 8, 8, 624)	0	block5a_activation[0][0], block5a_se_expand[0][0]
block5a_project_conv (Conv2D)	(None, 8, 8, 120)	74,880	block5a_se_excite[0][0]
block5a_project_bn (BatchNormalization)	(None, 8, 8, 120)	480	block5a_project_conv[0][0]
block5b_expand_conv (Conv2D)	(None, 8, 8, 720)	86,400	block5a_project_bn[0][0]
block5b_expand_bn (BatchNormalization)	(None, 8, 8, 720)	2,880	block5b_expand_conv[0][0]

block5b_expand_activation (Activation)	(None, 8, 8, 720)	0	block5b_expand_bn[0][0]
block5b_dwconv2 (DepthwiseConv2D)	(None, 8, 8, 720)	6,480	block5b_expand_activation…
block5b_bn (BatchNormalization)	(None, 8, 8, 720)	2,880	block5b_dwconv2[0][0]
block5b_activation (Activation)	(None, 8, 8, 720)	0	block5b_bn[0][0]
block5b_se_squeeze (GlobalAveragePooling2D)	(None, 720)	0	block5b_activation[0][0]
block5b_se_reshape (Reshape)	(None, 1, 1, 720)	0	block5b_se_squeeze[0][0]
block5b_se_reduce (Conv2D)	(None, 1, 1, 30)	21,630	block5b_se_reshape[0][0]
block5b_se_expand (Conv2D)	(None, 1, 1, 720)	22,320	block5b_se_reduce[0][0]
block5b_se_excite (Multiply)	(None, 8, 8, 720)	0	block5b_activation[0][0], block5b_se_expand[0][0]
block5b_project_conv (Conv2D)	(None, 8, 8, 120)	86,400	block5b_se_excite[0][0]
block5b_project_bn (BatchNormalization)	(None, 8, 8, 120)	480	block5b_project_conv[0][0]
block5b_drop (Dropout)	(None, 8, 8, 120)	0	block5b_project_bn[0][0]
block5b_add (Add)	(None, 8, 8, 120)	0	block5b_drop[0][0], block5a_project_bn[0][0]
block5c_expand_conv (Conv2D)	(None, 8, 8, 720)	86,400	block5b_add[0][0]
block5c_expand_bn (BatchNormalization)	(None, 8, 8, 720)	2,880	block5c_expand_conv[0][0]
block5c_expand_activation (Activation)	(None, 8, 8, 720)	0	block5c_expand_bn[0][0]
block5c_dwconv2 (DepthwiseConv2D)	(None, 8, 8, 720)	6,480	block5c_expand_activation…
block5c_bn (BatchNormalization)	(None, 8, 8, 720)	2,880	block5c_dwconv2[0][0]

block5c_activation (Activation)	(None, 8, 8, 720)	0	block5c_bn[0][0]
block5c_se_squeeze (GlobalAveragePooling2D)	(None, 720)	0	block5c_activation[0][0]
block5c_se_reshape (Reshape)	(None, 1, 1, 720)	0	block5c_se_squeeze[0][0]
block5c_se_reduce (Conv2D)	(None, 1, 1, 30)	21,630	block5c_se_reshape[0][0]
block5c_se_expand (Conv2D)	(None, 1, 1, 720)	22,320	block5c_se_reduce[0][0]
block5c_se_excite (Multiply)	(None, 8, 8, 720)	0	block5c_activation[0][0], block5c_se_expand[0][0]
block5c_project_conv (Conv2D)	(None, 8, 8, 120)	86,400	block5c_se_excite[0][0]
block5c_project_bn (BatchNormalization)	(None, 8, 8, 120)	480	block5c_project_conv[0][0]
block5c_drop (Dropout)	(None, 8, 8, 120)	0	block5c_project_bn[0][0]
block5c_add (Add)	(None, 8, 8, 120)	0	block5c_drop[0][0], block5b_add[0][0]
block5d_expand_conv (Conv2D)	(None, 8, 8, 720)	86,400	block5c_add[0][0]
block5d_expand_bn (BatchNormalization)	(None, 8, 8, 720)	2,880	block5d_expand_conv[0][0]
block5d_expand_activation (Activation)	(None, 8, 8, 720)	0	block5d_expand_bn[0][0]
block5d_dwconv2 (DepthwiseConv2D)	(None, 8, 8, 720)	6,480	block5d_expand_activation…
block5d_bn (BatchNormalization)	(None, 8, 8, 720)	2,880	block5d_dwconv2[0][0]
block5d_activation (Activation)	(None, 8, 8, 720)	0	block5d_bn[0][0]
block5d_se_squeeze (GlobalAveragePooling2D)	(None, 720)	0	block5d_activation[0][0]
block5d_se_reshape (Reshape)	(None, 1, 1, 720)	0	block5d_se_squeeze[0][0]
block5d_se_reduce (Conv2D)	(None, 1, 1, 30)	21,630	block5d_se_reshape[0][0]

block5d_se_expand (Conv2D)	(None, 1, 1, 720)	22,320	block5d_se_reduce[0][0]
block5d_se_excite (Multiply)	(None, 8, 8, 720)	0	block5d_activation[0][0], block5d_se_expand[0][0]
block5d_project_conv (Conv2D)	(None, 8, 8, 120)	86,400	block5d_se_excite[0][0]
block5d_project_bn (BatchNormalization)	(None, 8, 8, 120)	480	block5d_project_conv[0][0]
block5d_drop (Dropout)	(None, 8, 8, 120)	0	block5d_project_bn[0][0]
block5d_add (Add)	(None, 8, 8, 120)	0	block5d_drop[0][0], block5c_add[0][0]
block5e_expand_conv (Conv2D)	(None, 8, 8, 720)	86,400	block5d_add[0][0]
block5e_expand_bn (BatchNormalization)	(None, 8, 8, 720)	2,880	block5e_expand_conv[0][0]
block5e_expand_activation (Activation)	(None, 8, 8, 720)	0	block5e_expand_bn[0][0]
block5e_dwconv2 (DepthwiseConv2D)	(None, 8, 8, 720)	6,480	block5e_expand_activation…
block5e_bn (BatchNormalization)	(None, 8, 8, 720)	2,880	block5e_dwconv2[0][0]
block5e_activation (Activation)	(None, 8, 8, 720)	0	block5e_bn[0][0]
block5e_se_squeeze (GlobalAveragePooling2D)	(None, 720)	0	block5e_activation[0][0]
block5e_se_reshape (Reshape)	(None, 1, 1, 720)	0	block5e_se_squeeze[0][0]
block5e_se_reduce (Conv2D)	(None, 1, 1, 30)	21,630	block5e_se_reshape[0][0]
block5e_se_expand (Conv2D)	(None, 1, 1, 720)	22,320	block5e_se_reduce[0][0]
block5e_se_excite (Multiply)	(None, 8, 8, 720)	0	block5e_activation[0][0], block5e_se_expand[0][0]
block5e_project_conv (Conv2D)	(None, 8, 8, 120)	86,400	block5e_se_excite[0][0]
block5e_project_bn (BatchNormalization)	(None, 8, 8, 120)	480	block5e_project_conv[0][0]

block5e_drop (Dropout)	(None, 8, 8, 120)	0	block5e_project_bn[0][0]
block5e_add (Add)	(None, 8, 8, 120)	0	block5e_drop[0][0], block5d_add[0][0]
block5f_expand_conv (Conv2D)	(None, 8, 8, 720)	86,400	block5e_add[0][0]
block5f_expand_bn (BatchNormalization)	(None, 8, 8, 720)	2,880	block5f_expand_conv[0][0]
block5f_expand_activation (Activation)	(None, 8, 8, 720)	0	block5f_expand_bn[0][0]
block5f_dwconv2 (DepthwiseConv2D)	(None, 8, 8, 720)	6,480	block5f_expand_activation…
block5f_bn (BatchNormalization)	(None, 8, 8, 720)	2,880	block5f_dwconv2[0][0]
block5f_activation (Activation)	(None, 8, 8, 720)	0	block5f_bn[0][0]
block5f_se_squeeze (GlobalAveragePooling2D)	(None, 720)	0	block5f_activation[0][0]
block5f_se_reshape (Reshape)	(None, 1, 1, 720)	0	block5f_se_squeeze[0][0]
block5f_se_reduce (Conv2D)	(None, 1, 1, 30)	21,630	block5f_se_reshape[0][0]
block5f_se_expand (Conv2D)	(None, 1, 1, 720)	22,320	block5f_se_reduce[0][0]
block5f_se_excite (Multiply)	(None, 8, 8, 720)	0	block5f_activation[0][0], block5f_se_expand[0][0]
block5f_project_conv (Conv2D)	(None, 8, 8, 120)	86,400	block5f_se_excite[0][0]
block5f_project_bn (BatchNormalization)	(None, 8, 8, 120)	480	block5f_project_conv[0][0]
block5f_drop (Dropout)	(None, 8, 8, 120)	0	block5f_project_bn[0][0]
block5f_add (Add)	(None, 8, 8, 120)	0	block5f_drop[0][0], block5e_add[0][0]
block6a_expand_conv (Conv2D)	(None, 8, 8, 720)	86,400	block5f_add[0][0]
block6a_expand_bn (BatchNormalization)	(None, 8, 8, 720)	2,880	block6a_expand_conv[0][0]

block6a_se_reduce (Conv2D)	(None, 1, 1, 30)	21,630	block6a_se_reshape[0][0]
block6a_se_expand (Conv2D)	(None, 1, 1, 720)	22,320	block6a_se_reduce[0][0]
block6a_se_excite (Multiply)	(None, 4, 4, 720)	0	block6a_activation[0][0], block6a_se_expand[0][0]
block6a_project_conv (Conv2D)	(None, 4, 4, 208)	149,760	block6a_se_excite[0][0]
block6a_project_bn (BatchNormalization)	(None, 4, 4, 208)	832	block6a_project_conv[0][0]
block6b_expand_conv (Conv2D)	(None, 4, 4, 1248)	259,584	block6a_project_bn[0][0]
block6b_expand_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6b_expand_conv[0][0]
block6b_expand_activation (Activation)	(None, 4, 4, 1248)	0	block6b_expand_bn[0][0]
block6b_dwconv2 (DepthwiseConv2D)	(None, 4, 4, 1248)	11,232	block6b_expand_activation…
block6b_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6b_dwconv2[0][0]
block6b_activation (Activation)	(None, 4, 4, 1248)	0	block6b_bn[0][0]
block6b_se_squeeze (GlobalAveragePooling2D)	(None, 1248)	0	block6b_activation[0][0]
block6b_se_reshape (Reshape)	(None, 1, 1, 1248)	0	block6b_se_squeeze[0][0]
block6b_se_reduce (Conv2D)	(None, 1, 1, 52)	64,948	block6b_se_reshape[0][0]
block6b_se_expand (Conv2D)	(None, 1, 1, 1248)	66,144	block6b_se_reduce[0][0]
block6b_se_excite (Multiply)	(None, 4, 4, 1248)	0	block6b_activation[0][0], block6b_se_expand[0][0]
block6b_project_conv (Conv2D)	(None, 4, 4, 208)	259,584	block6b_se_excite[0][0]
block6b_project_bn (BatchNormalization)	(None, 4, 4, 208)	832	block6b_project_conv[0][0]
block6b_drop (Dropout)	(None, 4, 4, 208)	0	block6b_project_bn[0][0]

block6b_add (Add)	(None, 4, 4, 208)	0	block6b_drop[0][0], block6a_project_bn[0][0]
block6c_expand_conv (Conv2D)	(None, 4, 4, 1248)	259,584	block6b_add[0][0]
block6c_expand_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6c_expand_conv[0][0]
block6c_expand_activation (Activation)	(None, 4, 4, 1248)	0	block6c_expand_bn[0][0]
block6c_dwconv2 (DepthwiseConv2D)	(None, 4, 4, 1248)	11,232	block6c_expand_activation…
block6c_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6c_dwconv2[0][0]
block6c_activation (Activation)	(None, 4, 4, 1248)	0	block6c_bn[0][0]
block6c_se_squeeze (GlobalAveragePooling2D)	(None, 1248)	0	block6c_activation[0][0]
block6c_se_reshape (Reshape)	(None, 1, 1, 1248)	0	block6c_se_squeeze[0][0]
block6c_se_reduce (Conv2D)	(None, 1, 1, 52)	64,948	block6c_se_reshape[0][0]
block6c_se_expand (Conv2D)	(None, 1, 1, 1248)	66,144	block6c_se_reduce[0][0]
block6c_se_excite (Multiply)	(None, 4, 4, 1248)	0	block6c_activation[0][0], block6c_se_expand[0][0]
block6c_project_conv (Conv2D)	(None, 4, 4, 208)	259,584	block6c_se_excite[0][0]
block6c_project_bn (BatchNormalization)	(None, 4, 4, 208)	832	block6c_project_conv[0][0]
block6c_drop (Dropout)	(None, 4, 4, 208)	0	block6c_project_bn[0][0]
block6c_add (Add)	(None, 4, 4, 208)	0	block6c_drop[0][0], block6b_add[0][0]
block6d_expand_conv (Conv2D)	(None, 4, 4, 1248)	259,584	block6c_add[0][0]
block6d_expand_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6d_expand_conv[0][0]

block6d_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6d_dwconv2[0][0]
block6d_activation (Activation)	(None, 4, 4, 1248)	0	block6d_bn[0][0]
block6d_se_squeeze (GlobalAveragePooling2D)	(None, 1248)	0	block6d_activation[0][0]
block6d_se_reshape (Reshape)	(None, 1, 1, 1248)	0	block6d_se_squeeze[0][0]
block6d_se_reduce (Conv2D)	(None, 1, 1, 52)	64,948	block6d_se_reshape[0][0]
block6d_se_expand (Conv2D)	(None, 1, 1, 1248)	66,144	block6d_se_reduce[0][0]
block6d_se_excite (Multiply)	(None, 4, 4, 1248)	0	block6d_activation[0][0], block6d_se_expand[0][0]
block6d_project_conv (Conv2D)	(None, 4, 4, 208)	259,584	block6d_se_excite[0][0]
block6d_project_bn (BatchNormalization)	(None, 4, 4, 208)	832	block6d_project_conv[0][0]
block6d_drop (Dropout)	(None, 4, 4, 208)	0	block6d_project_bn[0][0]
block6d_add (Add)	(None, 4, 4, 208)	0	block6d_drop[0][0], block6c_add[0][0]
block6e_expand_conv (Conv2D)	(None, 4, 4, 1248)	259,584	block6d_add[0][0]
block6e_expand_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6e_expand_conv[0][0]
block6e_expand_activation (Activation)	(None, 4, 4, 1248)	0	block6e_expand_bn[0][0]
block6e_dwconv2 (DepthwiseConv2D)	(None, 4, 4, 1248)	11,232	block6e_expand_activation…
block6e_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6e_dwconv2[0][0]
block6e_activation (Activation)	(None, 4, 4, 1248)	0	block6e_bn[0][0]

block6e_se_squeeze (GlobalAveragePooling2D)	(None, 1248)	0	block6e_activation[0][0]
block6e_se_reshape (Reshape)	(None, 1, 1, 1248)	0	block6e_se_squeeze[0][0]
block6e_se_reduce (Conv2D)	(None, 1, 1, 52)	64,948	block6e_se_reshape[0][0]
block6e_se_expand (Conv2D)	(None, 1, 1, 1248)	66,144	block6e_se_reduce[0][0]
block6e_se_excite (Multiply)	(None, 4, 4, 1248)	0	block6e_activation[0][0], block6e_se_expand[0][0]
block6e_project_conv (Conv2D)	(None, 4, 4, 208)	259,584	block6e_se_excite[0][0]
block6e_project_bn (BatchNormalization)	(None, 4, 4, 208)	832	block6e_project_conv[0][0]
block6e_drop (Dropout)	(None, 4, 4, 208)	0	block6e_project_bn[0][0]
block6e_add (Add)	(None, 4, 4, 208)	0	block6e_drop[0][0], block6d_add[0][0]
block6f_expand_conv (Conv2D)	(None, 4, 4, 1248)	259,584	block6e_add[0][0]
block6f_expand_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6f_expand_conv[0][0]
block6f_expand_activation (Activation)	(None, 4, 4, 1248)	0	block6f_expand_bn[0][0]

block6f_dwconv2 (DepthwiseConv2D)	(None, 4, 4, 1248)	11,232	block6f_expand_activation…
block6f_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6f_dwconv2[0][0]
block6f_activation (Activation)	(None, 4, 4, 1248)	0	block6f_bn[0][0]
block6f_se_squeeze (GlobalAveragePooling2D)	(None, 1248)	0	block6f_activation[0][0]
block6f_se_reshape (Reshape)	(None, 1, 1, 1248)	0	block6f_se_squeeze[0][0]
block6f_se_reduce (Conv2D)	(None, 1, 1, 52)	64,948	block6f_se_reshape[0][0]
block6f_se_expand (Conv2D)	(None, 1, 1, 1248)	66,144	block6f_se_reduce[0][0]
block6f_se_excite (Multiply)	(None, 4, 4, 1248)	0	block6f_activation[0][0], block6f_se_expand[0][0]
block6f_project_conv (Conv2D)	(None, 4, 4, 208)	259,584	block6f_se_exc1te[0][0]
block6f_project_bn (BatchNormalization)	(None, 4, 4, 208)	832	block6f_project_conv[0][0]
block6f_drop (Dropout)	(None, 4, 4, 208)	0	block6f_project_bn[0][0]
block6f_add (Add)	(None, 4, 4, 208)	0	block6f_drop[0][0], block6e_add[0][0]
block6g_expand_conv (Conv2D)	(None, 4, 4, 1248)	259,584	block6f_add[0][0]
block6g_expand_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6g_expand_conv[0][0]

block6g_activation (Activation)	(None, 4, 4, 1248)	0	block6g_bn[0][0]
block6g_se_squeeze (GlobalAveragePooling2D)	(None, 1248)	0	block6g_activation[0][0]
block6g_se_reshape (Reshape)	(None, 1, 1, 1248)	0	block6g_se_squeeze[0][0]
block6g_se_reduce (Conv2D)	(None, 1, 1, 52)	64,948	block6g_se_reshape[0][0]
block6g_se_expand (Conv2D)	(None, 1, 1, 1248)	66,144	block6g_se_reduce[0][0]
block6g_se_excite (Multiply)	(None, 4, 4, 1248)	0	block6g_activation[0][0], block6g_se_expand[0][0]
block6g_project_conv (Conv2D)	(None, 4, 4, 208)	259,584	block6g_se_excite[0][0]
block6g_project_bn (BatchNormalization)	(None, 4, 4, 208)	832	block6g_project_conv[0][0]
block6g_drop (Dropout)	(None, 4, 4, 208)	0	block6g_project_bn[0][0]
block6g_add (Add)	(None, 4, 4, 208)	0	block6g_drop[0][0], block6f_add[0][0]
block6h_expand_conv (Conv2D)	(None, 4, 4, 1248)	259,584	block6g_add[0][0]
block6h_expand_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6h_expand_conv[0][0]
block6h_expand_activation (Activation)	(None, 4, 4, 1248)	0	block6h_expand_bn[0][0]
block6h_dwconv2 (DepthwiseConv2D)	(None, 4, 4, 1248)	11,232	block6h_expand_activation…
block6h_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6h_dwconv2[0][0]
block6h_activation (Activation)	(None, 4, 4, 1248)	0	block6h_bn[0][0]
block6h_se_squeeze (GlobalAveragePooling2D)	(None, 1248)	0	block6h_activation[0][0]

block6h_se_reshape (Reshape)	(None, 1, 1, 1248)	0	block6h_se_squeeze[0][0]
block6h_se_reduce (Conv2D)	(None, 1, 1, 52)	64,948	block6h_se_reshape[0][0]
block6h_se_expand (Conv2D)	(None, 1, 1, 1248)	66,144	block6h_se_reduce[0][0]
block6h_se_excite (Multiply)	(None, 4, 4, 1248)	0	block6h_activation[0][0], block6h_se_expand[0][0]
block6h_project_conv (Conv2D)	(None, 4, 4, 208)	259,584	block6h_se_excite[0][0]
block6h_project_bn (BatchNormalization)	(None, 4, 4, 208)	832	block6h_project_conv[0][0]
block6h_drop (Dropout)	(None, 4, 4, 208)	0	block6h_project_bn[0][0]
block6h_add (Add)	(None, 4, 4, 208)	0	block6h_drop[0][0], block6g_add[0][0]
block6i_expand_conv (Conv2D)	(None, 4, 4, 1248)	259,584	block6h_add[0][0]
block6i_expand_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6i_expand_conv[0][0]
block6i_expand_activation (Activation)	(None, 4, 4, 1248)	0	block6i_expand_bn[0][0]
block6i_dwconv2 (DepthwiseConv2D)	(None, 4, 4, 1248)	11,232	block6i_expand_activation…
block6i_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6i_dwconv2[0][0]
block6i_activation (Activation)	(None, 4, 4, 1248)	0	block6i_bn[0][0]
block6i_se_squeeze (GlobalAveragePooling2D)	(None, 1248)	0	block6i_activation[0][0]
block6i_se_reshape (Reshape)	(None, 1, 1, 1248)	0	block6i_se_squeeze[0][0]
block6i_se_reduce (Conv2D)	(None, 1, 1, 52)	64,948	block6i_se_reshape[0][0]
block6i_se_expand (Conv2D)	(None, 1, 1, 1248)	66,144	block6i_se_reduce[0][0]
block6i_se_excite (Multiply)	(None, 4, 4, 1248)	0	block6i_activation[0][0], block6i_se_expand[0][0]

block6j_bn (BatchNormalization)	(None, 4, 4, 1248)	4,992	block6j_dwconv2[0][0]
block6j_activation (Activation)	(None, 4, 4, 1248)	0	block6j_bn[0][0]
block6j_se_squeeze (GlobalAveragePooling2D)	(None, 1248)	0	block6j_activation[0][0]
block6j_se_reshape (Reshape)	(None, 1, 1, 1248)	0	block6j_se_squeeze[0][0]
block6j_se_reduce (Conv2D)	(None, 1, 1, 52)	64,948	block6j_se_reshape[0][0]
block6j_se_expand (Conv2D)	(None, 1, 1, 1248)	66,144	block6j_se_reduce[0][0]
block6j_se_excite (Multiply)	(None, 4, 4, 1248)	0	block6j_activation[0][0], block6j_se_expand[0][0]
block6j_project_conv (Conv2D)	(None, 4, 4, 208)	259,584	block6j_se_excite[0][0]
block6j_project_bn (BatchNormalization)	(None, 4, 4, 208)	832	block6j_project_conv[0][0]
block6j_drop (Dropout)	(None, 4, 4, 208)	0	block6j_project_bn[0][0]
block6j_add (Add)	(None, 4, 4, 208)	0	block6j_drop[0][0], block6i_add[0][0]
top_conv (Conv2D)	(None, 4, 4, 1408)	292,864	block6j_add[0][0]
top_bn (BatchNormalization)	(None, 4, 4, 1408)	5,632	top_conv[0][0]
top_activation (Activation)	(None, 4, 4, 1408)	0	top_bn[0][0]

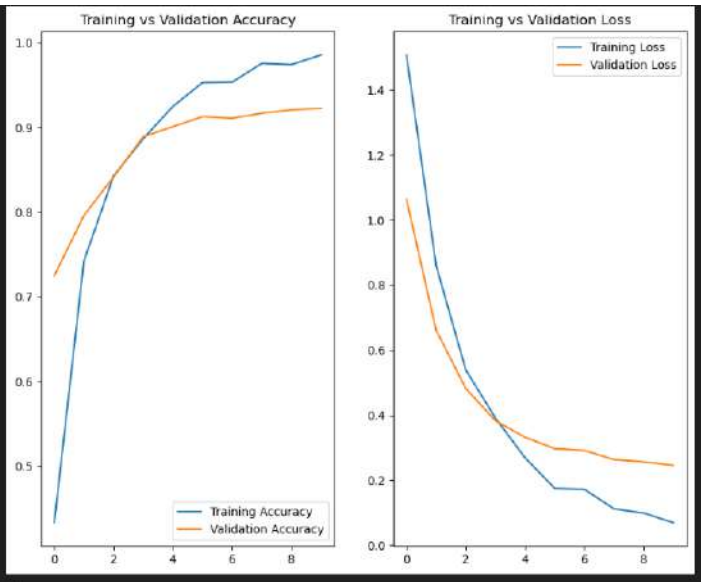
Total params: 8,769,374 (33.45 MB)

Trainable params: 7,966,188 (30.39 MB)

Non-trainable params: 803,186 (3.06 MB)

```python
history = model.fit(
    train_ds,
    validation_data=val_ds,
    epochs=10
)

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

epochs_range = range(len(acc))

plt.figure(figsize=(10,8))

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 vs 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 vs Validation Loss')

plt.show()
```

```
Epoch 1/10
64/64 ━━━━━━━━━━━━━━━━━━━━ 345s 3s/step - accuracy: 0.3201 - loss: 1.6829 - val_accuracy: 0.7248 - val_loss: 1.0638
Epoch 2/10
64/64 ━━━━━━━━━━━━━━━━━━━━ 173s 3s/step - accuracy: 0.7258 - loss: 0.9373 - val_accuracy: 0.7960 - val_loss: 0.6615
Epoch 3/10
64/64 ━━━━━━━━━━━━━━━━━━━━ 155s 2s/step - accuracy: 0.8310 - loss: 0.5848 - val_accuracy: 0.8416 - val_loss: 0.4821
Epoch 4/10
64/64 ━━━━━━━━━━━━━━━━━━━━ 206s 2s/step - accuracy: 0.8950 - loss: 0.3850 - val_accuracy: 0.8891 - val_loss: 0.3830
Epoch 5/10
64/64 ━━━━━━━━━━━━━━━━━━━━ 204s 3s/step - accuracy: 0.9242 - loss: 0.2789 - val_accuracy: 0.9010 - val_loss: 0.3319
Epoch 6/10
64/64 ━━━━━━━━━━━━━━━━━━━━ 160s 2s/step - accuracy: 0.9604 - loss: 0.1717 - val_accuracy: 0.9129 - val_loss: 0.2971
Epoch 7/10
64/64 ━━━━━━━━━━━━━━━━━━━━ 154s 2s/step - accuracy: 0.9545 - loss: 0.1724 - val_accuracy: 0.9109 - val_loss: 0.2918
Epoch 8/10
64/64 ━━━━━━━━━━━━━━━━━━━━ 211s 3s/step - accuracy: 0.9758 - loss: 0.1130 - val_accuracy: 0.9168 - val_loss: 0.2634
Epoch 9/10
64/64 ━━━━━━━━━━━━━━━━━━━━ 196s 2s/step - accuracy: 0.9778 - loss: 0.0927 - val_accuracy: 0.9208 - val_loss: 0.2566
Epoch 10/10
64/64 ━━━━━━━━━━━━━━━━━━━━ 174s 3s/step - accuracy: 0.9811 - loss: 0.0815 - val_accuracy: 0.9228 - val_loss: 0.2456
```




```
loss, accuracy = model.evaluate(test_ds_eval)
print(f'Test accuracy is{accuracy: .4f}, Test loss is {loss:.4f}')
```

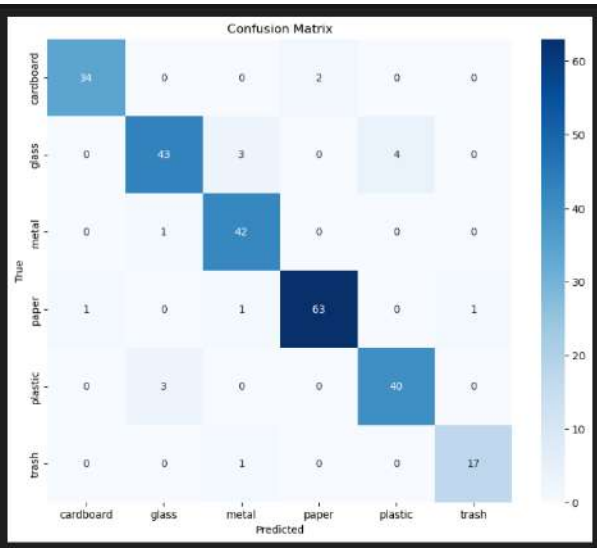
```
8/8 ━━━━━━━━━━━━━━━━━━━━ 9s 1s/step - accuracy: 0.9197 - loss: 0.2296
Test accuracy is 0.9336, Test loss is 0.2052
```

```python
y_true = np.concatenate([y.numpy() for x,y in test_ds_eval], axis=0)

y_pred_probs = model.predict(test_ds_eval)

y_pred = np.argmax(y_pred_probs, axis=1)

cm = confusion_matrix(y_true, y_pred)

print(cm)
print(classification_report(y_true, y_pred))
```

Python

```
8/8 ━━━━━━━━━━━━━━━━━━━━ 12s 1s/step
[[34  0  0  2  0  0]
 [ 0 43  3  0  4  0]
 [ 0  1 42  0  0  0]
 [ 1  0  1 63  0  1]
 [ 0  3  0  0 40  0]
 [ 0  0  1  0  0 17]]
              precision    recall  f1-score   support

           0       0.97      0.94      0.96        36
           1       0.91      0.86      0.89        50
           2       0.89      0.98      0.93        43
           3       0.97      0.95      0.96        66
           4       0.91      0.93      0.92        43
           5       0.94      0.94      0.94        18

    accuracy                           0.93       256
   macro avg       0.93      0.94      0.93       256
weighted avg       0.93      0.93      0.93       256
```

```python
plt.figure(figsize=(10,8))

sns.heatmap(cm, annot=True, fmt='d',
            xticklabels=class_names,
            yticklabels=class_names,
            cmap='Blues')

plt.xlabel('Predicted')
plt.ylabel('True')
plt.title('Confusion Matrix')
plt.show()
```


Confusion Matrix
True
Predicted
cardboard
glass
metal
paper
plastic
trash
34 0 0 2 0 0
0 43 3 0 4 0
0 1 42 0 0 0
1 0 1 63 0 1
0 3 0 0 40 0
0 0 1 0 0 17
60
50
40
30
20
10
0

```python
class_names = train_ds.class_names

for images, labels in test_ds_eval.take(1):

    predictions = model.predict(images)

    pred_labels = tf.argmax(predictions, axis=1)

    for i in range(8):
        plt.imshow(images[i].numpy().astype("uint8"))
        plt.title(f"True: {class_names[labels[i]]}, Pred: {class_names[pred_labels[i]]}")
        plt.axis("off")
        plt.show()
```

Python

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 12s 12s/step
```


True: plastic, Pred: plastic


True: glass, Pred: glass

True: paper, Pred: paper

True: glass, Pred: glass


True: glass, Pred: glass
True: paper, Pred: paper


True: metal, Pred: metal