License Plate Detection Model Training

Importing necessary libraries and dependencies

In [4]:
```
!pip install opencv-python
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: opencv-python in c:\programdata\anaconda3\lib\site-packages (4.10.0.84)
Requirement already satisfied: numpy>=1.21.2 in c:\programdata\anaconda3\lib\site-packages (from opencv-python) (1.26.4)
```

In [6]:
```
import os
import cv2
import shutil
import numpy as np
import pandas as pd
from glob import glob
import matplotlib.pyplot as plt
import xml.etree.ElementTree as xet
from sklearn.model_selection import train_test_split
```

In [8]:
```
!pip install torch
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: torch in c:\programdata\anaconda3\lib\site-packages (2.3.1)
Requirement already satisfied: filelock in c:\programdata\anaconda3\lib\site-packages (from torch) (3.13.1)
Requirement already satisfied: typing-extensions>=4.8.0 in c:\programdata\anaconda3\lib\site-packages (from torch) (4.11.0)
Requirement already satisfied: sympy in c:\programdata\anaconda3\lib\site-packages (from torch) (1.12)
Requirement already satisfied: networkx in c:\programdata\anaconda3\lib\site-packages (from torch) (3.2.1)
Requirement already satisfied: jinja2 in c:\programdata\anaconda3\lib\site-packages (from torch) (3.1.4)
Requirement already satisfied: fsspec in c:\programdata\anaconda3\lib\site-packages (from torch) (2024.3.1)
Requirement already satisfied: mkl<=2021.4.0,>=2021.1.1 in c:\programdata\anaconda3\lib\site-packages (from torch) (2021.4.0)
Requirement already satisfied: intel-openmp==2021.* in c:\programdata\anaconda3\lib\site-packages (from mkl<=2021.4.0,>=2021.1.1->torch) (2021.4.0)
Requirement already satisfied: tbb==2021.* in c:\programdata\anaconda3\lib\site-packages (from mkl<=2021.4.0,>=2021.1.1->torch) (2021.13.0)
Requirement already satisfied: MarkupSafe>=2.0 in c:\programdata\anaconda3\lib\site-packages (from jinja2->torch) (2.1.3)
Requirement already satisfied: mpmath>=0.19 in c:\programdata\anaconda3\lib\site-packages (from sympy->torch) (1.3.0)
```

Checking if GPU is available for training

In [13]:
```
import torch

print(f'{torch.cuda.is_available() = }')
print(f'{torch.cuda.device_count() = }')
```

```
torch.cuda.is_available() = False
torch.cuda.device_count() = 0
```

In [15]:
```
!pip install ultralytics
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: ultralytics in c:\programdata\anaconda3\lib\site-packages (8.2.50)
Requirement already satisfied: numpy<2.0.0,>=1.23.0 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (1.26.4)
Requirement already satisfied: matplotlib>=3.3.0 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (3.8.4)
Requirement already satisfied: opencv-python>=4.6.0 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (4.10.0.84)
Requirement already satisfied: pillow>=7.1.2 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (10.3.0)
Requirement already satisfied: pyyaml>=5.3.1 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (6.0.1)
Requirement already satisfied: requests>=2.23.0 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (2.32.2)
Requirement already satisfied: scipy>=1.4.1 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (1.13.1)
Requirement already satisfied: torch>=1.8.0 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (2.3.1)
Requirement already satisfied: torchvision>=0.9.0 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (0.18.1)
Requirement already satisfied: tqdm>=4.64.0 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (4.66.4)
Requirement already satisfied: psutil in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (5.9.0)
Requirement already satisfied: py-cpuinfo in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (9.0.0)
Requirement already satisfied: pandas>=1.1.4 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (2.2.2)
Requirement already satisfied: seaborn>=0.11.0 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (0.13.2)
Requirement already satisfied: ultralytics-thop>=2.0.0 in c:\programdata\anaconda3\lib\site-packages (from ultralytics) (2.0.0)
Requirement already satisfied: contourpy>=1.0.1 in c:\programdata\anaconda3\lib\site-packages (from matplotlib>=3.3.0->ultralytics) (1.2.0)
Requirement already satisfied: cycler>=0.10 in c:\programdata\anaconda3\lib\site-packages (from matplotlib>=3.3.0->ultralytics) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in c:\programdata\anaconda3\lib\site-packages (from matplotlib>=3.3.0->ultralytics) (4.51.0)
Requirement already satisfied: kiwisolver>=1.3.1 in c:\programdata\anaconda3\lib\site-packages (from matplotlib>=3.3.0->ultralytics) (1.4.4)
Requirement already satisfied: packaging>=20.0 in c:\programdata\anaconda3\lib\site-packages (from matplotlib>=3.3.0->ultralytics) (23.2)
Requirement already satisfied: pyparsing>=2.3.1 in c:\programdata\anaconda3\lib\site-packages (from matplotlib>=3.3.0->ultralytics) (3.0.9)
Requirement already satisfied: python-dateutil>=2.7 in c:\programdata\anaconda3\lib\site-packages (from matplotlib>=3.3.0->ultralytics) (2.9.0.post0)
Requirement already satisfied: pytz>=2020.1 in c:\programdata\anaconda3\lib\site-packages (from pandas>=1.1.4->ultralytics) (2024.1)
Requirement already satisfied: tzdata>=2022.7 in c:\programdata\anaconda3\lib\site-packages (from pandas>=1.1.4->ultralytics) (2023.3)
Requirement already satisfied: charset-normalizer<4,>=2 in c:\programdata\anaconda3\lib\site-packages (from requests>=2.23.0->ultralytics) (2.0.4)
Requirement already satisfied: idna<4,>=2.5 in c:\programdata\anaconda3\lib\site-packages (from requests>=2.23.0->ultralytics) (3.7)
Requirement already satisfied: urllib3<3,>=1.21.1 in c:\programdata\anaconda3\lib\site-packages (from requests>=2.23.0->ultralytics) (2.2.2)
Requirement already satisfied: certifi>=2017.4.17 in c:\programdata\anaconda3\lib\site-packages (from requests>=2.23.0->ultralytics) (2024.6.2)
Requirement already satisfied: filelock in c:\programdata\anaconda3\lib\site-packages (from torch>=1.8.0->ultralytics) (3.13.1)
Requirement already satisfied: typing-extensions>=4.8.0 in c:\programdata\anaconda3\lib\site-packages (from torch>=1.8.0->ultralytics) (4.11.0)
Requirement already satisfied: sympy in c:\programdata\anaconda3\lib\site-packages (from torch>=1.8.0->ultralytics) (1.12)
Requirement already satisfied: networkx in c:\programdata\anaconda3\lib\site-packages (from torch>=1.8.0->ultralytics) (3.2.1)
Requirement already satisfied: jinja2 in c:\programdata\anaconda3\lib\site-packages (from torch>=1.8.0->ultralytics) (3.1.4)
Requirement already satisfied: fsspec in c:\programdata\anaconda3\lib\site-packages (from torch>=1.8.0->ultralytics) (2024.3.1)
Requirement already satisfied: mkl<=2021.4.0,>=2021.1.1 in c:\programdata\anaconda3\lib\site-packages (from torch>=1.8.0->ultralytics) (2021.4.0)
Requirement already satisfied: colorama in c:\programdata\anaconda3\lib\site-packages (from tqdm>=4.64.0->ultralytics) (0.4.6)
Requirement already satisfied: intel-openmp==2021.* in c:\programdata\anaconda3\lib\site-packages (from mkl<=2021.4.0,>=2021.1.1->torch>=1.8.0->ultralytics) (2021.4.0)
Requirement already satisfied: tbb==2021.* in c:\programdata\anaconda3\lib\site-packages (from mkl<=2021.4.0,>=2021.1.1->torch>=1.8.0->ultralytics) (2021.13.0)
Requirement already satisfied: six>=1.5 in c:\programdata\anaconda3\lib\site-packages (from python-dateutil>=2.7->matplotlib>=3.3.0->ultralytics) (1.16.0)
Requirement already satisfied: MarkupSafe>=2.0 in c:\programdata\anaconda3\lib\site-packages (from jinja2->torch>=1.8.0->ultralytics) (2.1.3)
Requirement already satisfied: mpmath>=0.19 in c:\programdata\anaconda3\lib\site-packages (from sympy->torch>=1.8.0->ultralytics) (1.3.0)
```

In [17]:
```
!pip install -U ipywidgets
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: ipywidgets in c:\programdata\anaconda3\lib\site-packages (8.1.3)
Requirement already satisfied: comm>=0.1.3 in c:\programdata\anaconda3\lib\site-packages (from ipywidgets) (0.2.1)
Requirement already satisfied: ipython>=6.1.0 in c:\programdata\anaconda3\lib\site-packages (from ipywidgets) (8.25.0)
Requirement already satisfied: traitlets>=4.3.1 in c:\programdata\anaconda3\lib\site-packages (from ipywidgets) (5.14.3)
Requirement already satisfied: widgetsnbextension~=4.0.11 in c:\programdata\anaconda3\lib\site-packages (from ipywidgets) (4.0.11)
Requirement already satisfied: jupyterlab-widgets~=3.0.11 in c:\programdata\anaconda3\lib\site-packages (from ipywidgets) (3.0.11)
Requirement already satisfied: decorator in c:\programdata\anaconda3\lib\site-packages (from ipython>=6.1.0->ipywidgets) (5.1.1)
Requirement already satisfied: jedi>=0.16 in c:\programdata\anaconda3\lib\site-packages (from ipython>=6.1.0->ipywidgets) (0.18.1)
Requirement already satisfied: matplotlib-inline in c:\programdata\anaconda3\lib\site-packages (from ipython>=6.1.0->ipywidgets) (0.1.6)
Requirement already satisfied: prompt-toolkit<3.1.0,>=3.0.41 in c:\programdata\anaconda3\lib\site-packages (from ipython>=6.1.0->ipywidgets) (3.0.43)
Requirement already satisfied: pygments>=2.4.0 in c:\programdata\anaconda3\lib\site-packages (from ipython>=6.1.0->ipywidgets) (2.15.1)
Requirement already satisfied: stack-data in c:\programdata\anaconda3\lib\site-packages (from ipython>=6.1.0->ipywidgets) (0.2.0)
Requirement already satisfied: colorama in c:\programdata\anaconda3\lib\site-packages (from ipython>=6.1.0->ipywidgets) (0.4.6)
Requirement already satisfied: parso<0.9.0,>=0.8.0 in c:\programdata\anaconda3\lib\site-packages (from jedi>=0.16->ipython>=6.1.0->ipywidgets) (0.8.3)
Requirement already satisfied: wcwidth in c:\programdata\anaconda3\lib\site-packages (from prompt-toolkit<3.1.0,>=3.0.41->ipython>=6.1.0->ipywidgets) (0.2.5)
Requirement already satisfied: executing in c:\programdata\anaconda3\lib\site-packages (from stack-data->ipython>=6.1.0->ipywidgets) (0.8.3)
Requirement already satisfied: asttokens in c:\programdata\anaconda3\lib\site-packages (from stack-data->ipython>=6.1.0->ipywidgets) (2.0.5)
Requirement already satisfied: pure-eval in c:\programdata\anaconda3\lib\site-packages (from stack-data->ipython>=6.1.0->ipywidgets) (0.2.2)
Requirement already satisfied: six in c:\programdata\anaconda3\lib\site-packages (from asttokens->stack-data->ipython>=6.1.0->ipywidgets) (1.16.0)
```

Importing data

In [20]:
```
dataset_path = 'archive'
```

Function to extract the first sequence of digits from the given filename string

In [23]:
```
import re

def the_number_in_the_string(filename):
    """
    Extracts the first sequence of digits from the given filename string and returns it as an integer.
    If no digits are found, returns 0.
    """
    # Search for the first occurrence of one or more digits in the filename
    match = re.search(r'(\d+)', filename)

    # If a match is found, return the matched number as an integer
    if match:
        return int(match.group(0))
    # If no match is found, return 0
    else:
        return 0
```

In [25]:
```
labels_dict = dict(
    img_path=[],
    xmin=[],
    xmax=[],
    ymin=[],
    ymax=[],
    img_w=[],
    img_h=[]
)
```

In [27]:
```
# Get the list of XML files from the annotations directory
xml_files = glob(f'{dataset_path}/annotations/*.xml')
```

Processing each XML file

In [30]:
```
for filename in sorted(xml_files, key=the_number_in_the_string):
    # Parse the XML file
    info = xet.parse(filename)
    root = info.getroot()

    # Find the 'object' element in the XML and extract bounding box information
    member_object = root.find('object')
    labels_info = member_object.find('bndbox')
    xmin = int(labels_info.find('xmin').text)
    xmax = int(labels_info.find('xmax').text)
    ymin = int(labels_info.find('ymin').text)
    ymax = int(labels_info.find('ymax').text)

    # Get the image filename and construct the full path to the image
    img_name = root.find('filename').text
    img_path = os.path.join(dataset_path, 'images', img_name)

    # Append the extracted information to the respective lists in the dictionary
    labels_dict['img_path'].append(img_path)
    labels_dict['xmin'].append(xmin)
    labels_dict['xmax'].append(xmax)
    labels_dict['ymin'].append(ymin)
    labels_dict['ymax'].append(ymax)

    # Read the image to get its dimensions
    height, width, _ = cv2.imread(img_path).shape
    labels_dict['img_w'].append(width)
    labels_dict['img_h'].append(height)
```

```
# Convert the dictionary to a pandas DataFrame
alldata = pd.DataFrame(labels_dict)

# Display the DataFrame
alldata
```

Out[30]:

	img_path	xmin	xmax	ymin	ymax	img_w	img_h
0	archive\images\Cars0.png	226	419	125	173	500	268
1	archive\images\Cars1.png	134	262	128	160	400	248
2	archive\images\Cars2.png	229	270	176	193	400	400
3	archive\images\Cars3.png	142	261	128	157	400	225
4	archive\images\Cars4.png	156	503	82	253	590	350
...	...	...	...	...	...	...	...
428	archive\images\Cars428.png	142	258	128	157	400	225
429	archive\images\Cars429.png	86	208	166	195	301	400
430	archive\images\Cars430.png	38	116	159	197	400	225
431	archive\images\Cars431.png	55	343	82	147	400	192
432	archive\images\Cars432.png	95	196	258	284	467	300

433 rows × 7 columns

Train-test split

In [33]:

```
from sklearn.model_selection import train_test_split

# Split the data into training and test sets
# Use 10% of the data for the test set
train, test = train_test_split(alldata, test_size=1/10, random_state=42)

# Split the training data further into training and validation sets
# Use 8/9 of the remaining data for the training set, resulting in an 80/10/10 split overall
train, val = train_test_split(train, train_size=8/9, random_state=42)

# Print the number of samples in each set
print(f'''
      len(train) = {len(train)}
      len(val) = {len(val)}
      len(test) = {len(test)}
''')
```

```
len(train) = 345
len(val) = 44
len(test) = 44
```

Preparing data for model training

In [36]:

```
# Remove the 'datasets' directory if it exists
if os.path.exists('datasets'):
    shutil.rmtree('datasets')
```

In [38]:

```
def make_split_folder_in_yolo_format(split_name, split_df, output_folder):
    """
    Creates a folder structure for a dataset split (train/val/test) in YOLO format.
```

```
    Parameters:
    split_name (str): The name of the split (e.g., 'train', 'val', 'test').
    split_df (pd.DataFrame): The DataFrame containing the data for the split.
    output_folder (str): The root folder where the dataset will be created.

    The function will create 'labels' and 'images' subdirectories under '{output_folder}/cars_license_plate/{split_name}',
    and save the corresponding labels and images in YOLO format.
    """
    labels_path = os.path.join(output_folder, 'cars_license_plate', split_name, 'labels')
    images_path = os.path.join(output_folder, 'cars_license_plate', split_name, 'images')

    # Create directories for labels and images
    os.makedirs(labels_path, exist_ok=True)
    os.makedirs(images_path, exist_ok=True)

    # Iterate over each row in the DataFrame
    for _, row in split_df.iterrows():
        img_name, img_extension = os.path.splitext(os.path.basename(row['img_path']))

        # Calculate YOLO format bounding box coordinates
        x_center = (row['xmin'] + row['xmax']) / 2 / row['img_w']
        y_center = (row['ymin'] + row['ymax']) / 2 / row['img_h']
        width = (row['xmax'] - row['xmin']) / row['img_w']
        height = (row['ymax'] - row['ymin']) / row['img_h']

        # Save the label in YOLO format
        label_path = os.path.join(labels_path, f'{img_name}.txt')
        with open(label_path, 'w') as file:
            file.write(f"0 {x_center:.4f} {y_center:.4f} {width:.4f} {height:.4f}\n")

        # Copy the image to the images directory
        shutil.copy(row['img_path'], os.path.join(images_path, img_name + img_extension))

    print(f"Created '{images_path}' and '{labels_path}'")
```

In [40]:
```
# Create YOLO format folders for train, validation, and test splits
make_split_folder_in_yolo_format("train", train, "datasets")
make_split_folder_in_yolo_format("val", val, "datasets")
make_split_folder_in_yolo_format("test", test, "datasets")
```

```
Created 'datasets\cars_license_plate\train\images' and 'datasets\cars_license_plate\train\labels'
Created 'datasets\cars_license_plate\val\images' and 'datasets\cars_license_plate\val\labels'
Created 'datasets\cars_license_plate\test\images' and 'datasets\cars_license_plate\test\labels'
```

In [42]:
```
# Directory paths
image_dir = 'cars_license_plate_new/train/images'
label_dir = 'cars_license_plate_new/train/labels'
```

In [44]:
```
# Get the first image file
image_files = sorted(os.listdir(image_dir))
first_image_file = image_files[0]

# Construct paths for the image and its corresponding label
image_path = os.path.join(image_dir, first_image_file)
label_path = os.path.join(label_dir, os.path.splitext(first_image_file)[0] + '.txt')

# Load the image using OpenCV
image = cv2.imread(image_path)
# Convert the image from BGR (OpenCV default) to RGB (matplotlib default)
image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

# Read the label file to get bounding box information
with open(label_path, 'r') as f:
    lines = f.readlines()
```

In [46]:
```
# Plot the bounding box on the image
for line in lines:
```

```
    # Parse the label file line to extract bounding box information
    class_id, x_center, y_center, width, height = map(float, line.strip().split())
    img_height, img_width, _ = image.shape

    # Convert YOLO format to bounding box format
    x_center *= img_width
    y_center *= img_height
    width *= img_width
    height *= img_height

    # Calculate the top-left and bottom-right coordinates of the bounding box
    x1 = int(x_center - width / 2)
    y1 = int(y_center - height / 2)
    x2 = int(x_center + width / 2)
    y2 = int(y_center + height / 2)

    # Draw the bounding box on the image using a green rectangle
    cv2.rectangle(image, (x1, y1), (x2, y2), (0, 255, 0), 2)

# Display the image with bounding box using matplotlib
plt.imshow(image)
plt.axis('off')  # Hide the axis
plt.show()  # Display the image
```

In [48]:
```
# Define the content of the datasets.yaml file
datasets_yaml = '''
path: cars_license_plate_new

train: train/images
val: val/images
test: test/images

# number of classes
nc: 1

# class names
names: ['license_plate']
'''

# Write the content to the datasets.yaml file
with open('datasets.yaml', 'w') as file:
    file.write(datasets_yaml)
```

Model Training and Evaluation

In [51]:
```
from ultralytics import YOLO
```

```
model = YOLO('yolov8n.pt')
```

```
Downloading https://github.com/ultralytics/assets/releases/download/v8.2.0/yolov8n.pt to 'yolov8n.pt'...
100%|██████████| 6.23M/6.23M [00:03<00:00, 1.90MB/s]
```

In [53]:
```
model.train(
    data="datasets.yaml",  # Path to the dataset configuration file
    epochs=100,            # Number of training epochs
    batch=16,              # Batch size
    device='cpu',          # Use CPU for training
    imgsz=320,             # Image size (width and height) for training
    cache=True             # Cache images for faster training
)
```

```
New https://pypi.org/project/ultralytics/8.2.52 available  Update with 'pip install -U ultralytics'
Ultralytics YOLOv8.2.50  Python-3.12.3 torch-2.3.1+cpu CPU (AMD Ryzen 7 5800H with Radeon Graphics)
engine\trainer: task=detect, mode=train, model=yolov8n.pt, data=datasets.yaml, epochs=100, time=None, patience=100, batch=16, imgsz=320, save=True, save_period=-1, cache=True, device=cpu, workers=8, project=None, name=train19, 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=False, opset=None, workspace=4, 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, label_smoothing=0.0, 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, auto_augment=randaugment, erasing=0.4, crop_fraction=1.0, cfg=None, tracker=botsort.yaml, save_dir=runs\detect\train19
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, 3011043 parameters, 3011027 gradients, 8.2 GFLOPs

Transferred 319/355 items from pretrained weights
TensorBoard: Start with 'tensorboard --logdir runs\detect\train19', view at http://localhost:6006/
Freezing layer 'model.22.dfl.conv.weight'
train: Scanning C:\Documents\Intel Unnati\7th Jul\cars_license_plate_new\train\labels.cache... 345 images, 0 backgrounds, 0 corrupt: 100%|██████████| 345/345 [00:00<?, ?it/s]
train: Caching images (0.1GB RAM): 100%|██████████| 345/345 [00:00<00:00, 853.42it/s]
val: Scanning C:\Documents\Intel Unnati\7th Jul\cars_license_plate_new\val\labels.cache... 44 images, 0 backgrounds, 0 corrupt: 100%|██████████| 44/44 [00:00<?, ?it/s]
val: Caching images (0.0GB RAM): 100%|██████████| 44/44 [00:00<00:00, 843.20it/s]
Plotting labels to runs\detect\train19\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 320 train, 320 val
Using 0 dataloader workers
Logging results to runs\detect\train19
Starting training for 100 epochs...

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

```
1/100        0G      1.594      2.786      1.257         17        320: 100%|████████| 22/22 [00:22<00:00,  1.04s/it]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.52it/s]
                 all         44         44    0.00352      0.932      0.598       0.27

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
2/100        0G      1.579      1.518      1.137         16        320: 100%|████████| 22/22 [00:21<00:00,  1.02it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.07it/s]
                 all         44         44    0.00463      0.886      0.272       0.15

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
3/100        0G      1.536      1.401      1.154         15        320: 100%|████████| 22/22 [00:21<00:00,  1.02it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.97it/s]
                 all         44         44      0.677      0.295      0.317      0.149

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
4/100        0G      1.526      1.351      1.191         18        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.06it/s]
                 all         44         44      0.733      0.561      0.706      0.372

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
5/100        0G      1.534      1.288      1.187         18        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.09it/s]
                 all         44         44      0.679      0.568      0.629      0.298

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
6/100        0G      1.532      1.272      1.147         21        320: 100%|████████| 22/22 [00:21<00:00,  1.02it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.02it/s]
                 all         44         44      0.882      0.679      0.753      0.359

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
7/100        0G      1.468      1.145      1.156         15        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.05it/s]
                 all         44         44      0.703      0.295      0.357      0.164

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
8/100        0G      1.498      1.134       1.17         23        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.62it/s]
                 all         44         44      0.488      0.591      0.512      0.273

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
9/100        0G      1.456      1.069      1.161         13        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.95it/s]
                 all         44         44      0.834      0.727      0.741      0.402

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
10/100       0G      1.404      1.026       1.12         20        320: 100%|████████| 22/22 [00:21<00:00,  1.02it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.97it/s]
                 all         44         44      0.832      0.705       0.79      0.424

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
11/100       0G      1.371      1.007      1.112         24        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.10it/s]
                 all         44         44      0.812      0.882      0.881      0.506

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
12/100       0G       1.33     0.9416      1.072         21        320: 100%|████████| 22/22 [00:22<00:00,  1.02s/it]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.03it/s]
                 all         44         44      0.892      0.795       0.89       0.43

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
13/100       0G      1.311     0.8927      1.077         20        320: 100%|████████| 22/22 [00:21<00:00,  1.01it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.93it/s]
                 all         44         44      0.859      0.864      0.877      0.423

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
14/100       0G      1.339     0.9124      1.065         19        320: 100%|████████| 22/22 [00:22<00:00,  1.00s/it]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.78it/s]
                 all         44         44      0.824      0.886      0.871      0.471

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
15/100       0G      1.322     0.9129      1.097         14        320: 100%|████████| 22/22 [00:22<00:00,  1.01s/it]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.10it/s]
                 all         44         44      0.919      0.841      0.877      0.462
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      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    16/100         0G       1.32     0.8965       1.11         15        320: 100%|████████| 22/22 [00:22<00:00,  1.04s/it]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.01it/s]
                   all         44         44      0.822      0.818       0.79      0.408

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    17/100         0G      1.309      0.867      1.081         16        320: 100%|████████| 22/22 [00:22<00:00,  1.04s/it]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.08it/s]
                   all         44         44      0.914      0.795      0.844      0.438

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    18/100         0G      1.309     0.8775      1.105         15        320: 100%|████████| 22/22 [00:21<00:00,  1.00it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.10it/s]
                   all         44         44      0.846      0.871      0.866      0.499

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    19/100         0G      1.314      0.839      1.096         15        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.13it/s]
                   all         44         44      0.916      0.886      0.883      0.491

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    20/100         0G      1.239     0.8222      1.053         15        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.09it/s]
                   all         44         44      0.874      0.864      0.913      0.472

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    21/100         0G      1.193     0.7636      1.034         22        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.11it/s]
                   all         44         44      0.948      0.834      0.892      0.484

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    22/100         0G      1.184     0.7828      1.035         13        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.03it/s]
                   all         44         44      0.848      0.909       0.89       0.46

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    23/100         0G      1.159     0.7422      1.032         21        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.96it/s]
                   all         44         44      0.872      0.841      0.884      0.485

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    24/100         0G      1.118     0.7352      1.023         21        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.06it/s]
                   all         44         44      0.901      0.864       0.89      0.459

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    25/100         0G      1.212     0.7647      1.035         15        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.10it/s]
                   all         44         44      0.946        0.8      0.893      0.464

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    26/100         0G      1.165     0.7393      1.026         20        320: 100%|████████| 22/22 [00:22<00:00,  1.01s/it]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.96it/s]
                   all         44         44      0.946      0.792      0.875      0.477

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    27/100         0G      1.137     0.7245      1.024         12        320: 100%|████████| 22/22 [00:22<00:00,  1.02s/it]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.95it/s]
                   all         44         44      0.929      0.795      0.864      0.478

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    28/100         0G      1.126     0.7225      1.016         16        320: 100%|████████| 22/22 [00:22<00:00,  1.02s/it]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.07it/s]
                   all         44         44      0.901      0.828      0.887      0.466

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    29/100         0G      1.121     0.6994      1.002         24        320: 100%|████████| 22/22 [00:21<00:00,  1.02it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.08it/s]
                   all         44         44      0.906      0.909      0.939      0.513

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    30/100         0G      1.093     0.6998     0.9954         16        320: 100%|████████| 22/22 [00:21<00:00,  1.02it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.09it/s]
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                 all         44         44      0.885      0.909      0.895      0.518

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     31/100         0G      1.108     0.6991      1.016         18        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.10it/s]
                  all         44         44      0.902      0.832      0.885      0.513

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     32/100         0G      1.094     0.6919      1.004         13        320: 100%|██████████| 22/22 [00:21<00:00,  1.01it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.05it/s]
                  all         44         44      0.826      0.864      0.885      0.504

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     33/100         0G      1.079      0.686     0.9867         20        320: 100%|██████████| 22/22 [00:22<00:00,  1.01s/it]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.09it/s]
                  all         44         44      0.957      0.841       0.93      0.483

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     34/100         0G       1.05     0.6576     0.9923         17        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:01<00:00,  1.92it/s]
                  all         44         44      0.939      0.864       0.91      0.504

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     35/100         0G      1.053     0.6701      0.975         16        320: 100%|██████████| 22/22 [00:21<00:00,  1.02it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.10it/s]
                  all         44         44      0.894      0.818      0.891      0.502

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     36/100         0G      1.081      0.667      1.002         12        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:01<00:00,  1.96it/s]
                  all         44         44      0.907      0.882      0.901      0.486

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     37/100         0G      1.092     0.6963      1.017         17        320: 100%|██████████| 22/22 [00:22<00:00,  1.00s/it]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.05it/s]
                  all         44         44      0.907      0.864      0.907      0.489

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     38/100         0G      1.092     0.6777      1.004         18        320: 100%|██████████| 22/22 [00:23<00:00,  1.08s/it]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:01<00:00,  1.74it/s]
                  all         44         44      0.965      0.886      0.919       0.48

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     39/100         0G      1.038      0.631     0.9707         16        320: 100%|██████████| 22/22 [00:22<00:00,  1.01s/it]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:01<00:00,  1.83it/s]
                  all         44         44      0.968      0.886      0.913      0.456

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     40/100         0G      1.043     0.6512      0.979         15        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.01it/s]
                  all         44         44      0.942      0.841       0.92      0.511

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     41/100         0G      1.052     0.6469      0.986         16        320: 100%|██████████| 22/22 [00:22<00:00,  1.01s/it]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.09it/s]
                  all         44         44      0.906      0.878      0.918      0.465

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     42/100         0G      1.018     0.6178     0.9888         20        320: 100%|██████████| 22/22 [00:21<00:00,  1.00it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.01it/s]
                  all         44         44      0.901      0.886      0.904      0.471

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     43/100         0G      1.027     0.6354      1.001         14        320: 100%|██████████| 22/22 [00:21<00:00,  1.01it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.11it/s]
                  all         44         44      0.864      0.909      0.921      0.481

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     44/100         0G     0.9997     0.6243     0.9782         17        320: 100%|██████████| 22/22 [00:21<00:00,  1.02it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.08it/s]
                  all         44         44      0.979      0.841      0.946      0.502

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

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45/100         0G      1.018     0.6106     0.9723         13        320: 100%|████████| 22/22 [00:21<00:00,  1.02it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.09it/s]
                 all         44         44      0.865      0.909      0.937      0.501

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
46/100         0G      1.021     0.6275     0.9809         21        320: 100%|████████| 22/22 [00:21<00:00,  1.01it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.08it/s]
                 all         44         44      0.951      0.883      0.938      0.504

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
47/100         0G     0.9959     0.6146     0.9574         12        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.11it/s]
                 all         44         44      0.951      0.882      0.926      0.518

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
48/100         0G      1.032     0.6227     0.9625         17        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.07it/s]
                 all         44         44      0.846      0.932      0.937      0.527

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
49/100         0G     0.9399     0.5842     0.9562         22        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.04it/s]
                 all         44         44       0.85      0.901      0.923      0.514

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
50/100         0G     0.9598     0.5801     0.9622         17        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.09it/s]
                 all         44         44      0.882      0.848      0.901      0.503

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
51/100         0G     0.9702     0.5745     0.9626         15        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.08it/s]
                 all         44         44      0.884      0.868      0.924      0.498

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
52/100         0G     0.9914     0.5738     0.9571         16        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.09it/s]
                 all         44         44       0.88      0.886      0.923      0.495

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
53/100         0G      0.936     0.5642     0.9431         15        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.10it/s]
                 all         44         44      0.895      0.886      0.919      0.521

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
54/100         0G     0.9161     0.5534     0.9469         16        320: 100%|████████| 22/22 [00:21<00:00,  1.01it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.89it/s]
                 all         44         44      0.842      0.886      0.921      0.531

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
55/100         0G     0.9298     0.5598     0.9424         16        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.09it/s]
                 all         44         44      0.925      0.843      0.929      0.525

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
56/100         0G     0.9411     0.5534     0.9417         19        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.03it/s]
                 all         44         44       0.92      0.909       0.93      0.516

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
57/100         0G     0.9141     0.5605     0.9548         23        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.06it/s]
                 all         44         44      0.925      0.909      0.919      0.496

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
58/100         0G     0.9359     0.5466     0.9403         20        320: 100%|████████| 22/22 [00:21<00:00,  1.01it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.97it/s]
                 all         44         44       0.88      0.841      0.918      0.533

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
59/100         0G     0.9207     0.5741     0.9429         17        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
               Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.10it/s]
                 all         44         44      0.917      0.818      0.918      0.549
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      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    60/100         0G     0.9311     0.5448     0.9368         11        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.08it/s]
                   all         44         44      0.879      0.886      0.933      0.533

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    61/100         0G      0.903     0.5398     0.9373         14        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.12it/s]
                   all         44         44      0.924      0.841      0.932      0.518

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    62/100         0G      0.838     0.5165     0.9353         16        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.11it/s]
                   all         44         44      0.885      0.841      0.897      0.497

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    63/100         0G     0.8803     0.5269     0.9325         19        320: 100%|████████| 22/22 [00:22<00:00,  1.03s/it]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.11it/s]
                   all         44         44      0.918      0.909      0.936      0.513

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    64/100         0G      0.888     0.5474     0.9382         13        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.07it/s]
                   all         44         44        0.9      0.886      0.927      0.485

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    65/100         0G     0.8801     0.5419     0.9461         17        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.04it/s]
                   all         44         44      0.958      0.864      0.928      0.515

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    66/100         0G     0.8885     0.5272     0.9353         13        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.11it/s]
                   all         44         44       0.88      0.909      0.921      0.515

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    67/100         0G     0.8464     0.5289     0.9348         12        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  2.00it/s]
                   all         44         44       0.88      0.909      0.936      0.526

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    68/100         0G     0.8672     0.5234      0.939         18        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.12it/s]
                   all         44         44      0.907      0.888      0.922      0.509

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    69/100         0G     0.8536     0.5172     0.9371         16        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.12it/s]
                   all         44         44      0.888      0.909      0.924      0.505

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    70/100         0G     0.8811     0.5273     0.9352         14        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.11it/s]
                   all         44         44      0.886      0.909      0.935      0.526

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    71/100         0G     0.8502     0.5132     0.9182         18        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.13it/s]
                   all         44         44      0.898      0.886      0.934      0.537

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    72/100         0G     0.8767     0.5215     0.9255         14        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.04it/s]
                   all         44         44      0.909      0.864      0.934       0.52

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    73/100         0G      0.856     0.5127     0.9348         15        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.12it/s]
                   all         44         44      0.869      0.903      0.921      0.526

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
    74/100         0G     0.8285     0.4919     0.9155         14        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.01it/s]
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               all         44         44      0.888      0.903      0.936      0.526

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     75/100         0G     0.8196     0.5036     0.9209         19        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.09it/s]
                  all         44         44      0.908      0.901      0.941      0.541

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     76/100         0G     0.8199     0.4919     0.9132         11        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.10it/s]
                  all         44         44      0.887      0.864      0.935      0.534

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     77/100         0G     0.7854     0.4747     0.9139         22        320: 100%|██████████| 22/22 [00:21<00:00,  1.02it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.13it/s]
                  all         44         44      0.947      0.864      0.936      0.532

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     78/100         0G     0.8061     0.4751      0.918         16        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.12it/s]
                  all         44         44       0.95      0.859      0.938      0.534

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     79/100         0G     0.7829     0.4806     0.9164         17        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.03it/s]
                  all         44         44      0.899      0.909      0.925      0.538

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     80/100         0G     0.8195     0.4784       0.91         16        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.12it/s]
                  all         44         44      0.917      0.886      0.943      0.533

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     81/100         0G     0.7762     0.4836     0.9117         17        320: 100%|██████████| 22/22 [00:21<00:00,  1.02it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.01it/s]
                  all         44         44      0.951      0.881      0.945      0.548

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     82/100         0G     0.7922     0.4702     0.9113         12        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.10it/s]
                  all         44         44      0.928      0.875      0.945      0.547

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     83/100         0G     0.7643     0.4657     0.8988         21        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.05it/s]
                  all         44         44      0.927      0.872      0.934      0.543

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     84/100         0G     0.7421     0.4407     0.9026         19        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.11it/s]
                  all         44         44      0.927       0.87      0.942       0.54

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     85/100         0G     0.7862     0.4687     0.9058         14        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.08it/s]
                  all         44         44      0.951      0.885      0.925      0.531

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     86/100         0G     0.7471     0.4645     0.9049         18        320: 100%|██████████| 22/22 [00:21<00:00,  1.02it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.07it/s]
                  all         44         44      0.951      0.876      0.929      0.539

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     87/100         0G     0.7592     0.4708     0.9141         16        320: 100%|██████████| 22/22 [00:21<00:00,  1.03it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.07it/s]
                  all         44         44      0.935      0.864      0.941      0.538

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     88/100         0G     0.7433     0.4475     0.9071         16        320: 100%|██████████| 22/22 [00:21<00:00,  1.02it/s]
                Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 2/2 [00:01<00:00,  1.98it/s]
                  all         44         44      0.948      0.864      0.943      0.543

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
```

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      89/100         0G     0.7288     0.4428      0.894         19        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.09it/s]
                     all         44         44      0.947      0.864      0.941      0.548

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      90/100         0G     0.7407     0.4416     0.8943         17        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.08it/s]
                     all         44         44      0.945      0.864      0.943      0.549
Closing dataloader mosaic

      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      91/100         0G     0.9923     0.5605     0.9999          9        320: 100%|████████| 22/22 [00:22<00:00,  1.01s/it]
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.78it/s]
                     all         44         44      0.952      0.841      0.933      0.535
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      92/100         0G     0.9761     0.5226      0.989          9        320: 100%|████████| 22/22 [00:23<00:00,  1.06s/it]
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.97it/s]
                     all         44         44       0.95      0.855      0.933       0.55
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      93/100         0G     0.9603     0.5098     0.9773          9        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.10it/s]
                     all         44         44      0.967      0.864      0.944      0.556
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      94/100         0G     0.9583     0.5085     0.9641          9        320: 100%|████████| 22/22 [00:21<00:00,  1.04it/s]
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.11it/s]
                     all         44         44      0.956      0.841      0.943      0.544
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      95/100         0G     0.9543     0.4853     0.9829          9        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.09it/s]
                     all         44         44      0.973      0.822      0.939      0.549
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      96/100         0G     0.9593     0.4987     0.9799          9        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.06it/s]
                     all         44         44      0.949      0.838      0.937      0.548
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      97/100         0G     0.9177     0.4805     0.9647          9        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.02it/s]
                     all         44         44      0.921      0.864      0.934      0.547
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      98/100         0G     0.9341     0.4862     0.9712          9        320: 100%|████████| 22/22 [00:21<00:00,  1.05it/s]
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:01<00:00,  1.92it/s]
                     all         44         44      0.913      0.841      0.932      0.542
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
      99/100         0G     0.9248     0.4716     0.9649          9        320: 100%|████████| 22/22 [00:20<00:00,  1.05it/s]
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.03it/s]
                     all         44         44       0.95      0.863      0.932      0.535
      Epoch    GPU_mem   box_loss   cls_loss   dfl_loss  Instances       Size
     100/100         0G     0.9297     0.4793     0.9668          9        320: 100%|████████| 22/22 [00:21<00:00,  1.03it/s]
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.11it/s]
                     all         44         44      0.948      0.864      0.931       0.54
100 epochs completed in 0.645 hours.
Optimizer stripped from runs\detect\train19\weights\last.pt, 6.2MB
Optimizer stripped from runs\detect\train19\weights\best.pt, 6.2MB

Validating runs\detect\train19\weights\best.pt...
Ultralytics YOLOv8.2.50  Python-3.12.3 torch-2.3.1+cpu CPU (AMD Ryzen 7 5800H with Radeon Graphics)
Model summary (fused): 168 layers, 3005843 parameters, 0 gradients, 8.1 GFLOPs
                   Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|████████| 2/2 [00:00<00:00,  2.31it/s]
                     all         44         44      0.968      0.864      0.944      0.556
Speed: 0.6ms preprocess, 16.9ms inference, 0.0ms loss, 0.2ms postprocess per image
Results saved to runs\detect\train19
```

Out[53]: 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 0x000002CE5D3F2CC0>
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,
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13614,     0.13714,     0.13814,     0.13914,     0.14014,     0.14114,     0.14214,     0.14314,
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85686,      0.85786,     0.85886,     0.85986,     0.86086,     0.86186,     0.86286,     0.86386,
            0.86486,     0.86587,     0.86687,     0.86787,     0.86887,     0.86987,     0.87087,     0.87187,     0.87287,     0.87387,     0.87487,     0.87588,     0.87688,     0.87788,     0.87888,     0.87988,     0.
88088,      0.88188,     0.88288,     0.88388,     0.88488,     0.88589,     0.88689,     0.88789,
            0.88889,     0.88989,     0.89089,     0.89189,     0.89289,     0.89389,     0.89489,      0.8959,      0.8969,      0.8979,      0.8989,      0.8999,      0.9009,      0.9019,      0.9029,      0.9039,
0.9049,      0.90591,     0.90691,     0.90791,     0.90891,     0.90991,     0.91091,     0.91191,
            0.91291,     0.91391,     0.91491,     0.91592,     0.91692,     0.91792,     0.91892,     0.91992,     0.92092,     0.92192,     0.92292,     0.92392,     0.92492,     0.92593,     0.92693,     0.92793,     0.
92893,      0.92993,     0.93093,     0.93193,     0.93293,     0.93393,     0.93493,     0.93594,
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95295,      0.95395,     0.95495,     0.95596,     0.95696,     0.95796,     0.95896,     0.95996,
            0.96096,     0.96196,     0.96296,     0.96396,     0.96496,     0.96597,     0.96697,     0.96797,     0.96897,     0.96997,     0.97097,     0.97197,     0.97297,     0.97397,     0.97497,     0.97598,     0.
97698,      0.97798,     0.97898,     0.97998,     0.98098,     0.98198,     0.98298,     0.98398,
            0.98498,     0.98599,     0.98699,     0.98799,     0.98899,     0.98999,     0.99099,     0.99199,     0.99299,     0.99399,     0.99499,       0.996,       0.997,       0.998,       0.999,           1]), arra
y([[    0.95455,     0.95455,     0.95455,     0.95455,     0.95455,     0.95455,     0.95455,     0.95455,     0.95455,     0.95455,     0.95455,     0.95455,     0.95455,     0.95455,     0.95455,     0.95455,     0.954
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0.88636,     0.88636,     0.88636,     0.88636,     0.88628,     0.88554,     0.88479,
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0.87214,      0.8714,     0.87065,     0.86991,     0.86917,     0.86842,     0.86768,
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0.81531,     0.81448,     0.81364,     0.81281,     0.81198,     0.81115,     0.81031,
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0.79617,     0.79503,     0.79208,     0.78913,     0.78618,     0.78323,     0.78028,
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0.74105,      0.7341,     0.72726,     0.72635,     0.72544,     0.72453,     0.72362,
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0.70818,     0.70727,     0.70636,     0.70545,     0.70449,     0.68438,     0.68018,
             0.67829,     0.67641,     0.67453,     0.67265,     0.67077,     0.66889,     0.66701,     0.66513,     0.66324,     0.66136,     0.65948,     0.65807,     0.65678,     0.65549,     0.65419,      0.6529,
0.65161,     0.65032,     0.64903,     0.64774,     0.64645,     0.64516,     0.64387,
             0.64257,     0.64128,     0.63999,      0.6387,     0.63741,     0.63559,     0.63151,     0.62743,     0.62334,     0.61926,     0.61518,     0.60992,     0.60395,     0.59798,     0.59201,     0.58627,
0.58058,     0.57489,      0.5692,      0.5651,     0.56134,     0.55758,     0.55383,
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0.32165,     0.31362,     0.30764,     0.30166,     0.29568,     0.29151,     0.28742,
             0.28332,     0.27923,     0.27514,     0.25787,     0.23576,     0.19995,     0.18924,     0.17836,     0.16711,     0.15826,     0.15539,     0.15252,     0.14964,     0.14677,      0.1439,     0.14102,
0.13815,     0.13352,     0.12603,     0.11853,      0.1127,     0.10998,     0.10727,
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030239,    0.023424,           0,           0,           0,           0,           0,
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0,          0,          0,          0,          0,          0,          0,
            0,          0,          0,          0,          0,          0,          0,          0,          0,          0,          0,          0]]), 'Confidence', 'Recall']]
fitness: 0.5945190545287014
keys: ['metrics/precision(B)', 'metrics/recall(B)', 'metrics/mAP50(B)', 'metrics/mAP50-95(B)']
maps: array([    0.55564])
names: {0: 'license_plate'}
plot: True
results_dict: {'metrics/precision(B)': 0.9681071891700327, 'metrics/recall(B)': 0.8636363636363636, 'metrics/mAP50(B)': 0.9444430446978715, 'metrics/mAP50-95(B)': 0.5556386111765713, 'fitness': 0.5945190545287014}
save_dir: WindowsPath('runs/detect/train19')
speed: {'preprocess': 0.6023320284756748, 'inference': 16.895288770849056, 'loss': 0.0, 'postprocess': 0.24994394995949484}
task: 'detect'
```

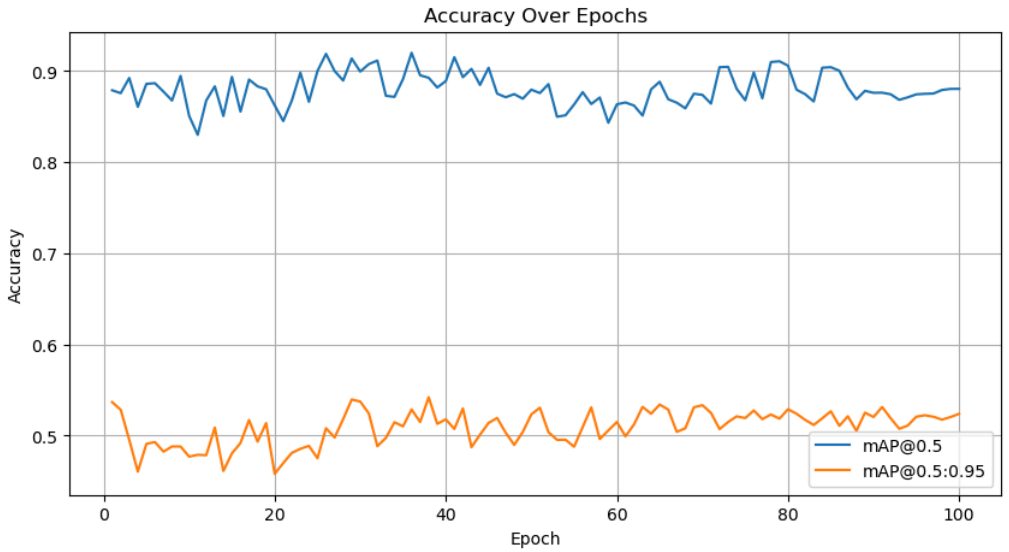
In [55]:

```
# Find the most recent training log directory
log_dir = max(glob('runs/detect/train*'), key = the_number_in_the_string)

# Load the training results
results = pd.read_csv(os.path.join(log_dir, 'results.csv'))
results.columns = results.columns.str.strip()  # Remove any leading/trailing whitespace from column names

# Extract epochs and accuracy metrics
epochs = results.index + 1  # Epochs are zero-indexed, so add 1
mAP_0_5 = results['metrics/mAP50(B)']  # Mean Average Precision at IoU=0.5
mAP_0_5_0_95 = results['metrics/mAP50-95(B)']  # Mean Average Precision at IoU=0.5:0.95

# Plot the accuracy over epochs
plt.figure(figsize=(10, 5))
plt.plot(epochs, mAP_0_5, label='mAP@0.5')
plt.plot(epochs, mAP_0_5_0_95, label='mAP@0.5:0.95')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.title('Accuracy Over Epochs')
plt.legend()
plt.grid(True)
plt.show()
```



In [57]:
```
# Save the trained model
model.save('best_numberplatedetection.pt')
```

Testing the model

In [60]:
```
def run(path_test_car):
    """
    Predicts and plots the bounding boxes on the given test image using the trained YOLO model.
    Also performs OCR on the detected bounding boxes to extract text.a
    """
    # Perform prediction on the test image using the model
    results = model.predict(path_test_car, device='cpu')

    # Load the image using OpenCV
    image = cv2.imread(path_test_car)
    # Convert the image from BGR (OpenCV default) to RGB (matplotlib default)
    image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

    # Extract the bounding boxes and labels from the results
    for result in results:
        for box in result.boxes:
            # Get the coordinates of the bounding box
            x1, y1, x2, y2 = map(int, box.xyxy[0])
            # Get the confidence score of the prediction
            confidence = box.conf[0]

            # Draw the bounding box on the image
            cv2.rectangle(image, (x1, y1), (x2, y2), (0, 255, 0), 2)
            # Draw the confidence score near the bounding box
            cv2.putText(image, f'{confidence*100:.2f}%', (x1, y1 - 10),
                        cv2.FONT_HERSHEY_SIMPLEX, 0.9, (255, 0, 0), 2)

            # Crop the bounding box from the image for OCR
            roi = image[y1:y2, x1:x2]

    # Plot the image with bounding boxes
    plt.imshow(image)
    plt.axis('off')  # Hide the axis
    plt.show()  # Display the image
```

In [62]:
```
print(test)
```

	img_path	xmin	xmax	ymin	ymax	img_w	img_h
425	archive\images\Cars425.png	211	301	103	132	500	232
75	archive\images\Cars75.png	209	218	196	201	400	248
181	archive\images\Cars181.png	69	128	195	209	225	400
30	archive\images\Cars30.png	155	200	169	182	400	240
364	archive\images\Cars364.png	61	115	140	167	400	242
408	archive\images\Cars408.png	160	187	217	228	400	267
253	archive\images\Cars253.png	25	64	124	137	400	210
155	archive\images\Cars155.png	150	203	177	190	400	267
168	archive\images\Cars168.png	82	137	95	125	400	225
415	archive\images\Cars415.png	133	261	157	192	400	300
152	archive\images\Cars152.png	92	199	258	284	467	300
70	archive\images\Cars70.png	179	213	115	133	400	226
203	archive\images\Cars203.png	116	271	112	165	400	267
335	archive\images\Cars335.png	156	221	163	198	399	400
39	archive\images\Cars39.png	225	328	180	213	400	300
395	archive\images\Cars395.png	241	288	182	205	400	301
274	archive\images\Cars274.png	196	253	149	169	400	300
72	archive\images\Cars72.png	156	255	182	208	400	332
9	archive\images\Cars9.png	164	272	224	247	442	333
281	archive\images\Cars281.png	151	243	169	183	400	247
287	archive\images\Cars287.png	148	262	180	213	400	332
362	archive\images\Cars362.png	139	162	172	179	400	300
353	archive\images\Cars353.png	93	201	189	221	400	246
55	archive\images\Cars55.png	143	210	171	208	400	299
289	archive\images\Cars289.png	163	271	140	173	400	307
198	archive\images\Cars198.png	166	273	225	246	442	333
148	archive\images\Cars148.png	135	218	134	158	400	225
392	archive\images\Cars392.png	144	260	150	209	400	262
341	archive\images\Cars341.png	47	115	161	192	400	267
268	archive\images\Cars268.png	213	271	133	168	300	225
126	archive\images\Cars126.png	103	293	99	201	400	300
400	archive\images\Cars400.png	303	340	191	217	400	267
305	archive\images\Cars305.png	361	434	167	183	450	270
93	archive\images\Cars93.png	347	367	122	132	400	251
428	archive\images\Cars428.png	142	258	128	157	400	225
77	archive\images\Cars77.png	229	309	151	178	400	270
298	archive\images\Cars298.png	166	233	148	184	400	268
140	archive\images\Cars140.png	283	424	239	286	435	290
323	archive\images\Cars323.png	123	279	28	65	400	225
429	archive\images\Cars429.png	86	208	166	195	301	400
225	archive\images\Cars225.png	189	384	161	215	600	375
154	archive\images\Cars154.png	70	264	197	265	375	500
78	archive\images\Cars78.png	149	249	210	239	400	300
73	archive\images\Cars73.png	119	283	22	69	400	225

In [66]:
```
run(test.iloc[12].img_path)
```

```
image 1/1 C:\Documents\Intel Unnati\Final\archive\images\Cars203.png: 224x320 1 license_plate, 58.6ms
Speed: 0.0ms preprocess, 58.6ms inference, 0.0ms postprocess per image at shape (1, 3, 224, 320)
```

In [68]:
```
run(test.iloc[20].img_path)
```

```
image 1/1 C:\Documents\Intel Unnati\Final\archive\images\Cars287.png: 288x320 1 license_plate, 41.9ms
Speed: 0.0ms preprocess, 41.9ms inference, 1.0ms postprocess per image at shape (1, 3, 288, 320)
```

In [70]:
```
run(test.iloc[25].img_path)
```

```
image 1/1 C:\Documents\Intel Unnati\Final\archive\images\Cars198.png: 256x320 1 license_plate, 40.8ms
Speed: 0.0ms preprocess, 40.8ms inference, 0.0ms postprocess per image at shape (1, 3, 256, 320)
```

In [72]:
```
run(test.iloc[30].img_path)
```

```
image 1/1 C:\Documents\Intel Unnati\Final\archive\images\Cars126.png: 256x320 1 license_plate, 29.5ms
Speed: 1.0ms preprocess, 29.5ms inference, 1.0ms postprocess per image at shape (1, 3, 256, 320)
```