

YOLOV11n (done)

December 21, 2024

```
[1]: from ultralytics import YOLO
from ultralytics.engine.results import Results
from IPython.display import display, Image
```

```
[3]: import torch
torch.cuda.empty_cache()
assert torch.cuda.is_available()
print(torch.cuda.is_available())
print(torch.cuda.get_device_name(0))
```

True
NVIDIA GeForce RTX 4060 Laptop GPU

```
[5]: model = YOLO('yolo11n.pt');
model.to('cuda');
```

```
[6]: data = "D:\Academics and University\Python\Intelligent Systems\Project_2\Welding Dataset\data.yaml"
```

```
[7]: results = model.train(data=data, batch=8, epochs=100, imgsz=640, workers=0, device=0)
```

```
New https://pypi.org/project/ultralytics/8.3.51 available Update with 'pip
install -U ultralytics'
Ultralytics 8.3.40 Python-3.11.11 torch-2.5.1 CUDA:0 (NVIDIA GeForce RTX 4060
Laptop GPU, 8188MiB)
engine\trainer: task=detect, mode=train, model=yolo11n.pt,
data=D:\Academics and University\Python\Intelligent Systems\Project 2\Welding
Dataset\data.yaml, epochs=100, time=None, patience=100, batch=8, imgsz=640,
save=True, save_period=-1, cache=False, device=0, workers=0, project=None,
name=train35, 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,
```

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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=runs\detect\train35
Overriding model.yaml nc=80 with nc=3

```

	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	6640	ultralytics.nn.modules.block.C3k2
[32, 64, 1, False, 0.25]				
3		-1 1	36992	ultralytics.nn.modules.conv.Conv
[64, 64, 3, 2]				
4		-1 1	26080	ultralytics.nn.modules.block.C3k2
[64, 128, 1, False, 0.25]				
5		-1 1	147712	ultralytics.nn.modules.conv.Conv
[128, 128, 3, 2]				
6		-1 1	87040	ultralytics.nn.modules.block.C3k2
[128, 128, 1, True]				
7		-1 1	295424	ultralytics.nn.modules.conv.Conv
[128, 256, 3, 2]				
8		-1 1	346112	ultralytics.nn.modules.block.C3k2
[256, 256, 1, True]				
9		-1 1	164608	ultralytics.nn.modules.block.SPPF
[256, 256, 5]				
10		-1 1	249728	ultralytics.nn.modules.block.C2PSA
[256, 256, 1]				
11		-1 1	0	torch.nn.modules.upsampling.Upsample
[None, 2, 'nearest']				
12		[-1, 6] 1	0	ultralytics.nn.modules.conv.Concat
[1]				
13		-1 1	111296	ultralytics.nn.modules.block.C3k2
[384, 128, 1, False]				
14		-1 1	0	torch.nn.modules.upsampling.Upsample
[None, 2, 'nearest']				
15		[-1, 4] 1	0	ultralytics.nn.modules.conv.Concat
[1]				
16		-1 1	32096	ultralytics.nn.modules.block.C3k2
[256, 64, 1, False]				
17		-1 1	36992	ultralytics.nn.modules.conv.Conv

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[64, 64, 3, 2]
18           [-1, 13]  1          0 ultralytics.nn.modules.conv.Concat
[1]
19           -1  1      86720 ultralytics.nn.modules.block.C3k2
[192, 128, 1, False]
20           -1  1     147712 ultralytics.nn.modules.conv.Conv
[128, 128, 3, 2]
21           [-1, 10]  1          0 ultralytics.nn.modules.conv.Concat
[1]
22           -1  1     378880 ultralytics.nn.modules.block.C3k2
[384, 256, 1, True]
23           [16, 19, 22]  1     431257 ultralytics.nn.modules.head.Detect
[3, [64, 128, 256]]
YOLOv1in summary: 319 layers, 2,590,425 parameters, 2,590,409 gradients

```

Transferred 448/499 items from pretrained weights

Freezing layer 'model.23.dfl.conv.weight'

AMP: running Automatic Mixed Precision (AMP) checks...

AMP: checks passed

train: Scanning D:\Academics and University\Python\Intelligent Systems\Project 2\Welding Dataset\train\labels.cache...

val: Scanning D:\Academics and University\Python\Intelligent Systems\Project 2\Welding Dataset\valid\labels.cache... 28

Plotting labels to runs\detect\train35\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=0.001429, momentum=0.9) with parameter groups
81 weight(decay=0.0), 88 weight(decay=0.0005), 87 bias(decay=0.0)

Image sizes 640 train, 640 val

Using 0 dataloader workers

Logging results to runs\detect\train35

Starting training for 100 epochs...

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
1/100	1.26G	2.003	3.201	1.761	14	640:
100%	203/203 [01:55<00:00,					
		Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:10					mAP50
		all	283	802	0.24	0.285
0.0544						0.13

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
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2/100	1.27G	2.039	2.892	1.788	5	640:
100%	203/203 [01:30<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.514	0.171	0.148
0.0562						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
3/100	1.34G	2.071	2.755	1.831	14	640:
100%	203/203 [01:26<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.196	0.272	0.134
0.057						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
4/100	1.3G	2.023	2.626	1.785	7	640:
100%	203/203 [01:44<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:10					
	all	283	802	0.319	0.245	0.229
0.0966						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
5/100	1.27G	1.96	2.518	1.741	10	640:
100%	203/203 [01:37<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.292	0.286	0.22
0.0918						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
6/100	1.29G	1.944	2.491	1.739	8	640:
100%	203/203 [01:26<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					

	all	283	802	0.321	0.278	0.198
0.0929						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
7/100	1.33G	1.919	2.411	1.702	17	640:
100%	203/203 [01:26<00:00,	Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:07					mAP50
	all	283	802	0.281	0.322	0.246
0.123						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
8/100	1.3G	1.875	2.348	1.687	13	640:
100%	203/203 [01:26<00:00,	Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:07					mAP50
	all	283	802	0.504	0.363	0.298
0.15						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
9/100	1.26G	1.837	2.249	1.655	17	640:
100%	203/203 [01:30<00:00,	Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:06					mAP50
	all	283	802	0.283	0.369	0.291
0.126						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
10/100	1.29G	1.846	2.264	1.661	17	640:
100%	203/203 [01:27<00:00,	Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:07					mAP50
	all	283	802	0.622	0.382	0.338
0.159						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
11/100 100%	1.29G 203/203 [01:28<00:00, mAP50-95): 100%	1.812 Class 18/18 [00:07 0.158	2.219	1.642	9	640:
			Box(P)	R	mAP50	
	all	283	802	0.36	0.401	0.334

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
12/100 100%	1.3G 203/203 [01:32<00:00, mAP50-95): 100%	1.818 Class 18/18 [00:07 0.176	2.183	1.644	13	640:
			Box(P)	R	mAP50	
	all	283	802	0.394	0.405	0.355

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
13/100 100%	1.26G 203/203 [01:31<00:00, mAP50-95): 100%	1.795 Class 18/18 [00:07 0.147	2.18	1.635	19	640:
			Box(P)	R	mAP50	
	all	283	802	0.278	0.353	0.308

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
14/100 100%	1.3G 203/203 [01:29<00:00, mAP50-95): 100%	1.791 Class 18/18 [00:07 0.173	2.133	1.616	19	640:
			Box(P)	R	mAP50	
	all	283	802	0.389	0.39	0.336

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
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	15/100	1.3G	1.758	2.103	1.594	13	640:
100%	203/203 [01:28<00:00,	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07	all	283	802	0.539	0.402	0.384
	0.189						

	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
16/100	1.29G	1.741	2.029	1.586	19	640:	
100%	203/203 [01:31<00:00,	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07	all	283	802	0.628	0.423	0.373
	0.188						

	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
17/100	1.29G	1.732	2.056	1.577	4	640:	
100%	203/203 [01:31<00:00,	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07	all	283	802	0.67	0.408	0.415
	0.22						

	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
18/100	1.3G	1.716	1.983	1.563	14	640:	
100%	203/203 [01:28<00:00,	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07	all	283	802	0.532	0.455	0.409
	0.208						

	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
19/100	1.31G	1.698	1.982	1.569	22	640:	
100%	203/203 [01:29<00:00,	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07	all	283	802	0.532	0.455	0.409

	all	283	802	0.689	0.373	0.409
0.213						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
20/100 100%	1.29G 203/203 [01:30<00:00,	1.719	2.01	1.568	11	640: mAP50-95): 100% 18/18 [00:07
		Class	Images	Instances	Box(P	R
						mAP50
	all	283	802	0.418	0.461	0.422
0.215						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
21/100 100%	1.34G 203/203 [01:27<00:00,	1.689	1.97	1.557	14	640: mAP50-95): 100% 18/18 [00:07
		Class	Images	Instances	Box(P	R
						mAP50
	all	283	802	0.421	0.485	0.405
0.201						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
22/100 100%	1.3G 203/203 [01:27<00:00,	1.689	1.947	1.549	9	640: mAP50-95): 100% 18/18 [00:07
		Class	Images	Instances	Box(P	R
						mAP50
	all	283	802	0.476	0.528	0.477
0.256						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
23/100 100%	1.29G 203/203 [01:27<00:00,	1.692	1.931	1.56	12	640: mAP50-95): 100% 18/18 [00:07
		Class	Images	Instances	Box(P	R
						mAP50
	all	283	802	0.57	0.436	0.447
0.232						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
24/100 100%	1.27G 203/203 [01:28<00:00, mAP50-95): 100%	1.678 Class 18/18 [00:07 all 0.242	1.922 Images 18/18 [00:07 283	1.539 Instances Box(P R	9	640: mAP50 0.465
			802	0.466	0.489	

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
25/100 100%	1.31G 203/203 [01:30<00:00, mAP50-95): 100%	1.656 Class 18/18 [00:07 all 0.265	1.876 Images 18/18 [00:07 283	1.522 Instances Box(P R	16	640: mAP50 0.484
			802	0.555	0.492	

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
26/100 100%	1.29G 203/203 [01:29<00:00, mAP50-95): 100%	1.651 Class 18/18 [00:07 all 0.262	1.851 Images 18/18 [00:07 283	1.508 Instances Box(P R	17	640: mAP50 0.486
			802	0.48	0.527	

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
27/100 100%	1.29G 203/203 [01:27<00:00, mAP50-95): 100%	1.631 Class 18/18 [00:07 all 0.25	1.834 Images 18/18 [00:07 283	1.519 Instances Box(P R	12	640: mAP50 0.482
			802	0.437	0.574	

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
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28/100	1.33G	1.623	1.834	1.5	25	640:
100%	203/203 [01:27<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					
	all	283	802	0.572	0.51	0.508
0.273						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
29/100	1.29G	1.623	1.828	1.5	9	640:
100%	203/203 [01:26<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					
	all	283	802	0.523	0.497	0.479
0.254						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
30/100	1.27G	1.627	1.809	1.515	20	640:
100%	203/203 [01:26<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					
	all	283	802	0.477	0.544	0.493
0.267						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
31/100	1.33G	1.588	1.771	1.468	18	640:
100%	203/203 [01:26<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.514	0.576	0.524
0.28						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
32/100	1.28G	1.598	1.759	1.488	17	640:
100%	203/203 [01:26<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					

	all	283	802	0.482	0.558	0.507
0.278						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
33/100	1.29G	1.608	1.776	1.486	13	640:
100%	203/203 [01:26<00:00,	Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:07					mAP50
	all	283	802	0.518	0.525	0.489
0.27						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
34/100	1.29G	1.583	1.75	1.476	5	640:
100%	203/203 [01:27<00:00,	Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:07					mAP50
	all	283	802	0.587	0.532	0.527
0.283						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
35/100	1.29G	1.563	1.707	1.455	9	640:
100%	203/203 [01:27<00:00,	Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:07					mAP50
	all	283	802	0.514	0.59	0.539
0.279						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
36/100	1.29G	1.569	1.715	1.469	13	640:
100%	203/203 [01:29<00:00,	Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:07					mAP50
	all	283	802	0.475	0.578	0.531
0.292						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
37/100 100%	1.27G 203/203 [01:28<00:00, mAP50-95): 100%	1.562 Class 18/18 [00:07 all 0.298	1.702	1.459	13	640:
			Box(P)	R	mAP50	
		283	802	0.45	0.598	0.523

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
38/100 100%	1.29G 203/203 [01:26<00:00, mAP50-95): 100%	1.549 Class 18/18 [00:07 all 0.287	1.67	1.437	7	640:
			Box(P)	R	mAP50	
		283	802	0.508	0.585	0.531

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
39/100 100%	1.29G 203/203 [01:25<00:00, mAP50-95): 100%	1.527 Class 18/18 [00:06 all 0.308	1.661	1.445	18	640:
			Box(P)	R	mAP50	
		283	802	0.556	0.552	0.556

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
40/100 100%	1.29G 203/203 [01:26<00:00, mAP50-95): 100%	1.542 Class 18/18 [00:07 all 0.307	1.661	1.429	15	640:
			Box(P)	R	mAP50	
		283	802	0.547	0.565	0.565

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
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41/100	1.27G	1.532	1.663	1.432	18	640:
100%	203/203 [01:25<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.587	0.566	0.577
0.32						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
42/100	1.28G	1.516	1.632	1.429	16	640:
100%	203/203 [01:26<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.513	0.599	0.537
0.305						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
43/100	1.29G	1.519	1.6	1.419	13	640:
100%	203/203 [01:26<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.581	0.531	0.558
0.306						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
44/100	1.34G	1.502	1.589	1.422	13	640:
100%	203/203 [01:27<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.579	0.574	0.577
0.34						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
45/100	1.29G	1.532	1.608	1.433	27	640:
100%	203/203 [01:27<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					

	all	283	802	0.552	0.545	0.551
0.299						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
46/100	1.26G	1.494	1.578	1.403	4	640:
100%	203/203 [01:27<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%		18/18 [00:07				
	all	283	802	0.559	0.583	0.579
0.322						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
47/100	1.3G	1.48	1.562	1.409	16	640:
100%	203/203 [01:27<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%		18/18 [00:07				
	all	283	802	0.592	0.569	0.583
0.33						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
48/100	1.29G	1.488	1.55	1.411	9	640:
100%	203/203 [01:27<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%		18/18 [00:06				
	all	283	802	0.54	0.593	0.589
0.34						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
49/100	1.26G	1.476	1.541	1.404	11	640:
100%	203/203 [01:26<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%		18/18 [00:07				
	all	283	802	0.519	0.589	0.58
0.34						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
50/100 100%	1.29G 203/203 [01:28<00:00, mAP50-95): 100%	1.483 Class 18/18 [00:07 0.331	1.571	1.409	17	640:
			Box(P)	R	mAP50	
	all	283	802	0.599	0.595	0.588

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
51/100 100%	1.29G 203/203 [01:28<00:00, mAP50-95): 100%	1.479 Class 18/18 [00:07 0.355	1.521	1.401	10	640:
			Box(P)	R	mAP50	
	all	283	802	0.643	0.564	0.602

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
52/100 100%	1.3G 203/203 [01:26<00:00, mAP50-95): 100%	1.462 Class 18/18 [00:07 0.349	1.505	1.385	23	640:
			Box(P)	R	mAP50	
	all	283	802	0.559	0.618	0.585

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
53/100 100%	1.3G 203/203 [01:27<00:00, mAP50-95): 100%	1.46 Class 18/18 [00:07 0.364	1.486	1.379	18	640:
			Box(P)	R	mAP50	
	all	283	802	0.618	0.608	0.613

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
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54/100	1.29G	1.45	1.5	1.383	13	640:
100%	203/203 [01:26<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.609	0.614	0.622
0.358						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
55/100	1.29G	1.445	1.493	1.376	11	640:
100%	203/203 [01:28<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.617	0.613	0.634
0.377						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
56/100	1.26G	1.433	1.461	1.38	26	640:
100%	203/203 [01:25<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.599	0.628	0.631
0.383						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
57/100	1.29G	1.421	1.475	1.364	18	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					
	all	283	802	0.584	0.63	0.628
0.362						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
58/100	1.28G	1.43	1.468	1.379	11	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					

	all	283	802	0.601	0.596	0.632
0.376						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
59/100	1.29G	1.42	1.451	1.367	28	640:
100%	203/203 [01:23<00:00,	Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:06					mAP50
	all	283	802	0.574	0.629	0.641
0.38						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
60/100	1.27G	1.408	1.434	1.351	16	640:
100%	203/203 [01:24<00:00,	Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:07					mAP50
	all	283	802	0.608	0.617	0.636
0.371						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
61/100	1.32G	1.413	1.43	1.355	20	640:
100%	203/203 [01:25<00:00,	Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:07					mAP50
	all	283	802	0.56	0.635	0.635
0.373						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
62/100	1.28G	1.389	1.387	1.332	12	640:
100%	203/203 [01:26<00:00,	Class	Images	Instances	Box(P	R
mAP50-95): 100%	18/18 [00:07					mAP50
	all	283	802	0.638	0.596	0.644
0.376						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
63/100 100%	1.33G 203/203 [01:26<00:00, mAP50-95): 100%	1.411 Class 18/18 [00:06 all 0.372	1.41 Images 18/18 [00:06 283	1.351 Instances 802	19 Box(P R 0.574	640: mAP50 0.631

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
64/100 100%	1.33G 203/203 [01:24<00:00, mAP50-95): 100%	1.387 Class 18/18 [00:06 all 0.388	1.407 Images 18/18 [00:06 283	1.339 Instances 802	23 Box(P R 0.591	640: mAP50 0.647

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
65/100 100%	1.33G 203/203 [01:23<00:00, mAP50-95): 100%	1.383 Class 18/18 [00:06 all 0.39	1.35 Images 18/18 [00:06 283	1.331 Instances 802	20 Box(P R 0.597	640: mAP50 0.65

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
66/100 100%	1.29G 203/203 [01:23<00:00, mAP50-95): 100%	1.374 Class 18/18 [00:07 all 0.381	1.366 Images 18/18 [00:07 283	1.323 Instances 802	8 Box(P R 0.582	640: mAP50 0.639

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
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67/100	1.32G	1.372	1.354	1.33	17	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					
	all	283	802	0.591	0.672	0.665
0.381						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
68/100	1.31G	1.373	1.35	1.326	12	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					
	all	283	802	0.603	0.633	0.648
0.387						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
69/100	1.28G	1.359	1.317	1.321	12	640:
100%	203/203 [01:25<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.632	0.63	0.656
0.385						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
70/100	1.28G	1.347	1.317	1.319	12	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					
	all	283	802	0.606	0.635	0.647
0.384						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
71/100	1.29G	1.327	1.292	1.298	8	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					

	all	283	802	0.644	0.611	0.658
0.395						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
72/100 100%	1.29G 203/203 [01:24<00:00,	1.34	1.303	1.31	23	640: mAP50-95): 100% 18/18 [00:06
		Class	Images	Instances	Box(P	R
						mAP50
	all	283	802	0.64	0.627	0.655
0.396						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
73/100 100%	1.3G 203/203 [01:24<00:00,	1.32	1.279	1.307	6	640: mAP50-95): 100% 18/18 [00:06
		Class	Images	Instances	Box(P	R
						mAP50
	all	283	802	0.663	0.638	0.669
0.401						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
74/100 100%	1.28G 203/203 [01:24<00:00,	1.336	1.302	1.307	13	640: mAP50-95): 100% 18/18 [00:06
		Class	Images	Instances	Box(P	R
						mAP50
	all	283	802	0.673	0.632	0.666
0.409						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
75/100 100%	1.29G 203/203 [01:24<00:00,	1.318	1.268	1.299	6	640: mAP50-95): 100% 18/18 [00:06
		Class	Images	Instances	Box(P	R
						mAP50
	all	283	802	0.635	0.65	0.671
0.405						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
76/100 100%	1.29G 203/203 [01:23<00:00, mAP50-95): 100%	1.313 Class 18/18 [00:06 0.419	1.261	1.292	5	640:
			Box(P)	R	mAP50	
	all	283	802	0.668	0.653	0.676

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
77/100 100%	1.29G 203/203 [01:23<00:00, mAP50-95): 100%	1.335 Class 18/18 [00:06 0.416	1.267	1.311	20	640:
			Box(P)	R	mAP50	
	all	283	802	0.627	0.662	0.665

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
78/100 100%	1.29G 203/203 [01:24<00:00, mAP50-95): 100%	1.313 Class 18/18 [00:06 0.421	1.245	1.287	13	640:
			Box(P)	R	mAP50	
	all	283	802	0.688	0.622	0.674

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
79/100 100%	1.3G 203/203 [01:24<00:00, mAP50-95): 100%	1.31 Class 18/18 [00:06 0.418	1.233	1.28	10	640:
			Box(P)	R	mAP50	
	all	283	802	0.672	0.637	0.678

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
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80/100	1.29G	1.284	1.238	1.278	10	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.649	0.645	0.681
0.416						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
81/100	1.29G	1.294	1.229	1.28	18	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					
	all	283	802	0.659	0.647	0.673
0.418						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
82/100	1.29G	1.28	1.214	1.274	14	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					
	all	283	802	0.677	0.653	0.681
0.421						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
83/100	1.29G	1.271	1.192	1.262	11	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					
	all	283	802	0.673	0.633	0.672
0.418						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
84/100	1.26G	1.27	1.194	1.268	11	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					

	all	283	802	0.689	0.653	0.689
0.427						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
85/100	1.26G	1.277	1.189	1.274	15	640:
100%	203/203 [01:24<00:00,	Class	Images	Instances	Box(P)	R
mAP50-95): 100%	18/18 [00:06					mAP50
	all	283	802	0.672	0.64	0.687
0.431						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
86/100	1.28G	1.257	1.165	1.256	24	640:
100%	203/203 [01:24<00:00,	Class	Images	Instances	Box(P)	R
mAP50-95): 100%	18/18 [00:06					mAP50
	all	283	802	0.702	0.632	0.687
0.432						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
87/100	1.29G	1.244	1.165	1.254	7	640:
100%	203/203 [01:24<00:00,	Class	Images	Instances	Box(P)	R
mAP50-95): 100%	18/18 [00:06					mAP50
	all	283	802	0.697	0.646	0.691
0.429						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
88/100	1.29G	1.238	1.148	1.247	18	640:
100%	203/203 [01:32<00:00,	Class	Images	Instances	Box(P)	R
mAP50-95): 100%	18/18 [00:07					mAP50
	all	283	802	0.678	0.659	0.695
0.441						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
89/100	1.3G	1.222	1.14	1.245	14	640:
100%	203/203 [01:32<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.674	0.675	0.7
0.442						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
90/100	1.29G	1.239	1.146	1.244	4	640:
100%	203/203 [01:27<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.69	0.671	0.7
0.44						

Closing dataloader mosaic

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
91/100	1.29G	1.185	1.062	1.263	16	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.698	0.636	0.689
0.43						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
92/100	1.29G	1.163	1.02	1.256	4	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.684	0.658	0.699
0.436						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
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93/100	1.26G	1.155	1.003	1.243	6	640:
100%	203/203 [01:25<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.728	0.642	0.698
0.439						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
94/100	1.29G	1.136	0.9873	1.226	7	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.739	0.643	0.701
0.444						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
95/100	1.29G	1.128	0.9771	1.223	6	640:
100%	203/203 [01:26<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.75	0.631	0.701
0.439						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
96/100	1.29G	1.123	0.9595	1.219	4	640:
100%	203/203 [01:25<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.718	0.661	0.708
0.443						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
97/100	1.27G	1.134	0.9671	1.23	10	640:
100%	203/203 [01:25<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					

	all	283	802	0.72	0.658	0.709
0.448						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
98/100	1.26G	1.12	0.949	1.224	6	640:
100%	203/203 [01:26<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.71	0.671	0.715
0.448						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
99/100	1.28G	1.119	0.9516	1.226	9	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:07					
	all	283	802	0.679	0.694	0.712
0.452						

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
100/100	1.29G	1.112	0.9388	1.218	5	640:
100%	203/203 [01:24<00:00,					
	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%	18/18 [00:06					
	all	283	802	0.752	0.641	0.711
0.452						

100 epochs completed in 2.651 hours.

Optimizer stripped from runs\detect\train35\weights\last.pt, 5.5MB
 Optimizer stripped from runs\detect\train35\weights\best.pt, 5.5MB

Validating runs\detect\train35\weights\best.pt...
 Ultralytics 8.3.40 Python-3.11.11 torch-2.5.1 CUDA:0 (NVIDIA GeForce RTX 4060 Laptop GPU, 8188MiB)
 YOLOv1n summary (fused): 238 layers, 2,582,737 parameters, 0 gradients

	Class	Images	Instances	Box(P)	R	mAP50
mAP50-95): 100%		18/18	[00:07]			
0.452	all	283	802	0.753	0.64	0.711
0.565	Bad Weld	141	194	0.767	0.768	0.809
0.562	Good Weld	175	335	0.785	0.785	0.833
0.23	Defect	128	273	0.708	0.366	0.49
Speed: 0.4ms preprocess, 4.3ms inference, 0.0ms loss, 2.3ms postprocess per image						
Results saved to runs\detect\train35						

```
[12]: model.val(data=data)
```

```
Ultralytics 8.3.40 Python-3.11.11 torch-2.5.1 CUDA:0 (NVIDIA GeForce RTX 4060
Laptop GPU, 8188MiB)

val: Scanning D:\Academics and University\Python\Intelligent
Systems\Project 2\Welding Dataset\valid\labels.cache... 28
Class Images Instances Box(P) R mAP50
mAP50-95): 100% | 18/18 [00:05]

0.452 all 283 802 0.752 0.638 0.711
0.564 Bad Weld 141 194 0.767 0.766 0.81
0.561 Good Weld 175 335 0.782 0.782 0.833
0.231 Defect 128 273 0.708 0.366 0.49
Speed: 0.7ms preprocess, 5.1ms inference, 0.0ms loss, 2.5ms postprocess per
image
Results saved to runs\detect\val
```

[12]: ultralytics.utils.metrics.DetMetrics object with attributes:

```
ap_class_index: array([0, 1, 2])
box: ultralytics.utils.metrics.Metric object
confusion_matrix: <ultralytics.utils.metrics.ConfusionMatrix object at
0x000001C14446E350>
curves: ['Precision-Recall(B)', 'F1-Confidence(B)', 'Precision-Confidence(B)', 'Recall-Confidence(B)']
curves_results: [[array([
    0, 0.001001, 0.002002, 0.003003,
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0.26927,	0.27027,	0.27127,	0.27227,	0.27327,	0.27427,
0.27528,	0.27628,	0.27728,	0.27828,	0.27928,	0.28028,
0.28128,	0.28228,	0.28328,	0.28428,	0.28529,	0.28629,
0.28729,	0.28829,	0.28929,	0.29029,	0.29129,	0.29229,
0.29329,	0.29429,	0.2953,	0.2963,	0.2973,	0.2983,
0.2993,	0.3003,	0.3013,	0.3023,	0.3033,	0.3043,
0.30531,	0.30631,	0.30731,	0.30831,	0.30931,	0.31031,
0.31131,	0.31231,	0.31331,	0.31431,	0.31532,	0.31632,
0.31732,	0.31832,	0.31932,	0.32032,	0.32132,	0.32232,
0.32332,	0.32432,	0.32533,	0.32633,	0.32733,	0.32833,
0.32933,	0.33033,	0.33133,	0.33233,	0.33333,	0.33433,
0.33534,	0.33634,	0.33734,	0.33834,	0.33934,	0.34034,
0.34134,	0.34234,	0.34334,	0.34434,	0.34535,	0.34635,
0.34735,	0.34835,	0.34935,	0.35035,	0.35135,	0.35235,
0.35335,	0.35435,	0.35536,	0.35636,	0.35736,	0.35836,

0.35936,					
	0.36036,	0.36136,	0.36236,	0.36336,	0.36436,
0.36537,	0.36637,	0.36737,	0.36837,	0.36937,	0.37037,
0.37137,	0.37237,	0.37337,	0.37437,	0.37538,	0.37638,
0.37738,	0.37838,	0.37938,	0.38038,	0.38138,	0.38238,
0.38338,					
	0.38438,	0.38539,	0.38639,	0.38739,	0.38839,
0.38939,	0.39039,	0.39139,	0.39239,	0.39339,	0.39439,
0.3954,	0.3964,	0.3974,	0.3984,	0.3994,	0.4004,
0.4014,	0.4024,	0.4034,	0.4044,	0.40541,	0.40641,
0.40741,					
	0.40841,	0.40941,	0.41041,	0.41141,	0.41241,
0.41341,	0.41441,	0.41542,	0.41642,	0.41742,	0.41842,
0.41942,	0.42042,	0.42142,	0.42242,	0.42342,	0.42442,
0.42543,	0.42643,	0.42743,	0.42843,	0.42943,	0.43043,
0.43143,					
	0.43243,	0.43343,	0.43443,	0.43544,	0.43644,
0.43744,	0.43844,	0.43944,	0.44044,	0.44144,	0.44244,
0.44344,	0.44444,	0.44545,	0.44645,	0.44745,	0.44845,
0.44945,	0.45045,	0.45145,	0.45245,	0.45345,	0.45445,
0.45546,					
	0.45646,	0.45746,	0.45846,	0.45946,	0.46046,
0.46146,	0.46246,	0.46346,	0.46446,	0.46547,	0.46647,
0.46747,	0.46847,	0.46947,	0.47047,	0.47147,	0.47247,
0.47347,	0.47447,	0.47548,	0.47648,	0.47748,	0.47848,
0.47948,					
	0.48048,	0.48148,	0.48248,	0.48348,	0.48448,
0.48549,	0.48649,	0.48749,	0.48849,	0.48949,	0.49049,
0.49149,	0.49249,	0.49349,	0.49449,	0.4955,	0.4965,
0.4975,	0.4985,	0.4995,	0.5005,	0.5015,	0.5025,
0.5035,					
	0.5045,	0.50551,	0.50651,	0.50751,	0.50851,
0.50951,	0.51051,	0.51151,	0.51251,	0.51351,	0.51451,
0.51552,	0.51652,	0.51752,	0.51852,	0.51952,	0.52052,
0.52152,	0.52252,	0.52352,	0.52452,	0.52553,	0.52653,
0.52753,					
	0.52853,	0.52953,	0.53053,	0.53153,	0.53253,
0.53353,	0.53453,	0.53554,	0.53654,	0.53754,	0.53854,
0.53954,	0.54054,	0.54154,	0.54254,	0.54354,	0.54454,
0.54555,	0.54655,	0.54755,	0.54855,	0.54955,	0.55055,
0.55155,					
	0.55255,	0.55355,	0.55455,	0.55556,	0.55656,
0.55756,	0.55856,	0.55956,	0.56056,	0.56156,	0.56256,
0.56356,	0.56456,	0.56557,	0.56657,	0.56757,	0.56857,
0.56957,	0.57057,	0.57157,	0.57257,	0.57357,	0.57457,
0.57558,					
	0.57658,	0.57758,	0.57858,	0.57958,	0.58058,

0.58158,	0.58258,	0.58358,	0.58458,	0.58559,	0.58659,
0.58759,	0.58859,	0.58959,	0.59059,	0.59159,	0.59259,
0.59359,	0.59459,	0.5956,	0.5966,	0.5976,	0.5986,
0.5996,					
	0.6006,	0.6016,	0.6026,	0.6036,	0.6046,
0.60561,	0.60661,	0.60761,	0.60861,	0.60961,	0.61061,
0.61161,	0.61261,	0.61361,	0.61461,	0.61562,	0.61662,
0.61762,	0.61862,	0.61962,	0.62062,	0.62162,	0.62262,
0.62362,					
	0.62462,	0.62563,	0.62663,	0.62763,	0.62863,
0.62963,	0.63063,	0.63163,	0.63263,	0.63363,	0.63463,
0.63564,	0.63664,	0.63764,	0.63864,	0.63964,	0.64064,
0.64164,	0.64264,	0.64364,	0.64464,	0.64565,	0.64665,
0.64765,					
	0.64865,	0.64965,	0.65065,	0.65165,	0.65265,
0.65365,	0.65465,	0.65566,	0.65666,	0.65766,	0.65866,
0.65966,	0.66066,	0.66166,	0.66266,	0.66366,	0.66466,
0.66567,	0.66667,	0.66767,	0.66867,	0.66967,	0.67067,
0.67167,					
	0.67267,	0.67367,	0.67467,	0.67568,	0.67668,
0.67768,	0.67868,	0.67968,	0.68068,	0.68168,	0.68268,
0.68368,	0.68468,	0.68569,	0.68669,	0.68769,	0.68869,
0.68969,	0.69069,	0.69169,	0.69269,	0.69369,	0.69469,
0.6957,					
	0.6967,	0.6977,	0.6987,	0.6997,	0.7007,
0.7017,	0.7027,	0.7037,	0.7047,	0.70571,	0.70671,
0.70771,	0.70871,	0.70971,	0.71071,	0.71171,	0.71271,
0.71371,	0.71471,	0.71572,	0.71672,	0.71772,	0.71872,
0.71972,					
	0.72072,	0.72172,	0.72272,	0.72372,	0.72472,
0.72573,	0.72673,	0.72773,	0.72873,	0.72973,	0.73073,
0.73173,	0.73273,	0.73373,	0.73473,	0.73574,	0.73674,
0.73774,	0.73874,	0.73974,	0.74074,	0.74174,	0.74274,
0.74374,					
	0.74474,	0.74575,	0.74675,	0.74775,	0.74875,
0.74975,	0.75075,	0.75175,	0.75275,	0.75375,	0.75475,
0.75576,	0.75676,	0.75776,	0.75876,	0.75976,	0.76076,
0.76176,	0.76276,	0.76376,	0.76476,	0.76577,	0.76677,
0.76777,					
	0.76877,	0.76977,	0.77077,	0.77177,	0.77277,
0.77377,	0.77477,	0.77578,	0.77678,	0.77778,	0.77878,
0.77978,	0.78078,	0.78178,	0.78278,	0.78378,	0.78478,
0.78579,	0.78679,	0.78779,	0.78879,	0.78979,	0.79079,
0.79179,					
	0.79279,	0.79379,	0.79479,	0.7958,	0.7968,
0.7978,	0.7988,	0.7998,	0.8008,	0.8018,	0.8028,
0.8038,	0.8048,	0.80581,	0.80681,	0.80781,	0.80881,

0.80981,	0.81081,	0.81181,	0.81281,	0.81381,	0.81481,
0.81582,					
	0.81682,	0.81782,	0.81882,	0.81982,	0.82082,
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0.82783,	0.82883,	0.82983,	0.83083,	0.83183,	0.83283,
0.83383,	0.83483,	0.83584,	0.83684,	0.83784,	0.83884,
0.83984,					
	0.84084,	0.84184,	0.84284,	0.84384,	0.84484,
0.84585,	0.84685,	0.84785,	0.84885,	0.84985,	0.85085,
0.85185,	0.85285,	0.85385,	0.85485,	0.85586,	0.85686,
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,					
	0.93694,	0.93794,	0.93894,	0.93994,	0.94094,
0.94194,	0.94294,	0.94394,	0.94494,	0.94595,	0.94695,
0.94795,	0.94895,	0.94995,	0.95095,	0.95195,	0.95295,
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,
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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,
0.16717,					
	0.16817,	0.16917,	0.17017,	0.17117,	0.17217,
0.17317,	0.17417,	0.17518,	0.17618,	0.17718,	0.17818,
0.17918,	0.18018,	0.18118,	0.18218,	0.18318,	0.18418,
0.18519,	0.18619,	0.18719,	0.18819,	0.18919,	0.19019,
0.19119,					
	0.19219,	0.19319,	0.19419,	0.1952,	0.1962,
0.1972,	0.1982,	0.1992,	0.2002,	0.2012,	0.2022,
0.2032,	0.2042,	0.20521,	0.20621,	0.20721,	0.20821,
0.20921,	0.21021,	0.21121,	0.21221,	0.21321,	0.21421,
0.21522,					
	0.21622,	0.21722,	0.21822,	0.21922,	0.22022,
0.22122,	0.22222,	0.22322,	0.22422,	0.22523,	0.22623,
0.22723,	0.22823,	0.22923,	0.23023,	0.23123,	0.23223,
0.23323,	0.23423,	0.23524,	0.23624,	0.23724,	0.23824,
0.23924,					

	0.24024,	0.24124,	0.24224,	0.24324,	0.24424,
0.24525,	0.24625,	0.24725,	0.24825,	0.24925,	0.25025,
0.25125,	0.25225,	0.25325,	0.25425,	0.25526,	0.25626,
0.25726,	0.25826,	0.25926,	0.26026,	0.26126,	0.26226,
0.26326,					
	0.26426,	0.26527,	0.26627,	0.26727,	0.26827,
0.26927,	0.27027,	0.27127,	0.27227,	0.27327,	0.27427,
0.27528,	0.27628,	0.27728,	0.27828,	0.27928,	0.28028,
0.28128,	0.28228,	0.28328,	0.28428,	0.28529,	0.28629,
0.28729,					
	0.28829,	0.28929,	0.29029,	0.29129,	0.29229,
0.29329,	0.29429,	0.2953,	0.2963,	0.2973,	0.2983,
0.2993,	0.3003,	0.3013,	0.3023,	0.3033,	0.3043,
0.30531,	0.30631,	0.30731,	0.30831,	0.30931,	0.31031,
0.31131,					
	0.31231,	0.31331,	0.31431,	0.31532,	0.31632,
0.31732,	0.31832,	0.31932,	0.32032,	0.32132,	0.32232,
0.32332,	0.32432,	0.32533,	0.32633,	0.32733,	0.32833,
0.32933,	0.33033,	0.33133,	0.33233,	0.33333,	0.33433,
0.33534,					
	0.33634,	0.33734,	0.33834,	0.33934,	0.34034,
0.34134,	0.34234,	0.34334,	0.34434,	0.34535,	0.34635,
0.34735,	0.34835,	0.34935,	0.35035,	0.35135,	0.35235,
0.35335,	0.35435,	0.35536,	0.35636,	0.35736,	0.35836,
0.35936,					
	0.36036,	0.36136,	0.36236,	0.36336,	0.36436,
0.36537,	0.36637,	0.36737,	0.36837,	0.36937,	0.37037,
0.37137,	0.37237,	0.37337,	0.37437,	0.37538,	0.37638,
0.37738,	0.37838,	0.37938,	0.38038,	0.38138,	0.38238,
0.38338,					
	0.38438,	0.38539,	0.38639,	0.38739,	0.38839,
0.38939,	0.39039,	0.39139,	0.39239,	0.39339,	0.39439,
0.3954,	0.3964,	0.3974,	0.3984,	0.3994,	0.4004,
0.4014,	0.4024,	0.4034,	0.4044,	0.40541,	0.40641,
0.40741,					
	0.40841,	0.40941,	0.41041,	0.41141,	0.41241,
0.41341,	0.41441,	0.41542,	0.41642,	0.41742,	0.41842,
0.41942,	0.42042,	0.42142,	0.42242,	0.42342,	0.42442,
0.42543,	0.42643,	0.42743,	0.42843,	0.42943,	0.43043,
0.43143,					
	0.43243,	0.43343,	0.43443,	0.43544,	0.43644,
0.43744,	0.43844,	0.43944,	0.44044,	0.44144,	0.44244,
0.44344,	0.44444,	0.44545,	0.44645,	0.44745,	0.44845,
0.44945,	0.45045,	0.45145,	0.45245,	0.45345,	0.45445,
0.45546,					
	0.45646,	0.45746,	0.45846,	0.45946,	0.46046,
0.46146,	0.46246,	0.46346,	0.46446,	0.46547,	0.46647,

0.46747,	0.46847,	0.46947,	0.47047,	0.47147,	0.47247,
0.47347,	0.47447,	0.47548,	0.47648,	0.47748,	0.47848,
0.47948,					
	0.48048,	0.48148,	0.48248,	0.48348,	0.48448,
0.48549,	0.48649,	0.48749,	0.48849,	0.48949,	0.49049,
0.49149,	0.49249,	0.49349,	0.49449,	0.4955,	0.4965,
0.4975,	0.4985,	0.4995,	0.5005,	0.5015,	0.5025,
0.5035,					
	0.5045,	0.50551,	0.50651,	0.50751,	0.50851,
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	0.76877,	0.76977,	0.77077,	0.77177,	0.77277,
0.77377,	0.77477,	0.77578,	0.77678,	0.77778,	0.77878,
0.77978,	0.78078,	0.78178,	0.78278,	0.78378,	0.78478,
0.78579,	0.78679,	0.78779,	0.78879,	0.78979,	0.79079,
0.79179,					
	0.79279,	0.79379,	0.79479,	0.7958,	0.7968,
0.7978,	0.7988,	0.7998,	0.8008,	0.8018,	0.8028,

```

0.8038,      0.8048,      0.80581,      0.80681,      0.80781,      0.80881,
0.80981,     0.81081,     0.81181,     0.81281,     0.81381,     0.81481,
0.81582,
0.82182,     0.82282,     0.82382,     0.82482,     0.82583,     0.82683,
0.82783,     0.82883,     0.82983,     0.83083,     0.83183,     0.83283,
0.83383,     0.83483,     0.83584,     0.83684,     0.83784,     0.83884,
0.83984,
0.84084,     0.84184,     0.84284,     0.84384,     0.84484,
0.84585,     0.84685,     0.84785,     0.84885,     0.84985,     0.85085,
0.85185,     0.85285,     0.85385,     0.85485,     0.85586,     0.85686,
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,
0.93694,     0.93794,     0.93894,     0.93994,     0.94094,
0.94194,     0.94294,     0.94394,     0.94494,     0.94595,     0.94695,
0.94795,     0.94895,     0.94995,     0.95095,     0.95195,     0.95295,
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]), array([[[
0.99485,     0.99485,     0.99485, ..., 0,          0,          0],
[ 0.97612,    0.97612,    0.97612, ..., 0,          0,          0],
[ 0.84615,    0.84615,    0.83516, ..., 0,          0,          0],
0]]), 'Confidence', 'Recall']]
```

fitness: 0.47763153294529914

```

keys: ['metrics/precision(B)', 'metrics/recall(B)', 'metrics/mAP50(B)',  

'metrics/mAP50-95(B)']  

maps: array([ 0.56357, 0.56106, 0.23051])  

names: {0: 'Bad Weld', 1: 'Good Weld', 2: 'Defect'}  

plot: True  

results_dict: {'metrics/precision(B)': 0.752487664228814, 'metrics/recall(B)':  

0.6378380212201716, 'metrics/mAP50(B)': 0.7108793339784579,  

'metrics/mAP50-95(B)': 0.45171511060828146, 'fitness': 0.47763153294529914}  

save_dir: WindowsPath('runs/detect/val')  

speed: {'preprocess': 0.7112430599468756, 'inference': 5.110292468391122,  

'loss': 0.0, 'postprocess': 2.5428815781017073}  

task: 'detect'

```

[13]: # Save the trained model

```

model_path = "D:\Academics and University\Python\Intelligent Systems\Project 2\my_yolov11n.pt"
model.save(model_path)

```

[14]:

```

import os
import random
from PIL import Image

# Function to display results
def display_results(model, img_dir, num_images=10):
    images = os.listdir(img_dir)
    sample_images = random.sample(images, num_images)
    save_dir = 'runs/detect/exp'
    os.makedirs(save_dir, exist_ok=True)

    for image_name in sample_images:
        image_path = os.path.join(img_dir, image_name)
        results = model(image_path)
        for result in results:
            result.plot(save=True, filename=os.path.join(save_dir, os.path.basename(image_path)))
            result_image_path = os.path.join(save_dir, os.path.basename(image_path))
            display(Image.open(result_image_path))

```

[15]: # Load the trained model for inference

```

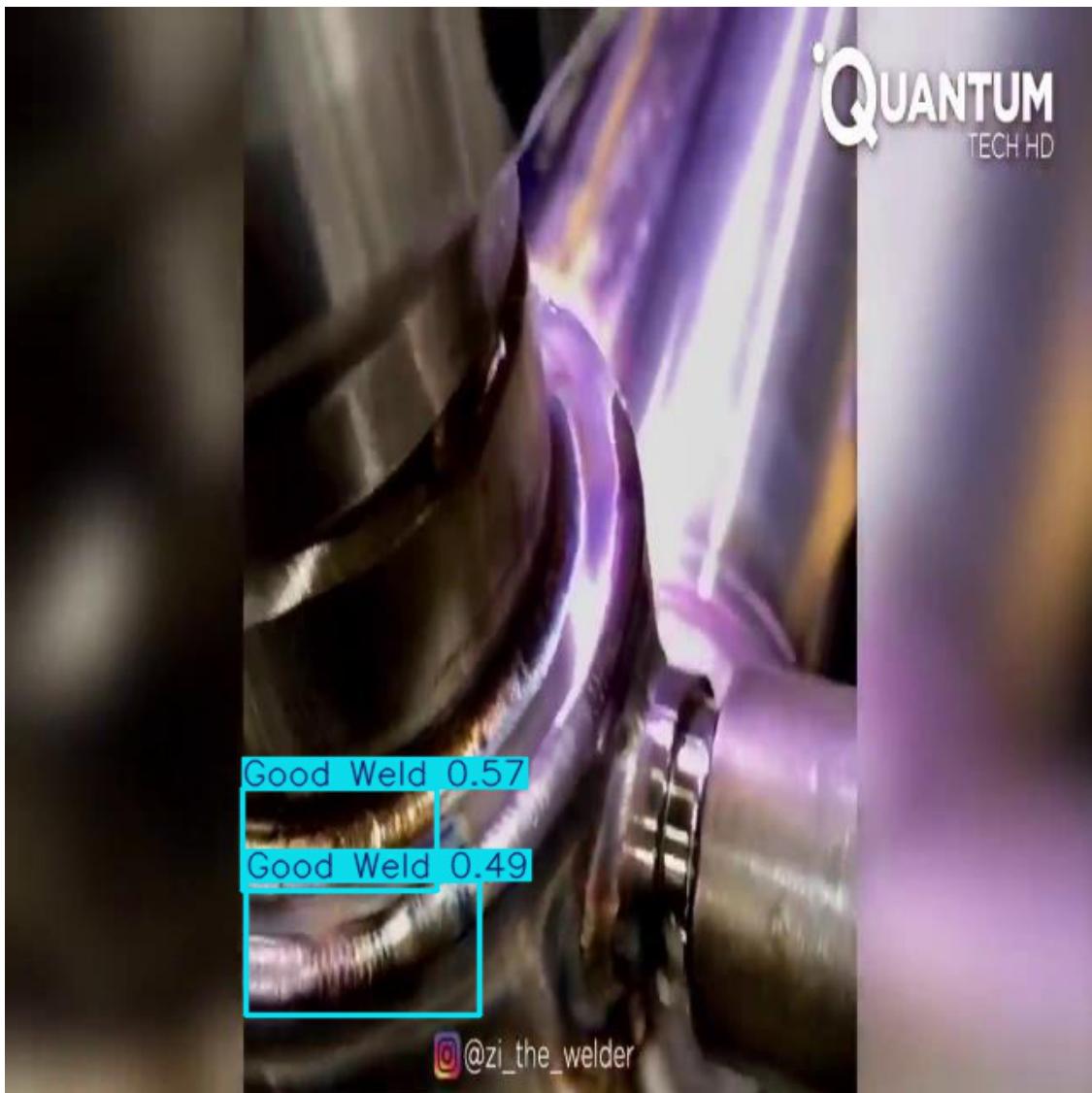
model = YOLO(model_path)

print("Displaying results from model trained on version 2 with augmentation:")
img_dir = "D:/Academics and University/Python/Intelligent Systems/Project 2/Welding Dataset/test/images"
display_results(model, img_dir)

```

Displaying results from model trained on version 2 with augmentation:

```
image 1/1 D:\Academics and University\Python\Intelligent Systems\Project  
2\Welding Dataset\test\images\good_weld_vid1266_jpeg.rf.cb9d92f6b9be101524092b92  
229f3df9.jpg: 640x640 2 Good Welds, 28.8ms  
Speed: 4.0ms preprocess, 28.8ms inference, 5.6ms postprocess per image at shape  
(1, 3, 640, 640)
```



```
image 1/1 D:\Academics and University\Python\Intelligent Systems\Project  
2\Welding Dataset\test\images\bad_weld_vid277_jpeg.jpg.rf.0e6aafa2605c842edfaeda  
ba06ded02c.jpg: 640x640 1 Bad Weld, 1 Good Weld, 33.9ms  
Speed: 11.7ms preprocess, 33.9ms inference, 3.2ms postprocess per image at shape  
(1, 3, 640, 640)
```



image 1/1 D:\Academics and University\Python\Intelligent Systems\Project
2\Welding Dataset\test\images\crack-welding-
images_11.jpeg.jpg.rf.5174724ff08d893dc926840b5d3a3e22.jpg: 640x640 1 Bad Weld,
1 Defect, 27.6ms
Speed: 4.4ms preprocess, 27.6ms inference, 2.9ms postprocess per image at shape
(1, 3, 640, 640)



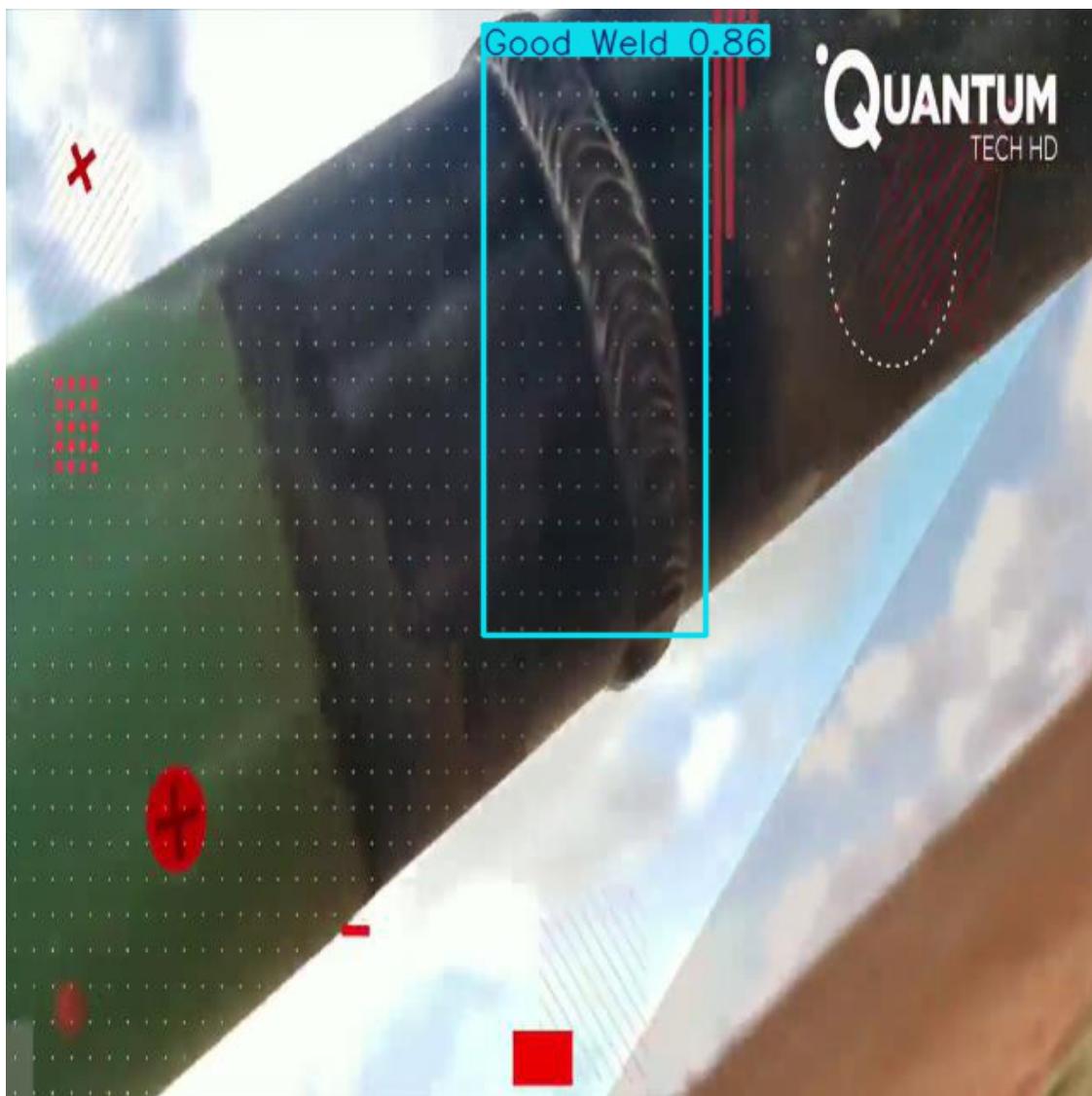
image 1/1 D:\Academics and University\Python\Intelligent Systems\Project
2\Welding Dataset\test\images\SampleV2_2_mp4-
59.jpg.rf.5e6543b79b7abac05cf8005d24f61eb5.jpg: 640x640 2 Bad Welds, 2 Defects,
29.4ms
Speed: 5.3ms preprocess, 29.4ms inference, 4.7ms postprocess per image at shape
(1, 3, 640, 640)



image 1/1 D:\Academics and University\Python\Intelligent Systems\Project
2\Welding Dataset\test\images\good_weld_vid274.jpeg.rf.b6f11d0f012275ef3823e747c
05bb460.jpg: 640x640 3 Good Welds, 22.3ms
Speed: 48.3ms preprocess, 22.3ms inference, 0.0ms postprocess per image at shape
(1, 3, 640, 640)



image 1/1 D:\Academics and University\Python\Intelligent Systems\Project
2\Welding Dataset\test\images\good_weld_vid780.jpeg.rf.f7e0a7a13d7a9d95291d104a3
6e20c4c.jpg: 640x640 1 Good Weld, 14.0ms
Speed: 5.7ms preprocess, 14.0ms inference, 14.9ms postprocess per image at shape
(1, 3, 640, 640)



```
image 1/1 D:\Acadamics and University\Python\Intelligent Systems\Project  
2\Welding  
Dataset\test\images\bad_weld_vid92.jpeg.rf.a3a1a6b5570c15b43fe91e402bb3e4d4.jpg:  
640x640 1 Bad Weld, 23.6ms  
Speed: 5.2ms preprocess, 23.6ms inference, 4.3ms postprocess per image at shape  
(1, 3, 640, 640)
```



```
image 1/1 D:\Acadamics and University\Python\Intelligent Systems\Project  
2\Welding Dataset\test\images\good_weld_vid1098.jpeg.jpg.rf.9237cce5d77a8a1c3a6d  
da6c976ca7d5.jpg: 640x640 (no detections), 26.0ms  
Speed: 4.9ms preprocess, 26.0ms inference, 1.4ms postprocess per image at shape  
(1, 3, 640, 640)
```



```
image 1/1 D:\Acadamics and University\Python\Intelligent Systems\Project  
2\Welding Dataset\test\images\good-stick-  
welds_19.png.jpg.rf.dc807e5b52e58b41c2c3c1dd6b833ec8.jpg: 640x640 10 Good Welds,  
28.2ms  
Speed: 6.5ms preprocess, 28.2ms inference, 3.1ms postprocess per image at shape  
(1, 3, 640, 640)
```

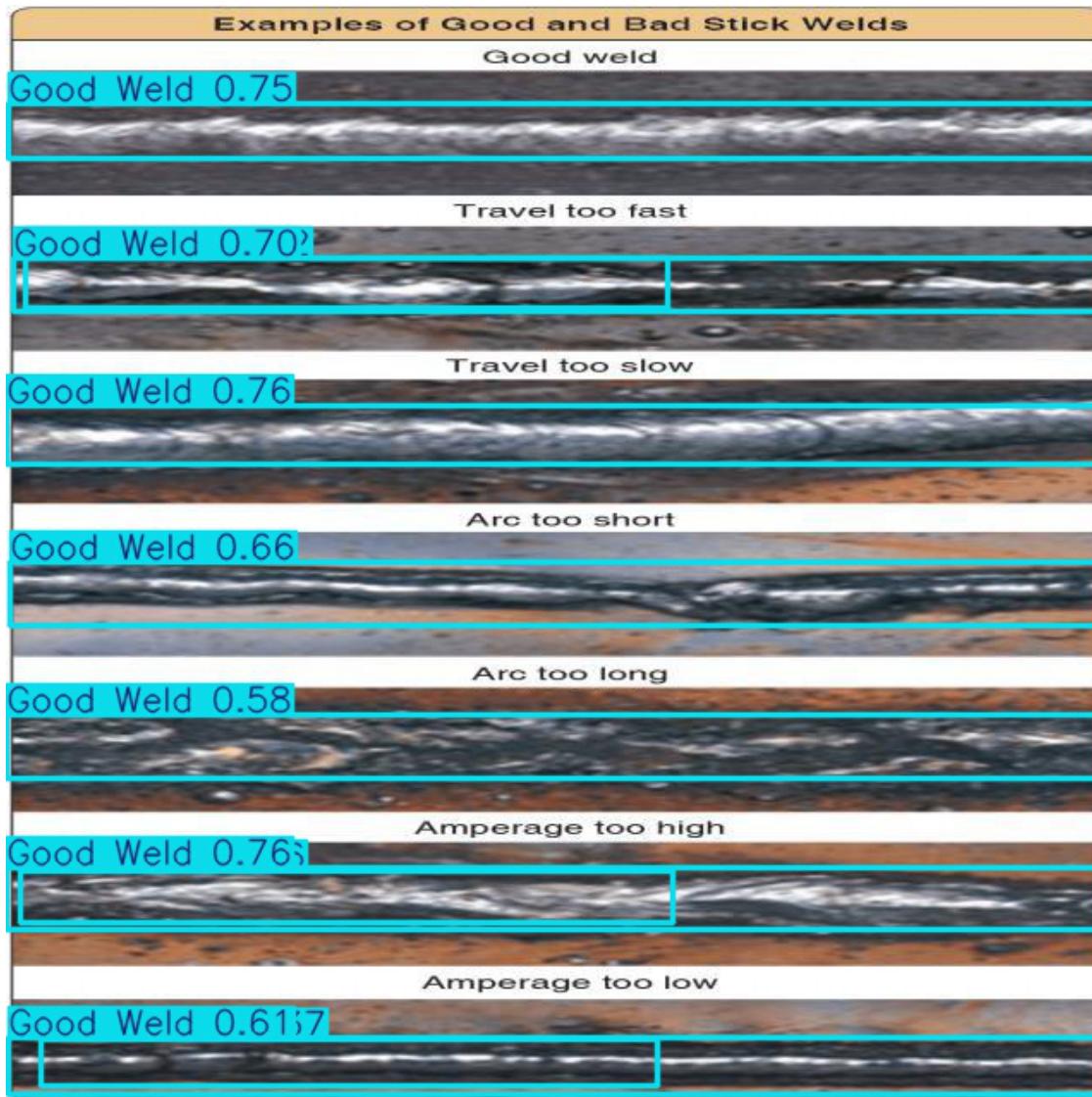
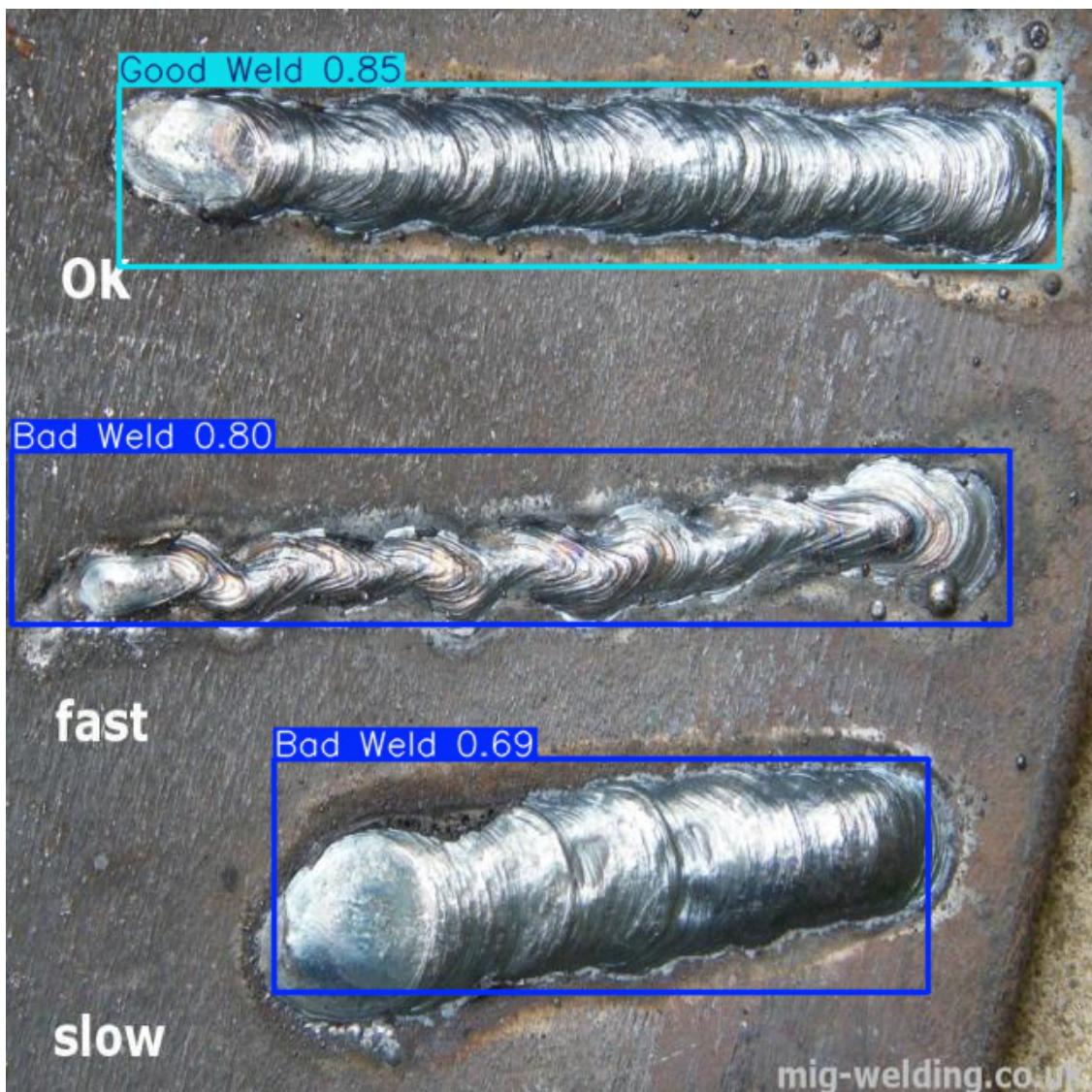


image 1/1 D:\Academics and University\Python\Intelligent Systems\Project
2\Welding Dataset\test\images\poor-Welding-
Images_22.jpeg.jpg.rf.3706f7e9a367ae053abfee4902a78288.jpg: 640x640 2 Bad Welds,
1 Good Weld, 27.7ms
Speed: 8.1ms preprocess, 27.7ms inference, 0.0ms postprocess per image at shape
(1, 3, 640, 640)



[]:

[]:

[]: