NeRF-MAE:

Masked AutoEncoders for Self-Supervised 3D Representation Learning for Neural Radiance Fields

European Conference on Computer Vision, ECCV 2024
also appeared at CVPR Neural Rendering Intelligence Workshop, CVPR 2024


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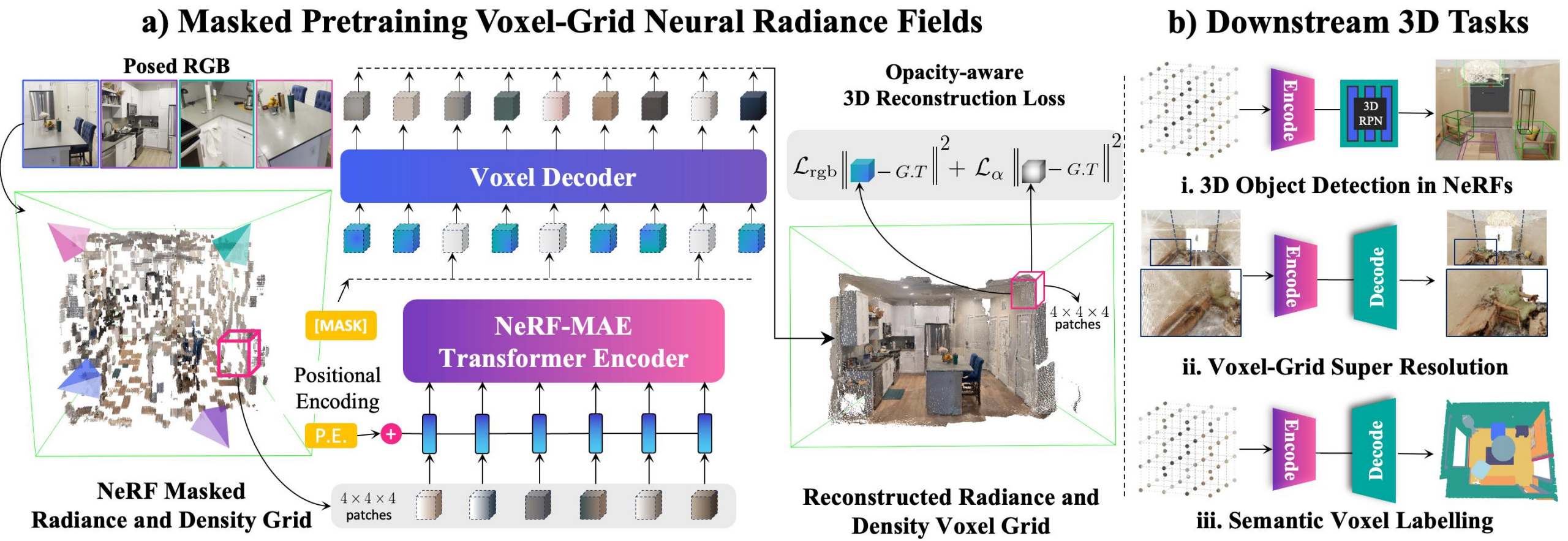
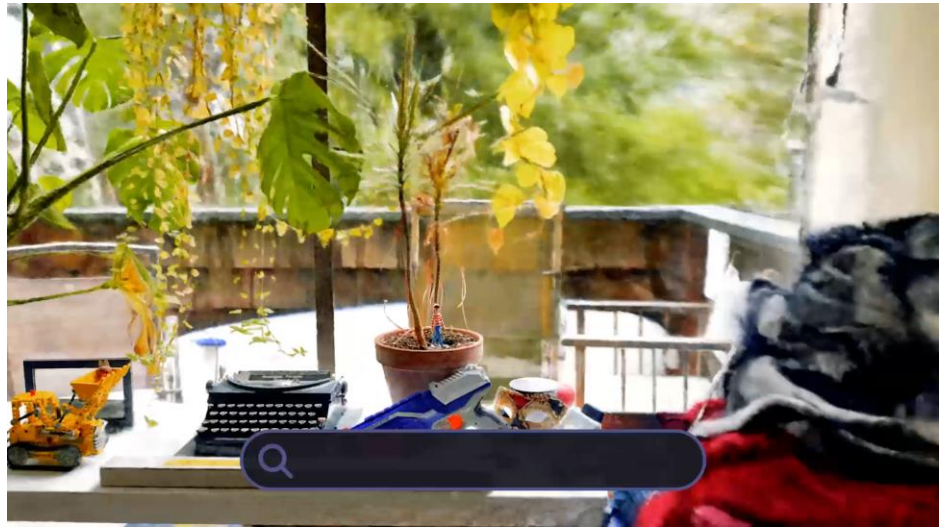
We propose NeRF-MAE, a framework for self-supervised 3D representation learning from NeRFs



Neural Fields beyond showcasing high-rendering quality

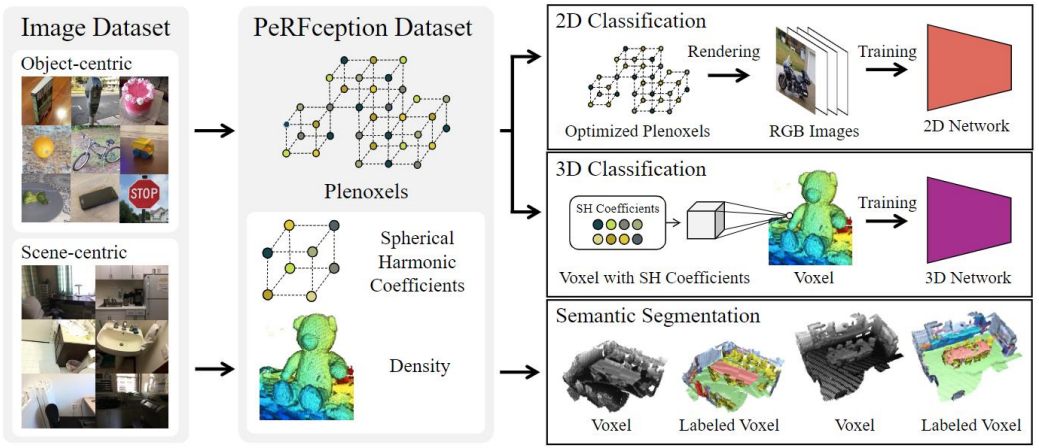


Language-Embedded Radiance Fields (LeRF, Kerr et al)

Inferring Accurate Geometry (NeRFMeshing, Rakotosaona et al)

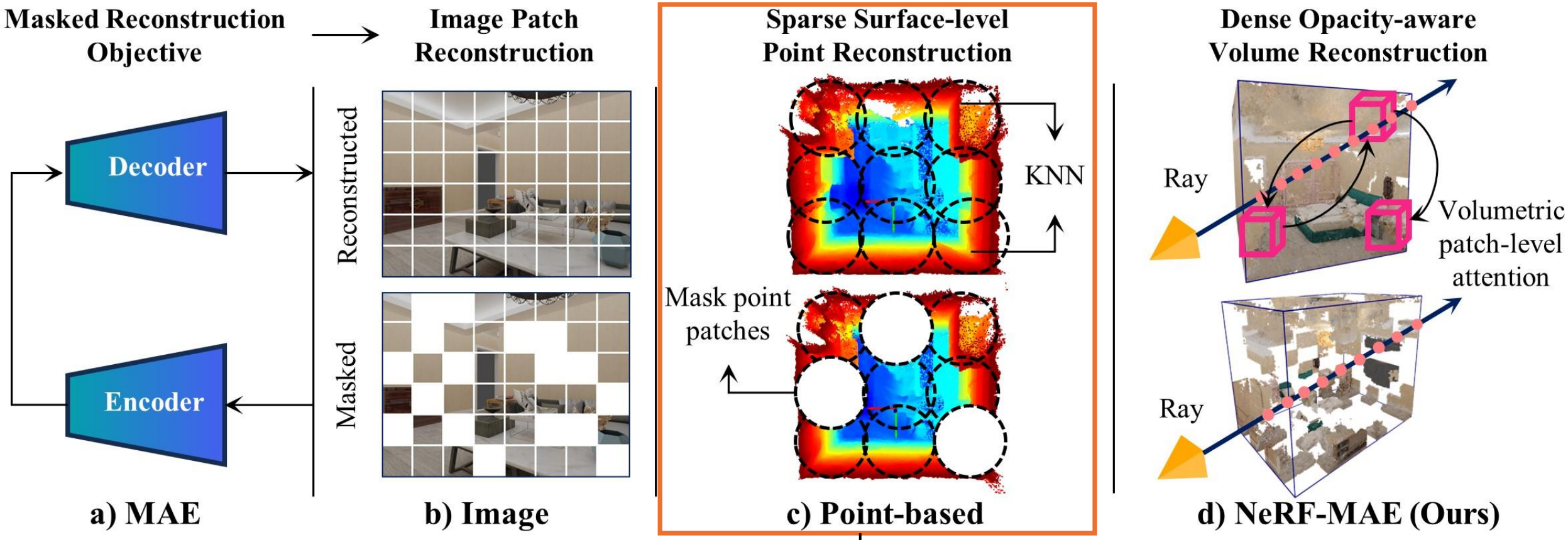
1. Scan Scene

Open-world Manipulation (F3RM, Shen et al)



Efficient Data Storage (PerFception, Jeong et al)

Existing **3D MAE Architectures** operate on pointclouds with **uneven information density** only model **surface-level information** and are **highy irregular data structures**

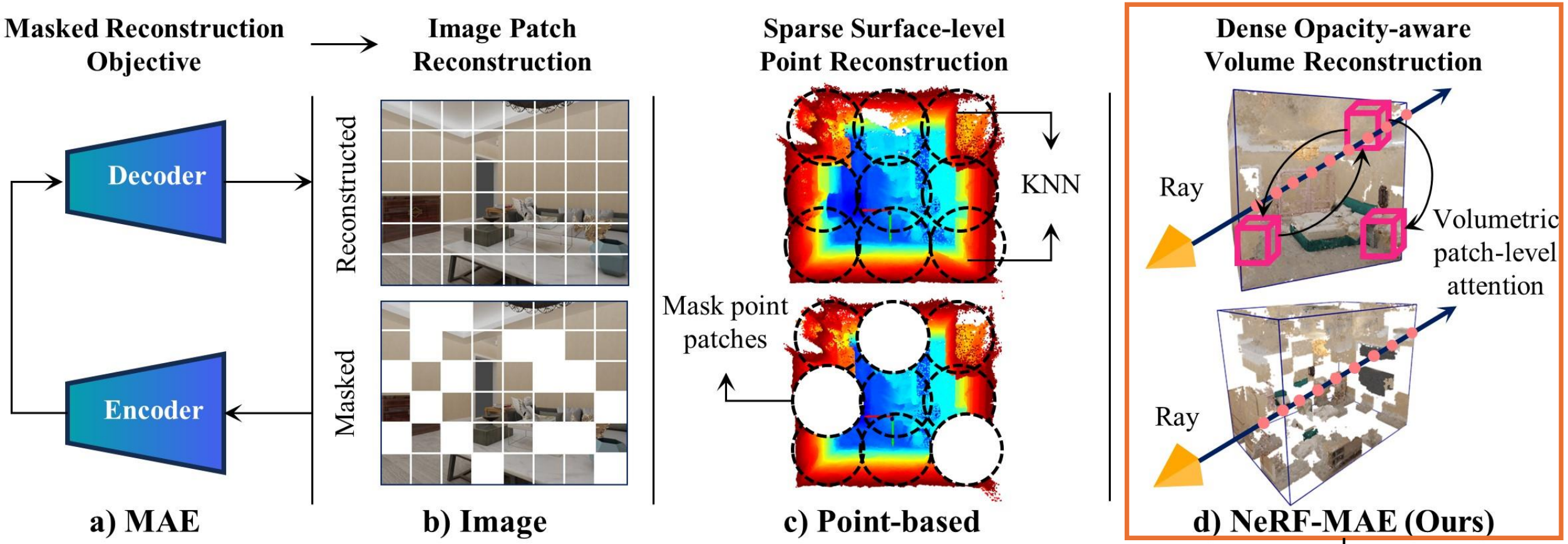


✗ Model Surface Level Information

✗ Irregular data Structures

✗ Uneven information density

Our approach uses **NeRF's dense grid** as input to the Transformer.
This makes our approach a direction extension of **image MAE to 3D**

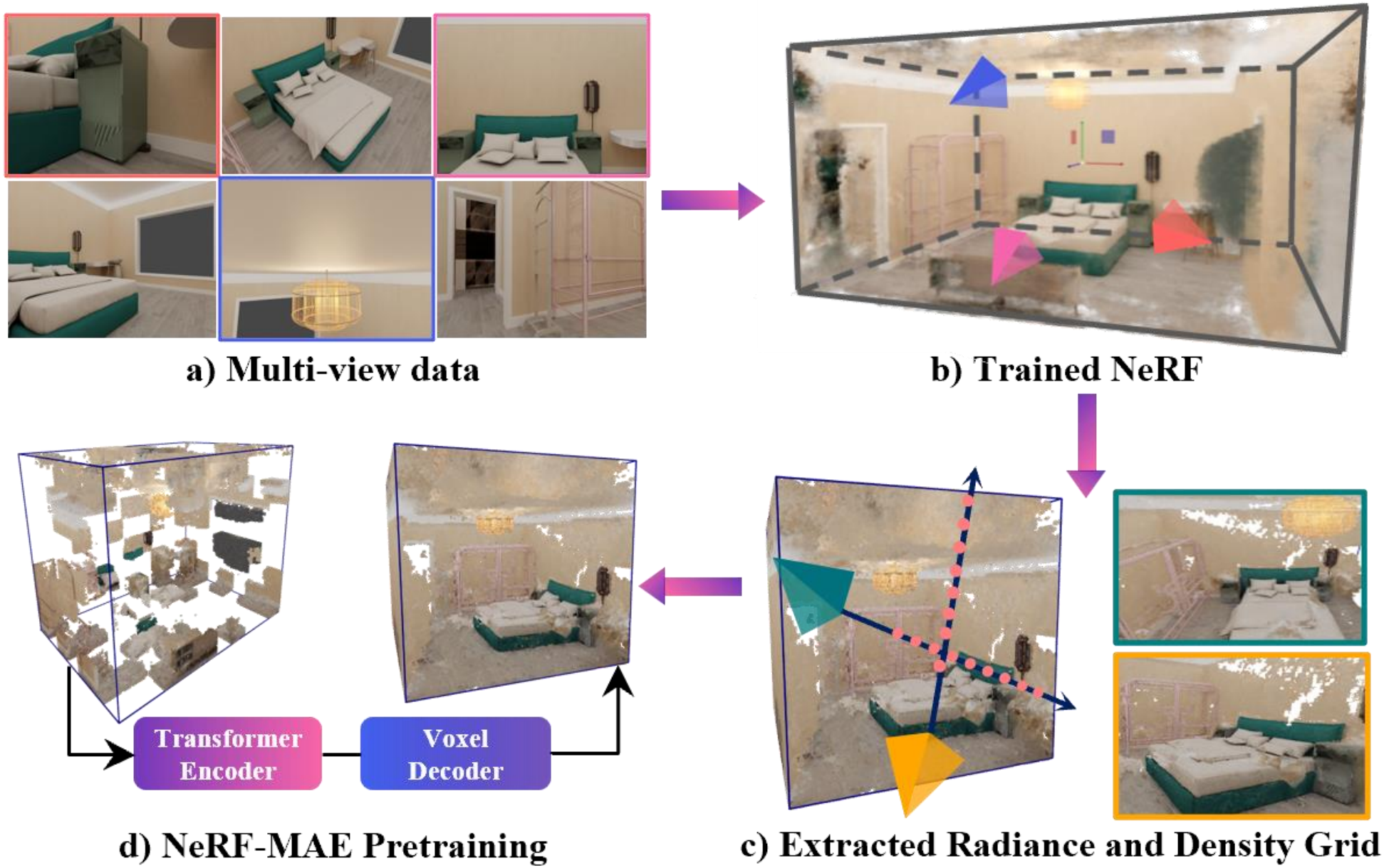


✓ High Information Density

✓ Regular unbiased Sampling

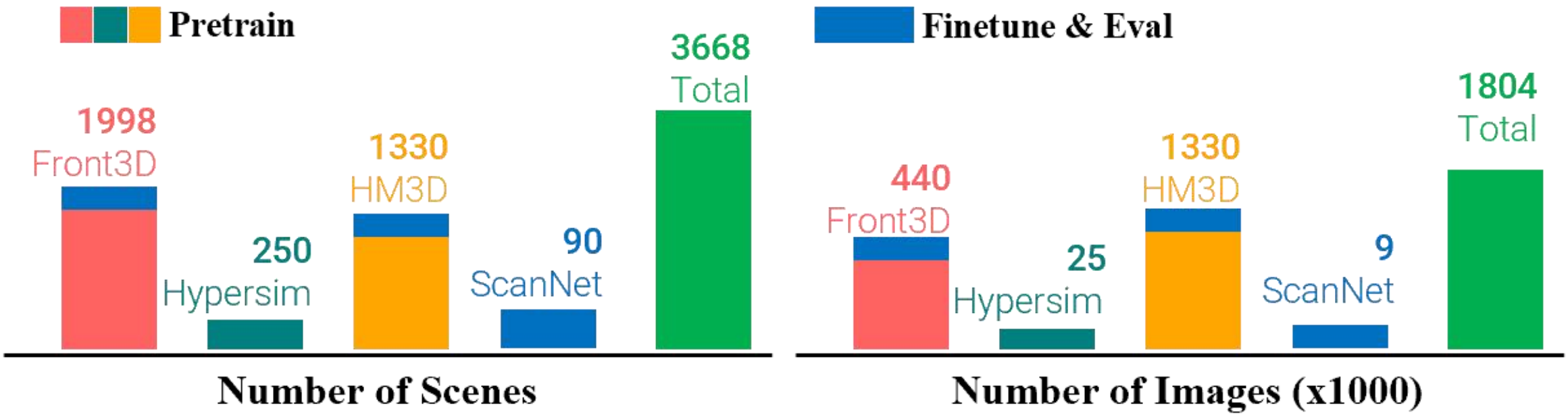
✓ Spatial data redundancy

Data Preprocessing flow for large-scale NeRF pretraining

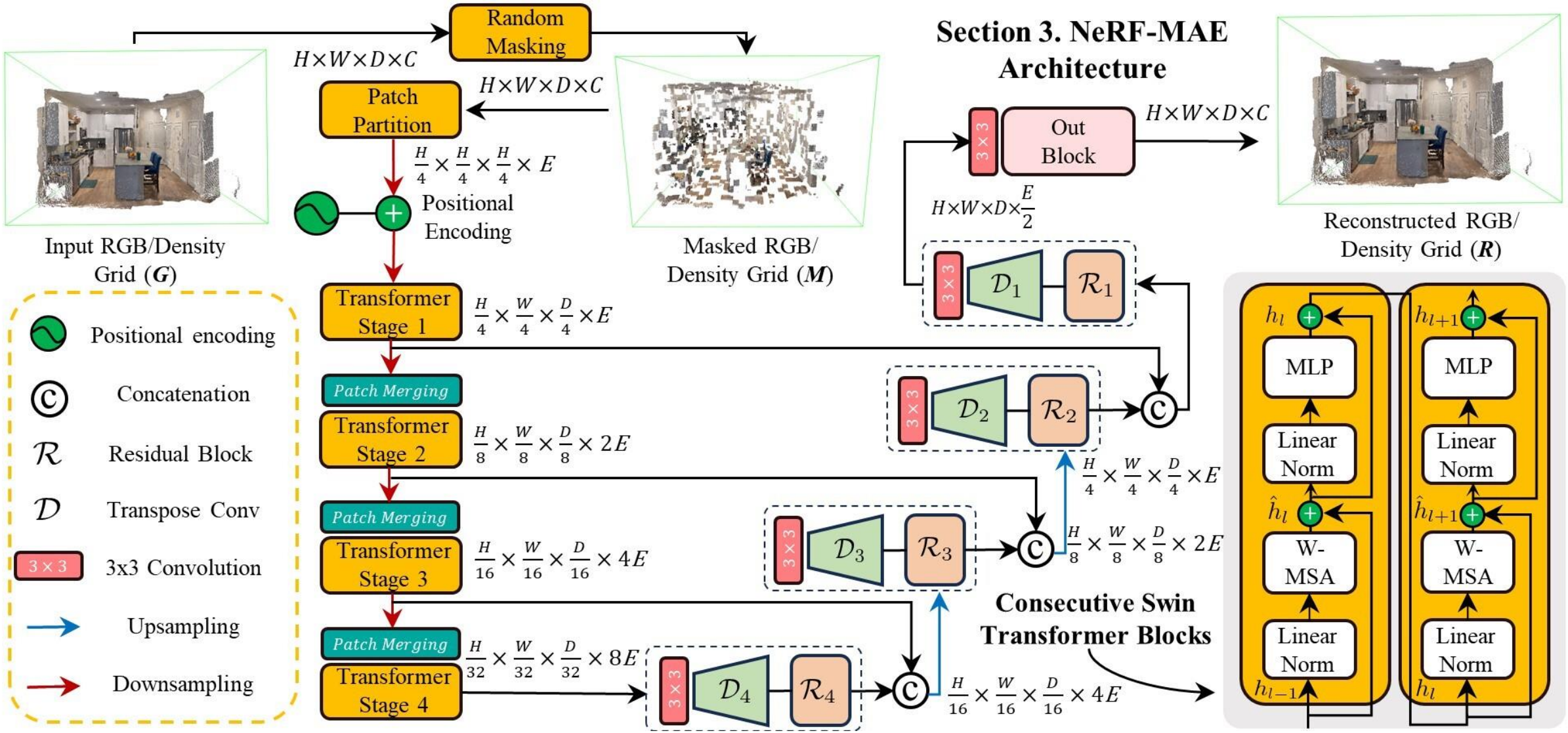


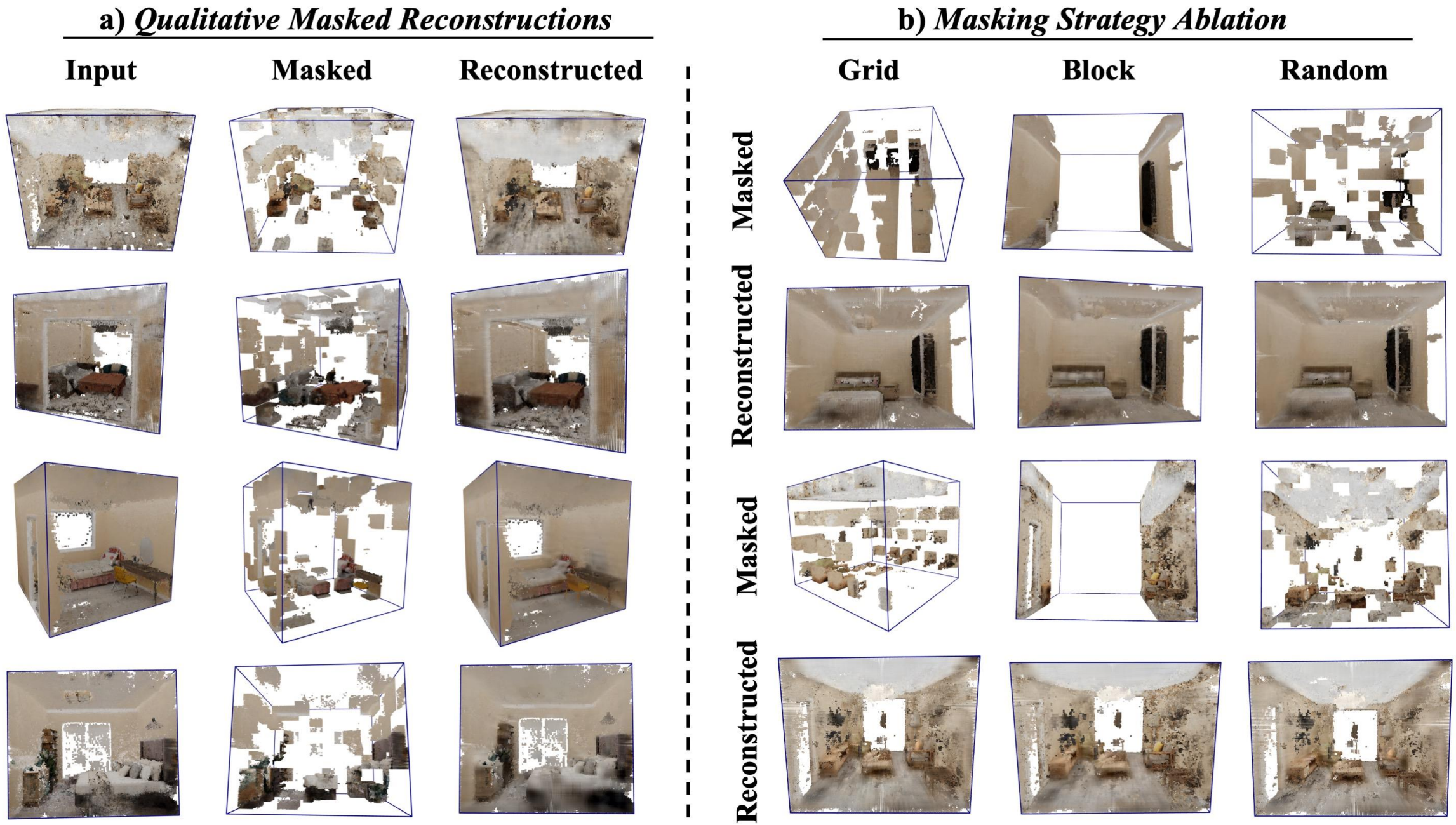
a) Multi-view Dataset Setup

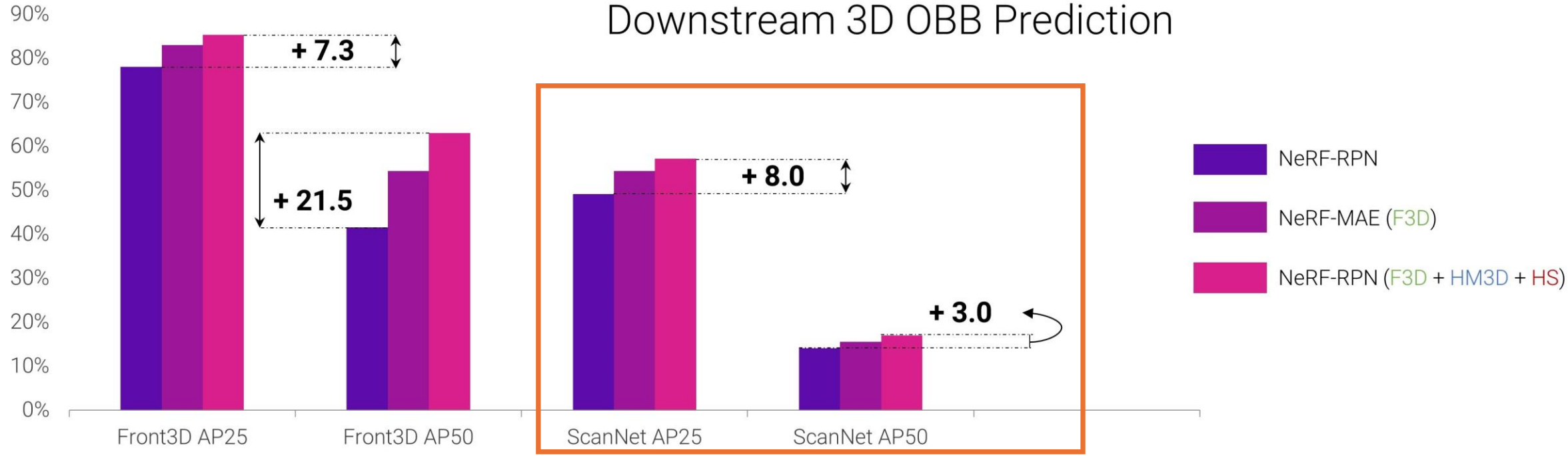
b) NeRF-MAE Data Mix & Statistics

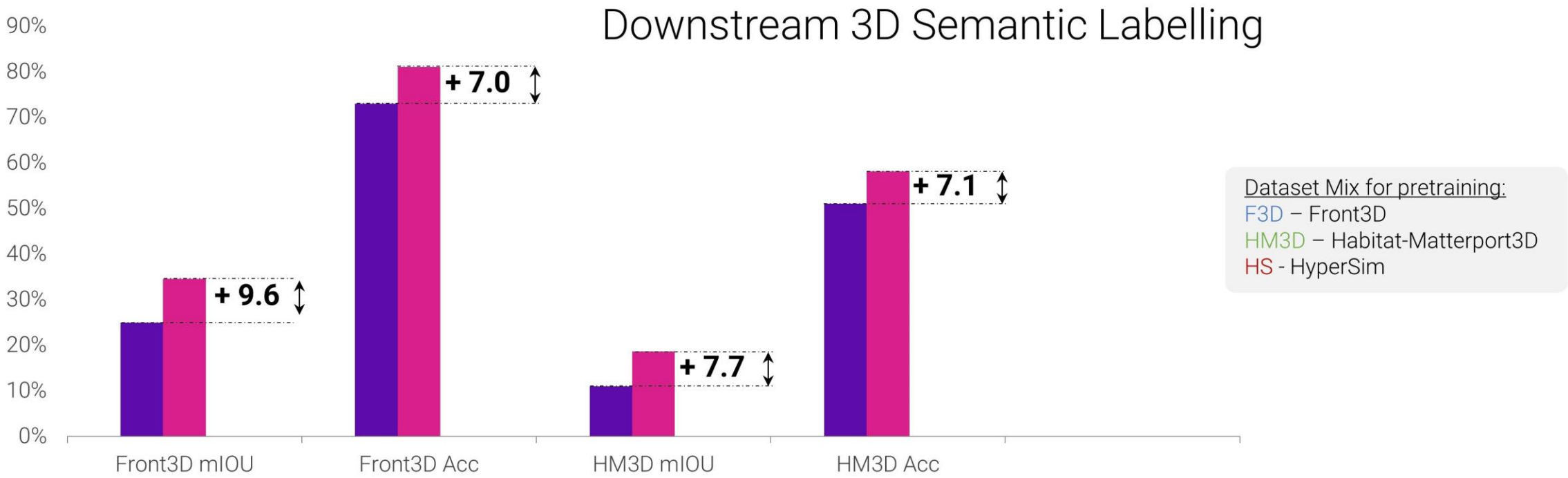


We utilize a **UNet architecture** employing SwinTransformer as encoder lightweight voxel decoder to enforce **mask reconstruction objective in 3D**

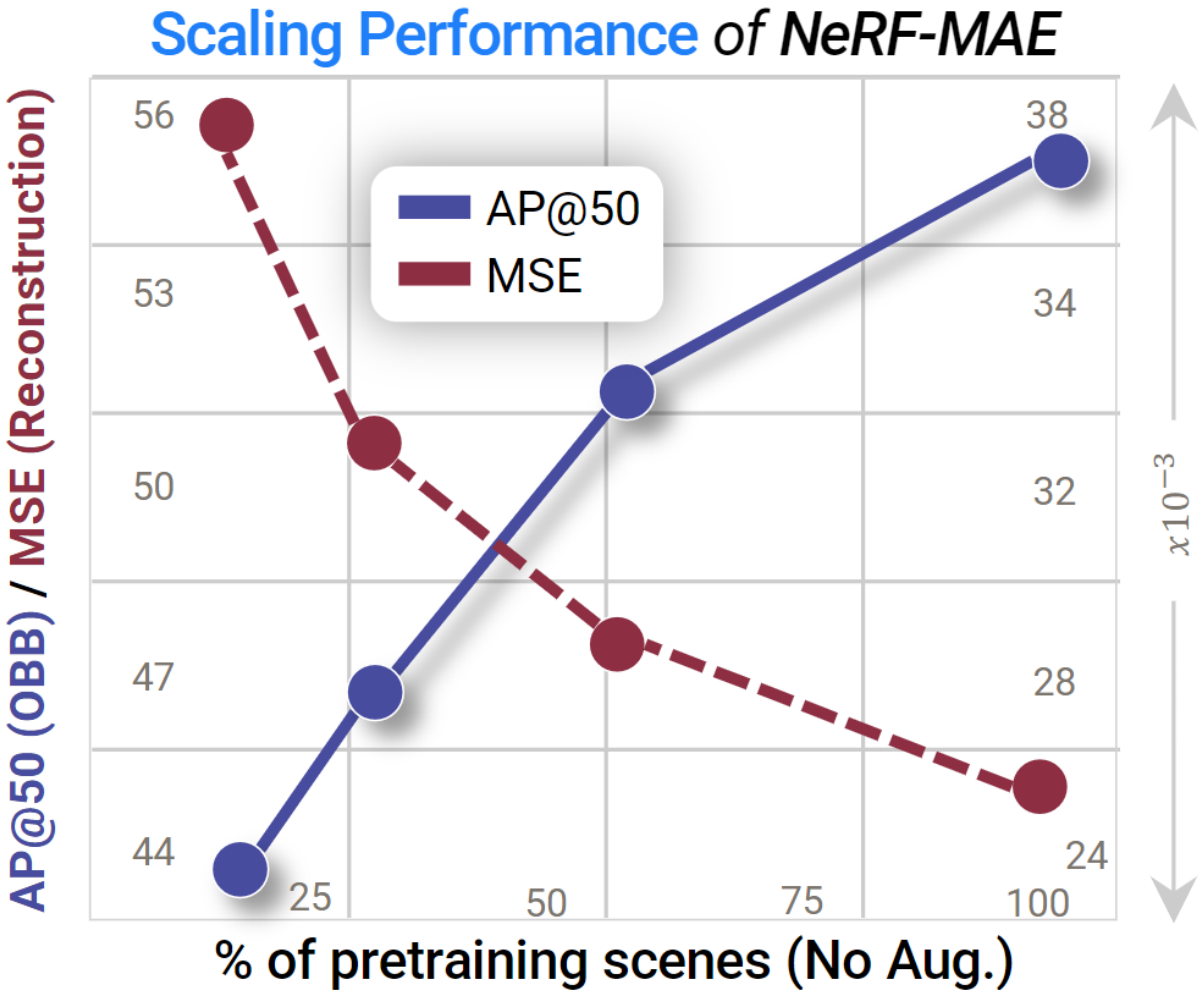


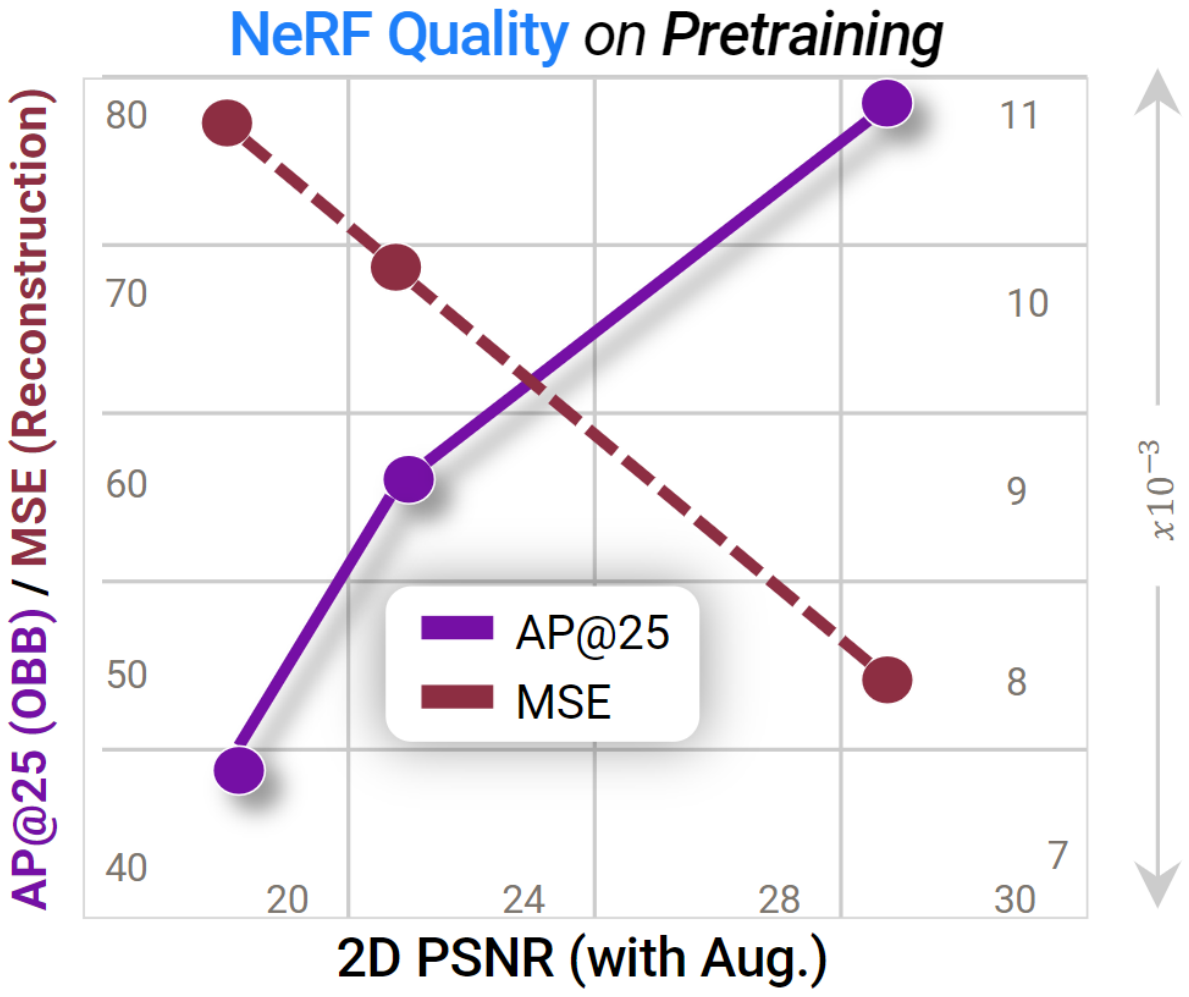

a) Qualitative Masked Reconstructions
Input
Masked
Reconstructed
b) Masking Strategy Ablation
Grid
Block
Random
Masked
Reconstructed
Masked
Reconstructed


Downstream 3D OBB Prediction
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
+ 7.3
+ 21.5
+ 8.0
+ 3.0
Front3D AP25
Front3D AP50
ScanNet AP25
ScanNet AP50
NeRF-RPN
NeRF-MAE (F3D)
NeRF-RPN (F3D + HM3D + HS)

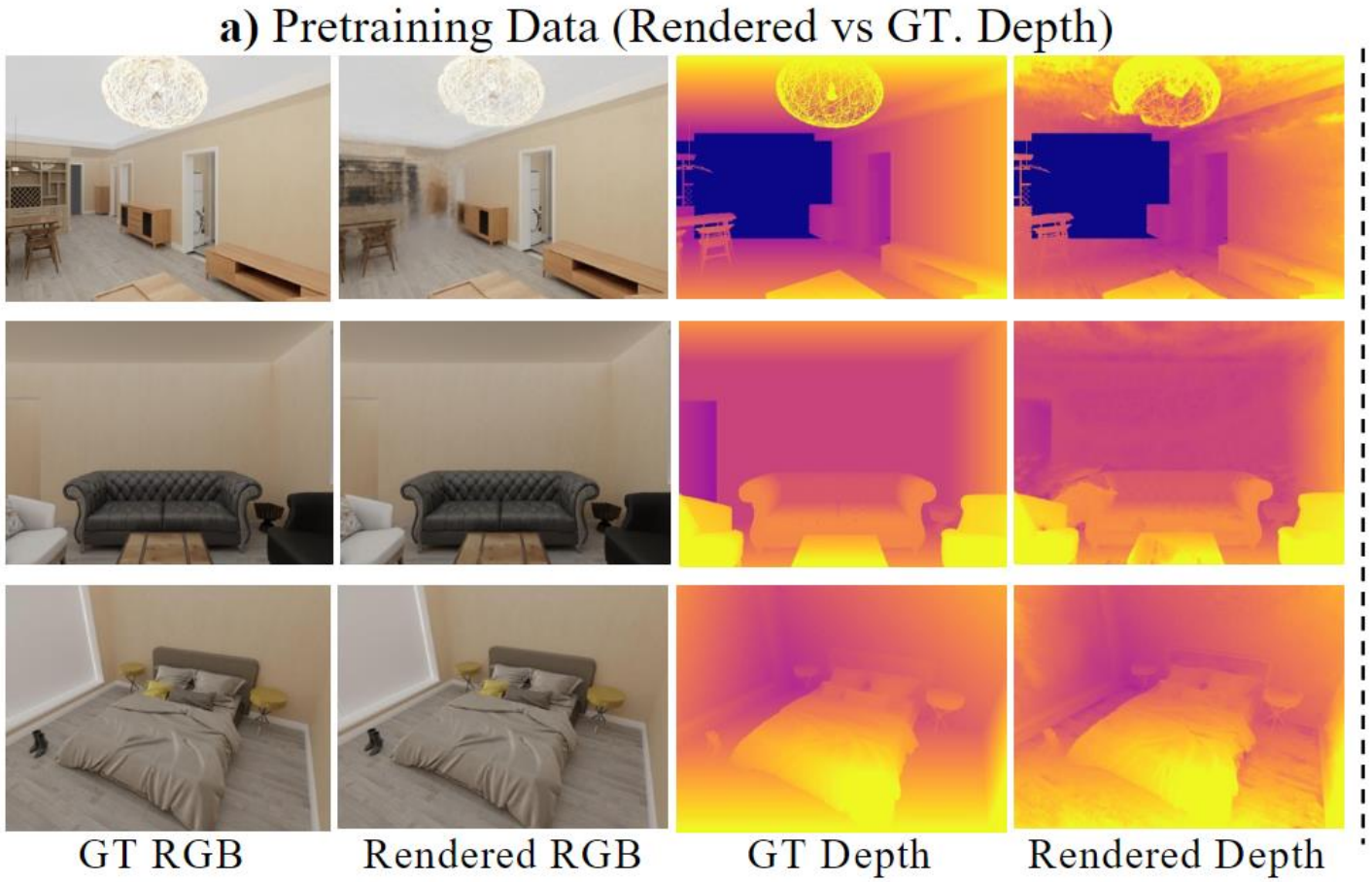

Downstream 3D Semantic Labelling
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
+ 9.6
+ 7.0
+ 7.7
+ 7.1
Front3D mIOU
Front3D Acc
HM3D mIOU
HM3D Acc
Dataset Mix for pretraining:
F3D – Front3D
HM3D – Habitat-Matterport3D
HS - HyperSim

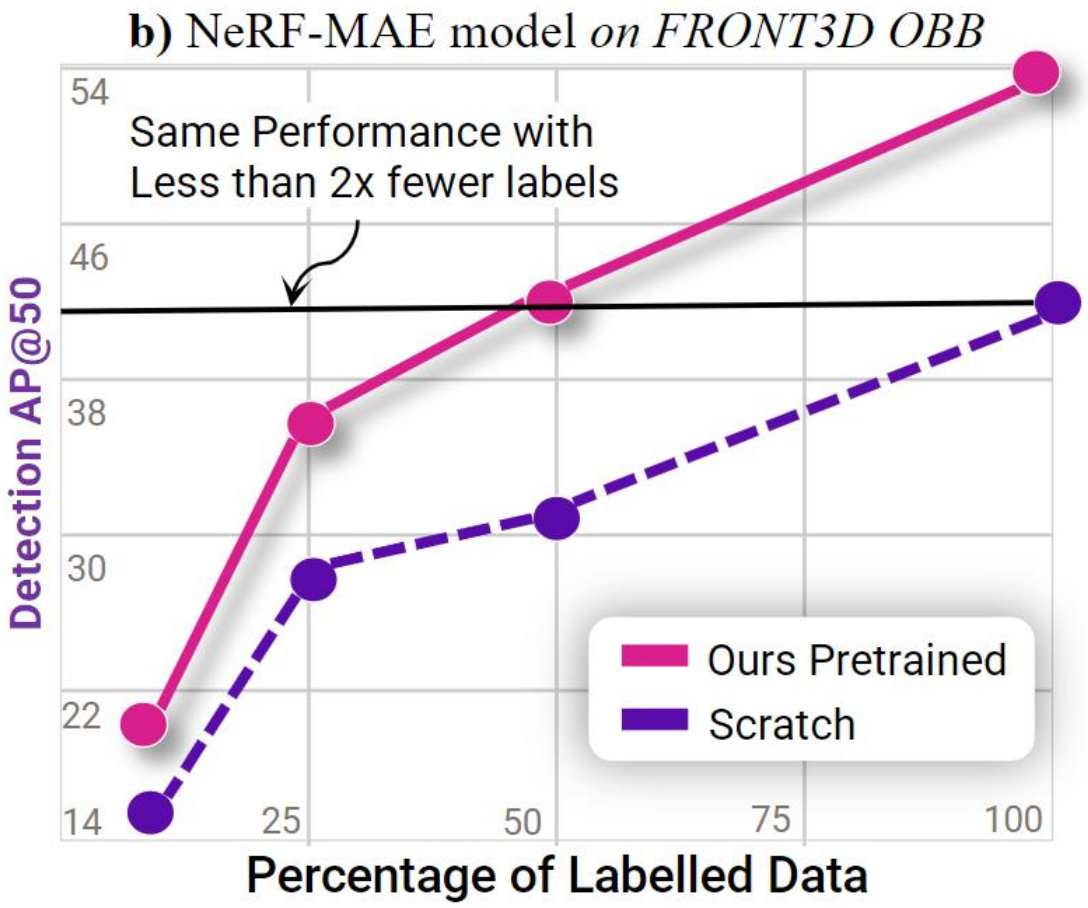
Quantitative Results



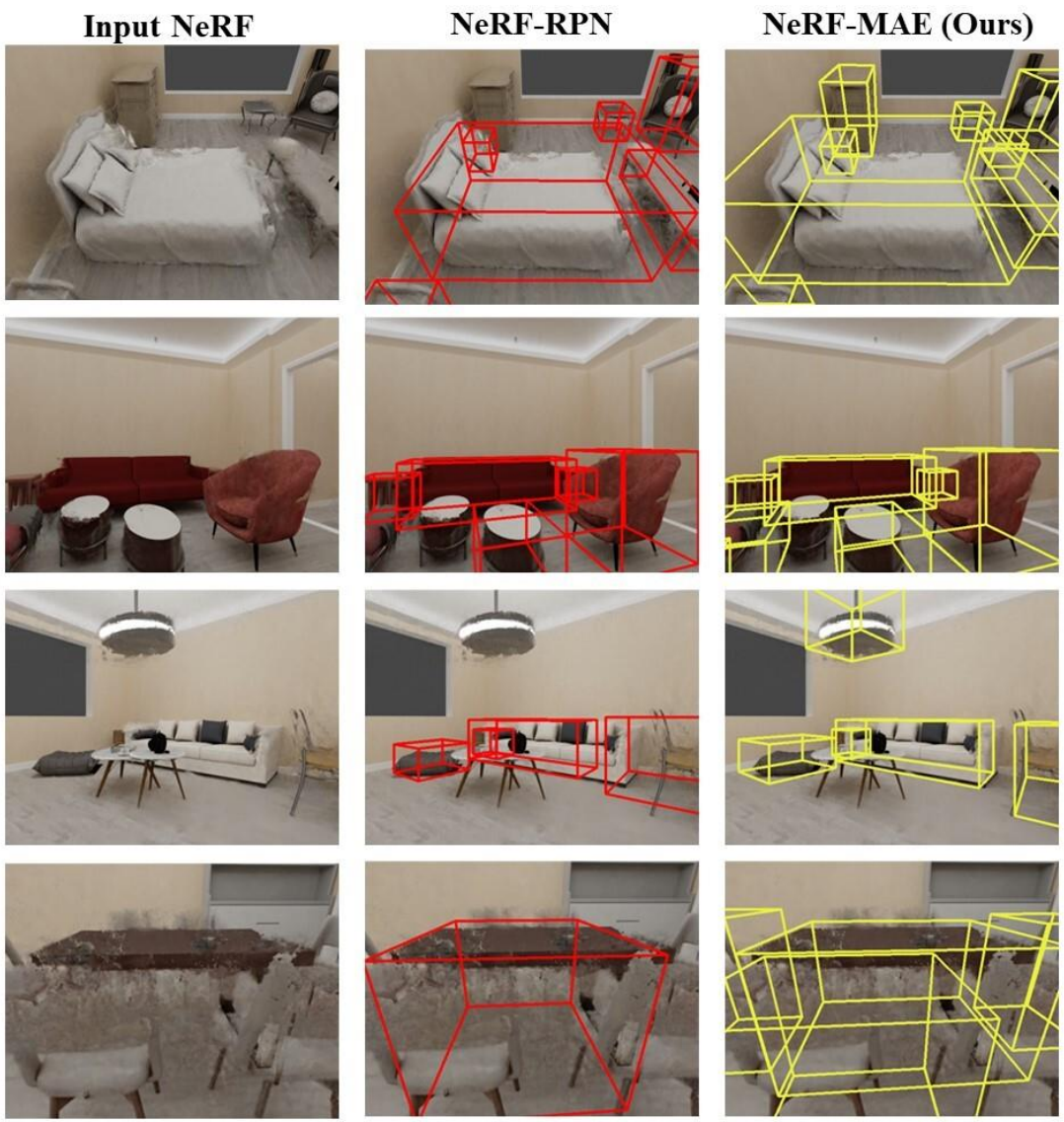


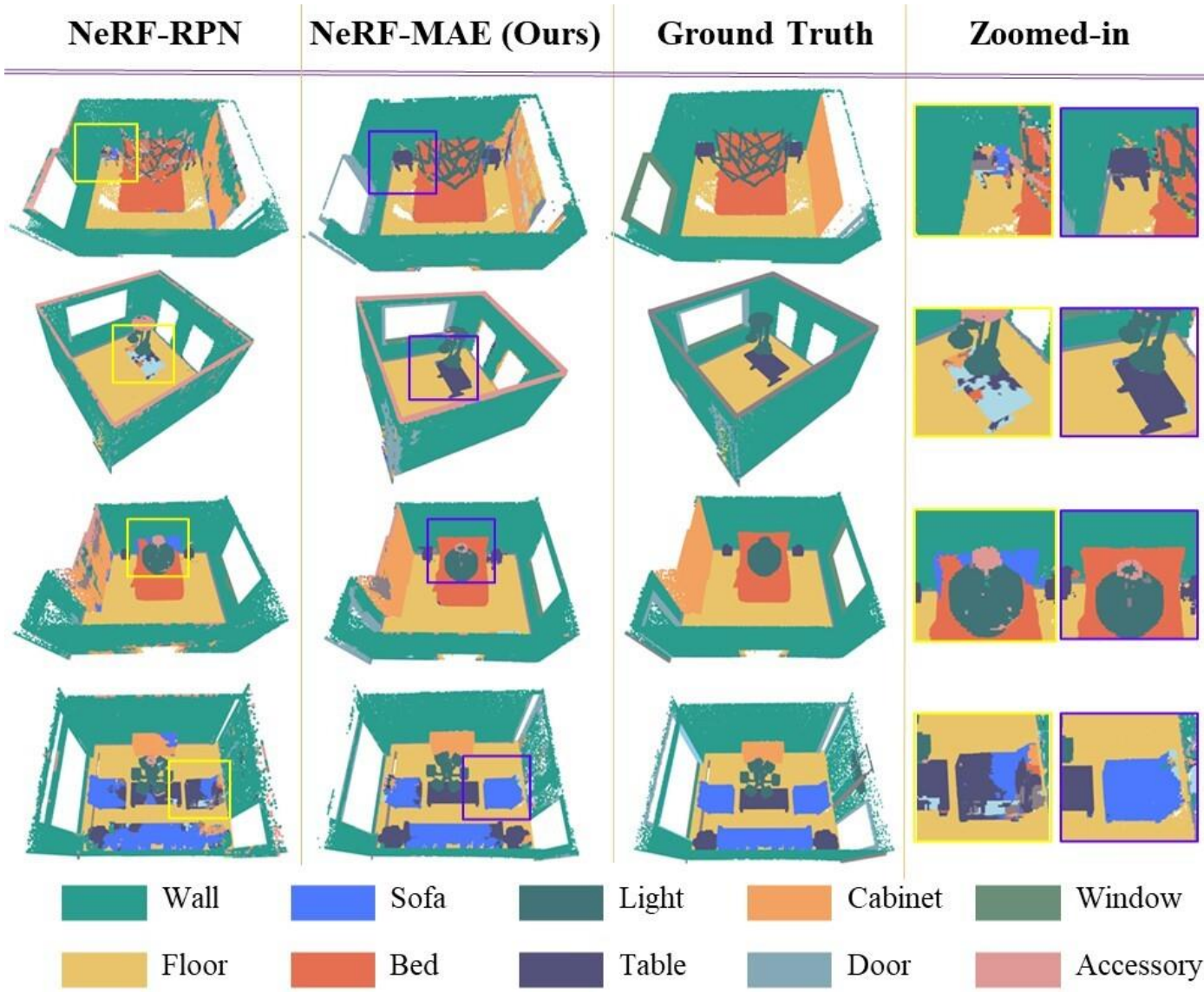
Results Analysis





Qualitative Results





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