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TANS

Target-Aware Nuisance Shaping for Object Detection

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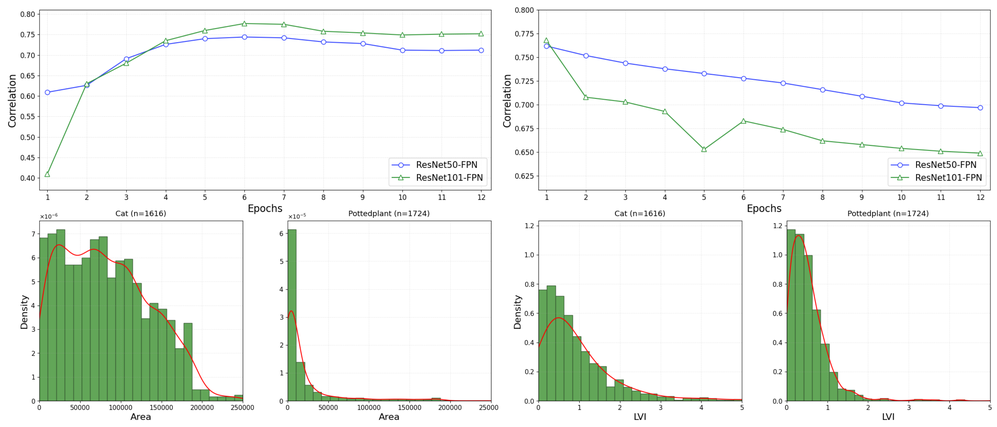
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NEURAL INFORMATION PROCESSING SYSTEMS

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01 Motivation: Scale and visibility bias

A detector should recognize objects across scales and visibility conditions. Generic augmentation increases variation but does not explicitly control how each class covers these attribute states.

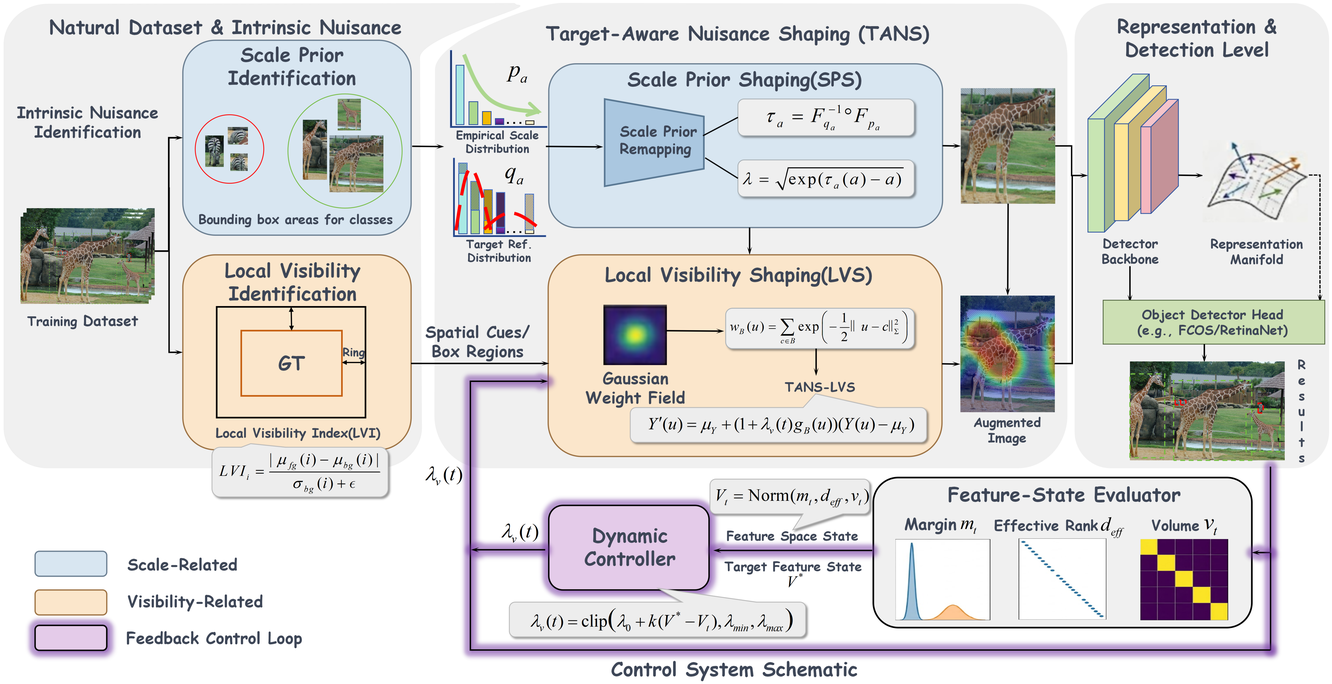


Pascal VOC: class AP remains correlated with area and Local Visibility Index (LVI). The category density plots reveal different scale and visibility distributions; LVI measures local foreground–background separability.

Scale and visibility have class-dependent structure. TANS uses that structure to guide generated samples, then adapts shaping strength as the representation evolves.

02 Method: Target-aware nuisance shaping

SPS transports class-conditional scales toward under-covered states. LVS shapes local contrast on the updated boxes; measured feature-state feedback adapts visibility strength.



03 Comparison: Policy search and shaping

Table 3: **Scale-aware policy search and target-aware shaping.**

Dimension	Scale-Aware Automatic Augmentations [43]	TANS
Optimization paradigm	Searches image- and instance-level scale-aware transformation policies.	Class-conditional scale priors and box-conditioned visibility shaping.
Sample generation	Applies searched transformations, probabilities, and magnitudes.	Monotone log-scale transport; local contrast modulation preserves geometry.
Controller	Searched policies; heuristic image-level and differentiable instance-level adaptation.	Measured feature-state statistics govern shaping strength.
Interpretability	Selected operators, probabilities, magnitudes, and schedules.	Scale priors, local visibility, and measured representation geometry.

Scale-Aware Automatic Augmentations: Chen et al., TPAMI 2023.
TANS grounds the intervention and its control in object attributes and measured representation geometry.

04 Experiments: Detection across architectures

Table 1: **COCO results with Faster R-CNN under the official MMDetection 1× schedule.** We highlight our proposed components in color. **Bold** numbers denote the best result, and underlined numbers denote the second best in each block.

Methods	MS COCO Metrics AP ↑	AP_{50} ↑	AP_{75} ↑	AP_s ↑	AP_m ↑	AP_l ↑
Detector: Faster R-CNN (ResNet-50-FPN)						
Baseline	35.8	57.0	38.4	20.6	39.1	46.4
+ Mixup ($\alpha = 0.5$) [18]	35.9	57.3	38.4	20.8	39.2	46.1
+ Manifold Mixup ($\alpha = 1.0$) [41]	36.4	57.5	39.2	21.2	40.0	46.5
+ Cutout [27]	36.1	57.4	38.7	21.1	39.6	46.6
+ CutMix ($\alpha = 1.0$) [19]	36.6	58.0	39.2	21.4	39.9	47.0
+ CutMix + SUMix [42]	36.9	58.2	39.5	21.6	40.3	47.2
+ Simple Copy-Paste [20]	37.7	58.6	40.8	22.9	40.9	48.0
+ SPS-only (Step 1)	38.2	59.1	41.5	23.3	41.5	48.8
+ LVS-only (Step 2)	38.1	59.0	41.5	23.6	41.4	48.5
+ TANS (Step 1 & 2)	**39.0**	**60.0**	**42.7**	**24.7**	**42.2**	**49.7**
Detector: Faster R-CNN (ResNet-101-FPN)						
Baseline	37.7	59.0	40.7	21.6	41.4	49.2
+ CutMix ($\alpha = 1.0$) [19]	38.6	59.7	41.6	22.4	42.5	49.9
+ CutMix + SUMix [42]	38.9	60.0	42.6	22.8	42.9	50.1
+ Simple Copy-Paste [20]	39.9	60.3	43.6	24.4	43.8	51.0
+ SPS-only (Step 1)	40.5	60.6	44.3	24.4	44.6	52.2
+ LVS-only (Step 2)	40.7	60.8	44.4	25.1	44.6	51.9
+ TANS (Step 1 & 2)	**41.8**	**61.5**	**45.5**	**26.1**	**45.9**	**52.7**

Table 2: **Results on Pascal VOC and YOLOv11.** Left: Faster R-CNN on Pascal VOC under the 2× schedule used in our implementation. Right: YOLOv11 on COCO under a common 1000-epoch maximum budget with early stopping. Values are reported in percentage points.

(a) Faster R-CNN on Pascal VOC

Methods	AP ↑
ResNet-50	
No Aug.	79.8
Copy-Paste	81.2
SPS-only (Step 1)	81.9
LVS-only (Step 2)	81.7
TANS (Step 1 & 2)	**82.6**
ResNet-101	
No Aug.	81.1
Copy-Paste	82.3
SPS-only (Step 1)	82.7
LVS-only (Step 2)	82.5
TANS (Step 1 & 2)	**83.5**

(b) YOLOv11 on COCO

Methods	$mAP_{50:95}$ ↑	mAP_{50} ↑	Prec. ↑	Rec. ↑
No Aug.	36.1	51.5	61.5	47.5
Mixup	40.7	56.9	63.8	52.1
Mosaic	43.0	59.4	66.9	54.4
Mosaic + Mixup	45.2	61.9	70.0	56.9
OA-DG [31]	43.6	60.1	69.1	55.3
ControlAug [29]	44.8	61.6	70.8	56.1
SPS-only (Step 1)	45.5	62.2	**71.8**	56.2
LVS-only (Step 2)	45.7	62.4	70.6	56.6
TANS (Step 1 & 2)	**46.6**	**63.4**	71.4	**58.3**