Compression in 3D Gaussian splatting

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View synthesis

- Generation of novel views defined by

$$F : \mathbb{R}^n \rightarrow \mathbb{R}^n$$

- Image based rendering
  - Reconstruction of a scene through images

Neural

- Surface or volume estimation
- Allowing for back propagation
- NeRF
  - Encoding an *implicit* radiance field

$$L : \mathbb{R}^3 \times \mathbb{S}^3 \rightarrow \mathbb{R}^n$$

  - Volume rendering techniques, slow

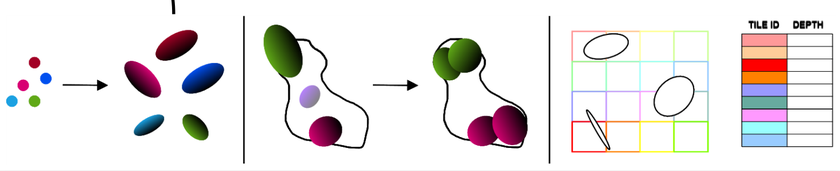
Discrete

1. From SfM initialise 3D Gaussians
2. SGD to split, prune and clone
3. Fast tile-based rasterizer

Explicit radiance field

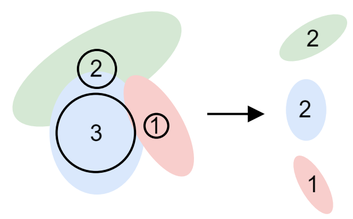
(mean, opacity, SH and covariance)

Large memory



Pruning

- Significance score
  - Pixel footprint in training views
  - Depended on opacity and normalized volume
  - Normalized: bias of large background Gaussians
- Redundancy score
  - Sampling a redundancy field



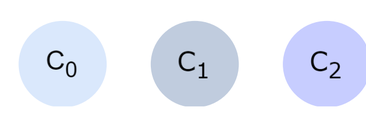
- Binary learnable masks
  - Mask parameter updated through SGD

SH reduction

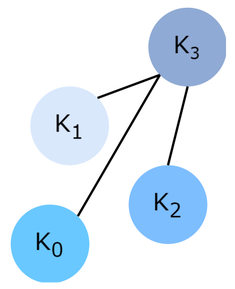
- Knowledge distillation

$$\mathcal{L} = \frac{1}{WH} \sum_{j=0}^{WH} \left\| \begin{matrix} C_{teacher}(r_j) \\ -C_{student}(r_j) \end{matrix} \right\|_2^2$$

- Varying SH bands
  - Variance in view-dependency



- Lower degree replacement

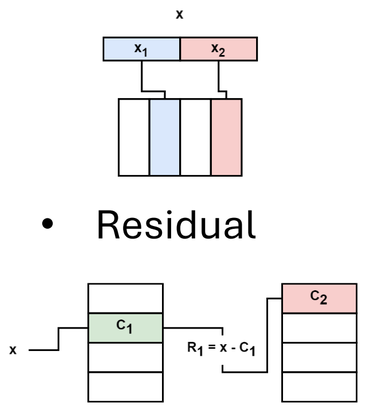


Vector quantization

- Representing data in a cluster through their centroid
- Lossy compression

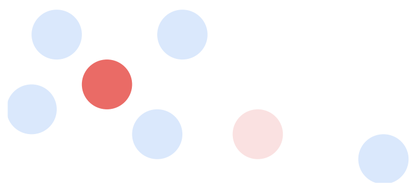
- Increasing clustering quality
  - SGD
  - Sensitive aware

  - Product
  - Residual



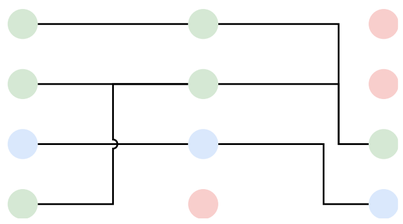
K-medoids

- Mitigating outliers
- Real data points as centroids



- Heavy in computation for large data sets

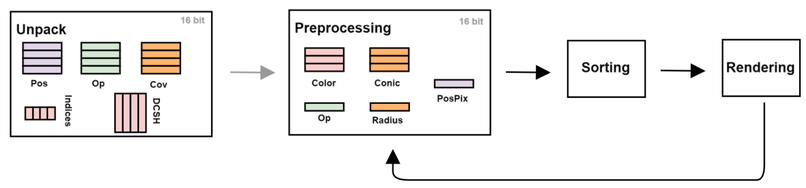
AGORAS

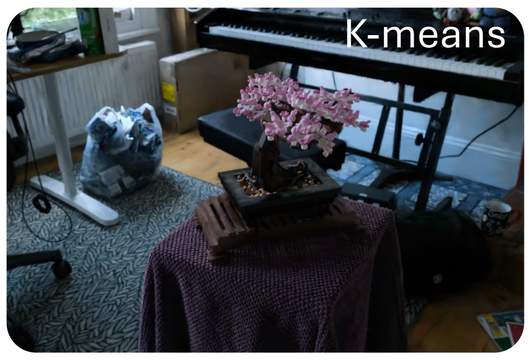


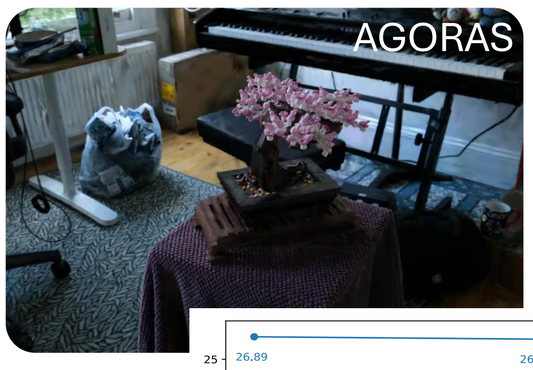
- Independent of data size
- Coupon collectors' problem: estimating clusters
- More sample sets (m), more quality but also more clustering time

Web integration

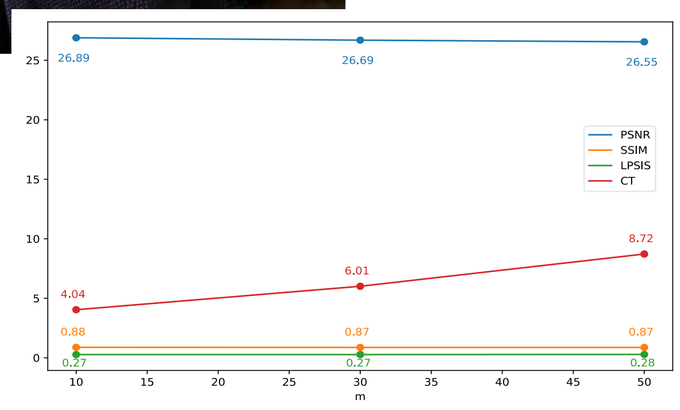
- Bringing compressed 3DGS to the Web
- Problems regarding
  - Scalar quantization (e.g. float16)
  - Entropy encoding (e.g. DEFLATE)
  - FPS and quality (e.g. WebGL) ⟶ **WebGPU**







Dataset	3DGS			K-means			AGORAS		
	SSIM	PSNR	LPSIS	SSIM	PSNR	LPSIS	SSIM	PSNR	LPSIS
Room	0.91	30.63	0.22	0.85	26.32	0.24	0.84	25.17	0.26
Counter	0.91	28.70	0.20	0.84	25.54	0.26	0.83	24.37	0.27
Kitchen	0.92	30.32	0.13	0.88	27.20	0.19	0.86	25.79	0.19
Bonsai	0.94	31.98	0.21	0.89	27.88	0.26	0.87	26.61	0.28



Conclusions

- AGORAS does not perform to standard because of the necessary limitation of the number of sample sets
- Compression schemes can be easily integrated into a web environment
- WebGPU permits the possibility of more than real time rendering through the possibility of integrating compressed representations