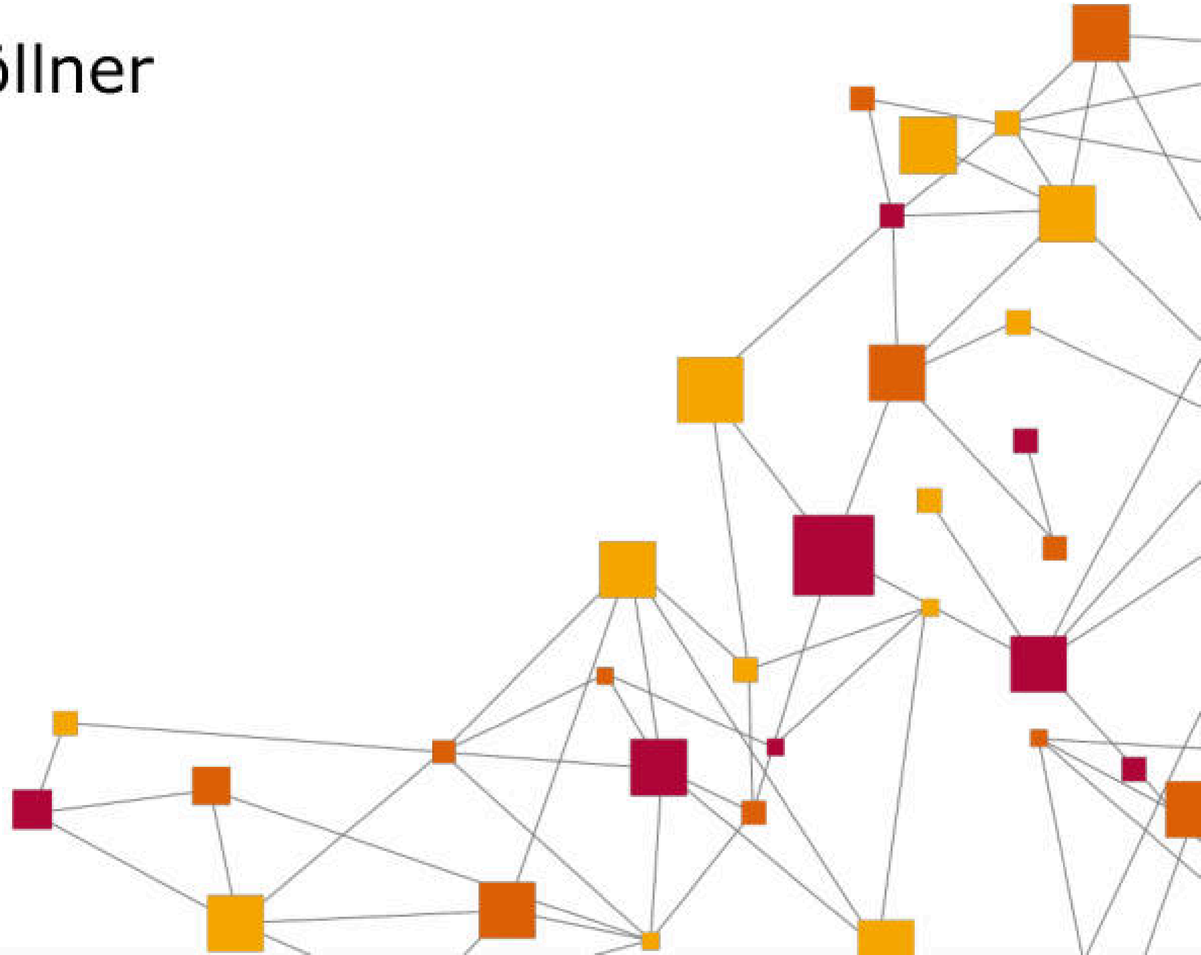
WebSVR: Joint Volume Measurement and Novel View Synthesis in Web-based 3D Environments

Raphael Kunert, Rico Richter, Jürgen Döllner

Hasso Plattner Institute & University of Potsdam
Potsdam, Germany

Web3D 2026
13.10.2026



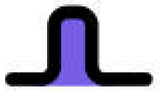
Overview



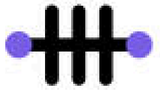
Motivation



SVR



VoISVR - Object Filling



WebSVR - Volume Estimation



WebSVR - Workspace

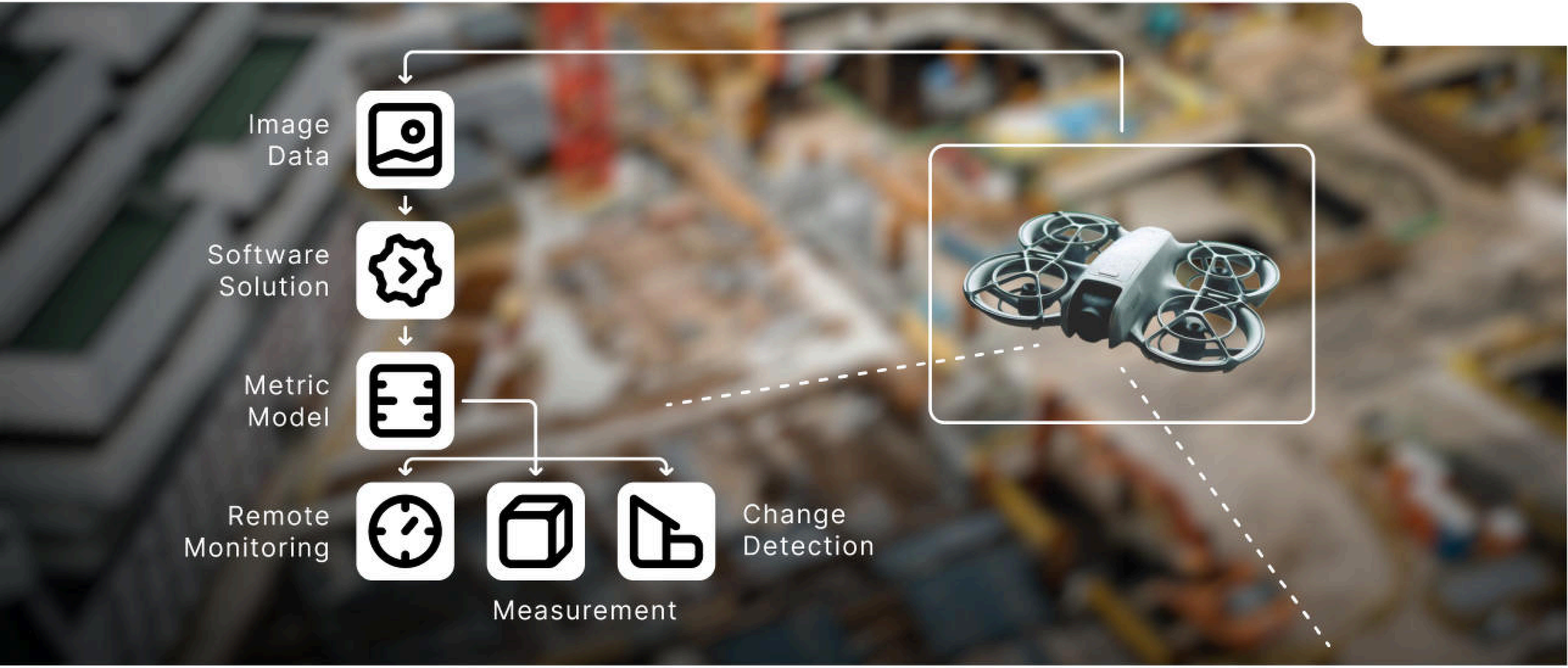


Evaluation



Future Work

Motivation


Image Data
Software Solution
Metric Model
Remote Monitoring
Measurement
Change Detection

Research Questions



RQ1 Is it possible to visualize and measure simultaneously?



RQ2 How does the proposed volume estimation compare against existing techniques?



RQ3 How does the method perform across different spatial scales?



RQ4 Which inputs yield good results?

State-of-the-art

3D Gaussian Splatting for Real-Time Radiance Field Rendering

Kerbl, B. Kopanas, G.

Leimkühler, T. Drettakis, G.

2023 ACM Trans. Graph. ARTICLE





State-of-the-art

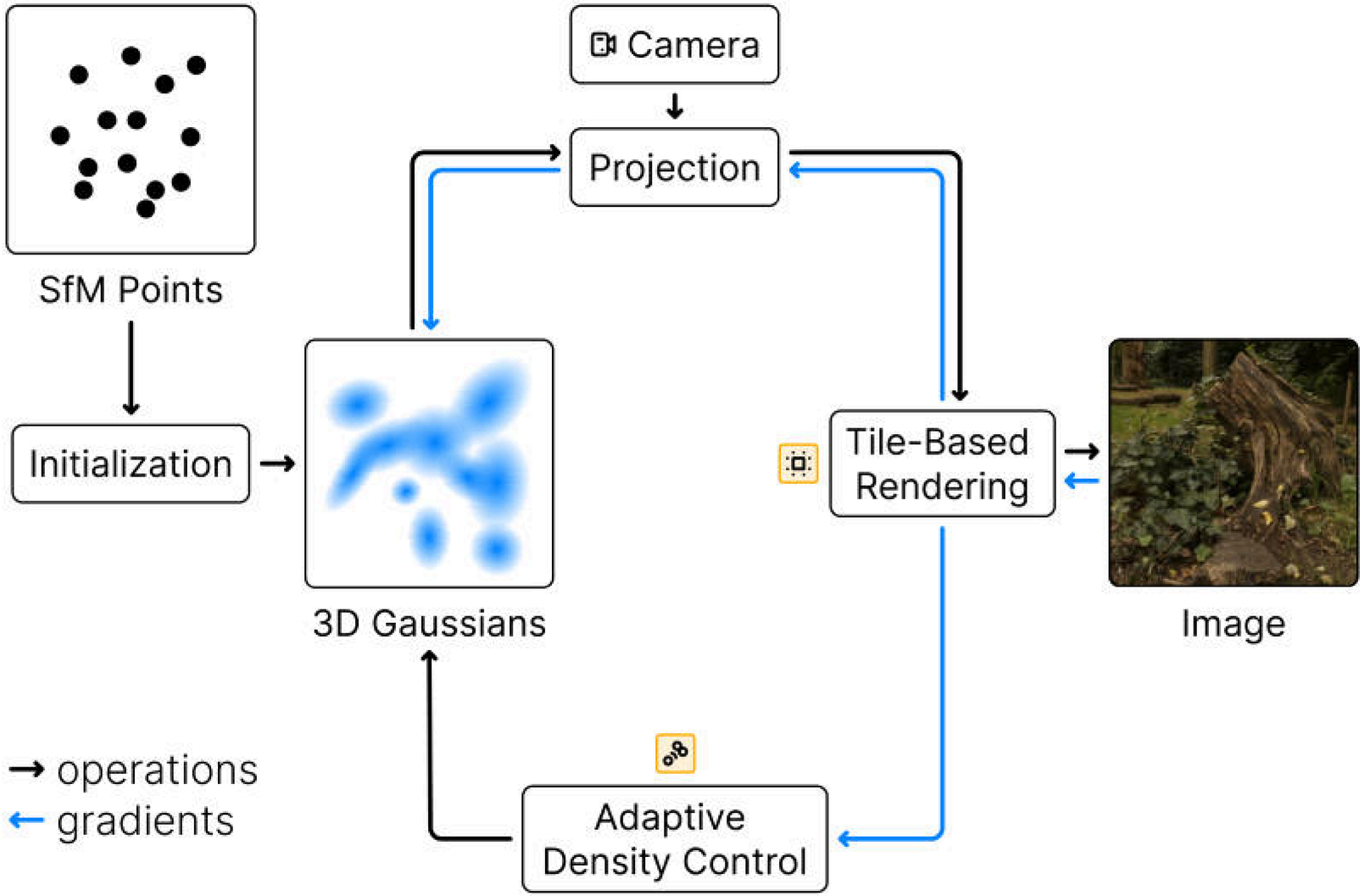
3D Gaussian Splatting for Real-Time Radiance Field Rendering

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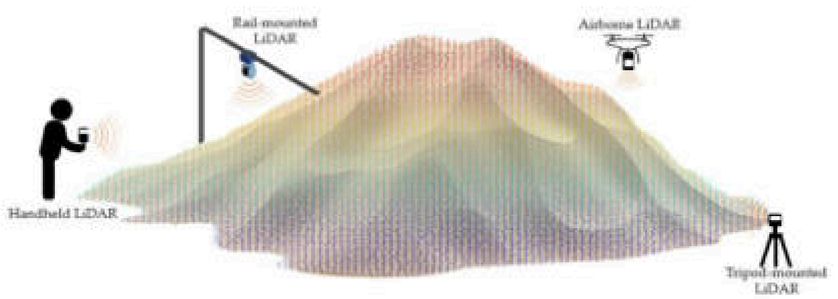
State-of-the-art

3D Gaussian Splatting for Real-Time Radiance Field Rendering

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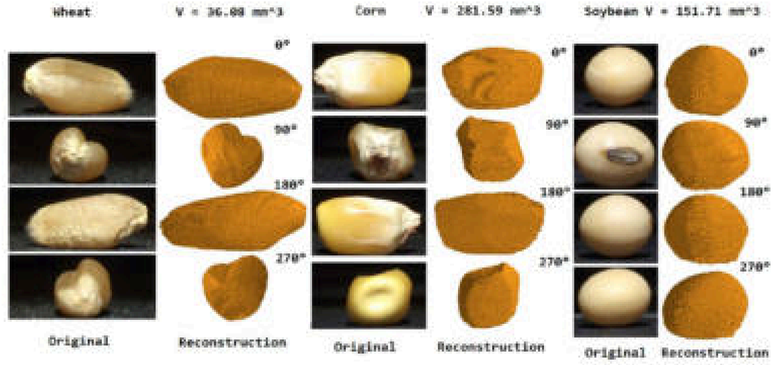


Stockpile volume estimation in open and confined environments

A review.

Alsayed, A. Nabawy, M.R.

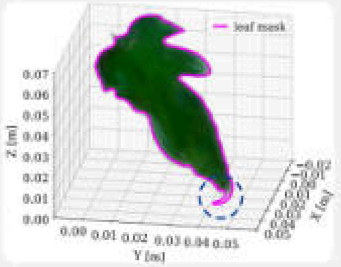
2023 Drones ARTICLE



Efficient seed volume measurement framework

Cao, C. Neilsen, M.

2020 International Conference on Computational Science and Computational Intelligence (CSCI) IN PROCEEDINGS



Combining Close Range UAVs and Gaussian Splatting for High-Speed Tomato Leaf Size Estimation and Counting

Baar, S. Kobayashi, Y. Watanabe, S.

2024 IEEE 13th Global Conference on Consumer Electronics (GCCE) IN PROCEEDINGS

Sparse Voxel Rasterization

Real-time High-fidelity Radiance Field Rendering

Sun, C. | Choe, J. | Loop, C. | Ma, W.C. | Wang, Y.C.F.

2025 IEEE/CVF Conference on Computer Vision and Pattern Recognition IN PROCEEDINGS

- Adaptive Density Control
- Tile-Based Rendering

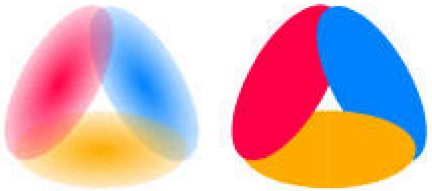
} 3DGS

+

- Voxel Primitives
- Grid-Aligned

+

- Morton Order Sorting
- Popping-Artifact Free





Sparse Voxel Rasterization

Real-time High-fidelity Radiance Field Rendering

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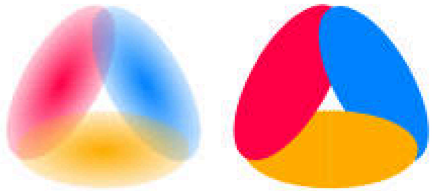
} 3DGS

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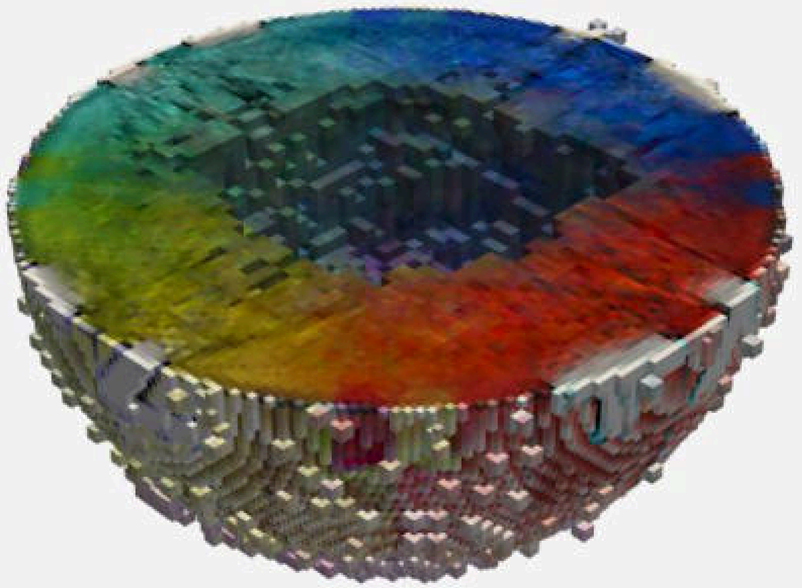




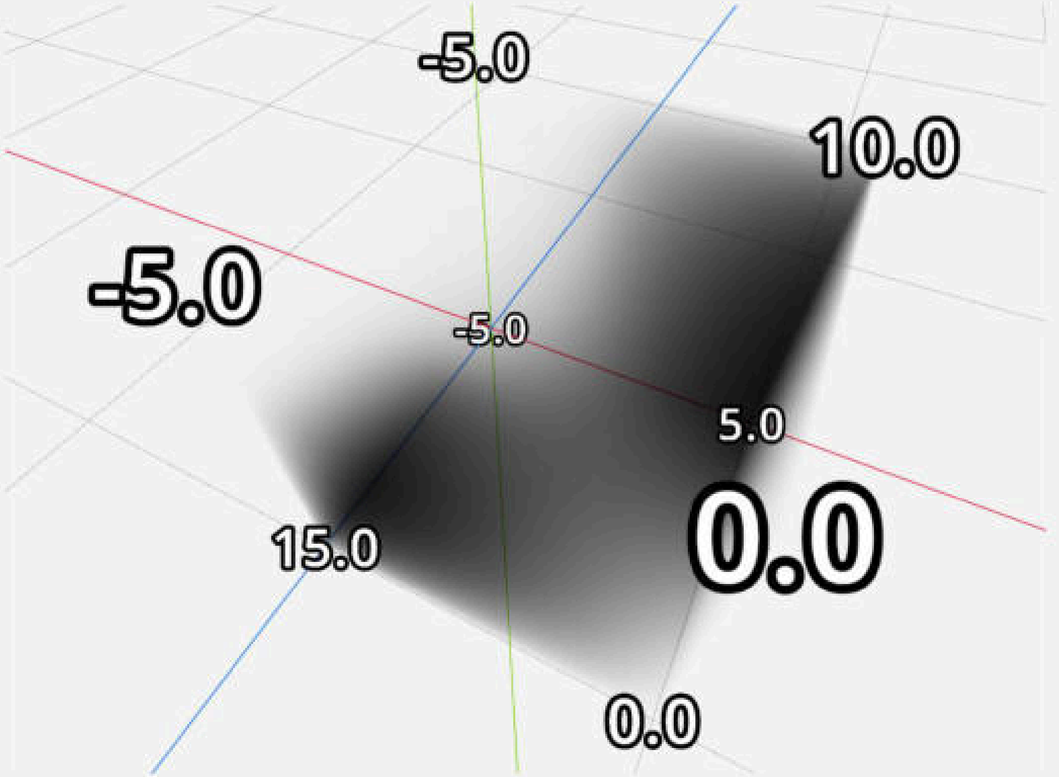
SVR for Volume Measurement – Challenges

Object Volume = Number of Voxels × Voxel Extent³ × Voxel Fill Level

Hollow Objects



Sub-Voxel Structure

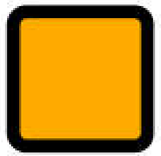


VoISVR

Object Filling

Object Filling

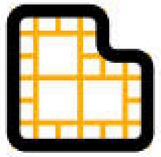
Goals



Filled
Interior



Filled
Occlusion

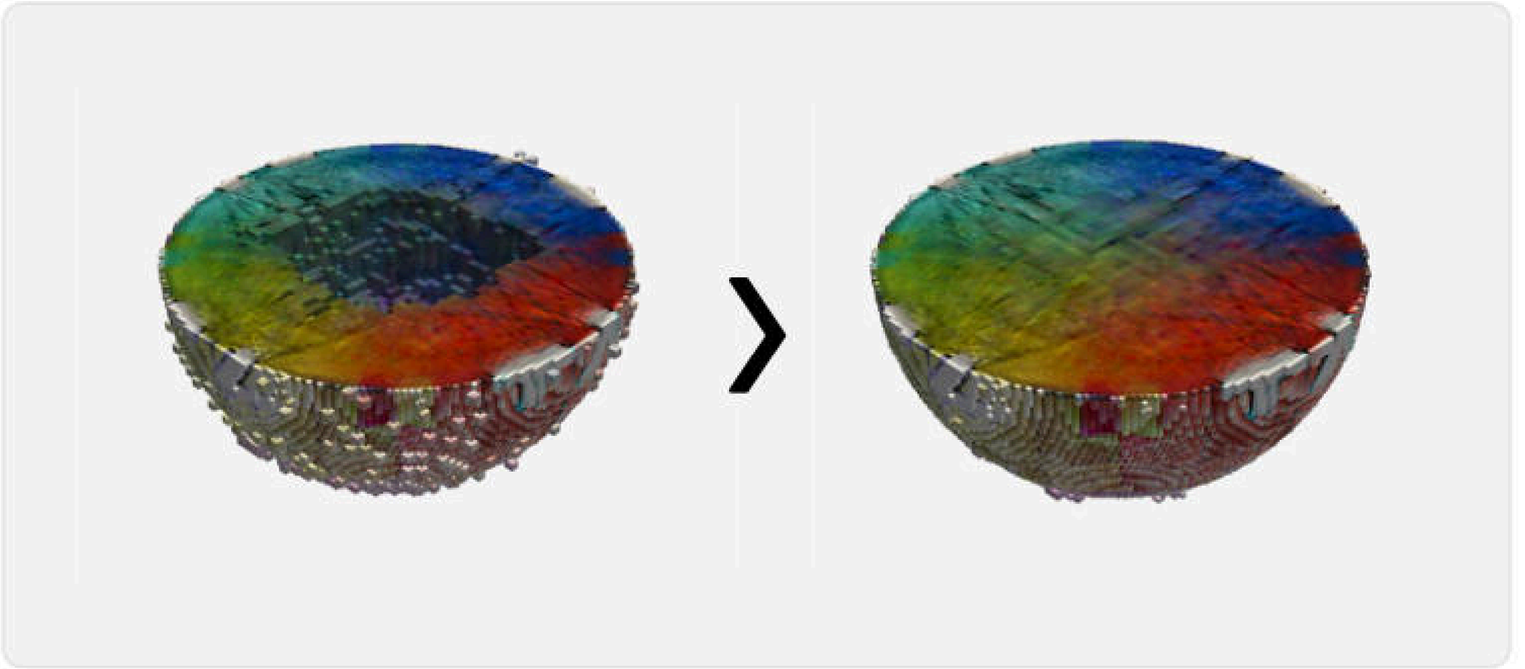


Maximized
Voxels



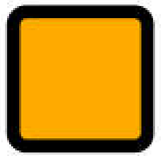
Opaque
Inner Voxels

Hollow Objects › Filled Objects



Object Filling

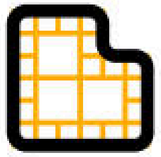
Goals



Filled Interior



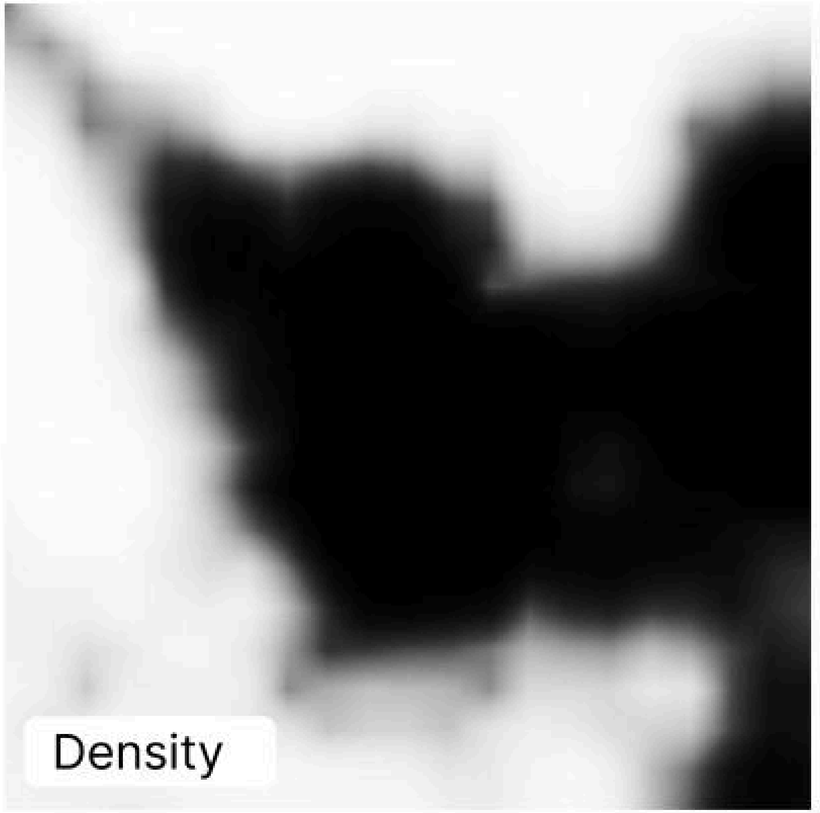
Filled Occlusion



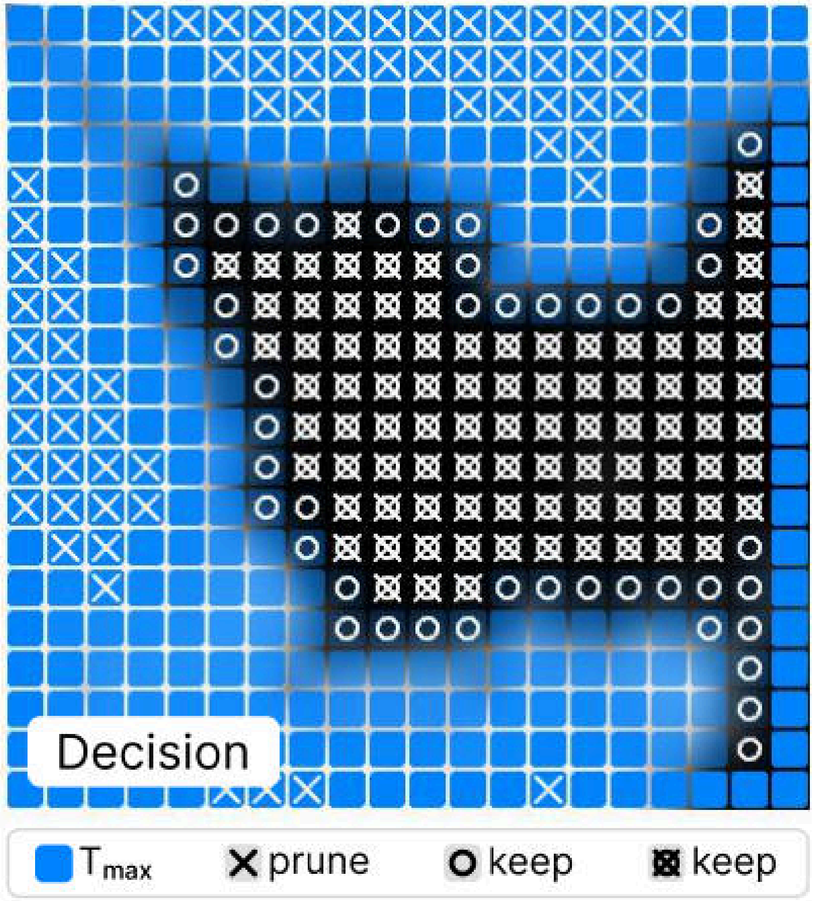
Maximized Voxels



Opaque Inner Voxels

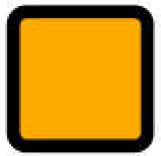






Object Filling

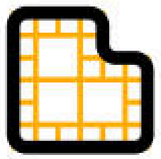
Goals



Filled
Interior



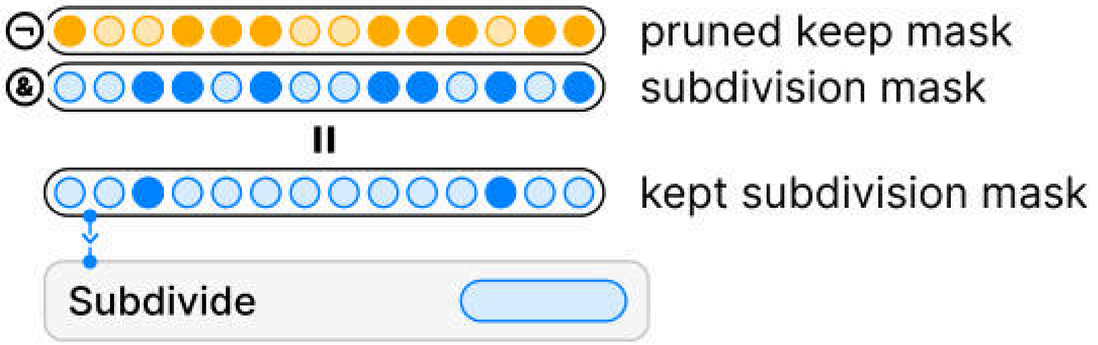
Filled
Occlusion



Maximized Voxels



Opaque Inner Voxels



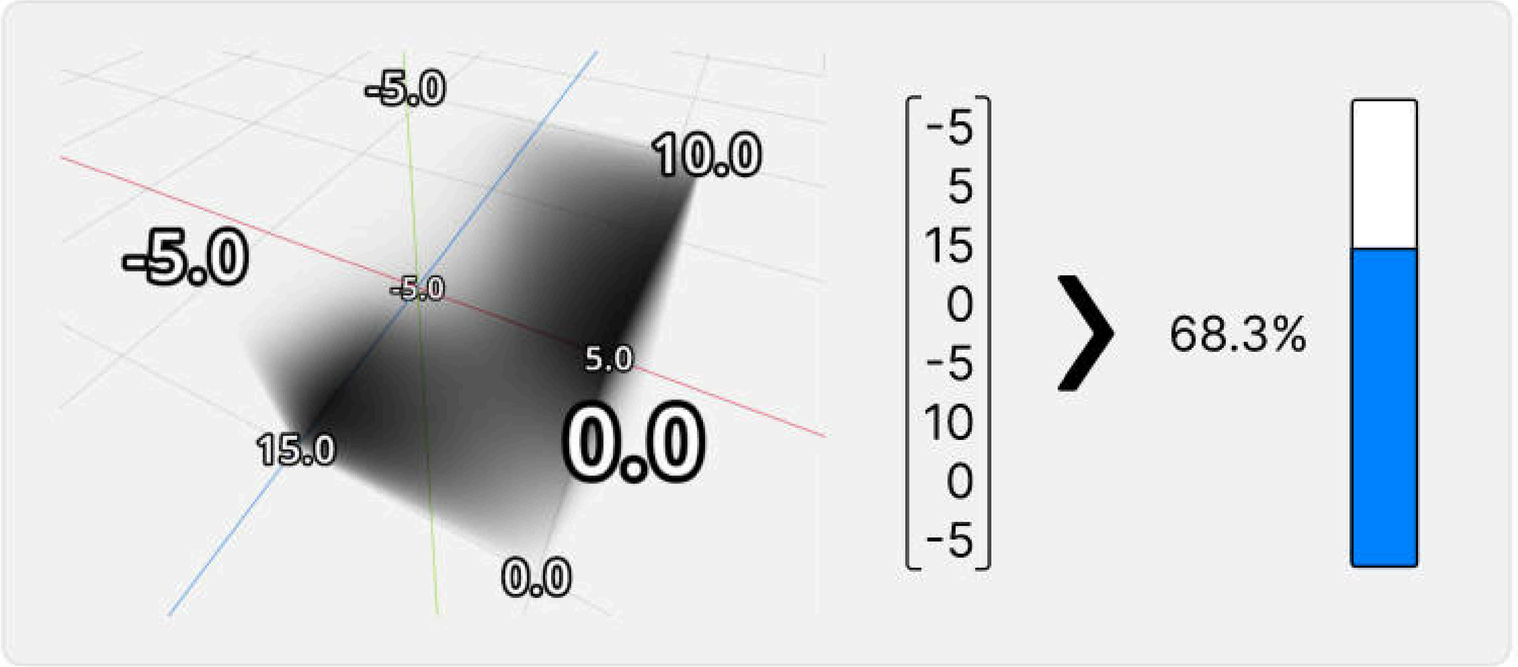
WebSVR

Volume Estimation

Volume Integral

Goals

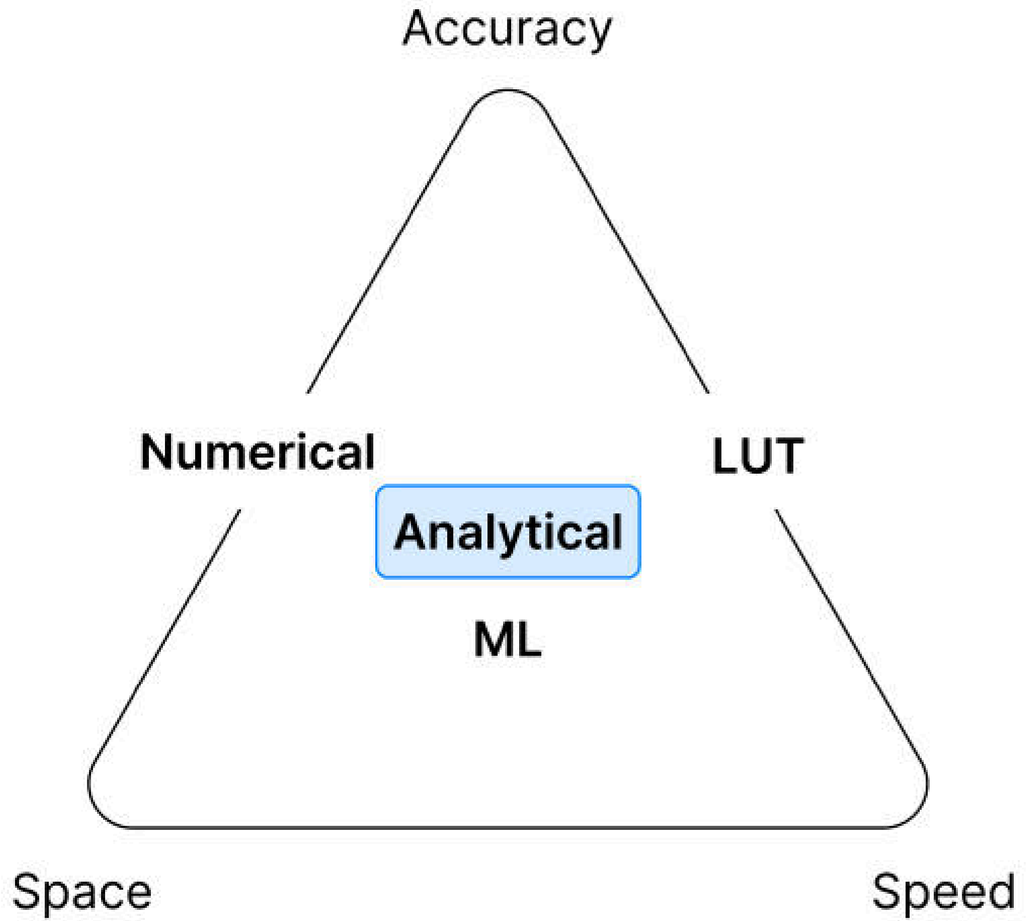
- Accurate
- Fast
- Space Efficient
- Parallel (GPU)
- 3-Dimensional



Volume Integral

Goals

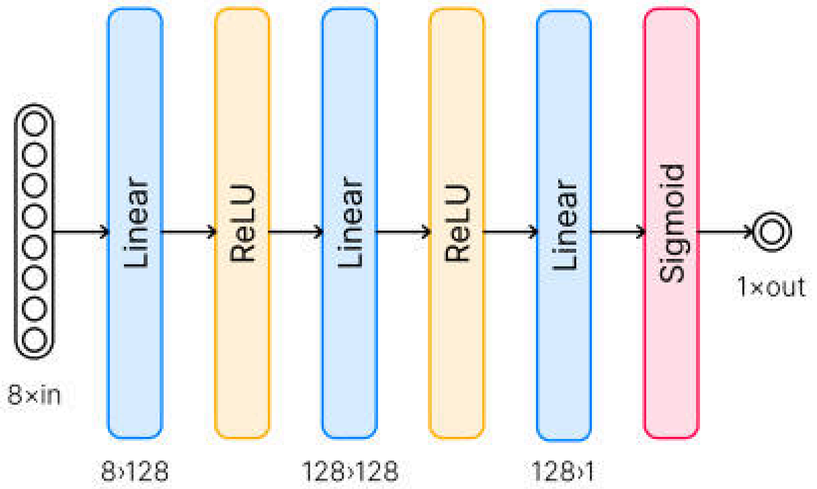
- Accurate
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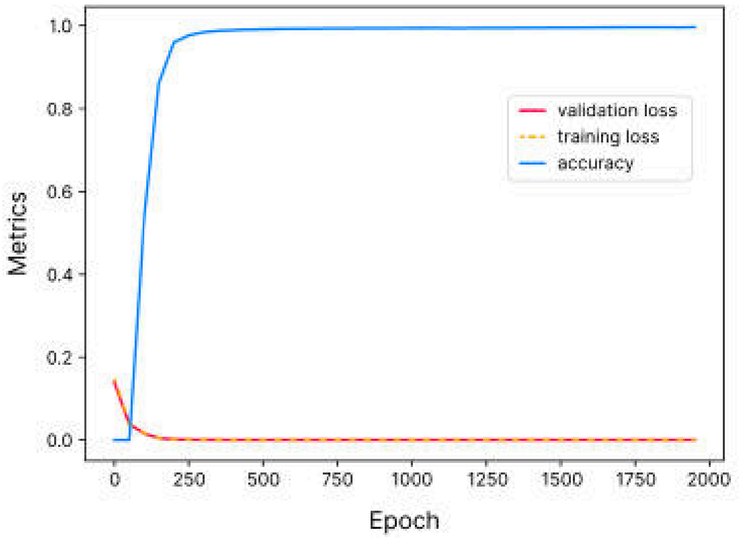


Volume Integral

Goals

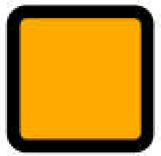
- **Accurate**
- **Fast**
- **Space Efficient**
- **Parallel (GPU)**
- **3-Dimensional**





Challenges Solved!

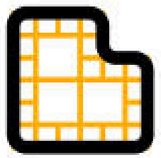
Object Filling



Filled
Interior



Filled
Occlusion



Maximized
Voxels



Opaque
Inner Voxels



Keep Mask

Volume Integral



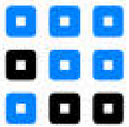
Accurate



Fast



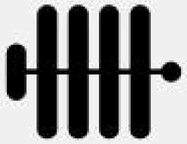
Space Efficient



Parallel (GPU)



3-Dimensional



MLP

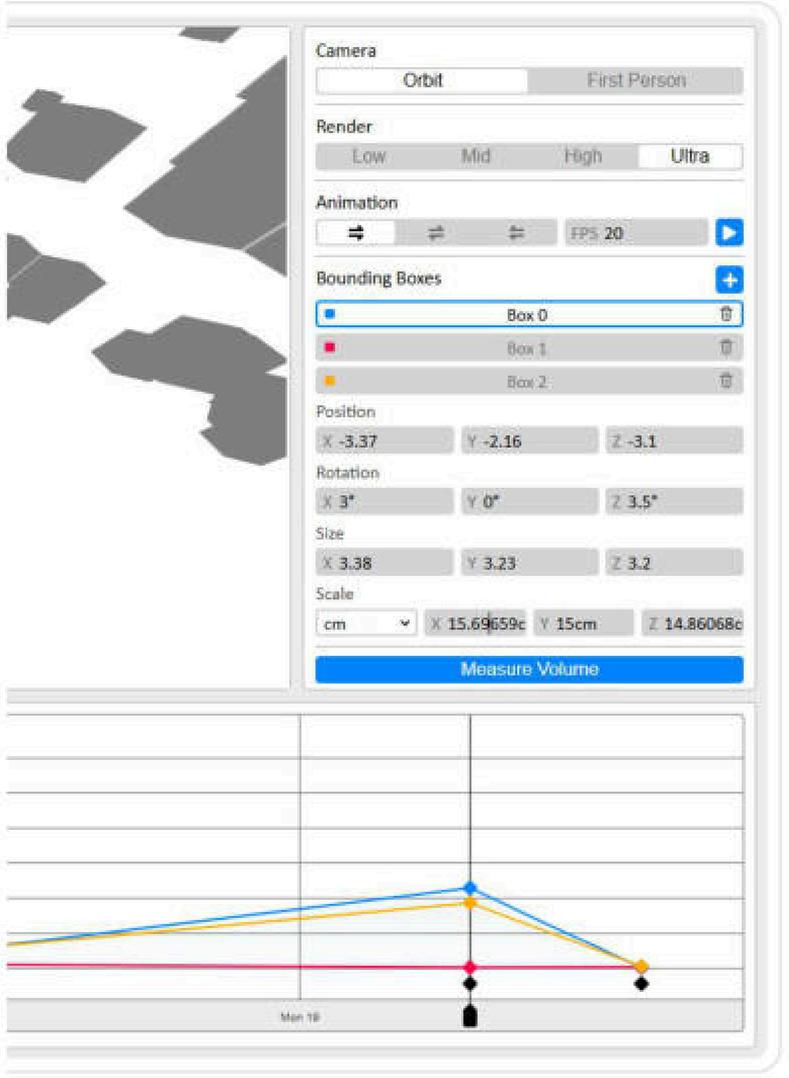
WebSVR

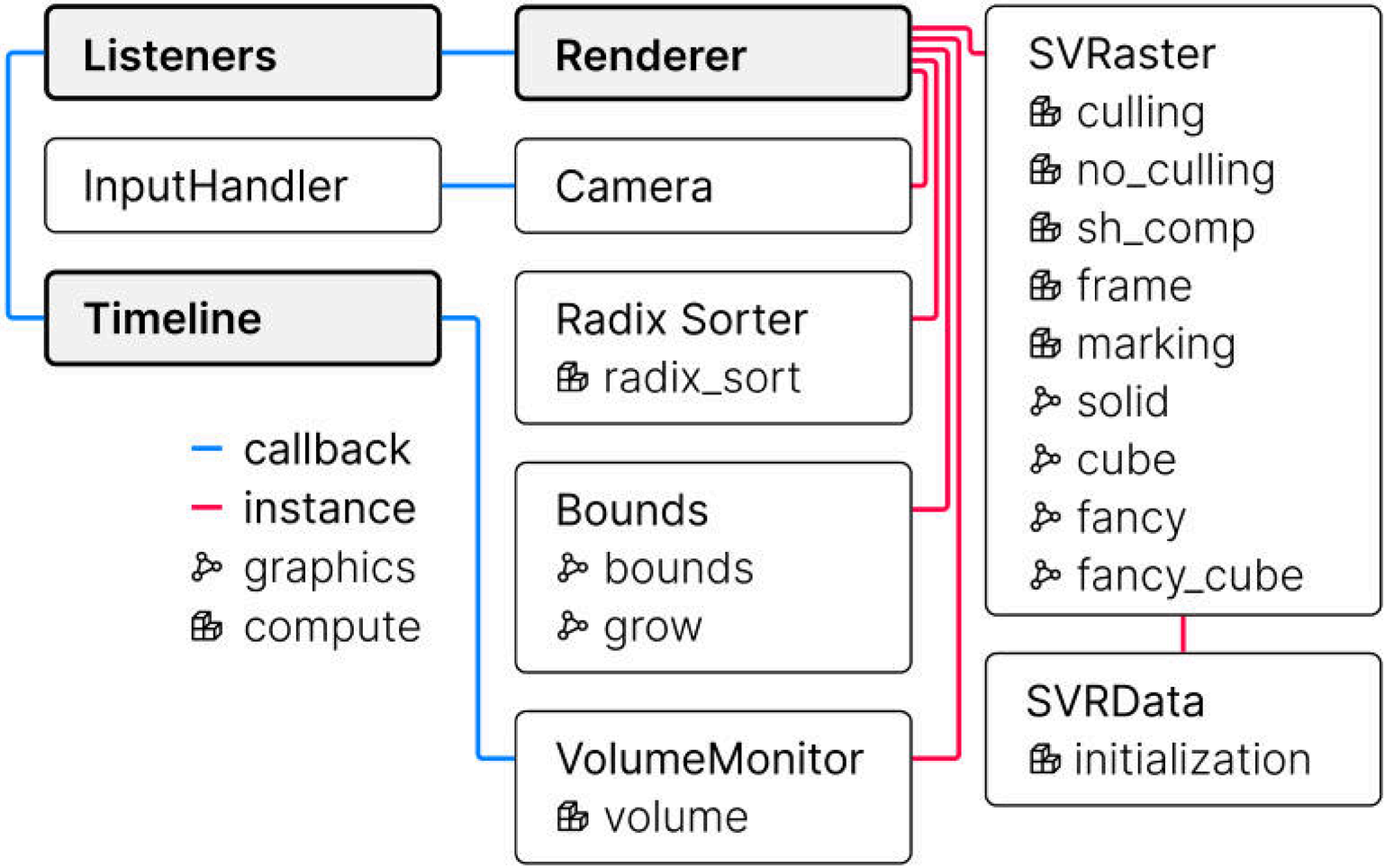
Workspace

Workspace



Project Structure



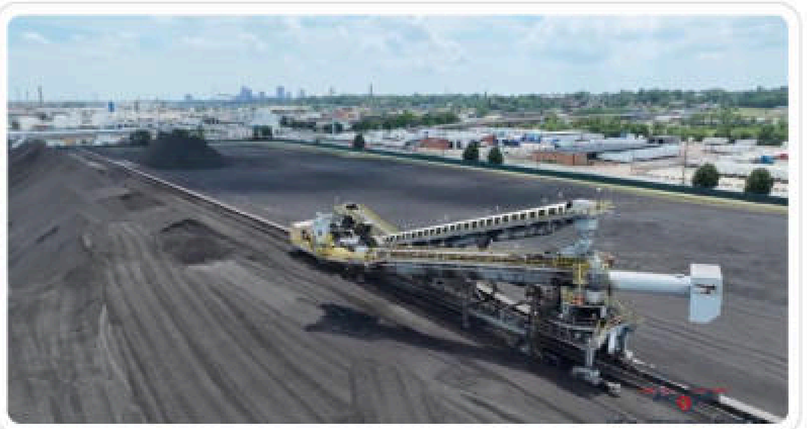


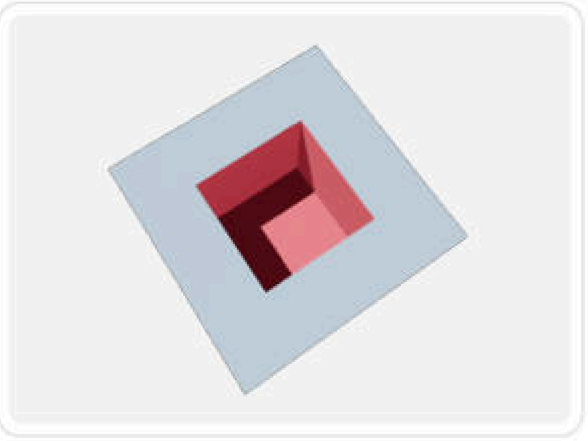
Evaluation

Results – Test Setup



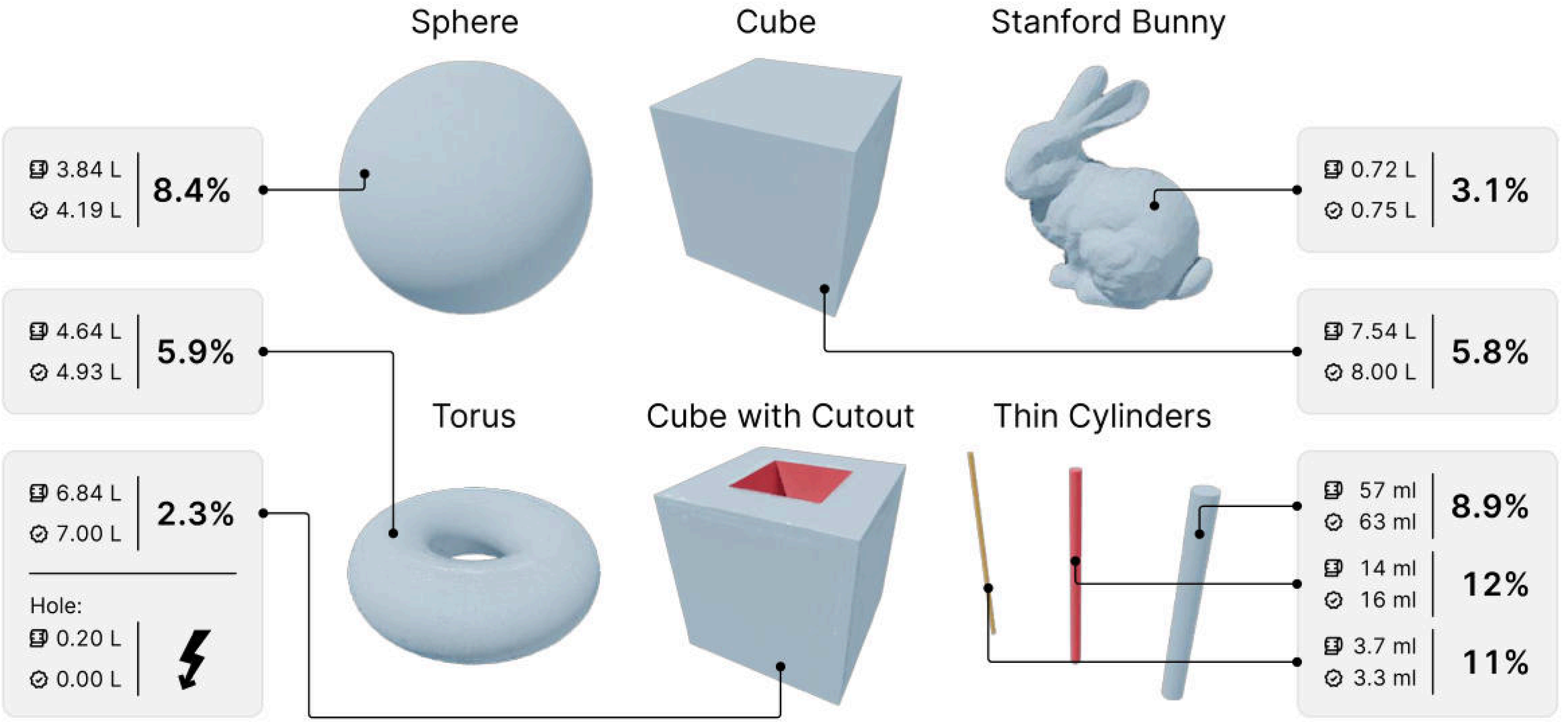








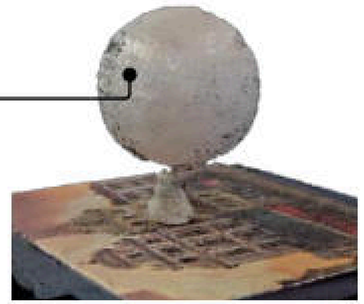
Results – Volume Measurement



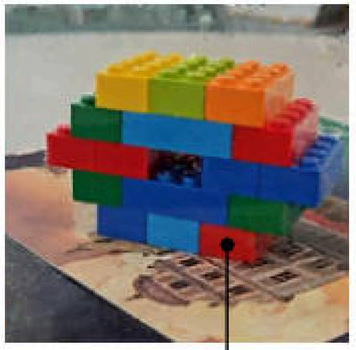
Results – Volume Measurement

Styrofoam Sphere

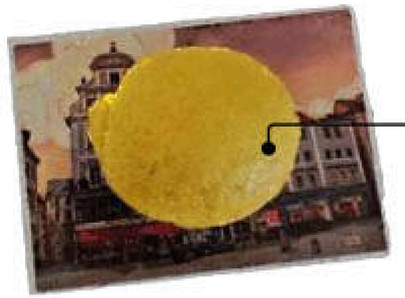
58.4 mL
65.5 mL
10.8%



Lego® Donut



Lemon



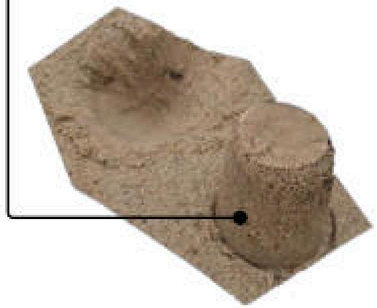
144 mL
197 mL
27.2%

1.1 L
1.0 L
10%

85.2 mL
86.8 mL
1.80%

Sand Pile

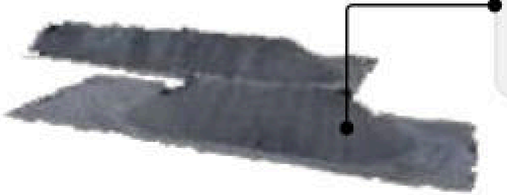
0.51 m³
0.67 m³
24.7%



Concrete Slab

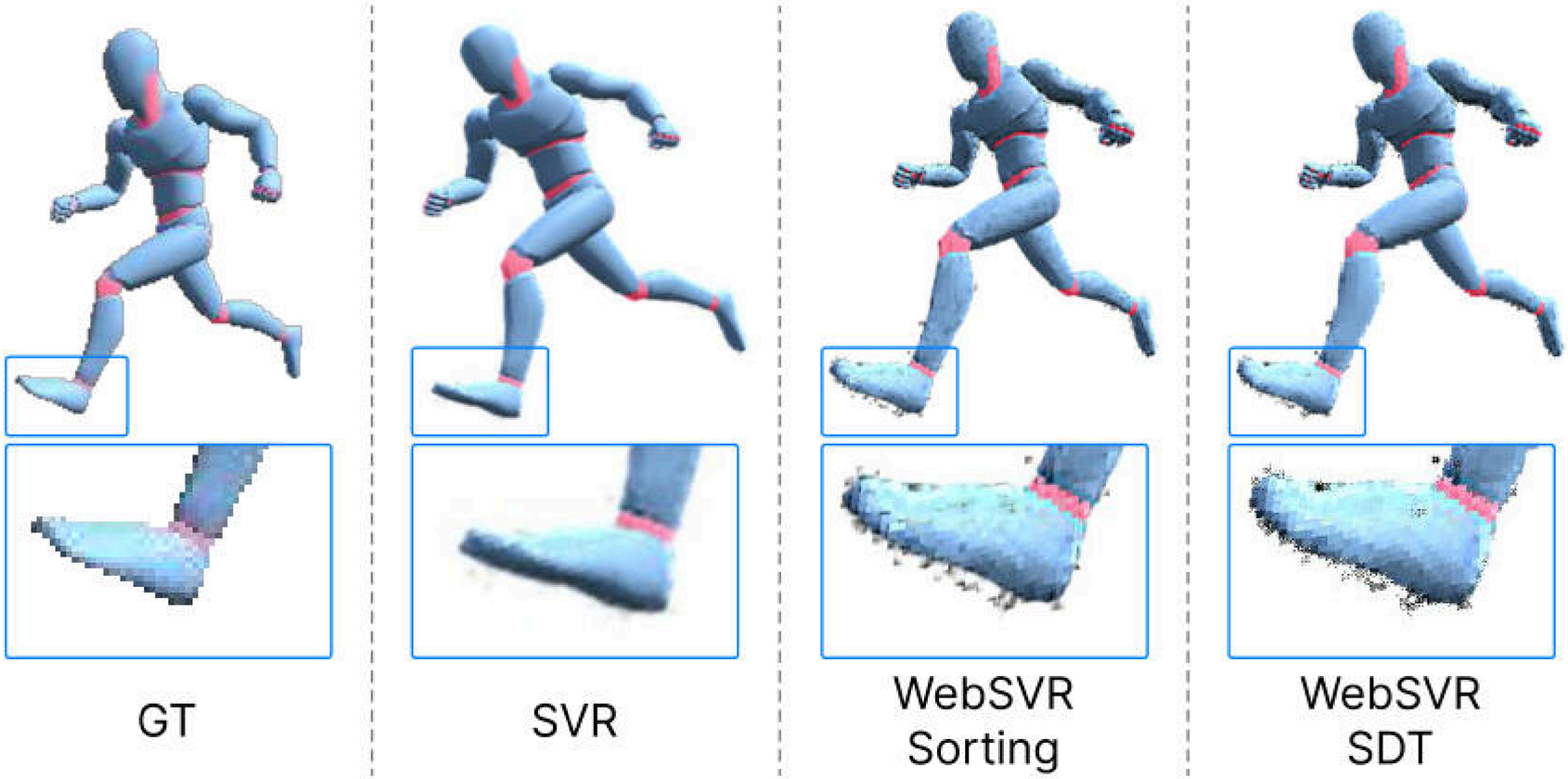


Coal Stockpile (front)

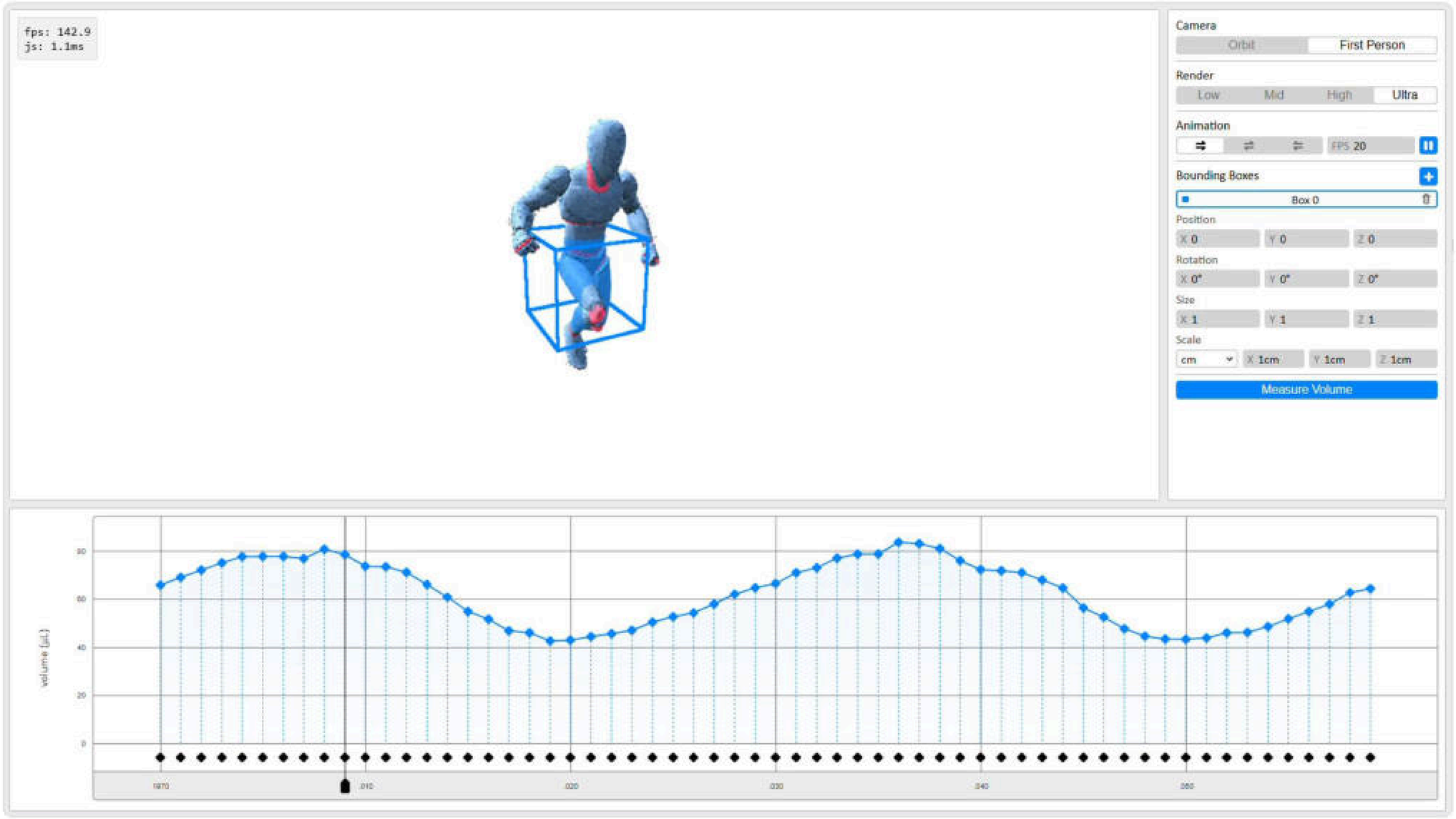


8.3k m³
10k m³
17.9%

Results – Visualization



Results – Animation



Research Questions – Answers



RQ1 Is it possible to visualize and measure simultaneously?



RQ2 How does the proposed volume estimation compare against existing techniques?



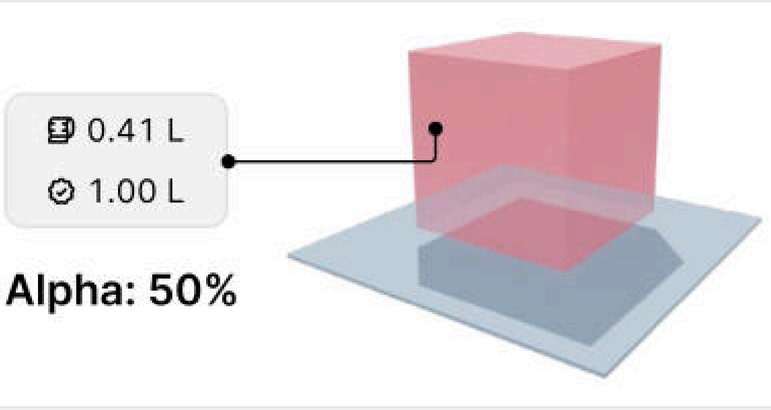
RQ3 How does the method perform across different spatial scales?



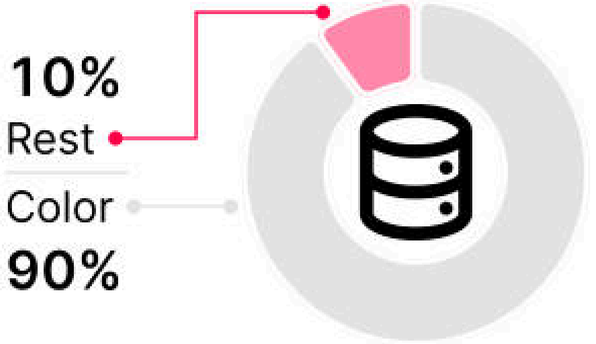
RQ4 Which inputs yield good results?

Future Work

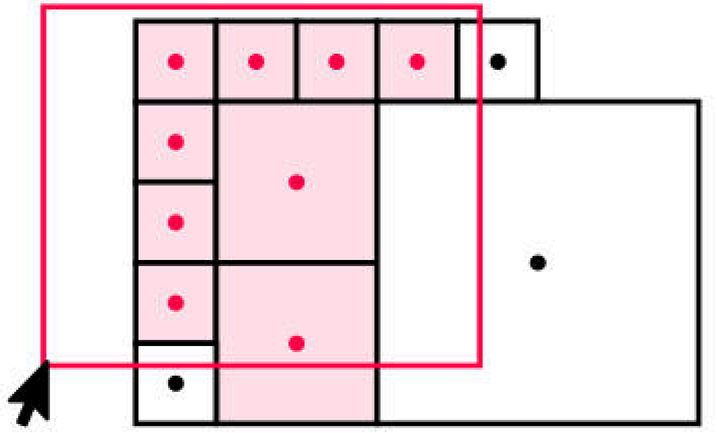
Transparency



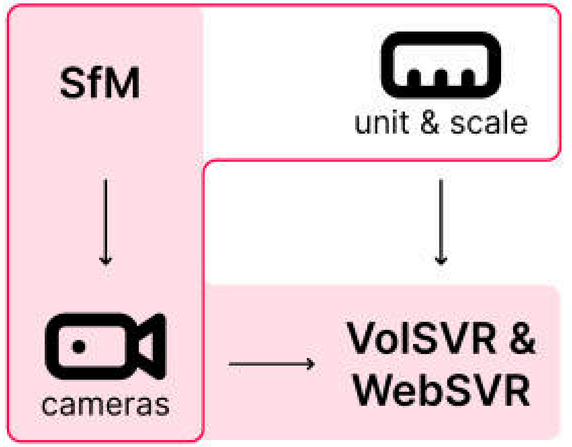
Storage



Selection



Preprocessing



Extensions

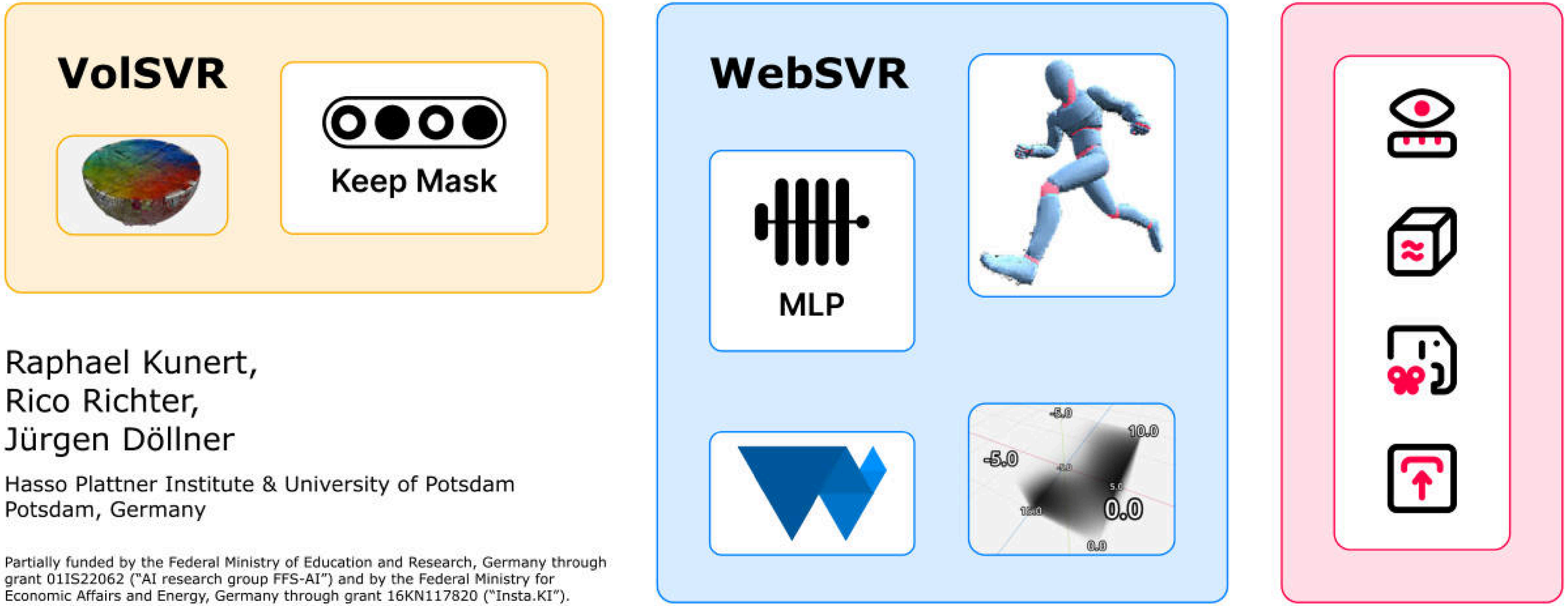
- **Mapanything: Universal Feed-Forward Metric 3D Reconstruction**
  2025 Keetha, N. Porzi, L. et al.
  Metric Scale | Transformer
- **Vipe: Video Pose Engine for 3D Geometric Perception**
  2025 Huang, J. Zhou, Q. et al.
  Moving Objects
- **Radsplat: Radiance Field-Informed Gaussian Splatting for Robust Real-Time Rendering with 900+ FPS**
  2025 Niemeyer, M. Manhardt, F. et al.
  Occlusion Culling | Pruning
- **A Hierarchical Compression Technique for 3D Gaussian Splatting Compression**
  2025 Huang, H. Huang, W. et al.
  Level of Detail | Octree

WebSVR: Joint Volume Measurement and Novel View Synthesis in Web-based 3D Environments

Raphael Kunert,
Rico Richter,
Jürgen Döllner

Hasso Plattner Institute & University of Potsdam
Potsdam, Germany

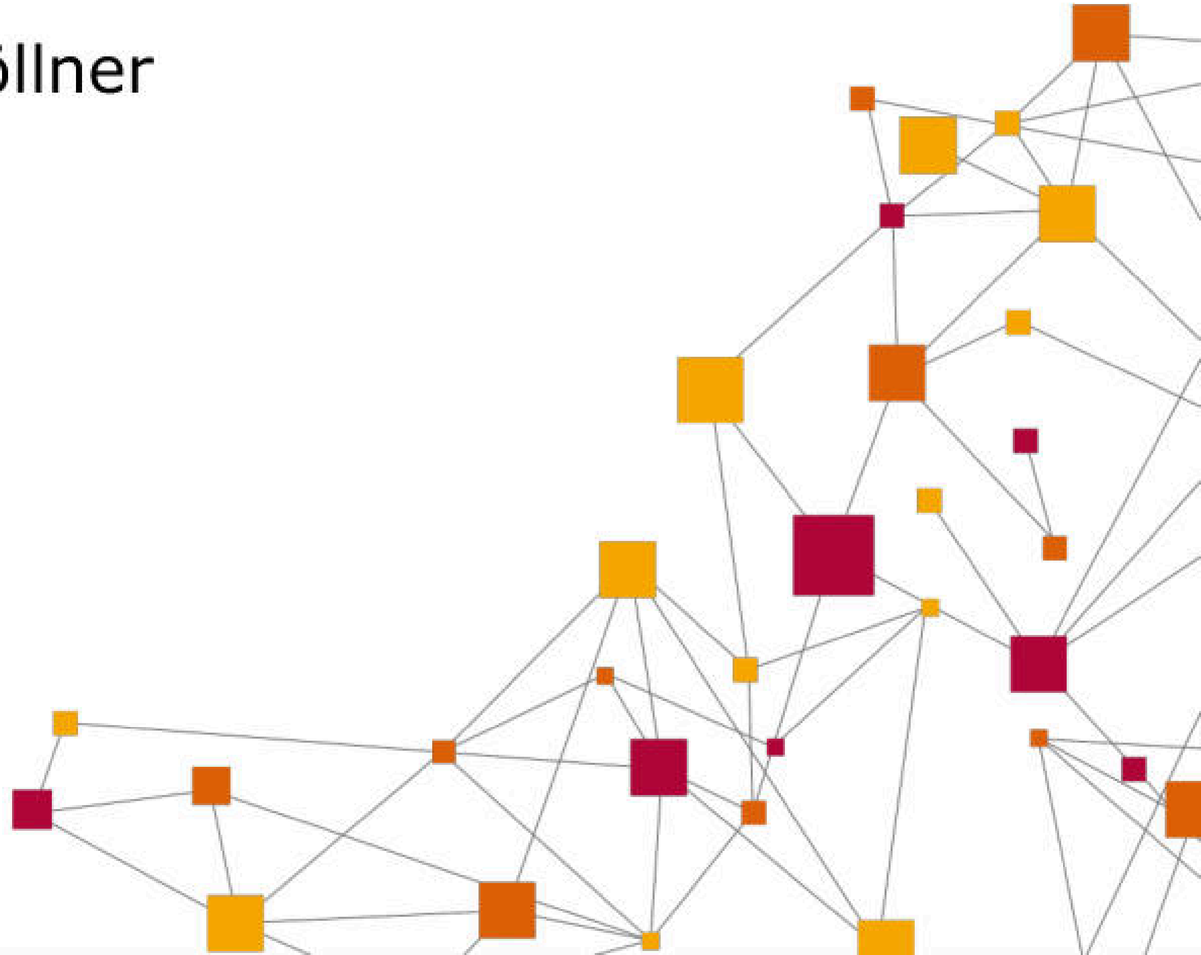
Partially funded by the Federal Ministry of Education and Research, Germany through grant 01IS22062 ("AI research group FFS-AI") and by the Federal Ministry for Economic Affairs and Energy, Germany through grant 16KN117820 ("Insta.KI").



WebSVR: Joint Volume Measurement and Novel View Synthesis in Web-based 3D Environments

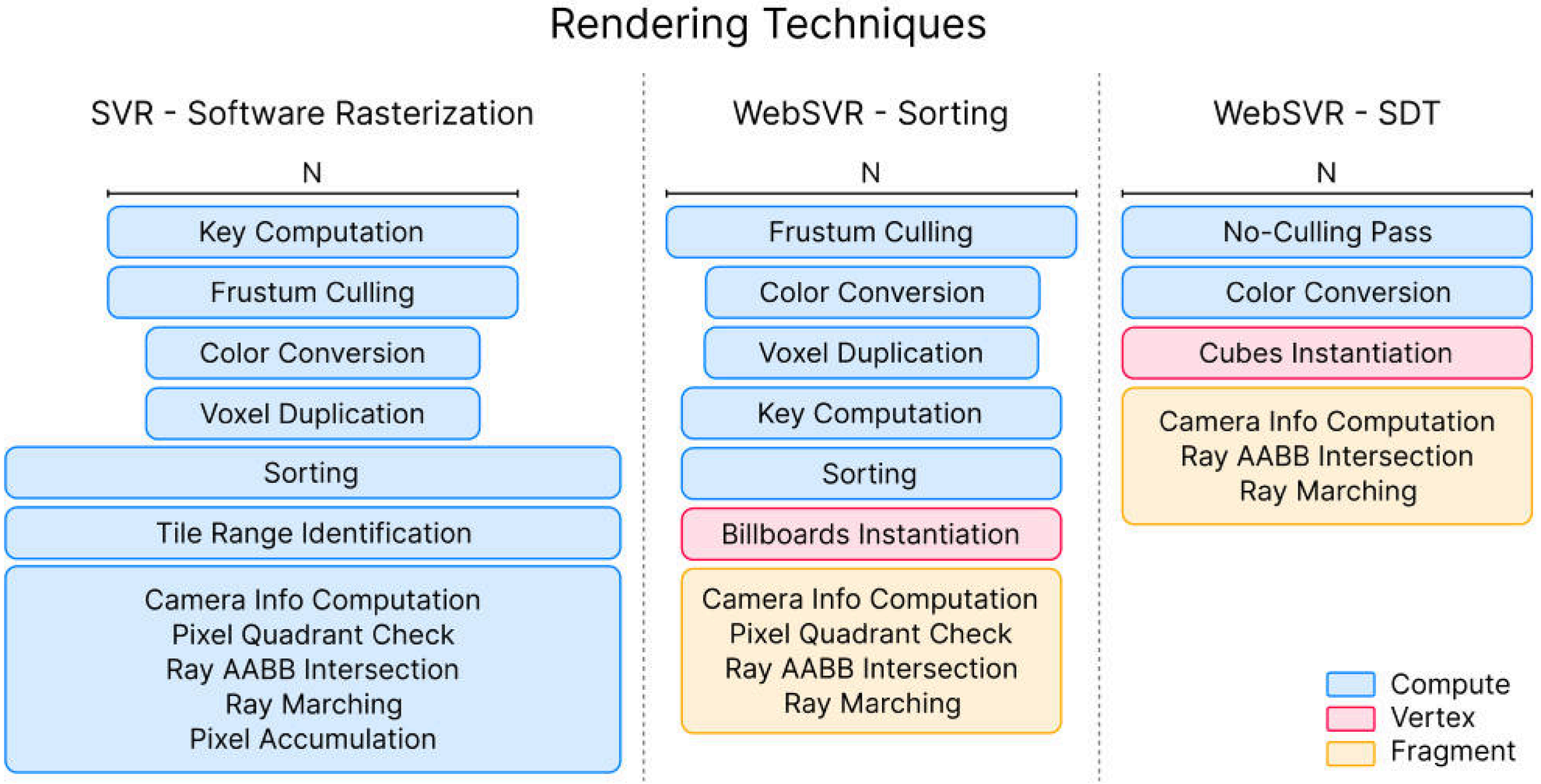
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Potsdam, Germany



Web3D 2026
13.10.2026

Visualization Contributions



Volume Integral

Integration Techniques

Approach	Device	Dim. ↑	Time ↓	Error ↓	Space ↓
Riemann sum 3D ($N = 512$)	GPU	3	512 ms	3.34×10^{-4}	0
Analytic 1D	CPU	1	0.35 µs	0	0
scipy.integrate.quad_vec	CPU	1	0.30 ms	6.59×10^{-13}	0
scipy.integrate.tplquad	CPU	3	36.39 s	1.49×10^{-8}	0
LUT 1D (bicubic, $N = 16^2$)	CPU	1	0.19 µs	2.47×10^{-4}	1 kB
LUT 3D (bicubic, $N = 16^8$)	CPU	3	–	–	17.18 GB
MLP (8›128›128›1)	GPU	3	0.03 ms	5.5×10^{-3}	83.5 kB

Hypotheses

RQ1 • Is it possible to visualize and measure simultaneously?

- hyp 1.1: Visualization and measuring are possible simultaneously.
- hyp 1.2: Visual differences from the SVR modifications are minor and do not distract from the realistic visualization.

RQ2 • How does the proposed volume estimation compare against existing techniques?

- hyp 2.1: SVRs sub-voxel geometry enables APE scores below 10%.
- hyp 2.2: Training the 3D representation for measuring takes longer with SVR.
- hyp 2.3: Files sizes of the 3D model are larger.

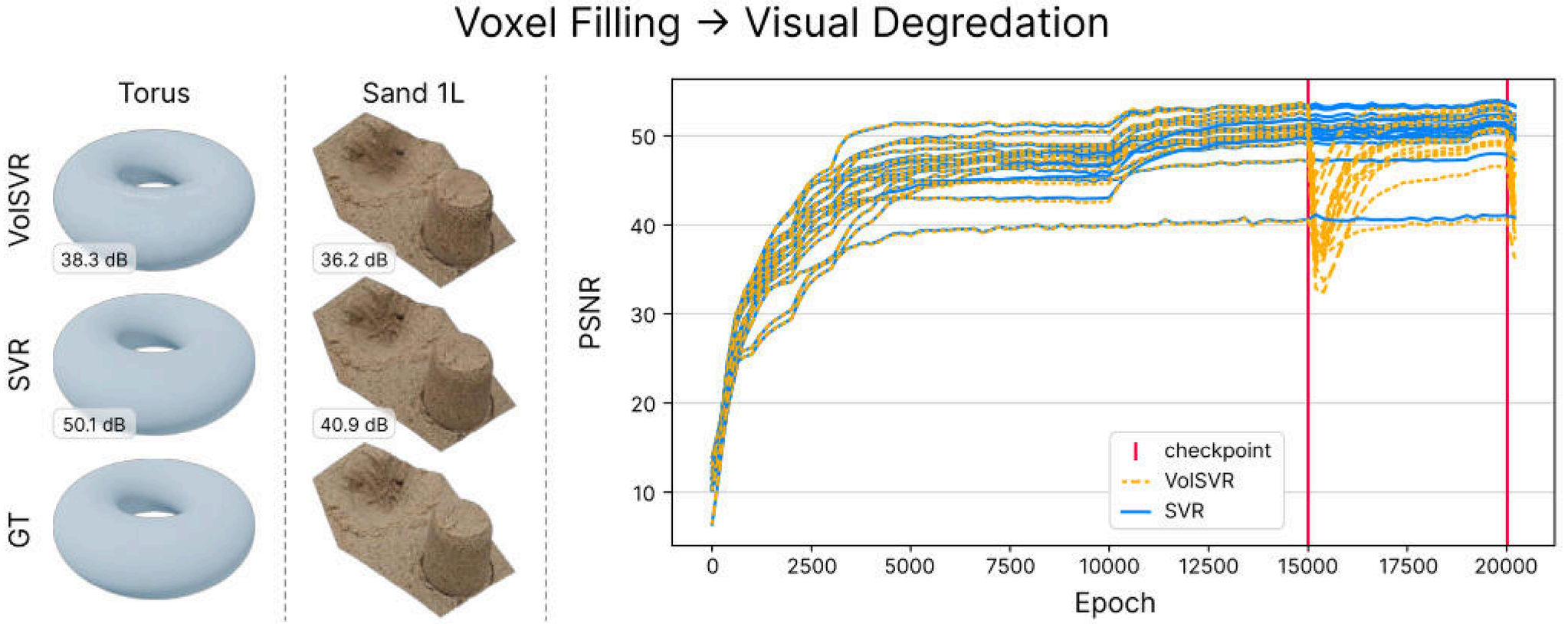
RQ3 • How does the method perform across different spatial scales?

- hyp 3.1: Captured macroscopic objects, i.e., everything not requiring a microscope to observe or larger, can be visualized and measured.
- hyp 3.2: Captured areas spanning several kilometers and smaller can be visualized and measured.

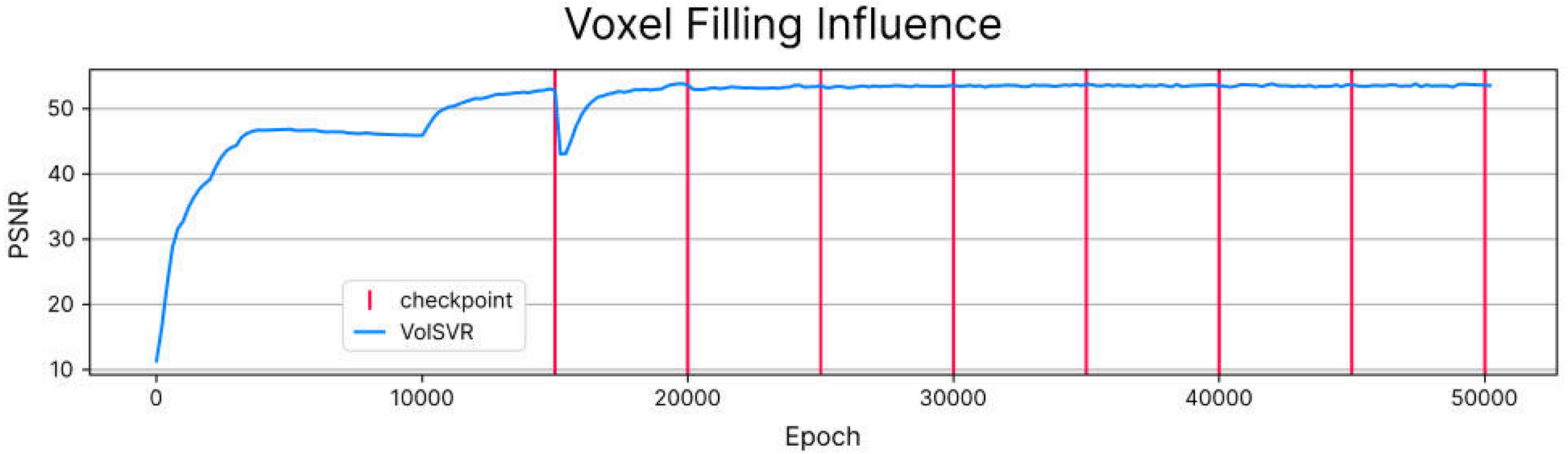
RQ4 • Which inputs yield good results?

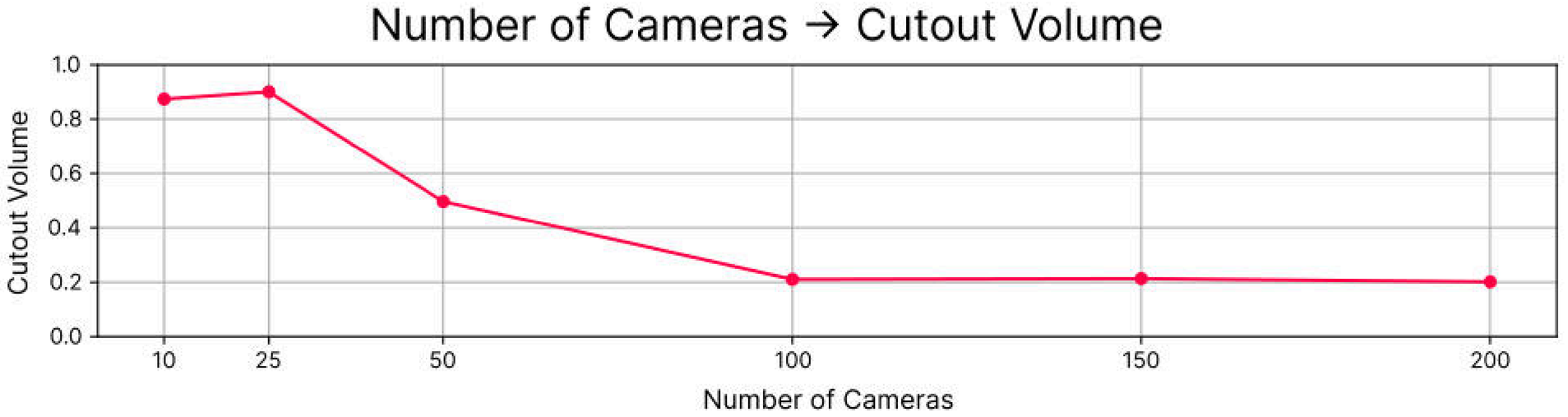
- hyp 4.1: The input must be at least 10-50 images.
- hyp 4.2: The image size required is about 1280 × 720 pixels (HD).
- hyp 4.3: The training parameters can remain their default values.
- hyp 4.4: Occlusion and lack of variation in camera placement both equally negatively affect visualization and volume measurement.

RQ1 – Voxel Filling

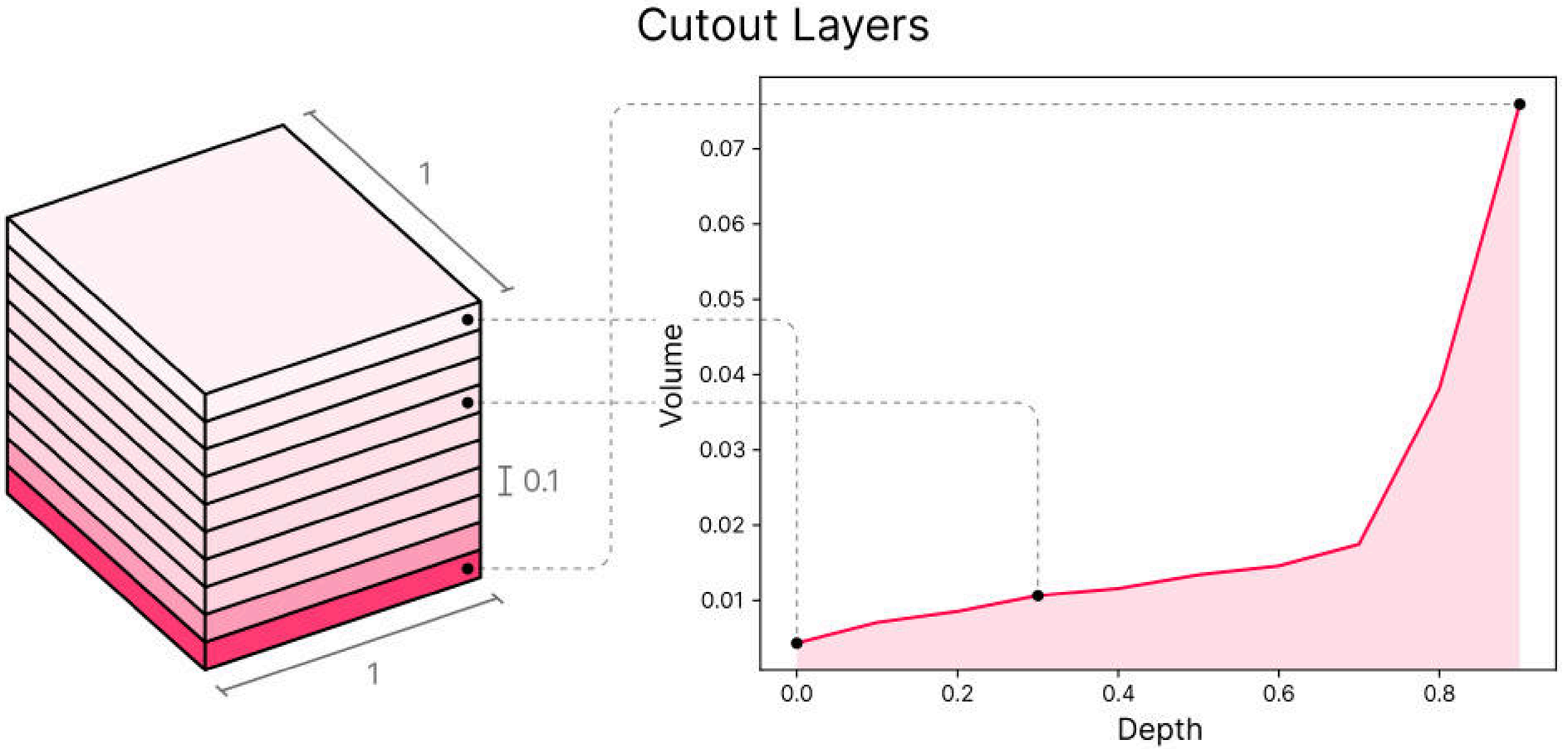


RQ1 & RQ4 – Voxel Filling & Camera Count





Cutout Volume



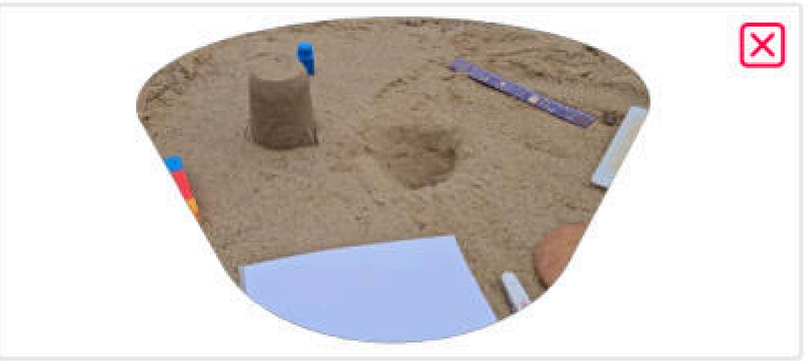
Masking

Image Preprocessing → Masking

Original Image



wrong 3D Cylinder Mask



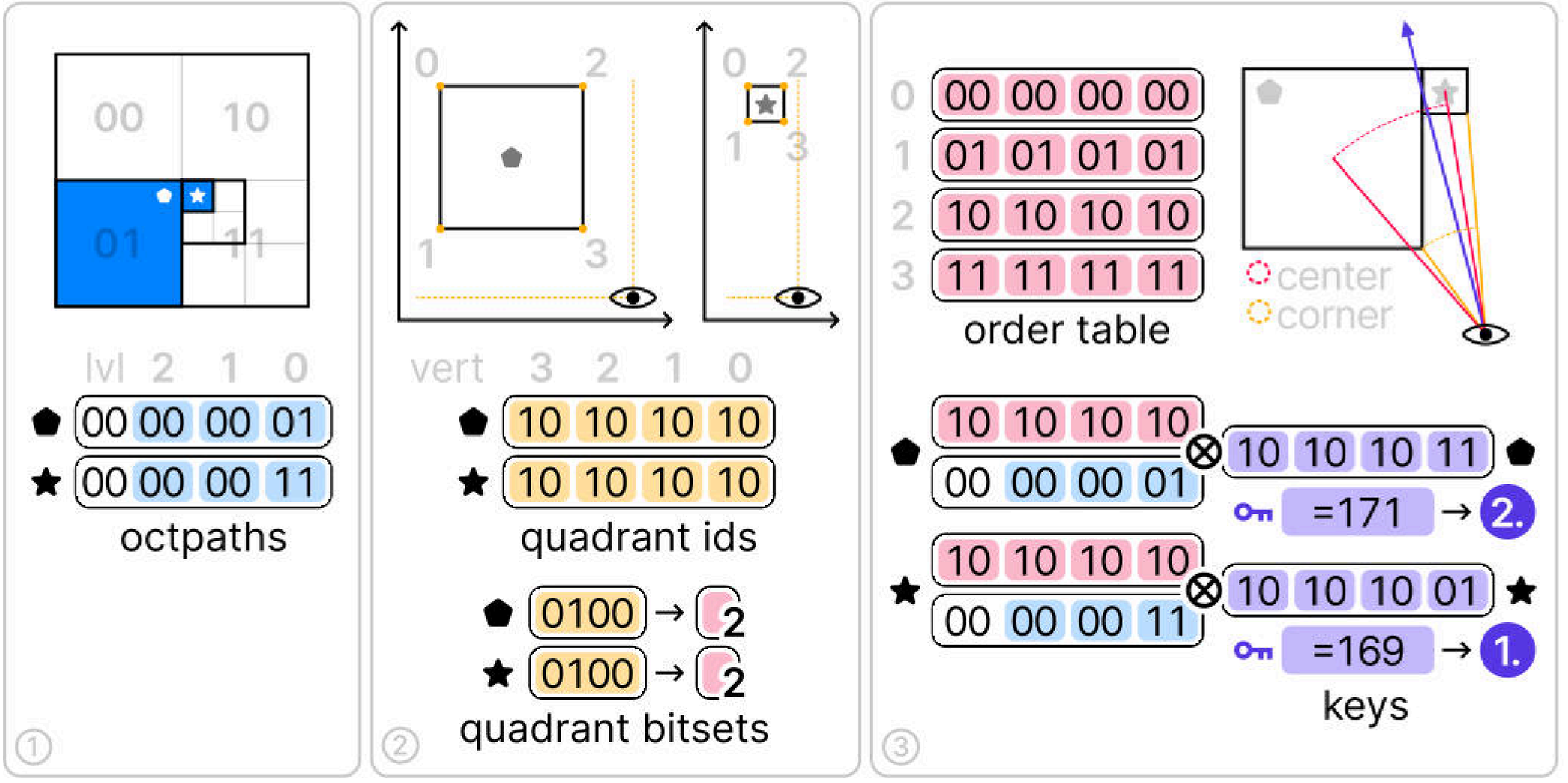
Geometry Aware Mask



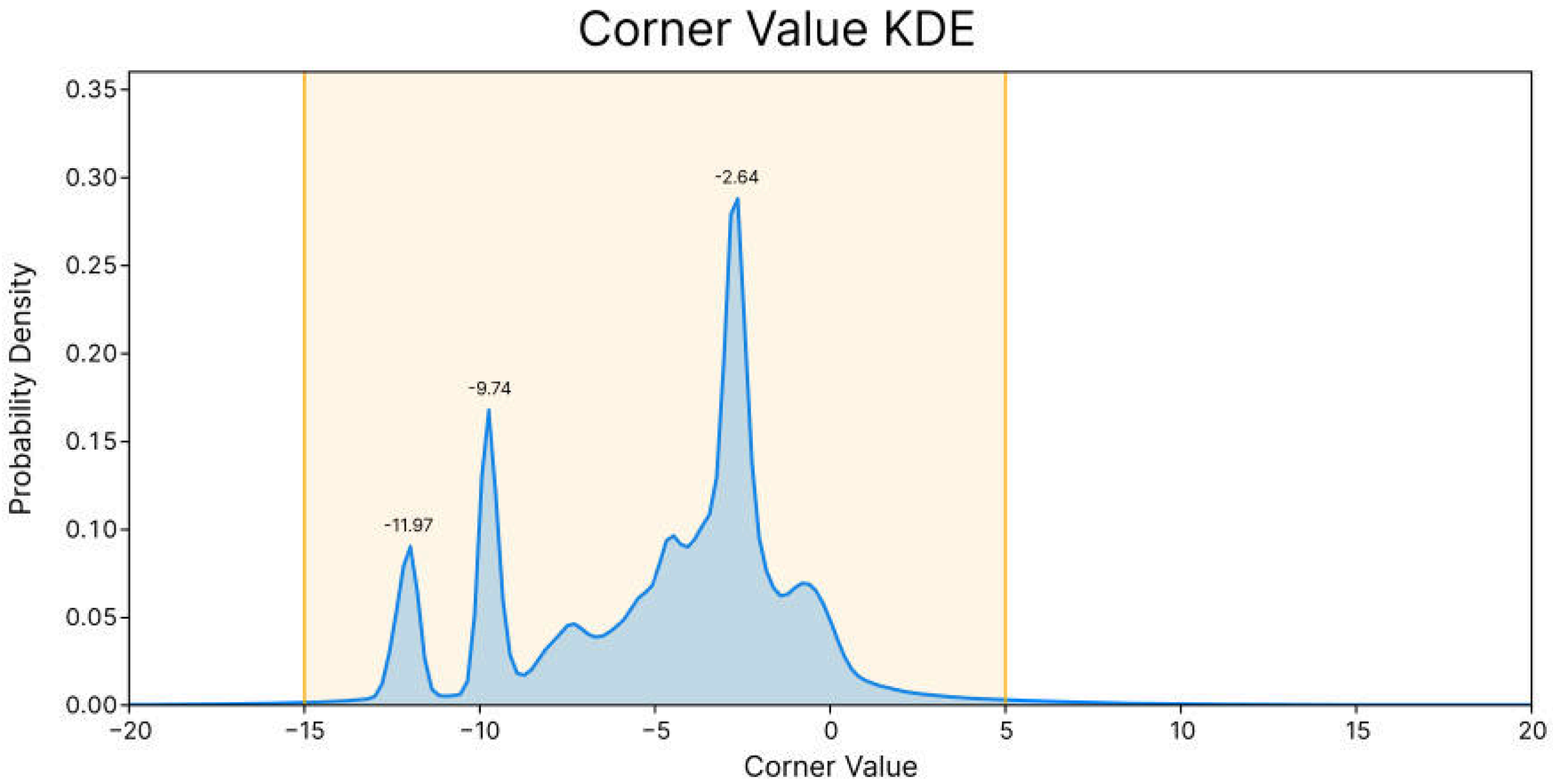
wrong 2D Convex Hull Mask



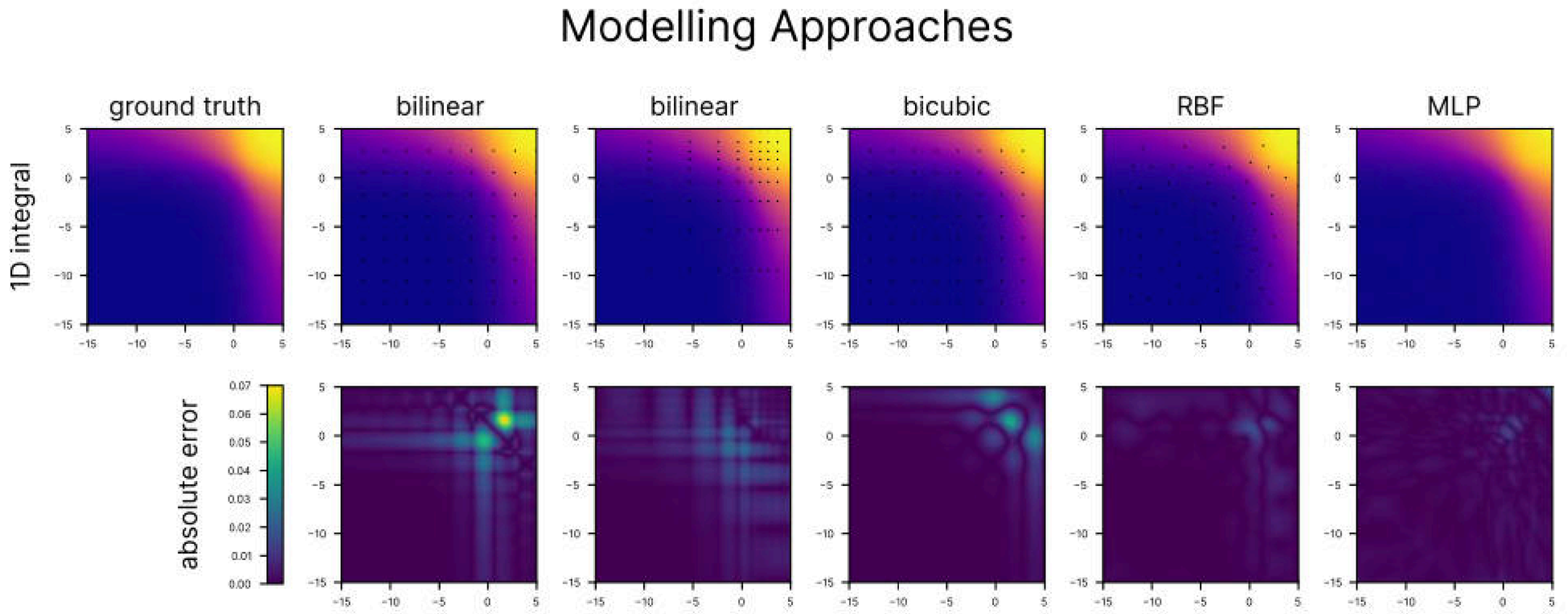
Morton Order Keys



Corner Value Bounds



LUT


Modelling Approaches
ground truth
bilinear
bilinear
bicubic
RBF
MLP
1D integral
absolute error

Systematic Literature Review

Manual vs. Semantic Scholar Ranking

