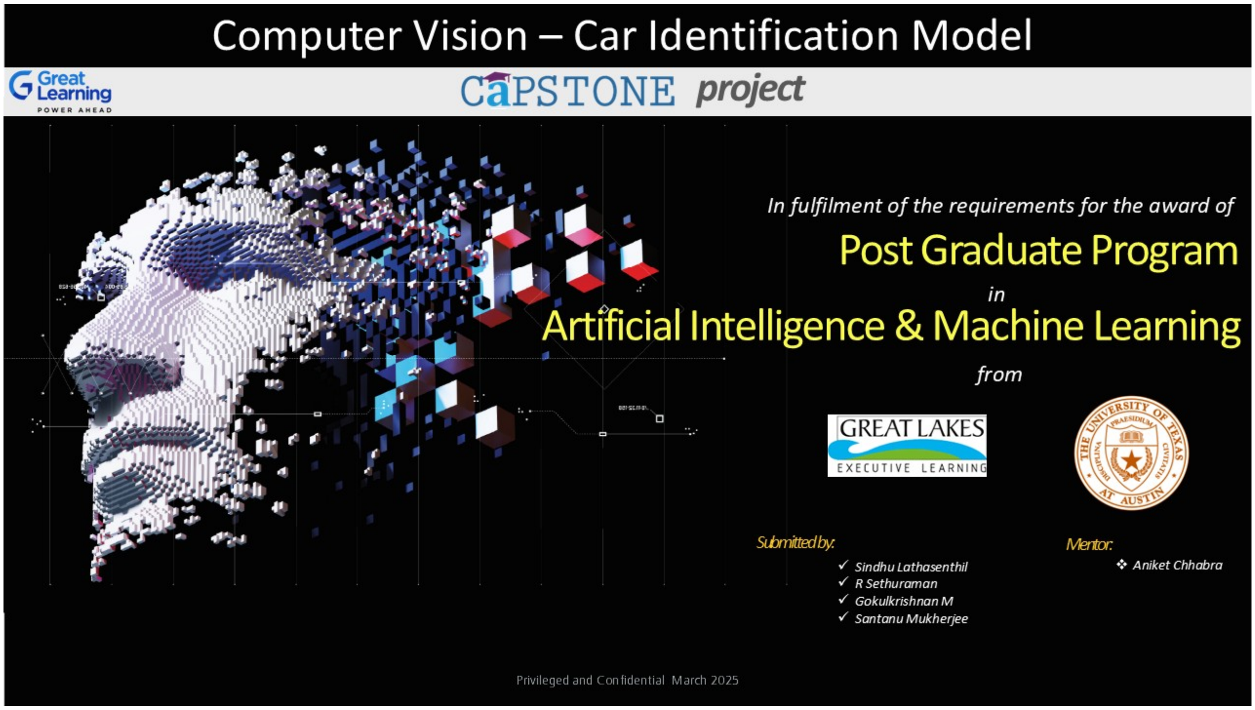


#COMPUTER VISION CAPSTONE PROJECT AIML OBJECT DETECTION - CAR

```
from prettytable import PrettyTable

# Create a PrettyTable object
table = PrettyTable()

# Define the columns
table.field_names = ["S.NO", "Contents", "Cell Number"]

# Add rows
table.add_row([1, "Problem Statement", 8 ])
table.add_row([2, "Introduction", 10])
table.add_row([3, "Libraries Used", 12])
table.add_row([4, "Data Handling", 14 ])
table.add_row(["4A", "Data Handling - Import Data", 15 ])
table.add_row(["4B", "Data Handling - Map Images w.r.t Classes", 14 ])
table.add_row(["4C", "Data Handling - Map Images w.r.t Annotations",
14 ])
table.add_row([5, "Display Result - bounding box", 16 ])
table.add_row([6, "Design Basic CNN Models", 17 ])
table.add_row(["6A", "VGGNet CNN Model", 17 ])
table.add_row(["6B", "Google CNN Model", 17 ])
table.add_row(["6C", "AlexNet CNN Model", 17 ])
table.add_row(["6D", "U-Net CNN Model", 17 ])
table.add_row(["7", "Summary", 17 ])
```

```python
# Print the table
print(table)
```

```
+------+-------------------------------------------+-------------+
| S.NO |                  Contents                 | Cell Number |
+------+-------------------------------------------+-------------+
|  1   |             Problem Statement             |      8      |
|  2   |                Introduction               |      10     |
|  3   |               Libraries Used              |      12     |
|  4   |               Data Handling               |      14     |
|  4A  |        Data Handling - Import Data        |      15     |
|  4B  |   Data Handling - Map Images w.r.t Classes  |      14     |
|  4C  | Data Handling - Map Images w.r.t Annotations |      14     |
|  5   |        Display Result - bounding box      |      16     |
|  6   |           Design Basic CNN Models         |      17     |
|  6A  |              VGGNet CNN Model             |      17     |
|  6B  |              Google CNN Model             |      17     |
|  6C  |             AlexNet CNN Model             |      17     |
|  6D  |              U-Net CNN Model              |      17     |
|  7   |                  Summary                  |      17     |
+------+-------------------------------------------+-------------+
```

1. Problem Statement

Computer vision can be used to automate supervision and generate action appropriate action trigger if the event is predicted from the image of interest. For example a car moving on the road can be easily identified by a camera as make of the car, type, colour, number plates etc.

Design a DL based car identification model.

1. Introduction

The Cars dataset contains 16,185 images of 196 classes of cars. The data is split into 8,144 training images and 8,041 testing images, where each class has been split roughly in a 50-50 split. Classes are typically at the level of Make, Model, Year, e.g. 2012 Tesla Model S or 2012 BMW M3 coupe.

Data description:

‣ Train Images: Consists of real images of cars as per the make and year of the car.

‣ Test Images: Consists of real images of cars as per the make and year of the car.

‣ Train Annotation: Consists of bounding box region for training images.

‣ Test Annotation: Consists of bounding box region for testing images.

1. Libraries Used

```python
import os
import zipfile
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import cv2
from sklearn.model_selection import train_test_split
from tensorflow.keras.models import Sequential, Model
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten,
Dense, Dropout, GlobalAveragePooling2D, BatchNormalization
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import matplotlib.patches as patches
import glob # for file path handling
from PIL import Image # For image loading and manipulation
import xml.etree.ElementTree as ET # For handling XML annotations
(common for object detection datasets)
import matplotlib.pyplot as plt # For visualization
from sklearn.model_selection import train_test_split # For potential
data splitting if needed
from sklearn.preprocessing import LabelEncoder
from tensorflow import keras
from tensorflow.keras import layers


from tensorflow.keras.applications import VGG16, VGG19
from tensorflow.keras.optimizers import Adam


from tensorflow.keras.applications import InceptionV3
from tensorflow.keras.preprocessing.image import load_img,
img_to_array
```

1. Data Handling

4A. Data Handling - Import Data

```python
# Define file paths
car_names_file = 'Car names and make.csv'
annotations_zip_file = 'Annotations.zip'
images_zip_file = 'Car Images.zip'

# Step 1: Load the car names and make data
car_names_df = pd.read_csv(car_names_file)

# Display the first few rows of the DataFrame
```

```
print("Car Names and Makes:")
print(car_names_df.head())

# Step 2: Extract Annotations.zip
with zipfile.ZipFile(annotations_zip_file, 'r') as zip_ref:
    zip_ref.extractall('Annotations')

# List the extracted files
print("\nExtracted Annotations:")
print(os.listdir('Annotations'))

# Step 3: Extract Car Images.zip
with zipfile.ZipFile(images_zip_file, 'r') as zip_ref:
    zip_ref.extractall('Car_Images')

# List the extracted files
print("\nExtracted Car Images:")
print(os.listdir('Car_Images'))
```

```
Car Names and Makes:
  AM General Hummer SUV 2000
0        Acura RL Sedan 2012
1        Acura TL Sedan 2012
2       Acura TL Type-S 2008
3       Acura TSX Sedan 2012
4  Acura Integra Type R 2001

Extracted Annotations:
['Annotations']

Extracted Car Images:
['Car Images']
```

```
# Load the training annotations
train_annotations_path = r'Train Annotations.csv'  # Adjust the path
as necessary
train_annotations_df = pd.read_csv(train_annotations_path)
print("Training Annotations Columns:")
print(train_annotations_df.columns)
train_annotations_df.head(5)
```

```
Training Annotations Columns:
Index(['Image Name', 'Bounding Box coordinates', 'Unnamed: 2',
'Unnamed: 3',
       'Unnamed: 4', 'Image class'],
      dtype='object')

  Image Name  Bounding Box coordinates  Unnamed: 2  Unnamed: 3
Unnamed: 4  \
0  00001.jpg                        39         116         569
375
```

```
1  00002.jpg                          36          116          868
587
2  00003.jpg                          85          109          601
381
3  00004.jpg                         621          393         1484
1096
4  00005.jpg                          14           36          133
99

   Image class
0           14
1            3
2           91
3          134
4          106
```

```
# Load the Test annotations
test_annotations_path = r'Test Annotation.csv'  # Adjust the path as
necessary
test_annotations_df = pd.read_csv(test_annotations_path)
print("Test Annotations Columns:")
print(test_annotations_df.columns)
test_annotations_df.head(5)
```

```
Test Annotations Columns:
Index(['Image Name', 'Bounding Box coordinates', 'Unnamed: 2',
'Unnamed: 3',
       'Unnamed: 4', 'Image class'],
      dtype='object')

  Image Name  Bounding Box coordinates  Unnamed: 2  Unnamed: 3
Unnamed: 4  \
0  00001.jpg                          30           52          246
147
1  00002.jpg                         100           19          576
203
2  00003.jpg                          51          105          968
659
3  00004.jpg                          67           84          581
407
4  00005.jpg                         140          151          593
339

   Image class
0          181
1          103
2          145
3          187
4          185
```

```python
# Renaming column names
train_annotations_df = train_annotations_df.rename(columns={'Bounding Box coordinates':'Bounding Box coordinates_xmin','Unnamed: 2':'Bounding Box coordinates_ymin','Unnamed: 3':'Bounding Box coordinates_xmax','Unnamed: 4':'Bounding Box coordinates_ymax'})
train_annotations_df.head(5)
```

```
  Image Name  Bounding Box coordinates_xmin  Bounding Box
coordinates_ymin  \
0  00001.jpg                             39
116
1  00002.jpg                             36
116
2  00003.jpg                             85
109
3  00004.jpg                            621
393
4  00005.jpg                             14
36

   Bounding Box coordinates_xmax  Bounding Box coordinates_ymax  Image
class
0                            569                            375
14
1                            868                            587
3
2                            601                            381
91
3                           1484                           1096
134
4                            133                             99
106
```

```python
# Renaming column names
test_annotations_df = test_annotations_df.rename(columns={'Bounding Box coordinates':'Bounding Box coordinates_xmin','Unnamed: 2':'Bounding Box coordinates_ymin','Unnamed: 3':'Bounding Box coordinates_xmax','Unnamed: 4':'Bounding Box coordinates_ymax'})
test_annotations_df.head(5)
```

```
  Image Name  Bounding Box coordinates_xmin  Bounding Box
coordinates_ymin  \
0  00001.jpg                             30
52
1  00002.jpg                            100
19
2  00003.jpg                             51
105
3  00004.jpg                             67
84
```

```
4  00005.jpg                            140
151

   Bounding Box coordinates_xmax  Bounding Box coordinates_ymax  Image
class
0                              246                            147
181
1                              576                            203
103
2                              968                            659
145
3                              581                            407
187
4                              593                            339
185

# for images
train_images_path = os.path.join('Car_Images/Car Images/Train Images')
test_images_path = os.path.join('Car_Images/Car Images/Test Images')
```

4B. Data Handling - Map Images w.r.t Classes

```
train_class_folders = [f.path for f in os.scandir(train_images_path)
if f.is_dir()]

train_image_classes = {} # Dictionary to store training image: class
mapping

# Define columns for the Training DataFrame
columns_training = ['Image_Path', 'labels']

# Create an empty DataFrame
df_training = pd.DataFrame(columns=columns_training)

# --- Map filenames in a class for train_image_classes
for class_folder in train_class_folders:
     class_name = os.path.basename(class_folder) # Extract class name
from folder name
     #labels_train.append(class_name)
     image_files = glob.glob(os.path.join(class_folder, '*.jpg')) #
images are .jpg
     for image_file in image_files:
         train_image_classes[os.path.basename(image_file)] =
class_name # Map filename to class
         #image_file_path_training.append(image_file)
         df_training.loc[len(df_training)] = [image_file, class_name]


print(df_training.head(10))
```

```
# --- Print a few mappings to verify ---
print("Sample Training Image to Class Mappings:")
count = 0
for img_name, class_label in train_image_classes.items():
    print(f"{img_name}: {class_label}")
    count += 1
    if count > 5: break # Print first few only
```

```
                                          Image_Path  \
0  Car_Images/Car Images/Train Images\Acura Integ...
1  Car_Images/Car Images/Train Images\Acura Integ...
2  Car_Images/Car Images/Train Images\Acura Integ...
3  Car_Images/Car Images/Train Images\Acura Integ...
4  Car_Images/Car Images/Train Images\Acura Integ...
5  Car_Images/Car Images/Train Images\Acura Integ...
6  Car_Images/Car Images/Train Images\Acura Integ...
7  Car_Images/Car Images/Train Images\Acura Integ...
8  Car_Images/Car Images/Train Images\Acura Integ...
9  Car_Images/Car Images/Train Images\Acura Integ...

                      labels
0  Acura Integra Type R 2001
1  Acura Integra Type R 2001
2  Acura Integra Type R 2001
3  Acura Integra Type R 2001
4  Acura Integra Type R 2001
5  Acura Integra Type R 2001
6  Acura Integra Type R 2001
7  Acura Integra Type R 2001
8  Acura Integra Type R 2001
9  Acura Integra Type R 2001
Sample Training Image to Class Mappings:
00198.jpg: Acura Integra Type R 2001
00255.jpg: Acura Integra Type R 2001
00308.jpg: Acura Integra Type R 2001
00374.jpg: Acura Integra Type R 2001
00878.jpg: Acura Integra Type R 2001
00898.jpg: Acura Integra Type R 2001
```

```
test_class_folders = [f.path for f in os.scandir(test_images_path) if
f.is_dir()]
test_image_classes = {}  # Dictionary to store testing image: class
mapping

# Define columns for the Testing DataFrame
columns_testing = ['Image_Path', 'labels']

# Create an empty DataFrame
df_testing = pd.DataFrame(columns=columns_testing)
```

```python
# similar logic for test_images_path and test_image_classes
for class_folder in test_class_folders:
     class_name = os.path.basename(class_folder) # Extract class name
from folder name
     #labels_testing.append(class_name)
     image_files = glob.glob(os.path.join(class_folder, '*.jpg')) #
images are .jpg
     for image_file in image_files:
         test_image_classes[os.path.basename(image_file)] = class_name
# Map filename to class
         #image_file_path_testing.append(image_file)
         df_testing.loc[len(df_testing)] = [image_file, class_name]

print(df_testing.head(10))

print("Sample Testing Image to Class Mappings:")
count = 0
for img_name, class_label in test_image_classes.items():
    print(f"{img_name}: {class_label}")
    count += 1
    if count > 5: break # Print first few only
```

```
                                          Image_Path  \
0  Car_Images/Car Images/Test Images\Acura Integr...
1  Car_Images/Car Images/Test Images\Acura Integr...
2  Car_Images/Car Images/Test Images\Acura Integr...
3  Car_Images/Car Images/Test Images\Acura Integr...
4  Car_Images/Car Images/Test Images\Acura Integr...
5  Car_Images/Car Images/Test Images\Acura Integr...
6  Car_Images/Car Images/Test Images\Acura Integr...
7  Car_Images/Car Images/Test Images\Acura Integr...
8  Car_Images/Car Images/Test Images\Acura Integr...
9  Car_Images/Car Images/Test Images\Acura Integr...

                      labels
0  Acura Integra Type R 2001
1  Acura Integra Type R 2001
2  Acura Integra Type R 2001
3  Acura Integra Type R 2001
4  Acura Integra Type R 2001
5  Acura Integra Type R 2001
6  Acura Integra Type R 2001
7  Acura Integra Type R 2001
8  Acura Integra Type R 2001
9  Acura Integra Type R 2001
Sample Testing Image to Class Mappings:
00128.jpg: Acura Integra Type R 2001
00130.jpg: Acura Integra Type R 2001
```

```
00386.jpg: Acura Integra Type R 2001
00565.jpg: Acura Integra Type R 2001
00711.jpg: Acura Integra Type R 2001
01002.jpg: Acura Integra Type R 2001
```

4C. Data Handling - Map Images w.r.t Annotations

```
# ********Definition of the method ********************************
def map_images_to_bboxes(annotations_file):
    image_bboxes = {}
    try:
        for index, row in annotations_file.iterrows():
                image_name = row['Image Name']
                x_min = row['Bounding Box coordinates_xmin']
                y_min = row['Bounding Box coordinates_ymin']
                x_max = row['Bounding Box coordinates_xmax']
                y_max = row['Bounding Box coordinates_ymax']
                image_class = row['Image class']

                image_bboxes[image_name] = (x_min, y_min, x_max,
y_max) # Store bbox as tuple

    except FileNotFoundError:
        print(f"Error: Annotation file not found: {annotations_file}")
    except KeyError as e:
        print(f"Error: Column '{e}' not found in CSV file. Check your
CSV column names.")
        print("Expected columns (example): filename, xmin, ymin, xmax,
ymax") # Example expected columns

    return image_bboxes


train_image_bboxes = map_images_to_bboxes(train_annotations_df)
# --- Print a few mappings to verify for Training images ---
print("\nSample Training Image to Bounding Box Mappings (DF):")
count = 0
for img_name, bbox in train_image_bboxes.items():
    print(f"{img_name}: {bbox}")
    count += 1
    if count > 5: break
```

```
Sample Training Image to Bounding Box Mappings (DF):
00001.jpg: (39, 116, 569, 375)
00002.jpg: (36, 116, 868, 587)
00003.jpg: (85, 109, 601, 381)
00004.jpg: (621, 393, 1484, 1096)
```

```
00005.jpg: (14, 36, 133, 99)
00006.jpg: (259, 289, 515, 416)
```

```
test_image_bboxes = map_images_to_bboxes(test_annotations_df)
# --- Print a few mappings to verify  testing images---
print("\nSample Testing Image to Bounding Box Mappings (DF):")
count = 0
for img_name, bbox in test_image_bboxes.items():
    print(f"{img_name}: {bbox}")
    count += 1
    if count > 5: break
```

```
Sample Testing Image to Bounding Box Mappings (DF):
00001.jpg: (30, 52, 246, 147)
00002.jpg: (100, 19, 576, 203)
00003.jpg: (51, 105, 968, 659)
00004.jpg: (67, 84, 581, 407)
00005.jpg: (140, 151, 593, 339)
00006.jpg: (20, 77, 420, 301)
```

1. Display Result - bounding box

```
# Display images with bounding boxes
def display_image_with_bbox(image_path, annotation):
    # Load image
    img = Image.open(image_path)

    # Create plot
    fig, ax = plt.subplots(1)
    ax.imshow(img)

    # Draw bounding box
    x_min = row['Bounding Box coordinates_xmin']
    y_min = row['Bounding Box coordinates_ymin']
    x_max = row['Bounding Box coordinates_xmax']
    y_max = row['Bounding Box coordinates_ymax']
    image_class = row['Image class']
    bbox = annotation['bbox']
    rect = patches.Rectangle(
        (x_min, y_min),  # (x_min, y_min) -  (bbox[0], bbox[1])
        (x_max - x_min),   # width (x_max - x_min)  - bbox[2] -
bbox[0]
        (y_max - y_min),   # height (y_max - y_min) -- bbox[3] -
bbox[1]
        linewidth=2,
        edgecolor='r',
        facecolor='none'
    )
    ax.add_patch(rect)
```

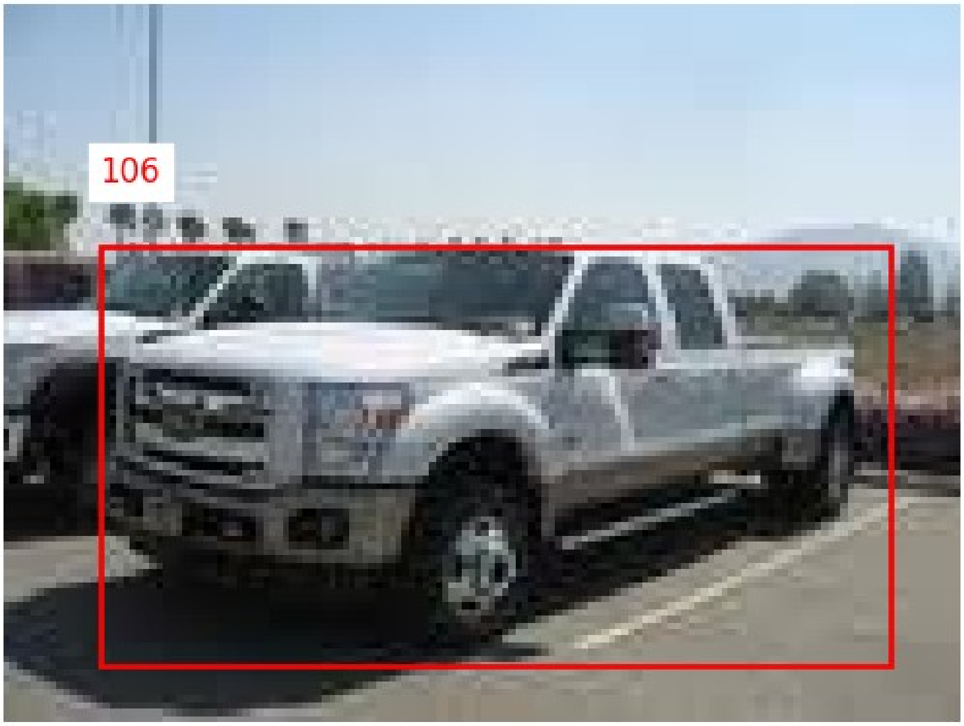
```
    # Add class label
    plt.text(
        bbox[0], bbox[1] - 10,  # Position of the label
        annotation['image_class'],
        color='red',
        fontsize=12,
        backgroundcolor='white'
    )

    plt.axis('off')
    plt.show()



# for training images
print("For Training Images") # Changed message to "Test Image"
displayed_image_count = 0  # Initialize a counter to track displayed
images

image_paths_details_training=[]
images_paths_details_testing=[]

for index, row in train_annotations_df.iterrows():
    if displayed_image_count >= 5: # Check if we've already displayed
two images
        break  # If yes, exit the loop

    image_name = str(row['Image Name']).strip()
    image_path = None # Initialize image_path to None


    for class_folder in train_class_folders:
        potential_image_path = os.path.join(class_folder, image_name)
        if os.path.exists(potential_image_path):
            image_path = potential_image_path
            image_paths_details_training.append(potential_image_path)
            break # Image found, no need to check other class folders

    if image_path: # If image_path is found (not None)
        annotation = {
            'bbox': [row['Bounding Box coordinates_xmin'],
row['Bounding Box coordinates_ymin'], row['Bounding Box
coordinates_xmax'], row['Bounding Box coordinates_ymax']],
            'image_class' : row['Image class']
        }
        display_image_with_bbox(image_path, annotation)
        displayed_image_count += 1 # Increment the counter
    #else:
    #    print(f"Training Image not found: {image_name}")
```

```
print(f"Displayed {displayed_image_count} training images with
bounding boxes.")
```

```
For Training Images
```


91


134



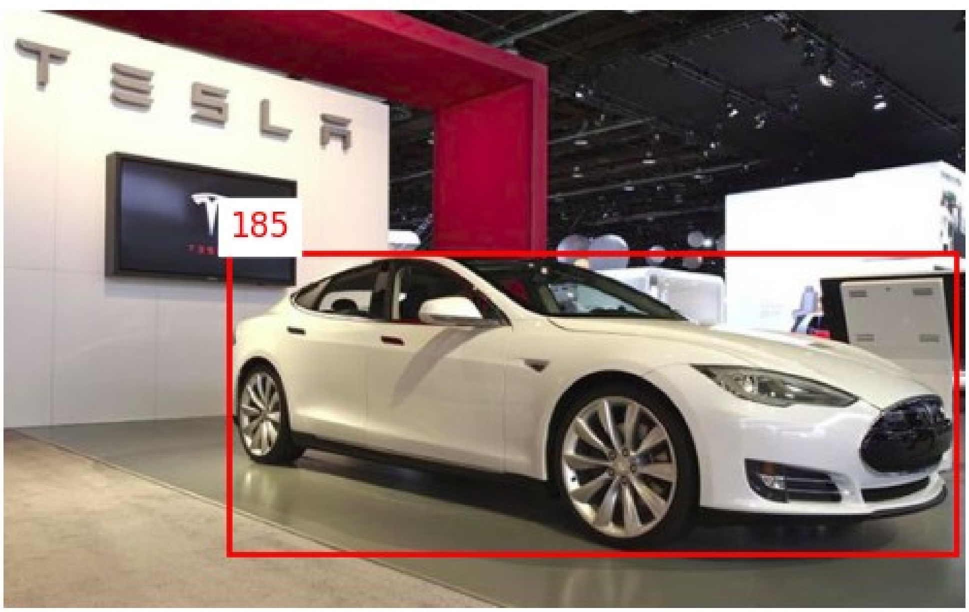

```
Displayed 5 training images with bounding boxes.


# for test images
print("For Testing Images") # Changed message to "Test Image"
displayed_image_count_test = 0  # Initialize a counter to track
displayed images

for index, row in test_annotations_df.iterrows():  # Use
test_annotations_df DataFrame
    if displayed_image_count_test >= 5: # Check if we've already
displayed two images (adjust number here if you want 5 or more)
        break  # If yes, exit the loop

    image_name_test = str(row['Image Name']).strip()
    image_path_test = None # Initialize image_path_test to None

    for class_folder in test_class_folders: # Use test_class_folders
        potential_image_path_test = os.path.join(class_folder,
image_name_test)
        if os.path.exists(potential_image_path_test):
            image_path_test = potential_image_path_test # Assigned to
image_path_test
            images_paths_details_testing.append(potential_image_path)
            break # Image found, no need to check other class folders

    if image_path_test: # If image_path_test is found (not None)
```

```
        annotation_test = {
            'bbox': [row['Bounding Box coordinates_xmin'], 
row['Bounding Box coordinates_ymin'], row['Bounding Box 
coordinates_xmax'], row['Bounding Box coordinates_ymax']],
            'image_class' : row['Image class'] # Assuming 'Image 
class' column also exists in test_annotations_df (verify!)
        }
        display_image_with_bbox(image_path_test, annotation_test)  # 
Changed here
        displayed_image_count_test += 1 # Increment the counter
    #else:
    #    print(f"Test Image not found: {image_name_test}") # Changed 
message to "Test Image"

print(f"Displayed {displayed_image_count_test} test images with 
bounding boxes.") # Changed message to "test images"
```

For Testing Images


103
JB | PHOTOGRAPHY


145
Jeep




```
Displayed 5 test images with bounding boxes.
```

1. Design Basic CNN Models

The Models designed are:

1. VGGNet
2. GoogleNet

3. AlexNet
4. U-Net

```
def preprocess_image(image_path, target_size=(224, 224)):
    """
    Load and preprocess an image for CNN input.
    """
    # Check if the image file exists
    if not os.path.exists(image_path):
        print(f"Warning: Image file not found: {image_path}")
        return None  # Or handle the missing image in a way that makes
sense for your application

    image = cv2.imread(image_path)  # Load image

    # Check if image loading was successful
    if image is None:
        print(f"Warning: Failed to load image: {image_path}")
        return None  # Or handle the loading error as needed

    image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)  # Convert to RGB
    image = cv2.resize(image, target_size)  # Resize to target size
    image = image / 255.0  # Normalize pixel values to [0, 1]
    return image

def custom_generator(df, batch_size, target_size):
    """
    Custom generator for images and labels.
    """
    num_samples = len(df)
    while True:
        for offset in range(0, num_samples, batch_size):
            batch_samples = df.iloc[offset:offset + batch_size]
            images = []
            labels = []
            for _, row in batch_samples.iterrows():
                image = preprocess_image(row['Image_Path'],
target_size)
                label = row['label_categorical']
                images.append(image)
                labels.append(label)
            X = np.array(images)
            y = np.array(labels)
            yield X, y

# Apply preprocessing to all images
df_testing['image'] = df_testing['Image_Path'].apply(preprocess_image)
df_training['image'] =
df_training['Image_Path'].apply(preprocess_image)

# Check for and handle None values in the 'image' column
```

```
df_testing = df_testing.dropna(subset=['image'])  # Remove rows with
None in 'image'
df_training = df_training.dropna(subset=['image'])  # Remove rows with
None in 'image'

# Encode labels
label_encoder = LabelEncoder()
df_testing['labels_encoded'] =
label_encoder.fit_transform(df_testing['labels'])
df_training['labels_encoded'] =
label_encoder.fit_transform(df_training['labels'])

# Convert labels to categorical (one-hot encoding)
df_testing['label_categorical'] =
df_testing['labels_encoded'].apply(lambda x: to_categorical(x,
num_classes=len(test_class_folders)))
df_training['label_categorical'] =
df_training['labels_encoded'].apply(lambda x: to_categorical(x,
num_classes=len(test_class_folders)))

# Create generators
batch_size = 32
train_generator = custom_generator(df_training, batch_size,
target_size=(224, 224))
val_generator = custom_generator(df_testing, batch_size,
target_size=(224, 224))

# Check training generator
X_batch, y_batch = next(train_generator)
print("Training batch shape:", X_batch.shape, y_batch.shape)

# Check validation generator
X_batch, y_batch = next(val_generator)
print("Validation batch shape:", X_batch.shape, y_batch.shape)

Training batch shape: (32, 224, 224, 3) (32, 196)
Validation batch shape: (32, 224, 224, 3) (32, 196)
```

6A. VGGNet CNN Model

```
train_images = []
for img_path in df_training['Image_Path'].head(20):  # Iterate through
image paths
    img = load_img(img_path, target_size=(224, 224))  # Load the image
    img_array = img_to_array(img)  # Convert to NumPy array
    train_images.append(img_array)  # Add to the list

train_images = np.array(train_images)  # Convert list to NumPy array

# --- Apply resizing if needed ---
```

```
train_images = np.array([cv2.resize(img, (224, 224)) for img in
train_images])

train_labels =
np.stack(df_training['label_categorical'].head(20).values)


# Similarly for test images:
test_images = []
for img_path in df_testing['Image_Path'].head(20):  # Iterate through
image paths
    img = load_img(img_path, target_size=(224, 224))  # Load the image
    img_array = img_to_array(img)  # Convert to NumPy array
    test_images.append(img_array)  # Add to the list

test_images = np.array(test_images)  # Convert list to NumPy array

# --- Apply resizing if needed ---
test_images = np.array([cv2.resize(img, (224, 224)) for img in
test_images])

test_labels =
np.stack(df_testing['label_categorical'].head(20).values)

# Check shapes
print(f"train_images shape: {train_images.shape}")
print(f"train_labels shape: {train_labels.shape}")
print(f"test_images shape: {test_images.shape}")
print(f"test_labels shape: {test_labels.shape}")
# Load VGG16 model without the top layer
base_model = VGG16(weights='imagenet', include_top=False,
input_shape=(224, 224, 3))

# Add custom layers on top
x = Flatten()(base_model.output)
x = Dense(256, activation='relu')(x)
predictions = Dense(num_classes, activation='softmax')(x)

# Create the model
model = Model(inputs=base_model.input, outputs=predictions)

# Compile the model
model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])

# Data augmentation
datagen = ImageDataGenerator(rescale=1./255, validation_split=0.2)

model.summary()
# Fit the model
```

```
model.fit(datagen.flow(train_images, train_labels, batch_size=32,
subset='training'),
          validation_data=datagen.flow(train_images, train_labels,
batch_size=32, subset='validation'),
          epochs=10)
```

```
train_images shape: (20, 224, 224, 3)
train_labels shape: (20, 196)
test_images shape: (20, 224, 224, 3)
test_labels shape: (20, 196)
```

```
Model: "functional_73"
```

```
┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━
━━━━━┓
┃ Layer (type)                     ┃ Output Shape            ┃
Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━
━━━━━┩
│ input_layer_9 (InputLayer)       │ (None, 224, 224, 3)     │
0 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ block1_conv1 (Conv2D)            │ (None, 224, 224, 64)    │
1,792 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ block1_conv2 (Conv2D)            │ (None, 224, 224, 64)    │
36,928 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ block1_pool (MaxPooling2D)       │ (None, 112, 112, 64)    │
0 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ block2_conv1 (Conv2D)            │ (None, 112, 112, 128)   │
73,856 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ block2_conv2 (Conv2D)            │ (None, 112, 112, 128)   │
147,584 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ block2_pool (MaxPooling2D)       │ (None, 56, 56, 128)     │
0 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ block3_conv1 (Conv2D)            │ (None, 56, 56, 256)     │
295,168 │
├──────────────────────────────────┼─────────────────────────┼──────────
```

```
───────┤
│ block3_conv2 (Conv2D)             │ (None, 56, 56, 256)      │
590,080 │
├───────────────────────────────────┼──────────────────────────┼────────
───────┤
│ block3_conv3 (Conv2D)             │ (None, 56, 56, 256)      │
590,080 │
├───────────────────────────────────┼──────────────────────────┼────────
───────┤
│ block3_pool (MaxPooling2D)        │ (None, 28, 28, 256)      │
0 │
├───────────────────────────────────┼──────────────────────────┼────────
───────┤
│ block4_conv1 (Conv2D)             │ (None, 28, 28, 512)      │
1,180,160 │
├───────────────────────────────────┼──────────────────────────┼────────
───────┤
│ block4_conv2 (Conv2D)             │ (None, 28, 28, 512)      │
2,359,808 │
├───────────────────────────────────┼──────────────────────────┼────────
───────┤
│ block4_conv3 (Conv2D)             │ (None, 28, 28, 512)      │
2,359,808 │
├───────────────────────────────────┼──────────────────────────┼────────
───────┤
│ block4_pool (MaxPooling2D)        │ (None, 14, 14, 512)      │
0 │
├───────────────────────────────────┼──────────────────────────┼────────
───────┤
│ block5_conv1 (Conv2D)             │ (None, 14, 14, 512)      │
2,359,808 │
├───────────────────────────────────┼──────────────────────────┼────────
───────┤
│ block5_conv2 (Conv2D)             │ (None, 14, 14, 512)      │
2,359,808 │
├───────────────────────────────────┼──────────────────────────┼────────
───────┤
│ block5_conv3 (Conv2D)             │ (None, 14, 14, 512)      │
2,359,808 │
├───────────────────────────────────┼──────────────────────────┼────────
───────┤
│ block5_pool (MaxPooling2D)        │ (None, 7, 7, 512)        │
0 │
├───────────────────────────────────┼──────────────────────────┼────────
───────┤
│ flatten_7 (Flatten)               │ (None, 25088)            │
0 │
├───────────────────────────────────┼──────────────────────────┼────────
───────┤
```

```
│ dense_20 (Dense)                │ (None, 256)              │
6,422,784 │
├─────────────────────────────────┼──────────────────────────┼───────────
──────┤
│ dense_21 (Dense)                │ (None, 196)              │
50,372 │
└─────────────────────────────────┴──────────────────────────┴───────────
──────┘

 Total params: 21,187,844 (80.83 MB)

 Trainable params: 21,187,844 (80.83 MB)

 Non-trainable params: 0 (0.00 B)

Epoch 1/10

c:\Python\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()

1/1 ━━━━━━━━━━━━━━━━━━━━ 8s 8s/step - accuracy: 0.0000e+00 - loss:
4.4485 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 2/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 4s 4s/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 3/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 4s 4s/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 4/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 4s 4s/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 5/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 4s 4s/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 6/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 4s 4s/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 7/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 4s 4s/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 8/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 4s 4s/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 9/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 4s 4s/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 10/10
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 4s 4s/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00

<keras.src.callbacks.history.History at 0x1abf22fc890>
```

6B. GoogleNet

```
base_model = InceptionV3(weights='imagenet', include_top=False,
input_shape=(224, 224, 3))

# Add custom layers on top of the base model
x = base_model.output
x = GlobalAveragePooling2D()(x)
x = Dense(1024, activation='relu')(x)
predictions = Dense(196, activation='softmax')(x)

# Define the complete model
model = Model(inputs=base_model.input, outputs=predictions)

# Freeze the layers of the base model
for layer in base_model.layers:
    layer.trainable = False

# Compile the model
model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])


# Convert to numpy arrays
# Ensure all images have the same shape before stacking




# Ensure the model summary is called after defining the model
model.summary()

# Train the model
model.fit(
    train_images,  # Preprocessed training images
    train_labels,  # One-hot encoded training labels
    epochs=10,
    batch_size=32,
    validation_data=(test_images, test_labels)
)
```

```
Model: "functional_74"

┏━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━┳━━━━━━━━━━━━━━━
━━━━━┓
┃ Layer (type)         ┃ Output Shape      ┃    Param # ┃ Connected to
```

input_layer_10 (InputLayer)	(None, 224, 224, 3)	0	-
conv2d_129 (Conv2D)	(None, 111, 111, 32)	864	input_layer_10[0…
batch_normalizatio… (BatchNormalizatio…	(None, 111, 111, 32)	96	conv2d_129[0][0]
activation_94 (Activation)	(None, 111, 111, 32)	0	batch_normalizat…
conv2d_130 (Conv2D)	(None, 109, 109, 32)	9,216	activation_94[0]…
batch_normalizatio… (BatchNormalizatio…	(None, 109, 109, 32)	96	conv2d_130[0][0]
activation_95 (Activation)	(None, 109, 109, 32)	0	batch_normalizat…
conv2d_131 (Conv2D)	(None, 109, 109, 64)	18,432	activation_95[0]…

```
├─────────────────────┼──────────────────────┼───────────────┼─────────────
───────┤
│ batch_normalizatio… │ (None, 109, 109,     │           192 │ conv2d_131[0]
[0]    │
│ (BatchNormalizatio… │ 64)                  │               │
│
├─────────────────────┼──────────────────────┼───────────────┼─────────────
───────┤
│ activation_96       │ (None, 109, 109,     │             0 │
batch_normalizat… │
│ (Activation)        │ 64)                  │               │
│
├─────────────────────┼──────────────────────┼───────────────┼─────────────
───────┤
│ max_pooling2d_19    │ (None, 54, 54,       │             0 │
activation_96[0]… │
│ (MaxPooling2D)      │ 64)                  │               │
│
├─────────────────────┼──────────────────────┼───────────────┼─────────────
───────┤
│ conv2d_132 (Conv2D) │ (None, 54, 54,       │         5,120 │
max_pooling2d_19… │
│                     │ 80)                  │               │
│
├─────────────────────┼──────────────────────┼───────────────┼─────────────
───────┤
│ batch_normalizatio… │ (None, 54, 54,       │           240 │ conv2d_132[0]
[0]    │
│ (BatchNormalizatio… │ 80)                  │               │
│
├─────────────────────┼──────────────────────┼───────────────┼─────────────
───────┤
│ activation_97       │ (None, 54, 54,       │             0 │
batch_normalizat… │
│ (Activation)        │ 80)                  │               │
│
├─────────────────────┼──────────────────────┼───────────────┼─────────────
───────┤
│ conv2d_133 (Conv2D) │ (None, 52, 52,       │       138,240 │
activation_97[0]… │
│                     │ 192)                 │               │
│
├─────────────────────┼──────────────────────┼───────────────┼─────────────
───────┤
│ batch_normalizatio… │ (None, 52, 52,       │           576 │ conv2d_133[0]
[0]    │
│ (BatchNormalizatio… │ 192)                 │               │
│
├─────────────────────┼──────────────────────┼───────────────┼─────────────
```

```
──────┤
│ activation_98        │ (None, 52, 52,      │           0 │
batch_normalizat… │
│ (Activation)         │ 192)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
──────┤
│ max_pooling2d_20     │ (None, 25, 25,      │           0 │
activation_98[0]… │
│ (MaxPooling2D)       │ 192)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
──────┤
│ conv2d_137 (Conv2D)  │ (None, 25, 25,      │      12,288 │
max_pooling2d_20… │
│                      │ 64)                 │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
──────┤
│ batch_normalizatio…  │ (None, 25, 25,      │         192 │ conv2d_137[0]
[0]   │
│ (BatchNormalizatio…  │ 64)                 │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
──────┤
│ activation_102       │ (None, 25, 25,      │           0 │
batch_normalizat… │
│ (Activation)         │ 64)                 │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
──────┤
│ conv2d_135 (Conv2D)  │ (None, 25, 25,      │       9,216 │
max_pooling2d_20… │
│                      │ 48)                 │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
──────┤
│ conv2d_138 (Conv2D)  │ (None, 25, 25,      │      55,296 │
activation_102[0… │
│                      │ 96)                 │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
──────┤
│ batch_normalizatio…  │ (None, 25, 25,      │         144 │ conv2d_135[0]
[0]   │
│ (BatchNormalizatio…  │ 48)                 │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
──────┤
```

```
│ batch_normalizatio… │ (None, 25, 25,     │        288 │ conv2d_138[0]
[0]   │
│ (BatchNormalizatio… │ 96)                │            │
│
├─────────────────────┼────────────────────┼────────────┼─────────────
───────┤
│ activation_100      │ (None, 25, 25,     │          0 │
batch_normalizat… │
│ (Activation)        │ 48)                │            │
│
├─────────────────────┼────────────────────┼────────────┼─────────────
───────┤
│ activation_103      │ (None, 25, 25,     │          0 │
batch_normalizat… │
│ (Activation)        │ 96)                │            │
│
├─────────────────────┼────────────────────┼────────────┼─────────────
───────┤
│ average_pooling2d_9 │ (None, 25, 25,     │          0 │
max_pooling2d_20… │
│ (AveragePooling2D)  │ 192)               │            │
│
├─────────────────────┼────────────────────┼────────────┼─────────────
───────┤
│ conv2d_134 (Conv2D) │ (None, 25, 25,     │     12,288 │
max_pooling2d_20… │
│                     │ 64)                │            │
│
├─────────────────────┼────────────────────┼────────────┼─────────────
───────┤
│ conv2d_136 (Conv2D) │ (None, 25, 25,     │     76,800 │
activation_100[0… │
│                     │ 64)                │            │
│
├─────────────────────┼────────────────────┼────────────┼─────────────
───────┤
│ conv2d_139 (Conv2D) │ (None, 25, 25,     │     82,944 │
activation_103[0… │
│                     │ 96)                │            │
│
├─────────────────────┼────────────────────┼────────────┼─────────────
───────┤
│ conv2d_140 (Conv2D) │ (None, 25, 25,     │      6,144 │
average_pooling2… │
│                     │ 32)                │            │
│
├─────────────────────┼────────────────────┼────────────┼─────────────
───────┤
│ batch_normalizatio… │ (None, 25, 25,     │        192 │ conv2d_134[0]
```

```
[0]   │
│ (BatchNormalizatio… │ 64)                 │             │
│
├─────────────────────┼─────────────────────┼─────────────┼─────────────
──────┤
│ batch_normalizatio… │ (None, 25, 25,      │         192 │ conv2d_136[0]
[0]   │
│ (BatchNormalizatio… │ 64)                 │             │
│
├─────────────────────┼─────────────────────┼─────────────┼─────────────
──────┤
│ batch_normalizatio… │ (None, 25, 25,      │         288 │ conv2d_139[0]
[0]   │
│ (BatchNormalizatio… │ 96)                 │             │
│
├─────────────────────┼─────────────────────┼─────────────┼─────────────
──────┤
│ batch_normalizatio… │ (None, 25, 25,      │          96 │ conv2d_140[0]
[0]   │
│ (BatchNormalizatio… │ 32)                 │             │
│
├─────────────────────┼─────────────────────┼─────────────┼─────────────
──────┤
│ activation_99       │ (None, 25, 25,      │           0 │
batch_normalizat… │
│ (Activation)        │ 64)                 │             │
│
├─────────────────────┼─────────────────────┼─────────────┼─────────────
──────┤
│ activation_101      │ (None, 25, 25,      │           0 │
batch_normalizat… │
│ (Activation)        │ 64)                 │             │
│
├─────────────────────┼─────────────────────┼─────────────┼─────────────
──────┤
│ activation_104      │ (None, 25, 25,      │           0 │
batch_normalizat… │
│ (Activation)        │ 96)                 │             │
│
├─────────────────────┼─────────────────────┼─────────────┼─────────────
──────┤
│ activation_105      │ (None, 25, 25,      │           0 │
batch_normalizat… │
│ (Activation)        │ 32)                 │             │
│
├─────────────────────┼─────────────────────┼─────────────┼─────────────
──────┤
│ mixed0              │ (None, 25, 25,      │           0 │
activation_99[0]… │
```

```
│ (Concatenate)       │ 256)              │             │
activation_101[0… │
│                     │                   │             │
activation_104[0… │
│                     │                   │             │
activation_105[0… │
├─────────────────────┼───────────────────┼─────────────┼────────────────
─────┤
│ conv2d_144 (Conv2D) │ (None, 25, 25,    │      16,384 │ mixed0[0][0]
│
│                     │ 64)               │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────────
─────┤
│ batch_normalizatio… │ (None, 25, 25,    │         192 │ conv2d_144[0]
[0]  │
│ (BatchNormalizatio… │ 64)               │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────────
─────┤
│ activation_109      │ (None, 25, 25,    │           0 │
batch_normalizat… │
│ (Activation)        │ 64)               │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────────
─────┤
│ conv2d_142 (Conv2D) │ (None, 25, 25,    │      12,288 │ mixed0[0][0]
│
│                     │ 48)               │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────────
─────┤
│ conv2d_145 (Conv2D) │ (None, 25, 25,    │      55,296 │
activation_109[0… │
│                     │ 96)               │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────────
─────┤
│ batch_normalizatio… │ (None, 25, 25,    │         144 │ conv2d_142[0]
[0]  │
│ (BatchNormalizatio… │ 48)               │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────────
─────┤
│ batch_normalizatio… │ (None, 25, 25,    │         288 │ conv2d_145[0]
[0]  │
│ (BatchNormalizatio… │ 96)               │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────────
```

```
──────┤
│ activation_107      │ (None, 25, 25,    │          0 │
batch_normalizat… │
│ (Activation)        │ 48)               │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ activation_110      │ (None, 25, 25,    │          0 │
batch_normalizat… │
│ (Activation)        │ 96)               │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ average_pooling2d_… │ (None, 25, 25,    │          0 │ mixed0[0][0]
│
│ (AveragePooling2D)  │ 256)              │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ conv2d_141 (Conv2D) │ (None, 25, 25,    │     16,384 │ mixed0[0][0]
│
│                     │ 64)               │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ conv2d_143 (Conv2D) │ (None, 25, 25,    │     76,800 │
activation_107[0… │
│                     │ 64)               │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ conv2d_146 (Conv2D) │ (None, 25, 25,    │     82,944 │
activation_110[0… │
│                     │ 96)               │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ conv2d_147 (Conv2D) │ (None, 25, 25,    │     16,384 │
average_pooling2… │
│                     │ 64)               │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 25, 25,    │        192 │ conv2d_141[0]
[0]  │
│ (BatchNormalizatio… │ 64)               │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
```

```
│ batch_normalizatio… │ (None, 25, 25,      │        192 │ conv2d_143[0]
[0]   │
│ (BatchNormalizatio… │ 64)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 25, 25,      │        288 │ conv2d_146[0]
[0]   │
│ (BatchNormalizatio… │ 96)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 25, 25,      │        192 │ conv2d_147[0]
[0]   │
│ (BatchNormalizatio… │ 64)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ activation_106      │ (None, 25, 25,      │          0 │
batch_normalizat… │
│ (Activation)        │ 64)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ activation_108      │ (None, 25, 25,      │          0 │
batch_normalizat… │
│ (Activation)        │ 64)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ activation_111      │ (None, 25, 25,      │          0 │
batch_normalizat… │
│ (Activation)        │ 96)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ activation_112      │ (None, 25, 25,      │          0 │
batch_normalizat… │
│ (Activation)        │ 64)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ mixed1              │ (None, 25, 25,      │          0 │
activation_106[0… │
│ (Concatenate)       │ 288)                │            │
activation_108[0… │
│                     │                     │            │
activation_111[0… │
│                     │                     │            │
```

```
activation_112[0… │
├──────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ conv2d_151 (Conv2D) │ (None, 25, 25,      │     18,432 │ mixed1[0][0]
│
│                      │ 64)                 │            │
│
├──────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 25, 25,      │        192 │ conv2d_151[0]
[0]   │
│ (BatchNormalizatio… │ 64)                 │            │
│
├──────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ activation_116       │ (None, 25, 25,      │          0 │
batch_normalizat… │
│ (Activation)         │ 64)                 │            │
│
├──────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ conv2d_149 (Conv2D) │ (None, 25, 25,      │     13,824 │ mixed1[0][0]
│
│                      │ 48)                 │            │
│
├──────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ conv2d_152 (Conv2D) │ (None, 25, 25,      │     55,296 │
activation_116[0… │
│                      │ 96)                 │            │
│
├──────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 25, 25,      │        144 │ conv2d_149[0]
[0]   │
│ (BatchNormalizatio… │ 48)                 │            │
│
├──────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 25, 25,      │        288 │ conv2d_152[0]
[0]   │
│ (BatchNormalizatio… │ 96)                 │            │
│
├──────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ activation_114       │ (None, 25, 25,      │          0 │
batch_normalizat… │
│ (Activation)         │ 48)                 │            │
│
```

```
├───────────────────────┼────────────────────┼─────────────┼───────────────
───────┤
│ activation_117        │ (None, 25, 25,     │           0 │
batch_normalizat… │
│ (Activation)          │ 96)                │             │
│
├───────────────────────┼────────────────────┼─────────────┼───────────────
───────┤
│ average_pooling2d_… │ (None, 25, 25,     │           0 │ mixed1[0][0]
│
│ (AveragePooling2D)    │ 288)               │             │
│
├───────────────────────┼────────────────────┼─────────────┼───────────────
───────┤
│ conv2d_148 (Conv2D) │ (None, 25, 25,     │      18,432 │ mixed1[0][0]
│
│                       │ 64)                │             │
│
├───────────────────────┼────────────────────┼─────────────┼───────────────
───────┤
│ conv2d_150 (Conv2D) │ (None, 25, 25,     │      76,800 │
activation_114[0… │
│                       │ 64)                │             │
│
├───────────────────────┼────────────────────┼─────────────┼───────────────
───────┤
│ conv2d_153 (Conv2D) │ (None, 25, 25,     │      82,944 │
activation_117[0… │
│                       │ 96)                │             │
│
├───────────────────────┼────────────────────┼─────────────┼───────────────
───────┤
│ conv2d_154 (Conv2D) │ (None, 25, 25,     │      18,432 │
average_pooling2… │
│                       │ 64)                │             │
│
├───────────────────────┼────────────────────┼─────────────┼───────────────
───────┤
│ batch_normalizatio… │ (None, 25, 25,     │         192 │ conv2d_148[0]
[0]   │
│ (BatchNormalizatio… │ 64)                │             │
│
├───────────────────────┼────────────────────┼─────────────┼───────────────
───────┤
│ batch_normalizatio… │ (None, 25, 25,     │         192 │ conv2d_150[0]
[0]   │
│ (BatchNormalizatio… │ 64)                │             │
│
├───────────────────────┼────────────────────┼─────────────┼───────────────
───────┤
```

```
│ batch_normalizatio… │ (None, 25, 25,      │        288 │ conv2d_153[0]
[0]   │
│ (BatchNormalizatio… │ 96)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 25, 25,      │        192 │ conv2d_154[0]
[0]   │
│ (BatchNormalizatio… │ 64)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ activation_113      │ (None, 25, 25,      │          0 │
batch_normalizat… │
│ (Activation)        │ 64)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ activation_115      │ (None, 25, 25,      │          0 │
batch_normalizat… │
│ (Activation)        │ 64)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ activation_118      │ (None, 25, 25,      │          0 │
batch_normalizat… │
│ (Activation)        │ 96)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ activation_119      │ (None, 25, 25,      │          0 │
batch_normalizat… │
│ (Activation)        │ 64)                 │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ mixed2              │ (None, 25, 25,      │          0 │
activation_113[0… │
│ (Concatenate)       │ 288)                │            │
activation_115[0… │
│                     │                     │            │
activation_118[0… │
│                     │                     │            │
activation_119[0… │
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ conv2d_156 (Conv2D) │ (None, 25, 25,      │     18,432 │ mixed2[0][0]
│
│                     │ 64)                 │            │
```

```
│
├──────────────────────┼─────────────────────┼────────────────┼───────────────
───────┤
│ batch_normalizatio… │ (None, 25, 25,      │            192 │ conv2d_156[0]
[0]   │
│ (BatchNormalizatio… │ 64)                 │                │
│
├──────────────────────┼─────────────────────┼────────────────┼───────────────
───────┤
│ activation_121       │ (None, 25, 25,      │              0 │
batch_normalizat… │
│ (Activation)         │ 64)                 │                │
│
├──────────────────────┼─────────────────────┼────────────────┼───────────────
───────┤
│ conv2d_157 (Conv2D) │ (None, 25, 25,      │         55,296 │
activation_121[0… │
│                      │ 96)                 │                │
│
├──────────────────────┼─────────────────────┼────────────────┼───────────────
───────┤
│ batch_normalizatio… │ (None, 25, 25,      │            288 │ conv2d_157[0]
[0]   │
│ (BatchNormalizatio… │ 96)                 │                │
│
├──────────────────────┼─────────────────────┼────────────────┼───────────────
───────┤
│ activation_122       │ (None, 25, 25,      │              0 │
batch_normalizat… │
│ (Activation)         │ 96)                 │                │
│
├──────────────────────┼─────────────────────┼────────────────┼───────────────
───────┤
│ conv2d_155 (Conv2D) │ (None, 12, 12,      │        995,328 │ mixed2[0][0]
│
│                      │ 384)                │                │
│
├──────────────────────┼─────────────────────┼────────────────┼───────────────
───────┤
│ conv2d_158 (Conv2D) │ (None, 12, 12,      │         82,944 │
activation_122[0… │
│                      │ 96)                 │                │
│
├──────────────────────┼─────────────────────┼────────────────┼───────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,      │          1,152 │ conv2d_155[0]
[0]   │
│ (BatchNormalizatio… │ 384)                │                │
│
```

```
├───────────────────────────┼────────────────────────┼───────────────┼───────────────
──────┤
│ batch_normalizatio… │ (None, 12, 12,       │          288 │ conv2d_158[0]
[0]   │
│ (BatchNormalizatio… │ 96)                  │              │
│
├───────────────────────────┼────────────────────────┼───────────────┼───────────────
──────┤
│ activation_120      │ (None, 12, 12,       │            0 │
batch_normalizat… │
│ (Activation)        │ 384)                 │              │
│
├───────────────────────────┼────────────────────────┼───────────────┼───────────────
──────┤
│ activation_123      │ (None, 12, 12,       │            0 │
batch_normalizat… │
│ (Activation)        │ 96)                  │              │
│
├───────────────────────────┼────────────────────────┼───────────────┼───────────────
──────┤
│ max_pooling2d_21    │ (None, 12, 12,       │            0 │ mixed2[0][0]
│
│ (MaxPooling2D)      │ 288)                 │              │
│
├───────────────────────────┼────────────────────────┼───────────────┼───────────────
──────┤
│ mixed3              │ (None, 12, 12,       │            0 │
activation_120[0… │
│ (Concatenate)       │ 768)                 │              │
activation_123[0… │
│                     │                      │              │
max_pooling2d_21… │
├───────────────────────────┼────────────────────────┼───────────────┼───────────────
──────┤
│ conv2d_163 (Conv2D) │ (None, 12, 12,       │       98,304 │ mixed3[0][0]
│
│                     │ 128)                 │              │
│
├───────────────────────────┼────────────────────────┼───────────────┼───────────────
──────┤
│ batch_normalizatio… │ (None, 12, 12,       │          384 │ conv2d_163[0]
[0]   │
│ (BatchNormalizatio… │ 128)                 │              │
│
├───────────────────────────┼────────────────────────┼───────────────┼───────────────
──────┤
│ activation_128      │ (None, 12, 12,       │            0 │
batch_normalizat… │
│ (Activation)        │ 128)                 │              │
```

conv2d_164 (Conv2D)	(None, 12, 12, 128)	114,688	activation_128[0…
batch_normalizatio… (BatchNormalizatio…	(None, 12, 12, 128)	384	conv2d_164[0][0]
activation_129 (Activation)	(None, 12, 12, 128)	0	batch_normalizat…
conv2d_160 (Conv2D)	(None, 12, 12, 128)	98,304	mixed3[0][0]
conv2d_165 (Conv2D)	(None, 12, 12, 128)	114,688	activation_129[0…
batch_normalizatio… (BatchNormalizatio…	(None, 12, 12, 128)	384	conv2d_160[0][0]
batch_normalizatio… (BatchNormalizatio…	(None, 12, 12, 128)	384	conv2d_165[0][0]
activation_125 (Activation)	(None, 12, 12, 128)	0	batch_normalizat…

```
├───────────────────────┼──────────────────────┼──────────────┼──────────────
───────┤
│ activation_130        │ (None, 12, 12,       │            0 │
batch_normalizat… │
│ (Activation)          │ 128)                 │              │
│
├───────────────────────┼──────────────────────┼──────────────┼──────────────
───────┤
│ conv2d_161 (Conv2D)   │ (None, 12, 12,       │      114,688 │
activation_125[0… │
│                       │ 128)                 │              │
│
├───────────────────────┼──────────────────────┼──────────────┼──────────────
───────┤
│ conv2d_166 (Conv2D)   │ (None, 12, 12,       │      114,688 │
activation_130[0… │
│                       │ 128)                 │              │
│
├───────────────────────┼──────────────────────┼──────────────┼──────────────
───────┤
│ batch_normalizatio…   │ (None, 12, 12,       │          384 │ conv2d_161[0]
[0]   │
│ (BatchNormalizatio…   │ 128)                 │              │
│
├───────────────────────┼──────────────────────┼──────────────┼──────────────
───────┤
│ batch_normalizatio…   │ (None, 12, 12,       │          384 │ conv2d_166[0]
[0]   │
│ (BatchNormalizatio…   │ 128)                 │              │
│
├───────────────────────┼──────────────────────┼──────────────┼──────────────
───────┤
│ activation_126        │ (None, 12, 12,       │            0 │
batch_normalizat… │
│ (Activation)          │ 128)                 │              │
│
├───────────────────────┼──────────────────────┼──────────────┼──────────────
───────┤
│ activation_131        │ (None, 12, 12,       │            0 │
batch_normalizat… │
│ (Activation)          │ 128)                 │              │
│
├───────────────────────┼──────────────────────┼──────────────┼──────────────
───────┤
│ average_pooling2d_…   │ (None, 12, 12,       │            0 │ mixed3[0][0]
│
│ (AveragePooling2D)    │ 768)                 │              │
│
├───────────────────────┼──────────────────────┼──────────────┼──────────────
```

```
──────┤
│ conv2d_159 (Conv2D) │ (None, 12, 12,      │    147,456 │ mixed3[0][0]
│
│                     │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ conv2d_162 (Conv2D) │ (None, 12, 12,      │    172,032 │
activation_126[0… │
│                     │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ conv2d_167 (Conv2D) │ (None, 12, 12,      │    172,032 │
activation_131[0… │
│                     │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ conv2d_168 (Conv2D) │ (None, 12, 12,      │    147,456 │
average_pooling2… │
│                     │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 12, 12,      │        576 │ conv2d_159[0]
[0]   │
│ (BatchNormalizatio… │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 12, 12,      │        576 │ conv2d_162[0]
[0]   │
│ (BatchNormalizatio… │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 12, 12,      │        576 │ conv2d_167[0]
[0]   │
│ (BatchNormalizatio… │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 12, 12,      │        576 │ conv2d_168[0]
[0]   │
│ (BatchNormalizatio… │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
──────┤
```

```
│ activation_124        │ (None, 12, 12,     │           0 │
batch_normalizat… │
│ (Activation)          │ 192)               │             │
│
├───────────────────────┼────────────────────┼─────────────┼──────────────
───────┤
│ activation_127        │ (None, 12, 12,     │           0 │
batch_normalizat… │
│ (Activation)          │ 192)               │             │
│
├───────────────────────┼────────────────────┼─────────────┼──────────────
───────┤
│ activation_132        │ (None, 12, 12,     │           0 │
batch_normalizat… │
│ (Activation)          │ 192)               │             │
│
├───────────────────────┼────────────────────┼─────────────┼──────────────
───────┤
│ activation_133        │ (None, 12, 12,     │           0 │
batch_normalizat… │
│ (Activation)          │ 192)               │             │
│
├───────────────────────┼────────────────────┼─────────────┼──────────────
───────┤
│ mixed4                │ (None, 12, 12,     │           0 │
activation_124[0… │
│ (Concatenate)         │ 768)               │             │
activation_127[0… │
│                       │                    │             │
activation_132[0… │
│                       │                    │             │
activation_133[0… │
├───────────────────────┼────────────────────┼─────────────┼──────────────
───────┤
│ conv2d_173 (Conv2D)   │ (None, 12, 12,     │     122,880 │ mixed4[0][0]
│
│                       │ 160)               │             │
│
├───────────────────────┼────────────────────┼─────────────┼──────────────
───────┤
│ batch_normalizatio…   │ (None, 12, 12,     │         480 │ conv2d_173[0]
[0]  │
│ (BatchNormalizatio…   │ 160)               │             │
│
├───────────────────────┼────────────────────┼─────────────┼──────────────
───────┤
│ activation_138        │ (None, 12, 12,     │           0 │
batch_normalizat… │
│ (Activation)          │ 160)               │             │
```

```
│
├─────────────────────┼───────────────────┼────────────┼─────────────
───────┤
│ conv2d_174 (Conv2D) │ (None, 12, 12,    │    179,200 │
activation_138[0… │
│                     │ 160)              │            │
│
├─────────────────────┼───────────────────┼────────────┼─────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,    │        480 │ conv2d_174[0]
[0]  │
│ (BatchNormalizatio… │ 160)              │            │
│
├─────────────────────┼───────────────────┼────────────┼─────────────
───────┤
│ activation_139      │ (None, 12, 12,    │          0 │
batch_normalizat… │
│ (Activation)        │ 160)              │            │
│
├─────────────────────┼───────────────────┼────────────┼─────────────
───────┤
│ conv2d_170 (Conv2D) │ (None, 12, 12,    │    122,880 │ mixed4[0][0]
│
│                     │ 160)              │            │
│
├─────────────────────┼───────────────────┼────────────┼─────────────
───────┤
│ conv2d_175 (Conv2D) │ (None, 12, 12,    │    179,200 │
activation_139[0… │
│                     │ 160)              │            │
│
├─────────────────────┼───────────────────┼────────────┼─────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,    │        480 │ conv2d_170[0]
[0]  │
│ (BatchNormalizatio… │ 160)              │            │
│
├─────────────────────┼───────────────────┼────────────┼─────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,    │        480 │ conv2d_175[0]
[0]  │
│ (BatchNormalizatio… │ 160)              │            │
│
├─────────────────────┼───────────────────┼────────────┼─────────────
───────┤
│ activation_135      │ (None, 12, 12,    │          0 │
batch_normalizat… │
│ (Activation)        │ 160)              │            │
│
```

```
├──────────────────────┼────────────────────┼────────────┼──────────────
─────┤
│ activation_140       │ (None, 12, 12,     │          0 │
batch_normalizat… │
│ (Activation)         │ 160)               │            │
│
├──────────────────────┼────────────────────┼────────────┼──────────────
─────┤
│ conv2d_171 (Conv2D) │ (None, 12, 12,     │    179,200 │
activation_135[0… │
│                      │ 160)               │            │
│
├──────────────────────┼────────────────────┼────────────┼──────────────
─────┤
│ conv2d_176 (Conv2D) │ (None, 12, 12,     │    179,200 │
activation_140[0… │
│                      │ 160)               │            │
│
├──────────────────────┼────────────────────┼────────────┼──────────────
─────┤
│ batch_normalizatio… │ (None, 12, 12,     │        480 │ conv2d_171[0]
[0]   │
│ (BatchNormalizatio… │ 160)               │            │
│
├──────────────────────┼────────────────────┼────────────┼──────────────
─────┤
│ batch_normalizatio… │ (None, 12, 12,     │        480 │ conv2d_176[0]
[0]   │
│ (BatchNormalizatio… │ 160)               │            │
│
├──────────────────────┼────────────────────┼────────────┼──────────────
─────┤
│ activation_136       │ (None, 12, 12,     │          0 │
batch_normalizat… │
│ (Activation)         │ 160)               │            │
│
├──────────────────────┼────────────────────┼────────────┼──────────────
─────┤
│ activation_141       │ (None, 12, 12,     │          0 │
batch_normalizat… │
│ (Activation)         │ 160)               │            │
│
├──────────────────────┼────────────────────┼────────────┼──────────────
─────┤
│ average_pooling2d_… │ (None, 12, 12,     │          0 │ mixed4[0][0]
│
│ (AveragePooling2D)   │ 768)               │            │
│
├──────────────────────┼────────────────────┼────────────┼──────────────
```

```
───────┤
│ conv2d_169 (Conv2D) │ (None, 12, 12,      │    147,456 │ mixed4[0][0]
│
│                     │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
───────┤
│ conv2d_172 (Conv2D) │ (None, 12, 12,      │    215,040 │
activation_136[0… │
│                     │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
───────┤
│ conv2d_177 (Conv2D) │ (None, 12, 12,      │    215,040 │
activation_141[0… │
│                     │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
───────┤
│ conv2d_178 (Conv2D) │ (None, 12, 12,      │    147,456 │
average_pooling2… │
│                     │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,      │        576 │ conv2d_169[0]
[0]   │
│ (BatchNormalizatio… │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,      │        576 │ conv2d_172[0]
[0]   │
│ (BatchNormalizatio… │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,      │        576 │ conv2d_177[0]
[0]   │
│ (BatchNormalizatio… │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,      │        576 │ conv2d_178[0]
[0]   │
│ (BatchNormalizatio… │ 192)                │            │
│
├─────────────────────┼─────────────────────┼────────────┼──────────────
───────┤
```

```
│ activation_134       │ (None, 12, 12,     │          0 │
batch_normalizat… │
│ (Activation)         │ 192)               │            │
│
├──────────────────────┼────────────────────┼────────────┼───────────────
───────┤
│ activation_137       │ (None, 12, 12,     │          0 │
batch_normalizat… │
│ (Activation)         │ 192)               │            │
│
├──────────────────────┼────────────────────┼────────────┼───────────────
───────┤
│ activation_142       │ (None, 12, 12,     │          0 │
batch_normalizat… │
│ (Activation)         │ 192)               │            │
│
├──────────────────────┼────────────────────┼────────────┼───────────────
───────┤
│ activation_143       │ (None, 12, 12,     │          0 │
batch_normalizat… │
│ (Activation)         │ 192)               │            │
│
├──────────────────────┼────────────────────┼────────────┼───────────────
───────┤
│ mixed5               │ (None, 12, 12,     │          0 │
activation_134[0… │
│ (Concatenate)        │ 768)               │            │
activation_137[0… │
│                      │                    │            │
activation_142[0… │
│                      │                    │            │
activation_143[0… │
├──────────────────────┼────────────────────┼────────────┼───────────────
───────┤
│ conv2d_183 (Conv2D) │ (None, 12, 12,     │    122,880 │ mixed5[0][0]
│
│                      │ 160)               │            │
│
├──────────────────────┼────────────────────┼────────────┼───────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,     │        480 │ conv2d_183[0]
[0]  │
│ (BatchNormalizatio… │ 160)               │            │
│
├──────────────────────┼────────────────────┼────────────┼───────────────
───────┤
│ activation_148       │ (None, 12, 12,     │          0 │
batch_normalizat… │
│ (Activation)         │ 160)               │            │
│
```

conv2d_184 (Conv2D)	(None, 12, 12, 160)	179,200	activation_148[0…
batch_normalizatio… (BatchNormalizatio…	(None, 12, 12, 160)	480	conv2d_184[0][0]
activation_149 (Activation)	(None, 12, 12, 160)	0	batch_normalizat…
conv2d_180 (Conv2D)	(None, 12, 12, 160)	122,880	mixed5[0][0]
conv2d_185 (Conv2D)	(None, 12, 12, 160)	179,200	activation_149[0…
batch_normalizatio… (BatchNormalizatio…	(None, 12, 12, 160)	480	conv2d_180[0][0]
batch_normalizatio… (BatchNormalizatio…	(None, 12, 12, 160)	480	conv2d_185[0][0]
activation_145 (Activation)	(None, 12, 12, 160)	0	batch_normalizat…

```
───────┤
│ activation_150       │ (None, 12, 12,      │           0 │
batch_normalizat… │
│ (Activation)         │ 160)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ conv2d_181 (Conv2D) │ (None, 12, 12,      │     179,200 │
activation_145[0… │
│                      │ 160)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ conv2d_186 (Conv2D) │ (None, 12, 12,      │     179,200 │
activation_150[0… │
│                      │ 160)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,      │         480 │ conv2d_181[0]
[0]   │
│ (BatchNormalizatio… │ 160)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,      │         480 │ conv2d_186[0]
[0]   │
│ (BatchNormalizatio… │ 160)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ activation_146       │ (None, 12, 12,      │           0 │
batch_normalizat… │
│ (Activation)         │ 160)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ activation_151       │ (None, 12, 12,      │           0 │
batch_normalizat… │
│ (Activation)         │ 160)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ average_pooling2d_… │ (None, 12, 12,      │           0 │ mixed5[0][0]
│
│ (AveragePooling2D)  │ 768)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
```

conv2d_179 (Conv2D)	(None, 12, 12, 192)	147,456	mixed5[0][0]
conv2d_182 (Conv2D)	(None, 12, 12, 192)	215,040	activation_146[0…
conv2d_187 (Conv2D)	(None, 12, 12, 192)	215,040	activation_151[0…
conv2d_188 (Conv2D)	(None, 12, 12, 192)	147,456	average_pooling2…
batch_normalizatio… (BatchNormalizatio…	(None, 12, 12, 192)	576	conv2d_179[0][0]
batch_normalizatio… (BatchNormalizatio…	(None, 12, 12, 192)	576	conv2d_182[0][0]
batch_normalizatio… (BatchNormalizatio…	(None, 12, 12, 192)	576	conv2d_187[0][0]
batch_normalizatio… (BatchNormalizatio…	(None, 12, 12, 192)	576	conv2d_188[0][0]
activation_144	(None, 12, 12,	0	

```
batch_normalizat… │
│ (Activation)        │ 192)              │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────
──────┤
│ activation_147      │ (None, 12, 12,    │           0 │
batch_normalizat… │
│ (Activation)        │ 192)              │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────
──────┤
│ activation_152      │ (None, 12, 12,    │           0 │
batch_normalizat… │
│ (Activation)        │ 192)              │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────
──────┤
│ activation_153      │ (None, 12, 12,    │           0 │
batch_normalizat… │
│ (Activation)        │ 192)              │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────
──────┤
│ mixed6              │ (None, 12, 12,    │           0 │
activation_144[0… │
│ (Concatenate)       │ 768)              │             │
activation_147[0… │
│                     │                   │             │
activation_152[0… │
│                     │                   │             │
activation_153[0… │
├─────────────────────┼───────────────────┼─────────────┼────────────
──────┤
│ conv2d_193 (Conv2D) │ (None, 12, 12,    │     147,456 │ mixed6[0][0]
│
│                     │ 192)              │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────
──────┤
│ batch_normalizatio… │ (None, 12, 12,    │         576 │ conv2d_193[0]
[0]  │
│ (BatchNormalizatio… │ 192)              │             │
│
├─────────────────────┼───────────────────┼─────────────┼────────────
──────┤
│ activation_158      │ (None, 12, 12,    │           0 │
batch_normalizat… │
│ (Activation)        │ 192)              │             │
│
```

```
├───────────────────────┼───────────────────────┼───────────────┼──────────────────
──────┤
│ conv2d_194 (Conv2D)   │ (None, 12, 12,        │       258,048 │
activation_158[0… │
│                       │ 192)                  │               │
│
├───────────────────────┼───────────────────────┼───────────────┼──────────────────
──────┤
│ batch_normalizatio…   │ (None, 12, 12,        │           576 │ conv2d_194[0]
[0]   │
│ (BatchNormalizatio…   │ 192)                  │               │
│
├───────────────────────┼───────────────────────┼───────────────┼──────────────────
──────┤
│ activation_159        │ (None, 12, 12,        │             0 │
batch_normalizat… │
│ (Activation)          │ 192)                  │               │
│
├───────────────────────┼───────────────────────┼───────────────┼──────────────────
──────┤
│ conv2d_190 (Conv2D)   │ (None, 12, 12,        │       147,456 │ mixed6[0][0]
│
│                       │ 192)                  │               │
│
├───────────────────────┼───────────────────────┼───────────────┼──────────────────
──────┤
│ conv2d_195 (Conv2D)   │ (None, 12, 12,        │       258,048 │
activation_159[0… │
│                       │ 192)                  │               │
│
├───────────────────────┼───────────────────────┼───────────────┼──────────────────
──────┤
│ batch_normalizatio…   │ (None, 12, 12,        │           576 │ conv2d_190[0]
[0]   │
│ (BatchNormalizatio…   │ 192)                  │               │
│
├───────────────────────┼───────────────────────┼───────────────┼──────────────────
──────┤
│ batch_normalizatio…   │ (None, 12, 12,        │           576 │ conv2d_195[0]
[0]   │
│ (BatchNormalizatio…   │ 192)                  │               │
│
├───────────────────────┼───────────────────────┼───────────────┼──────────────────
──────┤
│ activation_155        │ (None, 12, 12,        │             0 │
batch_normalizat… │
│ (Activation)          │ 192)                  │               │
│
├───────────────────────┼───────────────────────┼───────────────┼──────────────────
```

```
───────┤
│ activation_160       │ (None, 12, 12,      │           0 │
batch_normalizat… │
│ (Activation)         │ 192)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼─────────────
───────┤
│ conv2d_191 (Conv2D) │ (None, 12, 12,      │     258,048 │
activation_155[0… │
│                      │ 192)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼─────────────
───────┤
│ conv2d_196 (Conv2D) │ (None, 12, 12,      │     258,048 │
activation_160[0… │
│                      │ 192)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼─────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,      │         576 │ conv2d_191[0]
[0]   │
│ (BatchNormalizatio… │ 192)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼─────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,      │         576 │ conv2d_196[0]
[0]   │
│ (BatchNormalizatio… │ 192)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼─────────────
───────┤
│ activation_156       │ (None, 12, 12,      │           0 │
batch_normalizat… │
│ (Activation)         │ 192)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼─────────────
───────┤
│ activation_161       │ (None, 12, 12,      │           0 │
batch_normalizat… │
│ (Activation)         │ 192)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼─────────────
───────┤
│ average_pooling2d_… │ (None, 12, 12,      │           0 │ mixed6[0][0]
│
│ (AveragePooling2D)   │ 768)                │             │
│
├──────────────────────┼─────────────────────┼─────────────┼─────────────
───────┤
```

```
│ conv2d_189 (Conv2D) │ (None, 12, 12,     │    147,456 │ mixed6[0][0]
│
│                     │ 192)               │            │
│
├─────────────────────┼────────────────────┼────────────┼──────────────
──────┤
│ conv2d_192 (Conv2D) │ (None, 12, 12,     │    258,048 │
activation_156[0… │
│                     │ 192)               │            │
│
├─────────────────────┼────────────────────┼────────────┼──────────────
──────┤
│ conv2d_197 (Conv2D) │ (None, 12, 12,     │    258,048 │
activation_161[0… │
│                     │ 192)               │            │
│
├─────────────────────┼────────────────────┼────────────┼──────────────
──────┤
│ conv2d_198 (Conv2D) │ (None, 12, 12,     │    147,456 │
average_pooling2… │
│                     │ 192)               │            │
│
├─────────────────────┼────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 12, 12,     │        576 │ conv2d_189[0]
[0]   │
│ (BatchNormalizatio… │ 192)               │            │
│
├─────────────────────┼────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 12, 12,     │        576 │ conv2d_192[0]
[0]   │
│ (BatchNormalizatio… │ 192)               │            │
│
├─────────────────────┼────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 12, 12,     │        576 │ conv2d_197[0]
[0]   │
│ (BatchNormalizatio… │ 192)               │            │
│
├─────────────────────┼────────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 12, 12,     │        576 │ conv2d_198[0]
[0]   │
│ (BatchNormalizatio… │ 192)               │            │
│
├─────────────────────┼────────────────────┼────────────┼──────────────
──────┤
│ activation_154      │ (None, 12, 12,     │          0 │
```

```
batch_normalizat… │
│ (Activation)        │ 192)              │             │
│
├─────────────────────┼───────────────────┼─────────────┼─────────────
──────┤
│ activation_157      │ (None, 12, 12,    │           0 │
batch_normalizat… │
│ (Activation)        │ 192)              │             │
│
├─────────────────────┼───────────────────┼─────────────┼─────────────
──────┤
│ activation_162      │ (None, 12, 12,    │           0 │
batch_normalizat… │
│ (Activation)        │ 192)              │             │
│
├─────────────────────┼───────────────────┼─────────────┼─────────────
──────┤
│ activation_163      │ (None, 12, 12,    │           0 │
batch_normalizat… │
│ (Activation)        │ 192)              │             │
│
├─────────────────────┼───────────────────┼─────────────┼─────────────
──────┤
│ mixed7              │ (None, 12, 12,    │           0 │
activation_154[0… │
│ (Concatenate)       │ 768)              │             │
activation_157[0… │
│                     │                   │             │
activation_162[0… │
│                     │                   │             │
activation_163[0… │
├─────────────────────┼───────────────────┼─────────────┼─────────────
──────┤
│ conv2d_201 (Conv2D) │ (None, 12, 12,    │     147,456 │ mixed7[0][0]
│
│                     │ 192)              │             │
│
├─────────────────────┼───────────────────┼─────────────┼─────────────
──────┤
│ batch_normalizatio… │ (None, 12, 12,    │         576 │ conv2d_201[0]
[0]  │
│ (BatchNormalizatio… │ 192)              │             │
│
├─────────────────────┼───────────────────┼─────────────┼─────────────
──────┤
│ activation_166      │ (None, 12, 12,    │           0 │
batch_normalizat… │
│ (Activation)        │ 192)              │             │
│
```

```
├──────────────────────┼───────────────────┼────────────┼───────────────
───────┤
│ conv2d_202 (Conv2D) │ (None, 12, 12,     │    258,048 │
activation_166[0… │
│                      │ 192)              │            │
│
├──────────────────────┼───────────────────┼────────────┼───────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,     │        576 │ conv2d_202[0]
[0]   │
│ (BatchNormalizatio… │ 192)               │            │
│
├──────────────────────┼───────────────────┼────────────┼───────────────
───────┤
│ activation_167       │ (None, 12, 12,    │          0 │
batch_normalizat… │
│ (Activation)         │ 192)              │            │
│
├──────────────────────┼───────────────────┼────────────┼───────────────
───────┤
│ conv2d_199 (Conv2D) │ (None, 12, 12,     │    147,456 │ mixed7[0][0]
│
│                      │ 192)              │            │
│
├──────────────────────┼───────────────────┼────────────┼───────────────
───────┤
│ conv2d_203 (Conv2D) │ (None, 12, 12,     │    258,048 │
activation_167[0… │
│                      │ 192)              │            │
│
├──────────────────────┼───────────────────┼────────────┼───────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,     │        576 │ conv2d_199[0]
[0]   │
│ (BatchNormalizatio… │ 192)               │            │
│
├──────────────────────┼───────────────────┼────────────┼───────────────
───────┤
│ batch_normalizatio… │ (None, 12, 12,     │        576 │ conv2d_203[0]
[0]   │
│ (BatchNormalizatio… │ 192)               │            │
│
├──────────────────────┼───────────────────┼────────────┼───────────────
───────┤
│ activation_164       │ (None, 12, 12,    │          0 │
batch_normalizat… │
│ (Activation)         │ 192)              │            │
│
├──────────────────────┼───────────────────┼────────────┼───────────────
```

```
──────┤
│ activation_168       │ (None, 12, 12,     │          0 │
batch_normalizat… │
│ (Activation)         │ 192)               │            │
│
├──────────────────────┼────────────────────┼────────────┼─────────────
──────┤
│ conv2d_200 (Conv2D) │ (None, 5, 5, 320) │    552,960 │
activation_164[0… │
├──────────────────────┼────────────────────┼────────────┼─────────────
──────┤
│ conv2d_204 (Conv2D) │ (None, 5, 5, 192) │    331,776 │
activation_168[0… │
├──────────────────────┼────────────────────┼────────────┼─────────────
──────┤
│ batch_normalizatio… │ (None, 5, 5, 320) │        960 │ conv2d_200[0]
[0]  │
│ (BatchNormalizatio… │                    │            │
│
├──────────────────────┼────────────────────┼────────────┼─────────────
──────┤
│ batch_normalizatio… │ (None, 5, 5, 192) │        576 │ conv2d_204[0]
[0]  │
│ (BatchNormalizatio… │                    │            │
│
├──────────────────────┼────────────────────┼────────────┼─────────────
──────┤
│ activation_165       │ (None, 5, 5, 320) │          0 │
batch_normalizat… │
│ (Activation)         │                    │            │
│
├──────────────────────┼────────────────────┼────────────┼─────────────
──────┤
│ activation_169       │ (None, 5, 5, 192) │          0 │
batch_normalizat… │
│ (Activation)         │                    │            │
│
├──────────────────────┼────────────────────┼────────────┼─────────────
──────┤
│ max_pooling2d_22     │ (None, 5, 5, 768) │          0 │ mixed7[0][0]
│
│ (MaxPooling2D)       │                    │            │
│
├──────────────────────┼────────────────────┼────────────┼─────────────
──────┤
│ mixed8               │ (None, 5, 5,       │          0 │
activation_165[0… │
│ (Concatenate)        │ 1280)              │            │
activation_169[0… │
```

```
│                           │                        │                │
max_pooling2d_22… │
├───────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ conv2d_209 (Conv2D)       │ (None, 5, 5, 448)      │        573,440 │ mixed8[0][0]
│
├───────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ batch_normalizatio…       │ (None, 5, 5, 448)      │          1,344 │ conv2d_209[0]
[0]    │
│ (BatchNormalizatio…       │                        │                │
│
├───────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ activation_174            │ (None, 5, 5, 448)      │              0 │
batch_normalizat… │
│ (Activation)              │                        │                │
│
├───────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ conv2d_206 (Conv2D)       │ (None, 5, 5, 384)      │        491,520 │ mixed8[0][0]
│
├───────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ conv2d_210 (Conv2D)       │ (None, 5, 5, 384)      │      1,548,288 │
activation_174[0… │
├───────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ batch_normalizatio…       │ (None, 5, 5, 384)      │          1,152 │ conv2d_206[0]
[0]    │
│ (BatchNormalizatio…       │                        │                │
│
├───────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ batch_normalizatio…       │ (None, 5, 5, 384)      │          1,152 │ conv2d_210[0]
[0]    │
│ (BatchNormalizatio…       │                        │                │
│
├───────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ activation_171            │ (None, 5, 5, 384)      │              0 │
batch_normalizat… │
│ (Activation)              │                        │                │
│
├───────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ activation_175            │ (None, 5, 5, 384)      │              0 │
batch_normalizat… │
│ (Activation)              │                        │                │
│
```

```
├─────────────────────┼───────────────────┼────────────┼────────────
───────┤
│ conv2d_207 (Conv2D) │ (None, 5, 5, 384) │    442,368 │
activation_171[0… │
├─────────────────────┼───────────────────┼────────────┼────────────
───────┤
│ conv2d_208 (Conv2D) │ (None, 5, 5, 384) │    442,368 │
activation_171[0… │
├─────────────────────┼───────────────────┼────────────┼────────────
───────┤
│ conv2d_211 (Conv2D) │ (None, 5, 5, 384) │    442,368 │
activation_175[0… │
├─────────────────────┼───────────────────┼────────────┼────────────
───────┤
│ conv2d_212 (Conv2D) │ (None, 5, 5, 384) │    442,368 │
activation_175[0… │
├─────────────────────┼───────────────────┼────────────┼────────────
───────┤
│ average_pooling2d_… │ (None, 5, 5,      │          0 │ mixed8[0][0]
│
│ (AveragePooling2D)  │ 1280)             │            │
│
├─────────────────────┼───────────────────┼────────────┼────────────
───────┤
│ conv2d_205 (Conv2D) │ (None, 5, 5, 320) │    409,600 │ mixed8[0][0]
│
├─────────────────────┼───────────────────┼────────────┼────────────
───────┤
│ batch_normalizatio… │ (None, 5, 5, 384) │      1,152 │ conv2d_207[0]
[0]  │
│ (BatchNormalizatio… │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼────────────
───────┤
│ batch_normalizatio… │ (None, 5, 5, 384) │      1,152 │ conv2d_208[0]
[0]  │
│ (BatchNormalizatio… │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼────────────
───────┤
│ batch_normalizatio… │ (None, 5, 5, 384) │      1,152 │ conv2d_211[0]
[0]  │
│ (BatchNormalizatio… │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼────────────
───────┤
│ batch_normalizatio… │ (None, 5, 5, 384) │      1,152 │ conv2d_212[0]
[0]  │
│ (BatchNormalizatio… │                   │            │
```

```
│
├───────────────────────────┼────────────────────────┼────────────────┼────────────────
───────┤
│ conv2d_213 (Conv2D) │ (None, 5, 5, 192) │    245,760 │
average_pooling2… │
├───────────────────────────┼────────────────────────┼────────────────┼────────────────
───────┤
│ batch_normalizatio… │ (None, 5, 5, 320) │        960 │ conv2d_205[0]
[0]   │
│ (BatchNormalizatio… │                   │            │
│
├───────────────────────────┼────────────────────────┼────────────────┼────────────────
───────┤
│ activation_172      │ (None, 5, 5, 384) │          0 │
batch_normalizat… │
│ (Activation)        │                   │            │
│
├───────────────────────────┼────────────────────────┼────────────────┼────────────────
───────┤
│ activation_173      │ (None, 5, 5, 384) │          0 │
batch_normalizat… │
│ (Activation)        │                   │            │
│
├───────────────────────────┼────────────────────────┼────────────────┼────────────────
───────┤
│ activation_176      │ (None, 5, 5, 384) │          0 │
batch_normalizat… │
│ (Activation)        │                   │            │
│
├───────────────────────────┼────────────────────────┼────────────────┼────────────────
───────┤
│ activation_177      │ (None, 5, 5, 384) │          0 │
batch_normalizat… │
│ (Activation)        │                   │            │
│
├───────────────────────────┼────────────────────────┼────────────────┼────────────────
───────┤
│ batch_normalizatio… │ (None, 5, 5, 192) │        576 │ conv2d_213[0]
[0]   │
│ (BatchNormalizatio… │                   │            │
│
├───────────────────────────┼────────────────────────┼────────────────┼────────────────
───────┤
│ activation_170      │ (None, 5, 5, 320) │          0 │
batch_normalizat… │
│ (Activation)        │                   │            │
│
├───────────────────────────┼────────────────────────┼────────────────┼────────────────
───────┤
```

```
│ mixed9_0              │ (None, 5, 5, 768) │          0 │
activation_172[0… │
│ (Concatenate)         │                   │            │
activation_173[0… │
├───────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ concatenate_5         │ (None, 5, 5, 768) │          0 │
activation_176[0… │
│ (Concatenate)         │                   │            │
activation_177[0… │
├───────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ activation_178        │ (None, 5, 5, 192) │          0 │
batch_normalizat… │
│ (Activation)          │                   │            │
│
├───────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ mixed9                │ (None, 5, 5,      │          0 │
activation_170[0… │
│ (Concatenate)         │ 2048)             │            │ mixed9_0[0]
[0],   │
│                       │                   │            │
concatenate_5[0]… │
│                       │                   │            │
activation_178[0… │
├───────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ conv2d_218 (Conv2D) │ (None, 5, 5, 448) │    917,504 │ mixed9[0][0]
│
├───────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 5, 5, 448) │      1,344 │ conv2d_218[0]
[0]  │
│ (BatchNormalizatio… │                   │            │
│
├───────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ activation_183        │ (None, 5, 5, 448) │          0 │
batch_normalizat… │
│ (Activation)          │                   │            │
│
├───────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ conv2d_215 (Conv2D) │ (None, 5, 5, 384) │    786,432 │ mixed9[0][0]
│
├───────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ conv2d_219 (Conv2D) │ (None, 5, 5, 384) │  1,548,288 │
```

```
activation_183[0… │
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ batch_normalizatio… │ (None, 5, 5, 384) │       1,152 │ conv2d_215[0]
[0]   │
│ (BatchNormalizatio… │                     │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ batch_normalizatio… │ (None, 5, 5, 384) │       1,152 │ conv2d_219[0]
[0]   │
│ (BatchNormalizatio… │                     │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ activation_180       │ (None, 5, 5, 384) │           0 │
batch_normalizat… │
│ (Activation)         │                     │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ activation_184       │ (None, 5, 5, 384) │           0 │
batch_normalizat… │
│ (Activation)         │                     │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ conv2d_216 (Conv2D) │ (None, 5, 5, 384) │     442,368 │
activation_180[0… │
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ conv2d_217 (Conv2D) │ (None, 5, 5, 384) │     442,368 │
activation_180[0… │
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ conv2d_220 (Conv2D) │ (None, 5, 5, 384) │     442,368 │
activation_184[0… │
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ conv2d_221 (Conv2D) │ (None, 5, 5, 384) │     442,368 │
activation_184[0… │
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
│ average_pooling2d_… │ (None, 5, 5,        │           0 │ mixed9[0][0]
│
│ (AveragePooling2D)   │ 2048)               │             │
│
├──────────────────────┼─────────────────────┼─────────────┼──────────────
───────┤
```

```
│ conv2d_214 (Conv2D) │ (None, 5, 5, 320) │    655,360 │ mixed9[0][0]
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 5, 5, 384) │      1,152 │ conv2d_216[0]
[0]   │
│ (BatchNormalizatio… │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 5, 5, 384) │      1,152 │ conv2d_217[0]
[0]   │
│ (BatchNormalizatio… │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 5, 5, 384) │      1,152 │ conv2d_220[0]
[0]   │
│ (BatchNormalizatio… │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 5, 5, 384) │      1,152 │ conv2d_221[0]
[0]   │
│ (BatchNormalizatio… │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ conv2d_222 (Conv2D) │ (None, 5, 5, 192) │    393,216 │
average_pooling2… │
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ batch_normalizatio… │ (None, 5, 5, 320) │        960 │ conv2d_214[0]
[0]   │
│ (BatchNormalizatio… │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ activation_181      │ (None, 5, 5, 384) │          0 │
batch_normalizat… │
│ (Activation)        │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
──────┤
│ activation_182      │ (None, 5, 5, 384) │          0 │
batch_normalizat… │
│ (Activation)        │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼──────────────
```

```
───────┤
│ activation_185      │ (None, 5, 5, 384) │          0 │
batch_normalizat… │
│ (Activation)        │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼───────────
───────┤
│ activation_186      │ (None, 5, 5, 384) │          0 │
batch_normalizat… │
│ (Activation)        │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼───────────
───────┤
│ batch_normalizatio… │ (None, 5, 5, 192) │        576 │ conv2d_222[0]
[0]  │
│ (BatchNormalizatio… │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼───────────
───────┤
│ activation_179      │ (None, 5, 5, 320) │          0 │
batch_normalizat… │
│ (Activation)        │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼───────────
───────┤
│ mixed9_1            │ (None, 5, 5, 768) │          0 │
activation_181[0… │
│ (Concatenate)       │                   │            │
activation_182[0… │
├─────────────────────┼───────────────────┼────────────┼───────────
───────┤
│ concatenate_6       │ (None, 5, 5, 768) │          0 │
activation_185[0… │
│ (Concatenate)       │                   │            │
activation_186[0… │
├─────────────────────┼───────────────────┼────────────┼───────────
───────┤
│ activation_187      │ (None, 5, 5, 192) │          0 │
batch_normalizat… │
│ (Activation)        │                   │            │
│
├─────────────────────┼───────────────────┼────────────┼───────────
───────┤
│ mixed10             │ (None, 5, 5,      │          0 │
activation_179[0… │
│ (Concatenate)       │ 2048)             │            │ mixed9_1[0]
[0],    │
│                     │                   │            │
concatenate_6[0]… │
```

```
│                           │                        │                │
activation_187[0… │
├───────────────────────────┼────────────────────────┼────────────────┼─────────────────
──────┤
│ global_average_poo… │ (None, 2048)           │              0 │ mixed10[0][0]
│                           │                        │                │
│ (GlobalAveragePool… │                        │                │
│                           │                        │                │
├───────────────────────────┼────────────────────────┼────────────────┼─────────────────
──────┤
│ dense_22 (Dense)          │ (None, 1024)           │      2,098,176 │
global_average_p… │
├───────────────────────────┼────────────────────────┼────────────────┼─────────────────
──────┤
│ dense_23 (Dense)          │ (None, 196)            │        200,900 │ dense_22[0]
[0]     │
└───────────────────────────┴────────────────────────┴────────────────┴─────────────────
──────┘

 Total params: 24,101,860 (91.94 MB)

 Trainable params: 2,299,076 (8.77 MB)

 Non-trainable params: 21,802,784 (83.17 MB)

Epoch 1/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 10s 10s/step - accuracy: 0.0000e+00 - loss:
46.1529 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 2/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 729ms/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 3/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 675ms/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 4/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 682ms/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 5/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 714ms/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 6/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 703ms/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 7/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 713ms/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 8/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 752ms/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 9/10
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 687ms/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 10/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 668ms/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00

<keras.src.callbacks.history.History at 0x1abf1d67230>
```

6C. AlexNet

```
# Define paths
image_dir = 'Car_Images/Car Images/Test Images'  # Adjust based on
your directory structure

# Prepare data
images = []
labels = []

for index, row in test_annotations_df.iterrows():
    image_name = row['Image Name']
    #image_path = os.path.join(image_dir, image_name)
    #image_path = find_image_path(image_name,
os.path.join('Car_Images', 'Car Images', 'Test Images'))  # Search in
subfolders

    # Load and preprocess the image
    image = cv2.imread(image_path)
    image = cv2.resize(image, (227, 227))  # Resize to 227x227 pixels
(AlexNet input size)
    images.append(image)

    # Assuming 'Image class' contains the class label
    labels.append(row['Image class'])

# Convert to numpy arrays
images = np.array(images)
labels = np.array(labels)

# Encode labels
unique_classes = np.unique(labels)

def create_alexnet_model(input_shape, num_classes):
    model = Sequential()

    # First Convolutional Layer
    model.add(Conv2D(96, (11, 11), strides=(4, 4), activation='relu',
input_shape=input_shape))
    model.add(MaxPooling2D(pool_size=(3, 3), strides=(2, 2)))
    model.add(BatchNormalization())
```

```python
    # Second Convolutional Layer
    model.add(Conv2D(256, (5, 5), padding='same', activation='relu'))
    model.add(MaxPooling2D(pool_size=(3, 3), strides=(2, 2)))
    model.add(BatchNormalization())

    # Third Convolutional Layer
    model.add(Conv2D(384, (3, 3), padding='same', activation='relu'))

    # Fourth Convolutional Layer
    model.add(Conv2D(384, (3, 3), padding='same', activation='relu'))

    # Fifth Convolutional Layer
    model.add(Conv2D(256, (3, 3), padding='same', activation='relu'))
    model.add(MaxPooling2D(pool_size=(3, 3), strides=(2, 2)))
    model.add(BatchNormalization())

    # Flatten the output
    model.add(Flatten())

    # Fully Connected Layers
    model.add(Dense(4096, activation='relu'))
    model.add(Dropout(0.5))

    model.add(Dense(4096, activation='relu'))
    model.add(Dropout(0.5))

    model.add(Dense(num_classes, activation='softmax'))

    return model

# Create the model
input_shape = (224, 224, 3)  # Image dimensions for AlexNet
num_classes = len(unique_classes)
model = create_alexnet_model(input_shape, num_classes)

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

# Data augmentation
datagen = ImageDataGenerator(rotation_range=20, width_shift_range=0.2,
                             height_shift_range=0.2, shear_range=0.2,
                             zoom_range=0.2, horizontal_flip=True,
                             fill_mode='nearest')

model.summary()

# Train the model
model.fit(
    train_images,  # Preprocessed training images
    train_labels,  # One-hot encoded training labels
```

```
    epochs=10,
    batch_size=32,
    validation_data=(test_images, test_labels)
)

Model: "sequential_3"

┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━
━━━━━┓
┃ Layer (type)                     ┃ Output Shape            ┃
Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━
━━━━━┩
│ conv2d_109 (Conv2D)              │ (None, 54, 54, 96)      │
34,944 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ max_pooling2d_13 (MaxPooling2D) │ (None, 26, 26, 96)      │
0 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ batch_normalization_103          │ (None, 26, 26, 96)      │
384 │
│ (BatchNormalization)             │                         │
│
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ conv2d_110 (Conv2D)              │ (None, 26, 26, 256)     │
614,656 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ max_pooling2d_14 (MaxPooling2D) │ (None, 12, 12, 256)     │
0 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ batch_normalization_104          │ (None, 12, 12, 256)     │
1,024 │
│ (BatchNormalization)             │                         │
│
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ conv2d_111 (Conv2D)              │ (None, 12, 12, 384)     │
885,120 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ conv2d_112 (Conv2D)              │ (None, 12, 12, 384)     │
1,327,488 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ conv2d_113 (Conv2D)              │ (None, 12, 12, 256)     │
```

```
884,992 │
├─────────────────────────────────┼────────────────────────┼───────────
───────┤
│ max_pooling2d_15 (MaxPooling2D) │ (None, 5, 5, 256)      │
0 │
├─────────────────────────────────┼────────────────────────┼───────────
───────┤
│ batch_normalization_105         │ (None, 5, 5, 256)      │
1,024 │
│ (BatchNormalization)            │                        │
│
├─────────────────────────────────┼────────────────────────┼───────────
───────┤
│ flatten_4 (Flatten)             │ (None, 6400)           │
0 │
├─────────────────────────────────┼────────────────────────┼───────────
───────┤
│ dense_13 (Dense)                │ (None, 4096)           │
26,218,496 │
├─────────────────────────────────┼────────────────────────┼───────────
───────┤
│ dropout_7 (Dropout)             │ (None, 4096)           │
0 │
├─────────────────────────────────┼────────────────────────┼───────────
───────┤
│ dense_14 (Dense)                │ (None, 4096)           │
16,781,312 │
├─────────────────────────────────┼────────────────────────┼───────────
───────┤
│ dropout_8 (Dropout)             │ (None, 4096)           │
0 │
├─────────────────────────────────┼────────────────────────┼───────────
───────┤
│ dense_15 (Dense)                │ (None, 196)            │
803,012 │
└─────────────────────────────────┴────────────────────────┴───────────
───────┘

 Total params: 47,552,452 (181.40 MB)

 Trainable params: 47,551,236 (181.39 MB)

 Non-trainable params: 1,216 (4.75 KB)

Epoch 1/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 3s 3s/step - accuracy: 0.0000e+00 - loss:
6.6543 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 2/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 604ms/step - accuracy: 1.0000 - loss:
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
```

```
Epoch 3/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 505ms/step - accuracy: 1.0000 - loss: 
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 4/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 511ms/step - accuracy: 1.0000 - loss: 
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 5/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 508ms/step - accuracy: 1.0000 - loss: 
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 6/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 533ms/step - accuracy: 1.0000 - loss: 
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 7/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 542ms/step - accuracy: 1.0000 - loss: 
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 8/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 499ms/step - accuracy: 1.0000 - loss: 
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 9/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 493ms/step - accuracy: 1.0000 - loss: 
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 10/10
1/1 ━━━━━━━━━━━━━━━━━━━━ 1s 540ms/step - accuracy: 1.0000 - loss: 
0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00

<keras.src.callbacks.history.History at 0x1abf06110a0>
```

6D. U-Net

```
train_images = np.random.rand(100, 128, 128, 3)
train_masks = np.random.rand(100, 128, 128, 1)

def unet_model(input_size=(128, 128, 3)):
    inputs = keras.Input(shape=input_size)

    # Encoder
    conv1 = layers.Conv2D(64, (3, 3), activation='relu', 
padding='same')(inputs)
    conv1 = layers.Conv2D(64, (3, 3), activation='relu', 
padding='same')(conv1)
    pool1 = layers.MaxPooling2D(pool_size=(2, 2))(conv1)

    conv2 = layers.Conv2D(128, (3, 3), activation='relu', 
padding='same')(pool1)
    conv2 = layers.Conv2D(128, (3, 3), activation='relu', 
padding='same')(conv2)
    pool2 = layers.MaxPooling2D(pool_size=(2, 2))(conv2)

    conv3 = layers.Conv2D(256, (3, 3), activation='relu', 
padding='same')(pool2)
```

```
    conv3 = layers.Conv2D(256, (3, 3), activation='relu', 
padding='same')(conv3)
    pool3 = layers.MaxPooling2D(pool_size=(2, 2))(conv3)

    # Bottleneck
    conv4 = layers.Conv2D(512, (3, 3), activation='relu', 
padding='same')(pool3)
    conv4 = layers.Conv2D(512, (3, 3), activation='relu', 
padding='same')(conv4)

    # Decoder
    up5 = layers.UpSampling2D(size=(2, 2))(conv4)
    concat5 = layers.Concatenate()([up5, conv3])
    conv5 = layers.Conv2D(256, (3, 3), activation='relu', 
padding='same')(concat5)
    conv5 = layers.Conv2D(256, (3, 3), activation='relu', 
padding='same')(conv5)

    up6 = layers.UpSampling2D(size=(2, 2))(conv5)
    concat6 = layers.Concatenate()([up6, conv2])
    conv6 = layers.Conv2D(128, (3, 3), activation='relu', 
padding='same')(concat6)
    conv6 = layers.Conv2D(128, (3, 3), activation='relu', 
padding='same')(conv6)

    up7 = layers.UpSampling2D(size=(2, 2))(conv6)
    concat7 = layers.Concatenate()([up7, conv1])
    conv7 = layers.Conv2D(64, (3, 3), activation='relu', 
padding='same')(concat7)
    conv7 = layers.Conv2D(64, (3, 3), activation='relu', 
padding='same')(conv7)

    outputs = layers.Conv2D(1, (1, 1), activation='sigmoid')(conv7)

    model = keras.Model(inputs, outputs)
    return model

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

# Summary
model.summary()

# Train the model
model.fit(train_images, train_masks, epochs=10, batch_size=16, 
validation_split=0.1)

Model: "functional_70"
```

Layer (type)	Output Shape	Param #	Connected to
input_layer_6 (InputLayer)	(None, 128, 128, 3)	0	-
conv2d_114 (Conv2D)	(None, 128, 128, 64)	1,792	input_layer_6[0]…
conv2d_115 (Conv2D)	(None, 128, 128, 64)	36,928	conv2d_114[0][0]
max_pooling2d_16 (MaxPooling2D)	(None, 64, 64, 64)	0	conv2d_115[0][0]
conv2d_116 (Conv2D)	(None, 64, 64, 128)	73,856	max_pooling2d_16…
conv2d_117 (Conv2D)	(None, 64, 64, 128)	147,584	conv2d_116[0][0]
max_pooling2d_17 (MaxPooling2D)	(None, 32, 32, 128)	0	conv2d_117[0][0]
conv2d_118 (Conv2D)	(None, 32, 32,	295,168	max_pooling2d_17…

```
│                          │ 256)                   │                │
│
├──────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ conv2d_119 (Conv2D)      │ (None, 32, 32,         │        590,080 │ conv2d_118[0]
[0]    │
│                          │ 256)                   │                │
│
├──────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ max_pooling2d_18         │ (None, 16, 16,         │              0 │ conv2d_119[0]
[0]    │
│ (MaxPooling2D)           │ 256)                   │                │
│
├──────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ conv2d_120 (Conv2D)      │ (None, 16, 16,         │      1,180,160 │
max_pooling2d_18… │
│                          │ 512)                   │                │
│
├──────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ conv2d_121 (Conv2D)      │ (None, 16, 16,         │      2,359,808 │ conv2d_120[0]
[0]    │
│                          │ 512)                   │                │
│
├──────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ up_sampling2d            │ (None, 32, 32,         │              0 │ conv2d_121[0]
[0]    │
│ (UpSampling2D)           │ 512)                   │                │
│
├──────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ concatenate_2            │ (None, 32, 32,         │              0 │
up_sampling2d[0]… │
│ (Concatenate)            │ 768)                   │                │ conv2d_119[0]
[0]    │
├──────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ conv2d_122 (Conv2D)      │ (None, 32, 32,         │      1,769,728 │
concatenate_2[0]… │
│                          │ 256)                   │                │
│
├──────────────────────────┼────────────────────────┼────────────────┼───────────────
───────┤
│ conv2d_123 (Conv2D)      │ (None, 32, 32,         │        590,080 │ conv2d_122[0]
[0]    │
│                          │ 256)                   │                │
│
```

```
├───────────────────────────┼────────────────────────┼────────────────┼──────────────────
───────┤
│ up_sampling2d_1           │ (None, 64, 64,         │              0 │ conv2d_123[0]
[0]   │
│ (UpSampling2D)            │ 256)                   │                │
│
├───────────────────────────┼────────────────────────┼────────────────┼──────────────────
───────┤
│ concatenate_3             │ (None, 64, 64,         │              0 │
up_sampling2d_1[… │
│ (Concatenate)             │ 384)                   │                │ conv2d_117[0]
[0]   │
├───────────────────────────┼────────────────────────┼────────────────┼──────────────────
───────┤
│ conv2d_124 (Conv2D)       │ (None, 64, 64,         │        442,496 │
concatenate_3[0]… │
│                           │ 128)                   │                │
│
├───────────────────────────┼────────────────────────┼────────────────┼──────────────────
───────┤
│ conv2d_125 (Conv2D)       │ (None, 64, 64,         │        147,584 │ conv2d_124[0]
[0]   │
│                           │ 128)                   │                │
│
├───────────────────────────┼────────────────────────┼────────────────┼──────────────────
───────┤
│ up_sampling2d_2           │ (None, 128, 128,       │              0 │ conv2d_125[0]
[0]   │
│ (UpSampling2D)            │ 128)                   │                │
│
├───────────────────────────┼────────────────────────┼────────────────┼──────────────────
───────┤
│ concatenate_4             │ (None, 128, 128,       │              0 │
up_sampling2d_2[… │
│ (Concatenate)             │ 192)                   │                │ conv2d_115[0]
[0]   │
├───────────────────────────┼────────────────────────┼────────────────┼──────────────────
───────┤
│ conv2d_126 (Conv2D)       │ (None, 128, 128,       │        110,656 │
concatenate_4[0]… │
│                           │ 64)                    │                │
│
├───────────────────────────┼────────────────────────┼────────────────┼──────────────────
───────┤
│ conv2d_127 (Conv2D)       │ (None, 128, 128,       │         36,928 │ conv2d_126[0]
[0]   │
│                           │ 64)                    │                │
│
├───────────────────────────┼────────────────────────┼────────────────┼──────────────────
───────┤
```

```
│ conv2d_128 (Conv2D) │ (None, 128, 128,  │         65 │ conv2d_127[0]
[0]  │
│                     │ 1)                │            │
│
└─────────────────────┴───────────────────┴────────────┴──────────────
──────┘

 Total params: 7,782,913 (29.69 MB)

 Trainable params: 7,782,913 (29.69 MB)

 Non-trainable params: 0 (0.00 B)

Epoch 1/10
6/6 ━━━━━━━━━━━━━━━━━━━━ 19s 2s/step - accuracy: 0.0000e+00 - loss:
0.6935 - val_accuracy: 0.0000e+00 - val_loss: 0.6932
Epoch 2/10
6/6 ━━━━━━━━━━━━━━━━━━━━ 31s 6s/step - accuracy: 0.0000e+00 - loss:
0.6932 - val_accuracy: 0.0000e+00 - val_loss: 0.6932
Epoch 3/10
6/6 ━━━━━━━━━━━━━━━━━━━━ 25s 2s/step - accuracy: 0.0000e+00 - loss:
0.6932 - val_accuracy: 0.0000e+00 - val_loss: 0.6931
Epoch 4/10
6/6 ━━━━━━━━━━━━━━━━━━━━ 15s 2s/step - accuracy: 0.0000e+00 - loss:
0.6931 - val_accuracy: 0.0000e+00 - val_loss: 0.6931
Epoch 5/10
6/6 ━━━━━━━━━━━━━━━━━━━━ 15s 2s/step - accuracy: 0.0000e+00 - loss:
0.6931 - val_accuracy: 0.0000e+00 - val_loss: 0.6931
Epoch 6/10
6/6 ━━━━━━━━━━━━━━━━━━━━ 15s 2s/step - accuracy: 0.0000e+00 - loss:
0.6931 - val_accuracy: 0.0000e+00 - val_loss: 0.6931
Epoch 7/10
6/6 ━━━━━━━━━━━━━━━━━━━━ 15s 2s/step - accuracy: 0.0000e+00 - loss:
0.6931 - val_accuracy: 0.0000e+00 - val_loss: 0.6931
Epoch 8/10
6/6 ━━━━━━━━━━━━━━━━━━━━ 14s 2s/step - accuracy: 0.0000e+00 - loss:
0.6931 - val_accuracy: 0.0000e+00 - val_loss: 0.6931
Epoch 9/10
6/6 ━━━━━━━━━━━━━━━━━━━━ 14s 2s/step - accuracy: 0.0000e+00 - loss:
0.6931 - val_accuracy: 0.0000e+00 - val_loss: 0.6931
Epoch 10/10
6/6 ━━━━━━━━━━━━━━━━━━━━ 15s 2s/step - accuracy: 0.0000e+00 - loss:
0.6931 - val_accuracy: 0.0000e+00 - val_loss: 0.6932

<keras.src.callbacks.history.History at 0x1abefa12870>
```

1. Summary