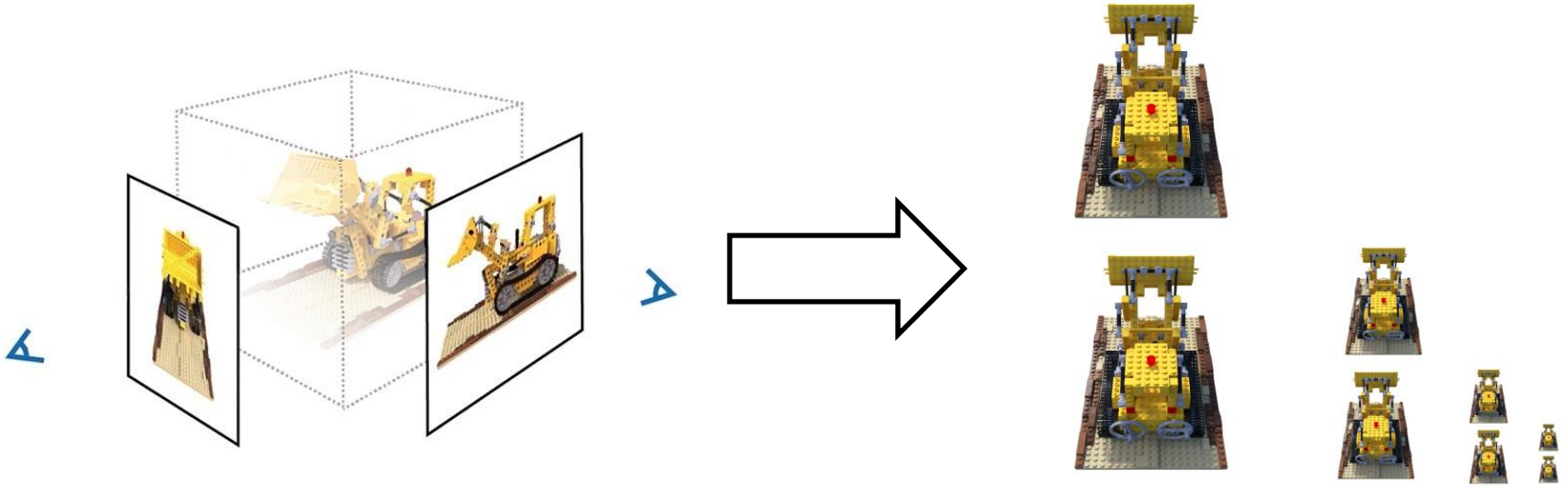
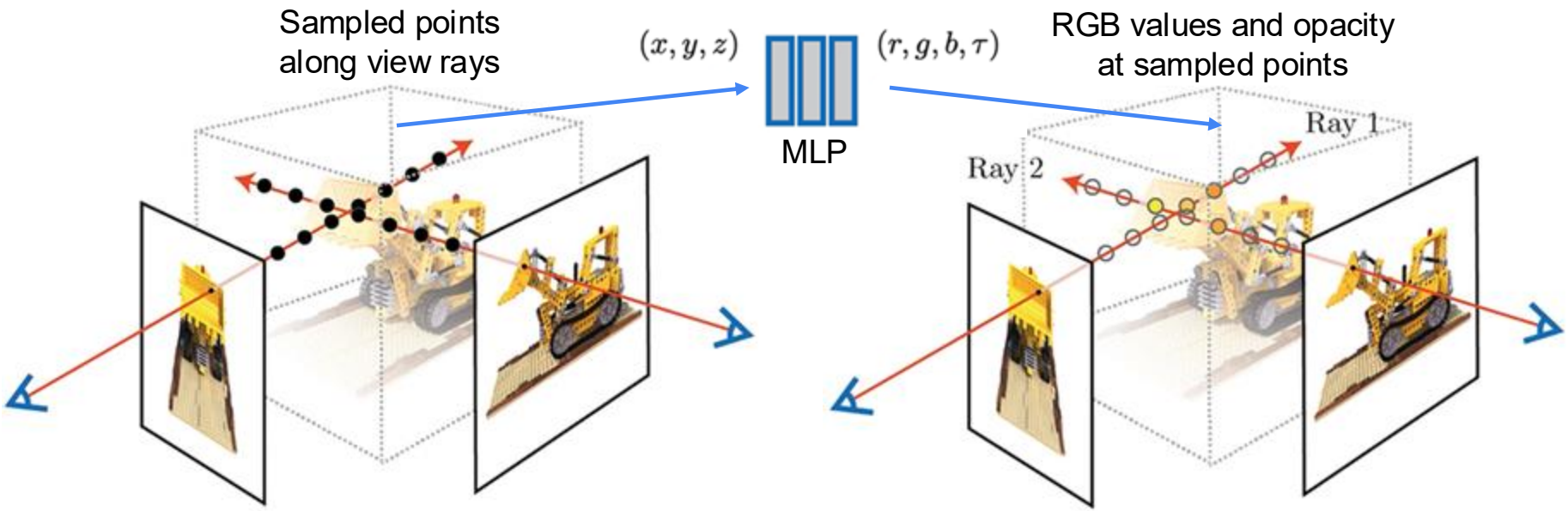
# Aliasing in 3D Reconstructions

## Mip-NeRF and Mip-Splatting

Seminar: Advanced Topics in Computer Graphics and Computer Vision
Winter 2024/2025
César Díaz Blanco



# Neural Radiance Fields (NeRF)

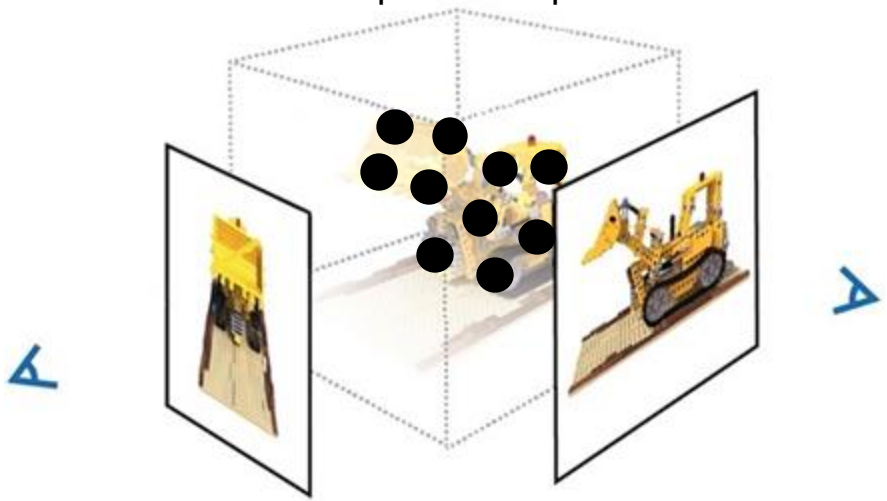





NeRF: Representing Scenes as Neural Radiance Fields for View Synthesis, Mildenhall, Srinivasan, Tancik, et al, ECCV 2020

# 3D Gaussian Splatting (3DGS)

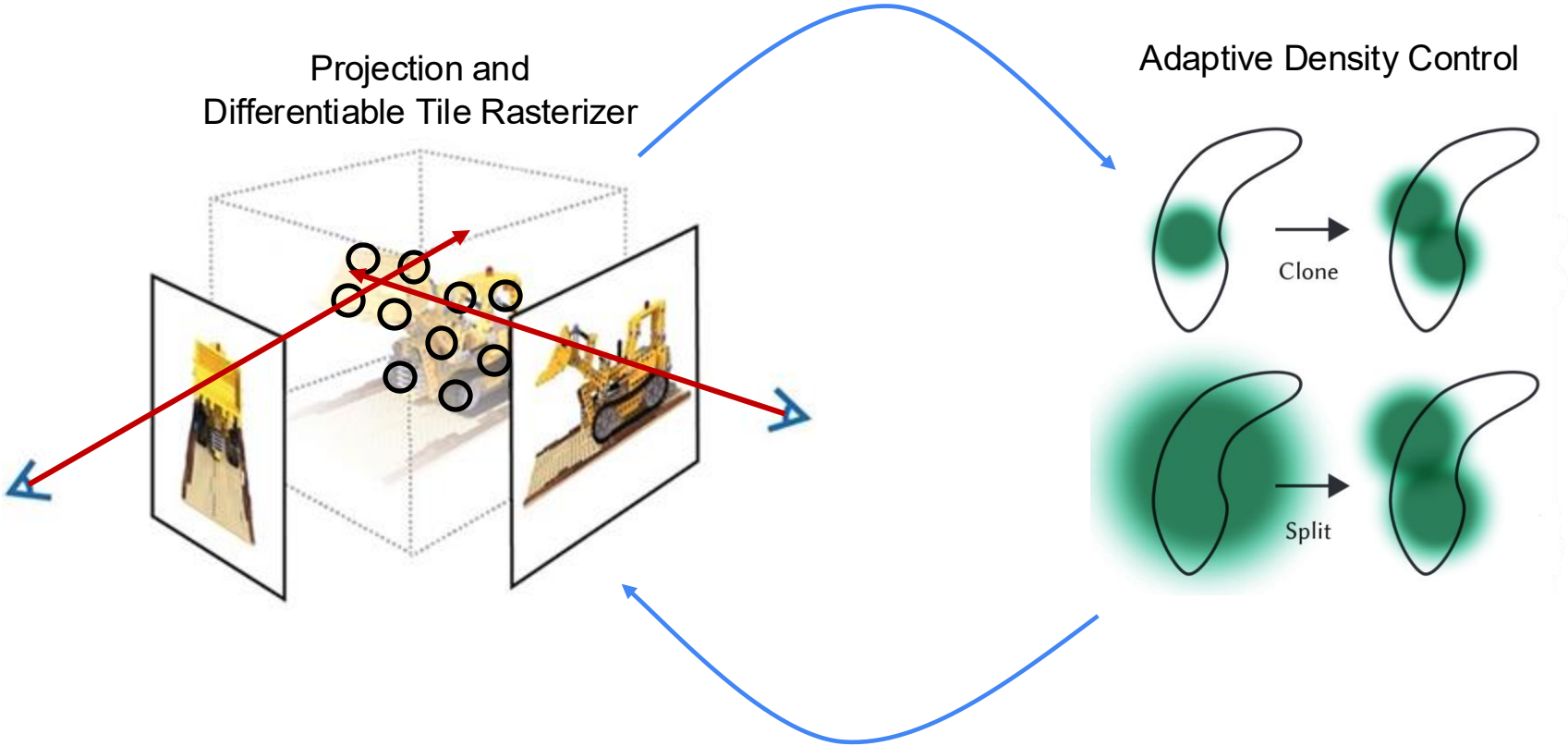
Structure from Motion's camera poses and correspondence points





3D Gaussian Splatting for Real-Time Radiance Field Rendering, Kerbl, Kopanas, et al, ACM Transactions on Graphics, 2023

# 3D Gaussian Splatting (3DGS)



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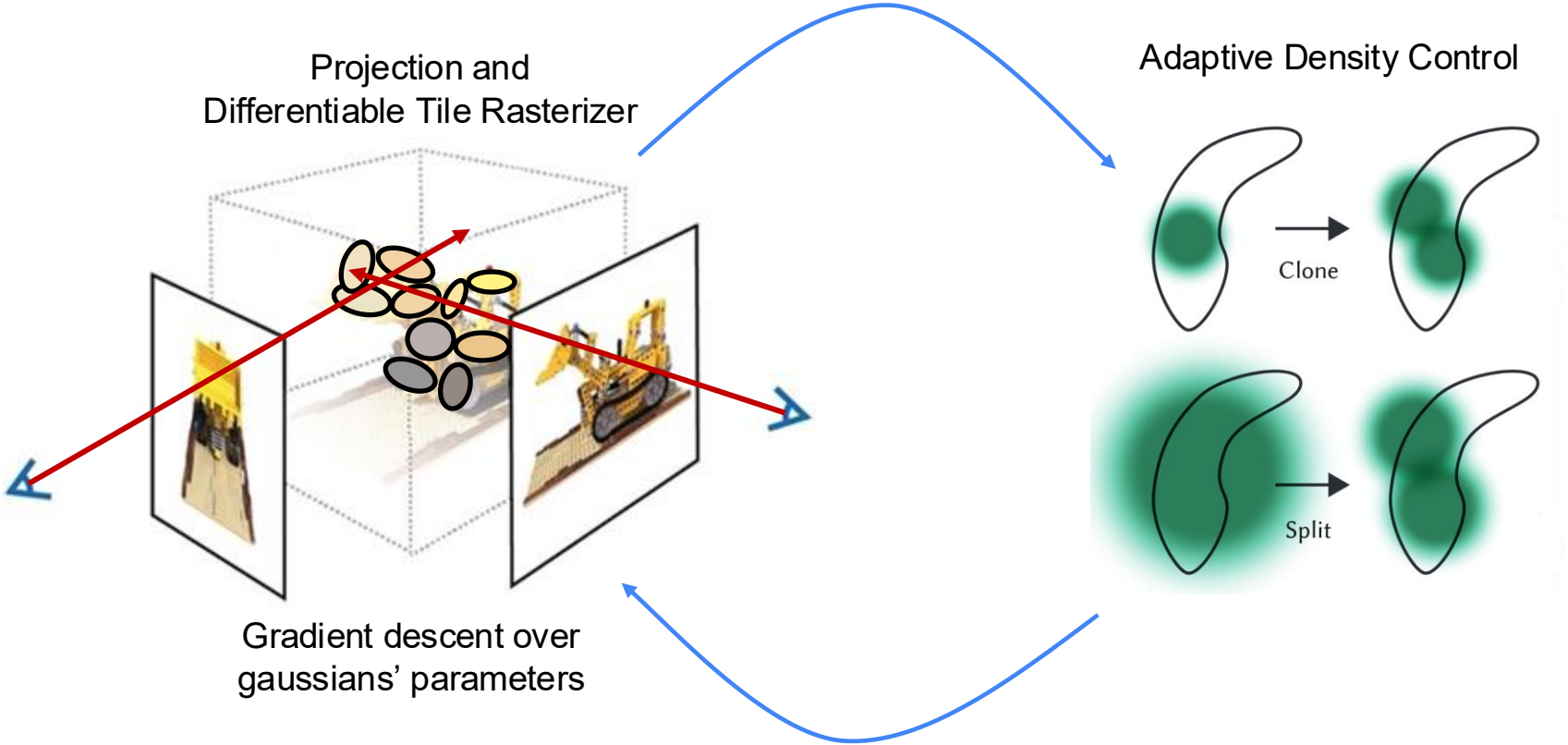
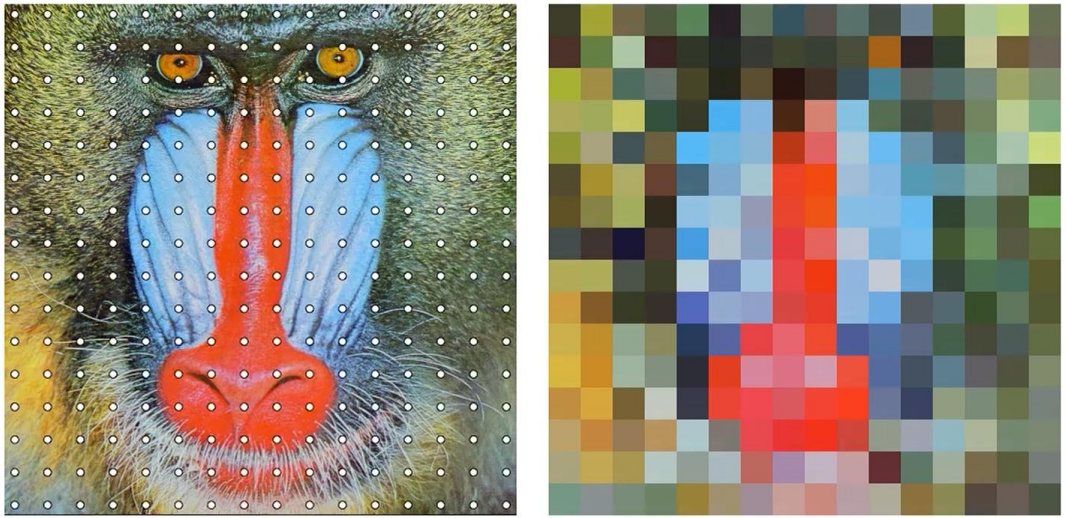
# 3D Gaussian Splatting (3DGS)






3D Gaussian Splatting for Real-Time Radiance Field Rendering, Kerbl, Kopanas, et al, ACM Transactions on Graphics, 2023

# Aliasing

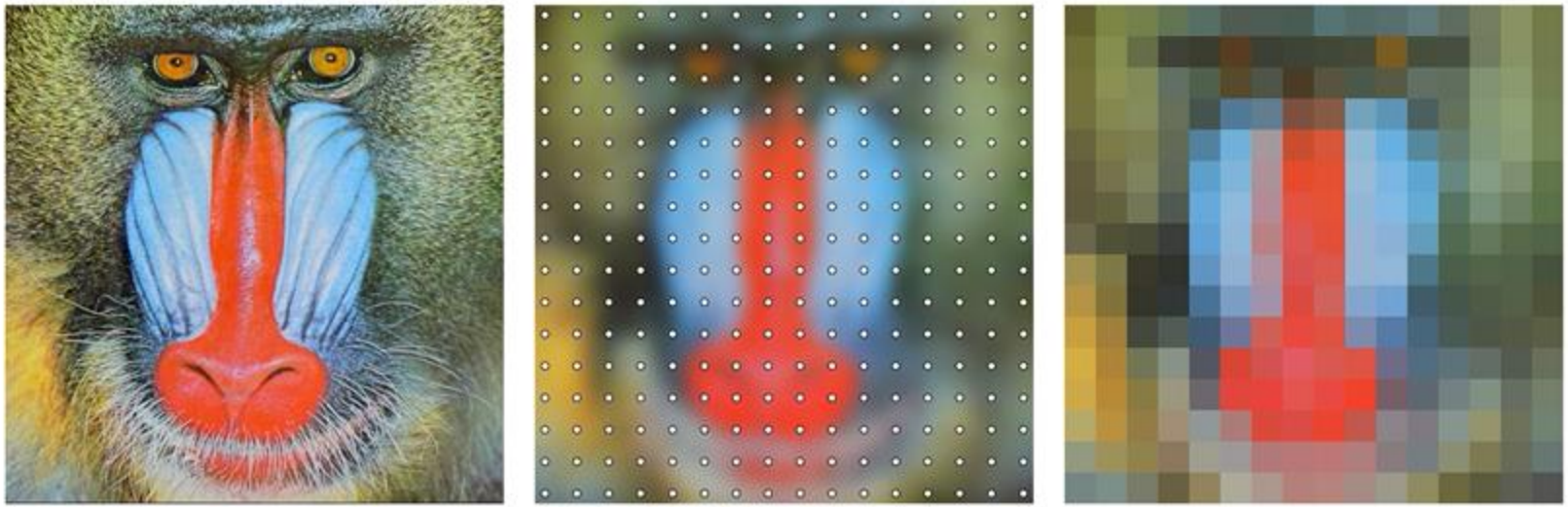


Naïve sample



Mip-NeRF: A Multiscale Representation for Anti-Aliasing Neural Radiance Fields, Barron, Mildenhall, Tancik, et al, ICCV, 2021

# Solving aliasing by prefiltering



Prefilter Sample



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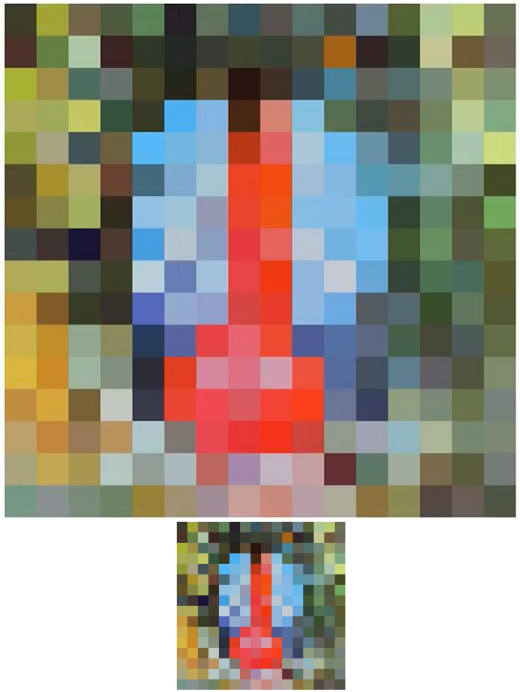
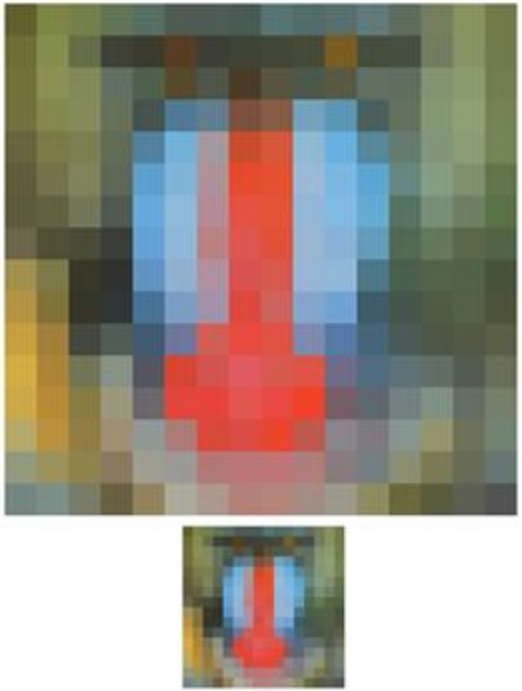
# Side by side

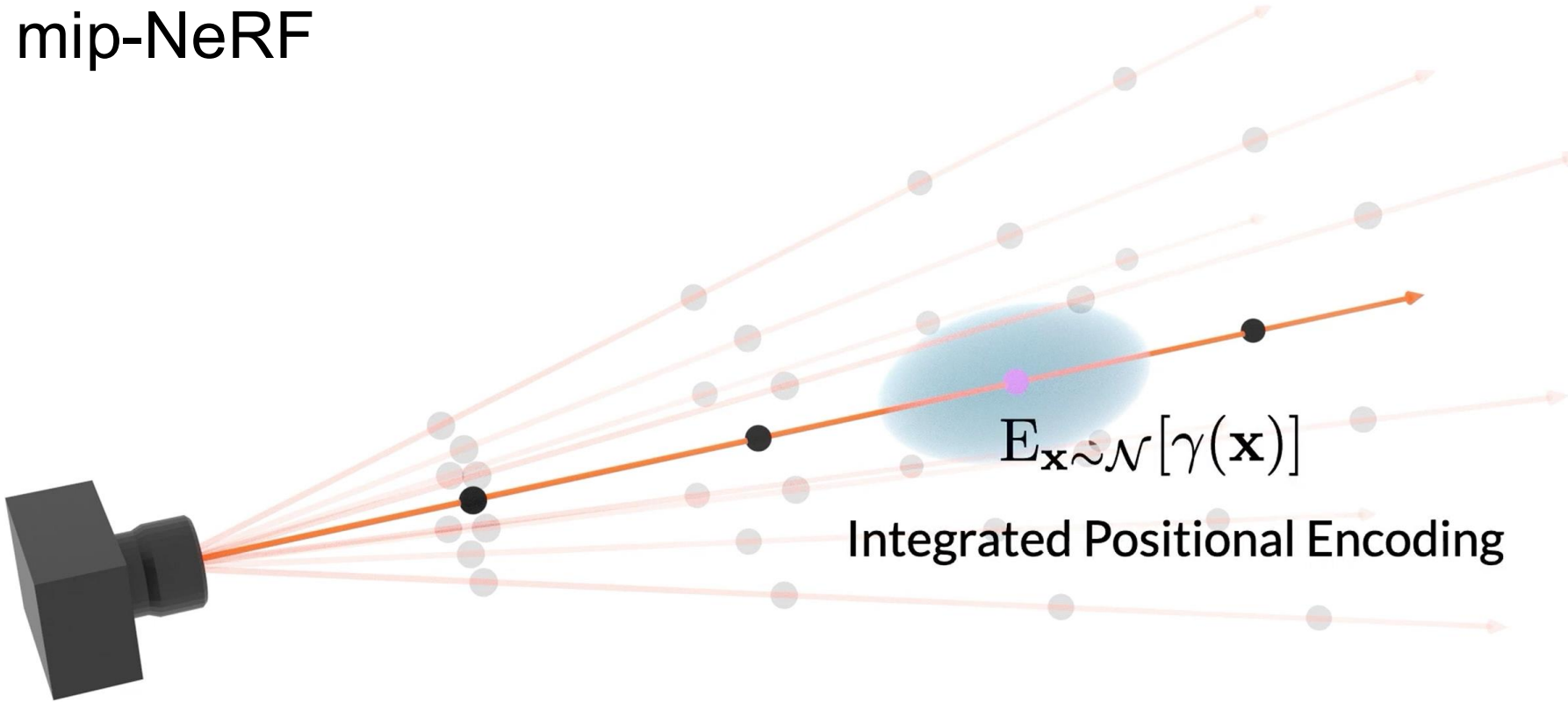


Sample



Prefilter and sample

# mip-NeRF



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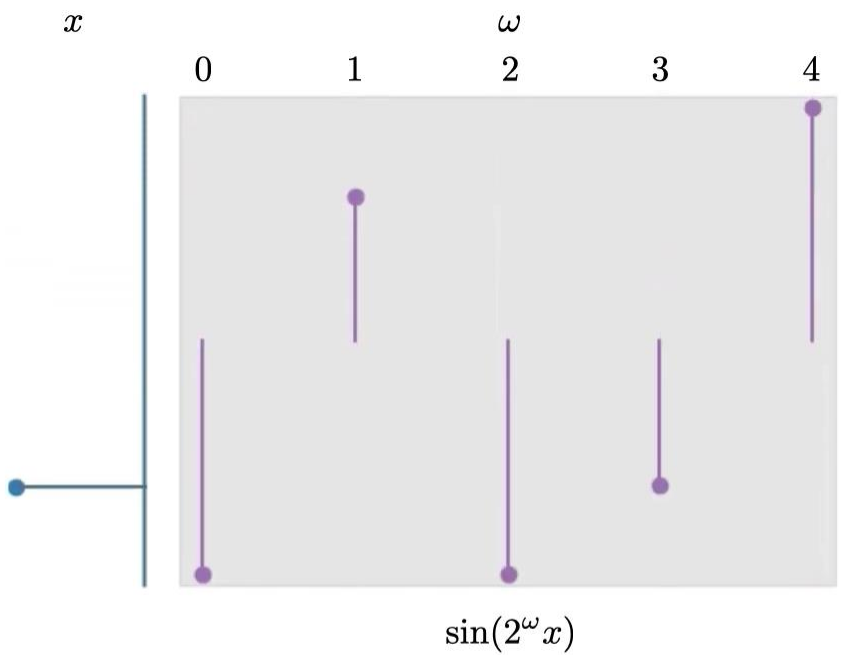
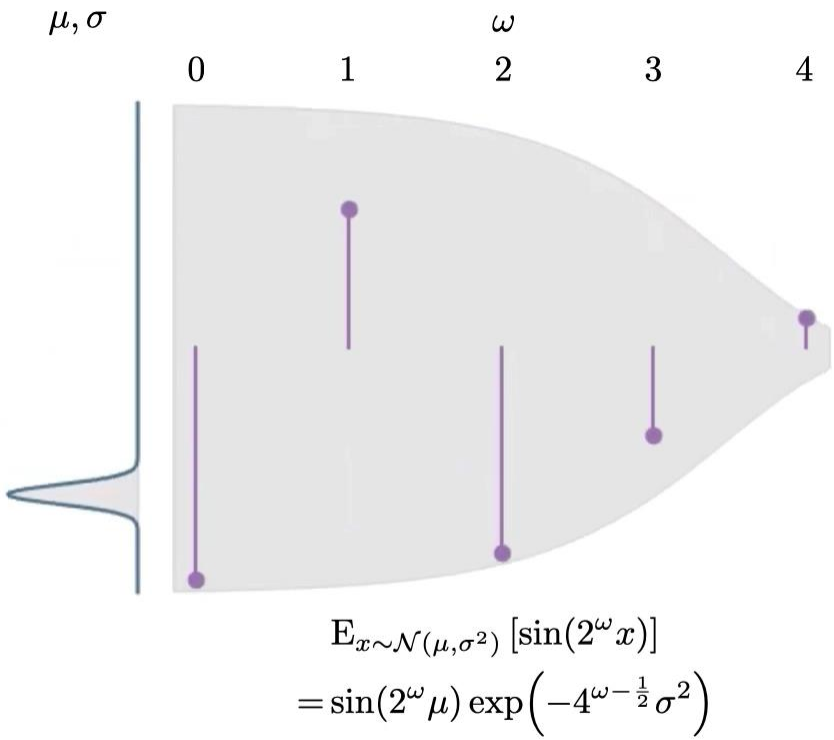
# Integrated Positional Encoding






Mip-NeRF: A Multiscale Representation for Anti-Aliasing Neural Radiance Fields, Barron, Mildenhall, Tancik, et al, ICCV, 2021

# NeRF vs mip-NeRF: Visual Comparison



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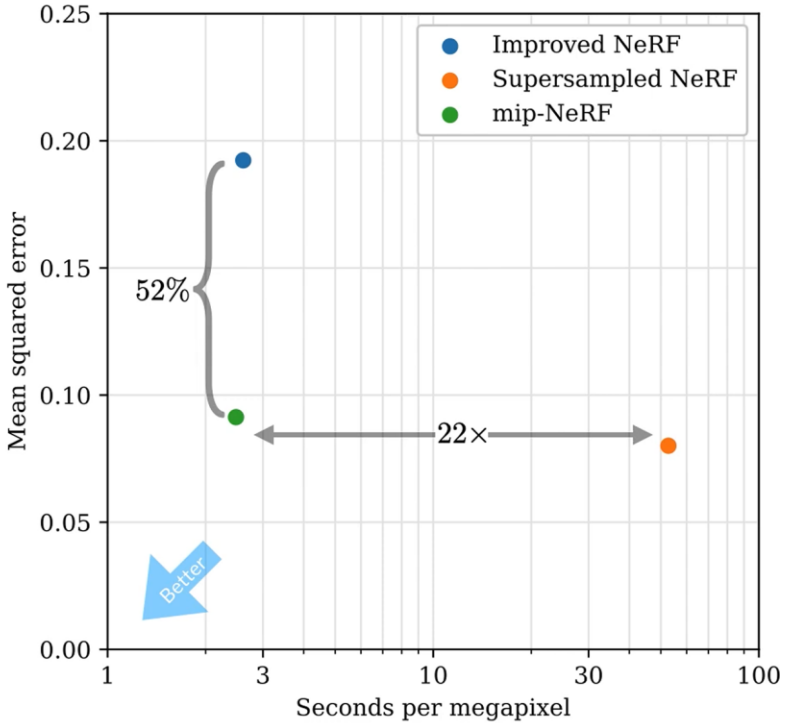
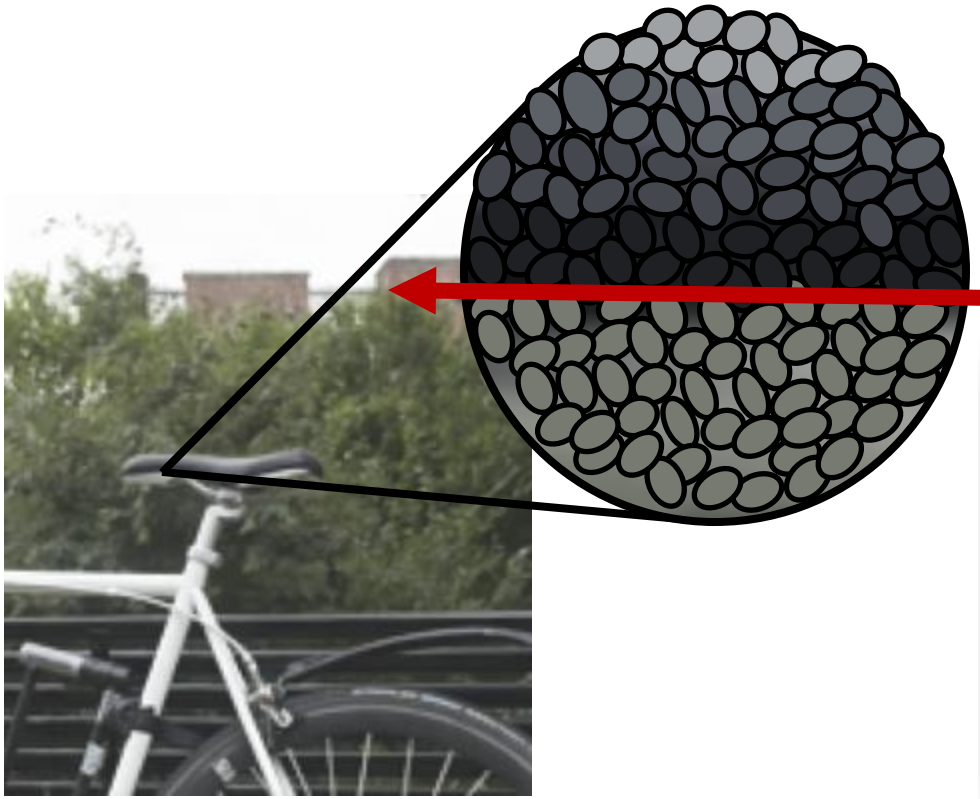
# NeRF vs mip-NeRF: Error and efficiency comparison






Mip-NeRF: A Multiscale Representation for Anti-Aliasing Neural Radiance Fields, Barron, Mildenhall, Tancik, et al, ICCV, 2021

# Small gaussians are problematic

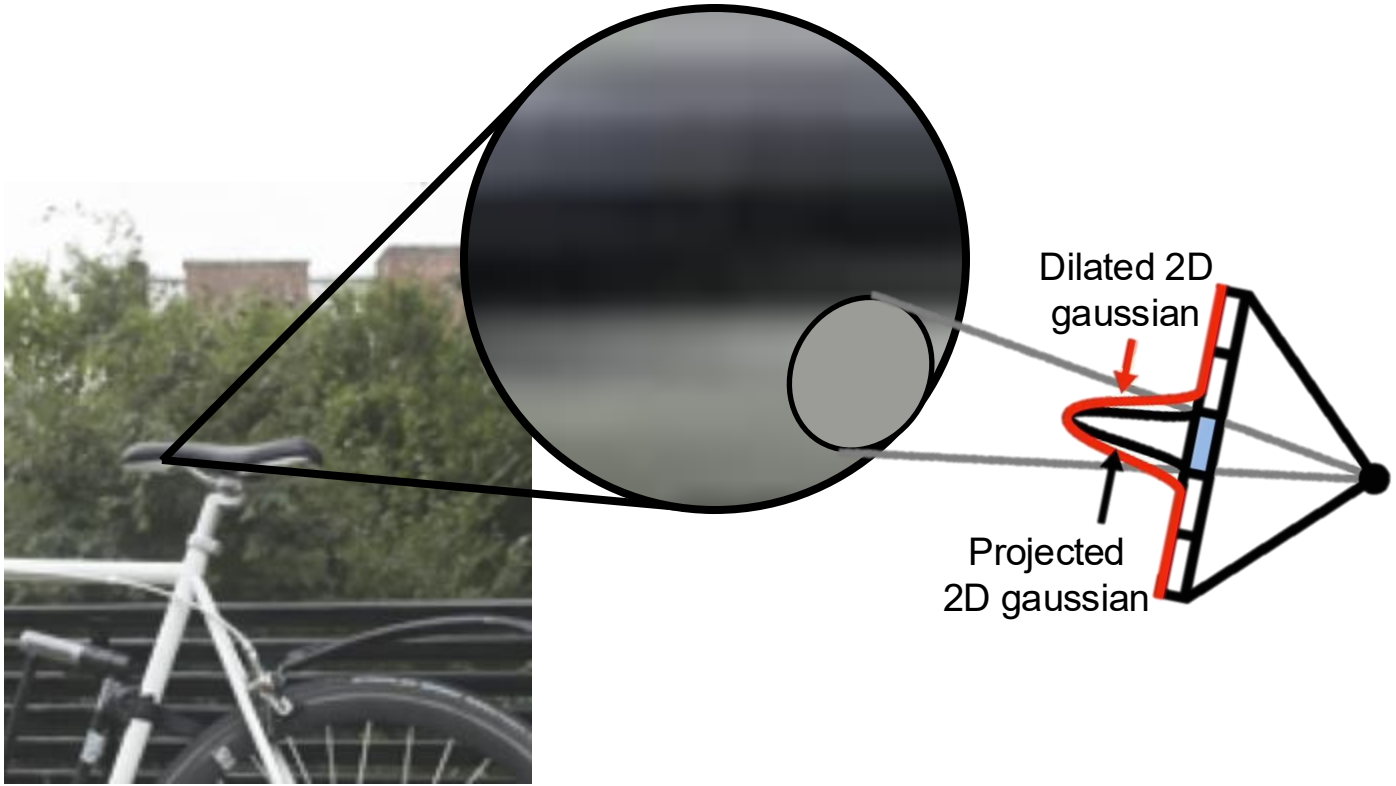






3D Gaussian Splatting for Real-Time Radiance Field Rendering, Kerbl, Kopanas, et al, ACM Transactions on Graphics, 2023

# 3DGS solution



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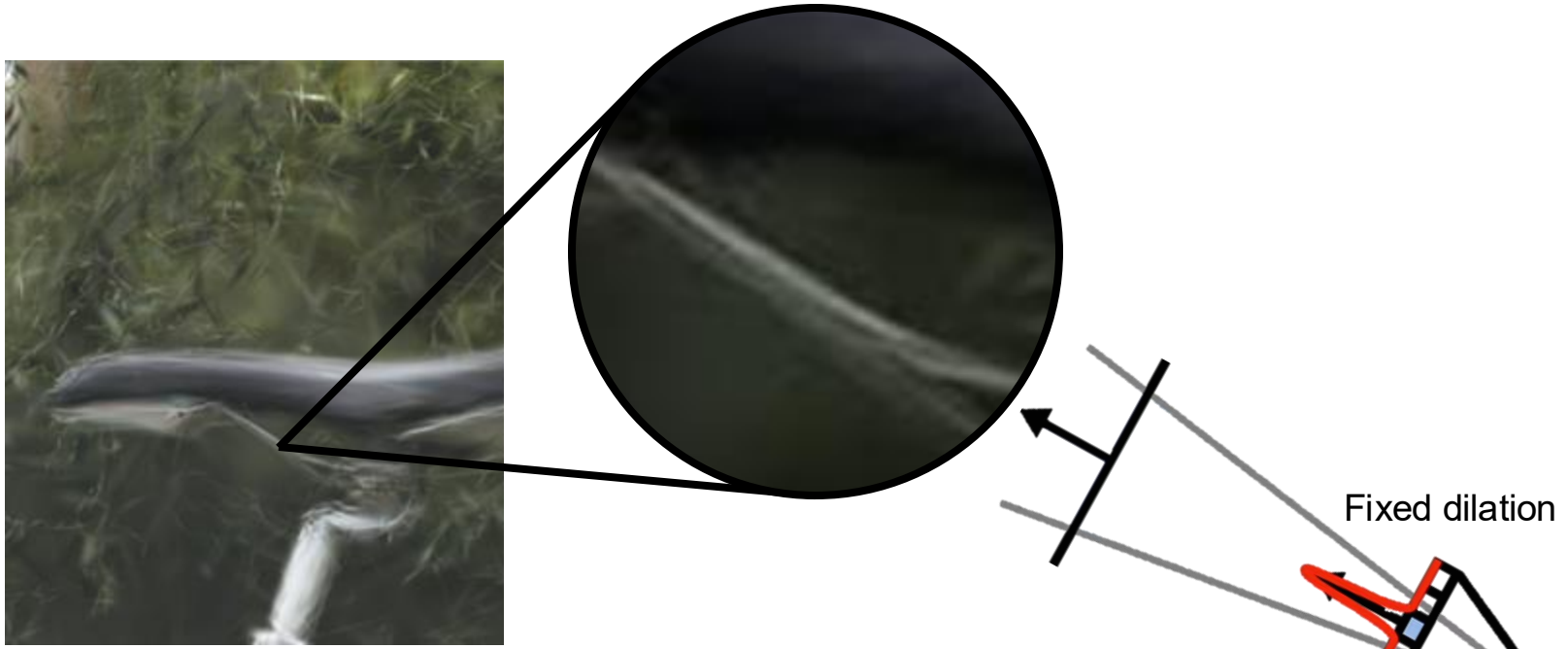
# 3DGS with increased focal length or zooming in

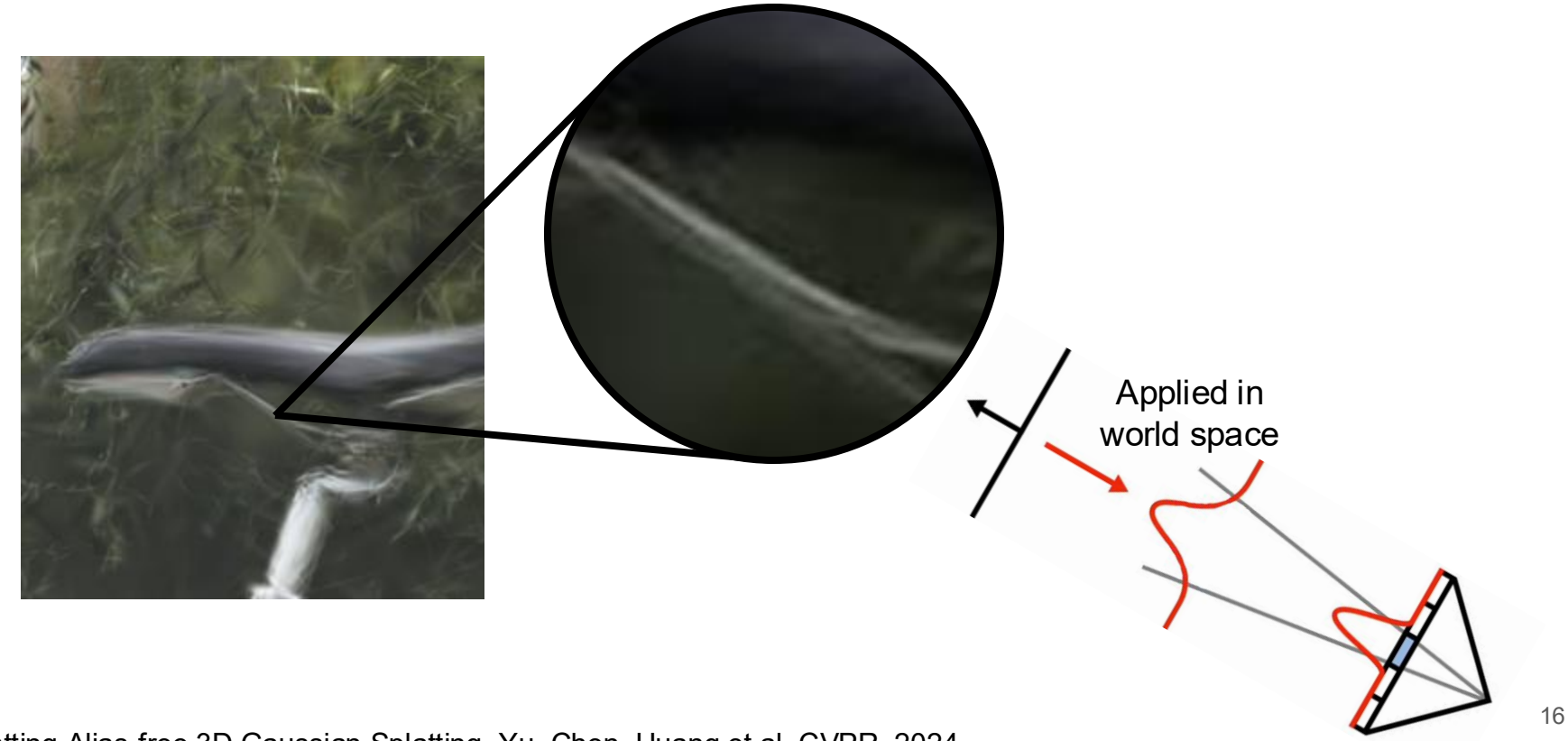



Erosion and high frequency artifacts



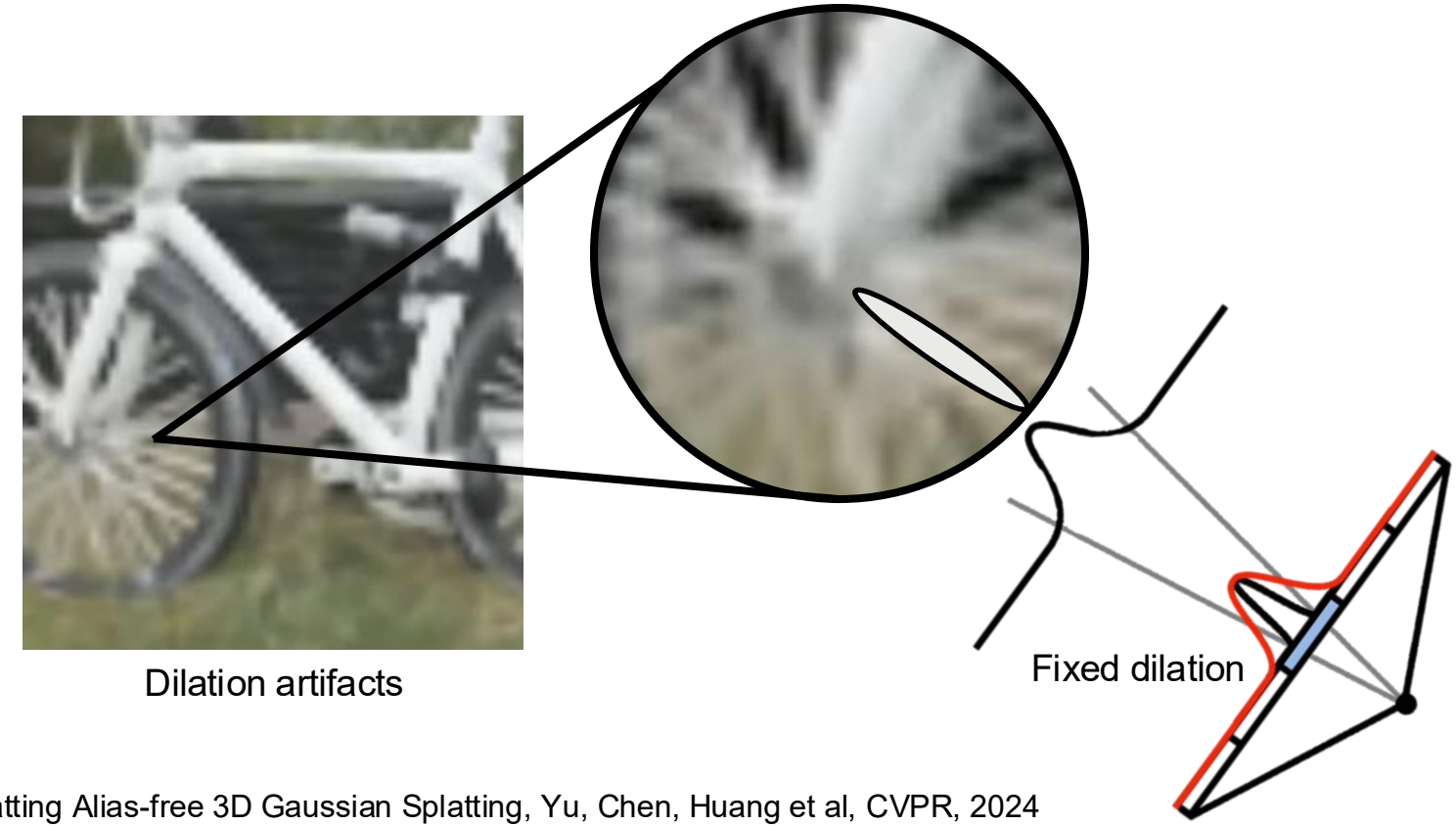
Mip-Splatting Alias-free 3D Gaussian Splatting, Yu, Chen, Huang et al, CVPR, 2024

# Mip-Splatting proposes a 3D Smoothing Filter



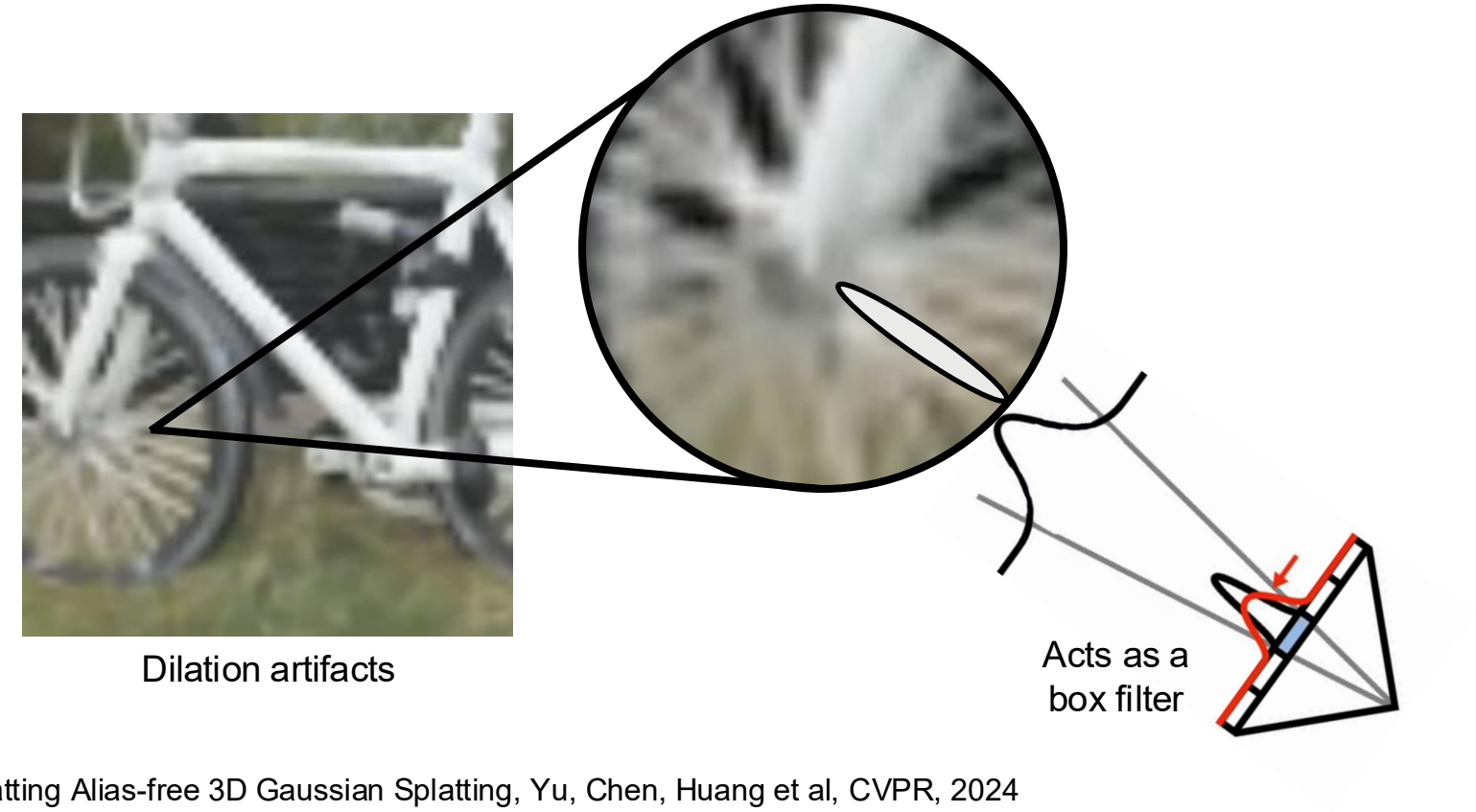

Mip-Splatting Alias-free 3D Gaussian Splatting, Yu, Chen, Huang et al, CVPR, 2024

# 3DGS with decreased focal length or zooming out




Mip-Splatting Alias-free 3D Gaussian Splatting, Yu, Chen, Huang et al, CVPR, 2024

# Mip-Splatting proposes a 2D Gaussian filter





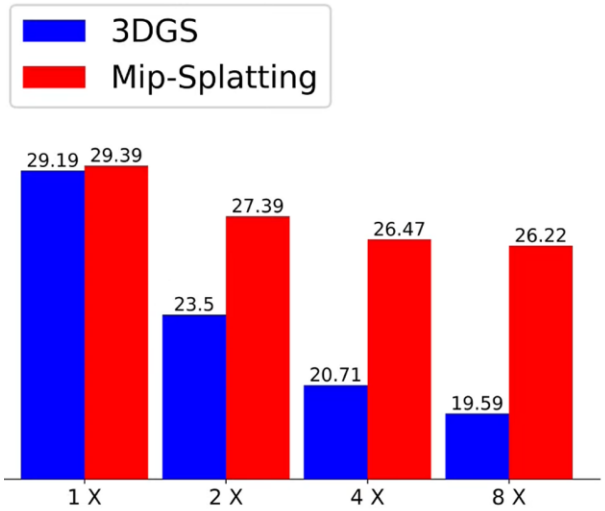

Mip-Splatting Alias-free 3D Gaussian Splatting, Yu, Chen, Huang et al, CVPR, 2024

# 3DGS vs Mip-Splatting: Visual Comparison

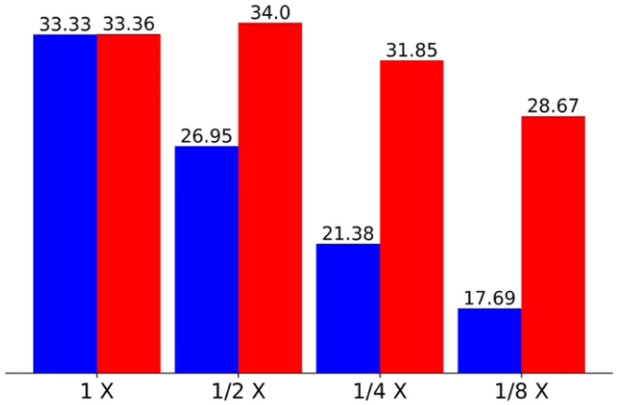


Mip-Splatting Alias-free 3D Gaussian Splatting, Yu, Chen, Huang et al, CVPR, 2024

# 3DGS vs Mip-Splatting: PSNR Comparison




Zooming-in
mip-NeRF360 dataset




Zooming out
Blender dataset



Mip-Splatting Alias-free 3D Gaussian Splatting, Yu, Chen, Huang et al, CVPR, 2024

# Side by side and summary

When **decreasing focal length or zooming out**, aliasing is approached in a similar way as in classical graphics by considering the area used by the pixel

mip-NeRF uses frustums

Mip-Splatting uses a gaussian box filter

NeRF | mip-NeRF | 3DGS | Mip-Splatting

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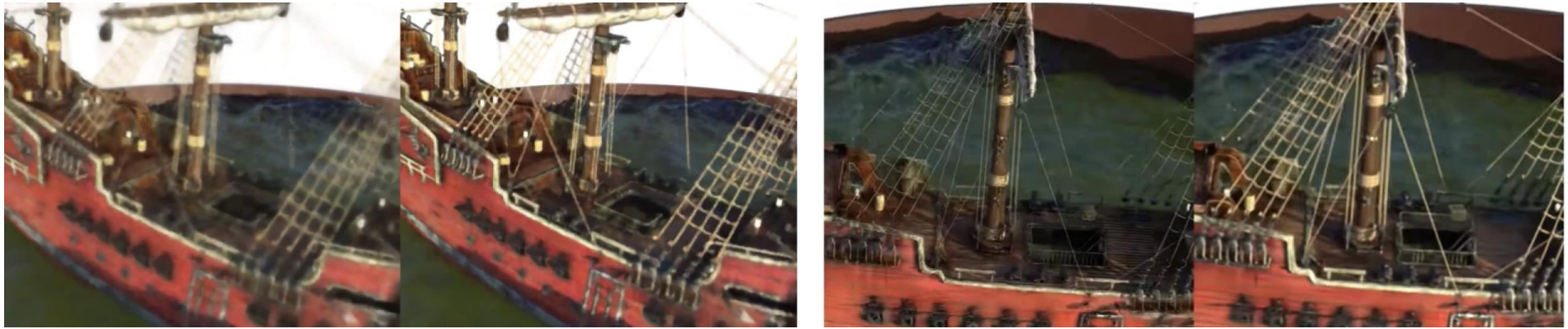
# Side by side and summary

When **increasing focal length or zooming in**, due to the non-native nature of the representations and their differential optimization, aliasing effects also arise

In NeRF, scale is not considered, and a new positional encoding is needed

In 3DGS, 2D gaussians are pushed to thin structures, and a 3D constraint is needed



NeRF mip-NeRF 3DGS Mip-Splatting

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Mip-Splatting Alias-free 3D Gaussian Splatting, Yu, Chen, Huang et al, CVPR, 2024

# Fin

Thanks for listening!
Please ask as many questions as you wish ☺

…leaving the videos since they are fun to watch

NeRF

mip-NeRF

3DGS

Mip-Splatting

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