Lagrangian Hashing for Compressed Neural Field Repfresentations

Shrisudhan Govindarajan*[1], Zeno Sambugaro*[2], Ahan Shabanov[1], Towaki Takikawa[3], Daniel Rebain[4], Weiwei Sun[4], Nicola Conci[2], Kwang Moo Yi[4], Andrea Tagliasacchi[1,3,5]

[1]Simon Fraser University, [2]University of Trento, [3]University of Toronto, [4]University of British Columbia, [5]Google DeepMind

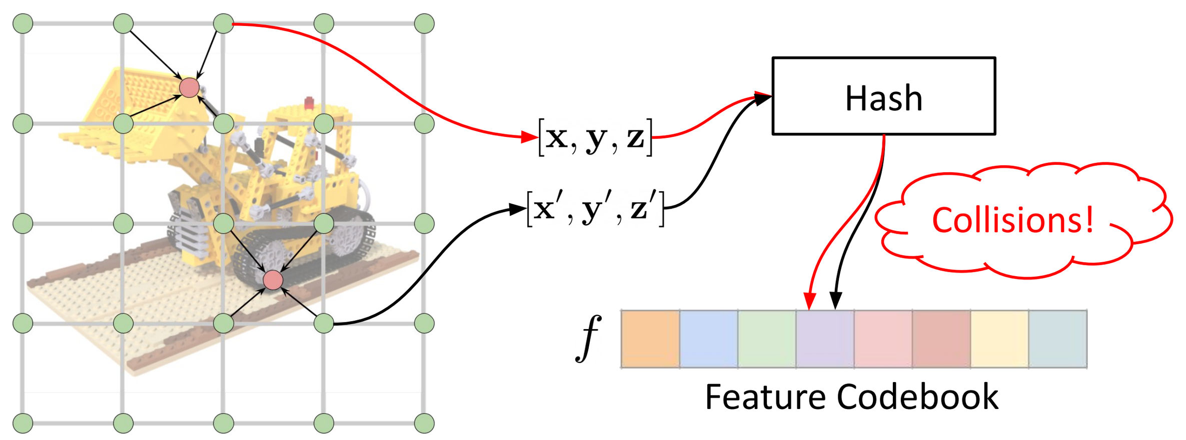
* denotes equal contribution

Motivation

What we want to do? Build *hybrid* representations that combine the merits of Lagrangian (i.e. points… 3DGS) and Eulerian (i.e. fields… NeRF) representations.

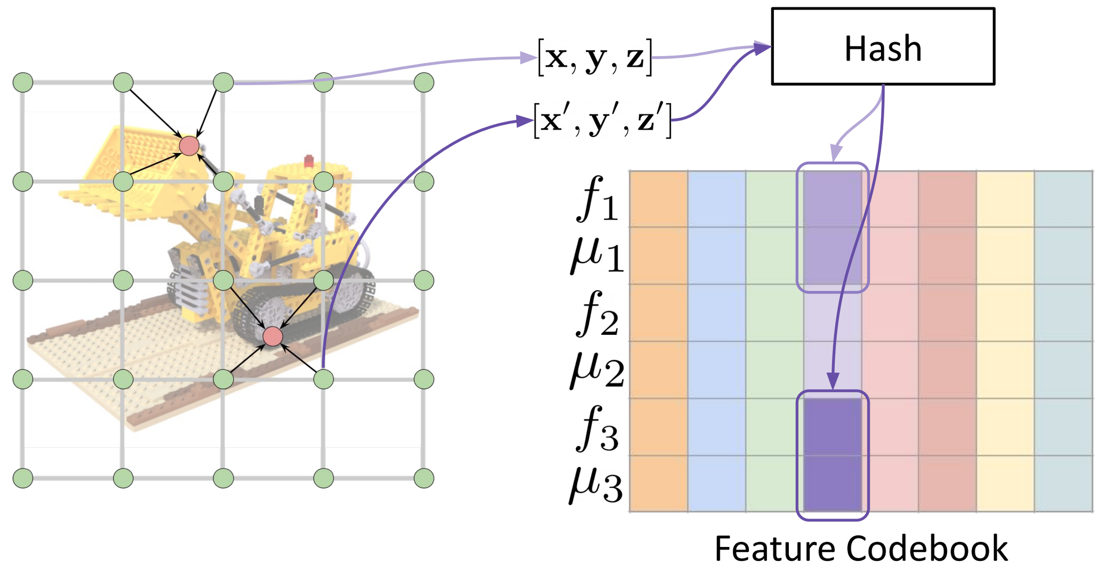
What have we achieved? A compact / compressed representation where high-frequency details are represented with points, and low-frequency with fields.

Previous Method: iNGP



Large codebook sizes in all LoDs to obtain a "unique" concatenated feature representation for each vertex.

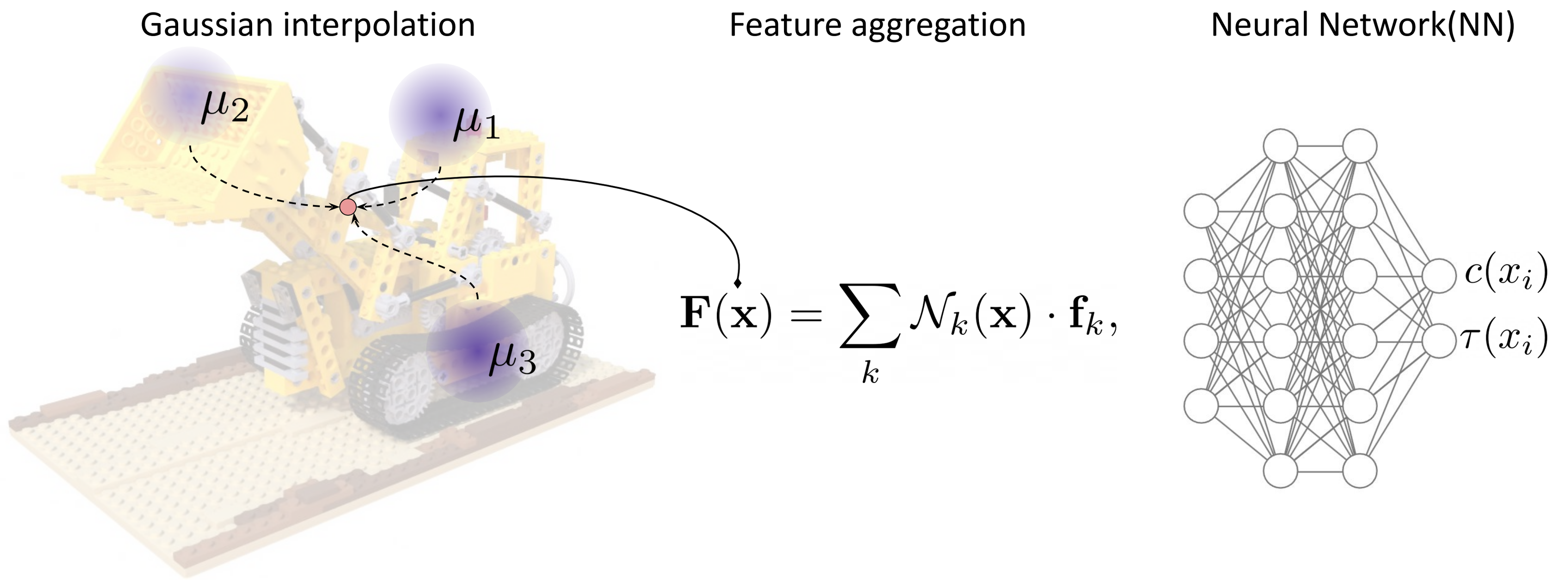
Ours: Lagrangian Hashing



For each vertex, we parameterize the codebook with K featurized points (K=3 above). Points have a local support, and the feature of a point is used only if the query is nearby – this is what resolves collisions – not an MLP.

Ours: Lagrangian Hashing

We compute Gaussian weights with respect to the input position for every feature and use them to aggregate the features, which is then decoded to outputs with an MLP.

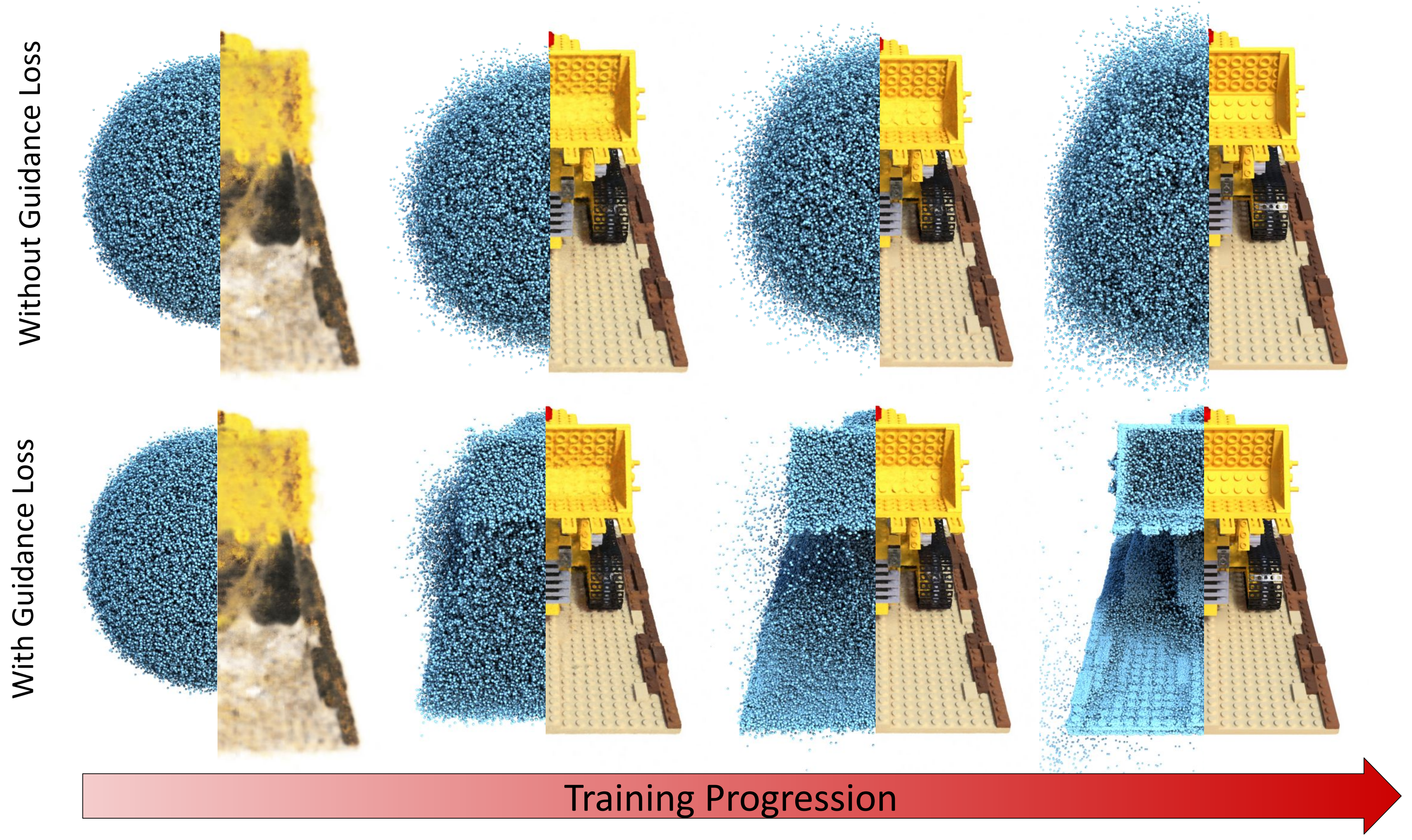


Guidance Loss

Problem: Gaussians have local support, so when we back-propagate a position $\mathbf{x}$ with respect to a Gaussian whose mean μ is too far from $\mathbf{x}$, gradients vanish.

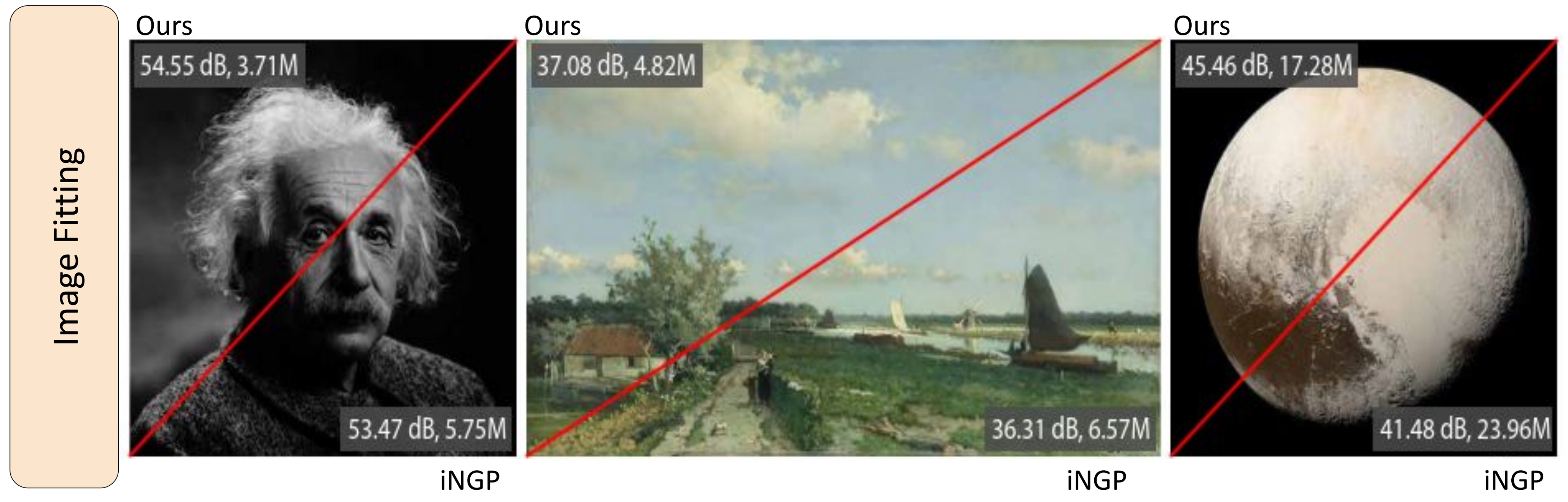
Solution: We optimize the position to minimize the discrepancy (KL-divergence) between the Gaussian $\mathrm{N}(\mathbf{x})$ and the NeRF volume integration weights $\mathrm{W}(\mathbf{x})$.

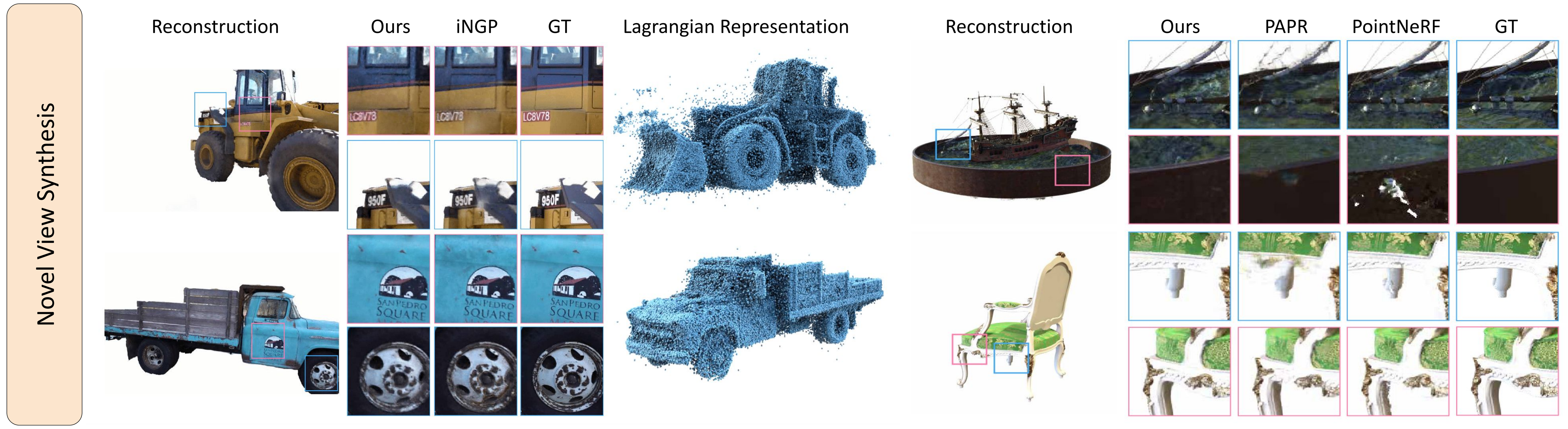
$$arg\,min_{\boldsymbol{\mu},\sigma^2}\ \mathrm{KL}(W(\mathbf{x})||\mathcal{N}(\mathbf{x})) \equiv arg\,min_{\boldsymbol{\mu},\sigma^2}\ -W(\mathbf{x})\cdot\log(\mathcal{N}(\mathbf{x}))$$

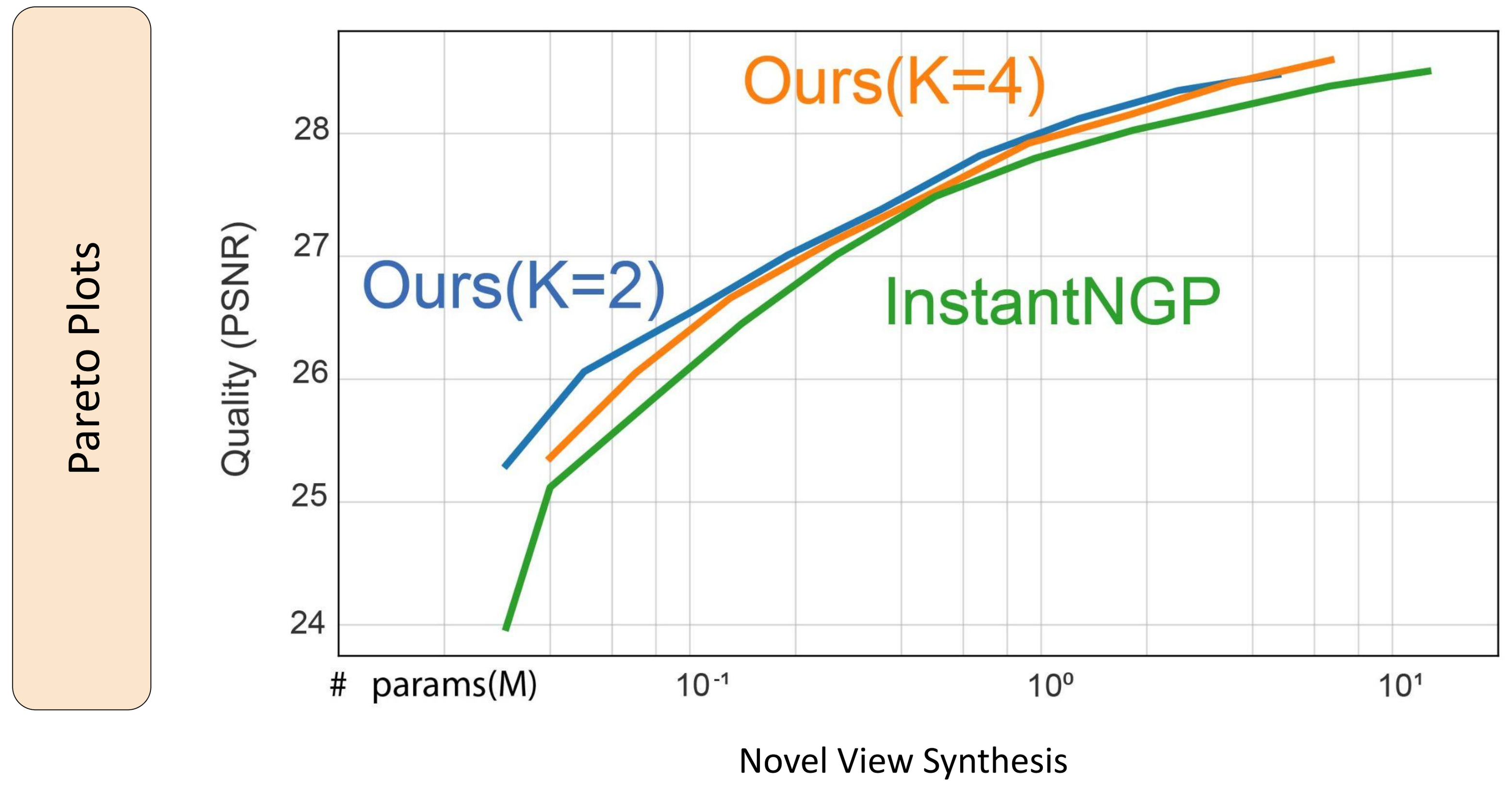


Results

Tablet







References:

NeRF. Mildenhall, B., Srinivasan, P.P., Tancik, M., Barron, J.T., Ramamoorthi, R., Ng, R.: Nerf: Representing scenes as neural radiance fields for view synthesis. ECCV 2020

iNGP. Müller, T., Evans, A., Schied, C., Keller, A.: Instant neural graphics primitives with a multiresolution hash encoding. TOG (Proc. of SIGGRAPH) (2022)

3DGS. Kerbl, B., Kopanas, G., Leimkühler, T., Drettakis, G.: 3d gaussian splatting for real-time radiance field rendering. TOG (Proc. of SIGGRAPH) (2023)