TRAVERSE RESEARCH

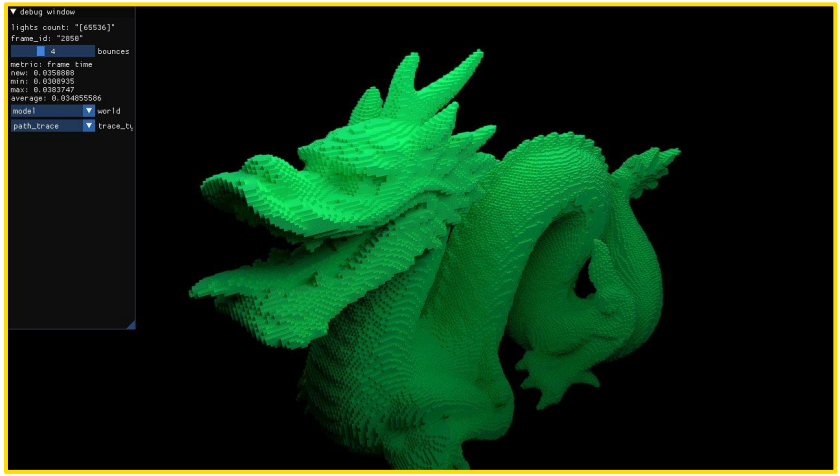
Volumetric rendering using rust

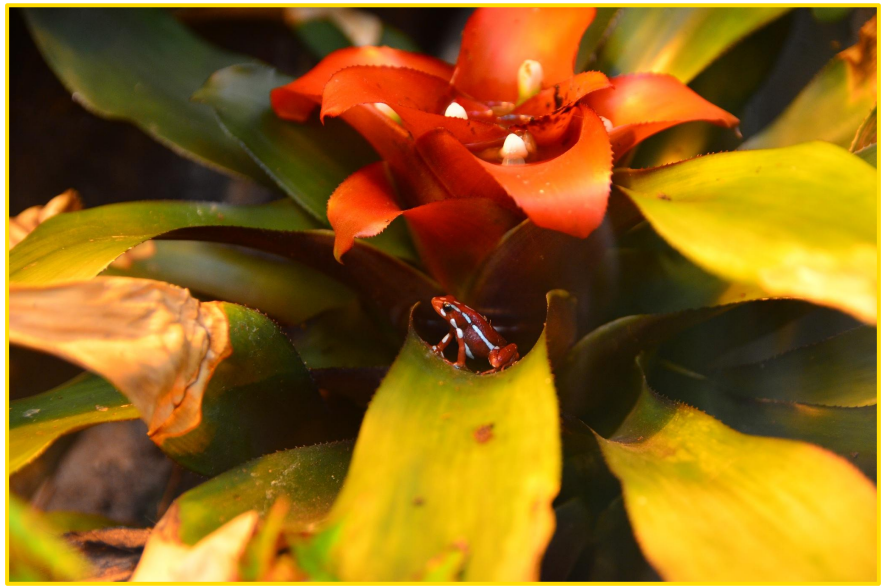
NEXT SLIDE

ABOUT ME:

Rosalie de Winther

- Skating
- Volumetric rendering
- Programming languages
- Photography

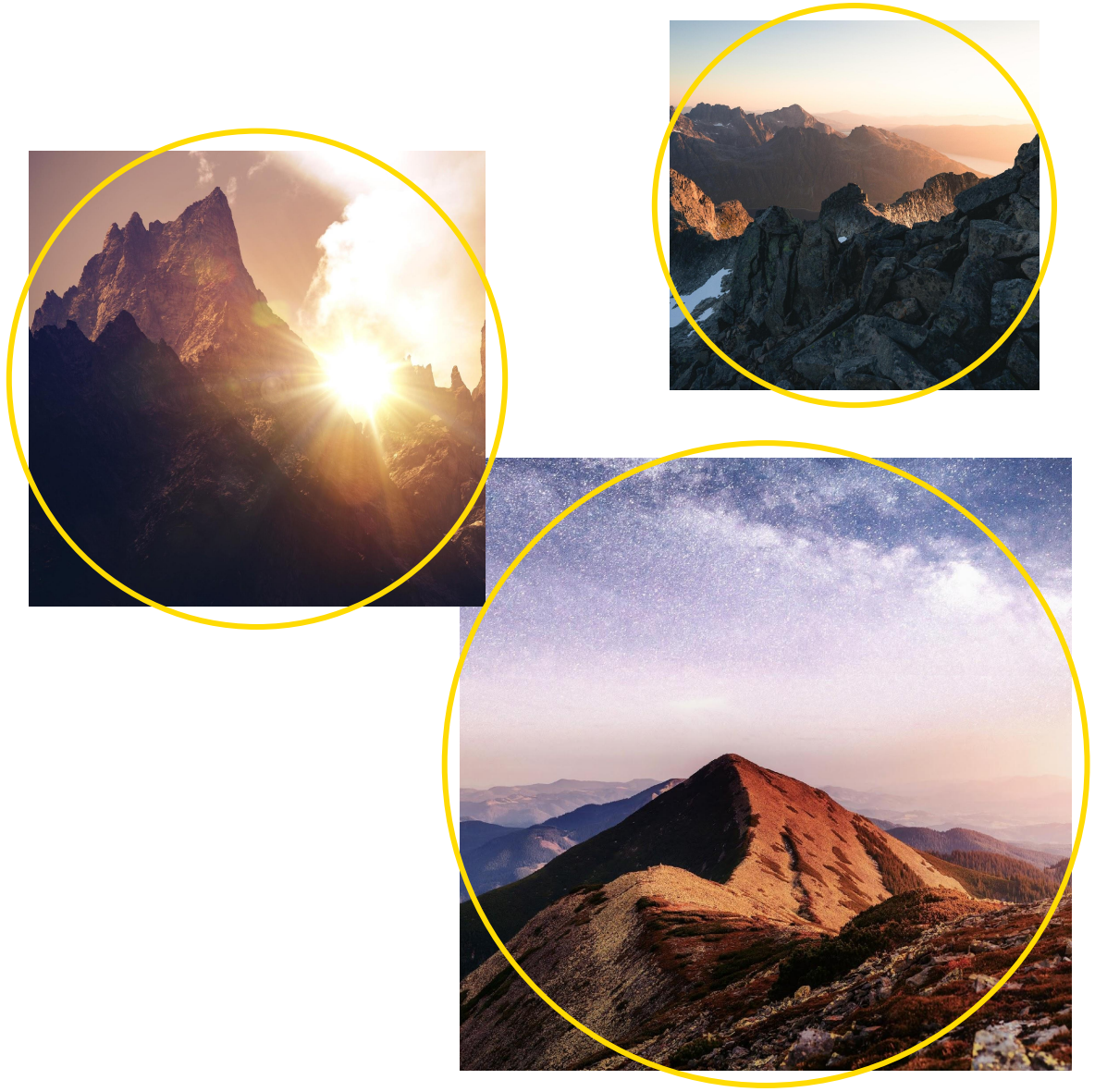




TRAVERSE RESEARCH

TODAY

1. What do we want?
2. How is it done?
3. How to improve?
4. VDB
5. Breda
6. Active research



VOLUMETRIC?

- Things that have volume
- Triangle meshes used for opaque surfaces

VOLUMETRIC?

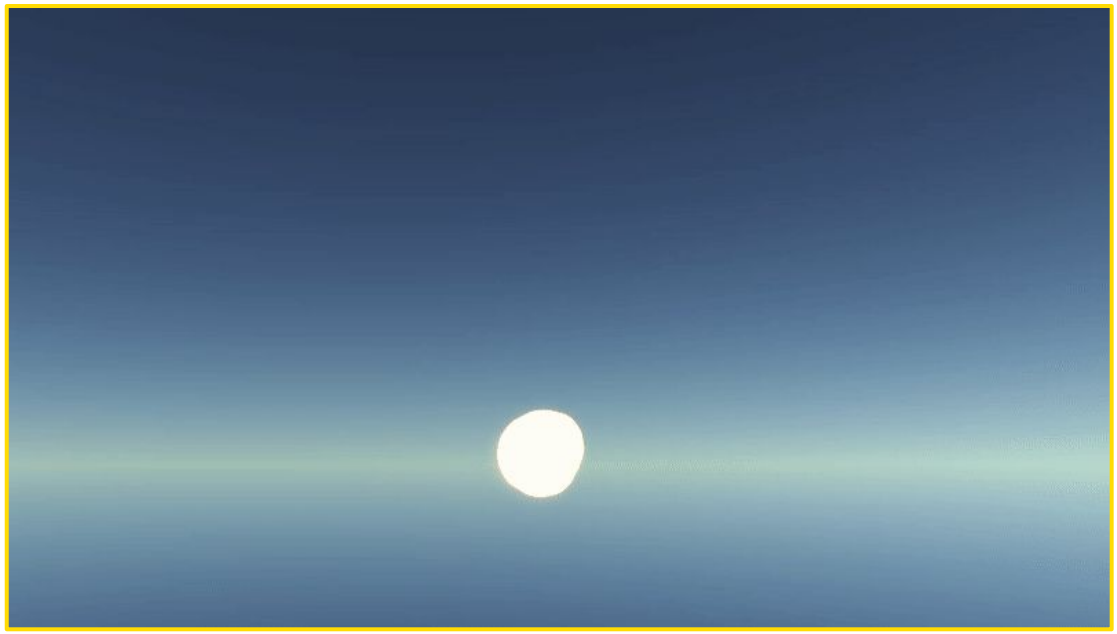
- Clouds

VOLUMETRIC?

- Clouds
- Dust/smoke

VOLUMETRIC?

- Clouds
- Dust/smoke
- Explosions

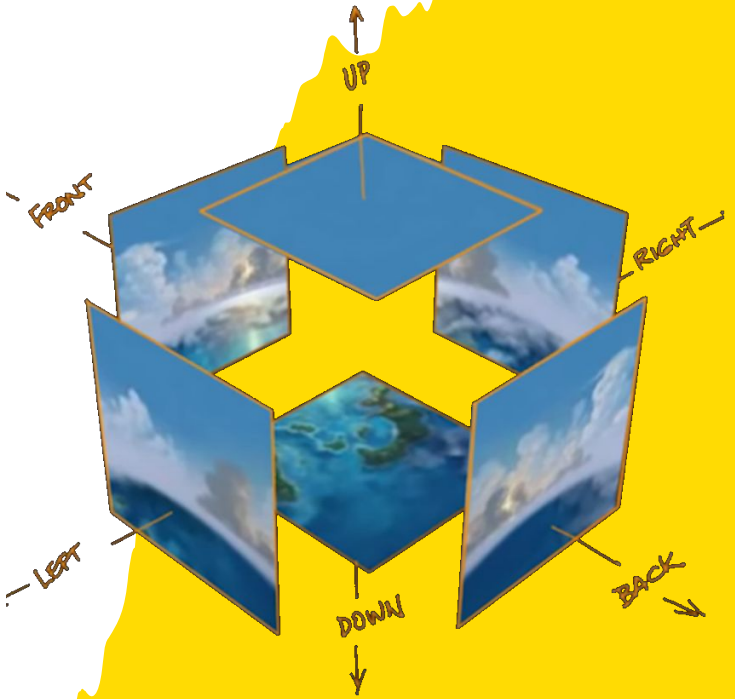



BUT HOW?

HOW

Cube map:

- Static
- Only for sky



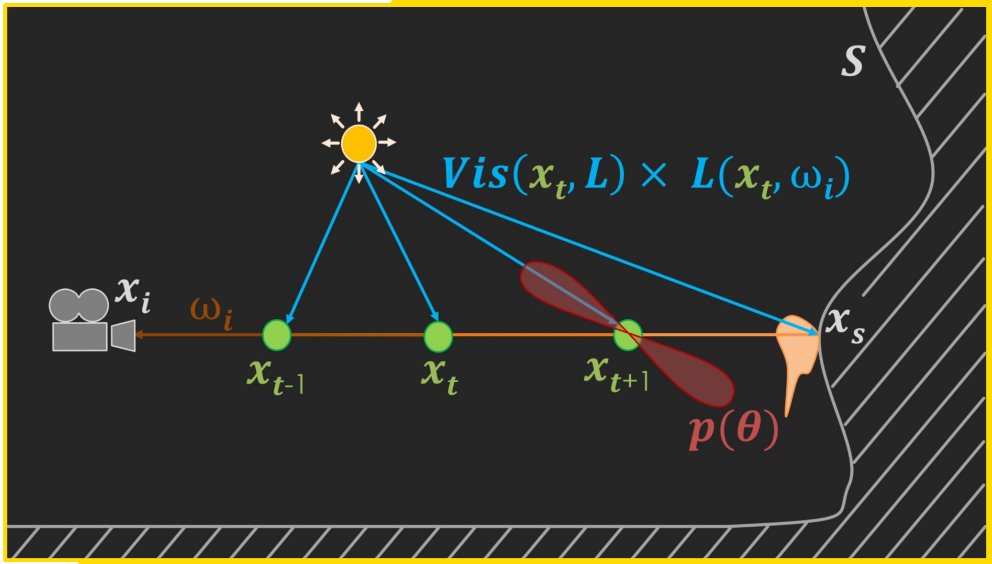
HOW

Texture + deformation

HOW

Analytical ray marching:

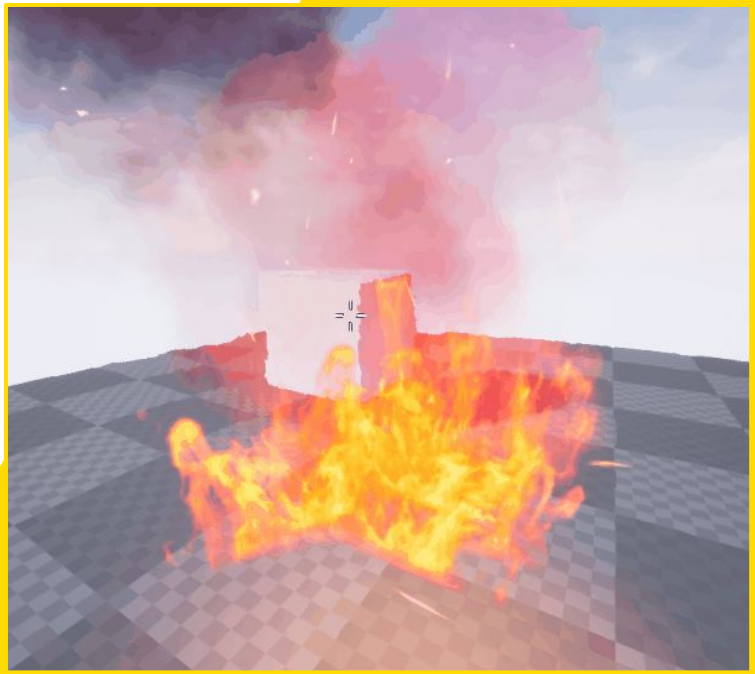
- 2.5D
- Use noise textures
- Used by modern engines currently



HOW

Smoke effect textures:

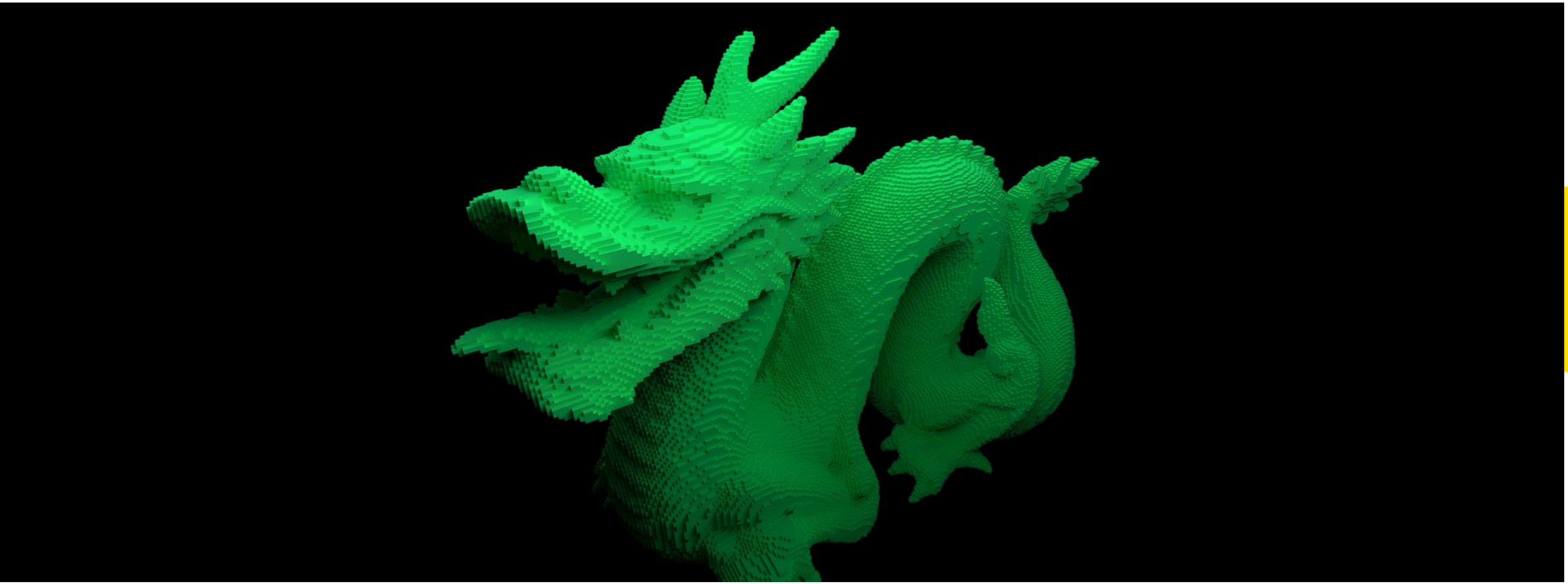
- Particle based
- Pre-rendered
- 2d textures



What now...

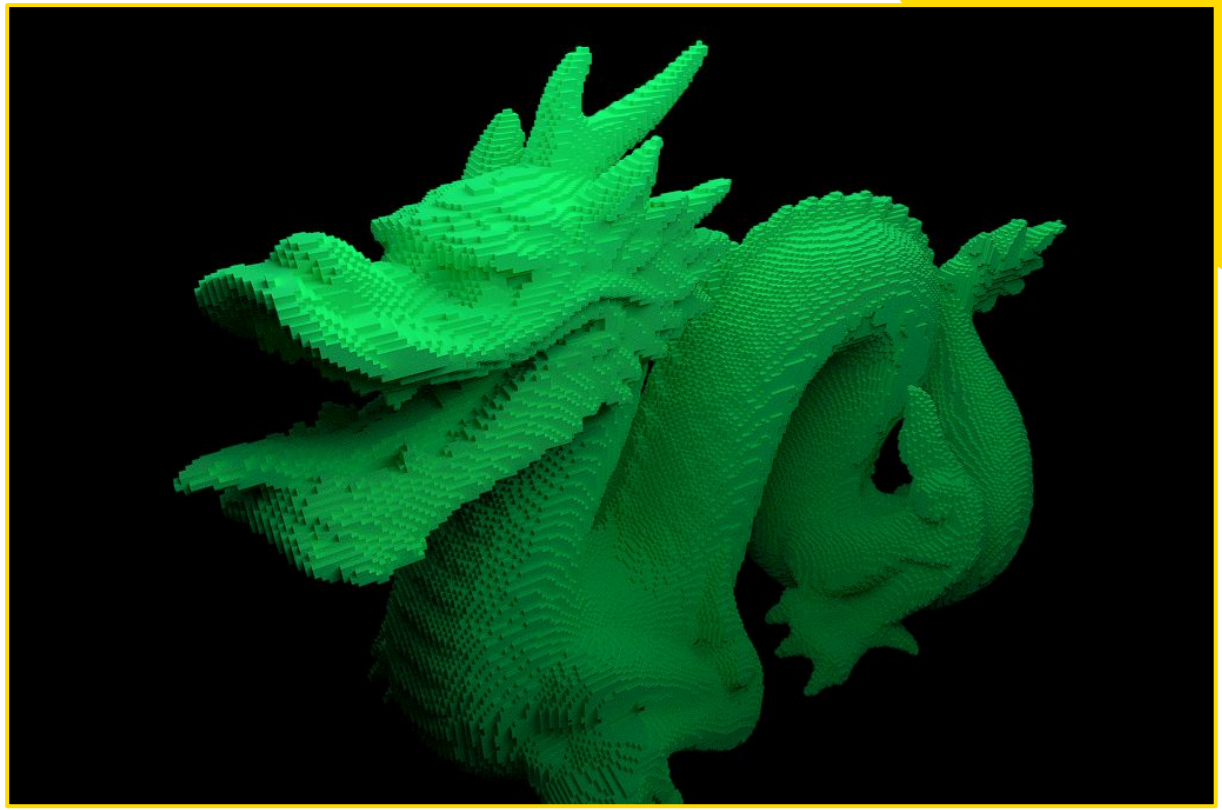
TRAVERSE RESEARCH

What now...



VOXELS

- 3D data representation
- Perfect for volume data
- But…

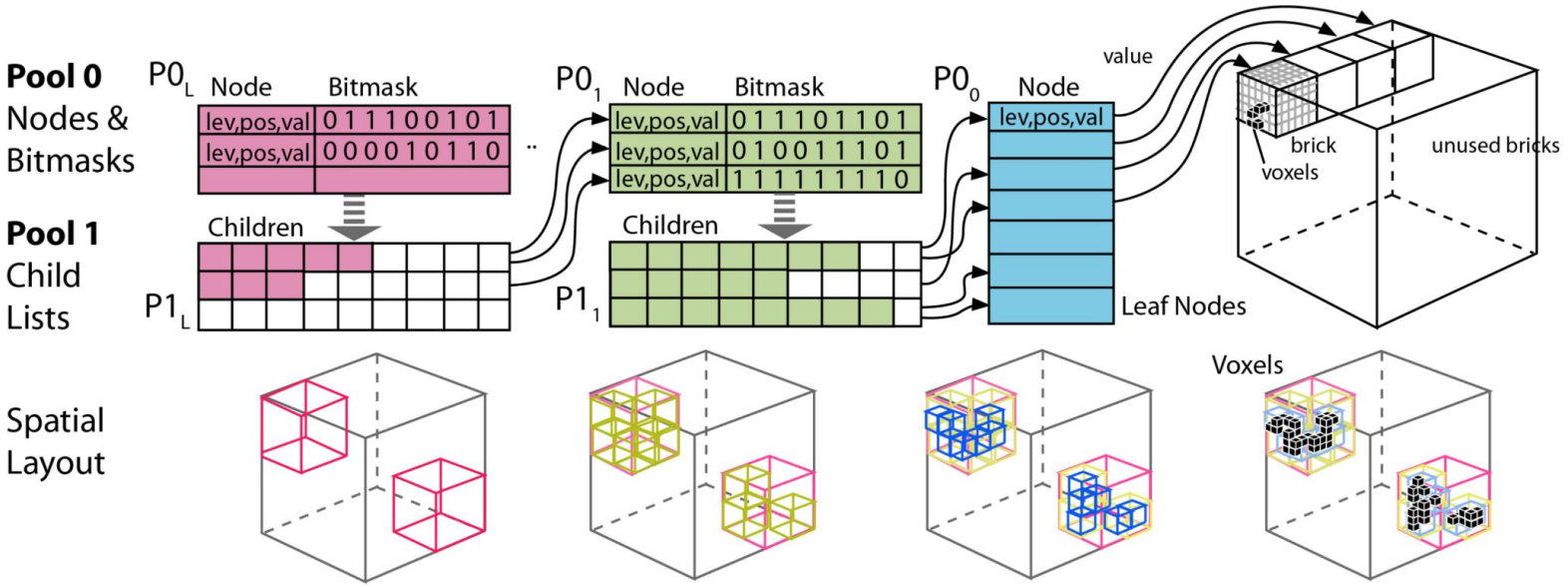


VOXELS

- Memory footprint
- Half res Disney cloud = 45GB
- Need a sparse data structure

VDB

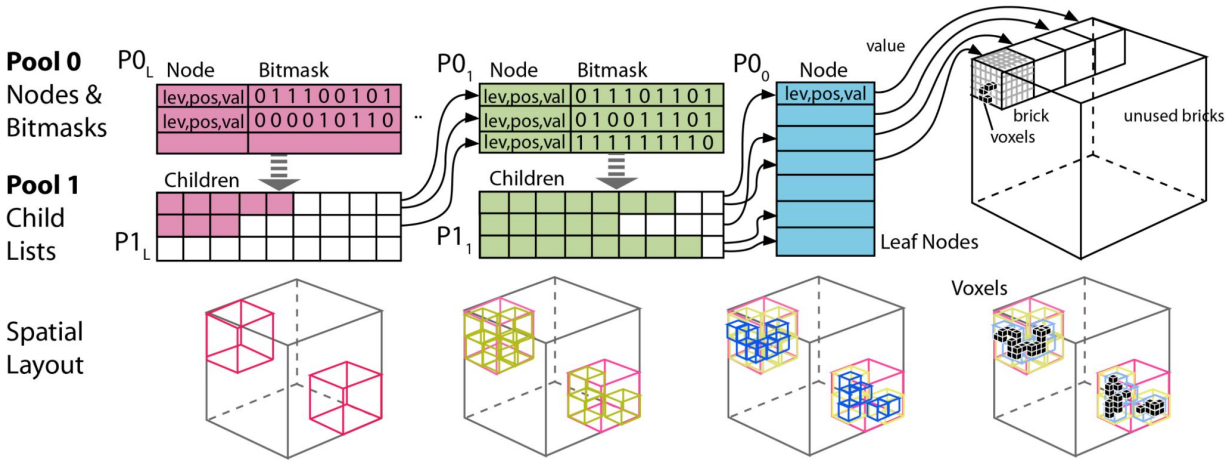
- Default for movie rendering
- Sparse 3 layer B+tree
- Faster sampling
- Massively smaller memory footprint



TRAVERSE RESEARCH

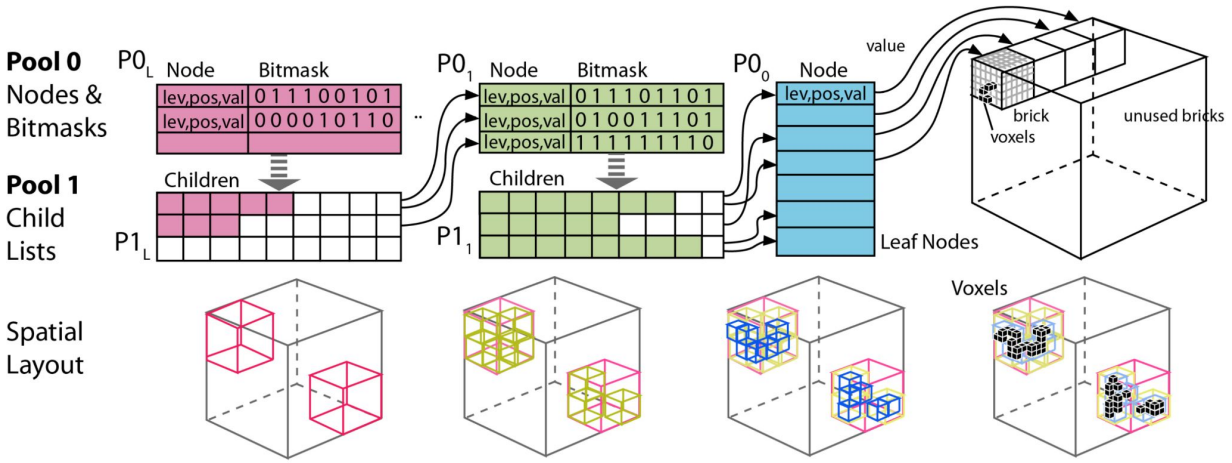
VDB

```rust
#[repr(C)]
#[derive(Zeroable, Clone, Copy, NoUninit)]
pub struct NodeL1 {
    pub child_mask: [u32; L1_CHILDREN / 32],
    pub child_pointer: u32,
}

#[repr(C)]
#[derive(Zeroable, Clone, Copy, NoUninit)]
pub struct NodeL2 {
    pub child_mask: [u32; L2_CHILDREN / 32],
    pub child_pointer: u32,
}

#[repr(C)]
#[derive(Clone, Copy, Zeroable, NoUninit)]
pub struct Leaf {
    pub value_mask: [u32; L3_CHILDREN / 32],
    pub values_pointer: u32,
}
```



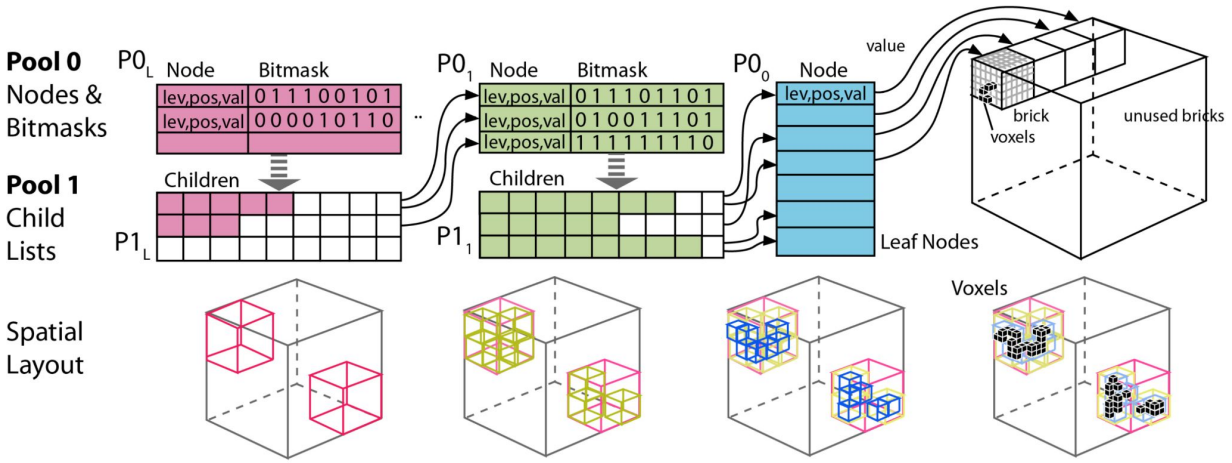
VDB

```rust
pub struct VdbVolumeAsset<T: Pod> {
    pub name: String,
    pub l1: Vec<NodeL1>,
    pub l2: Vec<NodeL2>,
    pub l3: Vec<Leaf>,
    pub voxel_data: Vec<T>,

    pub aabb_min: Vec3,
    pub aabb_max: Vec3,

    pub translation: Vec3,
    pub scale: Vec3,

    pub global_density_majorant: f32,
}
```



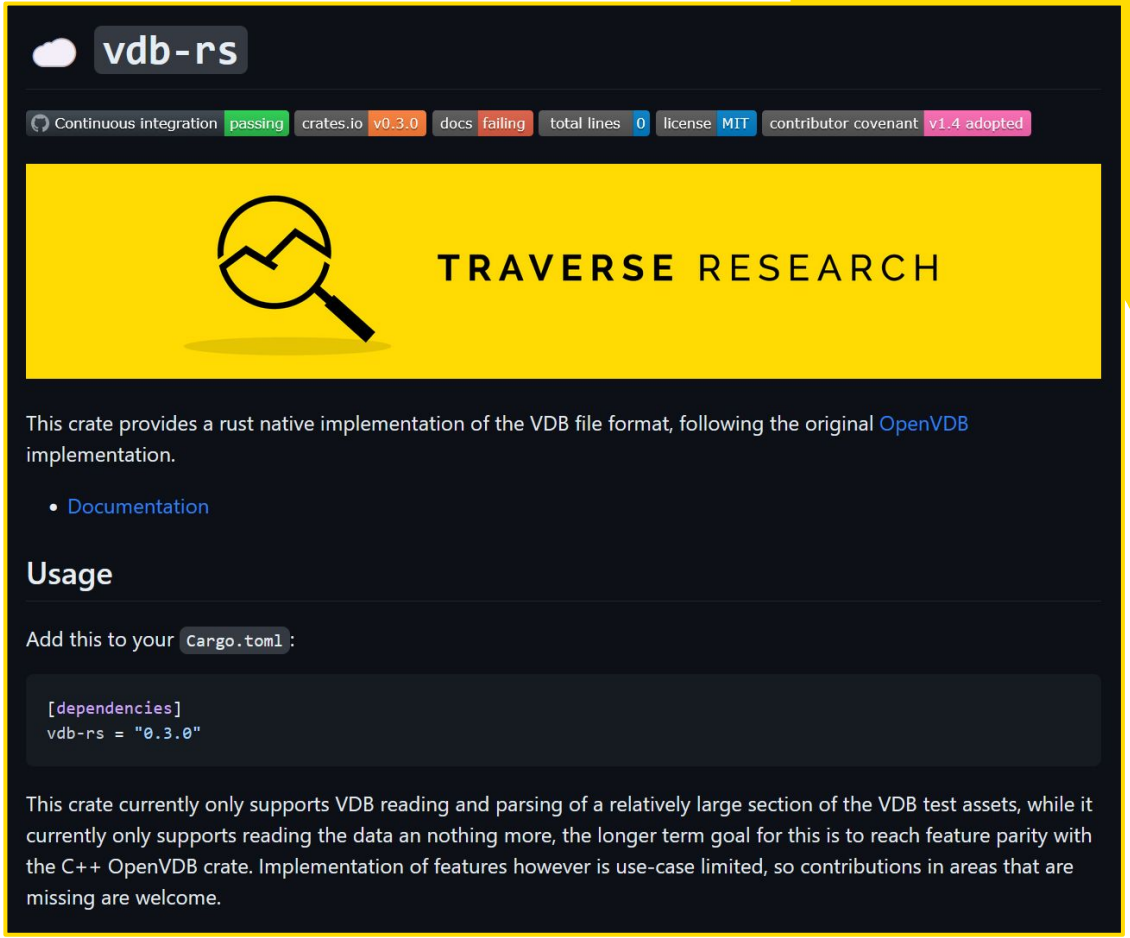
VDB

```rust
pub struct GpuVdbVolume {
    pub constants: Arc<dyn Buffer>,
    pub l1_buffer: Arc<dyn Buffer>,
    pub l2_buffer: Arc<dyn Buffer>,
    pub l3_buffer: Arc<dyn Buffer>,
    pub voxel_data_buffer: Arc<dyn Buffer>,
}
```



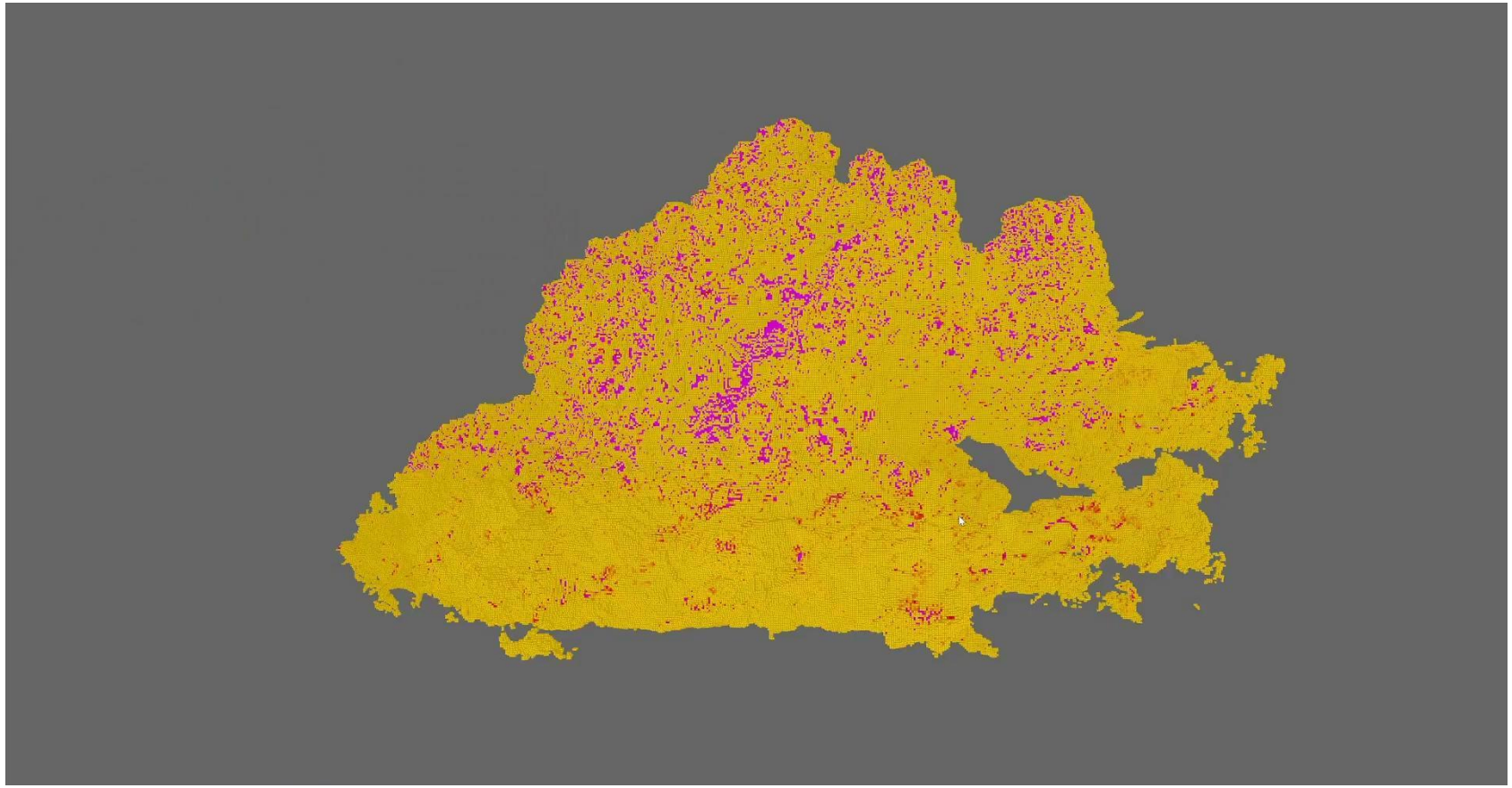
VDB-RS

- https://github.com/Traverse-Research/vdb-rs
- Supports Houdini, blender and more



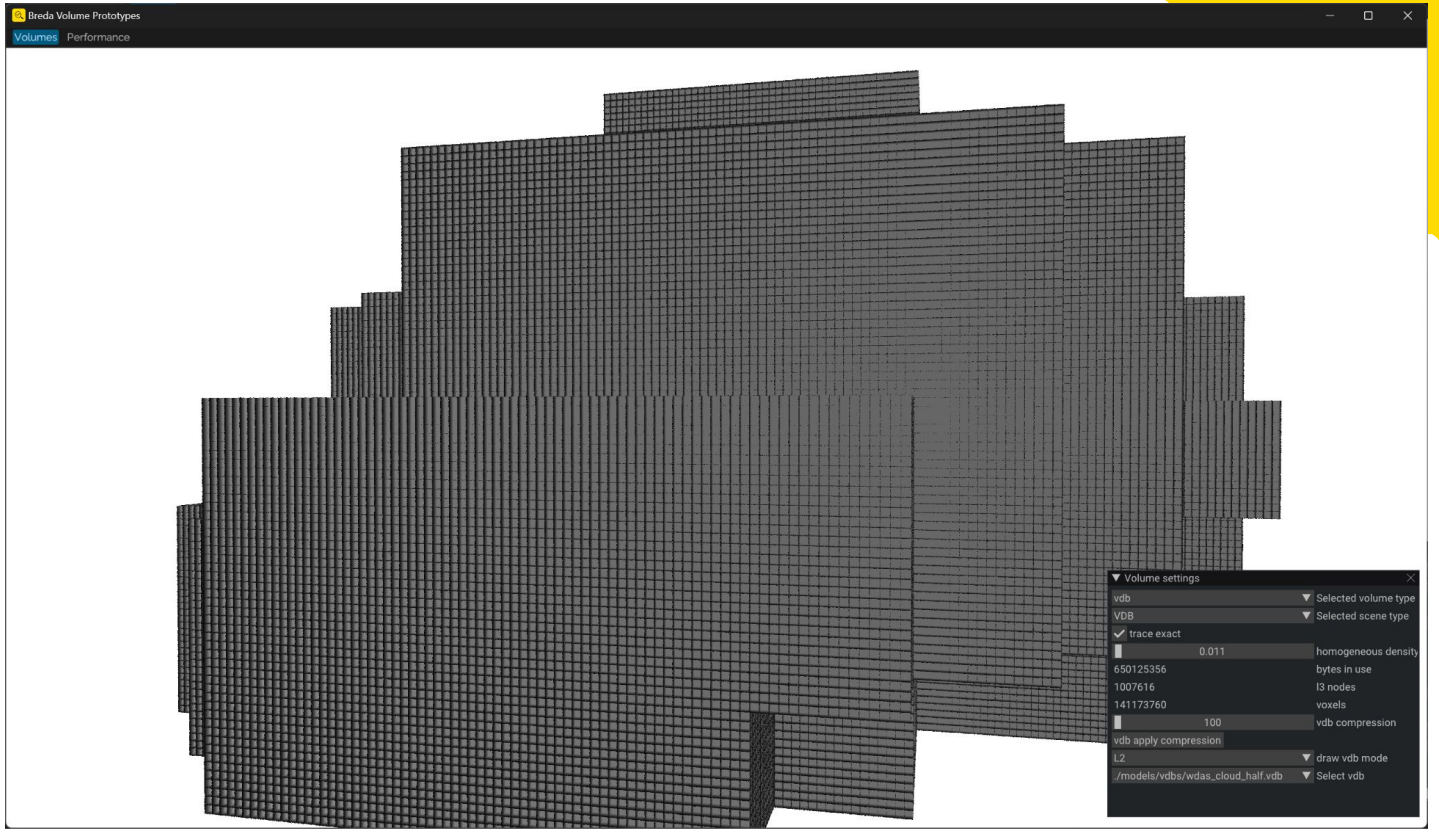
VDB-RS

- Quarter res Disney cloud due to rendering limitations
- Using bevy



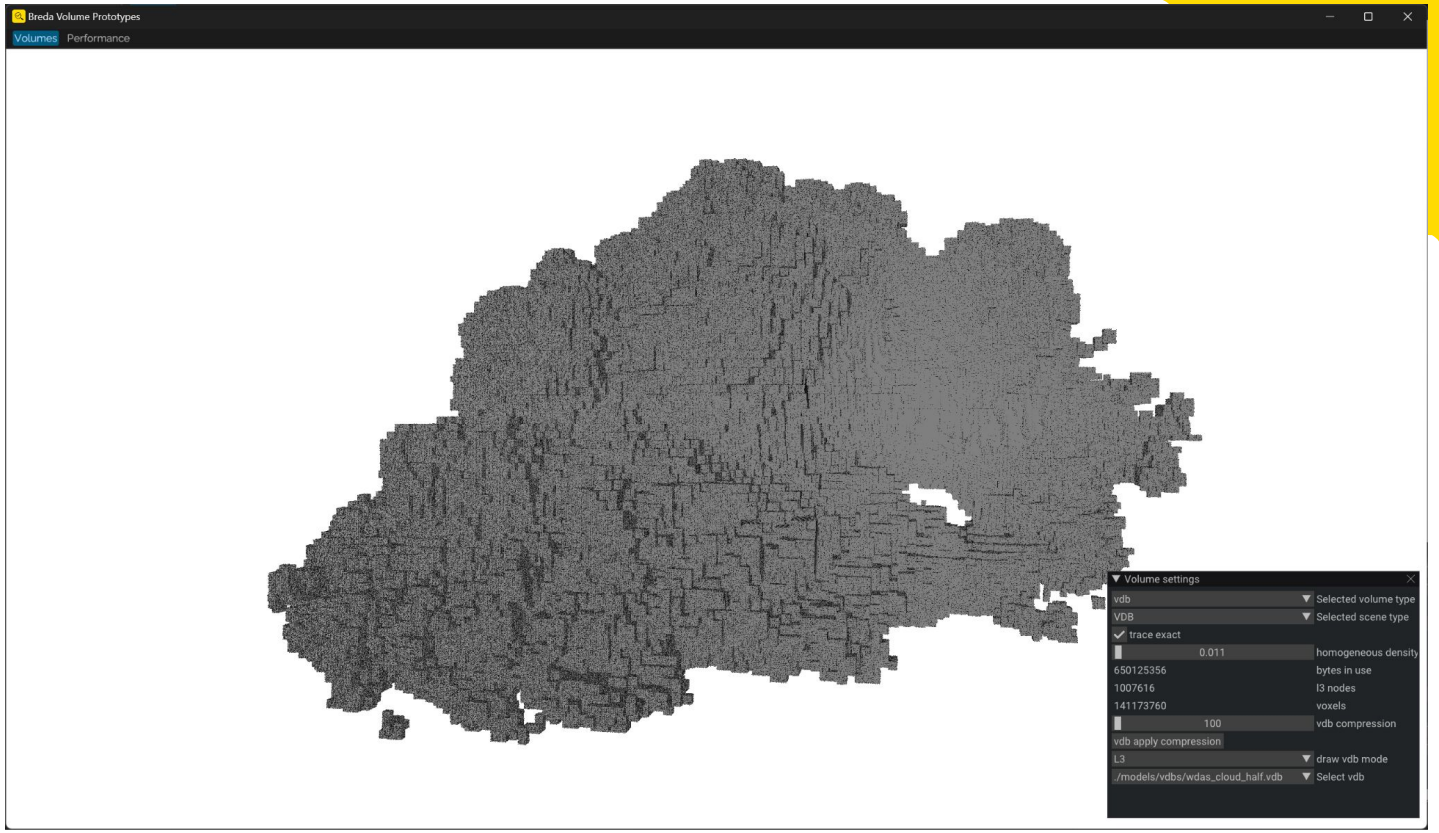
VDB-RS

- L2 nodes



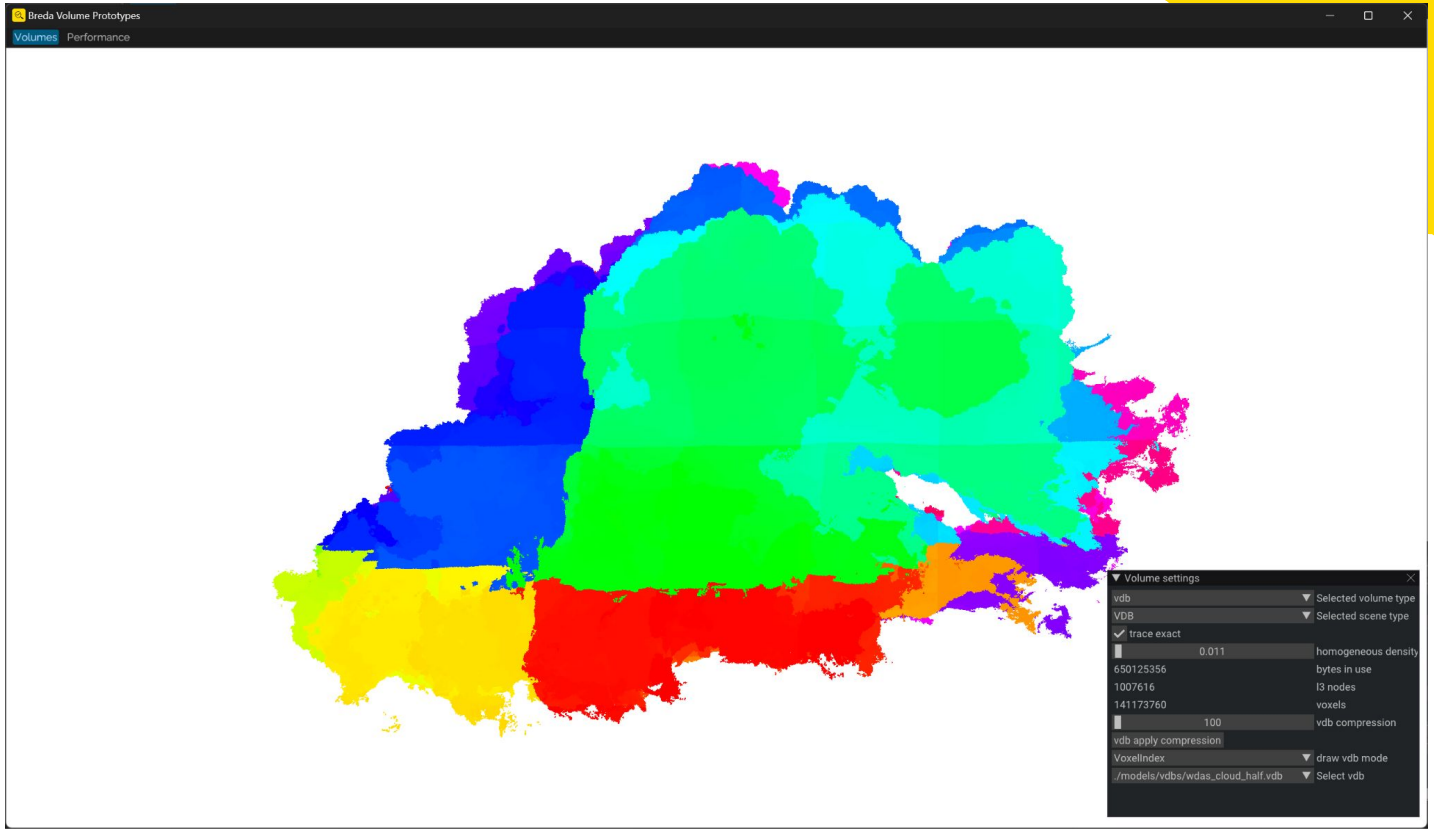
VDB-RS

- L3 nodes



VDB-RS

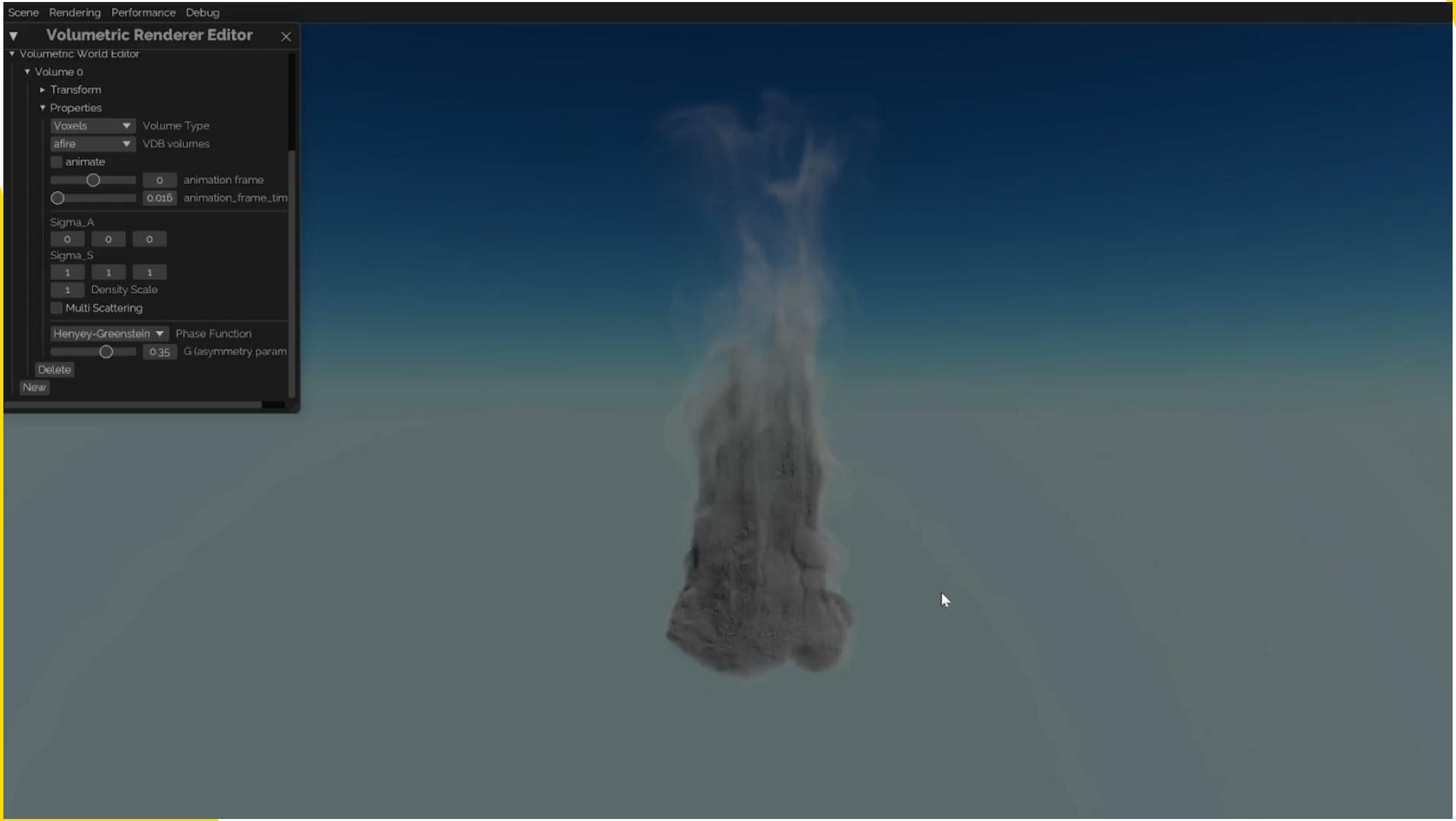
- Voxel data indices indicated by hue



BREDA OUR BELOVED

BREDA OUR BELOVED

- With many many thanks to Emilio


Scene
Rendering
Performance
Debug
Volumetric Renderer Editor
Volumetric World Editor
Volume 0
Transform
Properties
Voxels
Volume Type
afire
VDB volumes
animate
0
animation frame
0.016
animation_frame_tim
Sigma_A
0
0
0
Sigma_S
1
1
1
1
Density Scale
Multi Scattering
Henyey-Greenstein
Phase Function
0.35
G (asymmetry param
Delete
New

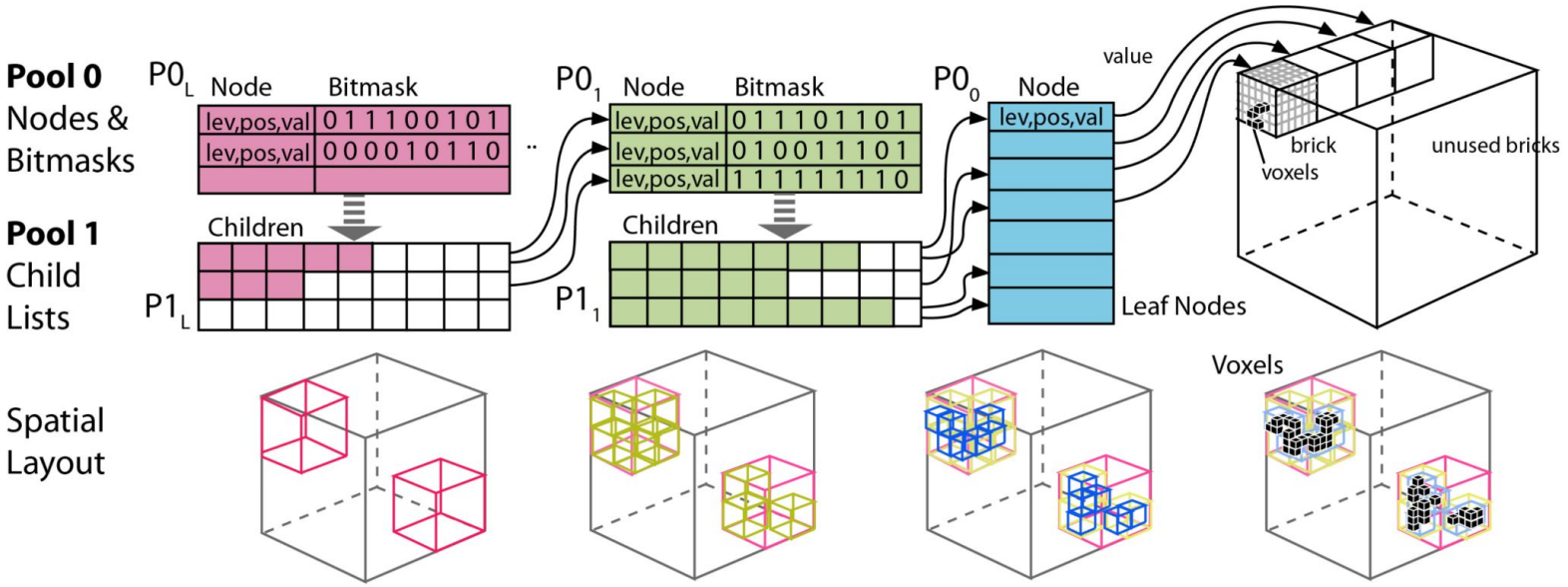
62


6

ACTIVE RESEARCH

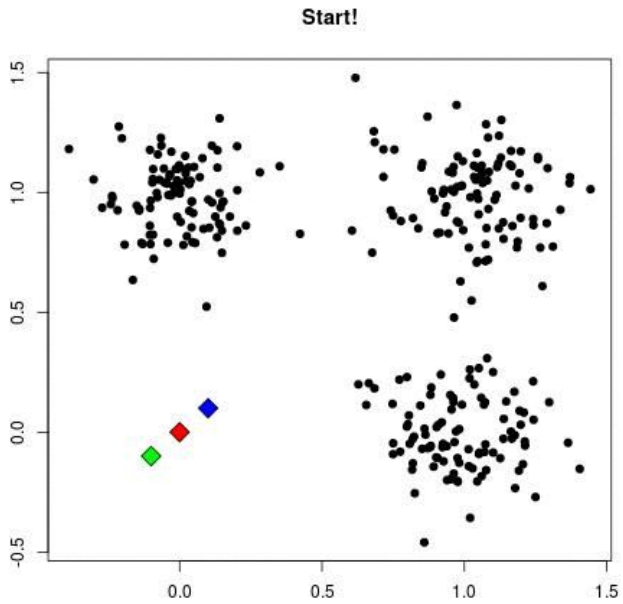
ACTIVE RESEARCH: COMPRESSION

- Remember the VDB structure
- 8^3 brick size = 512 voxels
- Find similar bricks



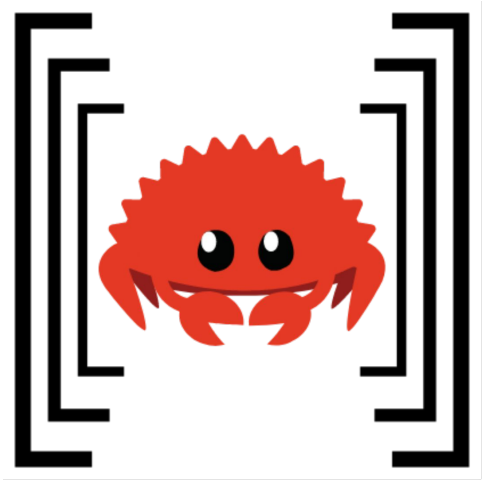
ACTIVE RESEARCH: COMPRESSION

- Clustering
- Complexity of O(512nk) = O(nk)
- Distance metrics?



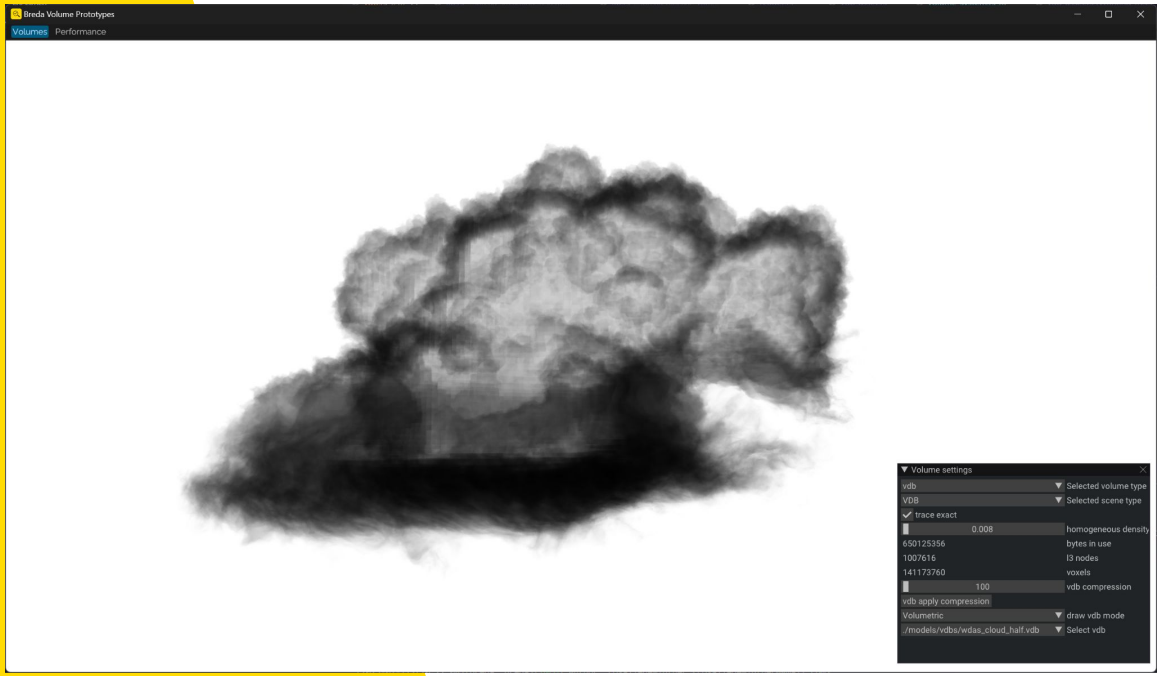
ACTIVE RESEARCH: COMPRESSION

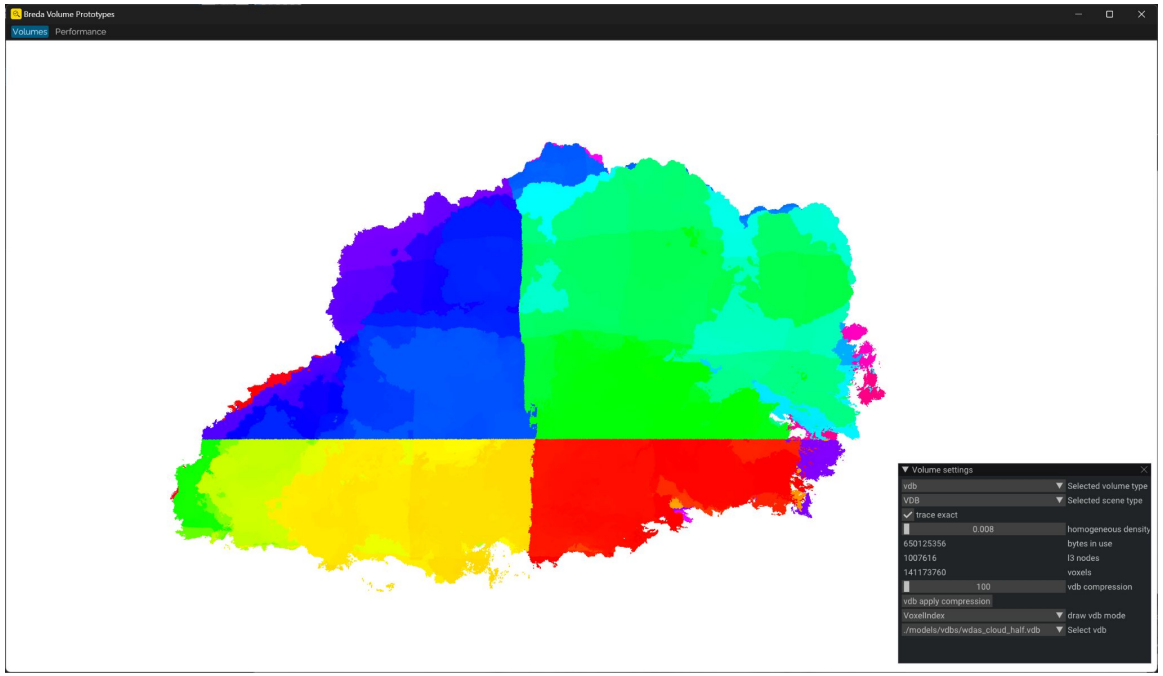
- Nalgebra: complex
- Ndarray: numpy-like



ACTIVE RESEARCH: COMPRESSION

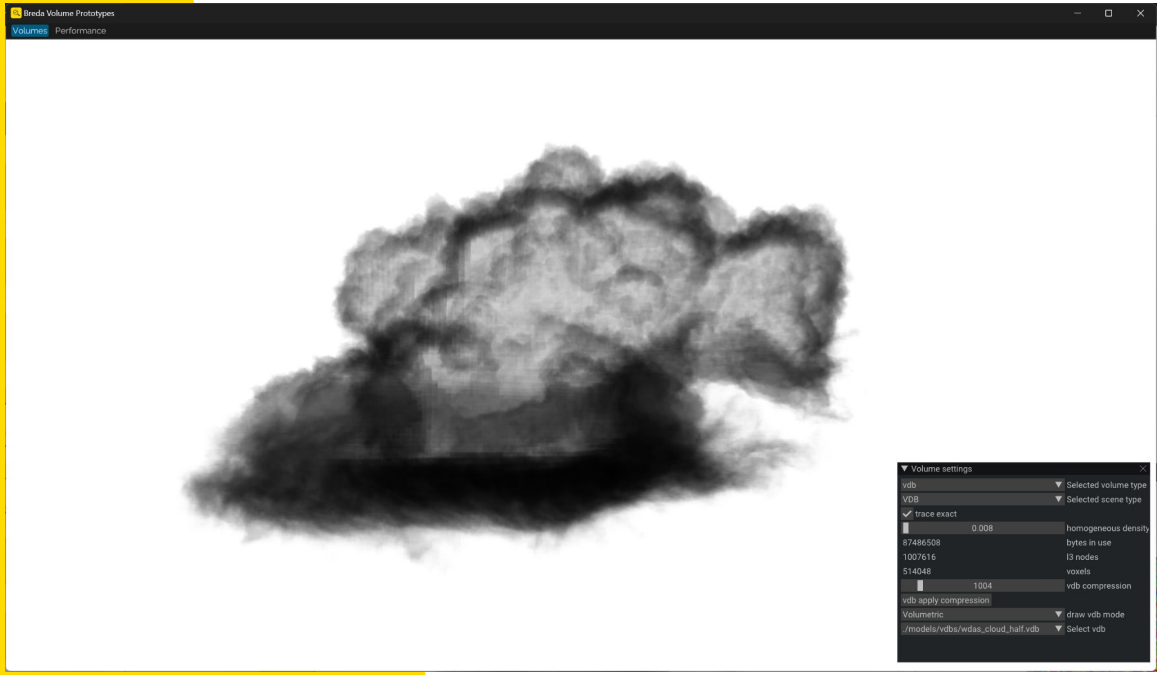
- Ground truth
- 650mb

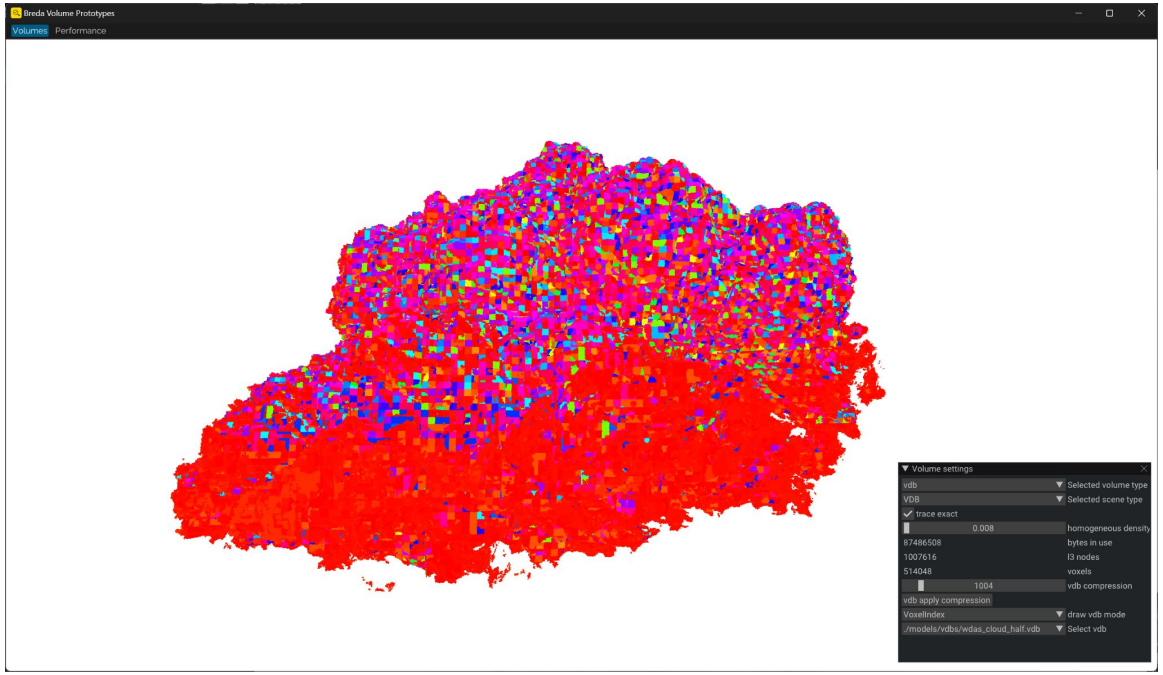




ACTIVE RESEARCH: COMPRESSION

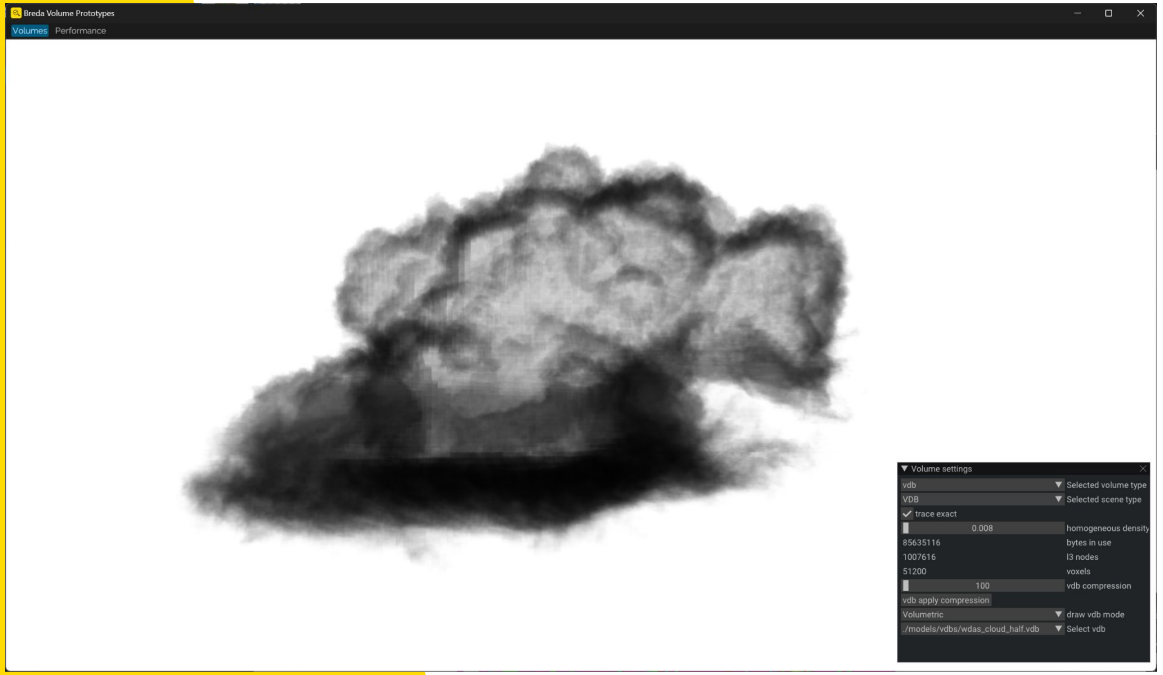
- k = 1004
- 87mb
- 12 minutes

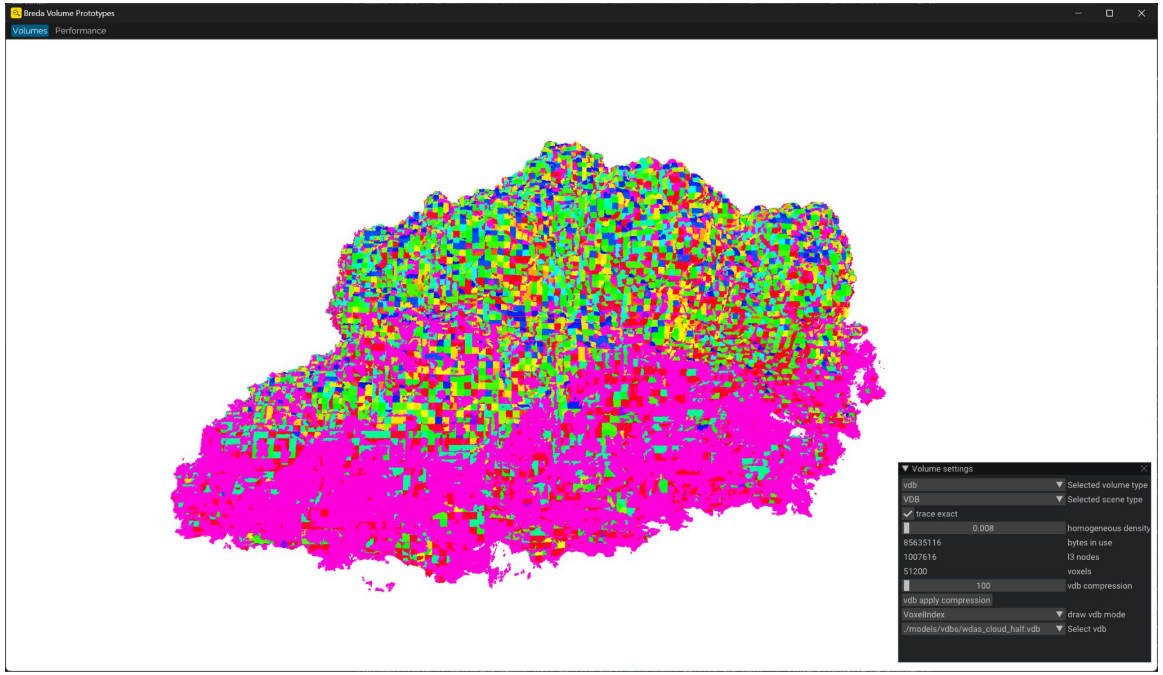




ACTIVE RESEARCH: COMPRESSION

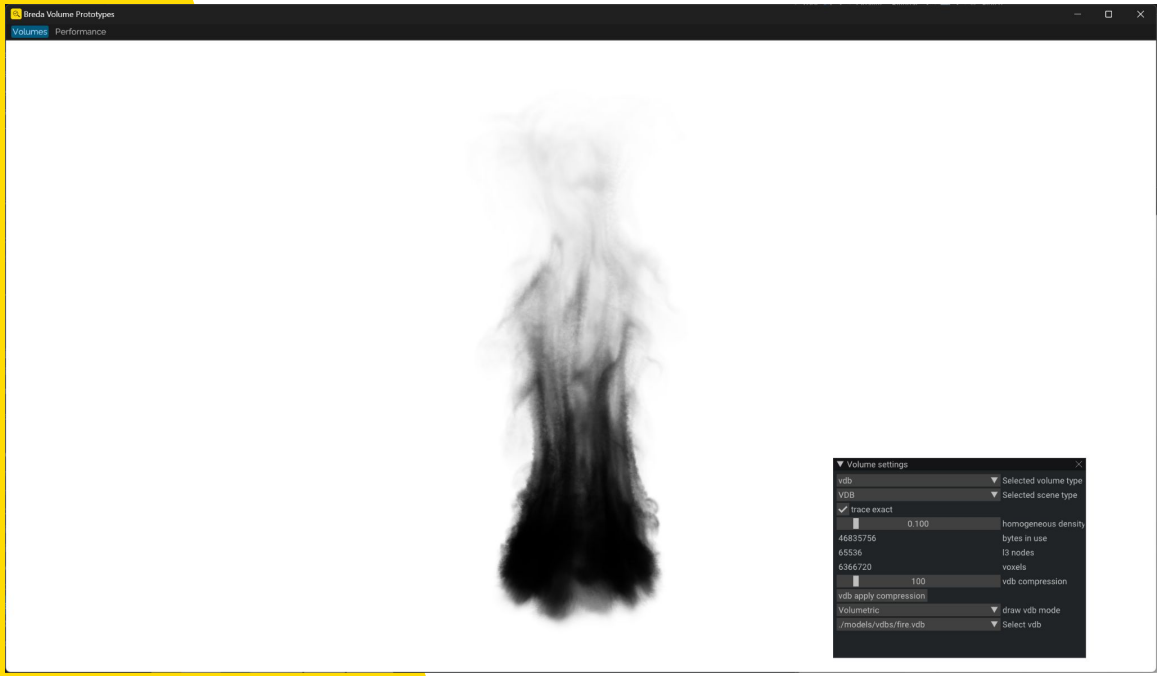
- k = 100
- 86mb
- 6 minutes

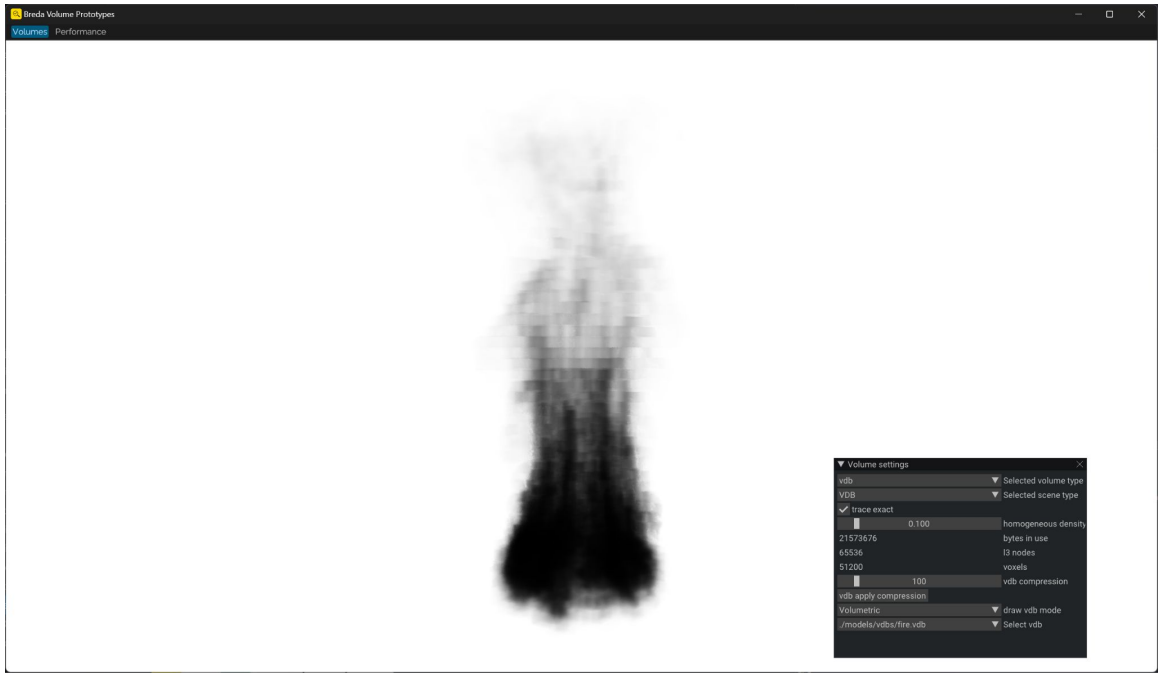




ACTIVE RESEARCH: COMPRESSION

- Great for large effect
- Less so for small detailed effect
- 47mb => 22mb





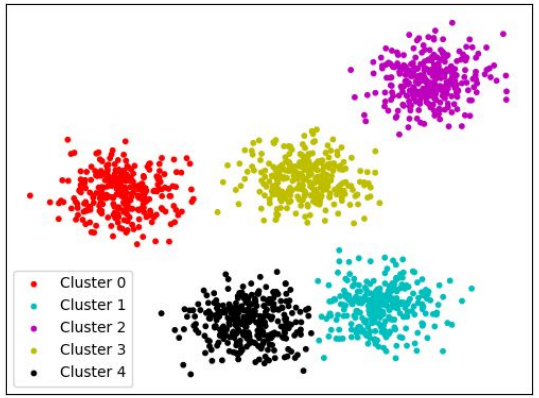
ACTIVE RESEARCH: ANIMATION

- What about the animated storms and smoke
- Flipbook


Volumetric Renderer Editor
Rotation (Y,P,R)
Translation
Properties
Volume Type
VDB volumes
animation frame
Sigma_A
Sigma_S
Density Scale
Multi Scattering
Henyey-Greenstein
Phase Function
Delete
New
Exposure Settings

WHAT'S NEXT

ANIMATION COMPRESSION



EMISSION

PERFORMANCE


THANK YOU