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1 8.1. Script Principal

[3]:
```
#Analisis conjunto de datos
carpeta_imagenes = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\images"
carpeta_etiquetas = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\labels"
carpeta_mascaras = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\masks"

carpeta_img_totas = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Limpieza\Dataset_Completo"

import os
import numpy as np
import matplotlib.pyplot as plt

total_imagenes = os.listdir(carpeta_img_totas)

print("Total de imagenes: ", len(total_imagenes))

print("**********************************************************************************
print("Imagenes procesadas:")
#Cargamos las imagenes
imagenes = os.listdir(carpeta_imagenes)
etiquetas = os.listdir(carpeta_etiquetas)
mascaras = os.listdir(carpeta_mascaras)

#Totales
print("Total de imagenes: ", len(imagenes))
#% de imagenes del total
print("Porcentaje de imagenes del total: ", len(imagenes)/
 ↪len(total_imagenes)*100)
print("Total de etiquetas: ", len(etiquetas))
print("Total de mascaras: ", len(mascaras))

#Total imagenes sin etiqueta
```

```
imagenes_sin_etiqueta = [i for i in imagenes if i not in etiquetas]
print("Total de imagenes sin etiqueta: ", len(imagenes_sin_etiqueta))

#Total imagenes sin mascara
imagenes_sin_mascara = [i for i in imagenes if i not in mascaras]
print("Total de imagenes sin mascara: ", len(imagenes_sin_mascara))

#Total etiquetas sin imagen
etiquetas_sin_imagen = [i for i in etiquetas if i not in imagenes]
print("Total de etiquetas sin imagen: ", len(etiquetas_sin_imagen))

#Total mascaras sin imagen
mascaras_sin_imagen = [i for i in mascaras if i not in imagenes]
print("Total de mascaras sin imagen: ", len(mascaras_sin_imagen))

#Total de imagenes con etiqueta y mascara
imagenes_con_etiqueta = [i for i in imagenes if i in etiquetas]
imagenes_con_mascara = [i for i in imagenes if i in mascaras]
imagenes_con_etiqueta_y_mascara = [i for i in imagenes_con_etiqueta if i in␣
 ↪imagenes_con_mascara]
print("Total de imagenes con etiqueta y mascara: ",␣
 ↪len(imagenes_con_etiqueta_y_mascara))

print("**********************************************************************************
# En train
carpeta_imagenes_train = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\train\images"
carpeta_etiquetas_train = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\train\labels"
carpeta_mascaras_train = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\train\masks"

imagenes_train = os.listdir(carpeta_imagenes_train)
etiquetas_train = os.listdir(carpeta_etiquetas_train)
mascaras_train = os.listdir(carpeta_mascaras_train)

#Totales
print("Total de imagenes train: ", len(imagenes_train))
print("Total de etiquetas train: ", len(etiquetas_train))
print("Total de mascaras train: ", len(mascaras_train))

print("**********************************************************************************
# En val
carpeta_imagenes_val = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\val\images"
```

```
carpeta_etiquetas_val = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\val\labels"
carpeta_mascaras_val = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\val\masks"

imagenes_val = os.listdir(carpeta_imagenes_val)
etiquetas_val = os.listdir(carpeta_etiquetas_val)
mascaras_val = os.listdir(carpeta_mascaras_val)

#Totales
print("Total de imagenes val: ", len(imagenes_val))
print("Total de etiquetas val: ", len(etiquetas_val))
print("Total de mascaras val: ", len(mascaras_val))
```

```
Total de imagenes:  4303
********************************************************************************
********************
Imagenes procesadas:
Total de imagenes:  561
Porcentaje de imagenes del total:  13.03741575644899
Total de etiquetas:  561
Total de mascaras:  566
Total de imagenes sin etiqueta:  561
Total de imagenes sin mascara:  561
Total de etiquetas sin imagen:  561
Total de mascaras sin imagen:  566
Total de imagenes con etiqueta y mascara:  0
********************************************************************************
********************
Total de imagenes train:  449
Total de etiquetas train:  449
Total de mascaras train:  452
********************************************************************************
********************
Total de imagenes val:  112
Total de etiquetas val:  112
Total de mascaras val:  114
```

1. Introducción

Este notebook está diseñado para preparar datos, dividirlos en conjuntos de entrenamiento/validación, y entrenar un modelo YOLOv8 para detectar huellas de tortugas. Los pasos incluyen:

Configuración de rutas y organización de archivos. Visualización de etiquetas en las imágenes. Conversión de etiquetas en formato YOLO. División del dataset. Entrenamiento del modelo YOLOv8.

2. Configuración inicial

[ ]:
```python
# Importar librerías necesarias
import os
import json
import cv2
import shutil
import random
from ultralytics import YOLO

# Configuración de rutas principales
CARPETA_MEZCLADA = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Para_Etiquetar_Huellas"
CARPETA_IMAGENES = os.path.join(CARPETA_MEZCLADA, "images")
CARPETA_JSON = os.path.join(CARPETA_MEZCLADA, "json")

# Crear carpetas separadas para imágenes y JSON
os.makedirs(CARPETA_IMAGENES, exist_ok=True)
os.makedirs(CARPETA_JSON, exist_ok=True)

# Mover archivos a sus respectivas carpetas
for archivo in os.listdir(CARPETA_MEZCLADA):
    ruta_archivo = os.path.join(CARPETA_MEZCLADA, archivo)
    if archivo.lower().endswith(('.jpg', '.jpeg', '.png')):
        shutil.move(ruta_archivo, os.path.join(CARPETA_IMAGENES, archivo))
    elif archivo.lower().endswith('.json'):
        shutil.move(ruta_archivo, os.path.join(CARPETA_JSON, archivo))

print("Archivos organizados:")
print(f"- Imágenes movidas a: {CARPETA_IMAGENES}")
print(f"- Archivos JSON movidos a: {CARPETA_JSON}")
```

3. Visualización de etiquetas

[ ]:
```python
import json
import cv2
import os

def visualizar_etiquetas(carpeta_imagenes, carpeta_json, carpeta_salida):
    """
    Dibuja las etiquetas de huellas en las imágenes basándose en los archivos␣
 ↪JSON.
    """
    os.makedirs(carpeta_salida, exist_ok=True)

    for archivo_json in os.listdir(carpeta_json):
        if archivo_json.endswith(".json"):
            ruta_json = os.path.join(carpeta_json, archivo_json)
```

```
            ruta_imagen = os.path.join(carpeta_imagenes, archivo_json.replace(".
 ↪json", ".JPG"))

            if os.path.exists(ruta_imagen):
                # Leer la imagen
                imagen = cv2.imread(ruta_imagen)

                # Leer el archivo JSON
                with open(ruta_json, 'r') as f:
                    datos = json.load(f)

                # Dibujar las etiquetas en la imagen
                for shape in datos.get("shapes", []):
                    if shape["shape_type"] == "linestrip":
                        puntos = shape["points"]
                        for i in range(len(puntos) - 1):
                            x1, y1 = int(puntos[i][0]), int(puntos[i][1])
                            x2, y2 = int(puntos[i + 1][0]), int(puntos[i +␣
 ↪1][1])
                            cv2.line(imagen, (x1, y1), (x2, y2), (0, 255, 0),␣
 ↪2)  # Línea verde

                # Guardar la imagen con etiquetas
                ruta_salida = os.path.join(carpeta_salida, archivo_json.
 ↪replace(".json", ".JPG"))
                cv2.imwrite(ruta_salida, imagen)

CARPETA_SALIDA_VISUALIZACION = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Imagenes_Con_Etiquetas"
visualizar_etiquetas(CARPETA_IMAGENES, CARPETA_JSON,␣
 ↪CARPETA_SALIDA_VISUALIZACION)
```

4. Generar etiquetas YOLO y vacías

[21]:
```
import os
import json
import shutil

def convertir_json_a_yolo(ruta_json, archivo_salida_txt,␣
 ↪carpeta_salida_etiquetas, ancho_imagen, alto_imagen):
    """
    Convierte un archivo JSON a formato YOLO con normalización y lo guarda.
    """
    with open(ruta_json, 'r') as f:
        datos = json.load(f)

    yolo_labels = []
```

```
    for shape in datos["shapes"]:
        if shape["shape_type"] == "linestrip":
            puntos = shape["points"]
            if len(puntos) >= 2:  # Asegurar que haya al menos dos puntos
                x1, y1 = puntos[0]
                x2, y2 = puntos[-1]

                # Normalizar coordenadas
                xc = ((x1 + x2) / 2) / ancho_imagen
                yc = ((y1 + y2) / 2) / alto_imagen
                w = abs(x2 - x1) / ancho_imagen
                h = abs(y2 - y1) / alto_imagen

                # Verificar que las coordenadas están en el rango [0, 1]
                if 0 <= xc <= 1 and 0 <= yc <= 1 and 0 <= w <= 1 and 0 <= h <=␣
↪1:
                    yolo_labels.append(f"0 {xc:.6f} {yc:.6f} {w:.6f} {h:.6f}")
                else:
                    print(f"Coordenadas fuera de rango en {archivo_salida_txt}:␣
↪{xc}, {yc}, {w}, {h}")

    ruta_salida = os.path.join(carpeta_salida_etiquetas, archivo_salida_txt)
    ruta_salida = ruta_salida.replace('.png', '.txt').replace('.jpg', '.txt').
↪replace('.jpeg', '.txt').replace('.JPG', '.txt')

    # Guardar etiquetas YOLO solo si hay datos válidos
    if yolo_labels:
        with open(ruta_salida, 'w') as f:
            f.write("\n".join(yolo_labels))

def procesar_imagenes_y_etiquetas(carpeta_imagenes, carpeta_json,␣
↪carpeta_salida_imagenes, carpeta_salida_etiquetas):
    """
    Copia imágenes con etiquetas JSON asociadas y convierte los JSON en formato␣
↪YOLO.
    Omite imágenes sin JSON asociado.
    """
    os.makedirs(carpeta_salida_imagenes, exist_ok=True)
    os.makedirs(carpeta_salida_etiquetas, exist_ok=True)

    for archivo in os.listdir(carpeta_imagenes):
        if archivo.lower().endswith(('.jpg', '.jpeg', '.png', '.JPG')):
            archivo_json = archivo.replace('.jpg', '.json').replace('.jpeg', '.
↪json').replace('.png', '.json').replace('.JPG', '.json')
            ruta_json = os.path.join(carpeta_json, archivo_json)
            ruta_imagen = os.path.join(carpeta_imagenes, archivo)
```

```
            if os.path.exists(ruta_json):  # Solo procesar imágenes con JSON␣
 ↪asociado
                # Obtener dimensiones de la imagen
                import cv2
                imagen = cv2.imread(ruta_imagen)
                alto_imagen, ancho_imagen = imagen.shape[:2]

                # Copiar imagen
                ruta_destino_imagen = os.path.join(carpeta_salida_imagenes,␣
 ↪archivo)
                shutil.copy(ruta_imagen, ruta_destino_imagen)

                # Convertir JSON a YOLO
                archivo_txt = archivo.replace('.jpg', '.txt').replace('.jpeg',␣
 ↪'.txt').replace('.png', '.txt').replace('.JPG', '.txt')
                convertir_json_a_yolo(ruta_json, archivo_txt,␣
 ↪carpeta_salida_etiquetas, ancho_imagen, alto_imagen)

def revisar_imagenes_sin_etiquetas(carpeta_imagenes, carpeta_salida_etiquetas):
    """
    Revisa si hay imágenes sin etiquetas YOLO asociadas.
    """
    etiquetas_faltantes = []
    for archivo in os.listdir(carpeta_imagenes):
        if archivo.lower().endswith(('.jpg', '.jpeg', '.png', '.JPG')):
            archivo_txt = archivo.replace('.jpg', '.txt').replace('.jpeg', '.
 ↪txt').replace('.png', '.txt').replace('.JPG', '.txt')
            ruta_txt = os.path.join(carpeta_salida_etiquetas, archivo_txt)
            if not os.path.exists(ruta_txt):
                etiquetas_faltantes.append(archivo)
    return etiquetas_faltantes

# Configuración de carpetas
CARPETA_IMAGENES = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Para_Etiquetar_Huellas\images"
CARPETA_JSON = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Para_Etiquetar_Huellas\json"
CARPETA_SALIDA_IMAGENES = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\images"
CARPETA_SALIDA_ETIQUETAS = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\labels"

# Procesar imágenes y etiquetas
procesar_imagenes_y_etiquetas(CARPETA_IMAGENES, CARPETA_JSON,␣
 ↪CARPETA_SALIDA_IMAGENES, CARPETA_SALIDA_ETIQUETAS)
```

```
# Revisar imágenes sin etiquetas YOLO asociadas
imagenes_sin_etiquetas = revisar_imagenes_sin_etiquetas(CARPETA_SALIDA_IMAGENES, CARPETA_SALIDA_ETIQUETAS)
print(f"Imágenes sin etiquetas YOLO txt asociadas: {imagenes_sin_etiquetas}")

# Eliminar imágenes sin etiquetas YOLO asociadas
for archivo in imagenes_sin_etiquetas:
    ruta_imagen = os.path.join(CARPETA_SALIDA_IMAGENES, archivo)
    os.remove(ruta_imagen)

print("Proceso completado: imágenes y etiquetas procesadas correctamente.")
```

```
Imágenes sin etiquetas YOLO txt asociadas: ['108FTASK_MAX_2283.JPG',
'108FTASK_MAX_2291.JPG', '108FTASK_MAX_2294.JPG', '108FTASK_MAX_2301.JPG',
'108FTASK_MAX_2302.JPG']
Proceso completado: imágenes y etiquetas procesadas correctamente.
```

5. Dividir el dataset

[22]:
```
def dividir_dataset(carpeta_dataset, carpeta_train, carpeta_val, val_ratio=0.2):
    """
    Divide un conjunto de datos en entrenamiento y validación.
    """
    os.makedirs(os.path.join(carpeta_train, "images"), exist_ok=True)
    os.makedirs(os.path.join(carpeta_train, "labels"), exist_ok=True)
    os.makedirs(os.path.join(carpeta_val, "images"), exist_ok=True)
    os.makedirs(os.path.join(carpeta_val, "labels"), exist_ok=True)

    imagenes = [f for f in os.listdir(os.path.join(carpeta_dataset, "images")) if f.lower().endswith(('.jpg', '.jpeg', '.png'))]
    random.shuffle(imagenes)

    val_size = int(len(imagenes) * val_ratio)

    for i, imagen in enumerate(imagenes):
        etiqueta = imagen.replace(".jpg", ".txt").replace(".jpeg", ".txt").replace(".png", ".txt").replace(".JPG", ".txt")
        set_destino = carpeta_val if i < val_size else carpeta_train

        shutil.copy(os.path.join(carpeta_dataset, "images", imagen), os.path.join(set_destino, "images", imagen))
        shutil.copy(os.path.join(carpeta_dataset, "labels", etiqueta), os.path.join(set_destino, "labels", etiqueta))

CARPETA_DATASET = r"C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado"
```

```
CARPETA_TRAIN = os.path.join(CARPETA_DATASET, "train")
CARPETA_VAL = os.path.join(CARPETA_DATASET, "val")
dividir_dataset(CARPETA_DATASET, CARPETA_TRAIN, CARPETA_VAL)
```

6. Entrenar YOLO

[2]:
```
import os
os.environ["KMP_DUPLICATE_LIB_OK"]="TRUE"
from ultralytics import YOLO
```

[2]:
```
import os
os.environ["KMP_DUPLICATE_LIB_OK"]="TRUE"
from ultralytics import YOLO

def entrenar_yolo(data_path, modelo_salida, epochs=1000, img_size=640):
    """
    Entrena un modelo YOLOv8 con el dataset proporcionado.
    """
    modelo = YOLO("yolov8n.pt")
    modelo.train(
        data=data_path,
        epochs=epochs,
        imgsz=img_size,
        save_period=10,
        project=os.path.dirname(modelo_salida),
        name=os.path.basename(modelo_salida).split('.')[0]
    )

DATA_PATH = r"C:\Users\Carlos\Desktop\pepe\data_other_pc.yaml"
MODELO_SALIDA = r"C:\Users\Carlos\Desktop\pepe\yolov8_model.pt"
entrenar_yolo(DATA_PATH, MODELO_SALIDA)
```

```
Ultralytics 8.3.49  Python-3.10.13 torch-2.5.1+cpu CPU (13th Gen Intel Core(TM)
i9-13900KF)
engine\trainer: task=detect, mode=train, model=yolov8n.pt,
data=C:\Users\Carlos\Desktop\pepe\data_other_pc.yaml, epochs=1000, time=None,
patience=100, batch=16, imgsz=640, save=True, save_period=10, cache=False,
device=None, workers=8, project=C:\Users\Carlos\Desktop\pepe,
name=yolov8_model6, exist_ok=False, pretrained=True, optimizer=auto,
verbose=True, seed=0, deterministic=True, single_cls=False, rect=False,
cos_lr=False, close_mosaic=10, resume=False, amp=True, fraction=1.0,
profile=False, freeze=None, multi_scale=False, overlap_mask=True, mask_ratio=4,
dropout=0.0, val=True, split=val, save_json=False, save_hybrid=False, conf=None,
iou=0.7, max_det=300, half=False, dnn=False, plots=True, source=None,
vid_stride=1, stream_buffer=False, visualize=False, augment=False,
agnostic_nms=False, classes=None, retina_masks=False, embed=None, show=False,
save_frames=False, save_txt=False, save_conf=False, save_crop=False,
show_labels=True, show_conf=True, show_boxes=True, line_width=None,
```

```
format=torchscript, keras=False, optimize=False, int8=False, dynamic=False,
simplify=True, opset=None, workspace=None, nms=False, lr0=0.01, lrf=0.01,
momentum=0.937, weight_decay=0.0005, warmup_epochs=3.0, warmup_momentum=0.8,
warmup_bias_lr=0.1, box=7.5, cls=0.5, dfl=1.5, pose=12.0, kobj=1.0, nbs=64,
hsv_h=0.015, hsv_s=0.7, hsv_v=0.4, degrees=0.0, translate=0.1, scale=0.5,
shear=0.0, perspective=0.0, flipud=0.0, fliplr=0.5, bgr=0.0, mosaic=1.0,
mixup=0.0, copy_paste=0.0, copy_paste_mode=flip, auto_augment=randaugment,
erasing=0.4, crop_fraction=1.0, cfg=None, tracker=botsort.yaml,
save_dir=C:\Users\Carlos\Desktop\pepe\yolov8_model6
Overriding model.yaml nc=80 with nc=1

                   from  n    params  module
arguments
  0                  -1  1       464  ultralytics.nn.modules.conv.Conv
[3, 16, 3, 2]
  1                  -1  1      4672  ultralytics.nn.modules.conv.Conv
[16, 32, 3, 2]
  2                  -1  1      7360  ultralytics.nn.modules.block.C2f
[32, 32, 1, True]
  3                  -1  1     18560  ultralytics.nn.modules.conv.Conv
[32, 64, 3, 2]
  4                  -1  2     49664  ultralytics.nn.modules.block.C2f
[64, 64, 2, True]
  5                  -1  1     73984  ultralytics.nn.modules.conv.Conv
[64, 128, 3, 2]
  6                  -1  2    197632  ultralytics.nn.modules.block.C2f
[128, 128, 2, True]
  7                  -1  1    295424  ultralytics.nn.modules.conv.Conv
[128, 256, 3, 2]
  8                  -1  1    460288  ultralytics.nn.modules.block.C2f
[256, 256, 1, True]
  9                  -1  1    164608  ultralytics.nn.modules.block.SPPF
[256, 256, 5]
 10                  -1  1         0  torch.nn.modules.upsampling.Upsample
[None, 2, 'nearest']
 11             [-1, 6]  1         0  ultralytics.nn.modules.conv.Concat
[1]
 12                  -1  1    148224  ultralytics.nn.modules.block.C2f
[384, 128, 1]
 13                  -1  1         0  torch.nn.modules.upsampling.Upsample
[None, 2, 'nearest']
 14             [-1, 4]  1         0  ultralytics.nn.modules.conv.Concat
[1]
 15                  -1  1     37248  ultralytics.nn.modules.block.C2f
[192, 64, 1]
 16                  -1  1     36992  ultralytics.nn.modules.conv.Conv
[64, 64, 3, 2]
 17            [-1, 12]  1         0  ultralytics.nn.modules.conv.Concat
```

```
[1]
 18                  -1  1    123648  ultralytics.nn.modules.block.C2f
[192, 128, 1]
 19                  -1  1    147712  ultralytics.nn.modules.conv.Conv
[128, 128, 3, 2]
 20             [-1, 9]  1         0  ultralytics.nn.modules.conv.Concat
[1]
 21                  -1  1    493056  ultralytics.nn.modules.block.C2f
[384, 256, 1]
 22        [15, 18, 21]  1    751507  ultralytics.nn.modules.head.Detect
[1, [64, 128, 256]]
Model summary: 225 layers, 3,011,043 parameters, 3,011,027 gradients, 8.2 GFLOPs

Transferred 319/355 items from pretrained weights
TensorBoard: Start with 'tensorboard --logdir
C:\Users\Carlos\Desktop\pepe\yolov8_model6', view at http://localhost:6006/
Freezing layer 'model.22.dfl.conv.weight'

train: Scanning
C:\Users\Carlos\Desktop\pepe\Dataset_Organizado\train\labels.cache… 449
images, 0 backgrounds, 0 corrupt: 100%|      | 449/449 [00:00<?, ?it/s]
val: Scanning
C:\Users\Carlos\Desktop\pepe\Dataset_Organizado\val\labels.cache… 112 images,
0 backgrounds, 0 corrupt: 100%|      | 112/112 [00:00<?, ?it/s]

Plotting labels to C:\Users\Carlos\Desktop\pepe\yolov8_model6\labels.jpg…


optimizer: 'optimizer=auto' found, ignoring 'lr0=0.01' and
'momentum=0.937' and determining best 'optimizer', 'lr0' and 'momentum'
automatically…
optimizer: AdamW(lr=0.002, momentum=0.9) with parameter groups 57
weight(decay=0.0), 64 weight(decay=0.0005), 63 bias(decay=0.0)
TensorBoard: model graph visualization added
Image sizes 640 train, 640 val
Using 0 dataloader workers
Logging results to C:\Users\Carlos\Desktop\pepe\yolov8_model6
Starting training for 1000 epochs…

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size

     1/1000         0G      3.096      3.328      2.562          5        640:
100%|      | 29/29 [00:37<00:00,  1.29s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.04it/s]

                   all        112        557     0.0075      0.452     0.0172
0.00467
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     2/1000         0G      2.805      2.891      2.243         11        640:
100%|      | 29/29 [00:36<00:00,  1.26s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.00it/s]
                   all        112        557     0.0188      0.431     0.0279
0.00754

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     3/1000         0G        2.8      2.873      2.248         12        640:
100%|      | 29/29 [00:36<00:00,  1.26s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.06it/s]
                   all        112        557     0.0286     0.0395     0.0071
0.00184

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     4/1000         0G      2.774      2.841      2.248         12        640:
100%|      | 29/29 [00:37<00:00,  1.28s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:04<00:00,  1.23s/it]
                   all        112        557     0.0317      0.118      0.017
0.00397

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     5/1000         0G      2.697      2.783      2.223          4        640:
100%|      | 29/29 [00:36<00:00,  1.26s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:04<00:00,  1.07s/it]
                   all        112        557     0.0941      0.111     0.0321
0.00871

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
     6/1000         0G      2.667      2.721      2.181          9        640:
100%|      | 29/29 [00:36<00:00,  1.26s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.04it/s]
                   all        112        557      0.112      0.154     0.0511
0.0145


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     7/1000         0G      2.622      2.652      2.133          6        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.12it/s]
                   all        112        557      0.112      0.133     0.0489
0.0141


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     8/1000         0G      2.572      2.647      2.111          5        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:04<00:00,  1.12s/it]
                   all        112        557     0.0688     0.0898     0.0191
0.00609


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     9/1000         0G      2.605      2.683      2.184         12        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:04<00:00,  1.08s/it]
                   all        112        557      0.107      0.106     0.0369
0.0108


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    10/1000         0G      2.541      2.616      2.125          9        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.11it/s]
```

```
                 all        112        557       0.11      0.133     0.0431
0.0133

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    11/1000         0G      2.563      2.611      2.123          9        640:
100%|      | 29/29 [00:36<00:00,  1.27s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                 all        112        557      0.126      0.126     0.0411
0.0126

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    12/1000         0G      2.527      2.621      2.106          3        640:
100%|      | 29/29 [00:37<00:00,  1.30s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:04<00:00,  1.06s/it]
                 all        112        557     0.0981      0.115     0.0498
0.0157

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    13/1000         0G      2.464      2.625      2.129         15        640:
100%|      | 29/29 [00:36<00:00,  1.27s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:04<00:00,  1.12s/it]
                 all        112        557     0.0873      0.185     0.0413
0.0126

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    14/1000         0G      2.437      2.576      2.049          3        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.03it/s]
                 all        112        557     0.0992      0.156     0.0505
0.0175
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    15/1000         0G      2.497      2.528      2.051         14        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557       0.17      0.135     0.0651
0.0193

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    16/1000         0G      2.423      2.531      2.051          7        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.21it/s]
                   all        112        557       0.11      0.115      0.042
0.0129

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    17/1000         0G       2.46      2.667      2.084          2        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.165      0.117     0.0642
0.0231

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    18/1000         0G      2.466      2.586      2.097          5        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.19it/s]
                   all        112        557       0.19      0.201     0.0975
0.0315

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
    19/1000         0G      2.449       2.54      2.079          2        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.05it/s]
                  all        112        557      0.136      0.178     0.0631
0.0181


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    20/1000         0G      2.435      2.534      2.033          3        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.10it/s]
                  all        112        557      0.163      0.154     0.0713
0.0226


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    21/1000         0G      2.413      2.525      2.026         13        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.16it/s]
                  all        112        557      0.158      0.194     0.0814
0.0267


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    22/1000         0G      2.416       2.52      2.043         13        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.05it/s]
                  all        112        557      0.211      0.208     0.0935
0.0309


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    23/1000         0G      2.348      2.504      2.015          1        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.15it/s]
```

```
                 all        112        557      0.158      0.194      0.089
0.0293

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    24/1000         0G      2.361      2.429      2.015          9        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.05it/s]
                 all        112        557       0.14      0.176     0.0734
0.0241

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    25/1000         0G       2.29      2.748      1.922          0        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.16it/s]
                 all        112        557      0.186      0.221      0.101
0.0332

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    26/1000         0G      2.348      2.466      1.984         11        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.18it/s]
                 all        112        557      0.164      0.212     0.0704
0.0229

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    27/1000         0G      2.331      2.419      1.979          8        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                 all        112        557      0.228      0.224      0.133
0.0415
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    28/1000         0G      2.354      2.486      1.978          4        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.18it/s]
                   all        112        557      0.239      0.174      0.102
0.0321

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    29/1000         0G      2.338       2.44      2.001         12        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.18it/s]
                   all        112        557      0.165       0.18     0.0729
0.024

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    30/1000         0G      2.299      2.431       1.98          1        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.07it/s]
                   all        112        557       0.18      0.176     0.0937
0.0291

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    31/1000         0G      2.271      2.458      1.958          4        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                   all        112        557      0.165      0.156     0.0596
0.0192

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
    32/1000         0G      2.284      2.373       1.96         17        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.04it/s]
                  all        112        557      0.243      0.156     0.0826
0.0277


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    33/1000         0G      2.289      2.397      1.961         30        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.21it/s]
                  all        112        557      0.214      0.176      0.116
0.0388


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    34/1000         0G      2.246      2.479      1.936          1        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.14it/s]
                  all        112        557      0.198      0.178     0.0992
0.0309


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    35/1000         0G      2.295      2.412      1.987          3        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.12it/s]
                  all        112        557      0.254      0.199      0.142
0.0471


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    36/1000         0G      2.234      2.366      1.937         18        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
```

```
                 all        112        557      0.229      0.214      0.126
0.0436

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    37/1000         0G      2.231      2.322      1.918          2        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                 all        112        557      0.263      0.223      0.146
0.053

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    38/1000         0G      2.238      2.336      1.911          6        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.21it/s]
                 all        112        557      0.227      0.162        0.1
0.0367

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    39/1000         0G      2.194      2.305      1.909          6        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.17it/s]
                 all        112        557       0.22      0.219      0.113
0.0367

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    40/1000         0G      2.274      2.381      1.955         22        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.23it/s]
                 all        112        557      0.213       0.16      0.108
0.0366
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    41/1000         0G      2.218      2.328      1.894         11        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.20it/s]
                   all        112        557      0.204      0.144     0.0852
0.0274


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    42/1000         0G      2.133      2.604      1.839          0        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.20it/s]
                   all        112        557      0.276      0.215      0.131
0.043


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    43/1000         0G      2.249      2.325      1.905         14        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.20it/s]
                   all        112        557      0.282      0.233      0.168
0.0613


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    44/1000         0G      2.181      2.327      1.894          4        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.22it/s]
                   all        112        557      0.272      0.217      0.153
0.0584


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
    45/1000         0G      2.235      2.354      1.906         13        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.231      0.214      0.146
0.0501

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    46/1000         0G      2.275      2.346      1.937          9        640:
100%|      | 29/29 [00:36<00:00,  1.26s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.24it/s]
                   all        112        557      0.255      0.189      0.117
0.0393

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    47/1000         0G      2.203      2.312      1.907          8        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.228      0.197      0.132
0.044

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    48/1000         0G      2.213      2.333      1.877          2        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.216       0.18      0.131
0.0429

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    49/1000         0G      2.175      2.296      1.869          7        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.22it/s]
```

```
                 all        112        557      0.276      0.237      0.156
0.0539

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    50/1000         0G      2.213      2.274      1.886         12        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                 all        112        557      0.286      0.241      0.172
0.0614

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    51/1000         0G      2.161      2.552      1.814          1        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.23it/s]
                 all        112        557      0.238      0.199      0.116
0.0405

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    52/1000         0G      2.208      2.295      1.912          9        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.19it/s]
                 all        112        557      0.249      0.229      0.152
0.0558

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    53/1000         0G      2.134      2.273      1.872         16        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.20it/s]
                 all        112        557      0.275      0.214      0.146
0.0512
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    54/1000         0G      2.162       2.29      1.864          3        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.23it/s]
                   all        112        557       0.26      0.219      0.169
0.0598

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    55/1000         0G      2.192      2.392      1.923          2        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.261      0.194      0.157
0.0538

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    56/1000         0G      2.189      2.333      1.876          4        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.21it/s]
                   all        112        557      0.254      0.214      0.139
0.0482

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    57/1000         0G      2.145      2.222      1.844          8        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.21it/s]
                   all        112        557      0.218      0.194      0.113
0.0383

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
    58/1000         0G      2.156      2.244      1.846         11        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.22it/s]
                   all        112        557      0.272       0.21      0.151
0.0522

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    59/1000         0G      2.173      2.256      1.857          3        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.24it/s]
                   all        112        557      0.313      0.242       0.19
0.0663

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    60/1000         0G      2.115      2.237      1.845          6        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.21it/s]
                   all        112        557      0.237      0.224      0.133
0.0493

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    61/1000         0G      2.143       2.24      1.838          8        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                   all        112        557      0.297      0.237      0.169
0.0589

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    62/1000         0G      2.131      2.226      1.843          5        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
```

```
                 all        112        557      0.263      0.207      0.148
0.0489

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    63/1000         0G      2.092      2.197      1.799          6        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.21it/s]
                 all        112        557      0.304      0.203      0.155
0.0515

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    64/1000         0G      2.097      2.228      1.835          2        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.19it/s]
                 all        112        557       0.26      0.228      0.165
0.0592

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    65/1000         0G      2.087      2.227      1.822         12        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                 all        112        557      0.275      0.226       0.15
0.052

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    66/1000         0G      2.134       2.15      1.817          9        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.24it/s]
                 all        112        557      0.254      0.215      0.146
0.0543
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    67/1000         0G      2.116      2.216      1.813         16        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.283      0.262      0.183
0.0663

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    68/1000         0G      2.067      2.223      1.804          9        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                   all        112        557      0.298      0.197      0.146
0.0538

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    69/1000         0G      2.206      2.399      1.844          1        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.22it/s]
                   all        112        557      0.276      0.248      0.179
0.0635

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    70/1000         0G      2.149      2.221      1.873          5        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.268      0.227      0.166
0.0613

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
    71/1000         0G      2.101      2.163      1.821          4        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.21it/s]
                   all        112        557      0.263       0.23      0.148
0.0484


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    72/1000         0G      2.099      2.195       1.81          9        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.283      0.208      0.148
0.0501


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    73/1000         0G       2.04      2.198      1.777          3        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.21it/s]
                   all        112        557      0.255      0.202      0.152
0.0537


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    74/1000         0G      2.085      2.211      1.811          5        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.272      0.223       0.16
0.0574


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    75/1000         0G      2.047      2.149       1.78         10        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.19it/s]
```

```
                 all        112        557      0.273       0.23      0.172
0.0605

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    76/1000         0G      2.074      2.154      1.796          8        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.24it/s]
                 all        112        557      0.329      0.278      0.214
0.079

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    77/1000         0G      2.028      2.107      1.758          5        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                 all        112        557      0.301      0.266      0.195
0.0723

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    78/1000         0G      2.119      2.174      1.821          6        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                 all        112        557      0.274      0.239      0.171
0.0634

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    79/1000         0G      2.042      2.147      1.791          3        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                 all        112        557      0.305      0.237      0.167
0.0591
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    80/1000         0G      2.086      2.176      1.814          5        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                   all        112        557      0.278      0.247      0.179
0.0644

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    81/1000         0G      2.117      2.295      1.864          1        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.309      0.224      0.179
0.0665

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    82/1000         0G      2.051      2.139      1.791         14        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.279      0.235      0.189
0.0742

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    83/1000         0G      2.078      2.141      1.801         10        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.334      0.257      0.192
0.0703

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
    84/1000         0G      2.037      2.181      1.768          3        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.294      0.226      0.181
0.062


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    85/1000         0G       2.01       2.08      1.737          9        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:04<00:00,  1.01s/it]
                   all        112        557      0.231      0.206      0.127
0.0417


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    86/1000         0G      2.015      2.069       1.77          8        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.23it/s]
                   all        112        557      0.266      0.226      0.154
0.0574


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    87/1000         0G      2.023      2.064      1.765          6        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                   all        112        557      0.308      0.255      0.212
0.0751


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    88/1000         0G      2.071      2.176       1.79          4        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.20it/s]
```

```
                 all        112        557      0.244      0.201      0.138
0.0449

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    89/1000         0G      2.039      2.126      1.762          6        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                 all        112        557      0.278       0.26      0.166
0.0593

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    90/1000         0G      1.994      2.017      1.747         55        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.21it/s]
                 all        112        557      0.366      0.248      0.206
0.073

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    91/1000         0G      2.021      2.079      1.771          9        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                 all        112        557      0.321      0.257      0.203
0.0786

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    92/1000         0G      2.015      2.084      1.757          5        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.21it/s]
                 all        112        557       0.28       0.24       0.17
0.0606
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    93/1000         0G      1.934      2.019      1.698          4        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.308      0.273      0.188
0.0689

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    94/1000         0G      1.972      2.037      1.737         14        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.304      0.257      0.189
0.0686

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    95/1000         0G      1.989      2.087      1.745          3        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                   all        112        557      0.363      0.233      0.215
0.0826

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    96/1000         0G       1.96      2.018      1.721         10        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                   all        112        557      0.319      0.223      0.174
0.0609

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
    97/1000         0G      2.015      2.041      1.733         21        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                   all        112        557      0.267      0.194      0.141
0.0537


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    98/1000         0G      1.992        2.1      1.786          8        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.262      0.223      0.155
0.0579


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    99/1000         0G      2.002      2.044       1.74         12        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.295      0.242      0.175
0.0642


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   100/1000         0G      1.975      2.181      1.772          1        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.249      0.219      0.145
0.0496


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   101/1000         0G      1.958      1.989      1.698         14        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
```

```
                 all        112        557      0.291       0.21      0.136
0.0451

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   102/1000         0G      1.991      2.061       1.74         10        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                 all        112        557      0.334      0.239      0.191
0.0705

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   103/1000         0G      1.947       2.15      1.723          2        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.24it/s]
                 all        112        557      0.291      0.257      0.173
0.0599

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   104/1000         0G      1.992      2.059      1.722         12        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                 all        112        557      0.374      0.228      0.198
0.0764

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   105/1000         0G      1.977      2.105      1.742         17        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.22it/s]
                 all        112        557      0.311      0.224      0.165
0.0582
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   106/1000         0G      1.942      2.005      1.716          8        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                   all        112        557      0.329      0.215       0.17
0.0637

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   107/1000         0G      1.912      1.999      1.692         14        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                   all        112        557      0.333      0.268      0.182
0.0669

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   108/1000         0G      1.904       1.99      1.685          2        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557       0.27      0.214      0.144
0.0478

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   109/1000         0G      1.909      1.973      1.693          7        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                   all        112        557      0.287      0.258      0.191
0.0678

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   110/1000         0G      1.966      2.056      1.723          2        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                   all        112        557       0.34      0.239      0.187
0.0637


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   111/1000         0G      1.965      2.067      1.696          7        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.311      0.232      0.174
0.0619


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   112/1000         0G      1.926      1.998      1.695         10        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.323      0.232      0.184
0.0609


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   113/1000         0G      1.912      1.928      1.669         13        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.339       0.25        0.2
0.0761


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   114/1000         0G      1.907      2.052      1.697          3        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
```

```
                 all        112        557      0.367      0.246      0.219
0.0855

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   115/1000         0G       1.88      1.902      1.648          5        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                 all        112        557      0.361      0.257        0.2
0.0748

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   116/1000         0G      1.945      1.945       1.68         11        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.23it/s]
                 all        112        557      0.283      0.241       0.18
0.0665

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   117/1000         0G      1.889       1.93      1.672         18        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                 all        112        557      0.318      0.271      0.211
0.0787

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   118/1000         0G      1.926      1.989      1.678          5        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.22it/s]
                 all        112        557      0.366      0.289      0.209
0.0759
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   119/1000         0G      1.896      2.043      1.678          7        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.314      0.287      0.196
0.0726

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   120/1000         0G      1.888       1.93      1.663         14        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                   all        112        557      0.378      0.263      0.191
0.0719

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   121/1000         0G      1.926      1.948      1.695         10        640:
100%|      | 29/29 [00:36<00:00,  1.26s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.321      0.282      0.196
0.0749

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   122/1000         0G      1.938      1.965      1.702          2        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.273      0.197      0.146
0.0517

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   123/1000         0G      1.861      1.887      1.649         24        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                   all        112        557      0.301      0.264      0.185
0.0713

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   124/1000         0G      1.891      1.882      1.661         19        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.329      0.237      0.191
0.0719

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   125/1000         0G      1.903      1.947      1.666         16        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.315      0.251      0.197
0.0752

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   126/1000         0G      1.904       1.91       1.66          4        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.262      0.232      0.159
0.0585

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   127/1000         0G      1.879      1.917      1.651         21        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
```

```
                 all        112        557      0.283      0.192      0.153
0.0507

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   128/1000         0G      1.899      1.931      1.654          3        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                 all        112        557      0.314      0.269      0.223
0.0818

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   129/1000         0G      1.878      1.882      1.654         11        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.22it/s]
                 all        112        557      0.276      0.242      0.176
0.0588

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   130/1000         0G      1.888      1.918      1.666         31        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                 all        112        557      0.317      0.251      0.173
0.0577

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   131/1000         0G       1.84      1.892       1.64          3        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                 all        112        557      0.308      0.271      0.183
0.0652
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   132/1000         0G      1.873      1.838      1.614         11        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.311      0.215      0.181
0.0649

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   133/1000         0G      1.884      1.889      1.653          8        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.301      0.242      0.181
0.0668

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   134/1000         0G      1.859      1.897      1.655          4        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.306      0.226      0.165
0.0567

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   135/1000         0G      1.869      1.894       1.67         13        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.419      0.232      0.223
0.0774

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   136/1000         0G      1.816      2.053      1.575          1        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.321      0.233      0.195
0.0675

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   137/1000         0G      1.892      1.879      1.646         44        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.375      0.233      0.212
0.0732

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   138/1000         0G      1.838      1.947      1.622          1        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.365      0.228      0.201
0.0756

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   139/1000         0G      1.794      1.829      1.597          4        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.338      0.212      0.199
0.0717

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   140/1000         0G       1.83      1.808      1.621          9        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
```

```
                 all        112        557      0.293      0.223      0.166
0.0551

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   141/1000         0G       1.85      1.828      1.633          8        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                 all        112        557      0.316       0.21      0.177
0.0603

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   142/1000         0G      1.834      1.844      1.619          4        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.24it/s]
                 all        112        557      0.275      0.239      0.165
0.0558

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   143/1000         0G      1.803      1.788      1.592         11        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                 all        112        557      0.333      0.246      0.205
0.0803

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   144/1000         0G       1.89      1.868      1.609          6        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                 all        112        557        0.3       0.28      0.195
0.0677
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   145/1000         0G      1.741      2.087      1.538          0        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.345      0.253      0.212
0.0825


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   146/1000         0G      1.816      1.826      1.583          1        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557       0.33      0.243      0.195
0.0685


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   147/1000         0G      1.846       1.88      1.647         12        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.282      0.246      0.188
0.0678


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   148/1000         0G        1.8      1.826      1.584          3        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.355      0.248       0.21
0.0758


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   149/1000         0G      1.824      1.825       1.61          4        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.247      0.231      0.157
0.0534


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   150/1000         0G       1.78      1.783      1.588          6        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.346      0.224      0.184
0.0635


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   151/1000         0G      1.881      1.849      1.644         21        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.24it/s]
                   all        112        557      0.372      0.251      0.204
0.0696


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   152/1000         0G      1.821      1.793      1.593         20        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557       0.31      0.233      0.182
0.0625


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   153/1000         0G      1.806      1.793        1.6         11        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
```

```
                 all        112        557      0.312      0.232      0.179
0.059

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   154/1000         0G      1.811      1.823      1.594         10        640:
100%|      | 29/29 [00:36<00:00,  1.26s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                 all        112        557      0.357      0.255      0.215
0.0715

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   155/1000         0G      1.795      1.818      1.595         16        640:
100%|      | 29/29 [00:38<00:00,  1.34s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.23it/s]
                 all        112        557      0.266      0.217      0.154
0.05

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   156/1000         0G      1.803      1.767       1.58         10        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                 all        112        557      0.329      0.237      0.184
0.0623

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   157/1000         0G      1.782      1.754      1.567         10        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.22it/s]
                 all        112        557      0.306      0.219       0.17
0.059
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   158/1000         0G      1.796       1.77      1.566         10        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.287      0.215      0.157
0.0561

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   159/1000         0G      1.824      1.773      1.593         14        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.274      0.239      0.165
0.0623

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   160/1000         0G      1.834      1.809       1.62          7        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.267      0.266      0.171
0.0624

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   161/1000         0G      1.813      1.792      1.619          6        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.345      0.275      0.222
0.0773

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   162/1000         0G      1.857      1.851      1.602          9        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.342       0.28      0.213
0.0691


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   163/1000         0G      1.752      1.757      1.562          1        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.278      0.226      0.172
0.0628


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   164/1000         0G      1.777      1.767      1.568          5        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.294      0.211      0.157
0.0538


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   165/1000         0G      1.828      1.802      1.601         12        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.319      0.257      0.204
0.0741


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   166/1000         0G      1.765      1.797      1.581          2        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.23it/s]
```

```
                 all        112        557      0.285      0.285      0.181
0.0613

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   167/1000         0G      1.793      1.788      1.599         13        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                 all        112        557      0.342      0.238      0.189
0.0632

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   168/1000         0G      1.795      1.795      1.608          5        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                 all        112        557      0.274      0.262      0.189
0.064

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   169/1000         0G      1.751      1.738      1.556          3        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.335      0.244      0.191
0.0651

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   170/1000         0G      1.765      1.743       1.56          2        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.338      0.273       0.23
0.0854
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   171/1000         0G      1.715      1.696      1.544          4        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.336      0.309      0.223
0.0807

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   172/1000         0G      1.716      1.705      1.533          7        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.356      0.246      0.208
0.0698

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   173/1000         0G      1.737      1.722      1.579          4        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.275      0.285      0.201
0.0708

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   174/1000         0G      1.758      1.749      1.568         19        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.409      0.259      0.232
0.0816

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   175/1000         0G      1.762      1.758      1.543         22        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.307      0.293      0.225
0.0801


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   176/1000         0G      1.789      1.774      1.579         10        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.337      0.282      0.204
0.0751


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   177/1000         0G      1.771      1.738      1.566         26        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.24it/s]
                   all        112        557      0.349      0.278      0.223
0.0797


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   178/1000         0G      1.753      2.035      1.531          1        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.361      0.289      0.226
0.0826


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   179/1000         0G      1.753      1.788      1.559          3        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
```

```
                 all        112        557       0.35      0.246      0.204
0.0767

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   180/1000         0G      1.764      1.737      1.616          1        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.352      0.242      0.183
0.0627

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   181/1000         0G       1.76      1.783      1.582          3        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                 all        112        557      0.423      0.244      0.223
0.0807

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   182/1000         0G      1.732      1.648      1.518          6        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                 all        112        557      0.381      0.266      0.228
0.078

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   183/1000         0G       1.78      1.811      1.586          6        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.344       0.28      0.227
0.0766
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   184/1000         0G       1.71      1.791      1.535          3        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.356      0.242      0.197
0.0752

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   185/1000         0G      1.716      1.659      1.541         29        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.336      0.241       0.19
0.0617

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   186/1000         0G      1.698       1.67      1.525          2        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.341      0.264      0.206
0.0691

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   187/1000         0G      1.712      1.673      1.553          2        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.318      0.235      0.183
0.065

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   188/1000         0G      1.709      1.659      1.534         20        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.298      0.264      0.185
0.0703

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   189/1000         0G      1.726      1.704      1.549         11        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.357      0.237      0.196
0.068

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   190/1000         0G      1.755      1.694      1.569          6        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                   all        112        557      0.396      0.226      0.186
0.0658

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   191/1000         0G      1.641      1.845      1.474          0        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.449      0.264      0.235
0.086

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   192/1000         0G      1.719      1.685      1.545         10        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
```

```
                 all        112        557      0.274      0.242      0.176
0.0614

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   193/1000         0G      1.652       1.63      1.497         10        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                 all        112        557      0.328      0.291      0.204
0.0693

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   194/1000         0G      1.729      1.692      1.546          7        640:
100%|      | 29/29 [00:35<00:00,  1.22s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.388      0.235      0.211
0.0732

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   195/1000         0G      1.717      1.704       1.53          8        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                 all        112        557      0.367      0.248      0.214
0.084

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   196/1000         0G      1.647      1.673      1.483          1        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                 all        112        557      0.372      0.264      0.213
0.0781
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   197/1000         0G       1.67      1.646      1.512         14        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.344      0.262      0.222
0.0759

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   198/1000         0G      1.706      1.697      1.539         13        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.314      0.244      0.196
0.0635

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   199/1000         0G      1.701      1.668      1.512          6        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.354      0.242      0.203
0.0669

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   200/1000         0G      1.689      1.598      1.501          6        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.426      0.217      0.209
0.0719

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   201/1000         0G      1.678      1.632      1.512         13        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.369      0.219      0.196
0.0686

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   202/1000         0G      1.699      1.761      1.534          2        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.356      0.269      0.209
0.0741

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   203/1000         0G      1.631       1.56       1.47         15        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.382      0.239      0.214
0.0773

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   204/1000         0G      1.655      1.615      1.483          5        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.311       0.23      0.186
0.0649

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   205/1000         0G      1.652      1.603      1.485          2        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
```

```
                 all        112        557      0.356      0.287      0.208
0.0741

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   206/1000         0G      1.648      1.578      1.478         10        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                 all        112        557      0.354      0.266      0.208
0.069

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   207/1000         0G       1.67      1.619      1.472         14        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                 all        112        557      0.385      0.215      0.182
0.0582

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   208/1000         0G      1.722      1.701      1.532          3        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                 all        112        557      0.325      0.271      0.189
0.0637

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   209/1000         0G      1.679       1.61      1.498          6        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                 all        112        557      0.365      0.248      0.209
0.0725
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   210/1000         0G      1.594      1.861      1.439          0        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                   all        112        557      0.322      0.259      0.186
0.0638

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   211/1000         0G      1.661      1.602      1.486         12        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.371      0.232      0.207
0.0699

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   212/1000         0G      1.586      1.839       1.43          0        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.361      0.268      0.223
0.0758

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   213/1000         0G      1.669       1.63      1.494          4        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.398      0.289      0.228
0.0783

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   214/1000         0G      1.626      1.527      1.462         11        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557       0.41      0.241      0.209
0.0763


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   215/1000         0G      1.564      1.639      1.406          0        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.367      0.246      0.212
0.0736


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   216/1000         0G      1.644      1.552      1.494          4        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.331      0.285      0.232
0.0827


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   217/1000         0G      1.623      1.538      1.464          9        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.358      0.289      0.219
0.0783


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   218/1000         0G      1.655      1.604      1.496          6        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
```

```
                 all        112        557      0.276      0.287       0.19
0.0687

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   219/1000         0G      1.623       1.62      1.461          2        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                 all        112        557      0.385      0.233      0.195
0.0652

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   220/1000         0G      1.695      1.618      1.525          5        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.322      0.242      0.177
0.0594

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   221/1000         0G      1.665      1.605      1.497         10        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                 all        112        557      0.317      0.219      0.169
0.0589

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   222/1000         0G      1.622      1.566      1.469         17        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                 all        112        557      0.318      0.273      0.191
0.0668
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   223/1000         0G      1.654      1.606      1.485          2        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.315       0.26      0.181
0.0617

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   224/1000         0G      1.749      1.606      1.544          6        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.358       0.26      0.204
0.071

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   225/1000         0G      1.696      1.596        1.5          4        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.342      0.215      0.169
0.0587

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   226/1000         0G      1.643      1.562      1.476          2        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.344      0.257        0.2
0.0753

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   227/1000         0G      1.554      1.455      1.406          1        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.393      0.221      0.185
0.0623

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   228/1000         0G      1.639      1.551      1.474          9        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.403      0.248      0.192
0.069

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   229/1000         0G      1.643      1.566      1.464          6        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.367      0.259      0.214
0.075

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   230/1000         0G      1.612      1.544      1.451          6        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                   all        112        557       0.37      0.273       0.21
0.0721

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   231/1000         0G      1.644       1.59      1.483          9        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
```

```
                 all        112        557      0.356      0.284      0.206
0.0698

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   232/1000         0G      1.597      1.539       1.48          3        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                 all        112        557      0.279      0.244       0.17
0.0609

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   233/1000         0G      1.599       1.52       1.47          2        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                 all        112        557      0.422      0.215      0.203
0.0715

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   234/1000         0G      1.552      1.772      1.397          0        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                 all        112        557      0.363      0.253      0.219
0.0768

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   235/1000         0G      1.579      1.552      1.432          7        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                 all        112        557      0.339      0.244      0.216
0.0742
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   236/1000         0G      1.615      1.571      1.478         20        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.33it/s]
                   all        112        557      0.317      0.273      0.208
0.0737

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   237/1000         0G      1.601      1.491      1.447         30        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.318      0.259      0.193
0.0677

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   238/1000         0G      1.608      1.508      1.447          5        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.33it/s]
                   all        112        557      0.355      0.241      0.193
0.0655

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   239/1000         0G      1.543      1.732      1.405          0        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.307      0.262      0.178
0.0577

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   240/1000         0G      1.667      1.593      1.497         31        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.365      0.276      0.213
0.0679

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   241/1000         0G      1.634      1.534      1.469          5        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.359      0.248      0.206
0.0687

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   242/1000         0G      1.578      1.473      1.432         12        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.327      0.269      0.188
0.0658

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   243/1000         0G      1.604      1.512      1.449         11        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.421      0.224      0.207
0.0712

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   244/1000         0G      1.579      1.506      1.435         10        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
```

```
                 all        112        557      0.348      0.215      0.178
0.0629

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   245/1000         0G      1.574      1.472      1.425         14        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.355      0.242      0.193
0.0635

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   246/1000         0G      1.596      1.501       1.44          9        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.368       0.25      0.194
0.0666

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   247/1000         0G      1.565       1.44      1.402         11        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                 all        112        557       0.36       0.26      0.212
0.0701

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   248/1000         0G       1.59      1.508      1.441          3        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.329      0.217      0.172
0.0603
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   249/1000         0G      1.631      1.577      1.468          2        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.33it/s]
                   all        112        557      0.387       0.23      0.201
0.0747

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   250/1000         0G      1.575      1.492      1.438          8        640:
100%|      | 29/29 [00:35<00:00,  1.22s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                   all        112        557      0.371      0.257      0.193
0.0668

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   251/1000         0G       1.56      1.472      1.415          7        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.292      0.237      0.176
0.0626

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   252/1000         0G      1.596      1.466       1.43         20        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.278      0.276      0.185
0.0629

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   253/1000         0G      1.543      1.449      1.431         14        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.362       0.25      0.193
0.0688


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   254/1000         0G      1.532      1.705      1.419          1        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557        0.4      0.259      0.208
0.0728


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   255/1000         0G      1.609      1.506      1.468          7        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.437      0.244      0.224
0.0794


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   256/1000         0G      1.564      1.483      1.429          9        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.432      0.235      0.221
0.0748


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   257/1000         0G      1.592      1.469      1.458          5        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
```

```
                 all        112        557       0.38      0.248      0.203
0.07

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   258/1000         0G      1.539      1.494      1.419          2        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.406      0.233      0.206
0.0728

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   259/1000         0G      1.565      1.448      1.433         11        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.369      0.262      0.215
0.0757

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   260/1000         0G      1.551      1.434      1.398         15        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                 all        112        557      0.386      0.206      0.188
0.0643

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   261/1000         0G      1.562      1.516      1.408          2        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.28it/s]
                 all        112        557      0.326      0.253      0.198
0.0693
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   262/1000         0G      1.533       1.45      1.396          5        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.331      0.276        0.2
0.0674

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   263/1000         0G      1.566      1.472      1.415          4        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.25it/s]
                   all        112        557      0.319      0.233      0.163
0.056

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   264/1000         0G      1.561      1.481      1.418          3        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.33it/s]
                   all        112        557      0.306      0.287       0.21
0.0691

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   265/1000         0G      1.559      1.478      1.418          7        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.333       0.26      0.194
0.0646

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   266/1000         0G      1.589      1.486      1.435         25        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.312      0.212      0.152
0.0511

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   267/1000         0G      1.601      1.527      1.466          6        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557       0.39      0.233      0.205
0.0683

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   268/1000         0G      1.582      1.494      1.424         10        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.344      0.282      0.209
0.0683

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   269/1000         0G      1.528      1.482        1.4          2        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.307      0.255      0.183
0.06

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   270/1000         0G      1.531      1.441      1.406          5        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
```

```
                 all        112        557      0.343      0.264        0.2
0.0671

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   271/1000         0G       1.53      1.432      1.381          3        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                 all        112        557      0.302      0.248       0.17
0.057

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   272/1000         0G      1.545      1.441       1.41          3        640:
100%|      | 29/29 [00:36<00:00,  1.26s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                 all        112        557      0.337      0.245      0.199
0.069

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   273/1000         0G      1.518      1.394      1.393         13        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.356      0.264      0.202
0.0699

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   274/1000         0G      1.524      1.404      1.419          2        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                 all        112        557      0.345      0.244      0.192
0.0671
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   275/1000         0G      1.549      1.509      1.449         14        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.319      0.285      0.204
0.0707

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   276/1000         0G      1.546      1.448      1.405          5        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.24it/s]
                   all        112        557      0.341      0.233      0.194
0.067

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   277/1000         0G      1.568      1.413      1.401         11        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                   all        112        557      0.345       0.26      0.198
0.0649

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   278/1000         0G      1.586      1.529      1.433          3        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                   all        112        557      0.372      0.257      0.212
0.0699

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
   279/1000         0G       1.53      1.417      1.413          9        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.369      0.259      0.205
0.0699

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   280/1000         0G      1.505      1.391      1.387          4        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.316      0.237      0.171
0.0599

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   281/1000         0G      1.523      1.374      1.396          1        640:
100%|      | 29/29 [00:36<00:00,  1.26s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.372      0.235      0.196
0.0681

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   282/1000         0G      1.522      1.384      1.399          6        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                   all        112        557      0.381      0.242      0.216
0.0757

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   283/1000         0G      1.521      1.353       1.38         13        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
```

```
                 all        112        557       0.49      0.214        0.2
0.0725

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   284/1000         0G      1.521       1.41      1.379          3        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.378       0.25      0.199
0.0707

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   285/1000         0G      1.541      1.442      1.402          5        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                 all        112        557      0.343      0.276      0.212
0.0747

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   286/1000         0G      1.487      1.375      1.364          6        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.32it/s]
                 all        112        557      0.295      0.293      0.206
0.0679

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   287/1000         0G      1.533       1.42      1.405         25        640:
100%|      | 29/29 [00:36<00:00,  1.25s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.29it/s]
                 all        112        557      0.352      0.278      0.213
0.0747
```

```
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   288/1000         0G      1.562      1.438      1.428          8        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.31it/s]
                   all        112        557      0.329      0.237      0.177
0.059


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   289/1000         0G      1.531      1.432      1.434         25        640:
100%|      | 29/29 [00:36<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.26it/s]
                   all        112        557      0.358      0.269      0.206
0.0723


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   290/1000         0G      1.536       1.39      1.407          4        640:
100%|      | 29/29 [00:35<00:00,  1.23s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.30it/s]
                   all        112        557      0.316      0.266      0.189
0.0701


      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
   291/1000         0G      1.448      1.431      1.329          0        640:
100%|      | 29/29 [00:35<00:00,  1.24s/it]
                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:03<00:00,  1.27it/s]
                   all        112        557      0.415      0.244      0.207
0.0741
EarlyStopping: Training stopped early as no improvement observed in
last 100 epochs. Best results observed at epoch 191, best model saved as
best.pt.
To update EarlyStopping(patience=100) pass a new patience value, i.e.
`patience=300` or use `patience=0` to disable EarlyStopping.
```

```
291 epochs completed in 3.191 hours.
Optimizer stripped from
C:\Users\Carlos\Desktop\pepe\yolov8_model6\weights\last.pt, 6.3MB
Optimizer stripped from
C:\Users\Carlos\Desktop\pepe\yolov8_model6\weights\best.pt, 6.3MB

Validating C:\Users\Carlos\Desktop\pepe\yolov8_model6\weights\best.pt…
Ultralytics 8.3.49  Python-3.10.13 torch-2.5.1+cpu CPU (13th Gen Intel Core(TM)
i9-13900KF)
Model summary (fused): 168 layers, 3,005,843 parameters, 0 gradients, 8.1 GFLOPs

                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 4/4 [00:02<00:00,  1.51it/s]

                   all        112        557       0.45      0.265      0.234
0.0859
Speed: 0.4ms preprocess, 15.8ms inference, 0.0ms loss, 0.6ms postprocess per
image
Results saved to C:\Users\Carlos\Desktop\pepe\yolov8_model6
```

[11]:
```
# Cargar el modelo entrenado
modelo = YOLO(r"C:
 ↪\Users\crome\Desktop\TFM\Modelos_Finales\yolov8_model6\weights\best.pt")
```

[12]:
```
from ultralytics import YOLO
import cv2
import matplotlib.pyplot as plt

# Ruta a una imagen de prueba
imagen_prueba = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\images\108FTASK_MAX_2379.
 ↪JPG"

# Realizar la predicción
resultados = modelo(imagen_prueba)

# Dibujar las predicciones sobre la imagen
imagen_con_predicciones = resultados[0].plot()
%matplotlib inline
# Mostrar la imagen con predicciones
plt.figure(figsize=(10, 10))
plt.imshow(cv2.cvtColor(imagen_con_predicciones, cv2.COLOR_BGR2RGB))
plt.axis("off")
plt.show()
```

```
image 1/1 C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\im
ages\108FTASK_MAX_2379.JPG: 480x640 9 turtle_tracks, 61.9ms
Speed: 4.0ms preprocess, 61.9ms inference, 2.0ms postprocess per image at shape
(1, 3, 480, 640)
```

[15]:
```
# Validar el modelo en el conjunto de validación
modelo.val(data=r"C:\Users\crome\Desktop\TFM\Codigo\data.yaml")
```

```
Ultralytics 8.3.39  Python-3.10.4 torch-2.1.0+cpu CPU (Intel Core(TM) i7-10750H
2.60GHz)

val: Scanning C:\Users\crome\Desktop\TFM\Dades\osaconservation\Data
set_Organizado\val\labels… 112 images, 0 backgrounds, 0 corrupt:
100%|      | 112/112 [00:00<00:00, 499.22it/s]

val: New cache created: C:\Users\crome\Desktop\TFM\Dades\osaconserv
ation\Dataset_Organizado\val\labels.cache

                 Class     Images  Instances      Box(P          R      mAP50
mAP50-95): 100%|      | 7/7 [00:08<00:00,  1.22s/it]

                   all        112        557       0.45      0.265      0.234
```

```
0.0859
Speed: 1.1ms preprocess, 57.5ms inference, 0.0ms loss, 1.5ms postprocess per
image
Results saved to runs\detect\val9
```

[15]:
```
ultralytics.utils.metrics.DetMetrics object with attributes:

ap_class_index: array([0])
box: ultralytics.utils.metrics.Metric object
confusion_matrix: <ultralytics.utils.metrics.ConfusionMatrix object at
0x000002B441B312A0>
curves: ['Precision-Recall(B)', 'F1-Confidence(B)', 'Precision-Confidence(B)',
'Recall-Confidence(B)']
curves_results: [[array([          0,    0.001001,    0.002002,    0.003003,
0.004004,    0.005005,    0.006006,    0.007007,    0.008008,    0.009009,
0.01001,    0.011011,    0.012012,    0.013013,    0.014014,    0.015015,
0.016016,    0.017017,    0.018018,    0.019019,     0.02002,    0.021021,
0.022022,    0.023023,
          0.024024,    0.025025,    0.026026,    0.027027,    0.028028,
0.029029,     0.03003,    0.031031,    0.032032,    0.033033,    0.034034,
0.035035,    0.036036,    0.037037,    0.038038,    0.039039,     0.04004,
0.041041,    0.042042,    0.043043,    0.044044,    0.045045,    0.046046,
0.047047,
          0.048048,    0.049049,     0.05005,    0.051051,    0.052052,
0.053053,    0.054054,    0.055055,    0.056056,    0.057057,    0.058058,
0.059059,     0.06006,    0.061061,    0.062062,    0.063063,    0.064064,
0.065065,    0.066066,    0.067067,    0.068068,    0.069069,     0.07007,
0.071071,
          0.072072,    0.073073,    0.074074,    0.075075,    0.076076,
0.077077,    0.078078,    0.079079,     0.08008,    0.081081,    0.082082,
0.083083,    0.084084,    0.085085,    0.086086,    0.087087,    0.088088,
0.089089,     0.09009,    0.091091,    0.092092,    0.093093,    0.094094,
0.095095,
          0.096096,    0.097097,    0.098098,    0.099099,      0.1001,
0.1011,      0.1021,      0.1031,      0.1041,     0.10511,     0.10611,
0.10711,     0.10811,     0.10911,     0.11011,     0.11111,     0.11211,
0.11311,     0.11411,     0.11512,     0.11612,     0.11712,     0.11812,
0.11912,
           0.12012,     0.12112,     0.12212,     0.12312,     0.12412,
0.12513,     0.12613,     0.12713,     0.12813,     0.12913,     0.13013,
0.13113,     0.13213,     0.13313,     0.13413,     0.13514,     0.13614,
0.13714,     0.13814,     0.13914,     0.14014,     0.14114,     0.14214,
0.14314,
           0.14414,     0.14515,     0.14615,     0.14715,     0.14815,
0.14915,     0.15015,     0.15115,     0.15215,     0.15315,     0.15415,
0.15516,     0.15616,     0.15716,     0.15816,     0.15916,     0.16016,
0.16116,     0.16216,     0.16316,     0.16416,     0.16517,     0.16617,
```

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plot: True
results_dict: {'metrics/precision(B)': 0.45011624411097634, 'metrics/recall(B)':
0.26452890363421977, 'metrics/mAP50(B)': 0.23422943002325464,
'metrics/mAP50-95(B)': 0.08585690834331036, 'fitness': 0.1006941605113048}
```

```
save_dir: WindowsPath('runs/detect/val9')
speed: {'preprocess': 1.1174529790878296, 'inference': 57.51746892929077,
'loss': 0.0, 'postprocess': 1.4801046677998133}
task: 'detect'
```

Implementación de U-Net

Porque la detección de huellas de tortugas es un problema de segmentación de instancias, se puede utilizar una arquitectura de red neuronal convolucional (CNN) llamada U-Net. U-Net es una red neuronal convolucional profunda que se utiliza para la segmentación de imágenes. La arquitectura de U-Net consta de un codificador y un decodificador. El codificador es una pila de capas convolucionales que se utilizan para extraer características de la imagen de entrada. El decodificador es una pila de capas convolucionales que se utilizan para generar una máscara de segmentación de la imagen de entrada.

1. Introducción

Este notebook implementa y entrena un modelo U-Net para segmentación de huellas. Sigue los pasos detallados para cargar, preprocesar los datos, definir la arquitectura, entrenar el modelo y evaluarlo.

2. Preparación Inicial

[1]:
```
# Importar librerías necesarias
import os
import numpy as np
import tensorflow as tf
from tensorflow.keras.layers import Input, Conv2D, MaxPooling2D, UpSampling2D,␣
 ↪concatenate
from tensorflow.keras.models import Model
from tensorflow.keras.optimizers import Adam
import cv2
import matplotlib.pyplot as plt

# Configuración inicial
IMAGE_SIZE = 256  # Tamaño al que redimensionaremos las imágenes y máscaras
BATCH_SIZE = 20  # Tamaño del lote
EPOCHS = 50 # Número de épocas
LEARNING_RATE = 1e-4 # Tasa de aprendizaje
```

[29]:
```
import os
import cv2
import numpy as np
import json

# Configuración de directorios
IMAGENES_DIR = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Para_Etiquetar_Huellas\images"
```

```
JSON_DIR = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Para_Etiquetar_Huellas\json"
MASCARAS_DIR = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\masks"

# Crear carpeta para las máscaras si no existe
os.makedirs(MASCARAS_DIR, exist_ok=True)

def crear_mascaras(imagenes_dir, json_dir, mascaras_dir, tamaño=(256, 256)):
    """
    Genera máscaras en escala de grises a partir de archivos JSON.
    """
    for json_file in os.listdir(json_dir):
        if json_file.endswith(".json"):
            ruta_json = os.path.join(json_dir, json_file)
            ruta_imagen = os.path.join(imagenes_dir, json_file.replace(".json",␣
 ↪".jpg"))

            # Leer el archivo JSON
            with open(ruta_json, 'r') as f:
                datos = json.load(f)

            # Leer dimensiones de la imagen
            imagen = cv2.imread(ruta_imagen)
            altura, ancho, _ = imagen.shape

            # Crear una máscara vacía
            mascara = np.zeros((altura, ancho), dtype=np.uint8)

            # Dibujar las líneas o formas en la máscara
            for shape in datos.get("shapes", []):
                if shape["shape_type"] == "linestrip":
                    puntos = np.array(shape["points"], dtype=np.int32)
                    cv2.polylines(mascara, [puntos], isClosed=False, color=255,␣
 ↪thickness=5)

            # Redimensionar la máscara al tamaño deseado
            mascara = cv2.resize(mascara, tamaño, interpolation=cv2.
 ↪INTER_NEAREST)

            # Guardar la máscara
            ruta_mascara = os.path.join(mascaras_dir, json_file.replace(".
 ↪json", ".png"))
            cv2.imwrite(ruta_mascara, mascara)

# Generar máscaras
```

```
crear_mascaras(IMAGENES_DIR, JSON_DIR, MASCARAS_DIR, tamaño=(256, 256))

print(f"Máscaras generadas en: {MASCARAS_DIR}")
```

```
Máscaras generadas en:
C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\masks
```

[25]:
```
# poner maskara en train y val
import os
import shutil

# Configuración de directorios
MASCARAS_DIR = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\masks"
TRAIN_MASKS = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\train\masks"
VAL_MASKS = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\val\masks"

# Crear directorios para las máscaras en train y val
os.makedirs(TRAIN_MASKS, exist_ok=True)
os.makedirs(VAL_MASKS, exist_ok=True)

# Mover las máscaras a train y val
mascaras = os.listdir(MASCARAS_DIR)
for i, mascara in enumerate(mascaras):
    if i % 5 == 0:
        shutil.move(os.path.join(MASCARAS_DIR, mascara), os.path.
 ↪join(VAL_MASKS, mascara))
    else:
        shutil.move(os.path.join(MASCARAS_DIR, mascara), os.path.
 ↪join(TRAIN_MASKS, mascara))

print(f"Máscaras movidas a: {TRAIN_MASKS} y {VAL_MASKS}")
```

```
Máscaras movidas a:
C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\train\masks
y C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\val\masks
```

[27]:
```
import shutil
import random


# Configuración de directorios
DATASET_DIR = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado"
TRAIN_DIR = os.path.join(DATASET_DIR, "train")
```

```
VAL_DIR = os.path.join(DATASET_DIR, "val")

# Crear carpetas de entrenamiento y validación
os.makedirs(os.path.join(TRAIN_DIR, "images"), exist_ok=True)
os.makedirs(os.path.join(TRAIN_DIR, "masks"), exist_ok=True)
os.makedirs(os.path.join(VAL_DIR, "images"), exist_ok=True)
os.makedirs(os.path.join(VAL_DIR, "masks"), exist_ok=True)

# Listar imágenes y máscaras
imagenes = os.listdir(IMAGENES_DIR)
mascaras = os.listdir(MASCARAS_DIR)

# Ordenar y dividir aleatoriamente
random.seed(42)
datos = list(zip(imagenes, mascaras))
random.shuffle(datos)

# Dividir en 80% entrenamiento y 20% validación
split_index = int(len(datos) * 0.8)
train_data = datos[:split_index]
val_data = datos[split_index:]

# Copiar datos
def copiar_datos(datos, destino_imagenes, destino_mascaras):
    for img_file, mask_file in datos:
        shutil.copy(os.path.join(IMAGENES_DIR, img_file), os.path.
 ↪join(destino_imagenes, img_file))
        shutil.copy(os.path.join(MASCARAS_DIR, mask_file), os.path.
 ↪join(destino_mascaras, mask_file))

copiar_datos(train_data, os.path.join(TRAIN_DIR, "images"), os.path.
 ↪join(TRAIN_DIR, "masks"))
copiar_datos(val_data, os.path.join(VAL_DIR, "images"), os.path.join(VAL_DIR,␣
 ↪"masks"))

print("Datos organizados en:")
print(f"- Entrenamiento: {TRAIN_DIR}")
print(f"- Validación: {VAL_DIR}")
```

```
Datos organizados en:
- Entrenamiento:
C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\train
- Validación:
C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\val
```

3. Cargar y Preprocesar los Datos

[1]:
```
import os
import cv2
import numpy as np

IMAGE_SIZE = 256  # Tamaño de las imágenes
TRAIN_DIR = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\train"
VAL_DIR = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\val"

def load_data(image_path, mask_path):
    """
    Carga y preprocesa las imágenes y máscaras.
    """
    images = []
    masks = []

    # Iterar sobre las imágenes en la carpeta
    for img_file in os.listdir(image_path):
        # Construir la ruta de la imagen
        img_path = os.path.join(image_path, img_file)

        # Leer la imagen
        if not os.path.exists(img_path):
            print(f"Imagen no encontrada: {img_path}")
            continue

        img = cv2.imread(img_path, cv2.IMREAD_COLOR)
        if img is None:
            print(f"Error al cargar la imagen: {img_path}")
            continue

        # Construir el nombre y la ruta de la máscara correspondiente
        mask_file = img_file.replace(".jpg", ".png").replace(".jpeg", ".png").
 ↪replace(".JPG", ".png")
        mask_path_full = os.path.join(mask_path, mask_file)

        # Leer la máscara
        if not os.path.exists(mask_path_full):
            print(f"Máscara no encontrada: {mask_path_full}")
            continue

        mask = cv2.imread(mask_path_full, cv2.IMREAD_GRAYSCALE | cv2.
 ↪IMREAD_ANYDEPTH)
        if mask is None:
            print(f"Error al cargar la máscara: {mask_path_full}")
            continue
```

```
        # Redimensionar y normalizar las imágenes y máscaras
        img = cv2.resize(img, (IMAGE_SIZE, IMAGE_SIZE)) / 255.0
        mask = cv2.resize(mask, (IMAGE_SIZE, IMAGE_SIZE)) / 255.0

        # Expandir la dimensión de la máscara para que sea compatible
        mask = np.expand_dims(mask, axis=-1)

        # Agregar la imagen y la máscara a las listas
        images.append(img)
        masks.append(mask)

    return np.array(images), np.array(masks)

# Cargar datos
train_images, train_masks = load_data(TRAIN_DIR + "/images", TRAIN_DIR + "/
 ↪masks")
val_images, val_masks = load_data(VAL_DIR + "/images", VAL_DIR + "/masks")

# Mostrar forma de los datos cargados
print(f"Imágenes de entrenamiento: {train_images.shape}, Máscaras de␣
 ↪entrenamiento: {train_masks.shape}")
print(f"Imágenes de validación: {val_images.shape}, Máscaras de validación:␣
 ↪{val_masks.shape}")
```

```
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\102FTASK_IRX_0726.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\102FTASK_IRX_0742.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\102FTASK_IRX_0762.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\102FTASK_IRX_0790.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\102FTASK_IRX_0801.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\102FTASK_IRX_0829.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\102FTASK_IRX_0872.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\102FTASK_IRX_0905.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\102FTASK_IRX_1001.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\103FTASK_IRX_1085.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\103FTASK_IRX_1138.png
```

```
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\103FTASK_IRX_1196.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\103FTASK_IRX_1268.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\103FTASK_IRX_1299.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\103FTASK_IRX_1346.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\105FTASK_IRX_1449.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\105FTASK_IRX_1474.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\105FTASK_IRX_1530.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\105FTASK_IRX_1606.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\105FTASK_IRX_1664.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\105FTASK_IRX_1707.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\105FTASK_IRX_1733.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\106FTASK_IRX_1782.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\106FTASK_IRX_1809.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\106FTASK_IRX_1867.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\106FTASK_IRX_1874.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\106FTASK_IRX_1953.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\106FTASK_IRX_1998.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\108FTASK_MAX_2160.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\108FTASK_MAX_2178.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\108FTASK_MAX_2317.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\108FTASK_MAX_2343.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\108FTASK_MAX_2360.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\110FTASK_IRX_2532.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\110FTASK_IRX_2778.png
```

```
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\111FTASK_IRX_2831.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\111FTASK_IRX_2875.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\111FTASK_IRX_2979.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\113FTASK_IRX_3252.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\113FTASK_IRX_3416.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\113FTASK_IRX_3439.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\114FTASK_IRX_3613.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\114FTASK_IRX_3672.png
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Organizado\train/masks\114FTASK_IRX_3794.png
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Organizado\train/masks\114FTASK_IRX_3831.png
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Organizado\train/masks\116FTASK_IRX_4067.png
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Organizado\train/masks\116FTASK_IRX_4142.png
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Organizado\train/masks\116FTASK_IRX_4190.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\117FTASK_IRX_1902.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\117FTASK_IRX_1936.png
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Organizado\train/masks\117FTASK_IRX_1982.png
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Organizado\train/masks\117FTASK_IRX_2009.png
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Organizado\train/masks\117FTASK_IRX_2038.png
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Organizado\train/masks\117FTASK_IRX_2081.png
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Organizado\train/masks\117FTASK_IRX_4318.png
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Organizado\train/masks\117FTASK_IRX_4384.png
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Organizado\train/masks\117FTASK_IRX_4438.png
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Organizado\train/masks\117FTASK_IRX_4526.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\117FTASK_IRX_4588.png
```

```
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\118FTASK_IRX_2099.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\118FTASK_IRX_2129.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\119FTASK_IRX_2161.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\119FTASK_IRX_2256.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\119FTASK_IRX_2321.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\119FTASK_IRX_2386.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\119FTASK_IRX_4784.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\119FTASK_IRX_4879.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\120FTASK_IRX_4975.png
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Organizado\train/masks\120FTASK_IRX_5017.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\120FTASK_IRX_5149.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\120FTASK_IRX_5181.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\120FTASK_IRX_5243.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\121FTASK_IRX_2485.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\122FTASK_IRX_2518.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\122FTASK_IRX_2533.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\122FTASK_IRX_2619.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\122FTASK_IRX_2675.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\122FTASK_IRX_2686.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\122FTASK_IRX_2702.png
Máscara no encontrada: C:\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_
Organizado\train/masks\122FTASK_IRX_2773.png
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Imágenes de entrenamiento: (360, 256, 256, 3), Máscaras de entrenamiento: (360,
256, 256, 1)
Imágenes de validación: (24, 256, 256, 3), Máscaras de validación: (24, 256,
256, 1)
```

4. Definir la Arquitectura U-Net

[3]:
```
#Desfasaco
def build_unet(input_size=(256, 256, 3)):
    """
    Construye el modelo U-Net.
    """
    inputs = Input(input_size)

    # Encoder
    c1 = Conv2D(64, (3, 3), activation='relu', padding='same')(inputs)
    c1 = Conv2D(64, (3, 3), activation='relu', padding='same')(c1)
    p1 = MaxPooling2D((2, 2))(c1)

    c2 = Conv2D(128, (3, 3), activation='relu', padding='same')(p1)
    c2 = Conv2D(128, (3, 3), activation='relu', padding='same')(c2)
    p2 = MaxPooling2D((2, 2))(c2)

    c3 = Conv2D(256, (3, 3), activation='relu', padding='same')(p2)
    c3 = Conv2D(256, (3, 3), activation='relu', padding='same')(c3)
    p3 = MaxPooling2D((2, 2))(c3)

    c4 = Conv2D(512, (3, 3), activation='relu', padding='same')(p3)
    c4 = Conv2D(512, (3, 3), activation='relu', padding='same')(c4)
    p4 = MaxPooling2D((2, 2))(c4)

    # Bottleneck
    c5 = Conv2D(1024, (3, 3), activation='relu', padding='same')(p4)
    c5 = Conv2D(1024, (3, 3), activation='relu', padding='same')(c5)

    # Decoder
    u6 = UpSampling2D((2, 2))(c5)
    u6 = concatenate([u6, c4])
    c6 = Conv2D(512, (3, 3), activation='relu', padding='same')(u6)
    c6 = Conv2D(512, (3, 3), activation='relu', padding='same')(c6)

    u7 = UpSampling2D((2, 2))(c6)
    u7 = concatenate([u7, c3])
    c7 = Conv2D(256, (3, 3), activation='relu', padding='same')(u7)
    c7 = Conv2D(256, (3, 3), activation='relu', padding='same')(c7)

    u8 = UpSampling2D((2, 2))(c7)
    u8 = concatenate([u8, c2])
    c8 = Conv2D(128, (3, 3), activation='relu', padding='same')(u8)
    c8 = Conv2D(128, (3, 3), activation='relu', padding='same')(c8)

    u9 = UpSampling2D((2, 2))(c8)
```

```
    u9 = concatenate([u9, c1])
    c9 = Conv2D(64, (3, 3), activation='relu', padding='same')(u9)
    c9 = Conv2D(64, (3, 3), activation='relu', padding='same')(c9)

    outputs = Conv2D(1, (1, 1), activation='sigmoid')(c9)

    model = Model(inputs, outputs)
    return model

# Construir el modelo
model = build_unet()
model.compile(optimizer=Adam(learning_rate=LEARNING_RATE),␣
 ↪loss='binary_crossentropy', metrics=['accuracy'])

# Resumen del modelo
model.summary()
```

```
Model: "model"
__________________________________________________________________________________
__________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================
==================
 input_1 (InputLayer)           [(None, 256, 256, 3  0           []
                                )]

 conv2d (Conv2D)                (None, 256, 256, 64  1792
['input_1[0][0]']
                                )

 conv2d_1 (Conv2D)              (None, 256, 256, 64  36928
['conv2d[0][0]']
                                )

 max_pooling2d (MaxPooling2D)   (None, 128, 128, 64  0
['conv2d_1[0][0]']
                                )

 conv2d_2 (Conv2D)              (None, 128, 128, 12  73856
['max_pooling2d[0][0]']
                                8)

 conv2d_3 (Conv2D)              (None, 128, 128, 12  147584
['conv2d_2[0][0]']
                                8)

 max_pooling2d_1 (MaxPooling2D)  (None, 64, 64, 128)  0
```

```
['conv2d_3[0][0]']

 conv2d_4 (Conv2D)              (None, 64, 64, 256)  295168
['max_pooling2d_1[0][0]']

 conv2d_5 (Conv2D)              (None, 64, 64, 256)  590080
['conv2d_4[0][0]']

__________________________________________________________________________________
__________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================
==================
 input_1 (InputLayer)           [(None, 256, 256, 3  0           []
                                )]

 conv2d (Conv2D)                (None, 256, 256, 64  1792
['input_1[0][0]']
                                )

 conv2d_1 (Conv2D)              (None, 256, 256, 64  36928
['conv2d[0][0]']
                                )

 max_pooling2d (MaxPooling2D)   (None, 128, 128, 64  0
['conv2d_1[0][0]']
                                )

 conv2d_2 (Conv2D)              (None, 128, 128, 12  73856
['max_pooling2d[0][0]']
                                8)

 conv2d_3 (Conv2D)              (None, 128, 128, 12  147584
['conv2d_2[0][0]']
                                8)

 max_pooling2d_1 (MaxPooling2D)  (None, 64, 64, 128)  0
['conv2d_3[0][0]']

 conv2d_4 (Conv2D)              (None, 64, 64, 256)  295168
['max_pooling2d_1[0][0]']

 conv2d_5 (Conv2D)              (None, 64, 64, 256)  590080
['conv2d_4[0][0]']

 max_pooling2d_2 (MaxPooling2D)  (None, 32, 32, 256)  0
['conv2d_5[0][0]']
```

```
 conv2d_6 (Conv2D)              (None, 32, 32, 512)  1180160
['max_pooling2d_2[0][0]']

 conv2d_7 (Conv2D)              (None, 32, 32, 512)  2359808
['conv2d_6[0][0]']

 max_pooling2d_3 (MaxPooling2D)  (None, 16, 16, 512)  0
['conv2d_7[0][0]']

 conv2d_8 (Conv2D)              (None, 16, 16, 1024  4719616
['max_pooling2d_3[0][0]']
                                )

 conv2d_9 (Conv2D)              (None, 16, 16, 1024  9438208
['conv2d_8[0][0]']
                                )

 up_sampling2d (UpSampling2D)   (None, 32, 32, 1024  0
['conv2d_9[0][0]']
                                )

 concatenate (Concatenate)      (None, 32, 32, 1536  0
['up_sampling2d[0][0]',
                                )
'conv2d_7[0][0]']

 conv2d_10 (Conv2D)             (None, 32, 32, 512)  7078400
['concatenate[0][0]']

 conv2d_11 (Conv2D)             (None, 32, 32, 512)  2359808
['conv2d_10[0][0]']

 up_sampling2d_1 (UpSampling2D)  (None, 64, 64, 512)  0
['conv2d_11[0][0]']

 concatenate_1 (Concatenate)    (None, 64, 64, 768)  0
['up_sampling2d_1[0][0]',
'conv2d_5[0][0]']

 conv2d_12 (Conv2D)             (None, 64, 64, 256)  1769728
['concatenate_1[0][0]']

 conv2d_13 (Conv2D)             (None, 64, 64, 256)  590080
['conv2d_12[0][0]']

 up_sampling2d_2 (UpSampling2D)  (None, 128, 128, 25  0
['conv2d_13[0][0]']
                                6)
```

```
 concatenate_2 (Concatenate)    (None, 128, 128, 38  0
['up_sampling2d_2[0][0]',
                                4)
'conv2d_3[0][0]']

 conv2d_14 (Conv2D)             (None, 128, 128, 12  442496
['concatenate_2[0][0]']
                                8)

 conv2d_15 (Conv2D)             (None, 128, 128, 12  147584
['conv2d_14[0][0]']
                                8)

 up_sampling2d_3 (UpSampling2D)  (None, 256, 256, 12  0
['conv2d_15[0][0]']
                                8)

 concatenate_3 (Concatenate)    (None, 256, 256, 19  0
['up_sampling2d_3[0][0]',
                                2)
'conv2d_1[0][0]']

 conv2d_16 (Conv2D)             (None, 256, 256, 64  110656
['concatenate_3[0][0]']
                                )

 conv2d_17 (Conv2D)             (None, 256, 256, 64  36928
['conv2d_16[0][0]']
                                )

 conv2d_18 (Conv2D)             (None, 256, 256, 1)  65
['conv2d_17[0][0]']

==================================================================================
==================
Total params: 31,378,945
Trainable params: 31,378,945
Non-trainable params: 0
----------------------------------------------------------------------------------
------------------
```

[4]:
```
#Nuevo modelo con arquitecura U-Net:
from keras.layers import Input, Conv2D, MaxPooling2D, UpSampling2D,␣
 ↪concatenate, Dropout, BatchNormalization, Add, Multiply,␣
 ↪GlobalAveragePooling2D, Dense, Reshape
from keras.models import Model
```

```
from keras.optimizers import Adam
from keras import backend as K

# Función de pérdida personalizada (Dice Loss)
def perdida_dice(y_real, y_pred):
    numerador = 2 * K.sum(y_real * y_pred)
    denominador = K.sum(y_real + y_pred)
    return 1 - (numerador + 1) / (denominador + 1)

# Bloque Residual
def bloque_residual(x, filtros):
    salto = Conv2D(filtros, (1, 1), activation='relu', padding='same')(x)  #␣
 ↪Asegurar que la forma coincida
    x = Conv2D(filtros, (3, 3), activation='relu', padding='same')(x)
    x = BatchNormalization()(x)
    x = Conv2D(filtros, (3, 3), activation='relu', padding='same')(x)
    x = BatchNormalization()(x)
    return Add()([x, salto])

# Bloque de Atención
def bloque_atencion(tensor_entrada, tensor_gating):
    forma = tensor_entrada.shape[-1]
    atencion = GlobalAveragePooling2D()(tensor_entrada)
    atencion = Dense(forma // 2, activation='relu')(atencion)
    atencion = Dense(forma, activation='sigmoid')(atencion)
    atencion = Reshape((1, 1, forma))(atencion)
    return Multiply()([tensor_entrada, atencion])

# Construcción del modelo U-Net
def construir_unet(tamano_entrada=(256, 256, 3)):
    entradas = Input(tamano_entrada)

    # Ajustar la entrada al número de filtros del primer bloque residual
    inicial = Conv2D(64, (1, 1), activation='relu', padding='same')(entradas)

    # Codificador (Encoder)
    c1 = bloque_residual(inicial, 64)
    p1 = MaxPooling2D((2, 2))(c1)

    c2 = bloque_residual(p1, 128)
    p2 = MaxPooling2D((2, 2))(c2)

    c3 = bloque_residual(p2, 256)
    p3 = MaxPooling2D((2, 2))(c3)

    c4 = bloque_residual(p3, 512)
    p4 = MaxPooling2D((2, 2))(c4)
```

```
    # Bottleneck (cuello de botella)
    c5 = Conv2D(1024, (3, 3), activation='relu', padding='same')(p4)
    c5 = BatchNormalization()(c5)
    c5 = Dropout(0.5)(c5)  # Dropout para reducir sobreajuste
    c5 = Conv2D(1024, (3, 3), activation='relu', padding='same')(c5)
    c5 = BatchNormalization()(c5)

    # Decodificador (Decoder)
    u6 = UpSampling2D((2, 2))(c5)  # Aumentar tamaño
    u6 = bloque_atencion(u6, c4)  # Aplicar atención
    u6 = concatenate([u6, c4])  # Concatenar con la salida del codificador
    c6 = bloque_residual(u6, 512)

    u7 = UpSampling2D((2, 2))(c6)
    u7 = bloque_atencion(u7, c3)
    u7 = concatenate([u7, c3])
    c7 = bloque_residual(u7, 256)

    u8 = UpSampling2D((2, 2))(c7)
    u8 = bloque_atencion(u8, c2)
    u8 = concatenate([u8, c2])
    c8 = bloque_residual(u8, 128)

    u9 = UpSampling2D((2, 2))(c8)
    u9 = bloque_atencion(u9, c1)
    u9 = concatenate([u9, c1])
    c9 = bloque_residual(u9, 64)

    # Salida del modelo
    salidas = Conv2D(1, (1, 1), activation='sigmoid')(c9)

    modelo = Model(entradas, salidas)
    return modelo

# Construcción y compilación del modelo
TASA_APRENDIZAJE = 0.001
modelo = construir_unet()
modelo.compile(optimizer=Adam(learning_rate=TASA_APRENDIZAJE),␣
 ↪loss=perdida_dice, metrics=['accuracy'])

# Resumen del modelo
modelo.summary()
```

```
Model: "model_1"
__________________________________________________________________________________
------------------
```

```
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================
==================
 input_2 (InputLayer)           [(None, 256, 256, 3  0           []
                                )]

 conv2d_19 (Conv2D)             (None, 256, 256, 64  256
['input_2[0][0]']
                                )

 conv2d_21 (Conv2D)             (None, 256, 256, 64  36928
['conv2d_19[0][0]']
                                )

 batch_normalization (BatchNorm  (None, 256, 256, 64  256
['conv2d_21[0][0]']
 alization)                     )

 conv2d_22 (Conv2D)             (None, 256, 256, 64  36928
['batch_normalization[0][0]']
----------------------------------------------------------------------------------
------------------
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================
==================
 input_2 (InputLayer)           [(None, 256, 256, 3  0           []
                                )]

 conv2d_19 (Conv2D)             (None, 256, 256, 64  256
['input_2[0][0]']
                                )

 conv2d_21 (Conv2D)             (None, 256, 256, 64  36928
['conv2d_19[0][0]']
                                )

 batch_normalization (BatchNorm  (None, 256, 256, 64  256
['conv2d_21[0][0]']
 alization)                     )

 conv2d_22 (Conv2D)             (None, 256, 256, 64  36928
['batch_normalization[0][0]']
                                )

 batch_normalization_1 (BatchNo  (None, 256, 256, 64  256
['conv2d_22[0][0]']
 rmalization)                   )
```

```
 conv2d_20 (Conv2D)             (None, 256, 256, 64  4160
['conv2d_19[0][0]']
                                )

 add (Add)                      (None, 256, 256, 64  0
['batch_normalization_1[0][0]',
                                )
'conv2d_20[0][0]']

 max_pooling2d_4 (MaxPooling2D)  (None, 128, 128, 64  0          ['add[0][0]']
                                )

 conv2d_24 (Conv2D)             (None, 128, 128, 12  73856
['max_pooling2d_4[0][0]']
                                8)

 batch_normalization_2 (BatchNo  (None, 128, 128, 12  512
['conv2d_24[0][0]']
 rmalization)                   8)

 conv2d_25 (Conv2D)             (None, 128, 128, 12  147584
['batch_normalization_2[0][0]']
                                8)

 batch_normalization_3 (BatchNo  (None, 128, 128, 12  512
['conv2d_25[0][0]']
 rmalization)                   8)

 conv2d_23 (Conv2D)             (None, 128, 128, 12  8320
['max_pooling2d_4[0][0]']
                                8)

 add_1 (Add)                    (None, 128, 128, 12  0
['batch_normalization_3[0][0]',
                                8)
'conv2d_23[0][0]']

 max_pooling2d_5 (MaxPooling2D)  (None, 64, 64, 128)  0          ['add_1[0][0]']

 conv2d_27 (Conv2D)             (None, 64, 64, 256)  295168
['max_pooling2d_5[0][0]']

 batch_normalization_4 (BatchNo  (None, 64, 64, 256)  1024
['conv2d_27[0][0]']
 rmalization)

 conv2d_28 (Conv2D)             (None, 64, 64, 256)  590080
['batch_normalization_4[0][0]']
```

```
 batch_normalization_5 (BatchNo  (None, 64, 64, 256)  1024
['conv2d_28[0][0]']
 rmalization)

 conv2d_26 (Conv2D)             (None, 64, 64, 256)  33024
['max_pooling2d_5[0][0]']

 add_2 (Add)                    (None, 64, 64, 256)  0
['batch_normalization_5[0][0]',
'conv2d_26[0][0]']

 max_pooling2d_6 (MaxPooling2D)  (None, 32, 32, 256)  0          ['add_2[0][0]']

 conv2d_30 (Conv2D)             (None, 32, 32, 512)  1180160
['max_pooling2d_6[0][0]']

 batch_normalization_6 (BatchNo  (None, 32, 32, 512)  2048
['conv2d_30[0][0]']
 rmalization)

 conv2d_31 (Conv2D)             (None, 32, 32, 512)  2359808
['batch_normalization_6[0][0]']

 batch_normalization_7 (BatchNo  (None, 32, 32, 512)  2048
['conv2d_31[0][0]']
 rmalization)

 conv2d_29 (Conv2D)             (None, 32, 32, 512)  131584
['max_pooling2d_6[0][0]']

 add_3 (Add)                    (None, 32, 32, 512)  0
['batch_normalization_7[0][0]',
'conv2d_29[0][0]']

 max_pooling2d_7 (MaxPooling2D)  (None, 16, 16, 512)  0          ['add_3[0][0]']

 conv2d_32 (Conv2D)             (None, 16, 16, 1024  4719616
['max_pooling2d_7[0][0]']
                                )

 batch_normalization_8 (BatchNo  (None, 16, 16, 1024  4096
['conv2d_32[0][0]']
 rmalization)                   )

 dropout (Dropout)              (None, 16, 16, 1024  0
['batch_normalization_8[0][0]']
                                )
```

```
 conv2d_33 (Conv2D)             (None, 16, 16, 1024  9438208
['dropout[0][0]']
                                )

 batch_normalization_9 (BatchNo  (None, 16, 16, 1024  4096
['conv2d_33[0][0]']
 rmalization)                   )

 up_sampling2d_4 (UpSampling2D)  (None, 32, 32, 1024  0
['batch_normalization_9[0][0]']
                                )

 global_average_pooling2d (Glob  (None, 1024)        0
['up_sampling2d_4[0][0]']
 alAveragePooling2D)

 dense (Dense)                  (None, 512)          524800
['global_average_pooling2d[0][0]'
                                                                  ]

 dense_1 (Dense)                (None, 1024)         525312      ['dense[0][0]']

 reshape (Reshape)              (None, 1, 1, 1024)   0
['dense_1[0][0]']

 multiply (Multiply)            (None, 32, 32, 1024  0
['up_sampling2d_4[0][0]',
                                )
'reshape[0][0]']

 concatenate_4 (Concatenate)    (None, 32, 32, 1536  0
['multiply[0][0]',
                                )                                  'add_3[0][0]']

 conv2d_35 (Conv2D)             (None, 32, 32, 512)  7078400
['concatenate_4[0][0]']

 batch_normalization_10 (BatchN  (None, 32, 32, 512)  2048
['conv2d_35[0][0]']
 ormalization)

 conv2d_36 (Conv2D)             (None, 32, 32, 512)  2359808
['batch_normalization_10[0][0]']

 batch_normalization_11 (BatchN  (None, 32, 32, 512)  2048
['conv2d_36[0][0]']
 ormalization)
```

```
 conv2d_34 (Conv2D)             (None, 32, 32, 512)  786944
['concatenate_4[0][0]']

 add_4 (Add)                    (None, 32, 32, 512)  0
['batch_normalization_11[0][0]',
'conv2d_34[0][0]']

 up_sampling2d_5 (UpSampling2D)  (None, 64, 64, 512)  0          ['add_4[0][0]']

 global_average_pooling2d_1 (Gl  (None, 512)         0
['up_sampling2d_5[0][0]']
 obalAveragePooling2D)

 dense_2 (Dense)                (None, 256)          131328
['global_average_pooling2d_1[0][0
                                                                  ]']

 dense_3 (Dense)                (None, 512)          131584
['dense_2[0][0]']

 reshape_1 (Reshape)            (None, 1, 1, 512)    0
['dense_3[0][0]']

 multiply_1 (Multiply)          (None, 64, 64, 512)  0
['up_sampling2d_5[0][0]',
'reshape_1[0][0]']

 concatenate_5 (Concatenate)    (None, 64, 64, 768)  0
['multiply_1[0][0]',
                                                                   'add_2[0][0]']

 conv2d_38 (Conv2D)             (None, 64, 64, 256)  1769728
['concatenate_5[0][0]']

 batch_normalization_12 (BatchN  (None, 64, 64, 256)  1024
['conv2d_38[0][0]']
 ormalization)

 conv2d_39 (Conv2D)             (None, 64, 64, 256)  590080
['batch_normalization_12[0][0]']

 batch_normalization_13 (BatchN  (None, 64, 64, 256)  1024
['conv2d_39[0][0]']
 ormalization)

 conv2d_37 (Conv2D)             (None, 64, 64, 256)  196864
['concatenate_5[0][0]']
```

```
 add_5 (Add)                    (None, 64, 64, 256)  0
['batch_normalization_13[0][0]',
'conv2d_37[0][0]']

 up_sampling2d_6 (UpSampling2D)  (None, 128, 128, 25  0          ['add_5[0][0]']
                                6)

 global_average_pooling2d_2 (Gl  (None, 256)         0
['up_sampling2d_6[0][0]']
 obalAveragePooling2D)

 dense_4 (Dense)                (None, 128)          32896
['global_average_pooling2d_2[0][0
                                                                  ]']

 dense_5 (Dense)                (None, 256)          33024
['dense_4[0][0]']

 reshape_2 (Reshape)            (None, 1, 1, 256)    0
['dense_5[0][0]']

 multiply_2 (Multiply)          (None, 128, 128, 25  0
['up_sampling2d_6[0][0]',
                                6)
'reshape_2[0][0]']

 concatenate_6 (Concatenate)    (None, 128, 128, 38  0
['multiply_2[0][0]',
                                4)                    'add_1[0][0]']

 conv2d_41 (Conv2D)             (None, 128, 128, 12  442496
['concatenate_6[0][0]']
                                8)

 batch_normalization_14 (BatchN  (None, 128, 128, 12  512
['conv2d_41[0][0]']
 ormalization)                  8)

 conv2d_42 (Conv2D)             (None, 128, 128, 12  147584
['batch_normalization_14[0][0]']
                                8)

 batch_normalization_15 (BatchN  (None, 128, 128, 12  512
['conv2d_42[0][0]']
 ormalization)                  8)

 conv2d_40 (Conv2D)             (None, 128, 128, 12  49280
```

```
['concatenate_6[0][0]']
                                8)

 add_6 (Add)                    (None, 128, 128, 12  0
['batch_normalization_15[0][0]',
                                8)
'conv2d_40[0][0]']

 up_sampling2d_7 (UpSampling2D)  (None, 256, 256, 12  0          ['add_6[0][0]']
                                8)

 global_average_pooling2d_3 (Gl  (None, 128)         0
['up_sampling2d_7[0][0]']
 obalAveragePooling2D)

 dense_6 (Dense)                (None, 64)           8256
['global_average_pooling2d_3[0][0
                                                                  ]']

 dense_7 (Dense)                (None, 128)          8320
['dense_6[0][0]']

 reshape_3 (Reshape)            (None, 1, 1, 128)    0
['dense_7[0][0]']

 multiply_3 (Multiply)          (None, 256, 256, 12  0
['up_sampling2d_7[0][0]',
                                8)
'reshape_3[0][0]']

 concatenate_7 (Concatenate)    (None, 256, 256, 19  0
['multiply_3[0][0]',
                                2)                    'add[0][0]']

 conv2d_44 (Conv2D)             (None, 256, 256, 64  110656
['concatenate_7[0][0]']
                                )

 batch_normalization_16 (BatchN  (None, 256, 256, 64  256
['conv2d_44[0][0]']
 ormalization)                  )

 conv2d_45 (Conv2D)             (None, 256, 256, 64  36928
['batch_normalization_16[0][0]']
                                )

 batch_normalization_17 (BatchN  (None, 256, 256, 64  256
['conv2d_45[0][0]']
```

```
 ormalization)                  )

 conv2d_43 (Conv2D)             (None, 256, 256, 64  12352
['concatenate_7[0][0]']
                                )

 add_7 (Add)                    (None, 256, 256, 64  0
['batch_normalization_17[0][0]',
                                )
'conv2d_43[0][0]']

 conv2d_46 (Conv2D)             (None, 256, 256, 1)  65          ['add_7[0][0]']

==================================================================================
==================
Total params: 34,055,937
Trainable params: 34,044,161
Non-trainable params: 11,776
----------------------------------------------------------------------------------
------------------
```

1. Entrenar el Modelo

[5]:
```
# Entrenar el modelo
#importar ModelCheckpoint
from tensorflow.keras.callbacks import ModelCheckpoint

history = model.fit(
    train_images, train_masks,
    validation_data=(val_images, val_masks),
    batch_size=BATCH_SIZE,
    epochs=EPOCHS,
    #guardar el modelo
    callbacks=[ModelCheckpoint('model.h5', save_best_only=True)]
)
```

```
Epoch 1/50
18/18 [==============================] - 423s 23s/step - loss: 0.3989 -
accuracy: 0.9223 - val_loss: 0.1401 - val_accuracy: 0.9812
Epoch 2/50
18/18 [==============================] - 417s 23s/step - loss: 0.1302 -
accuracy: 0.9787 - val_loss: 0.1065 - val_accuracy: 0.9812
Epoch 3/50
18/18 [==============================] - 418s 23s/step - loss: 0.1109 -
accuracy: 0.9787 - val_loss: 0.1037 - val_accuracy: 0.9812
Epoch 4/50
18/18 [==============================] - 417s 23s/step - loss: 0.1075 -
accuracy: 0.9787 - val_loss: 0.0977 - val_accuracy: 0.9812
```

```
Epoch 5/50
18/18 [==============================] - 419s 23s/step - loss: 0.1052 -
accuracy: 0.9787 - val_loss: 0.0990 - val_accuracy: 0.9812
Epoch 6/50
18/18 [==============================] - 425s 24s/step - loss: 0.1055 -
accuracy: 0.9787 - val_loss: 0.1068 - val_accuracy: 0.9812
Epoch 7/50
18/18 [==============================] - 424s 24s/step - loss: 0.1066 -
accuracy: 0.9787 - val_loss: 0.1032 - val_accuracy: 0.9812
Epoch 8/50
18/18 [==============================] - 422s 23s/step - loss: 0.1037 -
accuracy: 0.9787 - val_loss: 0.0943 - val_accuracy: 0.9812
Epoch 9/50
18/18 [==============================] - 421s 23s/step - loss: 0.1026 -
accuracy: 0.9787 - val_loss: 0.0966 - val_accuracy: 0.9812
Epoch 10/50
18/18 [==============================] - 420s 23s/step - loss: 0.1028 -
accuracy: 0.9787 - val_loss: 0.0932 - val_accuracy: 0.9812
Epoch 11/50
18/18 [==============================] - 464s 26s/step - loss: 0.1016 -
accuracy: 0.9787 - val_loss: 0.0976 - val_accuracy: 0.9812
Epoch 12/50
18/18 [==============================] - 665s 37s/step - loss: 0.1028 -
accuracy: 0.9787 - val_loss: 0.0927 - val_accuracy: 0.9812
Epoch 13/50
18/18 [==============================] - 462s 25s/step - loss: 0.1016 -
accuracy: 0.9787 - val_loss: 0.0986 - val_accuracy: 0.9812
Epoch 14/50
18/18 [==============================] - 415s 23s/step - loss: 0.1049 -
accuracy: 0.9787 - val_loss: 0.0957 - val_accuracy: 0.9812
Epoch 15/50
18/18 [==============================] - 455s 25s/step - loss: 0.1049 -
accuracy: 0.9787 - val_loss: 0.0975 - val_accuracy: 0.9812
Epoch 16/50
18/18 [==============================] - 584s 32s/step - loss: 0.1023 -
accuracy: 0.9787 - val_loss: 0.0968 - val_accuracy: 0.9812
Epoch 17/50
18/18 [==============================] - 416s 23s/step - loss: 0.1025 -
accuracy: 0.9787 - val_loss: 0.0989 - val_accuracy: 0.9812
Epoch 18/50
18/18 [==============================] - 416s 23s/step - loss: 0.1034 -
accuracy: 0.9787 - val_loss: 0.0977 - val_accuracy: 0.9812
Epoch 19/50
18/18 [==============================] - 501s 28s/step - loss: 0.1017 -
accuracy: 0.9787 - val_loss: 0.0942 - val_accuracy: 0.9812
Epoch 20/50
18/18 [==============================] - 621s 34s/step - loss: 0.1022 -
accuracy: 0.9787 - val_loss: 0.0931 - val_accuracy: 0.9812
```

```
Epoch 21/50
18/18 [==============================] - 575s 32s/step - loss: 0.1019 -
accuracy: 0.9787 - val_loss: 0.0935 - val_accuracy: 0.9812
Epoch 22/50
18/18 [==============================] - 567s 32s/step - loss: 0.1017 -
accuracy: 0.9787 - val_loss: 0.0924 - val_accuracy: 0.9812
Epoch 23/50
18/18 [==============================] - 595s 33s/step - loss: 0.1018 -
accuracy: 0.9787 - val_loss: 0.0957 - val_accuracy: 0.9812
Epoch 24/50
18/18 [==============================] - 421s 23s/step - loss: 0.1037 -
accuracy: 0.9787 - val_loss: 0.0935 - val_accuracy: 0.9812
Epoch 25/50
18/18 [==============================] - 455s 25s/step - loss: 0.1010 -
accuracy: 0.9787 - val_loss: 0.0928 - val_accuracy: 0.9812
Epoch 26/50
18/18 [==============================] - 461s 26s/step - loss: 0.1005 -
accuracy: 0.9787 - val_loss: 0.0952 - val_accuracy: 0.9812
Epoch 27/50
18/18 [==============================] - 421s 23s/step - loss: 0.1015 -
accuracy: 0.9787 - val_loss: 0.0937 - val_accuracy: 0.9812
Epoch 28/50
18/18 [==============================] - 425s 24s/step - loss: 0.1014 -
accuracy: 0.9787 - val_loss: 0.0927 - val_accuracy: 0.9812
Epoch 29/50
18/18 [==============================] - 429s 24s/step - loss: 0.1011 -
accuracy: 0.9787 - val_loss: 0.0927 - val_accuracy: 0.9812
Epoch 30/50
18/18 [==============================] - 432s 24s/step - loss: 0.1008 -
accuracy: 0.9787 - val_loss: 0.0921 - val_accuracy: 0.9812
Epoch 31/50
18/18 [==============================] - 439s 24s/step - loss: 0.1003 -
accuracy: 0.9787 - val_loss: 0.0922 - val_accuracy: 0.9812
Epoch 32/50
18/18 [==============================] - 435s 24s/step - loss: 0.1003 -
accuracy: 0.9787 - val_loss: 0.0920 - val_accuracy: 0.9812
Epoch 33/50
18/18 [==============================] - 427s 24s/step - loss: 0.1011 -
accuracy: 0.9787 - val_loss: 0.0935 - val_accuracy: 0.9812
Epoch 34/50
18/18 [==============================] - 428s 24s/step - loss: 0.1016 -
accuracy: 0.9787 - val_loss: 0.0924 - val_accuracy: 0.9812
Epoch 35/50
18/18 [==============================] - 426s 24s/step - loss: 0.1013 -
accuracy: 0.9787 - val_loss: 0.0946 - val_accuracy: 0.9812
Epoch 36/50
18/18 [==============================] - 432s 24s/step - loss: 0.1008 -
accuracy: 0.9787 - val_loss: 0.0928 - val_accuracy: 0.9812
```

```
Epoch 37/50
18/18 [==============================] - 436s 24s/step - loss: 0.1006 -
accuracy: 0.9787 - val_loss: 0.0932 - val_accuracy: 0.9812
Epoch 38/50
18/18 [==============================] - 427s 24s/step - loss: 0.1007 -
accuracy: 0.9787 - val_loss: 0.0922 - val_accuracy: 0.9812
Epoch 39/50
18/18 [==============================] - 428s 24s/step - loss: 0.1001 -
accuracy: 0.9787 - val_loss: 0.0922 - val_accuracy: 0.9812
Epoch 40/50
18/18 [==============================] - 426s 24s/step - loss: 0.1003 -
accuracy: 0.9787 - val_loss: 0.0922 - val_accuracy: 0.9812
Epoch 41/50
18/18 [==============================] - 425s 24s/step - loss: 0.1007 -
accuracy: 0.9787 - val_loss: 0.0937 - val_accuracy: 0.9812
Epoch 42/50
18/18 [==============================] - 430s 24s/step - loss: 0.1007 -
accuracy: 0.9787 - val_loss: 0.0923 - val_accuracy: 0.9812
Epoch 43/50
18/18 [==============================] - 432s 24s/step - loss: 0.1016 -
accuracy: 0.9787 - val_loss: 0.0929 - val_accuracy: 0.9812
Epoch 44/50
18/18 [==============================] - 424s 24s/step - loss: 0.1014 -
accuracy: 0.9787 - val_loss: 0.0928 - val_accuracy: 0.9812
Epoch 45/50
18/18 [==============================] - 423s 23s/step - loss: 0.1005 -
accuracy: 0.9787 - val_loss: 0.0918 - val_accuracy: 0.9812
Epoch 46/50
18/18 [==============================] - 452s 25s/step - loss: 0.0999 -
accuracy: 0.9787 - val_loss: 0.0918 - val_accuracy: 0.9812
Epoch 47/50
18/18 [==============================] - 429s 24s/step - loss: 0.1001 -
accuracy: 0.9787 - val_loss: 0.0928 - val_accuracy: 0.9812
Epoch 48/50
18/18 [==============================] - 413s 23s/step - loss: 0.1002 -
accuracy: 0.9787 - val_loss: 0.0918 - val_accuracy: 0.9812
Epoch 49/50
18/18 [==============================] - 410s 23s/step - loss: 0.0999 -
accuracy: 0.9787 - val_loss: 0.0921 - val_accuracy: 0.9812
Epoch 50/50
18/18 [==============================] - 457s 26s/step - loss: 0.0993 -
accuracy: 0.9787 - val_loss: 0.0912 - val_accuracy: 0.9812
```

[6]:
```python
# guardar modelo
model.save("modelo_unet.h5")

# guardar el modelo entrenado
```

```
model.save("modelo_unet.h5")

# guardar el historial de entrenamiento
import pickle
with open("history_unet.pkl", "wb") as f:
    pickle.dump(history.history, f)
```

[7]:
```
#Validar el modelo

# #Primero matriz de confusión
# from sklearn.metrics import confusion_matrix
# #cargar modelo
# import matplotlib.pyplot as plt
# from keras.models import load_model
# import time
# import numpy as np
# model = load_model("modelo_unet.h5")

# model.summary()

# # cargar el historial de entrenamiento
# import pickle
# with open("history_unet.pkl", "rb") as f:
#     history = pickle.load(f)

# # Predecir máscaras en el conjunto de validación
# predicciones = model.predict(val_images)

# # Convertir las máscaras a valores binarios
# predicciones_binarias = (predicciones > 0.5).astype(np.uint8)

# # Calcular la matriz de confusión
# confusion_matrices = []

# for i in range(len(val_masks)):
#     y_true = val_masks[i].flatten()
#     y_pred = predicciones_binarias[i].flatten()
#     confusion_matrices.append(confusion_matrix(y_true, y_pred))

# # Calcular la matriz de confusión promedio
# confusion_matrix_avg = np.mean(confusion_matrices, axis=0)

# # Mostrar la matriz de confusión promedio
# print("Matriz de confusión promedio:")
# print(confusion_matrix_avg)

# # Segundo métricas de evaluación
```

```
# from sklearn.metrics import accuracy_score, precision_score, recall_score,␣
 ↪f1_score

# # Calcular métricas de evaluación
# accuracy = accuracy_score(y_true, y_pred)
# precision = precision_score(y_true, y_pred)
# recall = recall_score(y_true, y_pred)
# f1 = f1_score(y_true, y_pred)

# # Mostrar métricas de evaluación
# print(f"Precisión: {precision:.4f}")
# print(f"Recall: {recall:.4f}")
# print(f"F1 Score: {f1:.4f}")

# # Tercero visualización de resultados
# import matplotlib.pyplot as plt

# # Seleccionar una muestra aleatoria de índices
# indices = np.random.choice(range(len(val_images)), size=5, replace=False)

# # Mostrar las imágenes y las máscaras correspondientes
# plt.figure(figsize=(15, 10))
# for i, idx in enumerate(indices, 1):
#     # Imagen original
#     plt.subplot(5, 3, 3 * i - 2)
#     plt.imshow(val_images[idx])
#     plt.axis("off")
#     plt.title("Imagen")

#     # Máscara real
#     plt.subplot(5, 3, 3 * i - 1)
#     plt.imshow(val_masks[idx].squeeze(), cmap="gray")
#     plt.axis("off")
#     plt.title("Máscara Real")

#     # Máscara predicha
#     plt.subplot(5, 3, 3 * i)
#     plt.imshow(predicciones_binarias[idx].squeeze(), cmap="gray")
#     plt.axis("off")
#     plt.title("Máscara Predicha")

# plt.tight_layout()
# plt.show()

# Cuarto visualización de métricas
# import matplotlib.pyplot as plt
```

```
# Mostrar la pérdida y la precisión en el entrenamiento y la validación
# plt.figure(figsize=(12, 4))

# plt.subplot(1, 2, 1)
# plt.plot(history.history['loss'], label='Pérdida de entrenamiento')
# plt.plot(history.history['val_loss'], label='Pérdida de validación')
# plt.xlabel('Épocas')

# plt.subplot(1, 2, 2)
# plt.plot(history.history['accuracy'], label='Precisión de entrenamiento')
# plt.plot(history.history['val_accuracy'], label='Precisión de validación')
# plt.xlabel('Épocas')

# plt.legend()
# plt.tight_layout()
# plt.show()

# # Quinto visualización de máscaras
# import matplotlib.pyplot as plt

# # Seleccionar una muestra aleatoria de índices
# indices = np.random.choice(range(len(val_images)), size=5, replace=False)

# # Mostrar las imágenes y las máscaras correspondientes
# plt.figure(figsize=(15, 10))

# # for i, idx in enumerate(indices, 1):
# #     # Imagen original
# #     plt.subplot(5, 3, 3 * i - 2)
# #     plt.imshow(val_images[idx])
# #     plt.axis("off")
# #     plt.title("Imagen")

# #     # Máscara real
# #     plt.subplot(5, 3, 3 * i - 1)
# #     plt.imshow(val_masks[idx].squeeze(), cmap="gray")
# #     plt.axis("off")
# #     plt.title("Máscara Real")

# #     # Máscara predicha
# #     plt.subplot(5, 3, 3 * i)
# #     plt.imshow(predicciones_binarias[idx].squeeze(), cmap="gray")
# #     plt.axis("off")
# #     plt.title("Máscara Predicha")

# plt.tight_layout()
# plt.show()
```

[ ]:
```
# Entrenar el modelo
# history_avanzado = modelo.fit(
#     train_images, train_masks,
#     validation_data=(val_images, val_masks),
#     batch_size=BATCH_SIZE,
#     epochs=EPOCHS
# )
```

6. Evaluar el Modelo

[4]:
```
#cargar modelo
import matplotlib.pyplot as plt
from keras.models import load_model
import time
import numpy as np
model = load_model("modelo_unet.h5")

model.summary()

# cargar el historial de entrenamiento
import pickle
with open("history_unet.pkl", "rb") as f:
    history = pickle.load(f)


# Evaluar en el conjunto de validación
inicio = time.time()
predictions = model.predict(val_images)
fin = time.time()

# Calcular el tiempo de inferencia
tiempo_total_por_frame = fin - inicio

print(f"Tiempo de inferencia: {fin - inicio:.4f} segundos")
fps = len(val_images) / (fin - inicio)
print(f"FPS: {fps:.2f} frames por segundo")


# Mostrar predicciones
def plot_predictions(images, masks, preds, num=5):
    """
    Muestra imágenes, máscaras reales y predicciones.
    """
    for i in range(num):
        plt.figure(figsize=(12, 4))
        plt.subplot(1, 3, 1)
        plt.title("Imagen")
```

```
        plt.imshow(images[i])
        plt.axis('off')

        plt.subplot(1, 3, 2)
        plt.title("Máscara Real")
        plt.imshow(masks[i].squeeze(), cmap='gray')
        plt.axis('off')

        plt.subplot(1, 3, 3)
        plt.title("Predicción")
        plt.imshow(preds[i].squeeze(), cmap='gray')
        plt.axis('off')

        plt.show()

plot_predictions(val_images, val_masks, predictions)

#calculamos las métricas
from sklearn.metrics import accuracy_score, precision_score

# Convertir las máscaras a valores binarios
binary_preds = (predictions > 0.5).astype(np.uint8)

# Calcular métricas
accuracy = accuracy_score(val_masks.flatten(), binary_preds.flatten())

# Mostrar métricas
print(f"Precisión: {accuracy:.4f}")

# Visualizar las métricas
import matplotlib.pyplot as plt

# Mostrar la pérdida y la precisión en el entrenamiento y la validación
plt.figure(figsize=(12, 4))

plt.subplot(1, 2, 1)
plt.plot(history['loss'], label='Pérdida de entrenamiento')
plt.plot(history['val_loss'], label='Pérdida de validación')
plt.xlabel('Épocas')
plt.ylabel('Pérdida')
plt.legend()

plt.subplot(1, 2, 2)
plt.plot(history['accuracy'], label='Precisión de entrenamiento')
plt.plot(history['val_accuracy'], label='Precisión de validación')
plt.xlabel('Épocas')
plt.ylabel('Precisión')
```

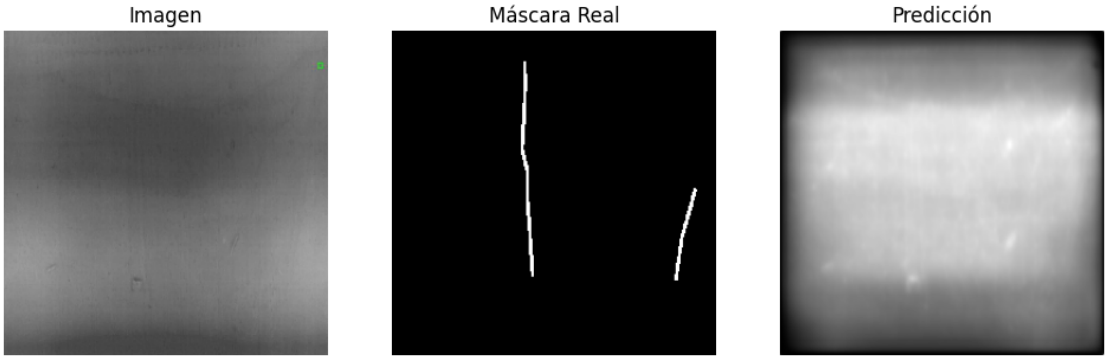
```
plt.legend()

plt.tight_layout()
plt.show()

#matriz de confusión
from sklearn.metrics import confusion_matrix
# Calcular la matriz de confusión
predicciones_binarias = (predictions > 0.5).astype(np.uint8)

confusion_matrices = []

for i in range(len(val_masks)):
    y_true = val_masks[i].flatten()
    y_pred = predicciones_binarias[i].flatten()
    confusion_matrices.append(confusion_matrix(y_true, y_pred))

# Calcular la matriz de confusión promedio
confusion_matrix_avg = np.mean(confusion_matrices, axis=0)

# Mostrar la matriz de confusión promedio
print("Matriz de confusión promedio:")
print(confusion_matrix_avg)
```

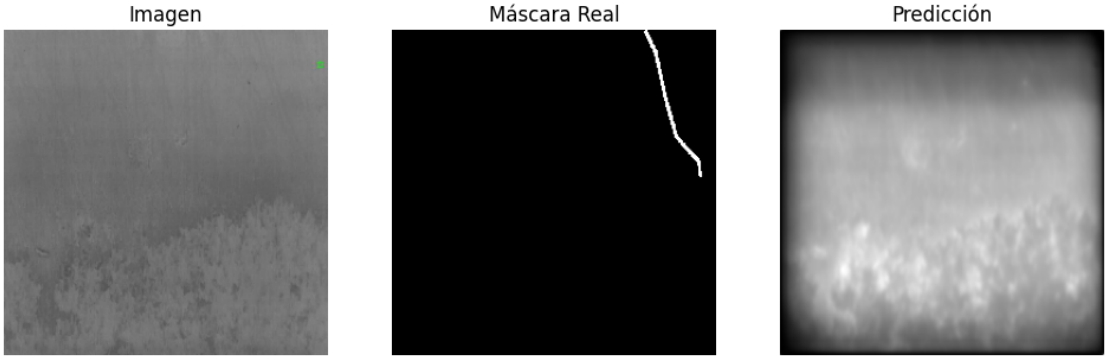
```
Model: "model"
__________________________________________________________________________________
__________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================
==================
 input_1 (InputLayer)           [(None, 256, 256, 3  0           []
                                )]

 conv2d (Conv2D)                (None, 256, 256, 64  1792
['input_1[0][0]']
                                )

 conv2d_1 (Conv2D)              (None, 256, 256, 64  36928
['conv2d[0][0]']
                                )

 max_pooling2d (MaxPooling2D)   (None, 128, 128, 64  0
['conv2d_1[0][0]']
                                )

 conv2d_2 (Conv2D)              (None, 128, 128, 12  73856
['max_pooling2d[0][0]']
```

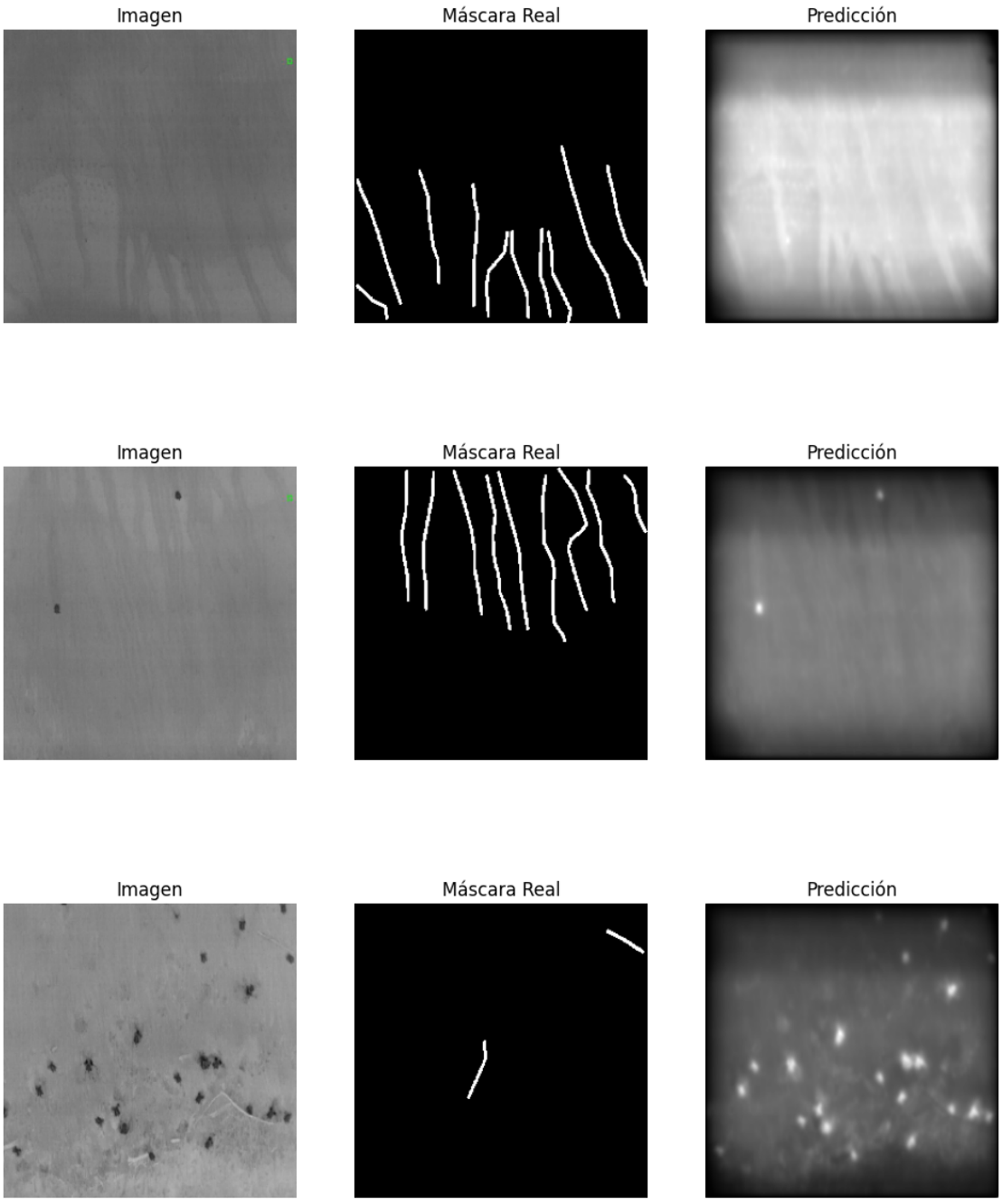
```
                                8)

 conv2d_3 (Conv2D)              (None, 128, 128, 12  147584
['conv2d_2[0][0]']
                                8)

 max_pooling2d_1 (MaxPooling2D)  (None, 64, 64, 128)  0
['conv2d_3[0][0]']

 conv2d_4 (Conv2D)              (None, 64, 64, 256)  295168
['max_pooling2d_1[0][0]']

 conv2d_5 (Conv2D)              (None, 64, 64, 256)  590080
['conv2d_4[0][0]']

 max_pooling2d_2 (MaxPooling2D)  (None, 32, 32, 256)  0
['conv2d_5[0][0]']

 conv2d_6 (Conv2D)              (None, 32, 32, 512)  1180160
['max_pooling2d_2[0][0]']

 conv2d_7 (Conv2D)              (None, 32, 32, 512)  2359808
['conv2d_6[0][0]']

 max_pooling2d_3 (MaxPooling2D)  (None, 16, 16, 512)  0
['conv2d_7[0][0]']

 conv2d_8 (Conv2D)              (None, 16, 16, 1024  4719616
['max_pooling2d_3[0][0]']
                                )

 conv2d_9 (Conv2D)              (None, 16, 16, 1024  9438208
['conv2d_8[0][0]']
                                )

 up_sampling2d (UpSampling2D)   (None, 32, 32, 1024  0
['conv2d_9[0][0]']
                                )

 concatenate (Concatenate)      (None, 32, 32, 1536  0
['up_sampling2d[0][0]',
                                )
'conv2d_7[0][0]']

 conv2d_10 (Conv2D)             (None, 32, 32, 512)  7078400
['concatenate[0][0]']

 conv2d_11 (Conv2D)             (None, 32, 32, 512)  2359808
```

```
['conv2d_10[0][0]']

 up_sampling2d_1 (UpSampling2D)  (None, 64, 64, 512)  0
['conv2d_11[0][0]']

 concatenate_1 (Concatenate)    (None, 64, 64, 768)  0
['up_sampling2d_1[0][0]',
'conv2d_5[0][0]']

 conv2d_12 (Conv2D)             (None, 64, 64, 256)  1769728
['concatenate_1[0][0]']

 conv2d_13 (Conv2D)             (None, 64, 64, 256)  590080
['conv2d_12[0][0]']

 up_sampling2d_2 (UpSampling2D)  (None, 128, 128, 25  0
['conv2d_13[0][0]']
                                6)

 concatenate_2 (Concatenate)    (None, 128, 128, 38  0
['up_sampling2d_2[0][0]',
                                4)
'conv2d_3[0][0]']

 conv2d_14 (Conv2D)             (None, 128, 128, 12  442496
['concatenate_2[0][0]']
                                8)

 conv2d_15 (Conv2D)             (None, 128, 128, 12  147584
['conv2d_14[0][0]']
                                8)

 up_sampling2d_3 (UpSampling2D)  (None, 256, 256, 12  0
['conv2d_15[0][0]']
                                8)

 concatenate_3 (Concatenate)    (None, 256, 256, 19  0
['up_sampling2d_3[0][0]',
                                2)
'conv2d_1[0][0]']

 conv2d_16 (Conv2D)             (None, 256, 256, 64  110656
['concatenate_3[0][0]']
                                )

 conv2d_17 (Conv2D)             (None, 256, 256, 64  36928
['conv2d_16[0][0]']
                                )
```

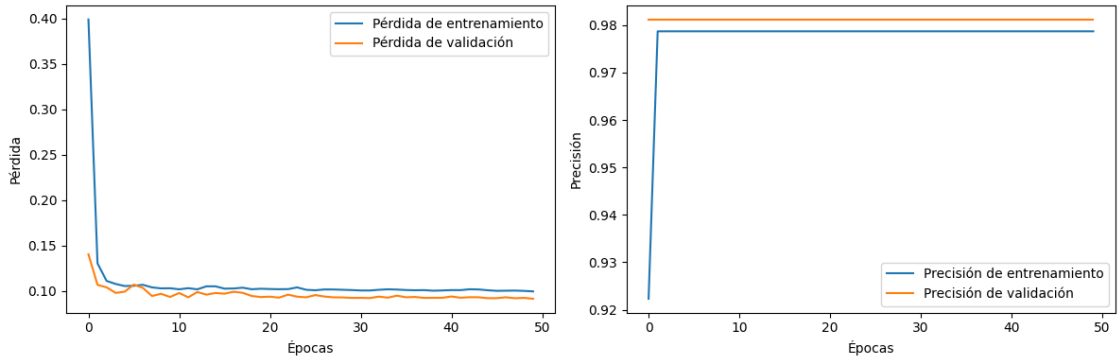
```
 conv2d_18 (Conv2D)             (None, 256, 256, 1)  65
['conv2d_17[0][0]']

==================================================================================
==================
Total params: 31,378,945
Trainable params: 31,378,945
Non-trainable params: 0
----------------------------------------------------------------------------------
------------------
1/1 [==============================] - 13s 13s/step
Tiempo de inferencia: 12.6713 segundos
FPS: 1.89 frames por segundo
```








```
Precisión: 0.9812
```




```
Matriz de confusión promedio:
[[64304.08333333     0.        ]
 [ 1231.91666667     0.        ]]
```

[12]:
```
from tensorflow.keras.preprocessing.image import load_img, img_to_array
import numpy as np
import matplotlib.pyplot as plt

# Cargar la imagen
image_path = r"C:
 ↪\Users\crome\Desktop\TFM\Dades\osaconservation\Dataset_Organizado\images\108FTASK_MAX_2379.
 ↪JPG"
image = load_img(image_path, target_size=(256, 256))  # Asumiendo que el modelo␣
 ↪usa imágenes de 256x256

# Convertir a array y normalizar si es necesario
image_array = img_to_array(image) / 255.0  # Normalización a [0,1] si el modelo␣
 ↪fue entrenado así

# Añadir una dimensión extra para el batch
image_batch = np.expand_dims(image_array, axis=0)

# Realizar la predicción
prediction = model.predict(image_batch)

# Visualizar la imagen y su predicción
plt.figure(figsize=(12, 6))
plt.subplot(1, 2, 1)
plt.title("Imagen de Entrada")
plt.imshow(image_array)
plt.axis('off')

plt.subplot(1, 2, 2)
plt.title("Predicción del Modelo")
```

```
plt.imshow(prediction.squeeze(), cmap='gray')  # Mostrar la predicción
plt.axis('off')

plt.show()
```

```
1/1 [==============================] - 0s 424ms/step
```