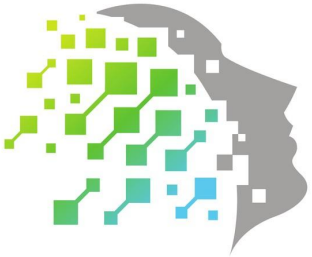

ICLR 2025

CAT-3DGS: A Context-Adaptive Triplane Approach to Rate-Distortion-Optimized 3DGS Compression

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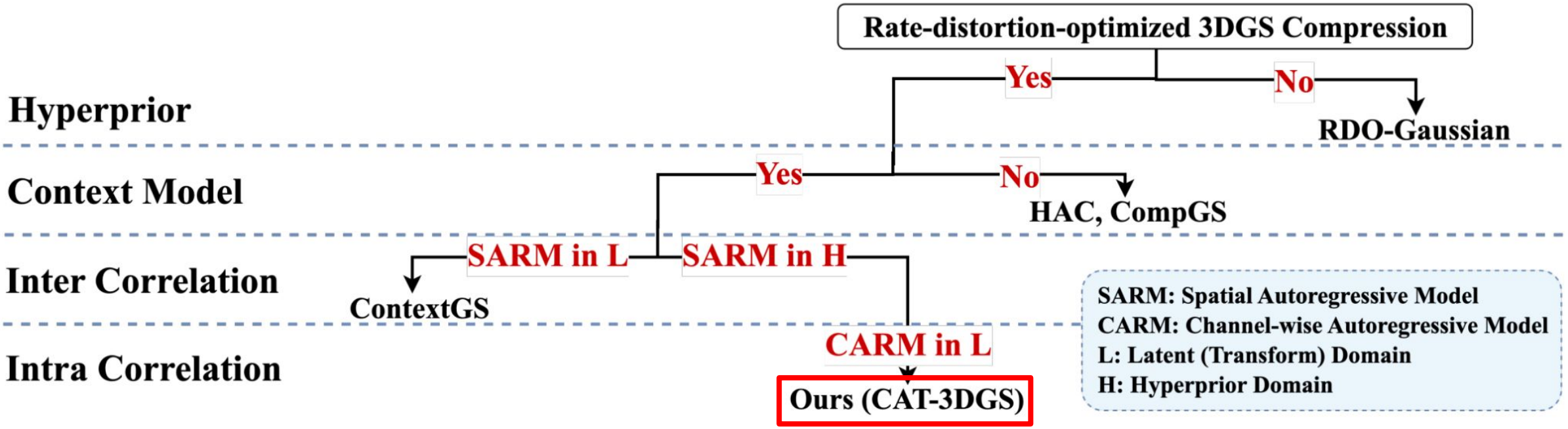
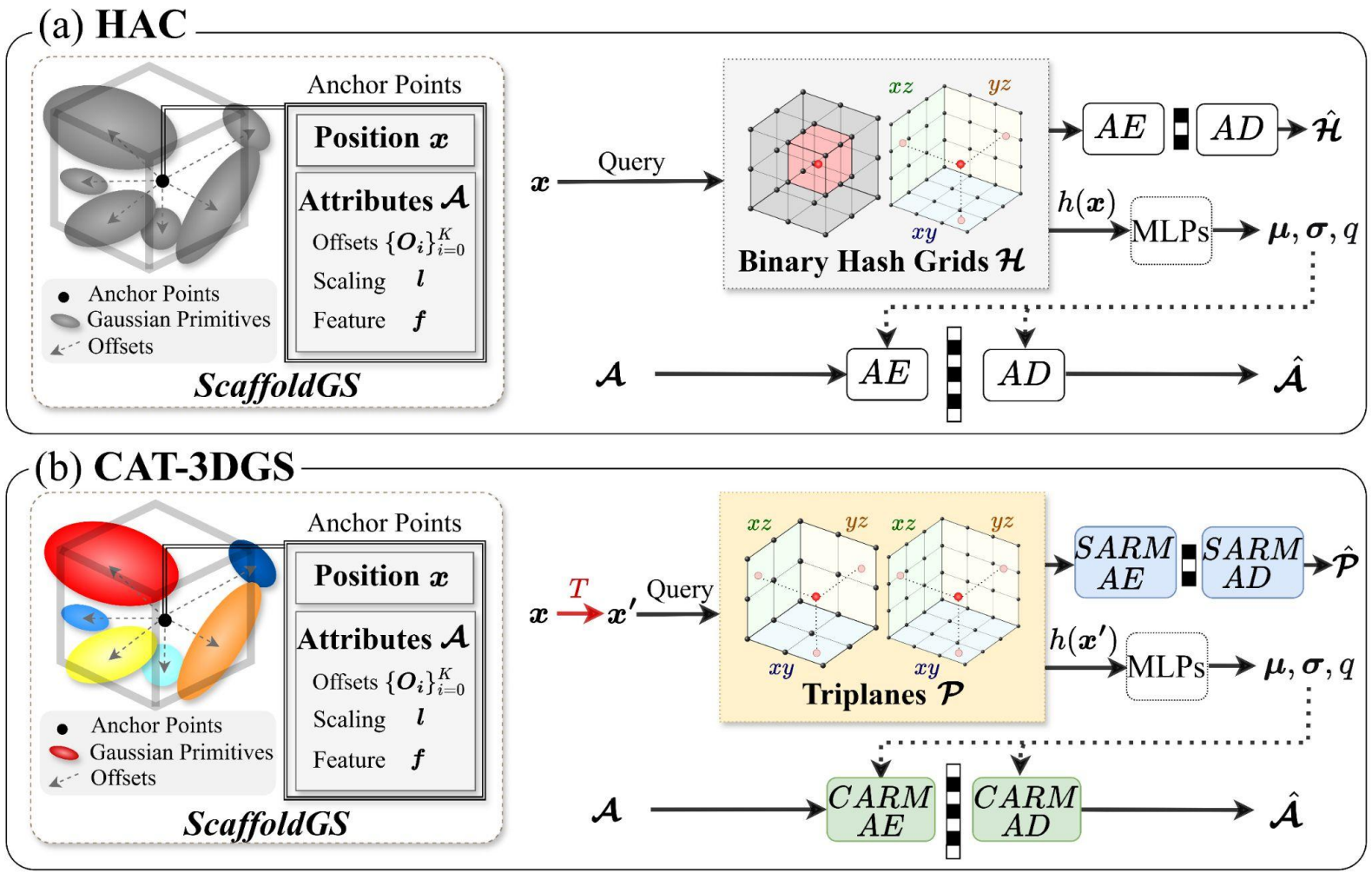
Background

- 3D Gaussian Splatting (3DGS) excels in real-time, high-quality novel view synthesis.
- 3DGS's inherent redundancy demands efficient compression with **entropy coding** and **rate-distortion optimization**.



Attribute Coding: HAC vs. CAT-3DGS Introduction



HAC

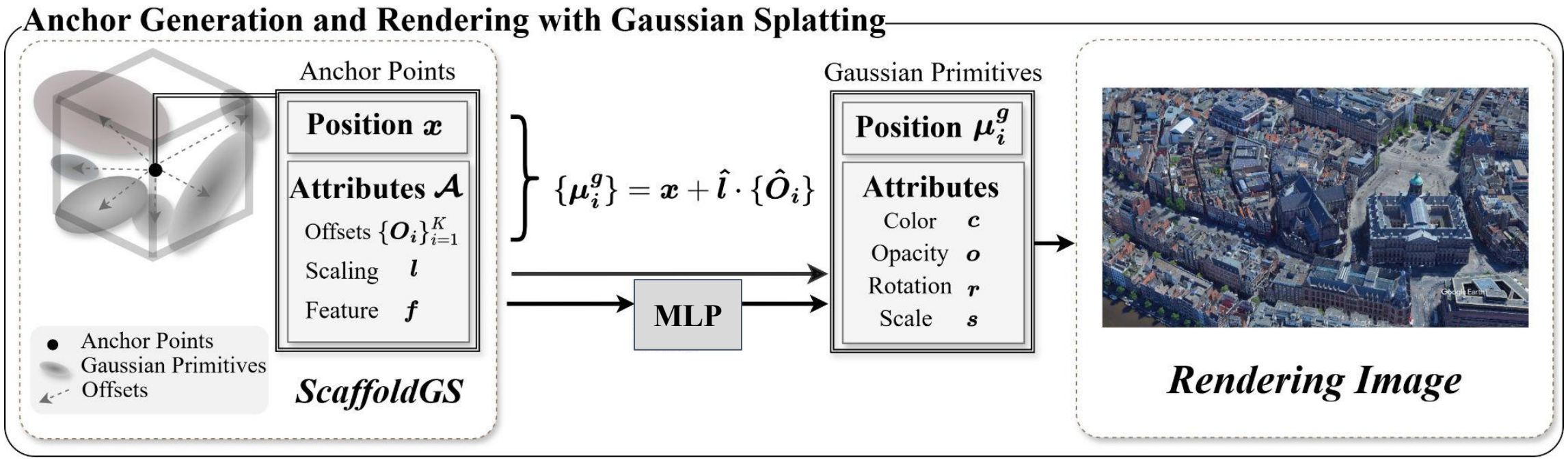
Hash-grid-based Hyperprior

Proposed CAT-3DGS

1. Triplane-based Hyperprior
2. Channel-wise AR models

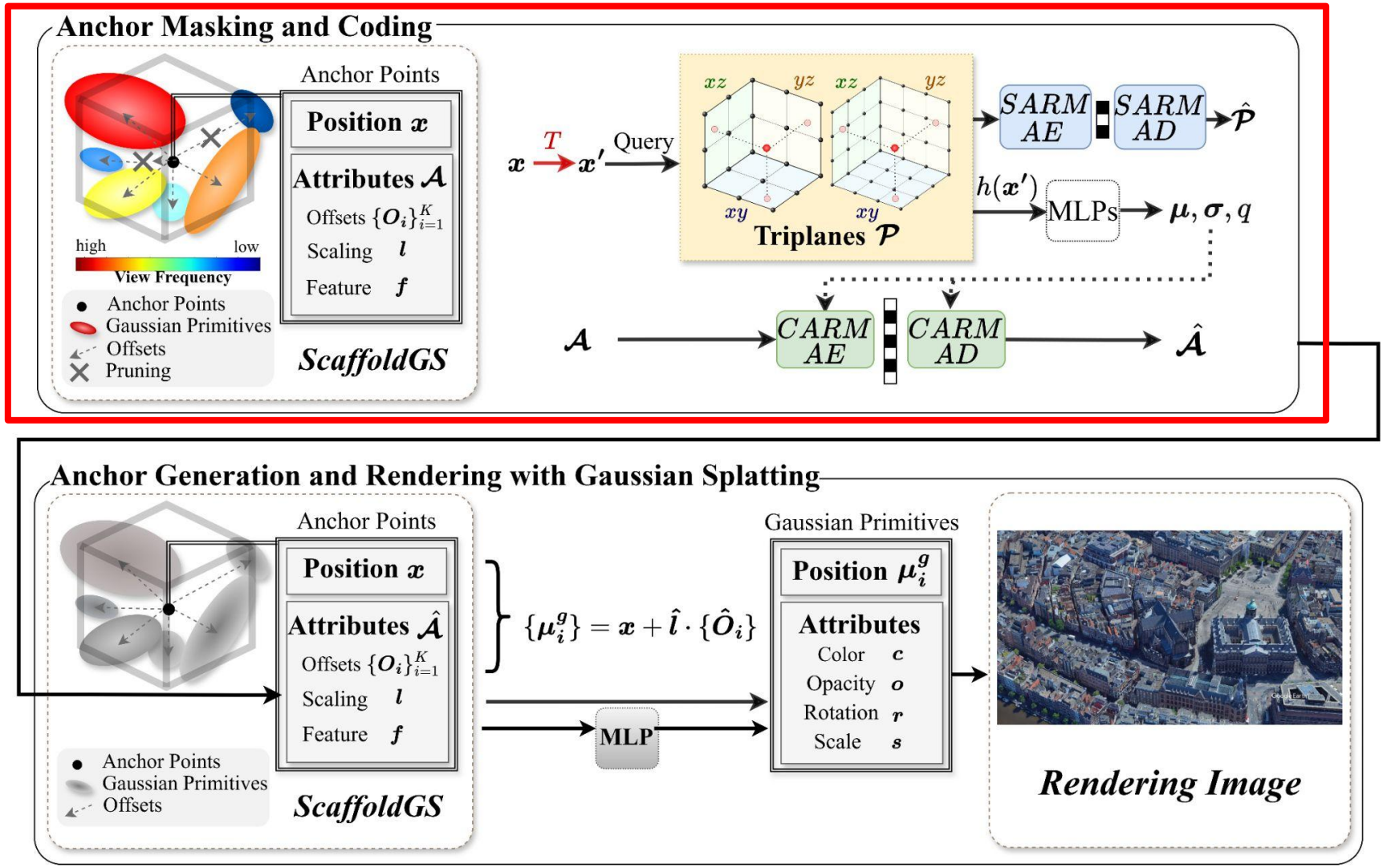
- CARM: Channelwise Autoregressive Models. SARM: Spatial Autoregressive Models.

ScaffoldGS



- **Goal:** A compact representation for 3DGS to reduce the parameter count
- **Method:** Use each anchor point to represent a cluster of Gaussian primitives

System Overview of CAT-3DGS Proposed Method

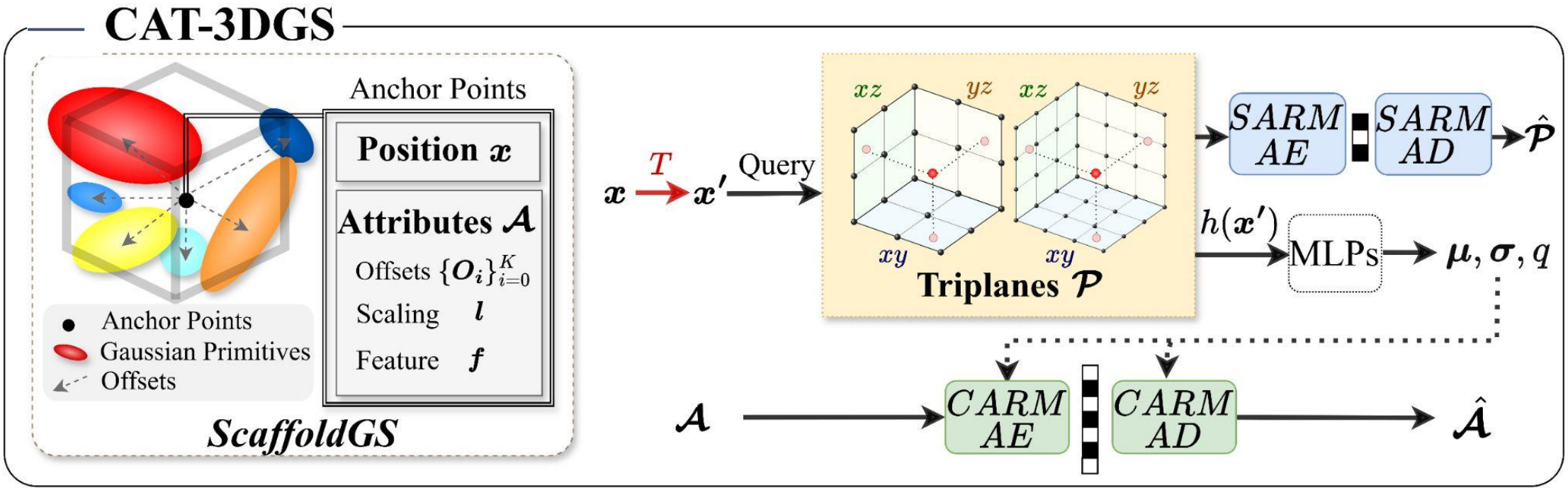


- Apply **masking** and **coding** within ScaffoldGS for efficient data transmission

Anchor Coding

Proposed Method

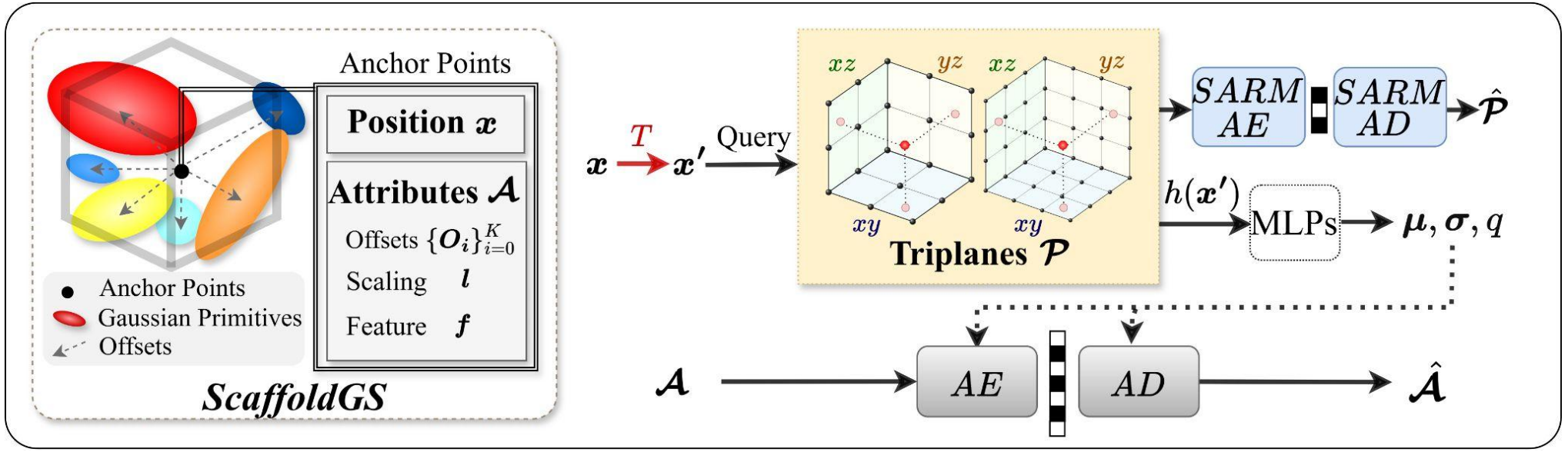
- Learn the hyperprior and employ channel-wise AR models to predict probabilities for entropy coding



- CARM: Channel-wise Autoregressive Models. SARM: Spatial Autoregressive Models.

Attribute Coding with Hyperprior Proposed Method

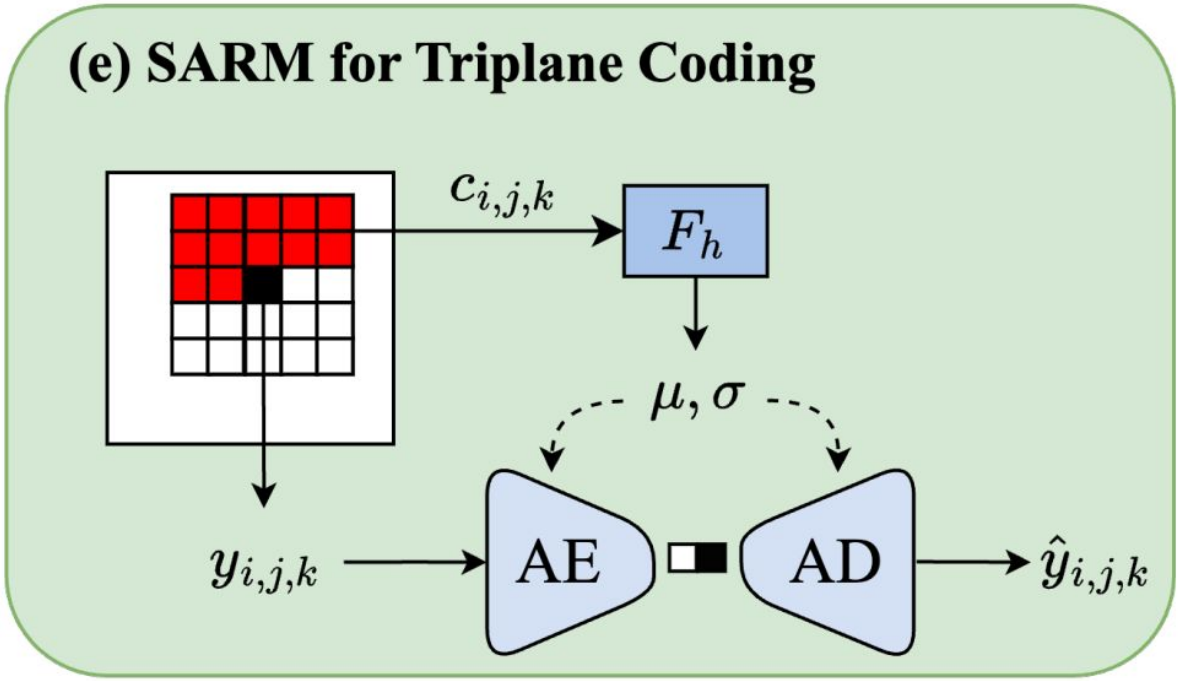
- **Tensor decomposition using triplane**: Decompose the 3D space onto three 2D planes
- **Triplane-based hyperprior**:
  - Exploit the inter correlation of anchor points in 3D space
  - Enable efficient spatial autoregressive coding for triplane



Spatial Autoregressive Models (SARM) for Triplane Coding

Proposed Method

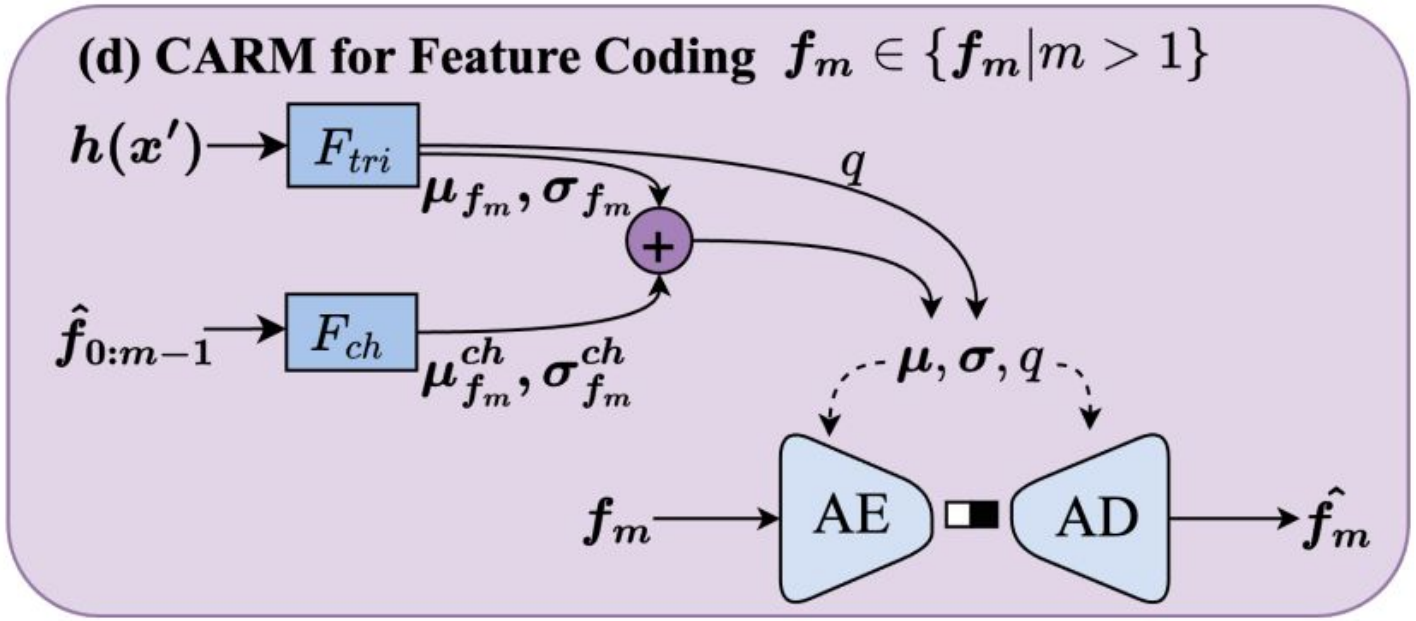
- **Motivation:** Leverage inter correlation between anchor points
- **Contextual Decoding:** Use nearby decoded grid points for enhanced precision



Channel-wise Autoregressive Models (CARM) for Feature Coding

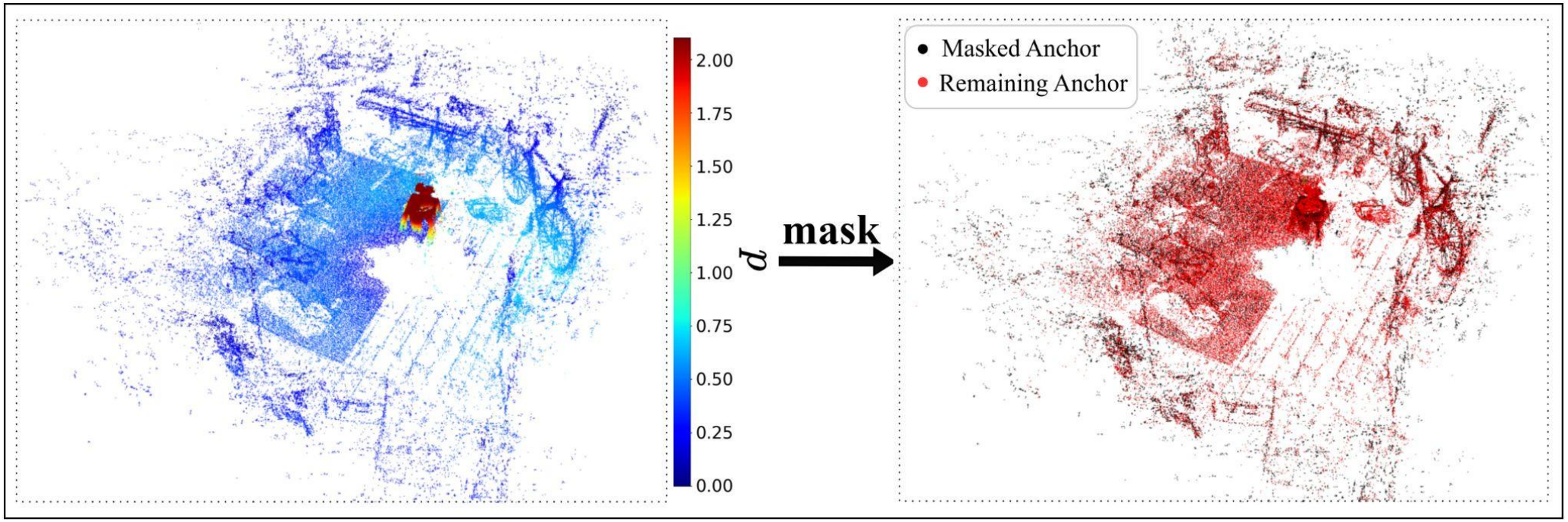
Proposed Method

- **Motivation:** Leverage the intra correlation among the components of a feature vector
- **Contextual Decoding:** Use previously decoded slices for enhanced precision



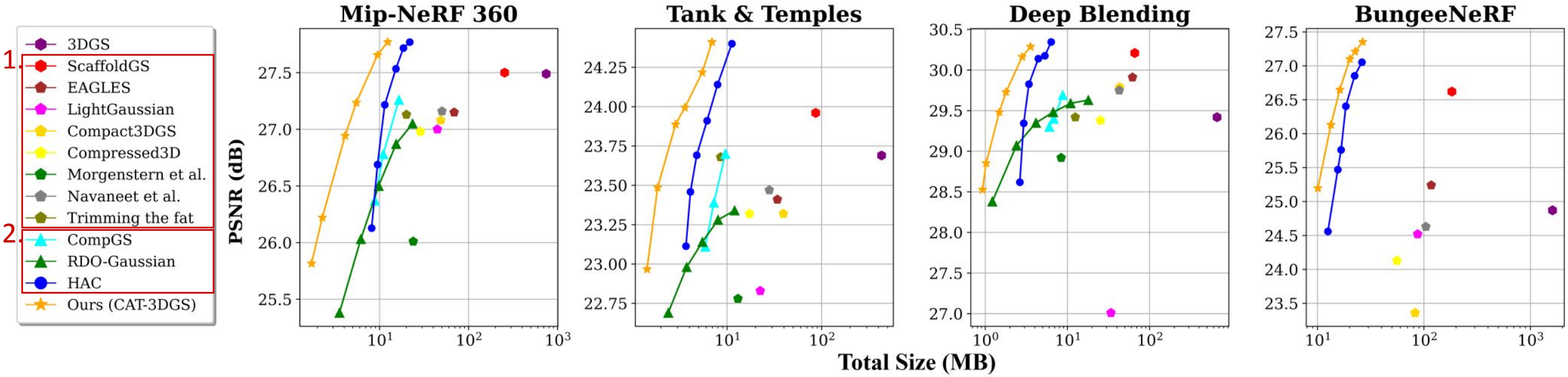
View Frequency aware Masking Proposed Method

- **Improved Masking Mechanism**
  - View frequency p serves as a weight influencing the mask
  - Skip less critical ones while retaining the critical ones for coding



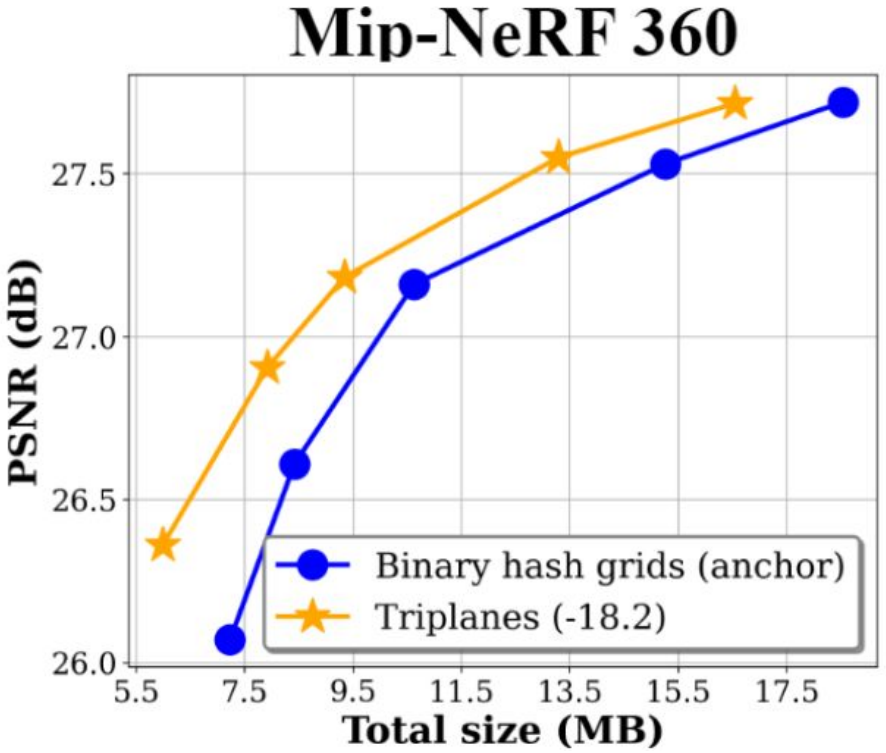
Rate-Distortion Comparison

- **Baselines**
  1. Compact Representation
  2. Rate-distortion-optimized Compression
- **Achieve state-of-the-art rate-distortion performance**



Triplanes versus Binary Hash Grids

- **Triplanes > Binary Hash Grids:**
  - Capture the spatial correlation of the anchor points better
  - More efficient entropy coding with spatial autoregressive models



Channel-wise Autoregressive Models (CARM)

Experiment Results

- 40% reduction for feature size while remaining the rendering quality
- Uneven partition for each slice -> Energy Compaction

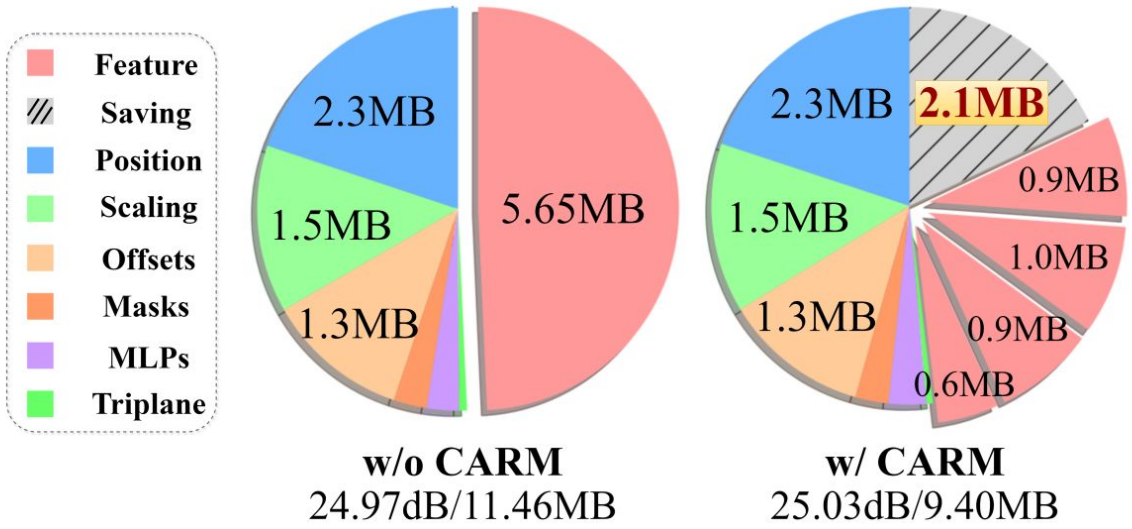


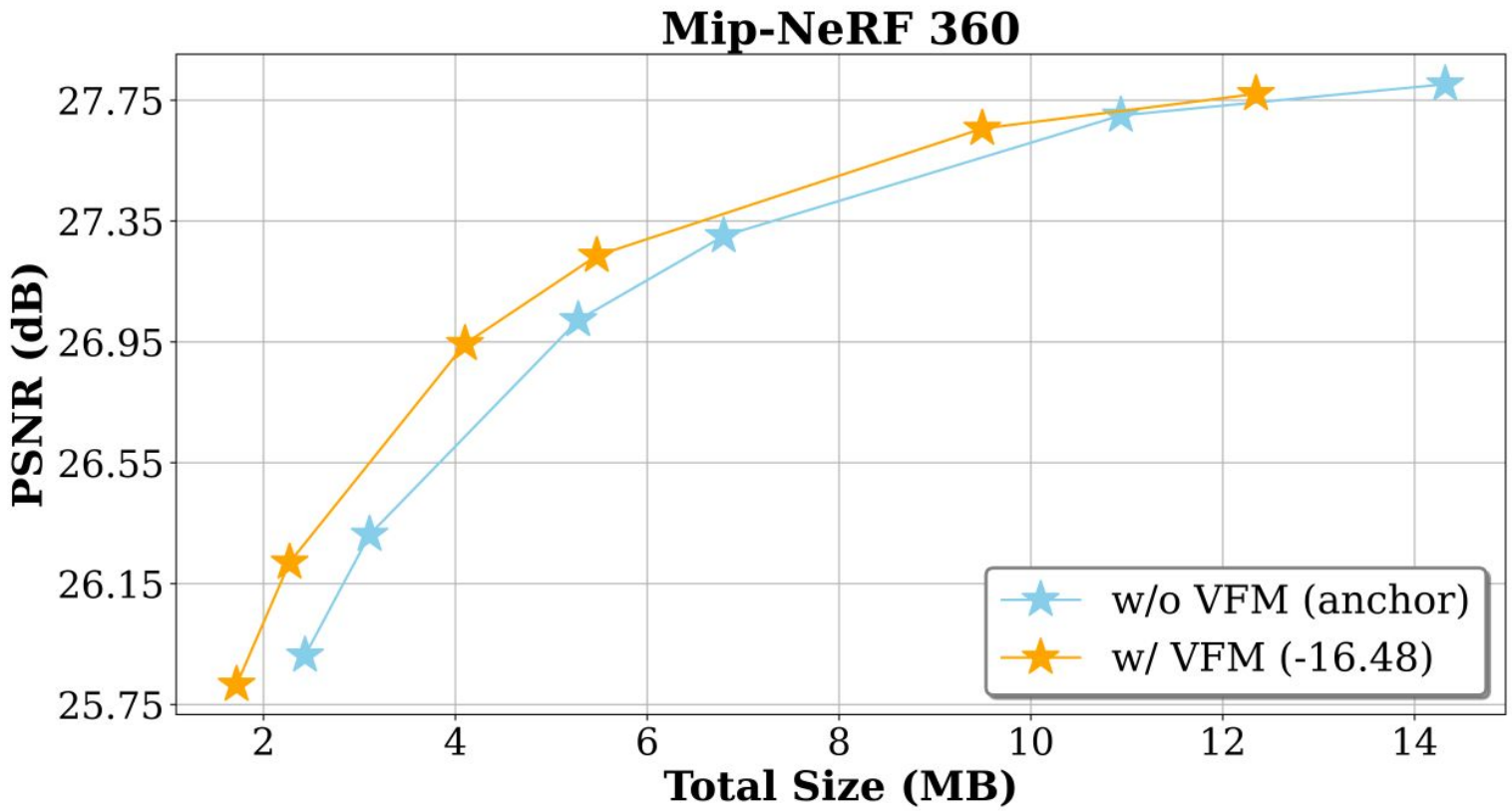
Figure 7: Breakdown analysis of different coding parts w/ and w/o our CARM for the *bicycle* scene.

Table 1: The impact of the slice number and partition in our CARM on compression performance The results are obtained with Mip-NeRF 360.

M Slices	Channels per Slice	BD-rate
1	50	0
2	25, 25	-6.3
2	15, 35	-8.9
4	12, 12, 13, 13	-8.9
4	5, 10, 15, 20	-11.9

View Frequency aware masking Experiment Results

- Retain similar render quality while significantly reducing the storage size



Contributions

01	Triplane-based Hyperprior	Leverage the inter correlation between anchors for efficient spatial autoregressive coding
02	Channel-wise AR models	Exploit the intra correlation within each anchor
03	View Frequency-aware Masking	Skip less critical Gaussians from coding
04	SOTA RD Performance	Achieve state-of-the-art rate-distortion performance on several real-world datasets