



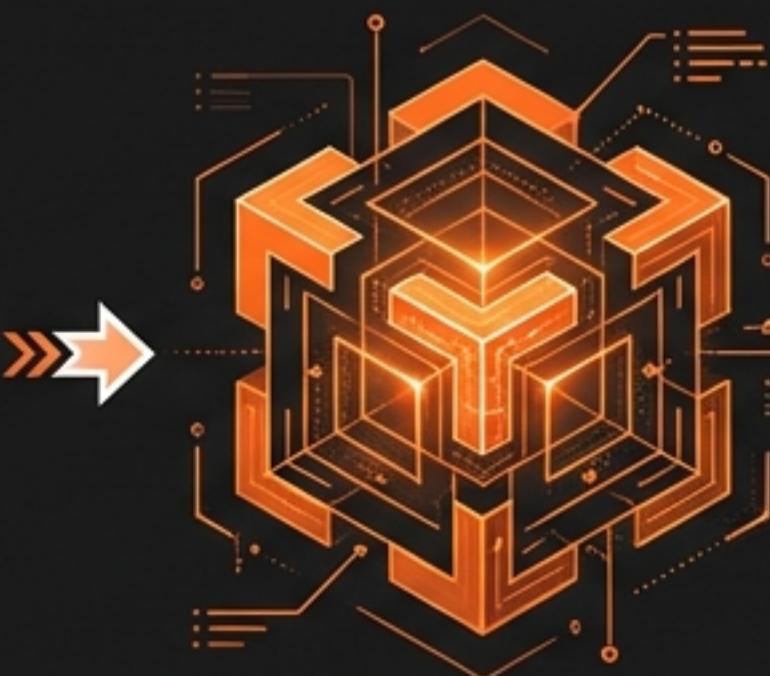
# **RESNET50 TRANSFER LEARNING CIFAR-10 CLASSIFICATION STRATEGY**

TECHNICAL ANALYSIS,  
ARCHITECTURAL DYNAMICS, AND  
FORENSIC EVALUATION

DATE: JANUARY 2026  
STATUS: COMPREHENSIVE REVIEW  
METRIC GOAL: MACRO-AVERAGED F1

## OBJECTIVE

Transition from low-complexity grayscale datasets (Fashion MNIST) to high-complexity RGB feature extraction.

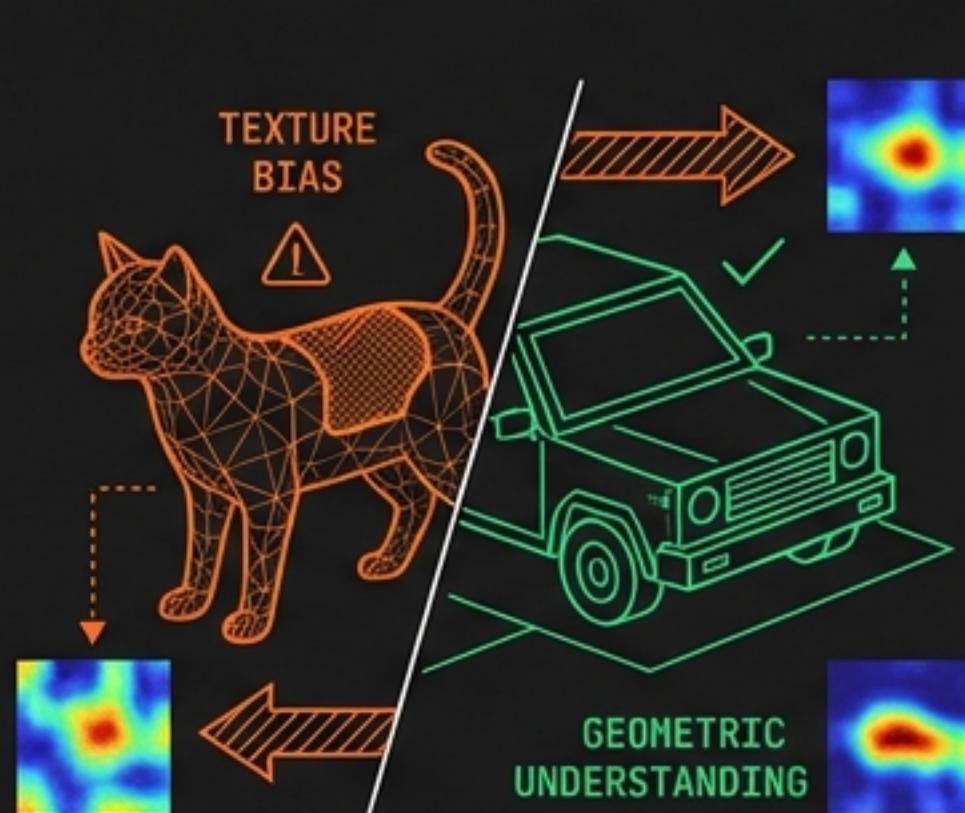


Target architecture leverages ResNet50 backbone for 32x32 CIFAR-10 classification.

## VERDICT

Model demonstrates robust spatial localization (Grad-CAM validated). Critical bias detected in deformable object textures (Cats/Dogs) vs. rigid structures.

Texture bias exceeds geometric understanding in failure cases.



## KEY METRICS

MINIMUM VIABLE ACCURACY (MVA)

65%

Metric: Macro-Averaged F1-Score

Mitigates Class Imbalance Bias

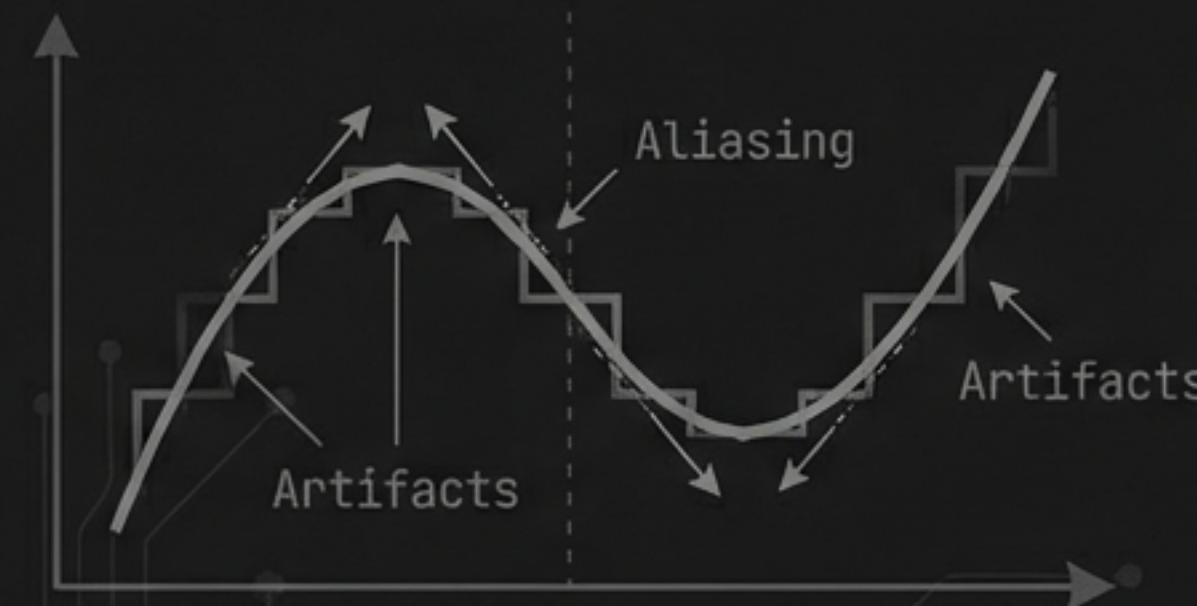
# DATA PIPELINE & DIMENSIONAL DIMENSIONAL INTEGRITY



**KEY INSIGHT: STRICT DIMENSIONAL AUDITING PREVENTS 'GARBAGE IN, GARBAGE OUT' SCENARIOS.**

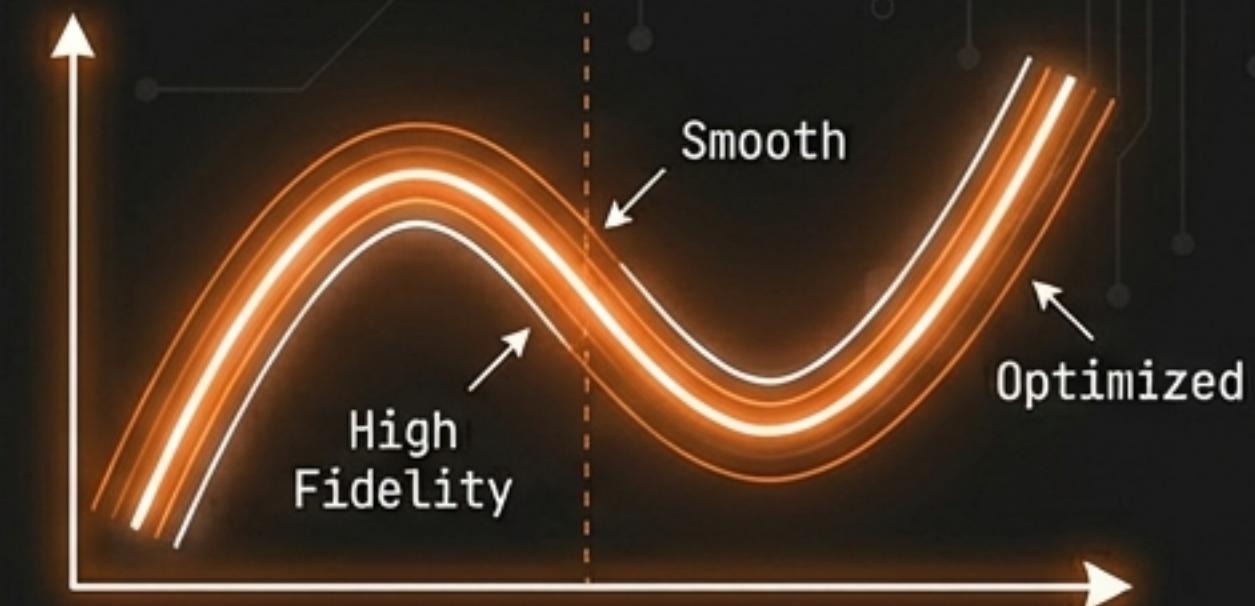
# DEEP DIVE: INTERPOLATION STRATEGY

## BILINEAR (STANDARD)



Standard resizing introduces aliasing artifacts. Degrades feature fidelity at low resolutions.

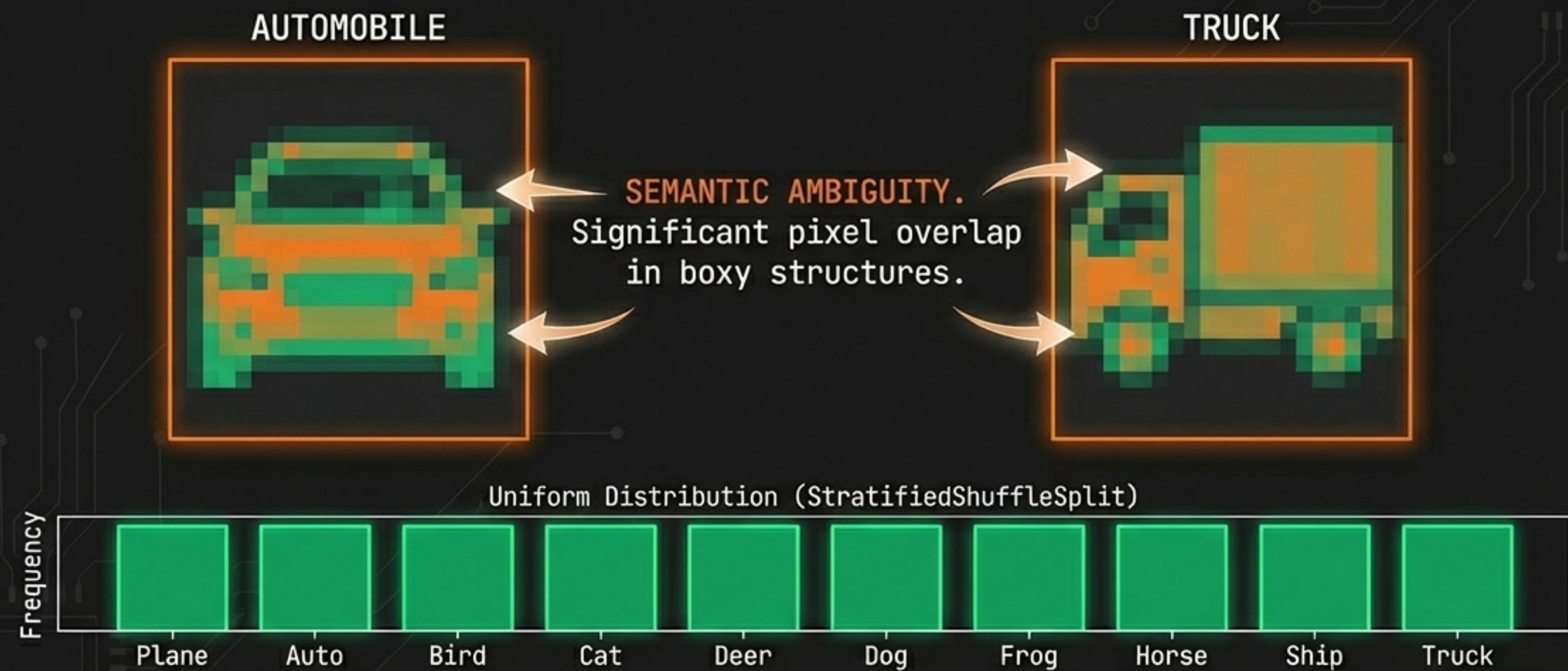
## BICUBIC (SELECTED)



**Optimized Strategy.** Preserves high-frequency textures critical for ResNet backbone feature reuse.

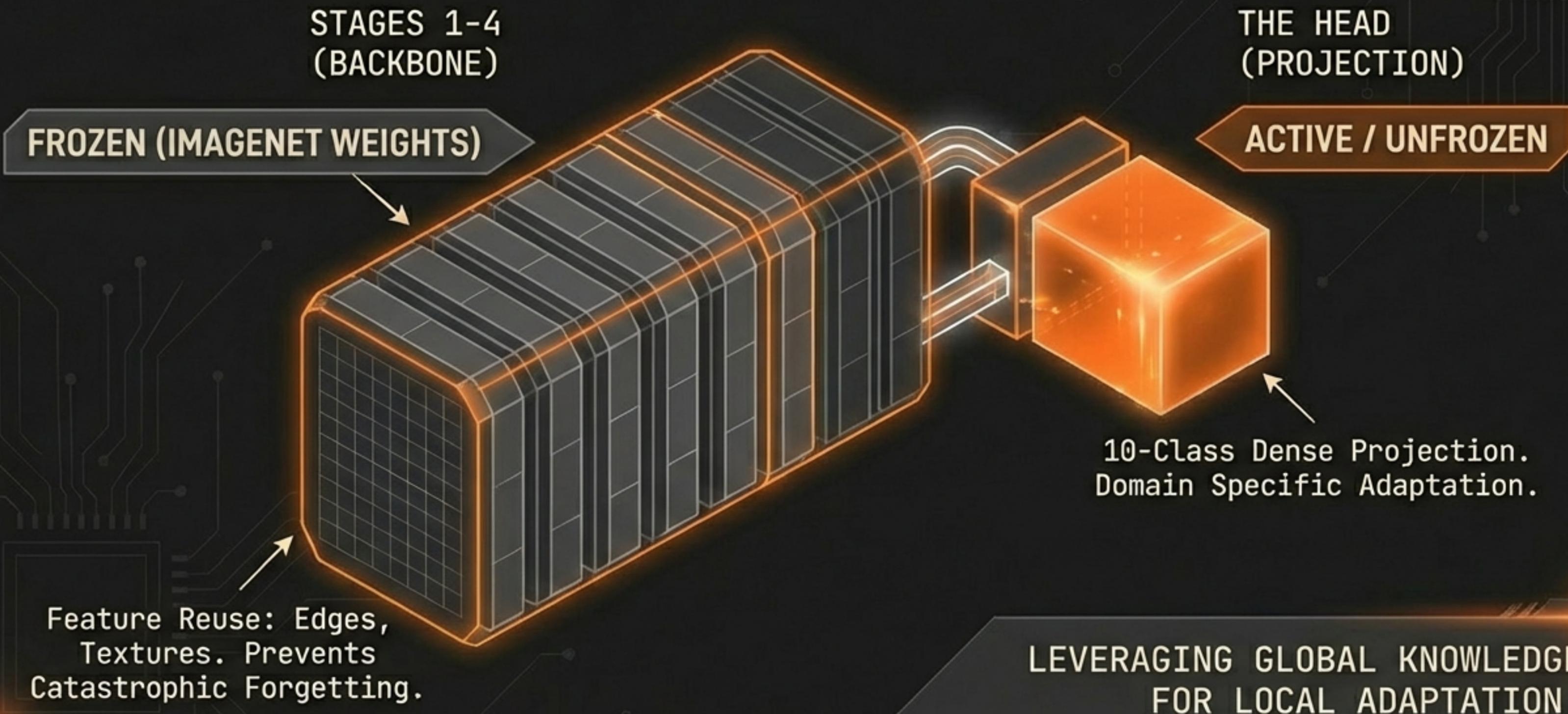
**Context:** ResNet backbone expects 224x224 inputs. Upsampling quality from 32x32 is the single point of failure for feature fidelity.

# EDA: THE SEMANTIC GAP



**THE LIMITS OF RESOLUTION:** 32x32 pixels create inherent challenges for discriminatory power between structurally similar classes.

# ARCHITECTURAL STRATEGY: RESNET50 TRANSFER LEARNING



# TRAINING DYNAMICS & OPTIMIZATION

## DIFFERENTIAL LEARNING RATES

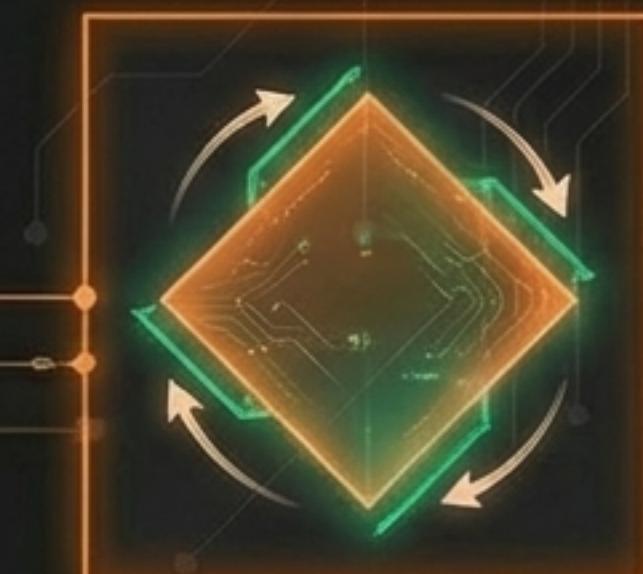
Backbone: Low LR (Stability)  
Head: High LR (Plasticity)

## ONECYCLELR SCHEDULER

Super-convergence strategy.  
Rapid LR increase followed  
by decay.

## INVARIANCE AUGMENTATION

Geometric: Flip/Rotate  
Photometric: Brightness  
Goal: Force Spatial Invariance.



# DIAGNOSTIC: THE CONFUSION MATRIX

		Predicted								
		Cat	Dog	Plane	Car	Truck	Ship	Horse	Deer	Frog
Actual	Cat	95	15	18						
	Dog	15	92	7						
	Plane			98	20	22				
	Bird			2	96	1				
	Car				97					
	Truck					95	3			
	Ship					2	92	5		
	Horse						5	95		
	Deer							1	97	
	Frog									

## CLUSTER A: TEXTURE SIMILARITY

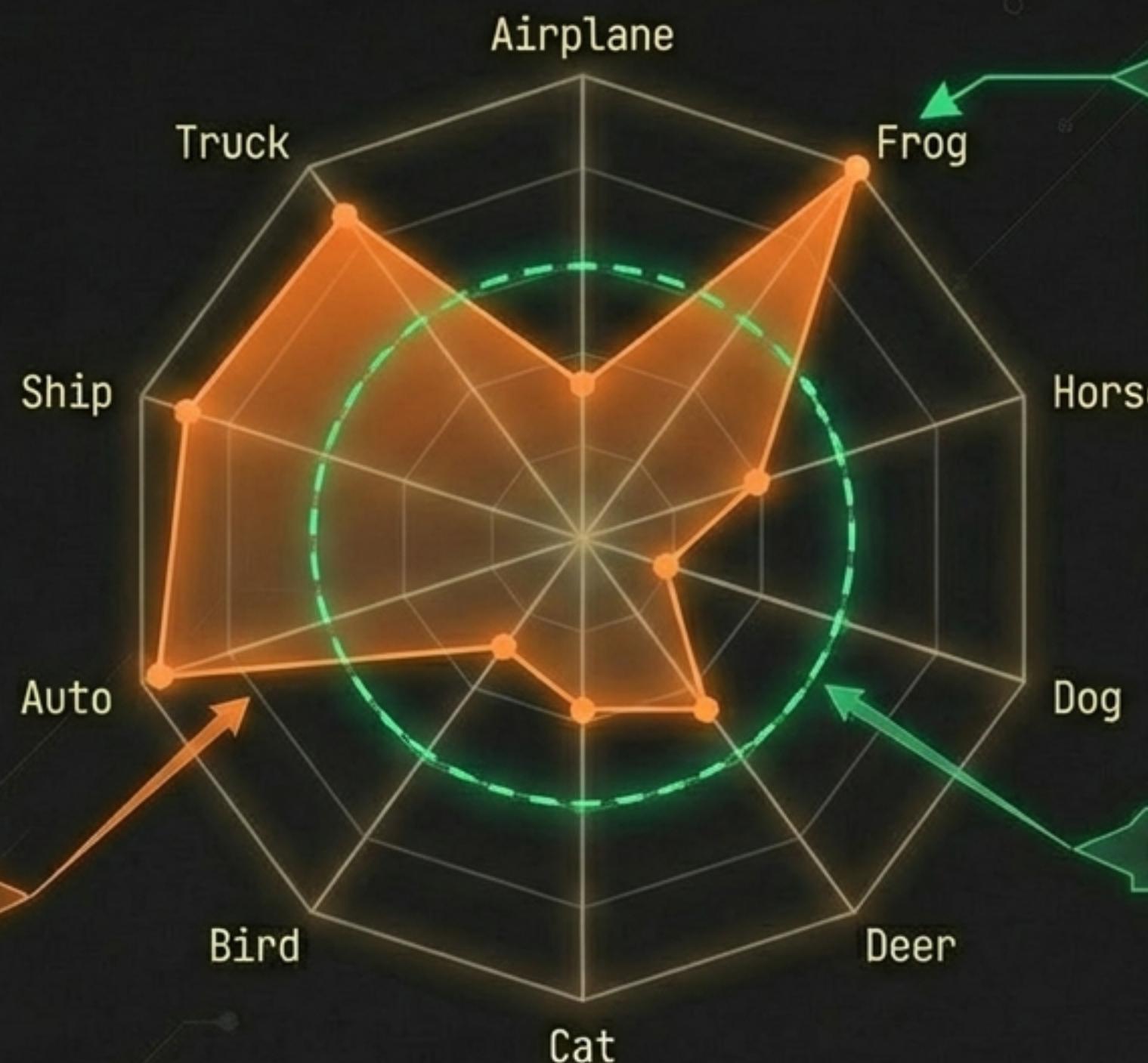
High confusion: Cat <-> Dog  
Driver: Fur texture dominance.

## CLUSTER B: BACKGROUND BIAS

High confusion: Plane <-> Bird  
Driver: Blue Sky context.

DIAGNOSING THE OFF-DIAGONAL NOISE.

# CLASS-WISE PERFORMANCE DECOMPOSITION



RIGID OBJECT SUPERIORITY

THE FROG PHENOMENON

High accuracy driven by unique color dominance (Green) vs. structural complexity.

GLOBAL MEAN THRESHOLD

# EXPLAINABLE AI (XAI): GRAD-CAM FORENSICS

INPUT



HEATMAP



OVERLAY



INPUT-OUTPUT ALIGNMENT VERIFIED

**PASSED THE “CLEVER HANS” AUDIT.** The model learns semantics and geometry, effectively ignoring contextual background noise.

# ROOT CAUSE ANALYSIS: BIAS & TEXTURE

## CONTEXTUAL OVERRFITTING



→ Ship classified as Plane.

Diagnosis: "Blue Water ≈ Blue Sky.  
Model over-weighted the background  
context."

## SEMANTIC OVERLAP



→ Dog classified as Cat.

Diagnosis: "Texture Dominance. Model  
prioritized low-frequency features (fur)  
over geometric shape (snout)."

# INTEGRATED FORENSIC REPORT



## SYMPTOM: VARIANCE IN ACCURACY

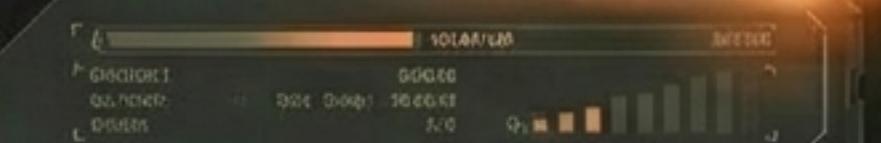
Significant performance gap between Rigid and Deformable classes.

## DIAGNOSIS: GENERALIST PROFILE

Model lacks 'Specialist' discriminators for classes with high Inter-Class Similarity.

## VERDICT: SYSTEMATIC ERROR

Errors are not random. Driven by Semantic Overlap (Cat/Dog) and Background Correlation.

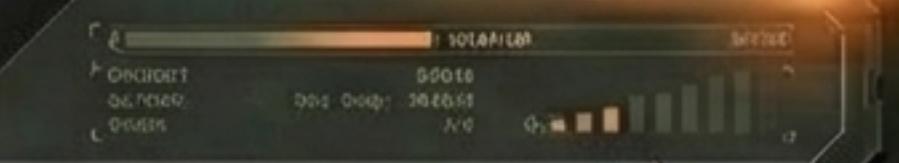


# INTERVENTION I: HARD EXAMPLE MINING



## STRATEGY: RETRAINING ON CONFUSED CLUSTERS

- Create specialized batches consisting ONLY of high-confusion classes.
- GOAL: Force optimizer to abandon low-frequency features (fur) and discover high-frequency discriminators (pupil shape, ear geometry).



# INTERVENTION II: ADVANCED AUGMENTATION

## STANDARD



Single Concept.

## CUTMIX



Blended Concepts.

► **LOGIC:** CutMix forces the model to focus on structural boundaries rather than continuous texture patches.

► **ARCHITECTURAL NOTE:** Re-verify network depth. Test ResNet18 vs. ResNet50 to reduce over-parameterization risks.

## CONCLUSION & ROADMAP

### STATUS: MVA > 65% ACHIEVED

- Robust Spatial Localization verified via Grad-CAM.
- Data Pipeline Integrity Confirmed.

### NEXT STEPS

1. Implement Weighted CrossEntropyLoss for Deformable classes.
2. Deploy CutMix Augmentation.
3. A/B Test ResNet18 vs. ResNet50.

FROM BLACK BOX TO TRANSPARENT STRATEGIC ASSET.

