yolov8m_finetuned_1 Hyperparameter Tuning Report

Generated: 2025-11-28 21:37:03

1. Optimization Overview

Property	Value
Model	yolov8m_finetuned_1
Dataset	bdd100k_yolo_tuning
Total Trials	42
Completed Trials	41
Failed Trials	1
Best Trial	35
Best mAP@0.5	0.5771
Optimization Duration	2:37:27.650793

2. Optimization Configuration

Parameter	Value
Total Trials	40
Epochs per Trial	8
Batch Size	96
Startup Trials (TPE)	10
Device	cuda
Number of Classes	10
Train Images	16391
Val Images	10000

2.5 Executive Summary & Key Findings

Metric	Value
■ Best Performance	Trial #35: mAP@0.5 = 0.5771
■ Performance Range	0.5258 to 0.5771 (9.7% improvement)
■ Mean Performance	0.5647 across 41 trials
■ Best Optimizer	SGD (mean: 0.5689)
■■ Optimal Image Size	768px (4.12% better)
■■ Optimization Time	2:37:27.650793
■ Success Rate	41/42 trials (97.6%)

Key Insights:

• The optimization process successfully explored 42 trials, achieving a 9.7% performance improvement from worst to best.

• **SGD** optimizer demonstrated superior performance with mean mAP@0.5 of 0.5689.

• Image size of **768px** provided optimal accuracy-efficiency tradeoff.

• High consistency achieved: mean performance (0.5647) close to best (0.5771), indicating robust hyperparameter space.

3. Best Hyperparameters

Parameter	Value	Description
imgsz	768	
optimizer	SGD	Optimization algorithm
lr0	0.000161	Initial learning rate
momentum	0.909850	SGD momentum / Adam beta1
weight_decay	0.000428	Weight decay (L2 penalty)
warmup_epochs	1	Warmup epochs
warmup_momentum	0.514931	Warmup momentum
warmup_bias_lr	0.018938	
mosaic	0.820538	Mosaic augmentation
mixup	0.023789	Mixup augmentation

4. Top 20 Trials Performance

#	mAP@0.5	ImgSz	Opt	lr0	mom	mixup	mosaic
1	0.5771	768	SGD	0.0002	0.910	0.02	0.82
2	0.5769	768	SGD	0.0002	0.857	0.17	0.98
3	0.5767	768	SGD	0.0001	0.909	0.12	0.89
4	0.5765	768	SGD	0.0002	0.926	0.19	0.96
5	0.5762	768	SGD	0.0002	0.906	0.04	0.88
6	0.5761	768	SGD	0.0001	0.895	0.08	0.89
7	0.5760	768	SGD	0.0001	0.906	0.14	0.82
8	0.5759	768	SGD	0.0001	0.857	0.13	0.99
9	0.5756	768	SGD	0.0002	0.969	0.11	0.94
10	0.5756	768	SGD	0.0002	0.913	0.16	0.98
11	0.5754	768	SGD	0.0002	0.924	0.18	0.83
12	0.5752	768	SGD	0.0001	0.889	0.15	0.70
13	0.5751	768	SGD	0.0013	0.939	0.16	0.92
14	0.5750	768	SGD	0.0007	0.879	0.12	0.92
15	0.5749	768	SGD	0.0007	0.875	0.19	0.91
16	0.5747	768	SGD	0.0002	0.857	0.20	0.97
17	0.5722	768	Adam	0.0002	0.858	0.14	0.55
18	0.5721	768	Adam	0.0004	0.952	0.20	0.84
19	0.5715	768	Adam	0.0001	0.921	0.12	0.75
20	0.5688	768	Adam	0.0001	0.897	0.19	0.89

4.1 Detailed Hyperparameters - Top 5 Trials

Rank 1: Trial 35 (mAP@0.5: 0.5771)

imgsz=768, lr0=0.000161, mixup=0.023789, momentum=0.909850, mosaic=0.820538, optimizer=SGD, warmup_bias_lr=0.018938, warmup_epochs=1, warmup_momentum=0.514931, weight_decay=0.000428

Rank 2: Trial 0 (mAP@0.5: 0.5769)

imgsz=768, lr0=0.000184, mixup=0.166489, momentum=0.856970, mosaic=0.984955, optimizer=SGD, warmup_bias_lr=0.002058, warmup_epochs=2, warmup_momentum=0.818633, weight_decay=0.000540

Rank 3: Trial 22 (mAP@0.5: 0.5767)

imgsz=768, lr0=0.000141, mixup=0.123344, momentum=0.909425, mosaic=0.891341, optimizer=SGD, warmup_bias_lr=0.005799, warmup_epochs=3, warmup_momentum=0.668541, weight_decay=0.000731

Rank 4: Trial 11 (mAP@0.5: 0.5765)
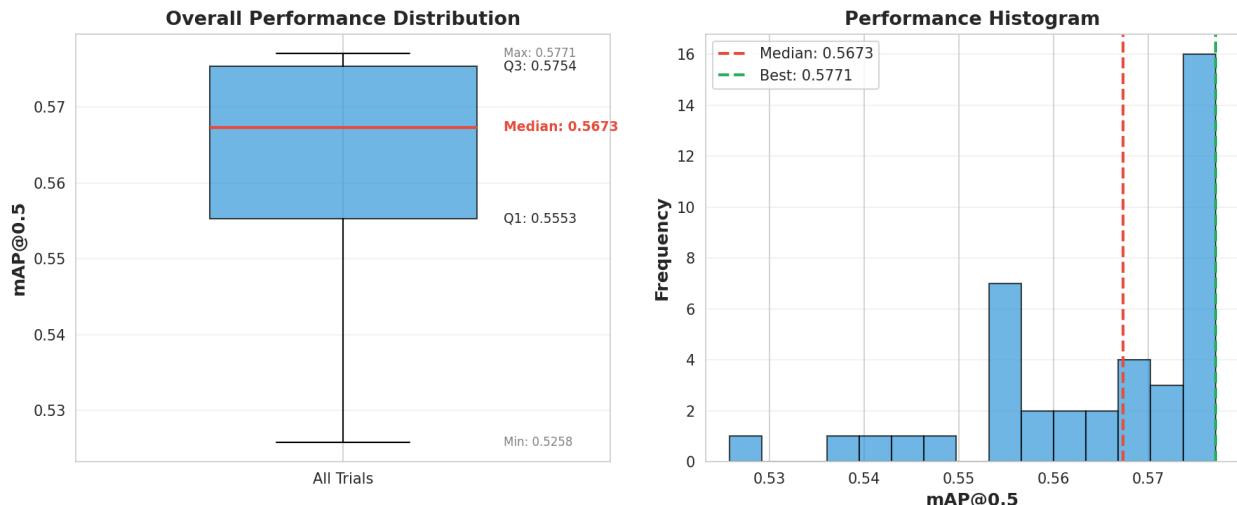
imgsz=768, lr0=0.000192, mixup=0.189244, momentum=0.925614, mosaic=0.964981, optimizer=SGD, warmup_bias_lr=0.002411, warmup_epochs=2, warmup_momentum=0.751166, weight_decay=0.000922

Rank 5: Trial 34 (mAP@0.5: 0.5762)

imgsz=768, lr0=0.000153, mixup=0.038448, momentum=0.906332, mosaic=0.878509, optimizer=SGD, warmup_bias_lr=0.024714, warmup_epochs=1, warmup_momentum=0.548316, weight_decay=0.000937
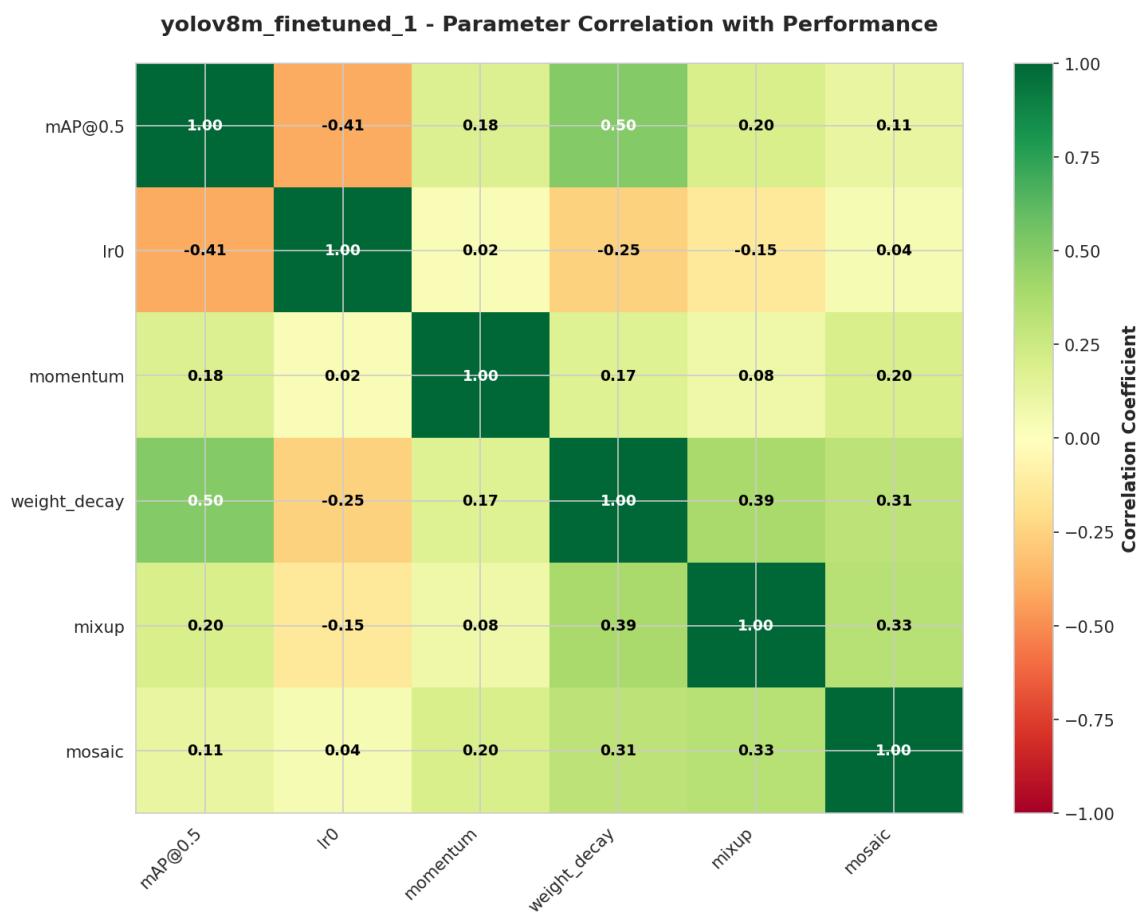
5. Optimization Visualizations & Analysis

5.0 Performance Distribution Analysis

Statistic	Value
Mean	0.5647
Median	0.5673
Std Dev	0.0126
IQR (Q3-Q1)	0.0201
Range	0.0512
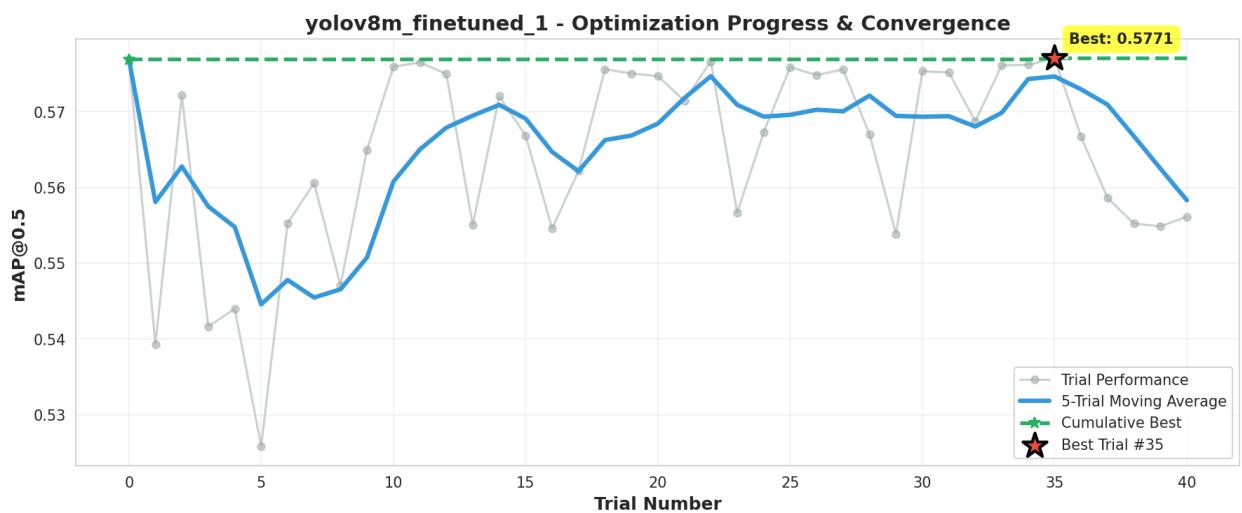
5.1 Parameter Correlation Analysis

yolov8m_finetuned_1 - Parameter Correlation with Performance

Correlation Insights:
- Strongest positive correlation: **weight_decay** (0.504) - Higher values tend to improve performance.
- Strongest negative correlation: **lr0** (-0.405) - Higher values tend to decrease performance.
- Green cells indicate positive correlation, red cells indicate negative correlation.
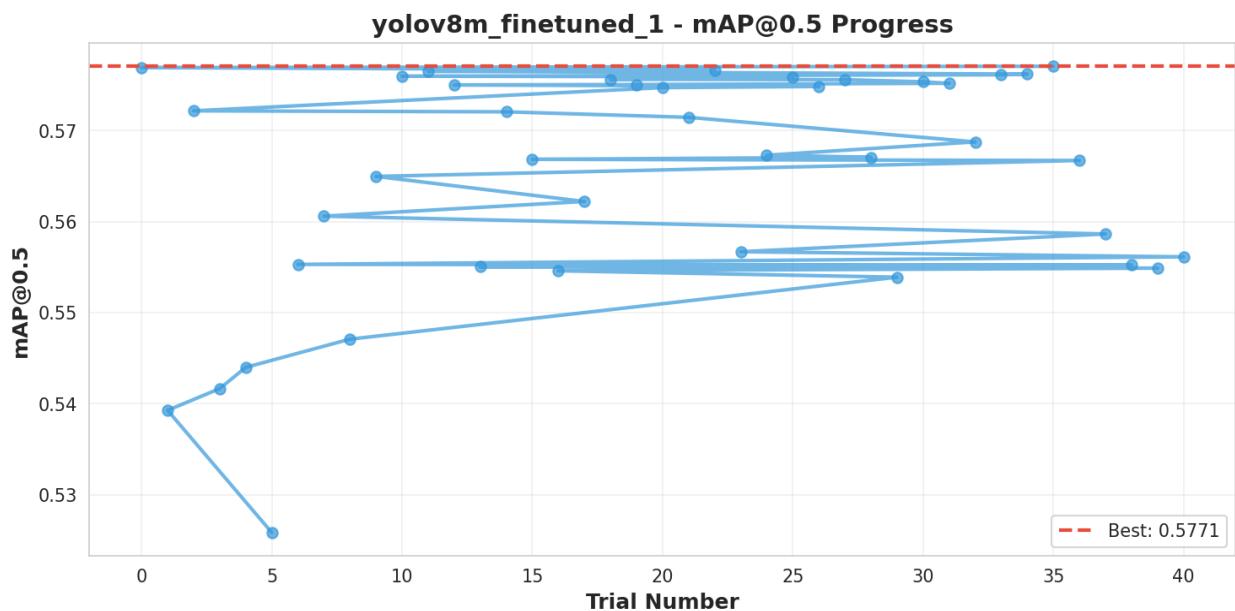
5.2 Optimization Timeline & Convergence
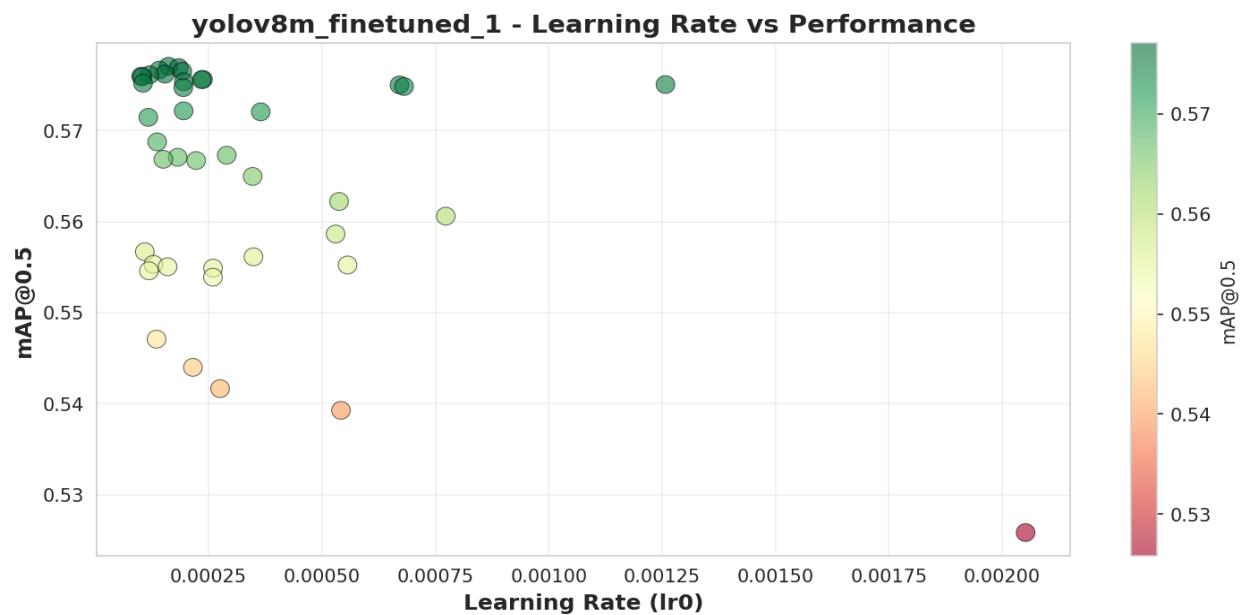
Convergence Analysis:

• Best solution found at trial **#35** (85.4% through optimization).

• Moving average shows late discovery pattern.

• Cumulative best curve indicates moderate exploration of hyperparameter space.
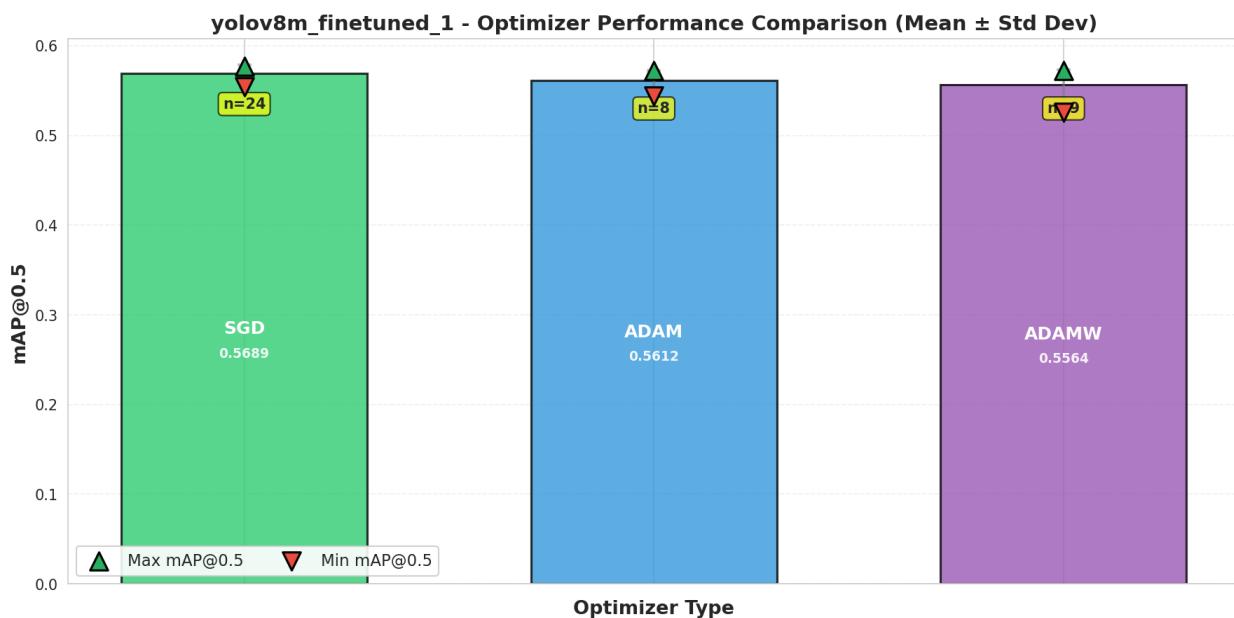
5.3 mAP@0.5 Progress Over Trials

yolov8m_finetuned_1 - mAP@0.5 Progress

5.4 Learning Rate Impact on Performance

yolov8m_finetuned_1 - Learning Rate vs Performance

5.5 Optimizer Performance Comparison

yolov8m_finetuned_1 - Optimizer Performance Comparison (Mean ± Std Dev)

Optimizer	Mean	Max	Min	Std Dev	Trials
SGD	0.5689	0.5771	0.5539	0.0099	24
ADAM	0.5612	0.5721	0.5440	0.0108	8
ADAMW	0.5564	0.5722	0.5258	0.0164	9
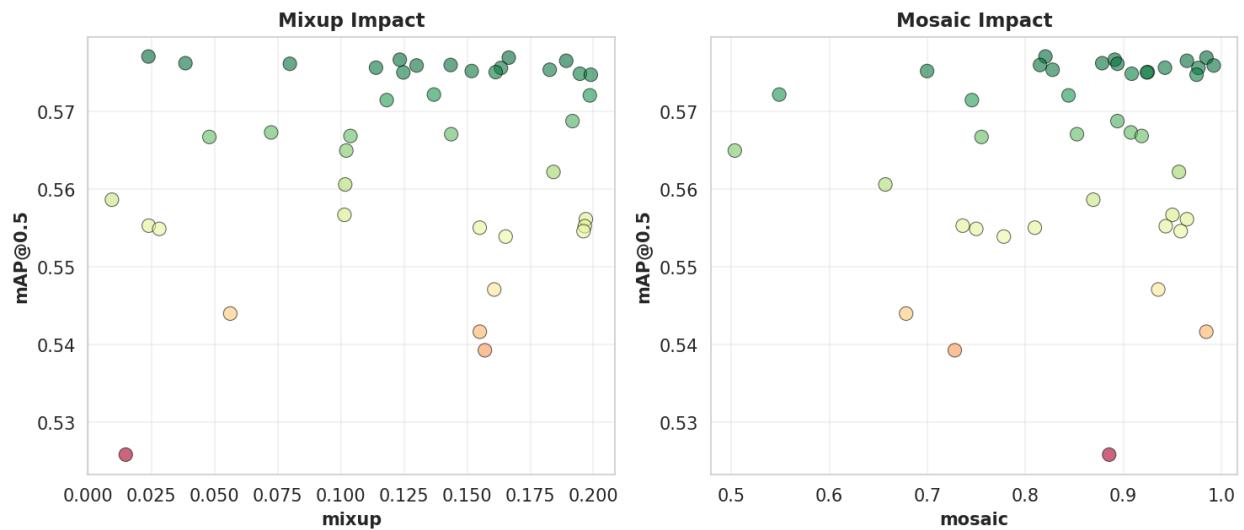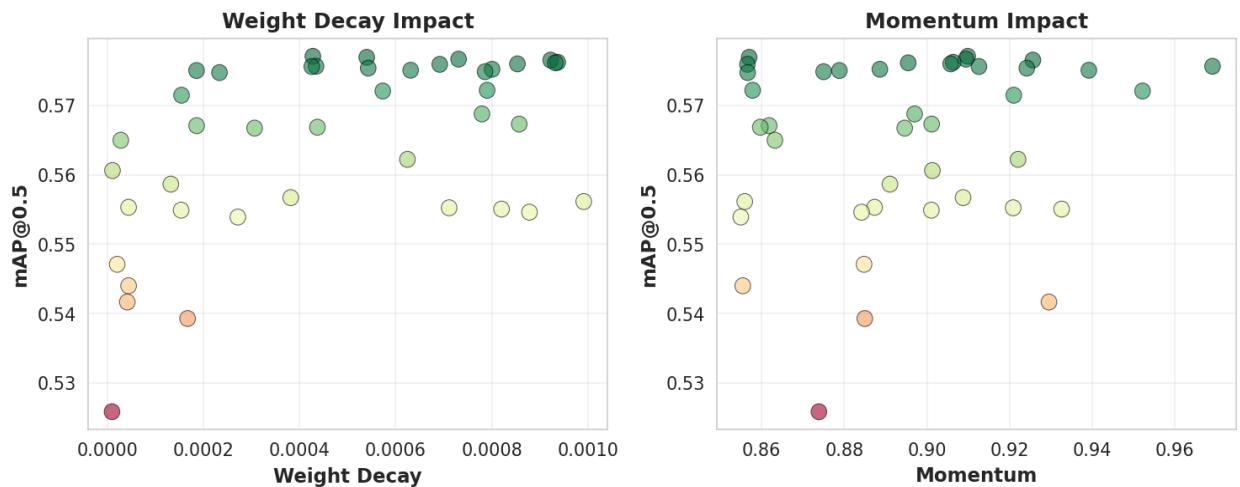
Analysis: SGD achieved the highest mean performance (0.5689) across 24 trials. The error bars show the standard deviation, indicating performance consistency.

5.6 Augmentation Parameters Impact

5.7 Regularization Parameters Impact


Weight Decay Impact

Momentum Impact

5.8 Image Size Impact on Performance

yolov8m_finetuned_1 - Image Size Impact on Performance
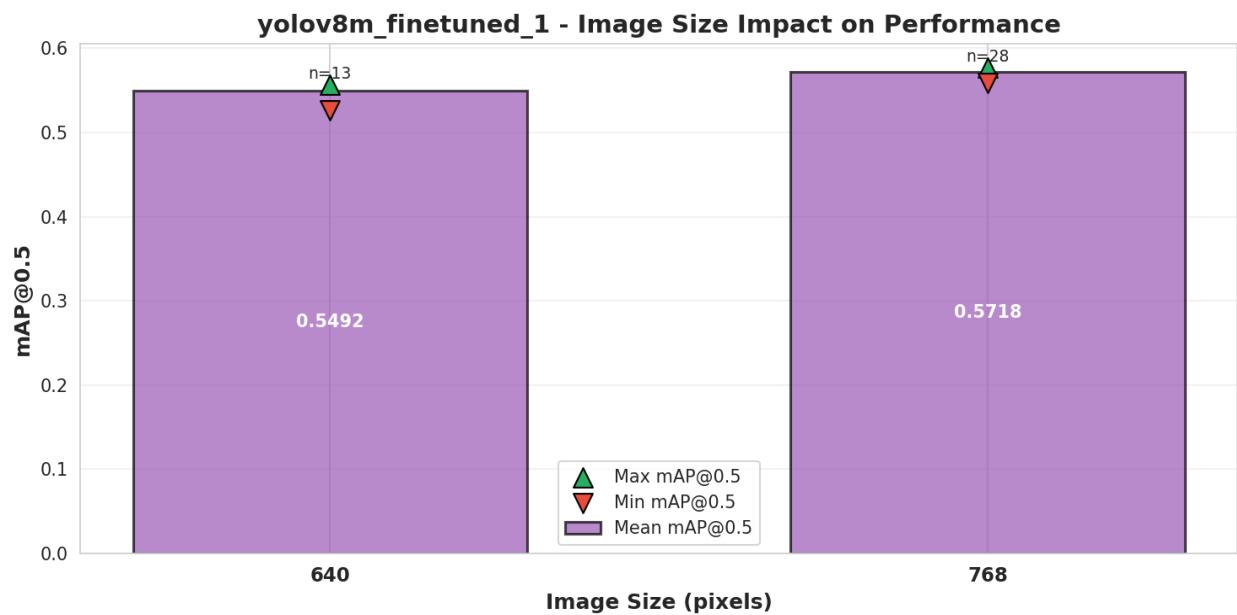
Image Size	Mean mAP@0.5	Max mAP@0.5	Min mAP@0.5	Trials
640	0.5492	0.5567	0.5258	13
768	0.5718	0.5771	0.5586	28

5.9 Key Insights & Production Recommendations

■ **Optimal Configuration for Production Deployment:**

1. Image Processing:
• Use **768px** input resolution for optimal accuracy
• Expected performance: **mAP@0.5 = 0.5771**
• Tradeoff: Higher resolution improves accuracy but increases inference time

2. Optimizer Configuration:
• Algorithm: **SGD**
• Learning rate (lr0): **0.000161**
• Momentum: **0.9099**
• Weight decay: **0.000428**

3. Training Warmup:
• Warmup epochs: **1**
• Warmup momentum: **0.5149**
• Warmup bias lr: **0.018938**

4. Data Augmentation:
• Mosaic augmentation: **0.8205** (strong augmentation for robustness)
• Mixup augmentation: **0.0238** (light augmentation)
• Recommendation: Use these exact values for similar datasets

5. Performance Metrics:
• Best trial found at **#35** out of 42 trials
• Performance improvement: **9.7%** over worst trial
• Consistency: Mean mAP@0.5 = 0.5647 (Std = 0.0126)

6. Deployment Recommendations:
• **SGD** optimizer demonstrated best performance (mean: 0.5689)
• **SGD** outperformed AdamW by 2.3%
• For maximum accuracy, use 768px images
• For faster inference with slight accuracy trade-off, consider 640px (mAP: 0.5492)

7. Next Steps:
• Train full model with these hyperparameters
• Monitor validation metrics for overfitting
• Consider ensemble methods for further improvement

■ **Confidence Level:**
• Based on 41 successful trials
• Optimization converged steadily (best at 85.4% through search)
• Standard deviation (0.0126) indicates high consistency

Metric	Best Trial	Mean Performance	Worst Trial
mAP@0.5	0.5771	0.5647	0.5258
Trial #	#35	-	#5
Learning Rate	0.000161	0.000335	0.002051
Momentum	0.9099	0.8953	0.8738

6. All Trials Summary

Metric	Value
Completed Trials	41
Best mAP@0.5	0.5771
Worst mAP@0.5	0.5258
Mean mAP@0.5	0.5647
Std Dev mAP@0.5	0.0126
Median mAP@0.5	0.5673