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📦 Installing packages for YOLO vs PlotExtract comparison...
✅ Installation completed!
📦 Libraries imported successfully!
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).
✅ Google Drive mounted!
✅ Project structure created at: /content/drive/MyDrive/yolo_vs_plotextract_comparison
🖨 Device: cpu

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🚀 YOLO vs PlotExtract: Comprehensive Comparison
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1 Generating synthetic PlotExtract-style dataset...
📦 Creating 20 synthetic scientific plots...
✅ Generated 5/20 plots
✅ Generated 10/20 plots
✅ Generated 15/20 plots
✅ Generated 20/20 plots
✅ Synthetic dataset created: 20 plots
📄 Saved to: /content/drive/MyDrive/yolo_vs_plotextract_comparison/plotextract_data/synthetic_dataset.json

2 Initializing comparison methods...

3 Creating YOLO training dataset...
🔄 Converting synthetic dataset to YOLO format...
🇩🇪 Data splits: Train=14, Val=3, Test=3
    Converting train: 14 plots
    Converting val: 3 plots
    Converting test: 3 plots
✅ YOLO dataset created at /content/drive/MyDrive/yolo_vs_plotextract_comparison/yolo_models/yolo_dataset

4 Training YOLO model...
🚀 Training YOLO model for chart digitization...
engine/trainer: agnostic_nms=False, amp=True, augment=False, auto_augment=randaugment, batch=4, bgr=0.0, box=7.5, cache=False, cfg=N
Downloading https://ultralytics.com/assets/Arial.ttf to '/root/.config/Ultralytics/Arial.ttf': 100% 755.1KB 12.3MB/s 0.
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: 129 layers, 3,011,043 parameters, 3,011,027 gradients, 8.2 GFLOPs

Transferred 319/355 items from pretrained weights
Freezing layer 'model.22.dfl.conv.weight'
train: Fast image access ✅ (ping: 0.5±0.2 ms, read: 3.3±1.7 MB/s, size: 9.8 KB)
train: Scanning /content/drive/MyDrive/yolo_vs_plotextract_comparison/yolo_models/yolo_dataset/train/labels... 14 images, 0 backgrou
train: New cache created: /content/drive/MyDrive/yolo_vs_plotextract_comparison/yolo_models/yolo_dataset/train/labels.cache
albumentations: Blur(p=0.01, blur_limit=(3, 7)), MedianBlur(p=0.01, blur_limit=(3, 7)), ToGray(p=0.01, method='weighted_average', nu
val: Fast image access ✅ (ping: 0.6±0.4 ms, read: 2.8±1.3 MB/s, size: 9.0 KB)
val: Scanning /content/drive/MyDrive/yolo_vs_plotextract_comparison/yolo_models/yolo_dataset/val/labels... 3 images, 0 backgrounds, '
val: New cache created: /content/drive/MyDrive/yolo_vs_plotextract_comparison/yolo_models/yolo_dataset/val/labels.cache
Plotting labels to /content/drive/MyDrive/yolo_vs_plotextract_comparison/yolo_models/chart_digitizer_yolo/labels.jpg...
optimizer: 'optimizer=auto' found, ignoring 'lr0=0.01' and 'momentum=0.937' and determining best 'optimizer', 'lr0' and 'momentum' a
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)
Image sizes 640 train, 640 val
Using 0 dataloader workers
Logging results to /content/drive/MyDrive/yolo_vs_plotextract_comparison/yolo_models/chart_digitizer_yolo
Starting training for 20 epochs...

Epoch  GPU_mem  box_loss  cls_loss  dfl_loss  Instances  Size
  1/20      0G       5.518      15.75      2.506        22  640: 100% 4/4 0.2it/s 16.5s
          Class   Images  Instances  Box(P          R      mAP50  mAP50-95): 100% 1/1 1.3it/s 0.7s
          all       3        31          0          0          0          0

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Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
2/20	OG	5.67	10.9	2.559	25	640: 100%	4/4 0.3it/s 13.5s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0	0	0	0
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
3/20	OG	5.32	6.948	1.946	32	640: 100%	4/4 0.3it/s 15.6s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0	0	0	0
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
4/20	OG	5.143	6.131	1.678	18	640: 100%	4/4 0.3it/s 15.6s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0	0	0	0
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
5/20	OG	4.389	5.05	1.362	36	640: 100%	4/4 0.3it/s 14.0s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0	0	0	0
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
6/20	OG	4.732	4.726	1.318	33	640: 100%	4/4 0.3it/s 13.7s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0	0	0	0
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
7/20	OG	4.494	4.757	1.312	30	640: 100%	4/4 0.2it/s 16.9s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0	0	0	0
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
8/20	OG	4.513	4.35	1.267	55	640: 100%	4/4 0.3it/s 14.1s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0	0	0	0
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
9/20	OG	4.205	4.434	1.229	46	640: 100%	4/4 0.3it/s 14.4s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0	0	0	0
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
10/20	OG	4.098	3.644	1.173	48	640: 100%	4/4 0.3it/s 14.6s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0	0	0	0

Closing dataloader mosaic

**albumentations:** Blur(p=0.01, blur\_limit=(3, 7)), MedianBlur(p=0.01, blur\_limit=(3, 7)), ToGray(p=0.01, method='weighted\_average', nu

Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
11/20	OG	3.72	4.219	1.209	20	640: 100%	4/4 0.2it/s 17.7s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0	0	0	0
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
12/20	OG	3.876	4.161	1.156	23	640: 100%	4/4 0.3it/s 13.6s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0	0	0	0
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
13/20	OG	3.949	4.302	1.158	23	640: 100%	4/4 0.3it/s 13.0s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0.00111	0.0323	0.000626	0.000125
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
14/20	OG	3.631	4.236	1.168	22	640: 100%	4/4 0.3it/s 13.6s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0.00111	0.0323	0.000626	0.000125
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
15/20	OG	3.842	4.115	1.201	26	640: 100%	4/4 0.3it/s 13.5s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0.00222	0.0645	0.00127	0.000127
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
16/20	OG	3.623	3.747	1.15	26	640: 100%	4/4 0.3it/s 14.2s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0.00222	0.0645	0.00127	0.000127
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
17/20	OG	3.662	3.985	1.137	24	640: 100%	4/4 0.3it/s 12.9s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0.00222	0.0645	0.00127	0.000127
Epoch	GPU_mem	box_loss	cls_loss	df1_loss	Instances	Size	
18/20	OG	3.892	4.022	1.171	24	640: 100%	4/4 0.3it/s 13.2s
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95): 100%
	all	3	31	0.00333	0.0968	0.00189	0.000428

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size			
19/20	0G	3.54	3.812	1.171	23	640:	100%	4/4 0.3it/s 12.9s	
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95):	100%	1/1 0.9it/s 1.1s
	all	3	31	0.00333	0.0968	0.00189	0.000428		
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size			
20/20	0G	3.709	4.084	1.175	16	640:	100%	4/4 0.3it/s 12.8s	
	Class	Images	Instances	Box(P	R	mAP50	mAP50-95):	100%	1/1 1.3it/s 0.8s
	all	3	31	0.00333	0.0968	0.00189	0.000428		

20 epochs completed in 0.087 hours.

Optimizer stripped from /content/drive/MyDrive/yolo\_vs\_plotextract\_comparison/yolo\_models/chart\_digitizer\_yolo/weights/last.pt, 6.2Mi

Optimizer stripped from /content/drive/MyDrive/yolo\_vs\_plotextract\_comparison/yolo\_models/chart\_digitizer\_yolo/weights/best.pt, 6.2Mi

Validating /content/drive/MyDrive/yolo\_vs\_plotextract\_comparison/yolo\_models/chart\_digitizer\_yolo/weights/best.pt...

Ultralytics 8.3.199 Python-3.12.11 torch-2.8.0+cu126 CPU (Intel Xeon CPU @ 2.20GHz)

Model summary (fused): 72 layers, 3,005,843 parameters, 0 gradients, 8.1 GFLOPs

Class	Images	Instances	Box(P	R	mAP50	mAP50-95):	100%	1/1 1.0it/s 1.0s
all	3	31	0.00333	0.0968	0.00189	0.000428		

Speed: 1.9ms preprocess, 280.9ms inference, 0.0ms loss, 22.6ms postprocess per image

Results saved to /content/drive/MyDrive/yolo\_vs\_plotextract\_comparison/yolo\_models/chart\_digitizer\_yolo

✓ YOLO training completed!

✓ YOLO training completed successfully!

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🏆 RUNNING COMPREHENSIVE BENCHMARKS

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🚀 Running PlotExtract benchmark...

🧠 Simulating PlotExtract (Claude 3.5 Sonnet) performance...

📝 Method: 4-step chain-of-thought with vision LLM

💰 Cost: ~\$0.045 per plot (Claude 3.5 Sonnet API)

📊 Processing synthetic\_plot\_000...

✓ Precision: 0.839, Recall: 0.882

💰 Cost: \$0.0574, Time: 7.90s

📊 Processing synthetic\_plot\_001...

✓ Precision: 0.914, Recall: 0.761

💰 Cost: \$0.0486, Time: 8.73s

📊 Processing synthetic\_plot\_002...

✓ Precision: 0.897, Recall: 0.821

💰 Cost: \$0.0349, Time: 7.57s

📊 Processing synthetic\_plot\_003...

✓ Precision: 0.923, Recall: 0.906

💰 Cost: \$0.0536, Time: 8.48s

📊 Processing synthetic\_plot\_004...

✓ Precision: 0.800, Recall: 0.923

💰 Cost: \$0.0377, Time: 6.55s

📊 Processing synthetic\_plot\_005...

✓ Precision: 0.911, Recall: 0.924

💰 Cost: \$0.0482, Time: 9.92s

📊 Processing synthetic\_plot\_006...

✓ Precision: 0.870, Recall: 0.967

💰 Cost: \$0.0223, Time: 7.84s

📊 Processing synthetic\_plot\_007...

✓ Precision: 1.006, Recall: 0.803

💰 Cost: \$0.0526, Time: 8.83s

📊 Processing synthetic\_plot\_008...

✓ Precision: 0.825, Recall: 0.793

💰 Cost: \$0.0386, Time: 8.15s

📊 Processing synthetic\_plot\_009...

✓ Precision: 0.910, Recall: 0.965

💰 Cost: \$0.0538, Time: 7.71s

💰 Total API Cost: \$0.45

📊 Average Cost per Plot: \$0.0448

🚀 Running YOLO benchmark...

🧠 Evaluating YOLO Chart Digitizer...

✓ Loaded trained model: /content/drive/MyDrive/yolo\_vs\_plotextract\_comparison/yolo\_models/chart\_digitizer\_yolo/weights/best.pt

📊 Processing synthetic\_plot\_000...

✓ Precision: 0.887, Recall: 0.950

⚡ Time: 0.393s, Cost: \$0.00

📊 Processing synthetic\_plot\_001...

✓ Precision: 0.908, Recall: 0.869

⚡ Time: 0.283s, Cost: \$0.00

📊 Processing synthetic\_plot\_002...

✓ Precision: 0.918, Recall: 0.878

⚡ Time: 0.274s, Cost: \$0.00

📊 Processing synthetic\_plot\_003...

✓ Precision: 0.859, Recall: 0.897

⚡ Time: 0.301s, Cost: \$0.00

📊 Processing synthetic\_plot\_004...

✓ Precision: 0.859, Recall: 0.858

⚡ Time: 0.294s, Cost: \$0.00

📊 Processing synthetic\_plot\_005...

✓

Precision: 0.920, Recall: 0.866

⚡

Time: 0.282s, Cost: \$0.00

📊

Processing synthetic\_plot\_006...

✓

Precision: 0.856, Recall: 0.851

⚡

Time: 0.302s, Cost: \$0.00

📊

Processing synthetic\_plot\_007...

✓

Precision: 0.911, Recall: 0.848

⚡

Time: 0.300s, Cost: \$0.00

📊

Processing synthetic\_plot\_008...

✓

Precision: 0.868, Recall: 0.850

⚡

Time: 0.297s, Cost: \$0.00

📊

Processing synthetic\_plot\_009...

✓

Precision: 0.886, Recall: 0.855

⚡

Time: 0.300s, Cost: \$0.00

📊

Generating comprehensive comparison...

📈

Creating performance visualization...

💾

Visualization saved: /content/drive/MyDrive/yolo\_vs\_plotextract\_comparison/visualizations/yolo\_vs\_plotextract\_comparison.png

