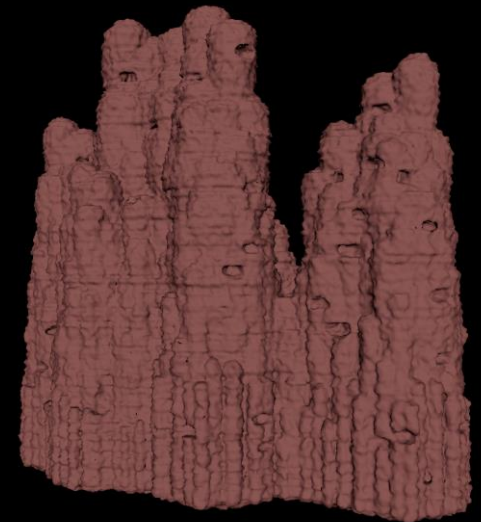
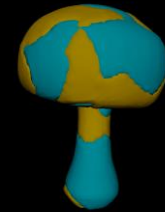


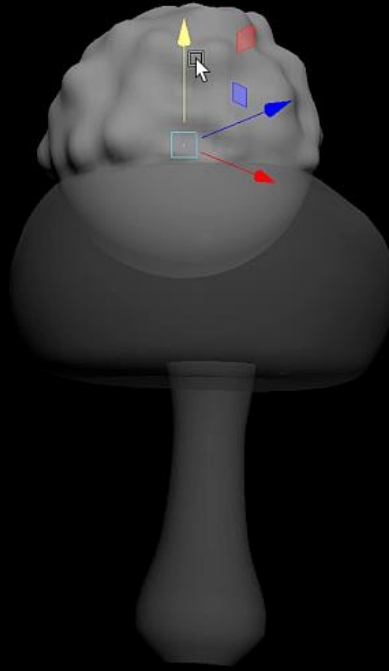
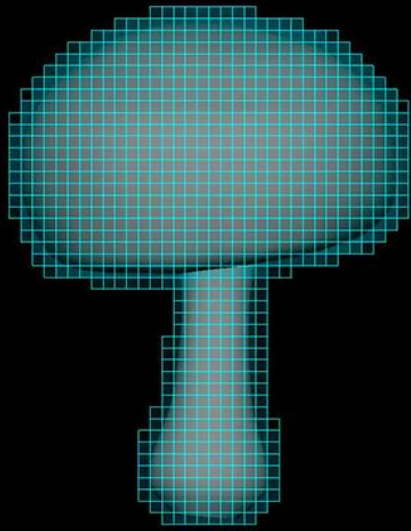
# Bifrost Workshop

## Lesson 4

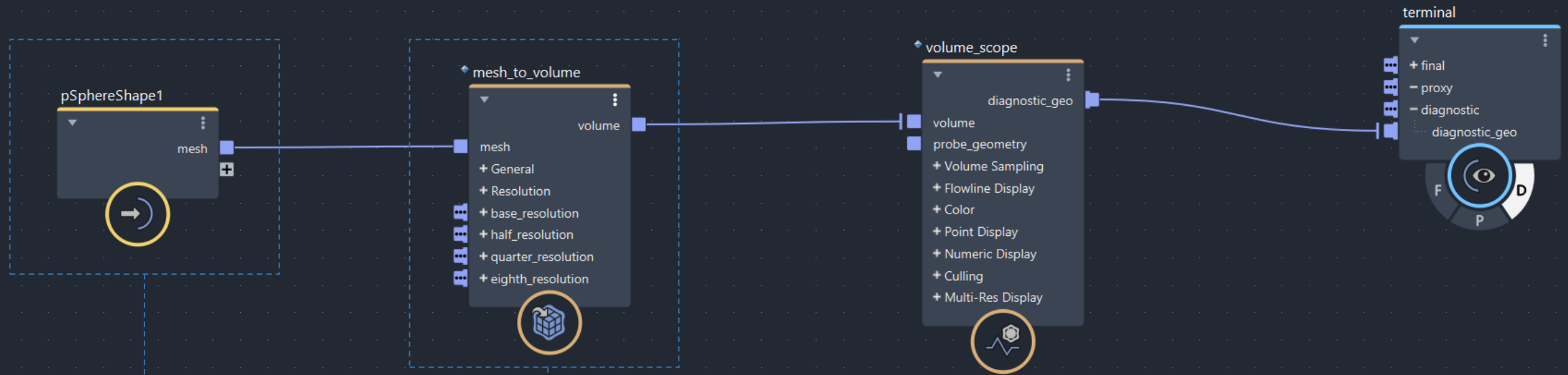
### Intro to Volumes



# Volume Basics

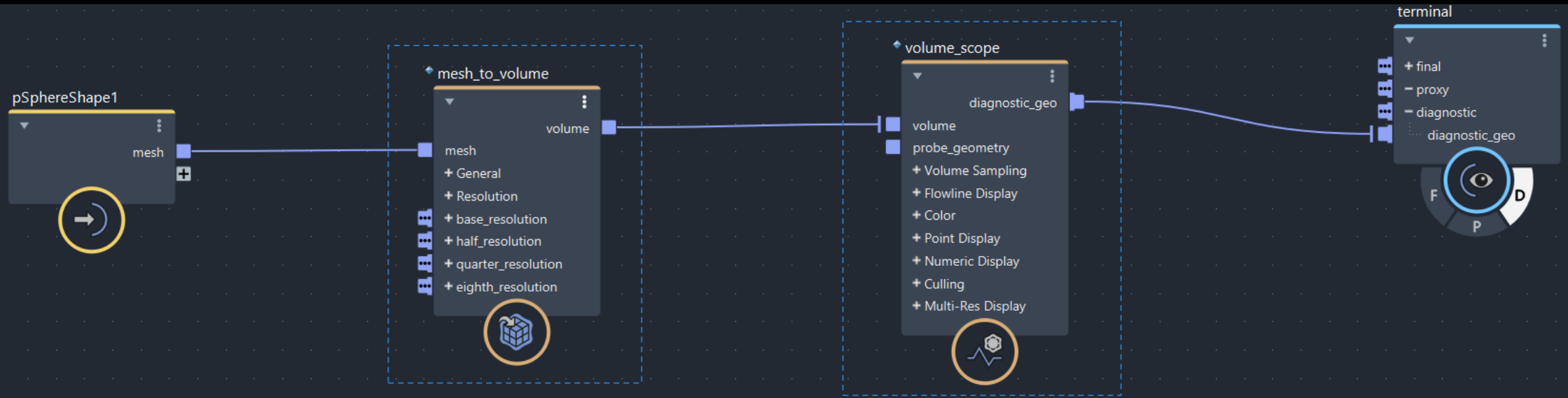


# Volume Basics



A voxel is the smallest element of a volume in 3D space.  
Each voxel can store information such as signed distance, fog density and velocity.

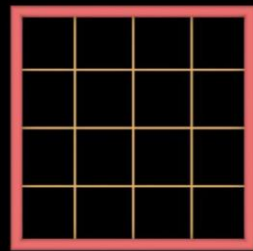
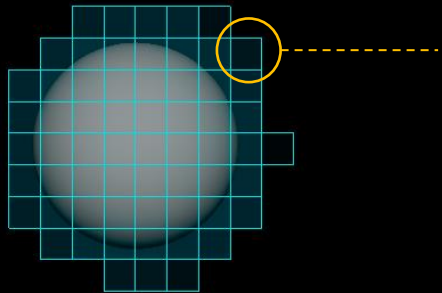
# Volume Basics



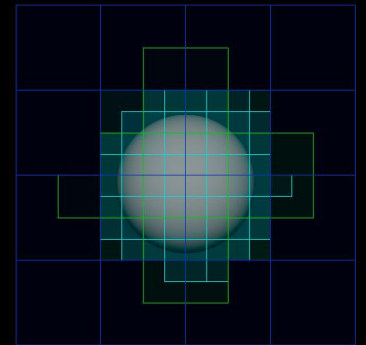
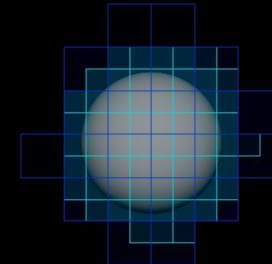
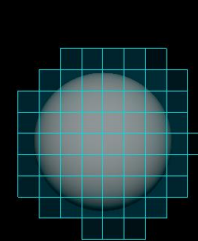
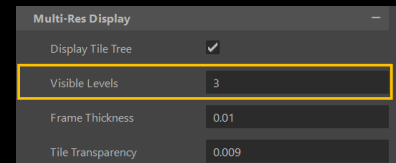
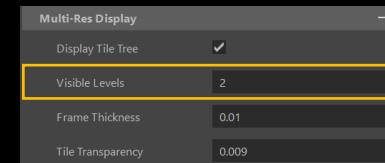
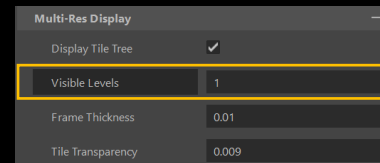
## Tile Tree:

- Each tile is composed of a fixed number of voxels.
- Multi-resolution and extends far in space.
- The size of the tiles reflect the resolution of a volume

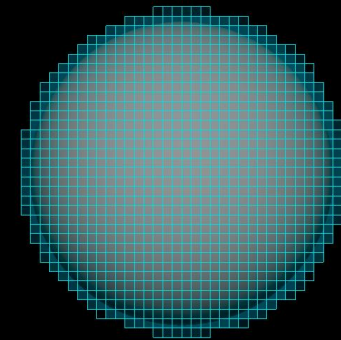
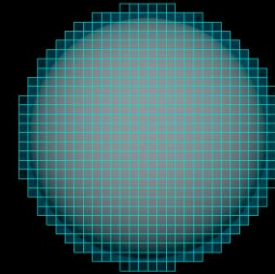
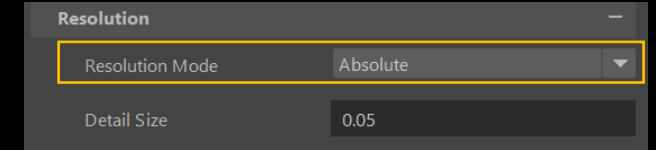
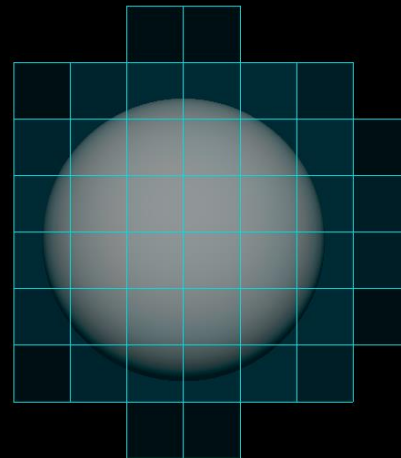
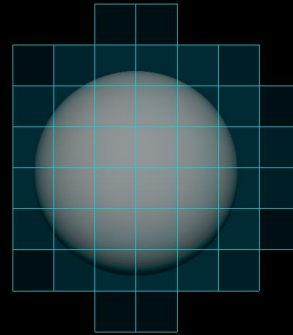
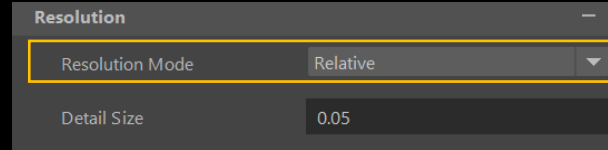
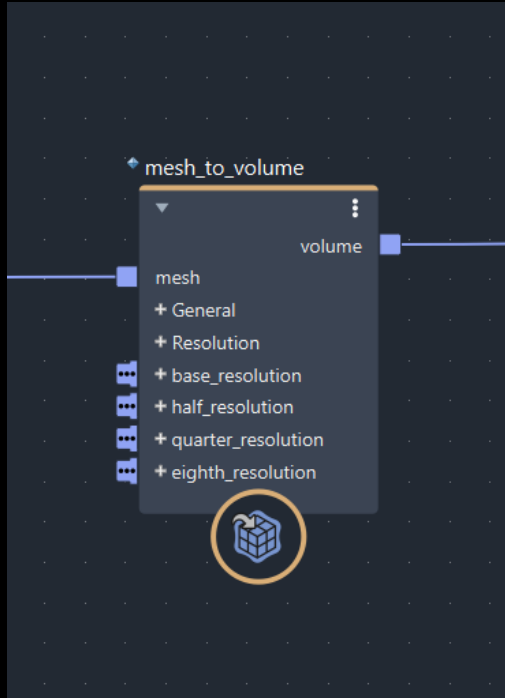
Volume Subdivision Str **Power2**



Power 2: 4x4x4 voxels



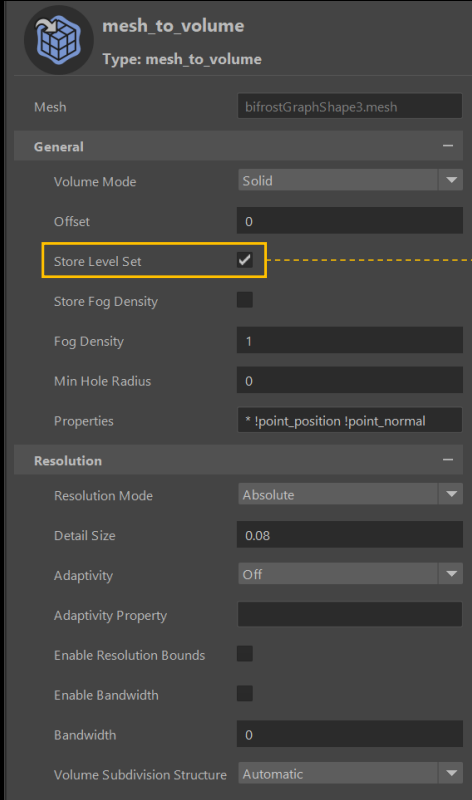
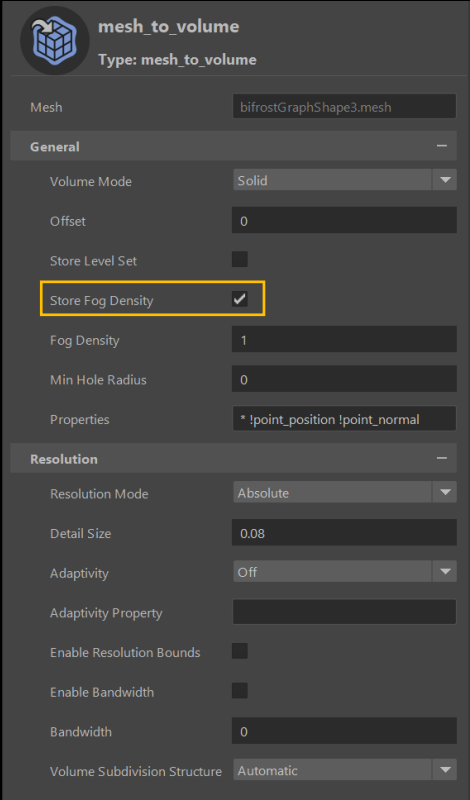
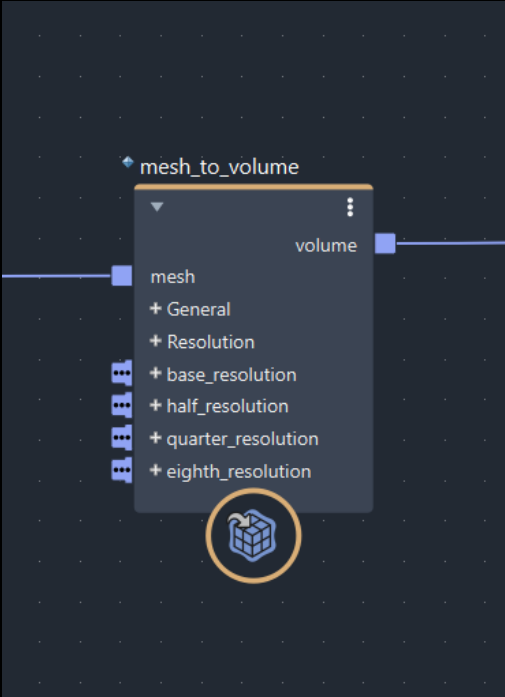
# Volume Basics



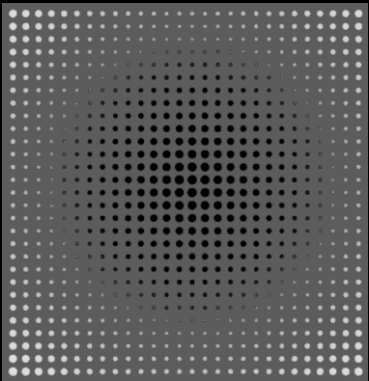
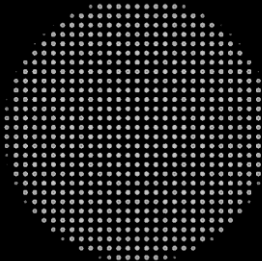
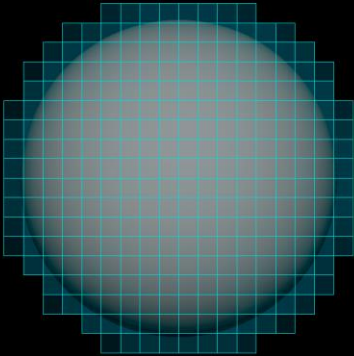
**Relative Mode:** the voxel size is relative to the bounding box of the input mesh  
larger mesh → larger voxel

**Absolute Mode:** the voxel size is in world-space unit  
The scale of the mesh doesn't affect the voxel size.

# Volume Basics

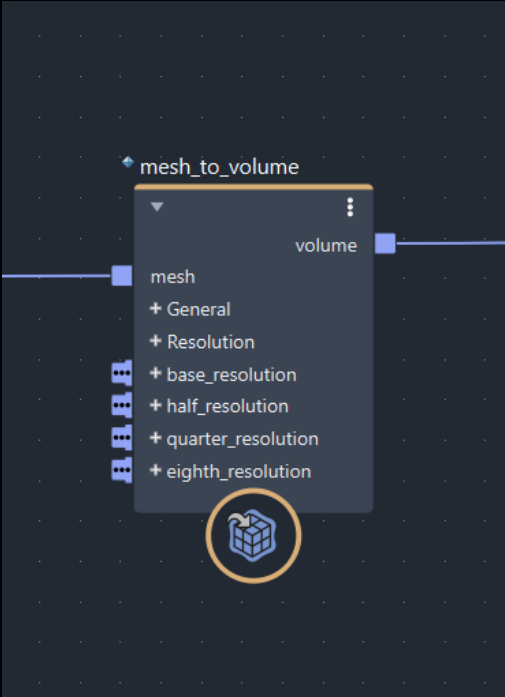


“Store Level Set” stores the signed distance of every voxel



White: positive value  
Black: negative value

# Volume Basics



**mesh\_to\_volume**  
Type: mesh\_to\_volume

Mesh

**General**

Volume Mode

Offset

☒ Store Level Set

Store Fog Density ☐

Fog Density

Min Hole Radius

Properties

**Resolution**

Resolution Mode

Detail Size

Adaptivity

Adaptivity Property

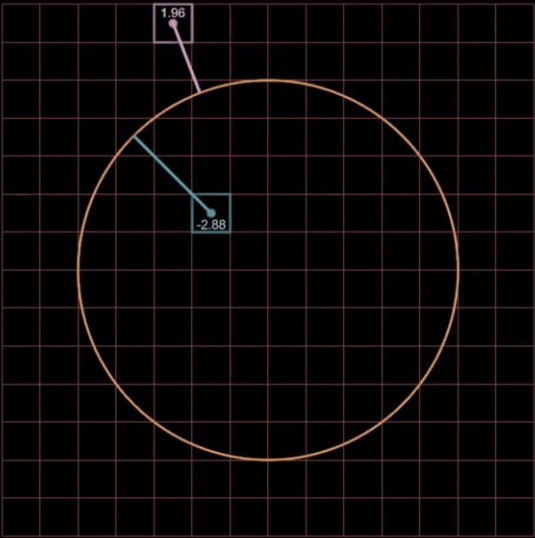
Enable Resolution Bounds ☐

Enable Bandwidth ☐

Bandwidth

Volume Subdivision Structure

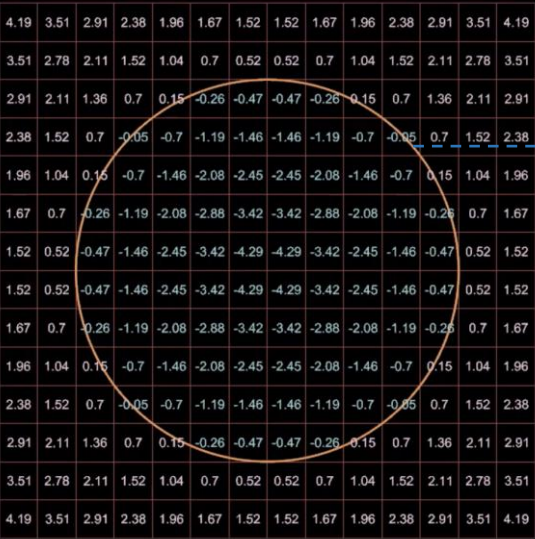
## Signed Distance Field



If 'Store Level Set' is selected, the node calculates the signed distance of each voxel.

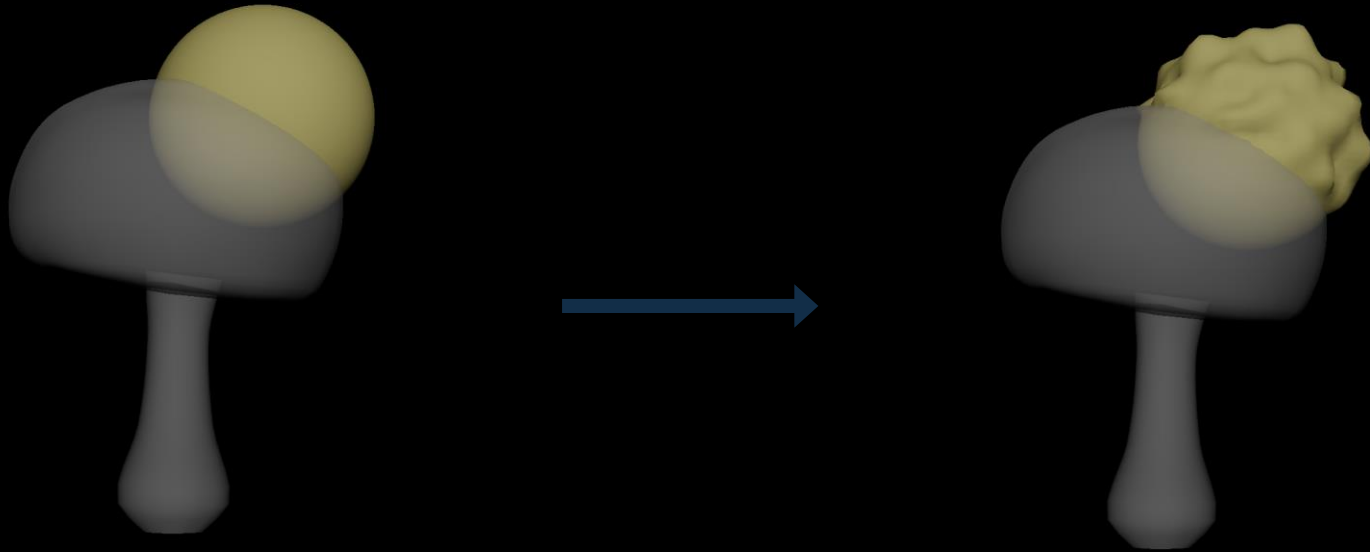
Signed distance: the shortest distance between the voxel and the surface of the geometry

Inside the geometry → negative value  
Outside the geometry → positive value



Level Set (the set of points with the same signed distance value)

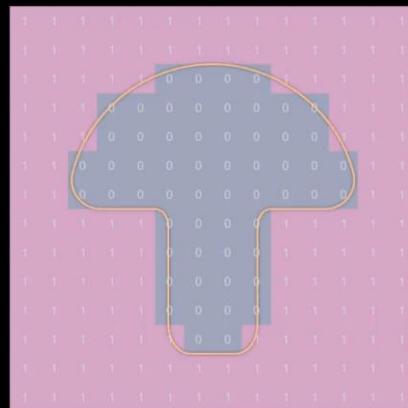
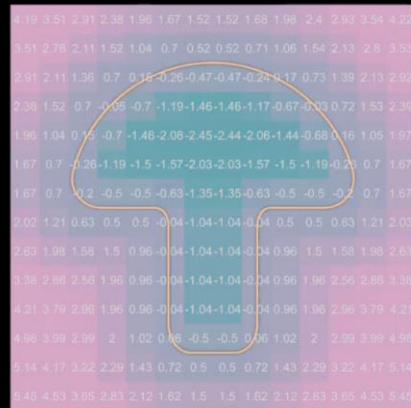
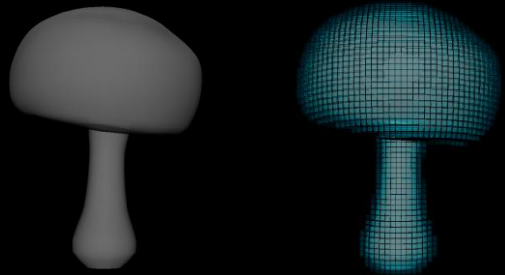
The signed distance of each voxel is stored in a level set volume.



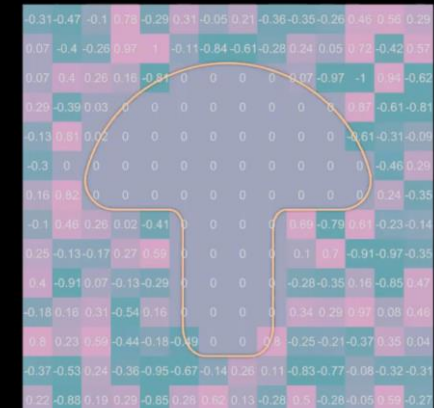
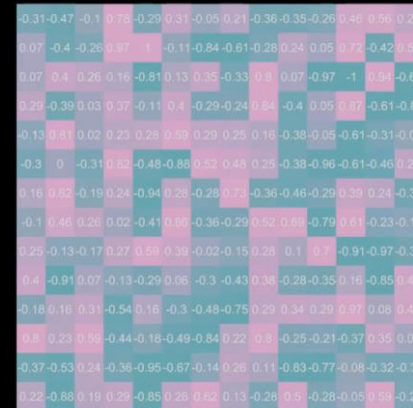


# Volume Basics

## Application of Signed Distance Field

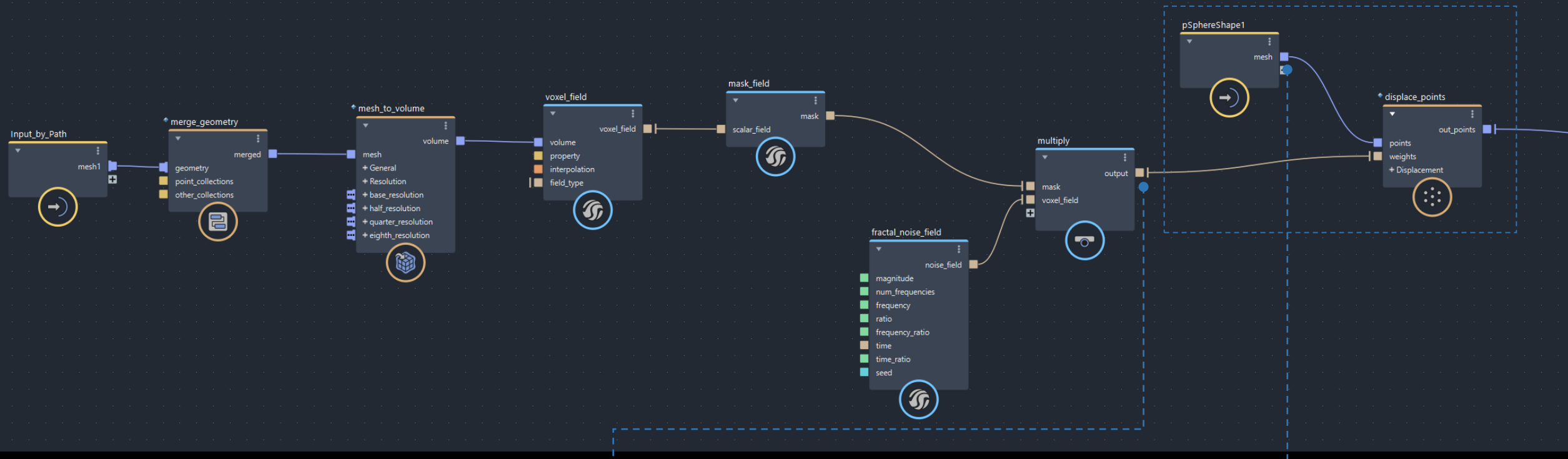


X



# Volume Basics

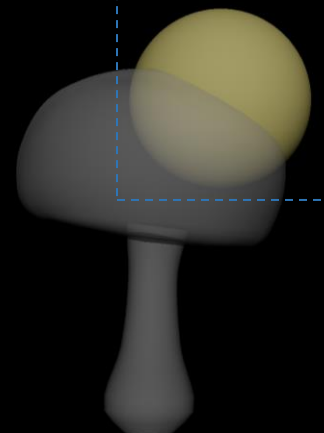
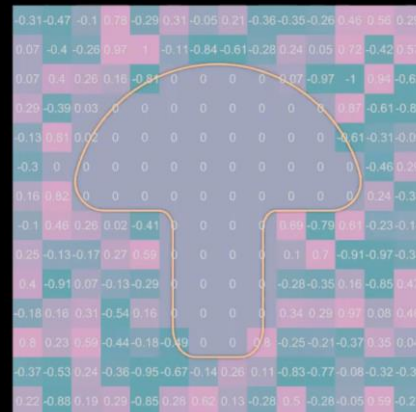
## Application of Signed Distance Field



Using the field generated from the voxel field and  
fractal noise field to provide the weights for the  
point displacement

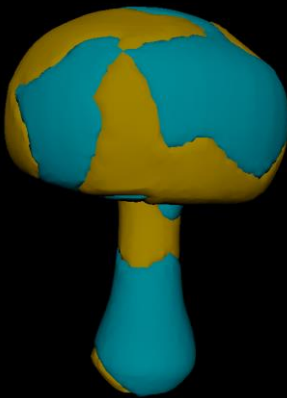
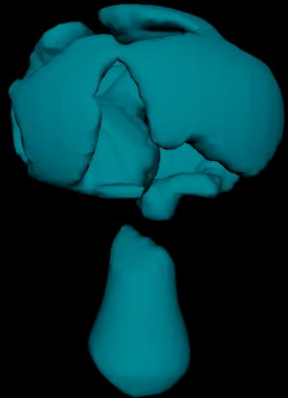
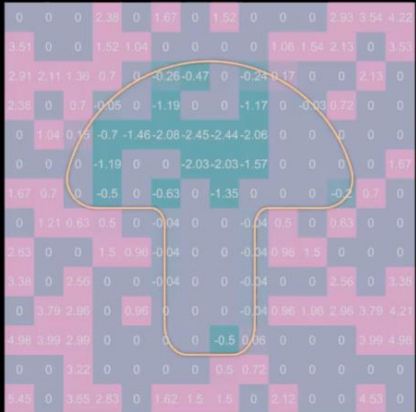
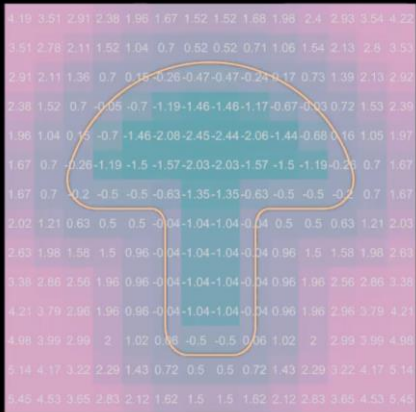
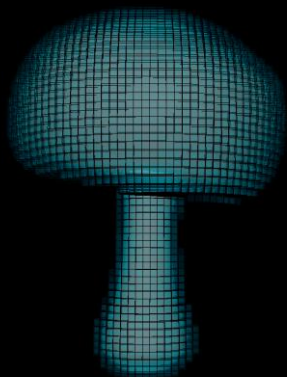
Area inside the mushroom: 0

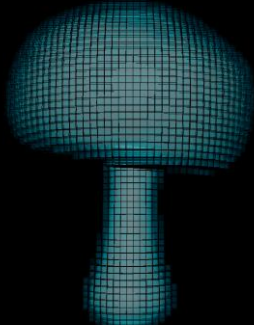
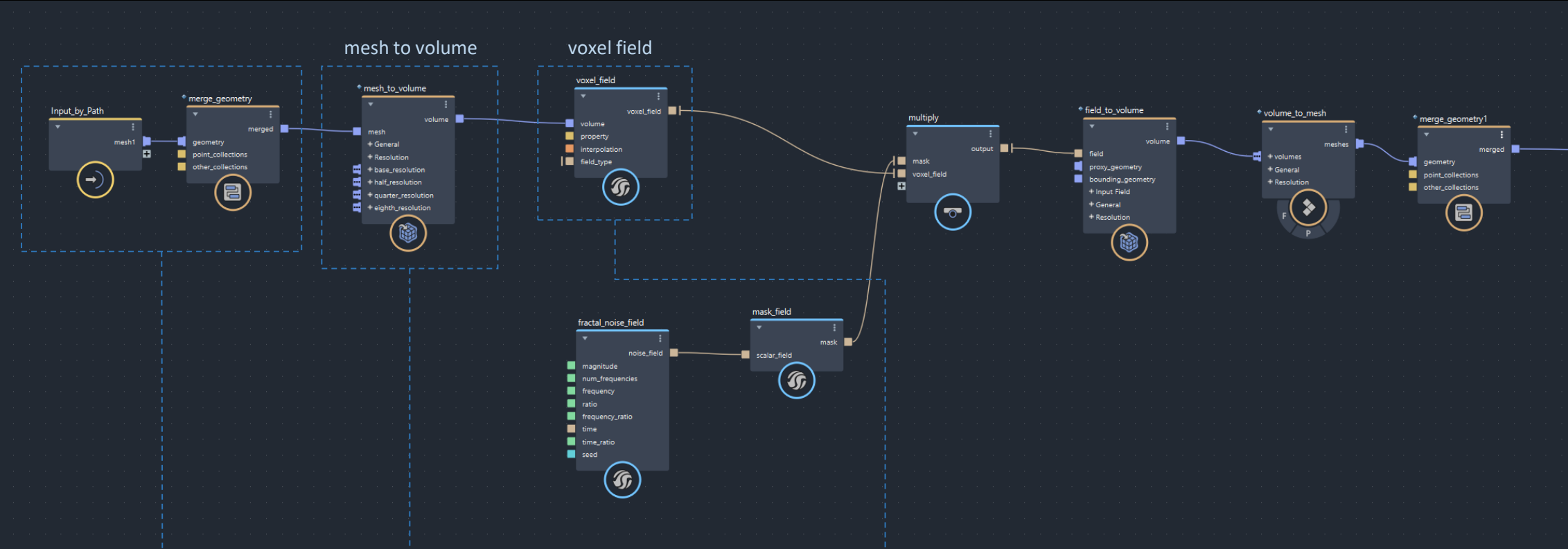
Area outside the mushroom: fractal noise values



# Volume Basics

Field to Volume

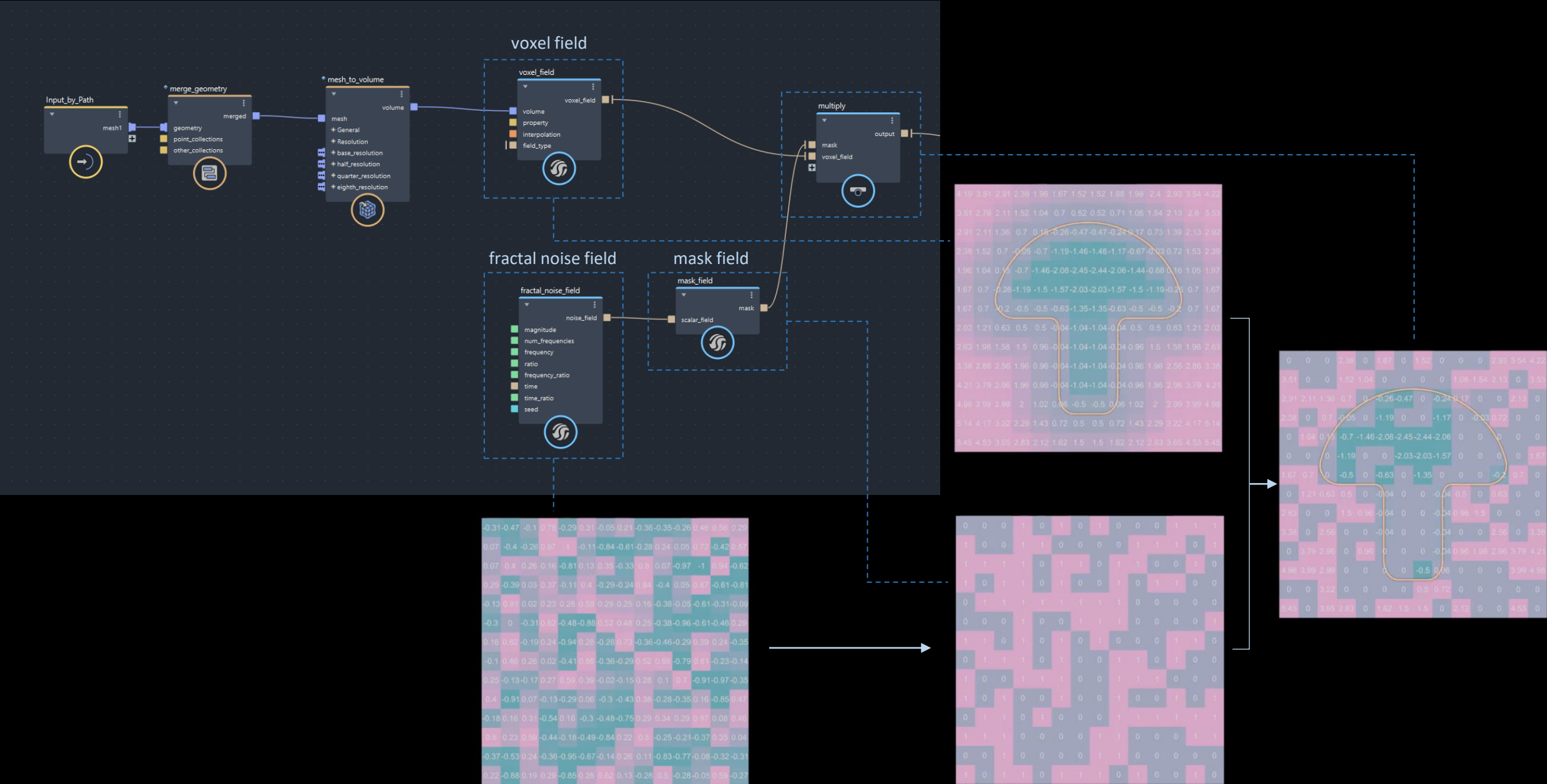




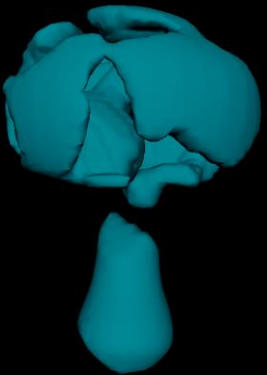
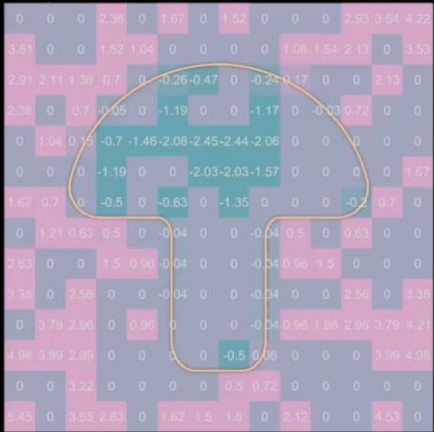
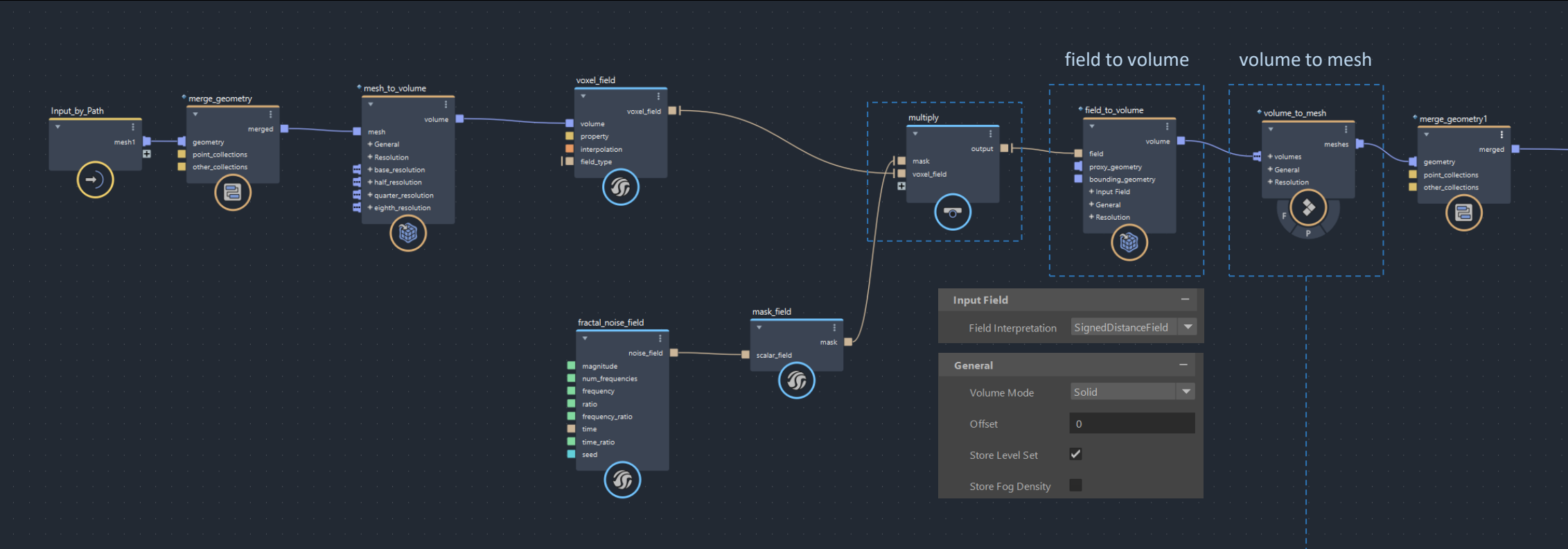
3.19	3.51	2.91	2.38	1.96	1.67	1.52	1.52	1.68	1.98	2.4	2.93	3.54	4.22
3.51	2.78	2.11	1.52	1.04	0.7	0.52	0.52	0.71	1.06	1.54	2.13	2.8	3.53
2.91	2.11	1.36	0.7	0.15	-0.26	-0.47	-0.47	-0.24	0.17	0.73	1.39	2.13	2.92
2.38	1.52	0.7	-0.05	-0.7	-1.19	-1.46	-1.46	-1.17	-0.67	-0.33	0.72	1.53	2.38
1.96	1.04	0.15	-0.7	-1.46	-2.08	-2.45	-2.44	-2.06	-1.44	-0.68	0.16	1.05	1.97
1.67	0.7	-0.26	-1.19	-1.5	-1.57	-2.03	-2.03	-1.57	-1.5	-1.19	-0.21	0.7	1.67
1.67	0.7	-0.2	-0.5	-0.5	-0.63	-1.35	-1.35	-0.63	-0.5	-0.5	-0.2	0.7	1.67
2.02	1.21	0.63	0.5	0.5	-0.04	-1.04	-1.04	-0.04	0.5	0.5	0.63	1.21	2.03
2.83	1.98	1.58	1.5	0.96	-0.04	-1.04	-1.04	-0.04	0.96	1.5	1.58	1.98	2.83
3.38	2.88	2.58	1.96	0.96	-0.04	-1.04	-1.04	-0.04	0.96	1.96	2.58	2.88	3.38
4.21	3.79	2.96	1.96	0.96	-0.04	-1.04	-1.04	-0.04	0.96	1.96	2.96	3.79	4.21
5.98	3.98	2.99	2	1.02	0.66	-0.5	-0.5	0.66	1.02	2	2.99	3.98	4.98
5.14	4.17	3.22	2.29	1.43	0.72	0.5	0.5	0.72	1.43	2.29	3.22	4.17	5.14
4.45	4.53	3.65	2.83	2.12	1.62	1.5	1.5	1.62	2.12	2.83	3.65	4.53	5.45

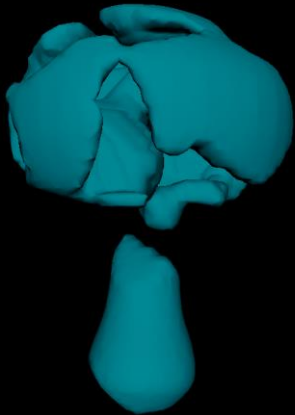
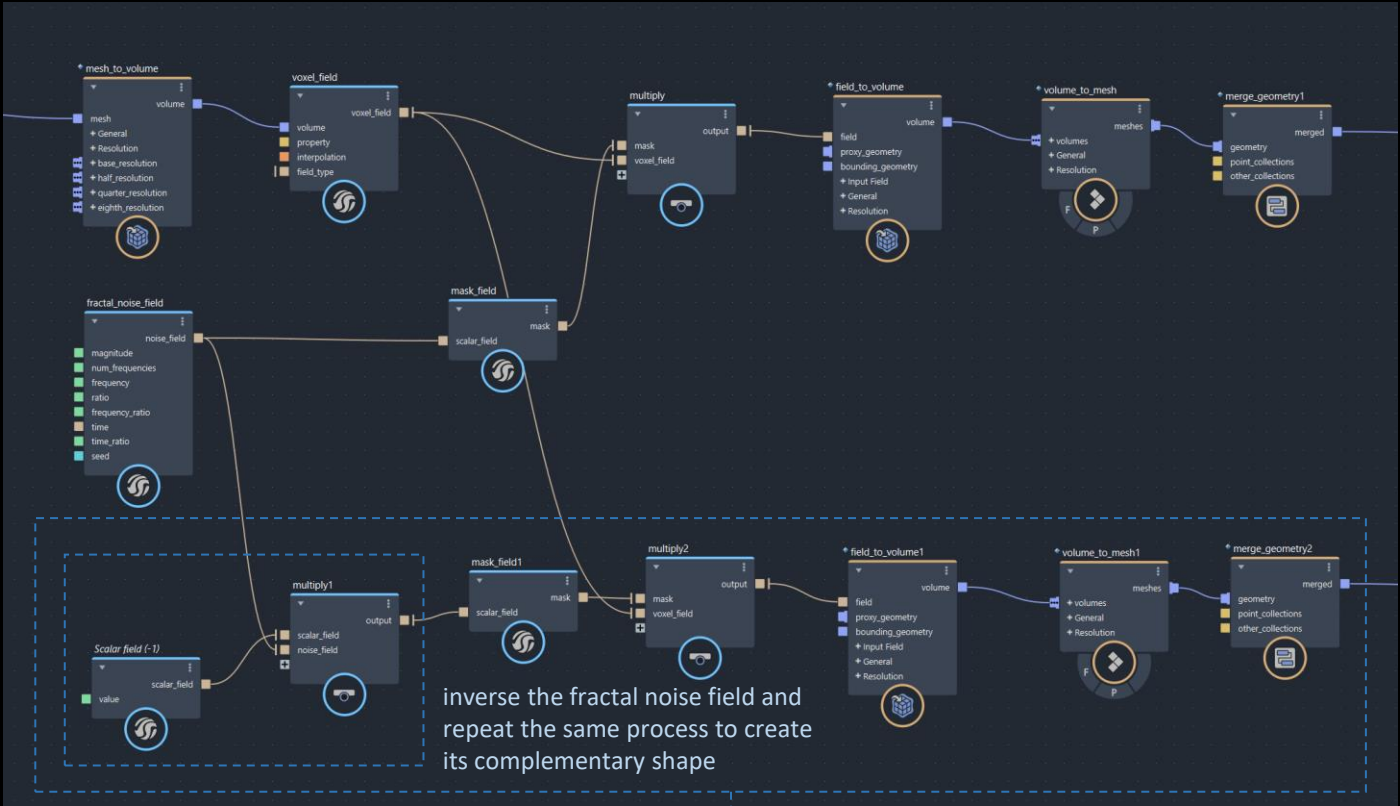
# Volume Basics

Field to Volume

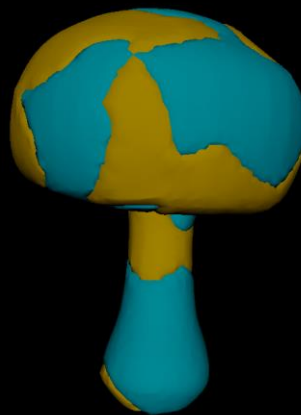
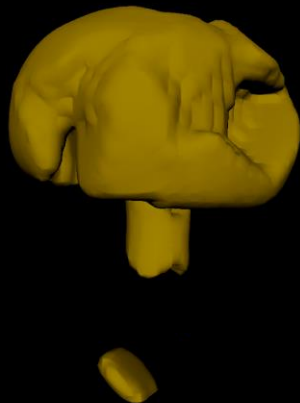






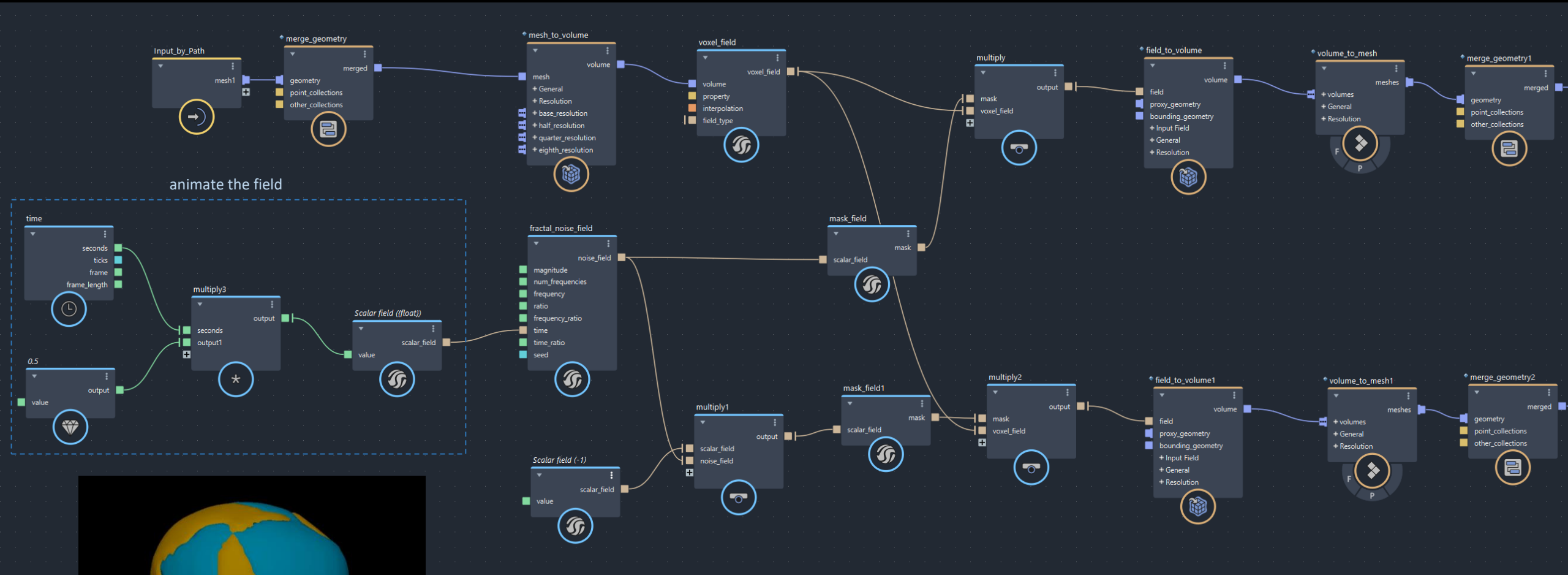


+



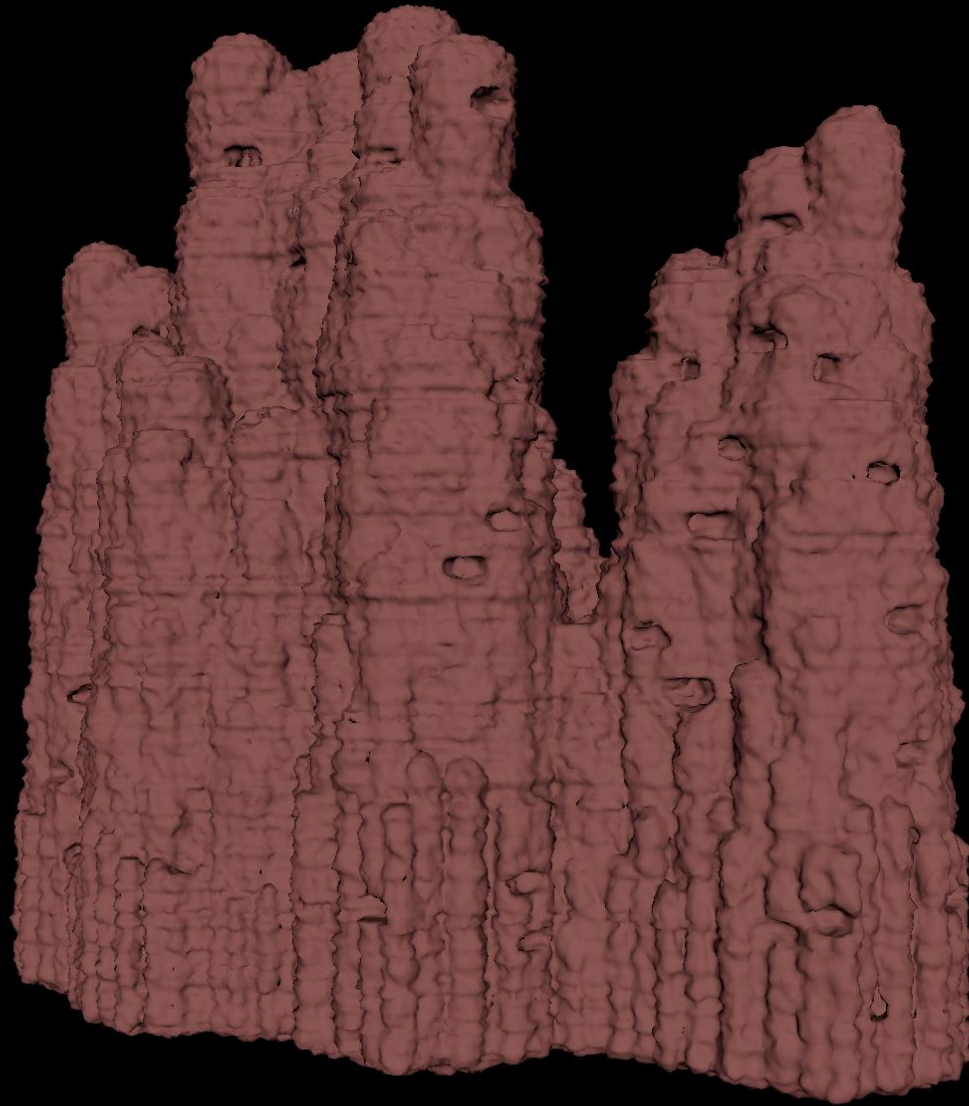
# Volume Basics

## Field to Volume

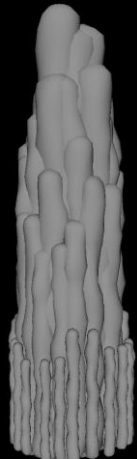
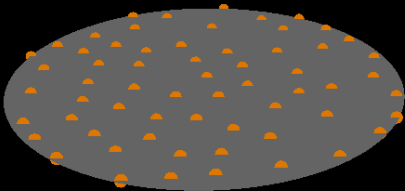
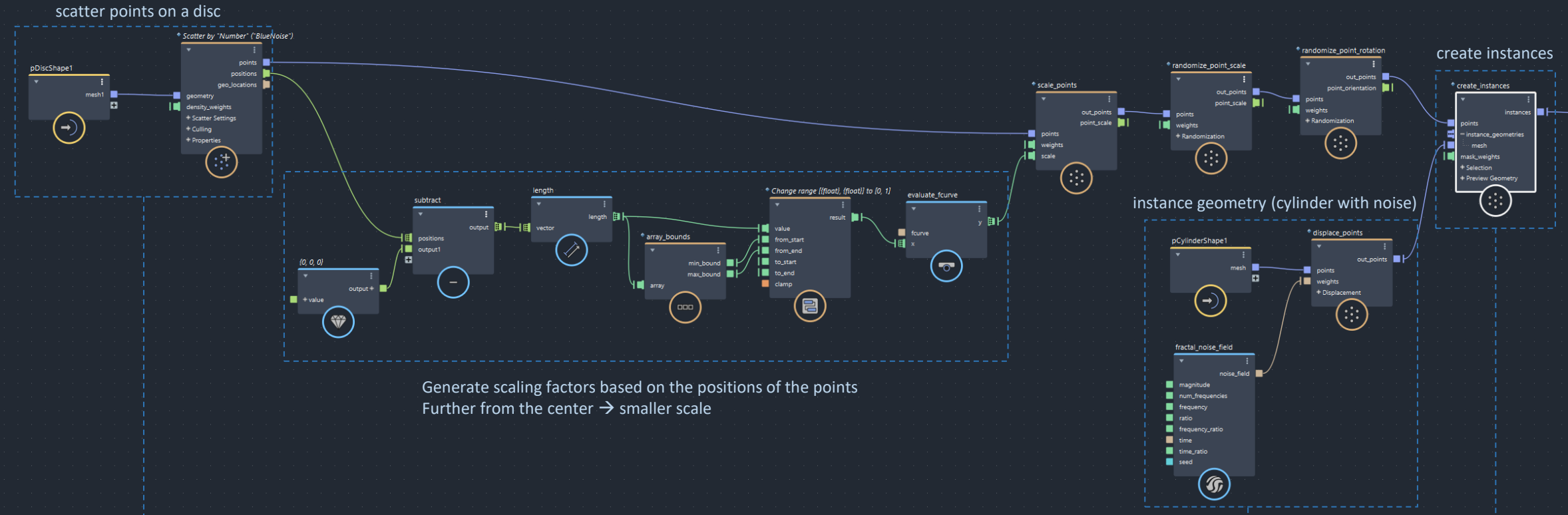




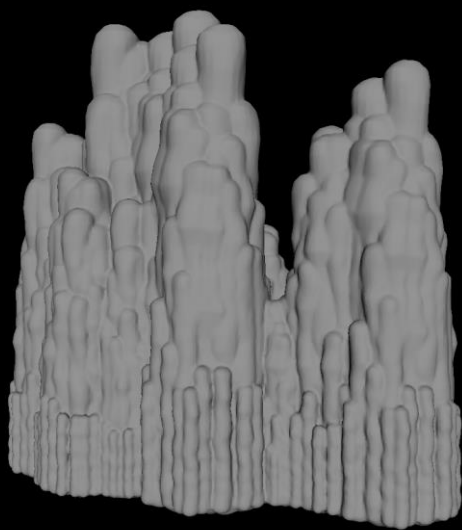
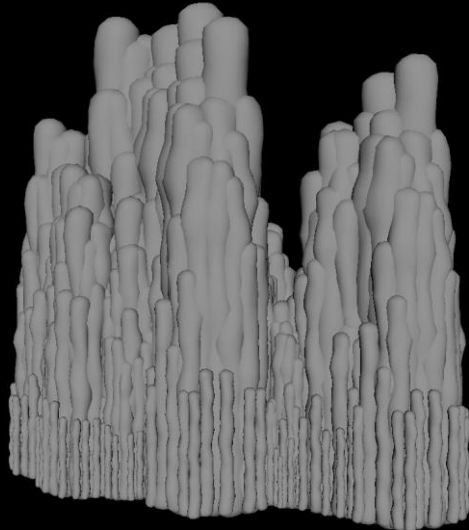
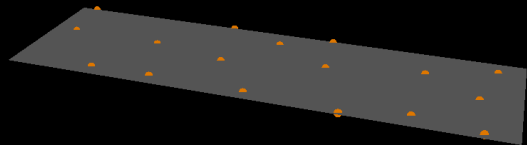
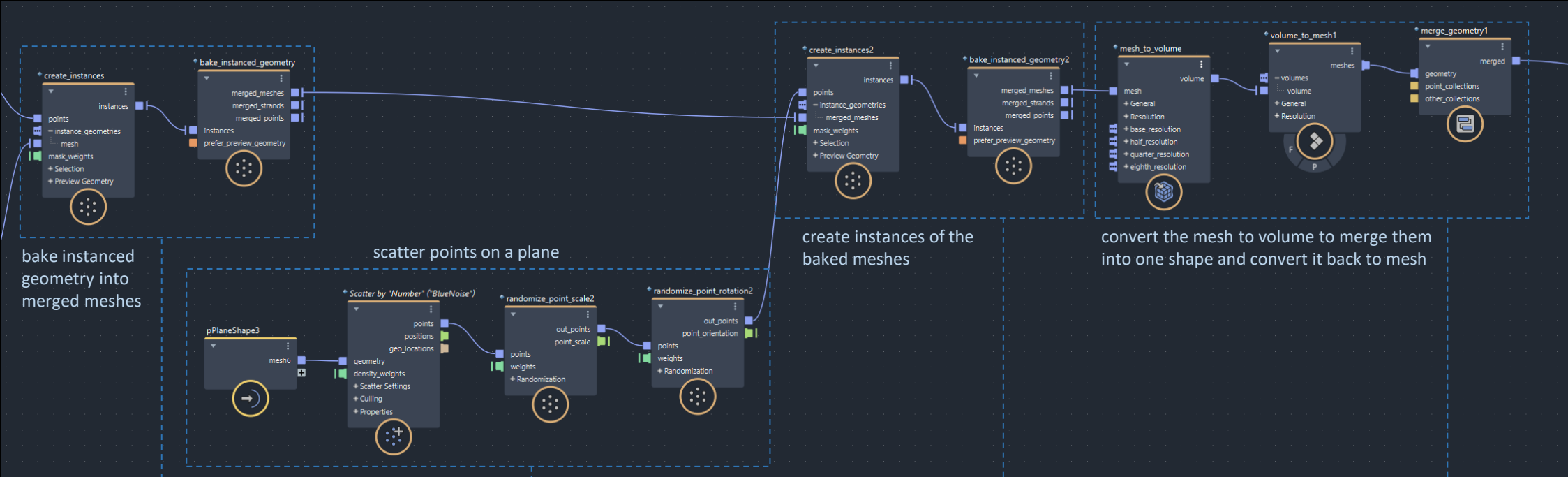
## Create Shapes and Details with Volumes



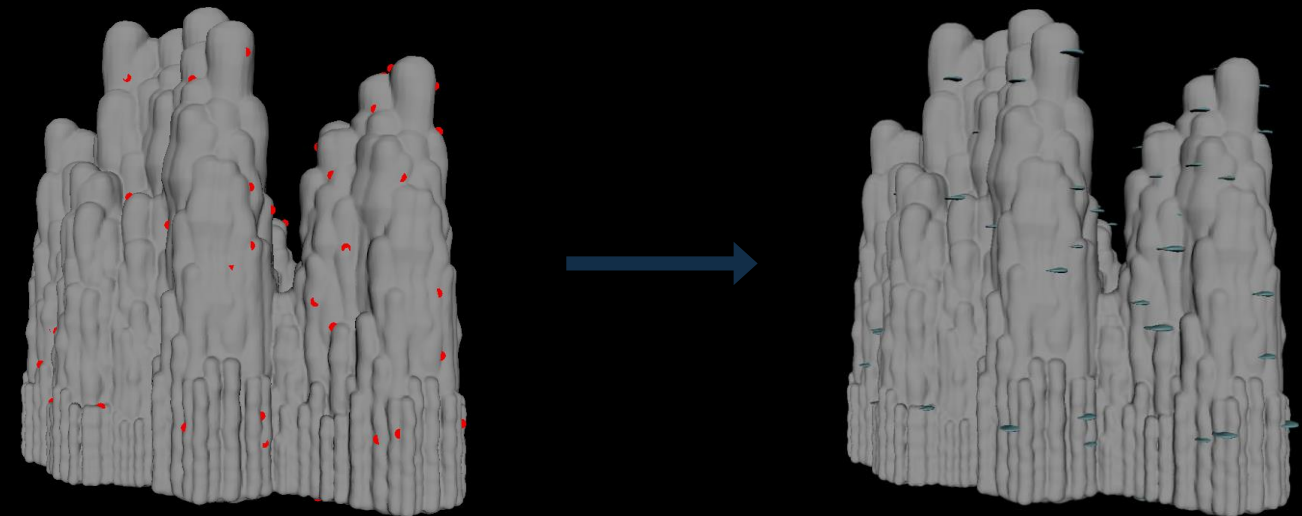
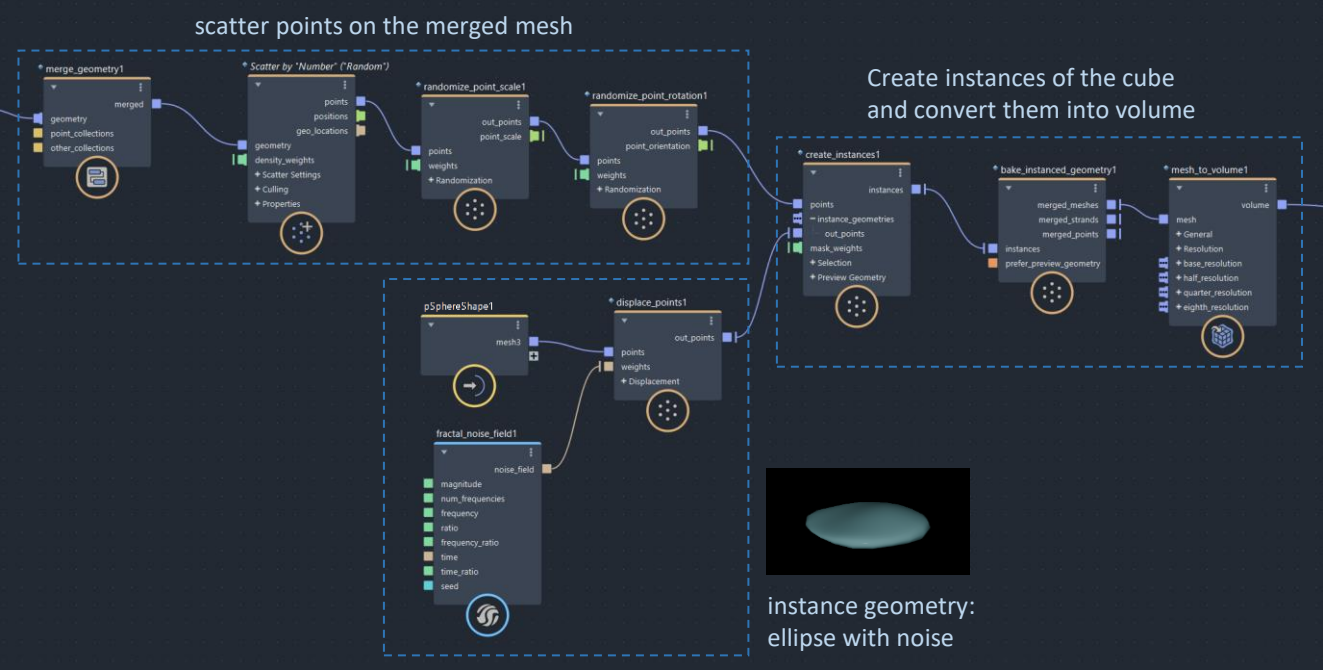
# Create Shapes and Textures with Volumes



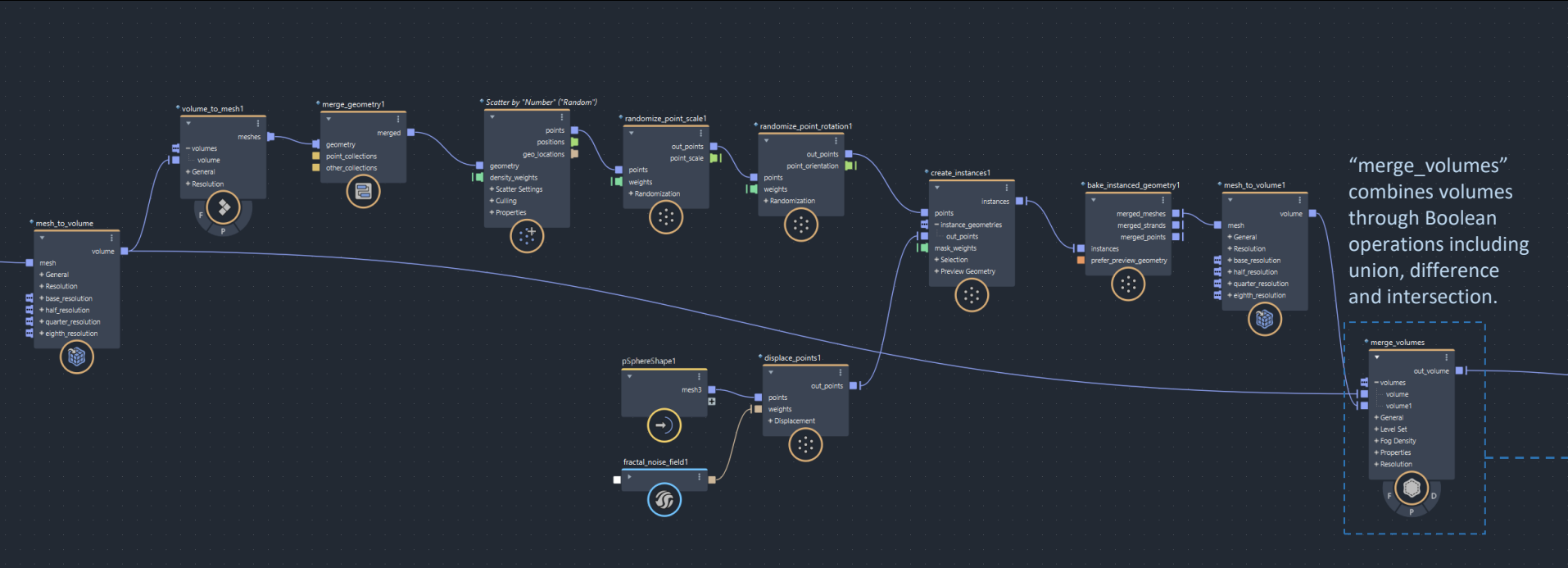
# Create Shapes and Details with Volumes



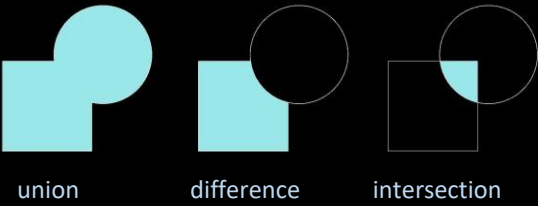
# Create Shapes and Details with Volumes



# Create Shapes and Details with Volumes



## Boolean Operations



**merge\_volumes**  
Type: merge\_volumes

**General**

Enable☒

Invert Order☐

**Level Set**

Level Set ModeDifference

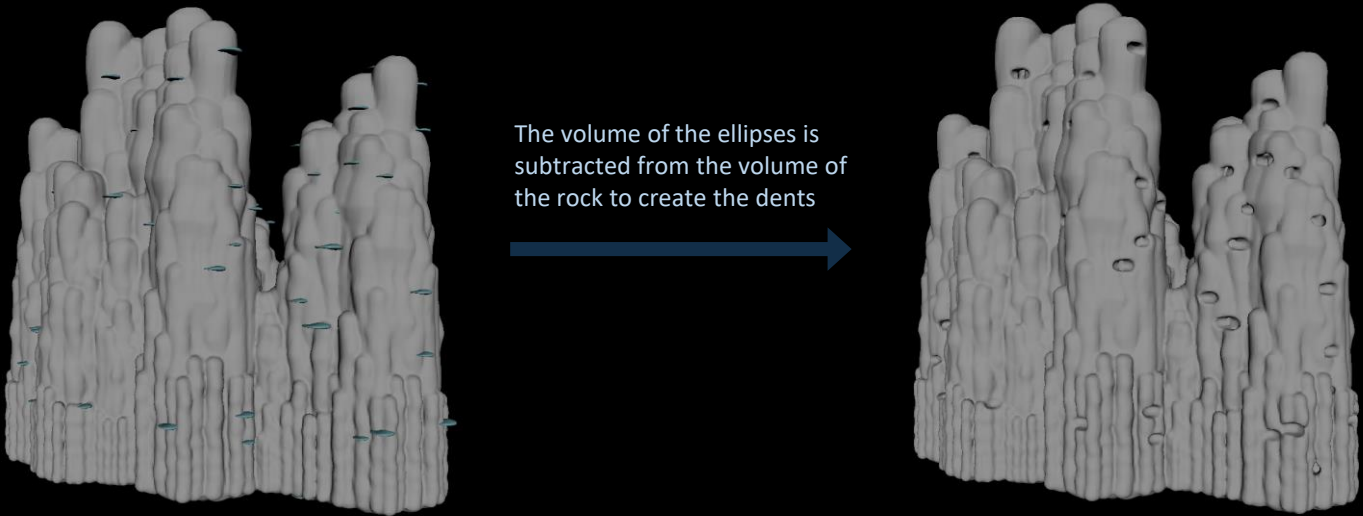
**Fog Density**

Fog Density ModeAdd

Alpha0

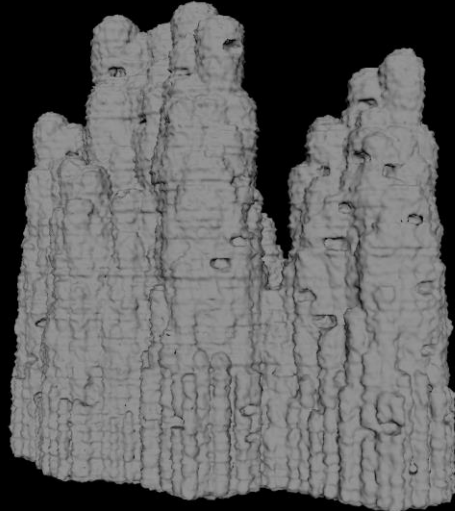
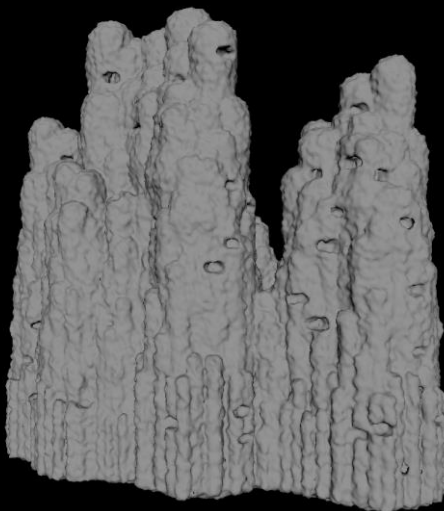
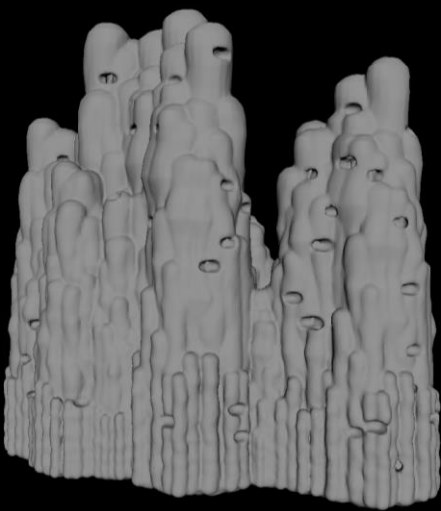
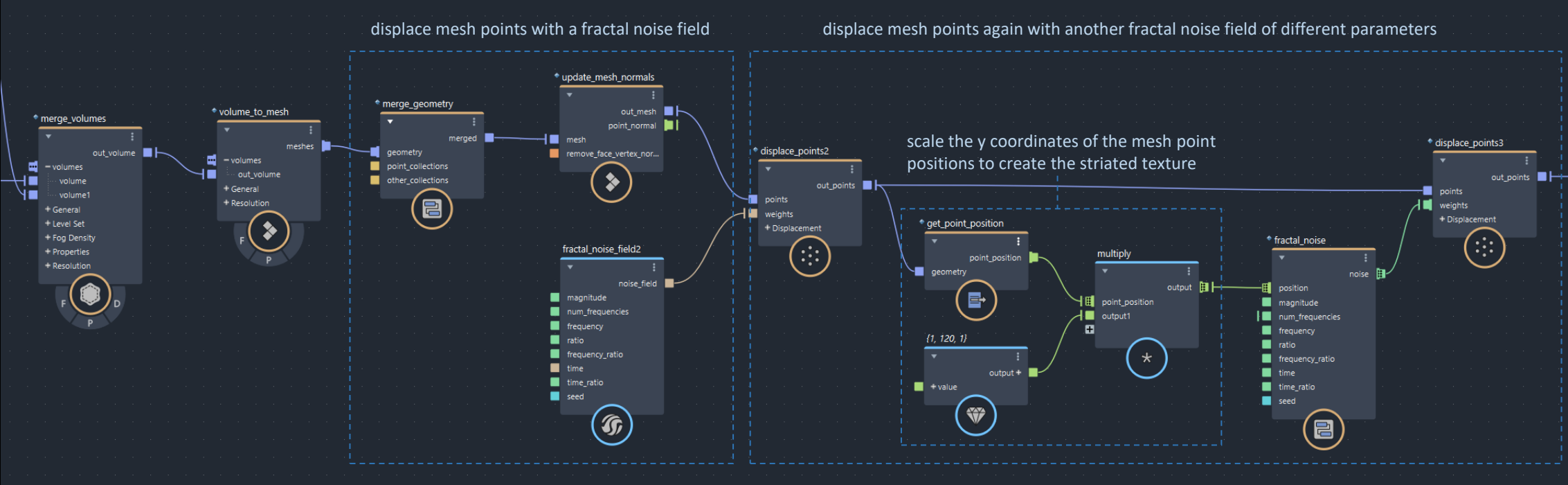
**Properties**

Properties ModeAutomatic





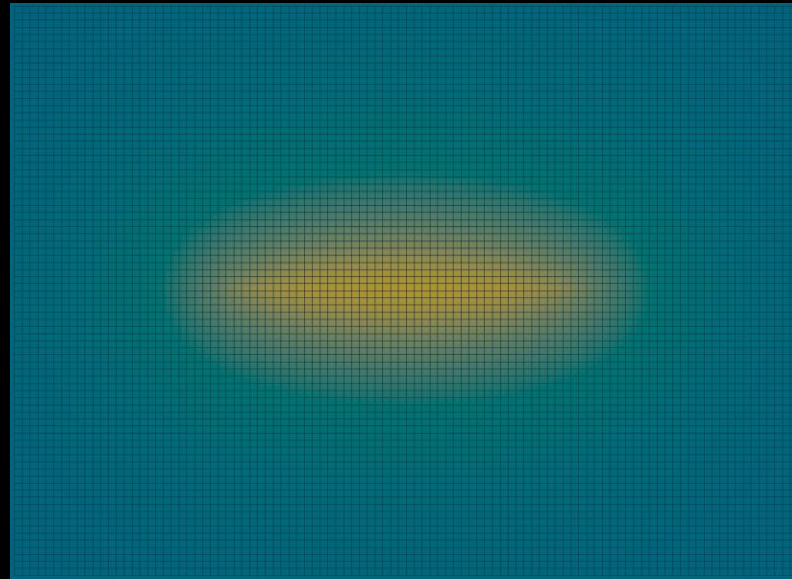
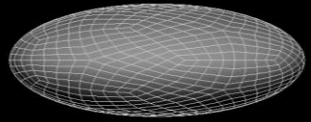
# Create Shapes and Details with Volumes



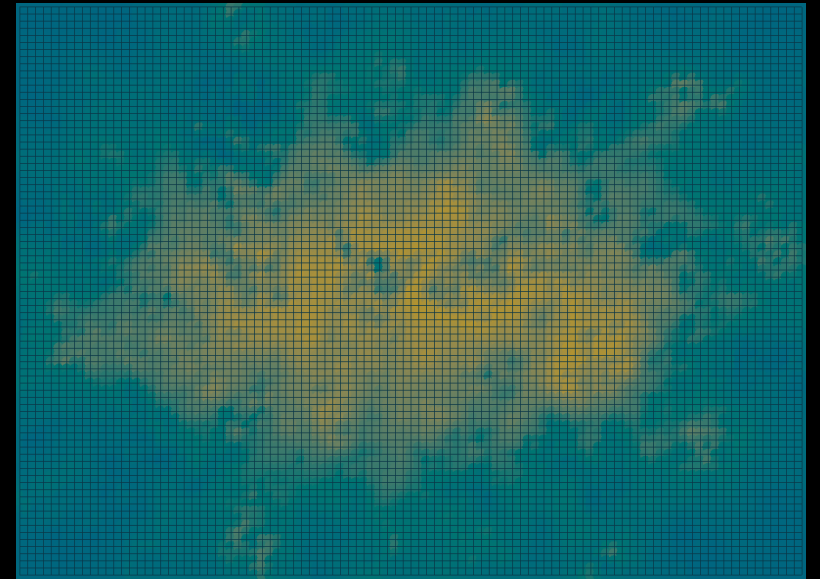
Advection



# Advection



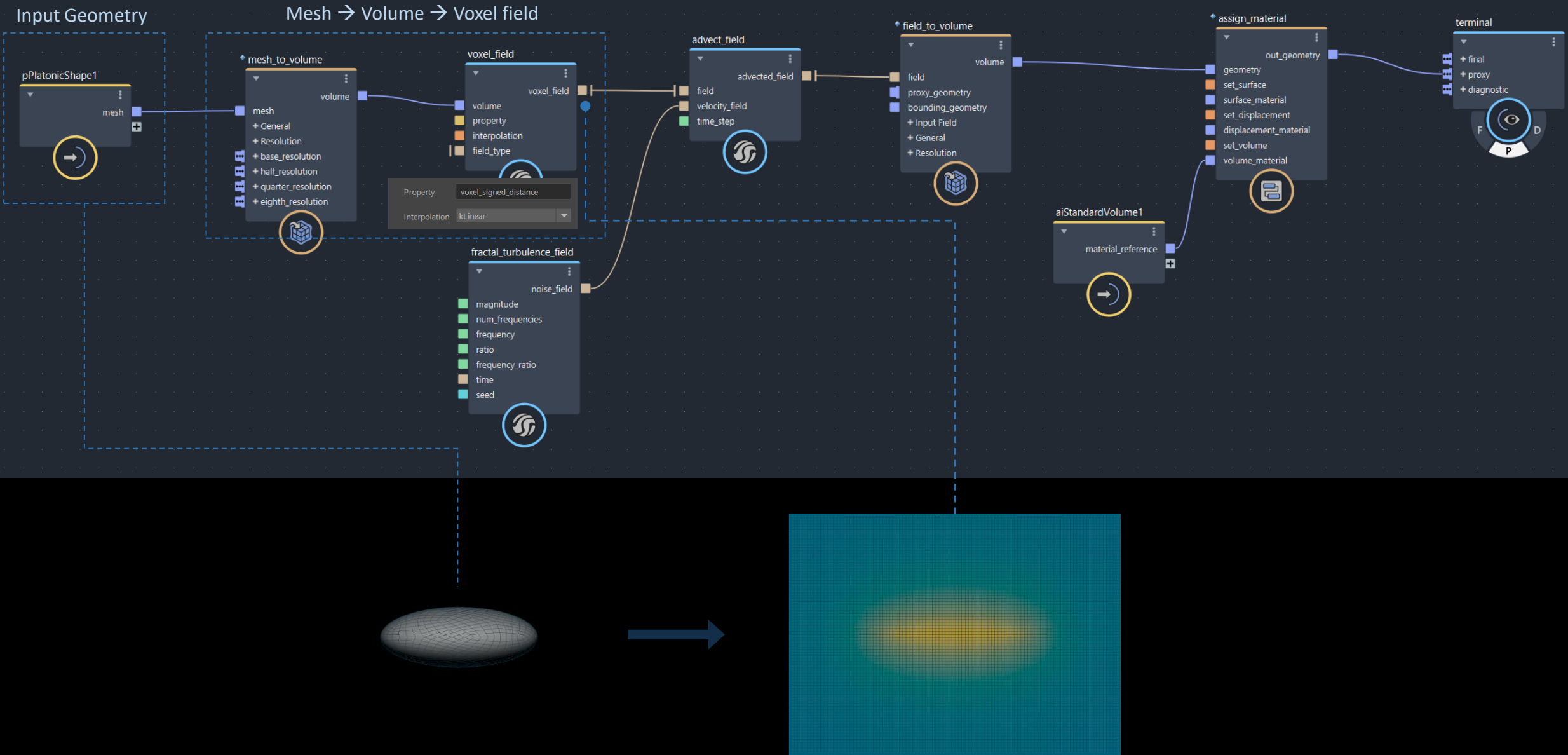
Voxel field



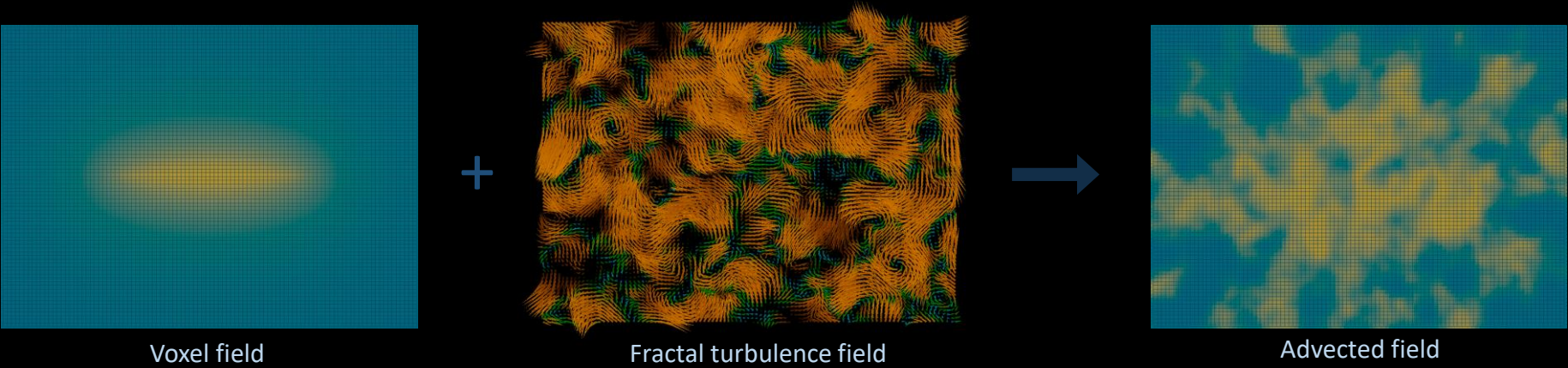
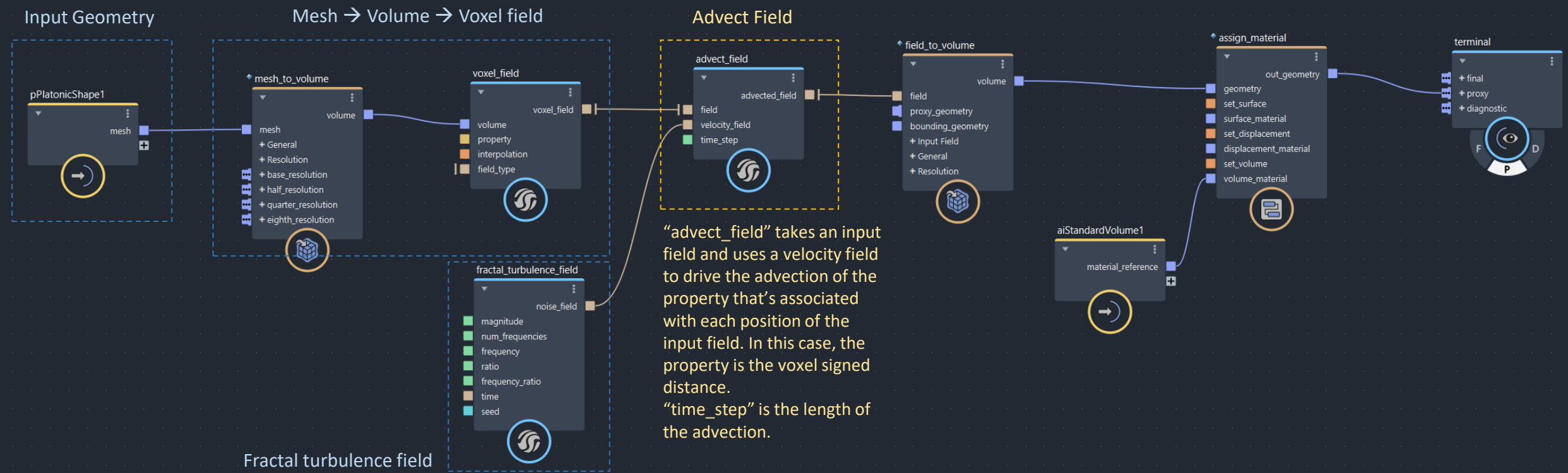
Advected field



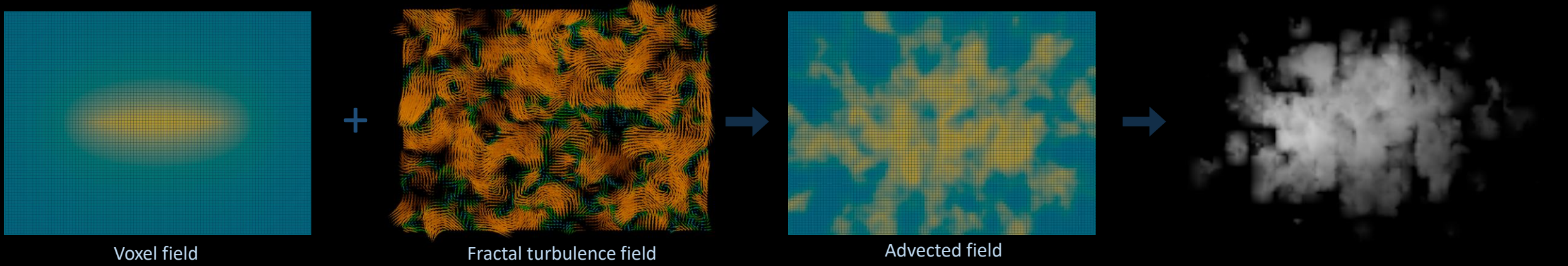
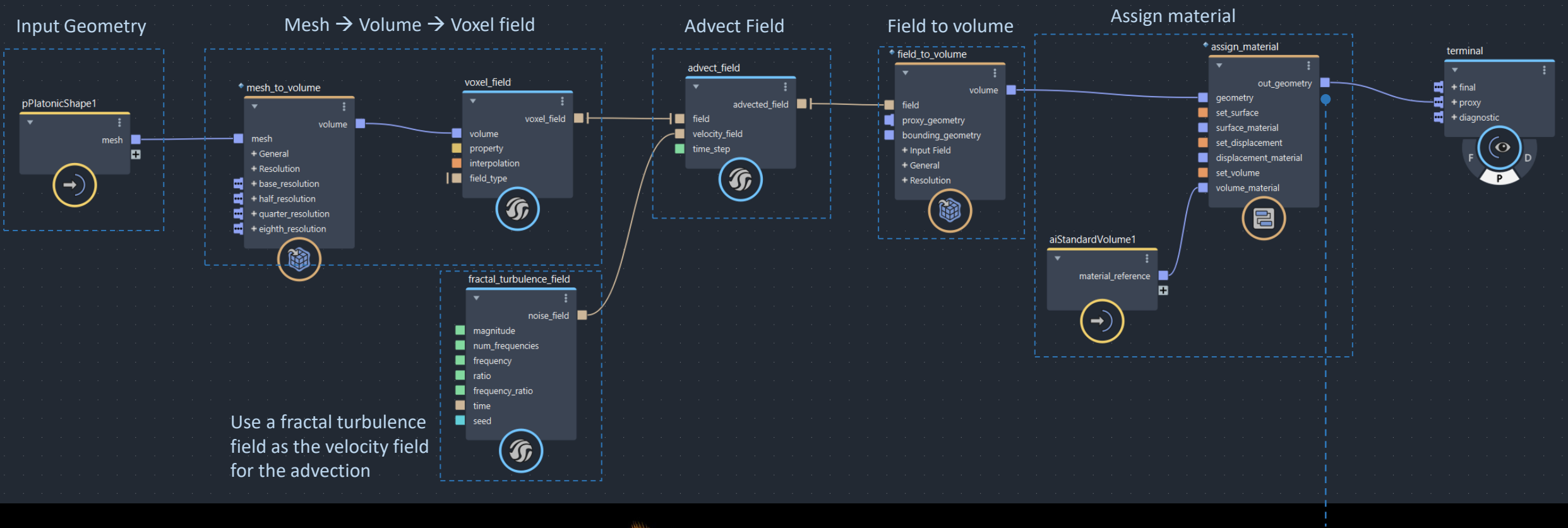
# Advection



# Advection

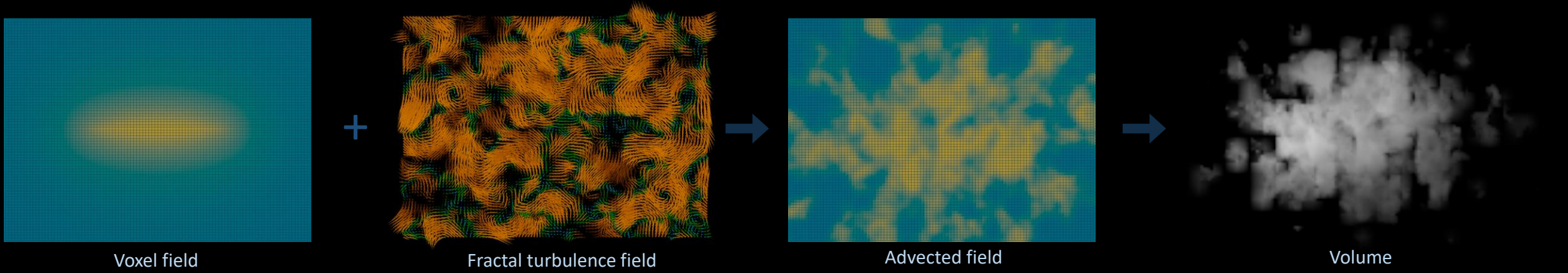
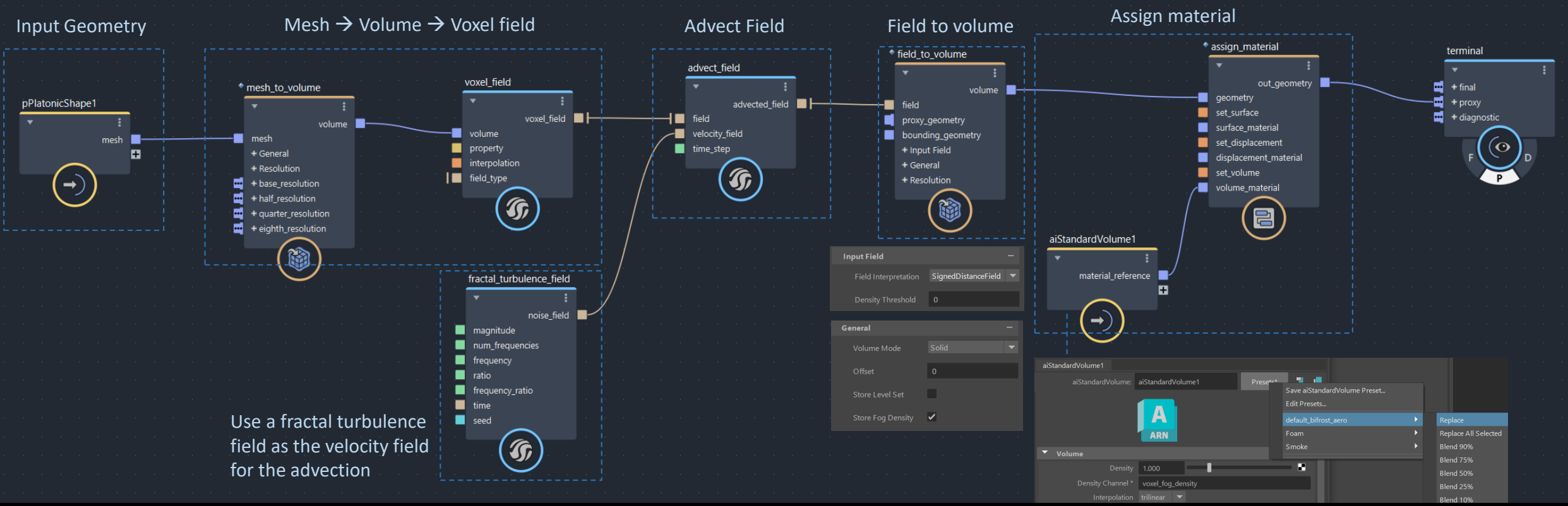


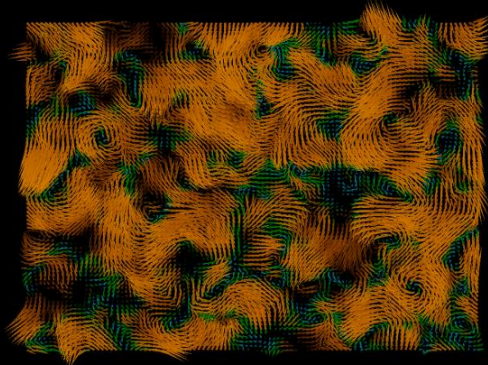
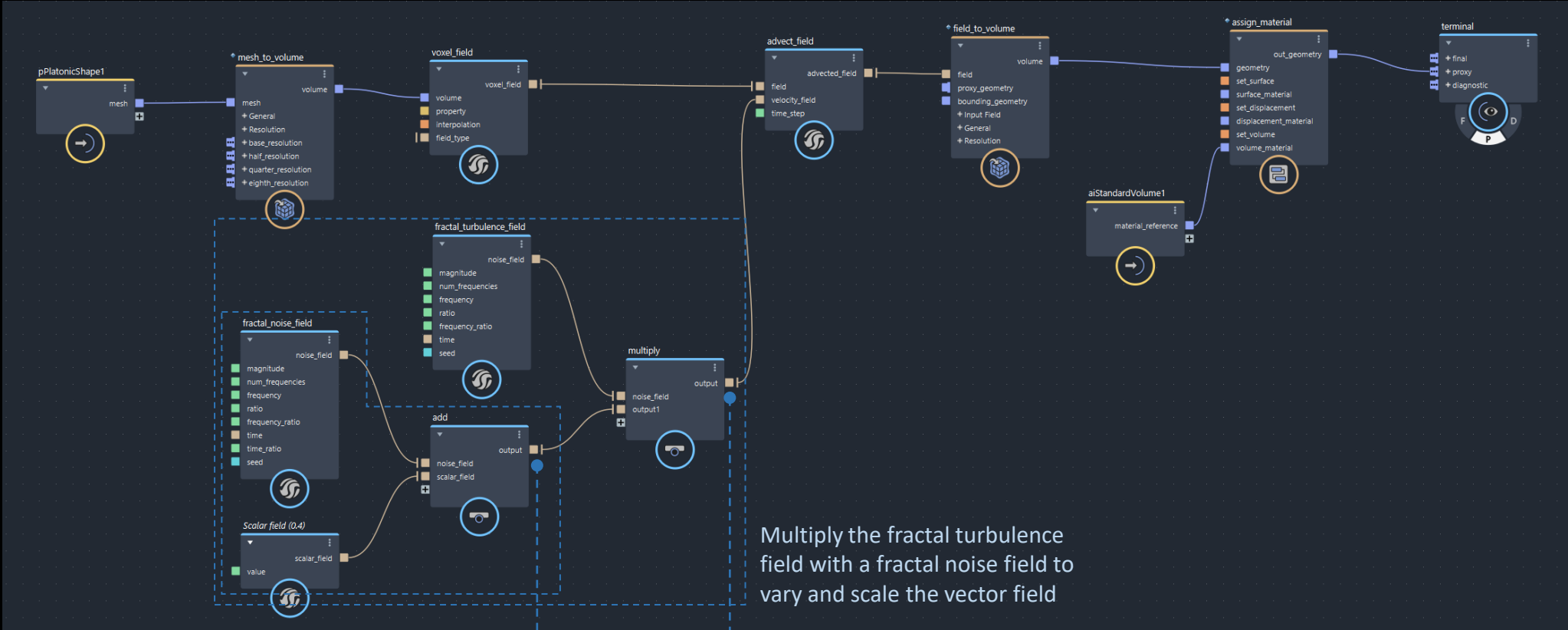
# Advection



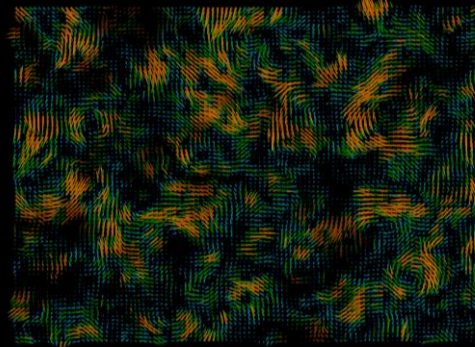
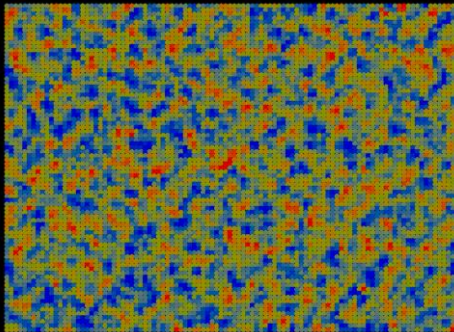


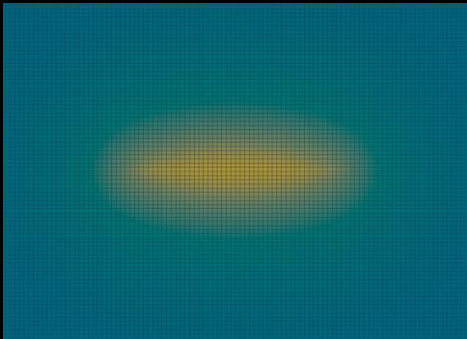
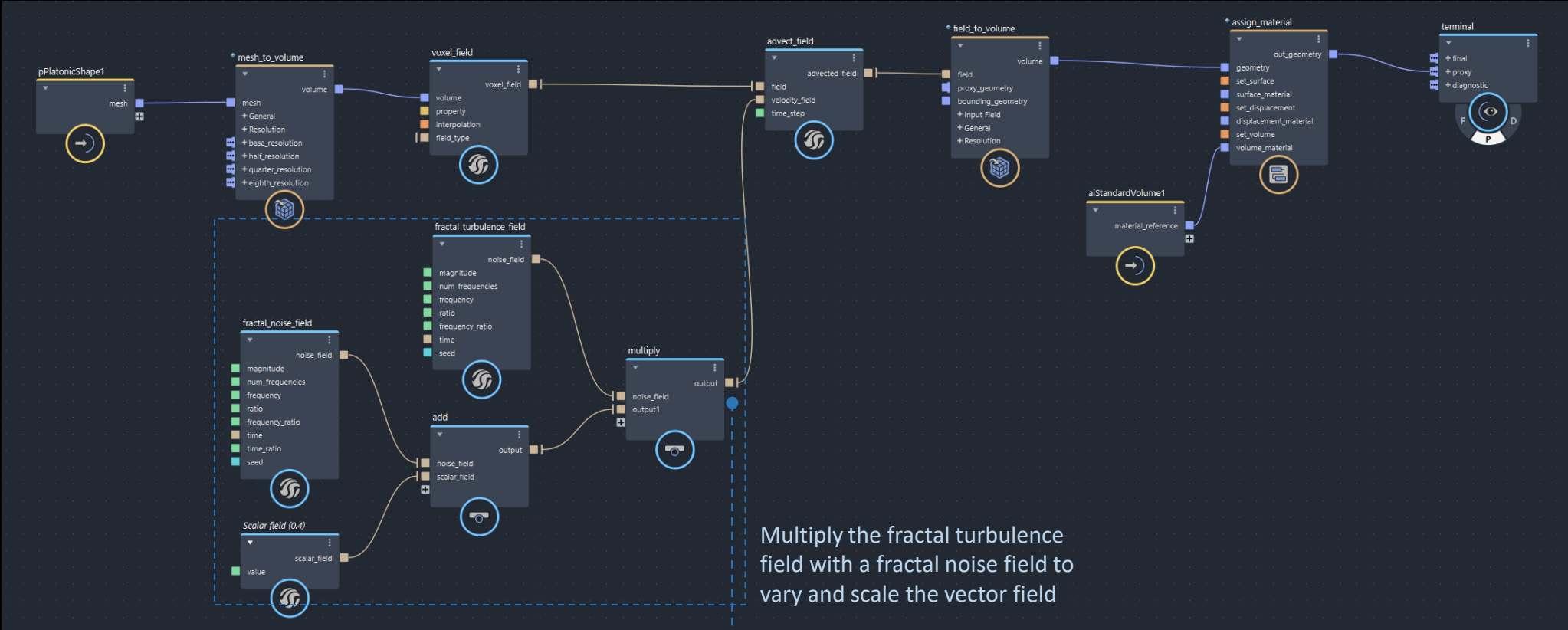
# Advection





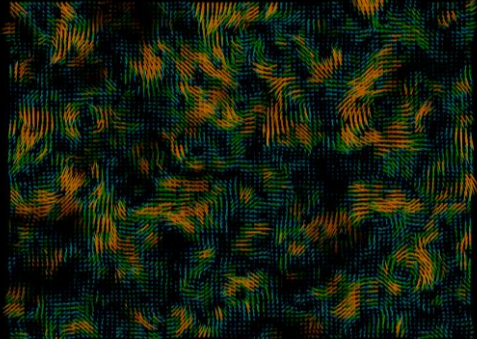
X



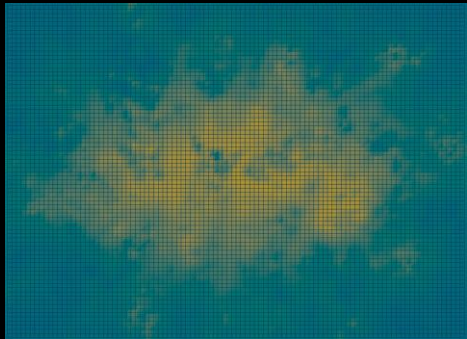


Voxel field

+



Velocity field

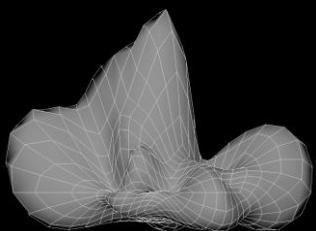
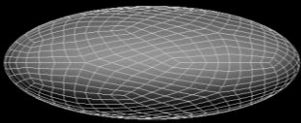
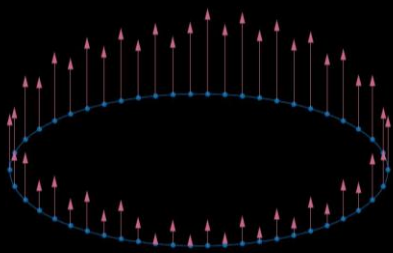
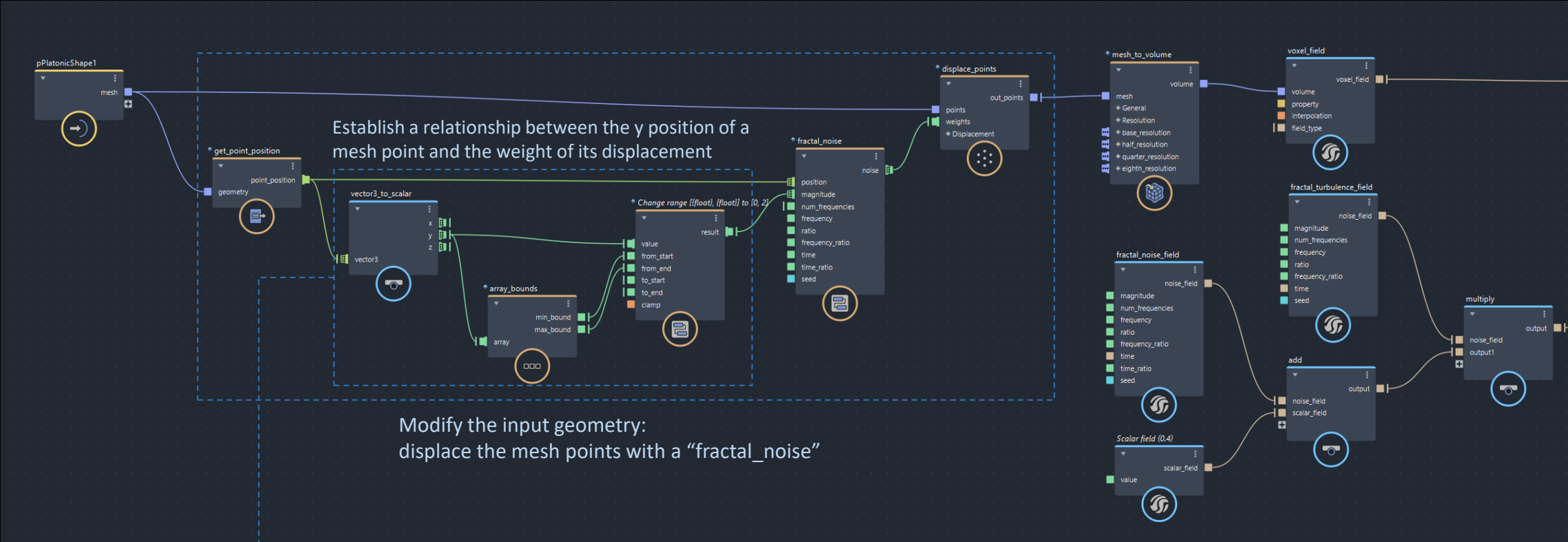


Advected field



Volume

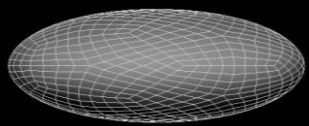
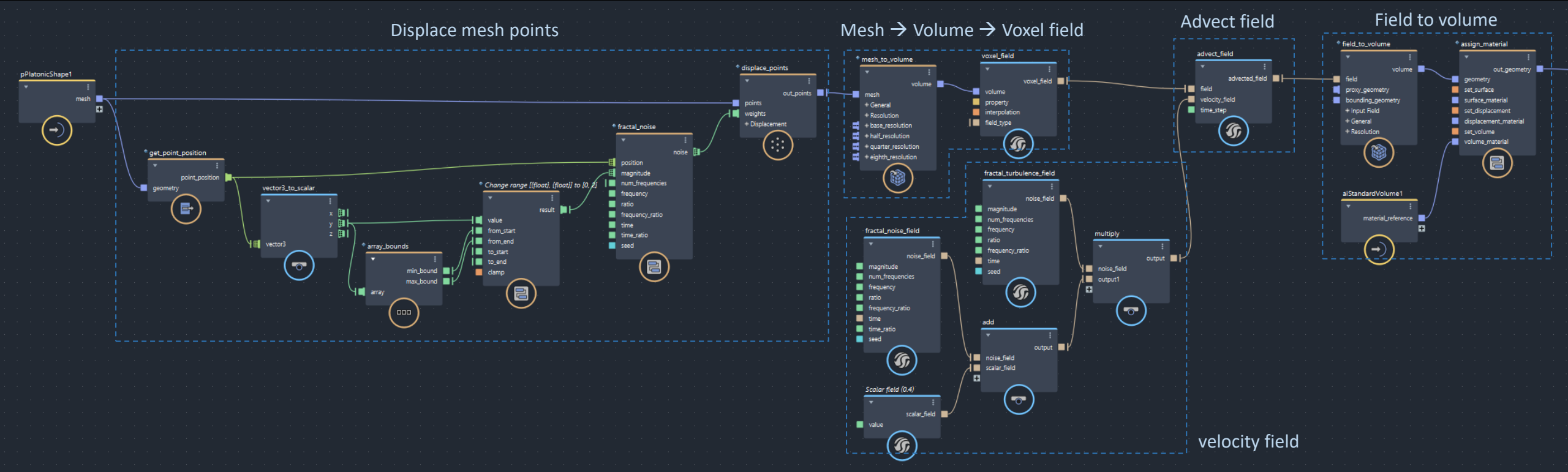




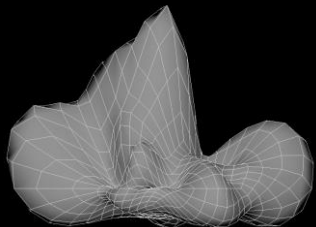
Displace the points to better depict the shape of the cloud (the bottom of a cloud is usually flatter than the top): Higher y value → more displacement

# Advection

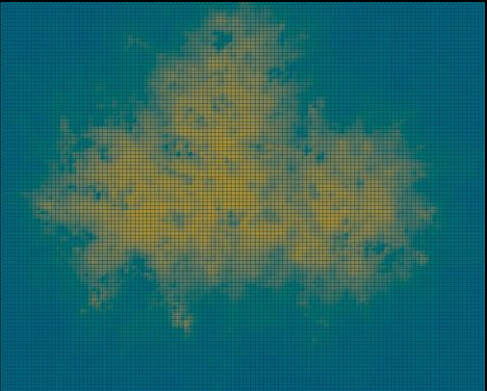
Adjust parameters



Input mesh



displaced mesh



Advected field

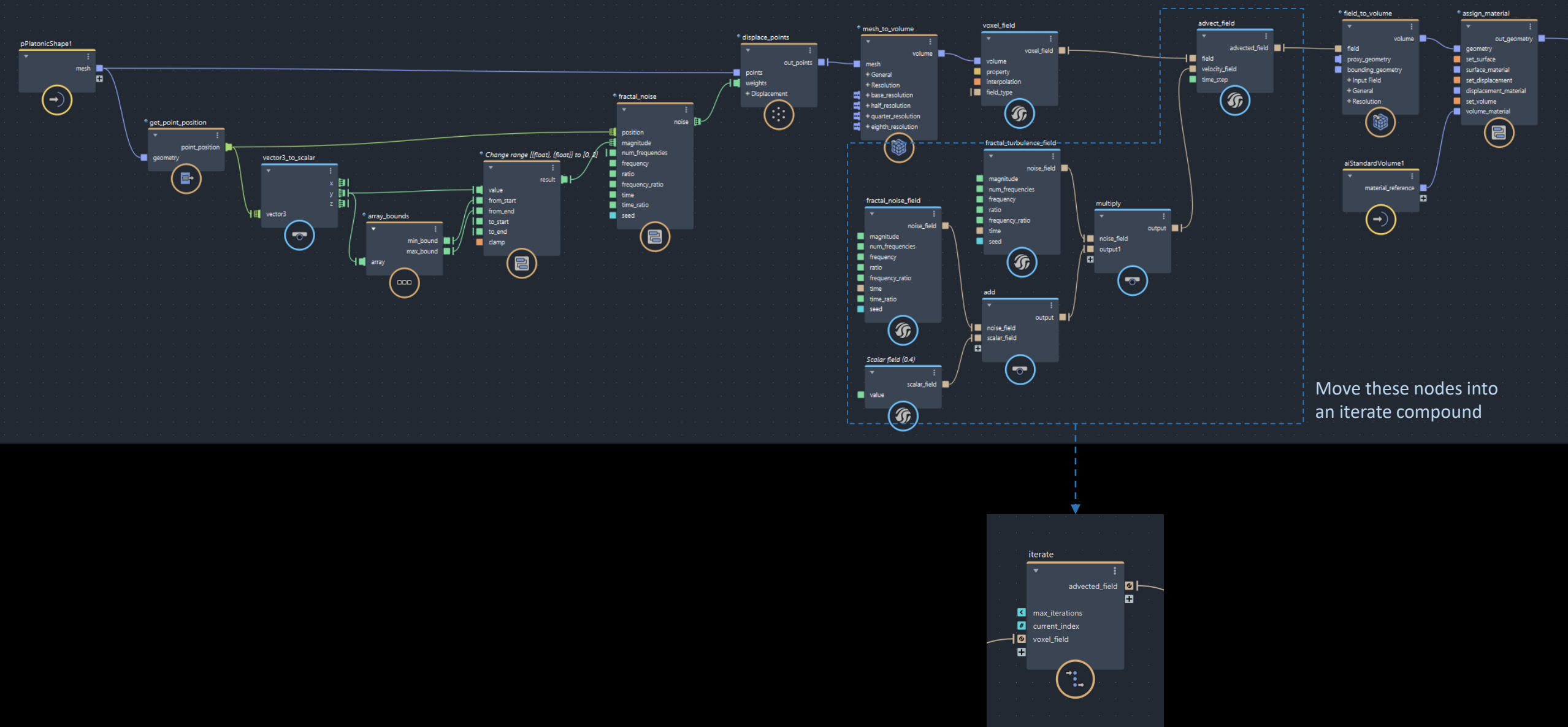


volume



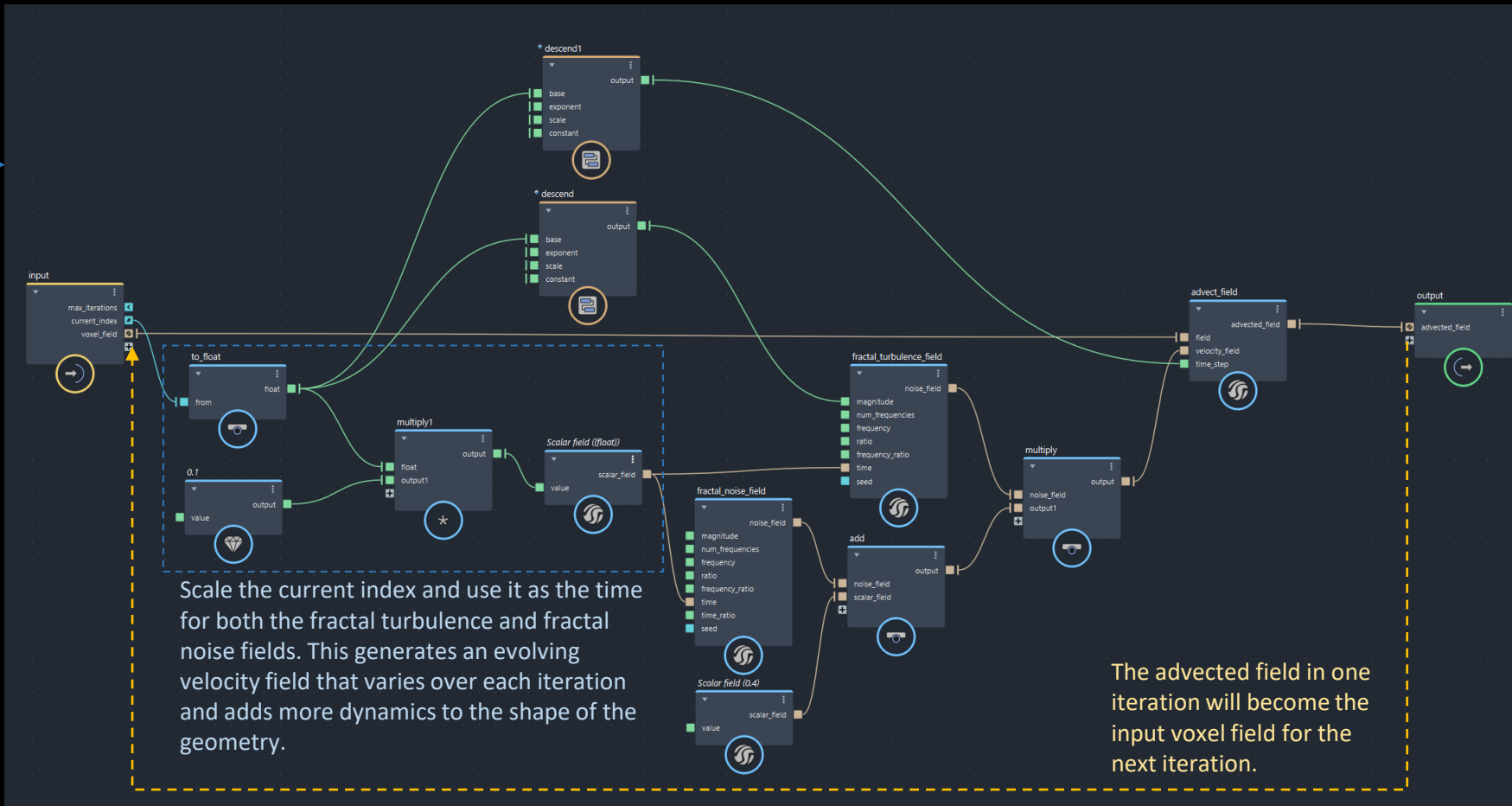
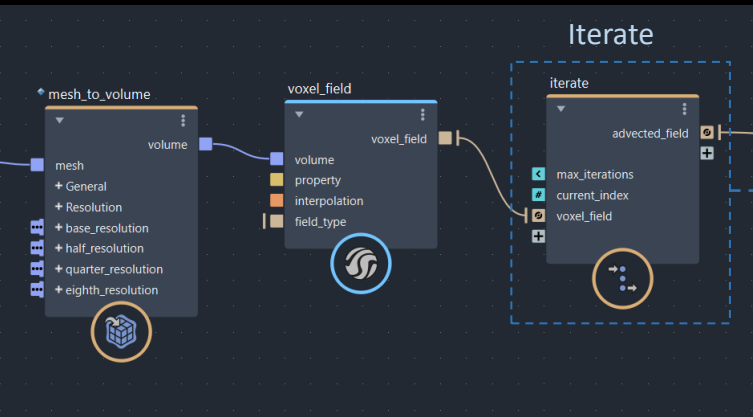
# Advection

# Iterative advection



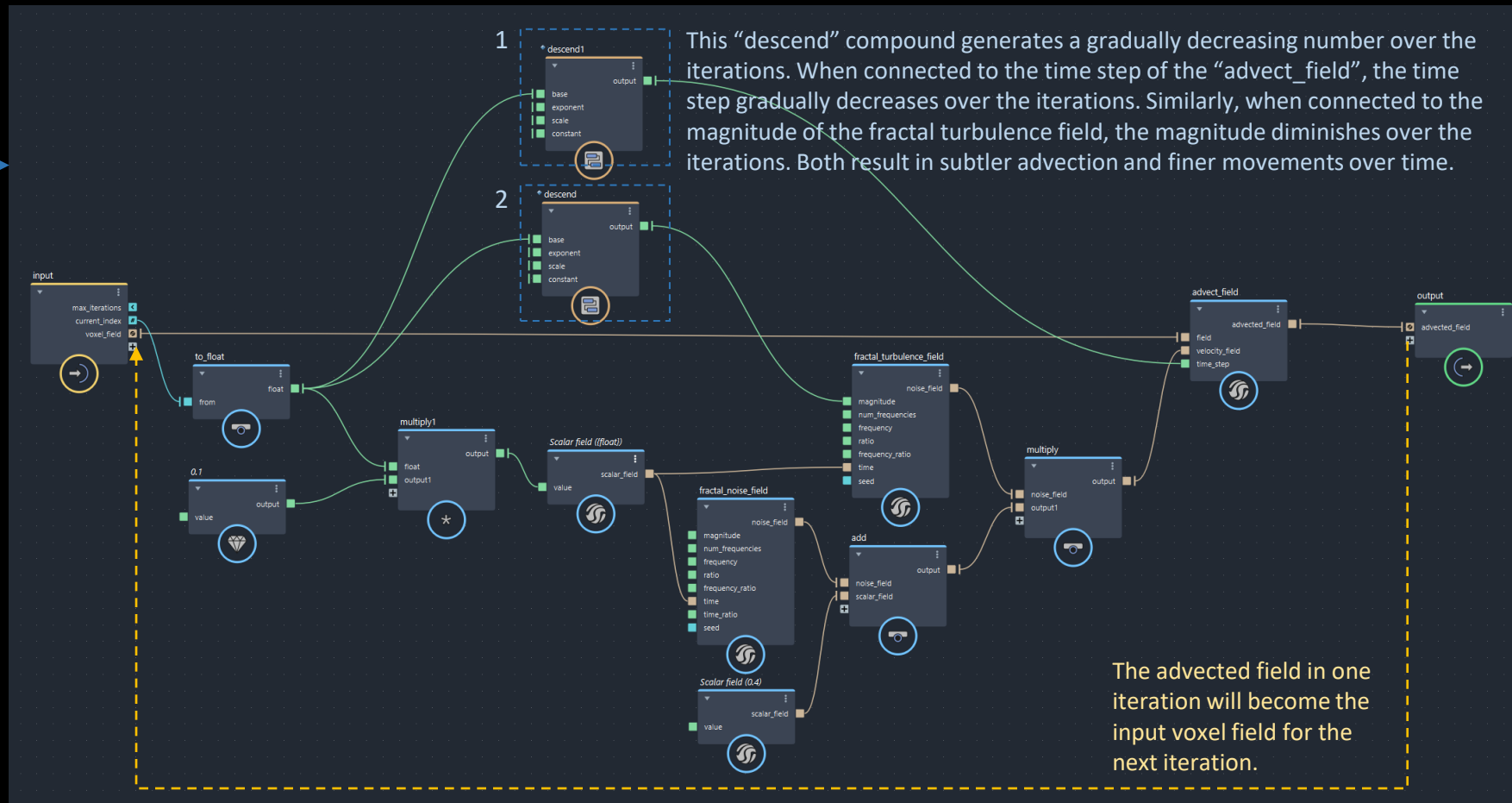
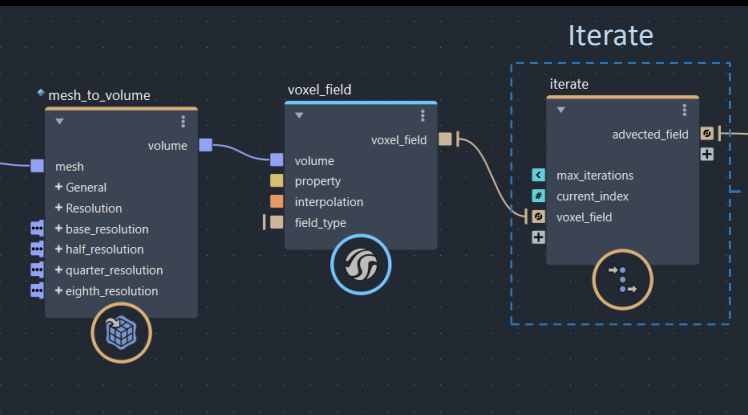
# Advection

# Iterative advection



# Advection

## Iterative advection



$$f(x) = \frac{2.5}{x^2 + 1}$$

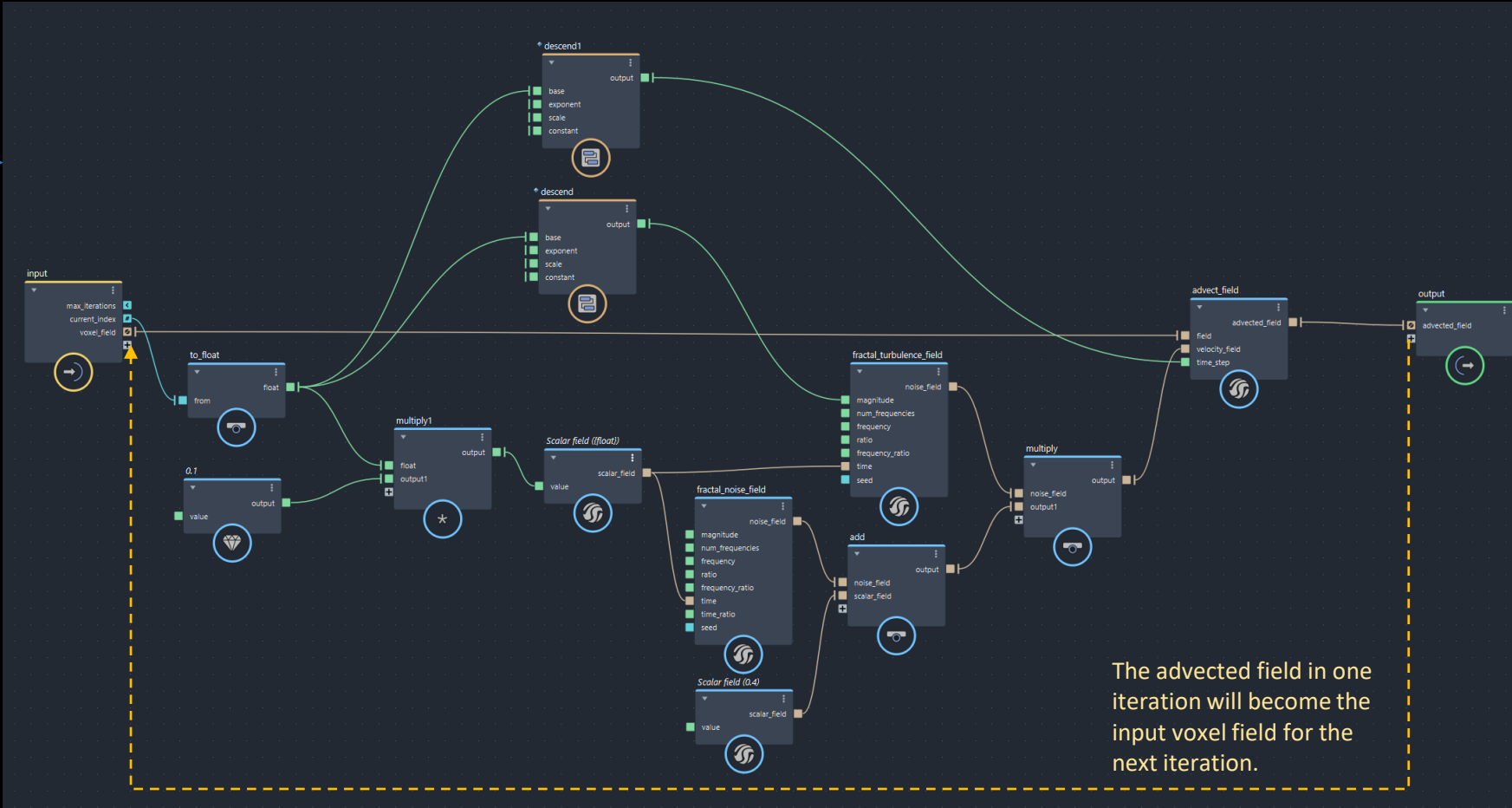
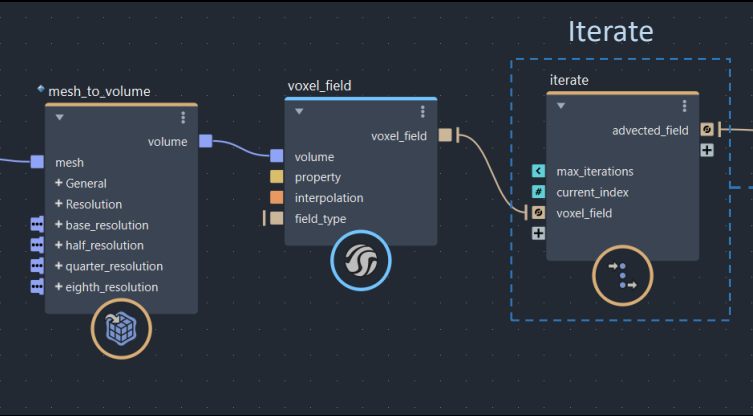


$$f(x) = \frac{1}{x^3 + 1.3}$$



# Advection

# Iterative advection

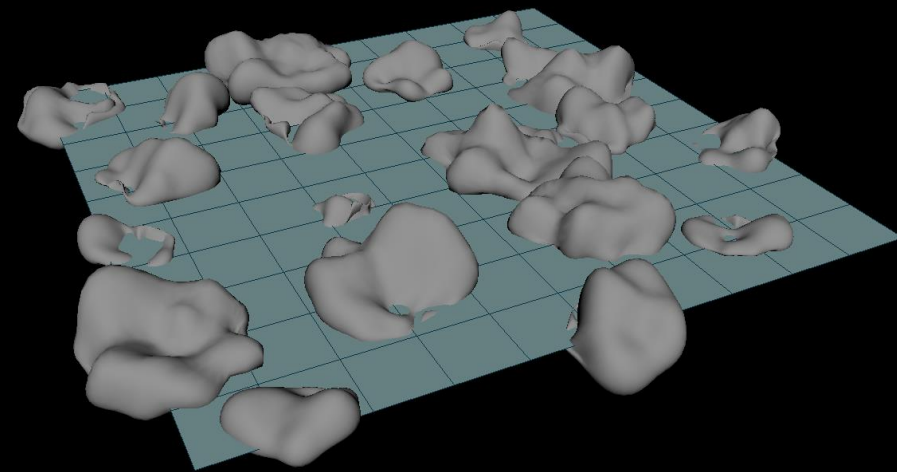
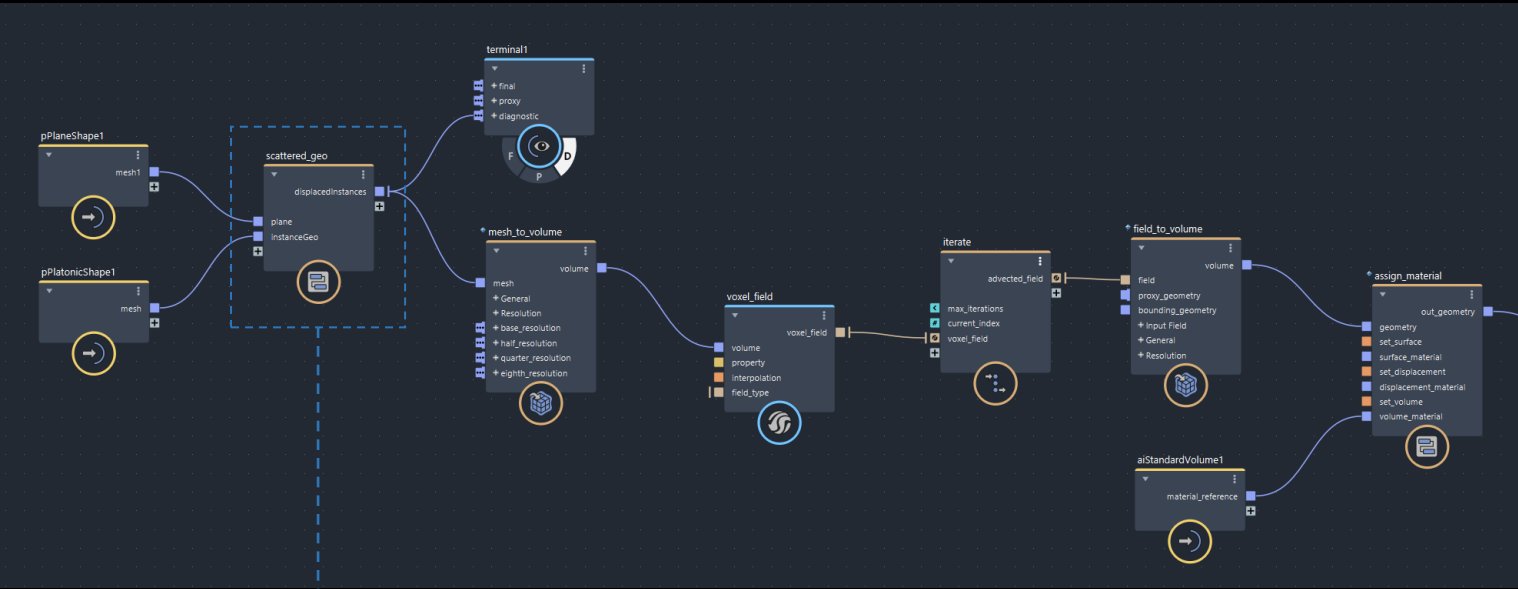


Iteration 1

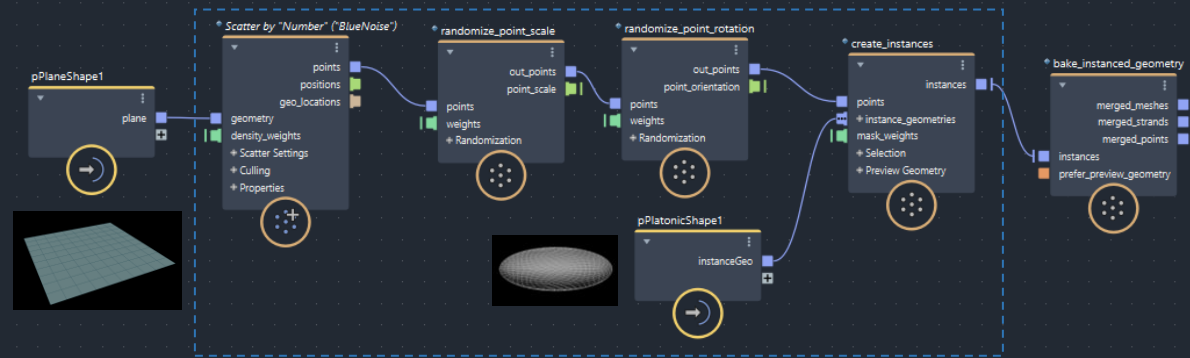
Iteration 5

# Advection

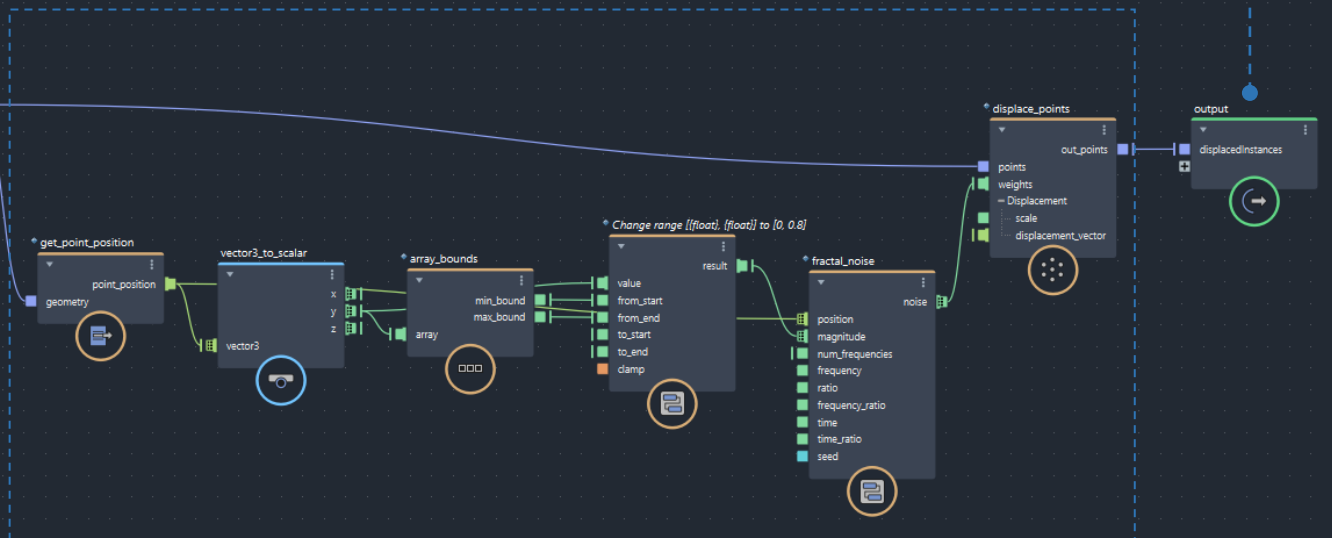
# Scattered clouds



## Scatter points on a plane and create instances of the input geometry



## Displace points



# Advection

Scattered clouds

