



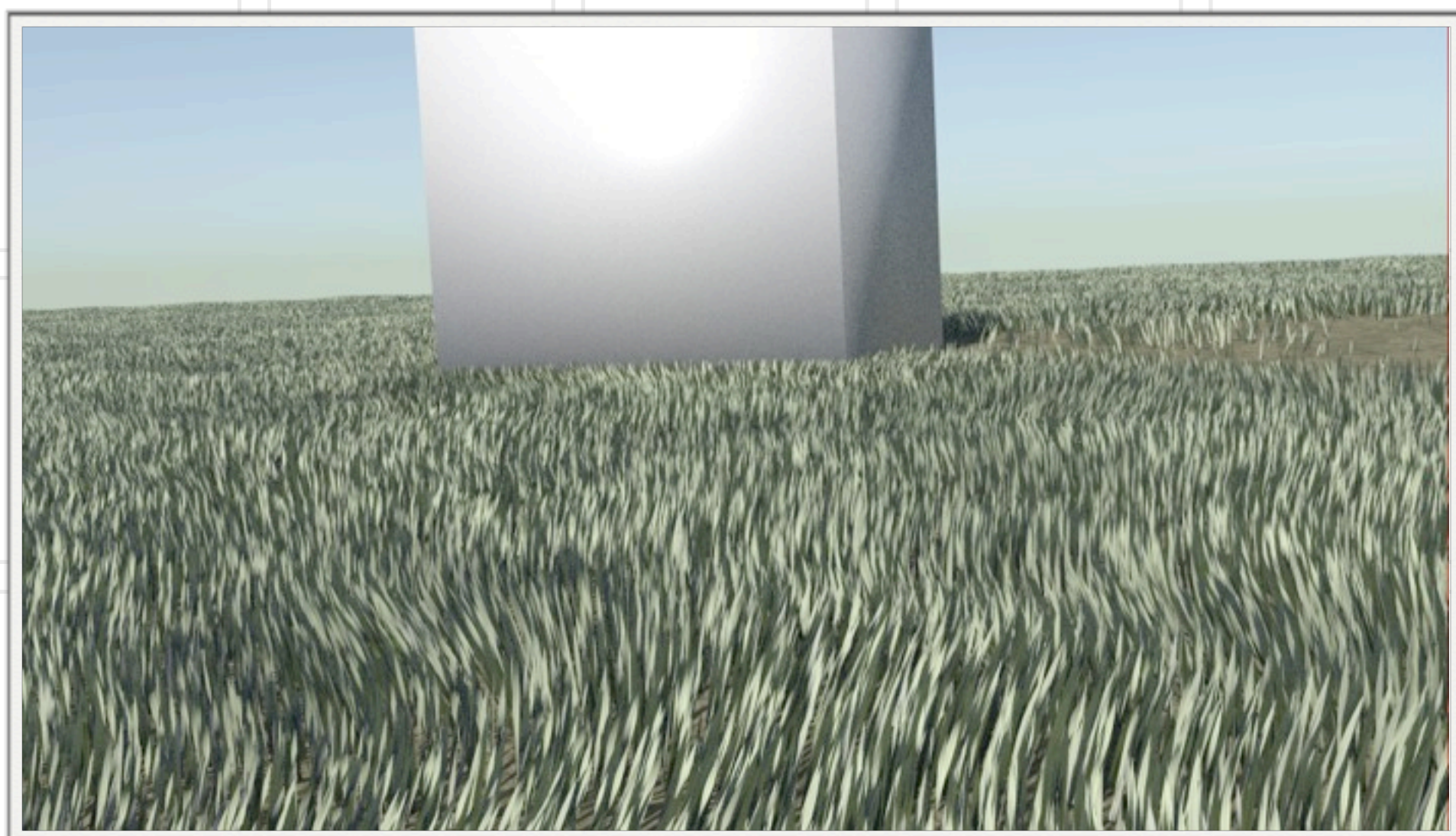
Next Steps: Houdini Procedural Modeling

M05: Grass - Building and Rendering Curves

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Goal of this Module



- ▶ Learn how to add attributes to a curve
- ▶ Remember that in Mantra you can render curves
- ▶ Once the attributes are created
 - ▶ How do we make shaping tools for the grass blade
- ▶ Create a two sided shader for the grass
 - ▶ Includes color information
 - ▶ Includes Displacement information

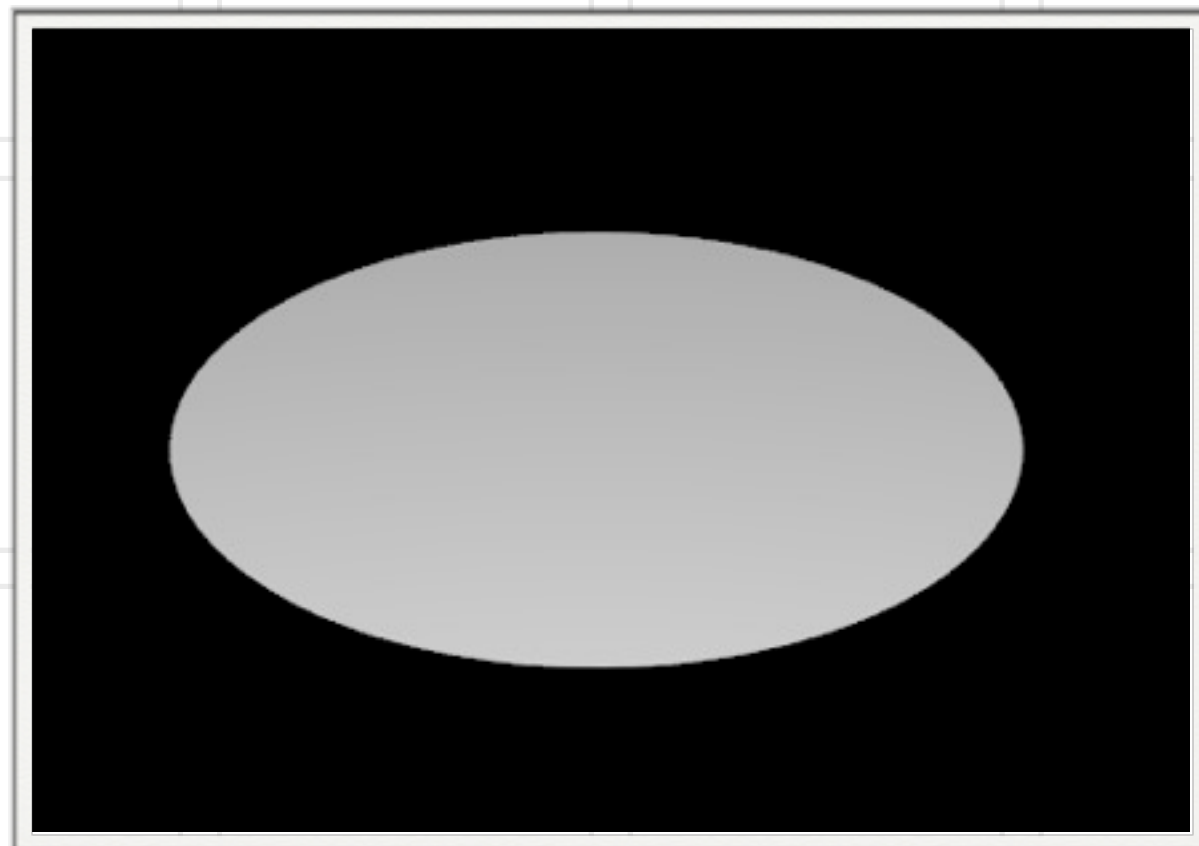
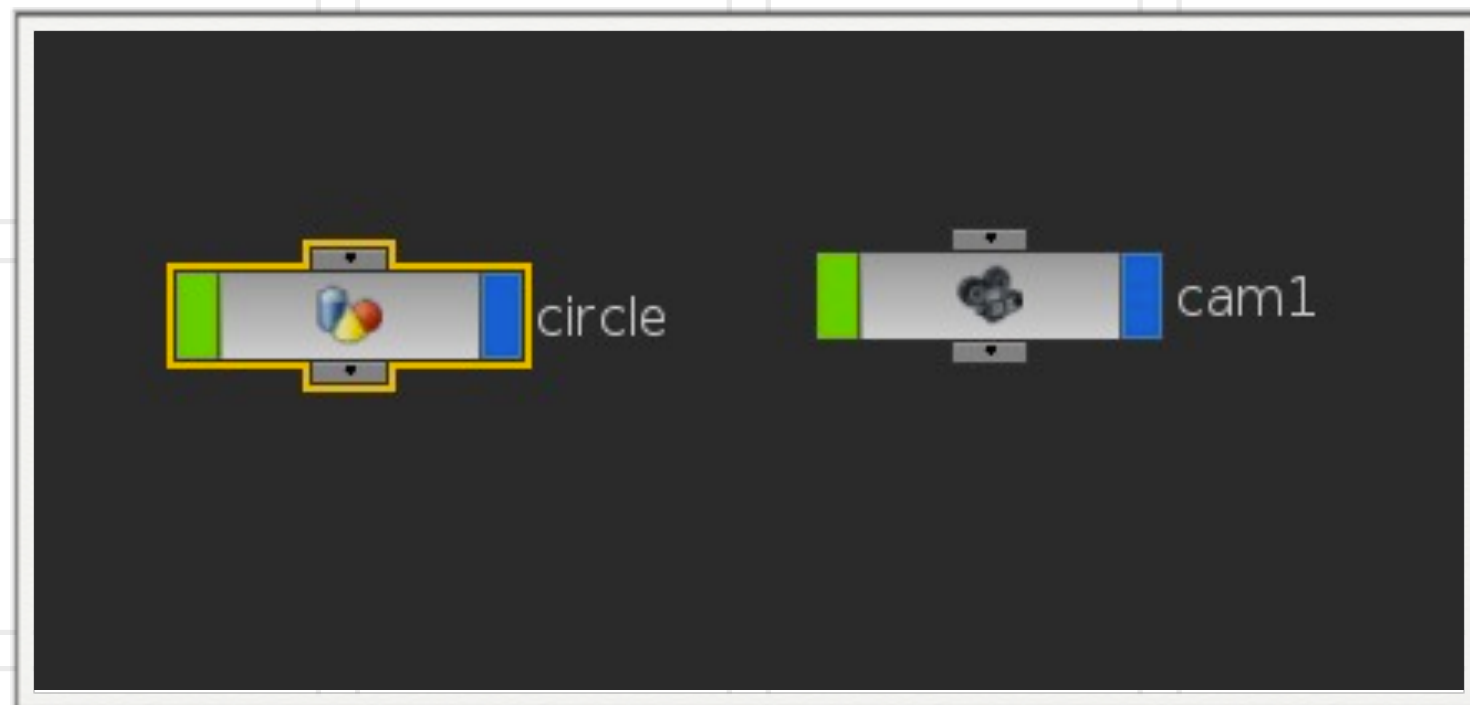


A Quick Test

Do Curves Really Render? Are they Controllable?

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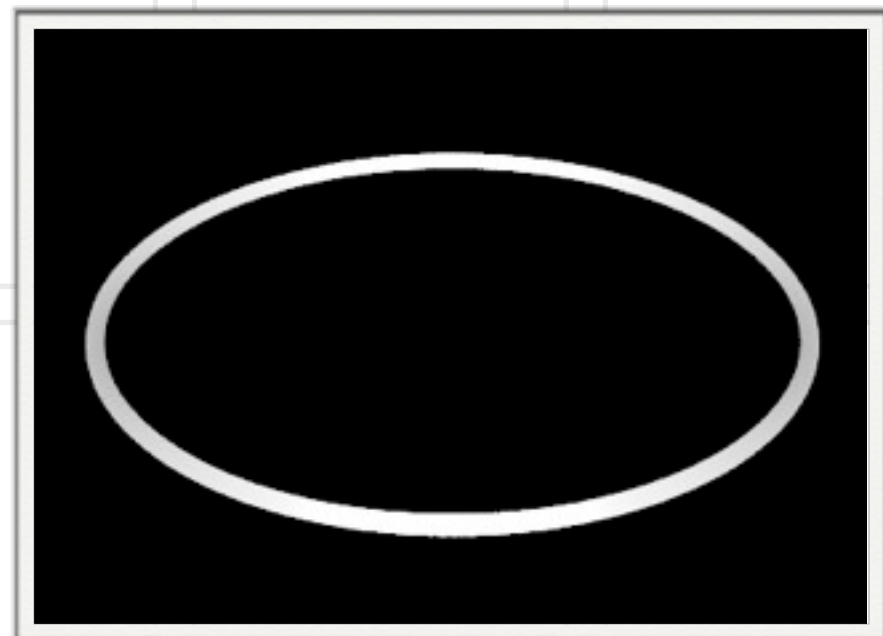
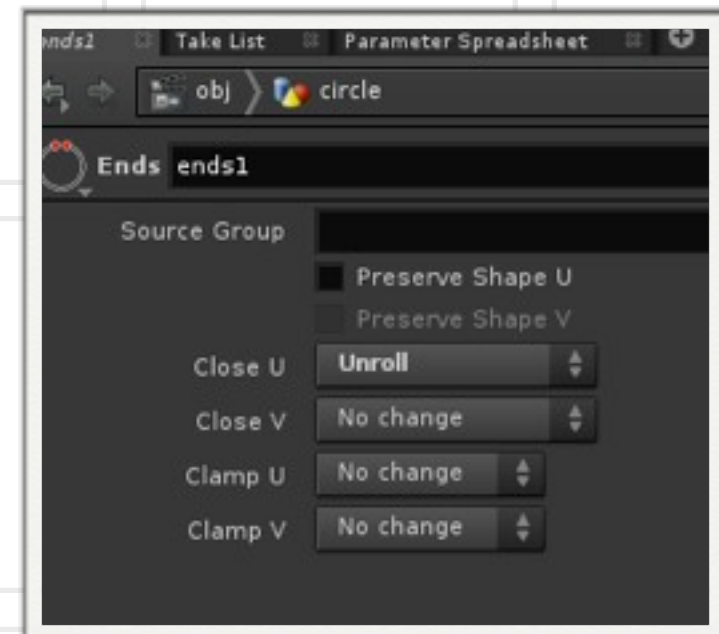
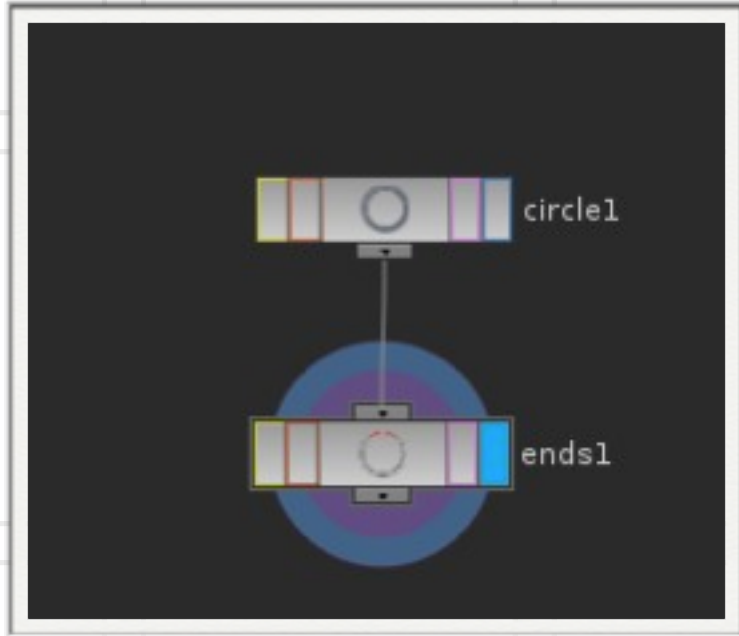
The Setup



- ▶ Create New Scene
- ▶ Drop Down a Circle
 - ▶ Plane - ZX
 - ▶ Type - NURBS
 - ▶ Divisions - 10
- ▶ Place Camera in Scene
- ▶ Go to Render
 - ▶ You get a nice surface render of the circle

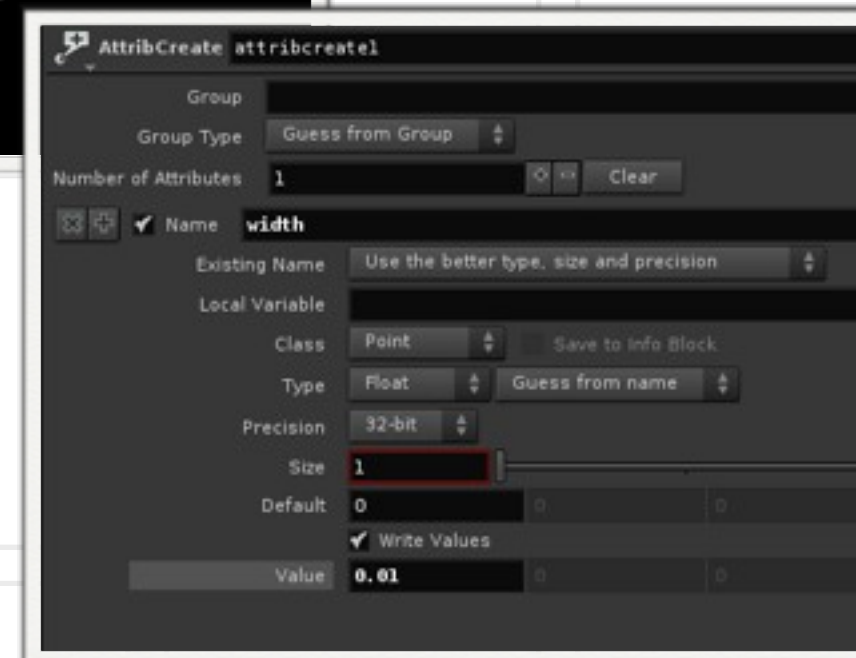
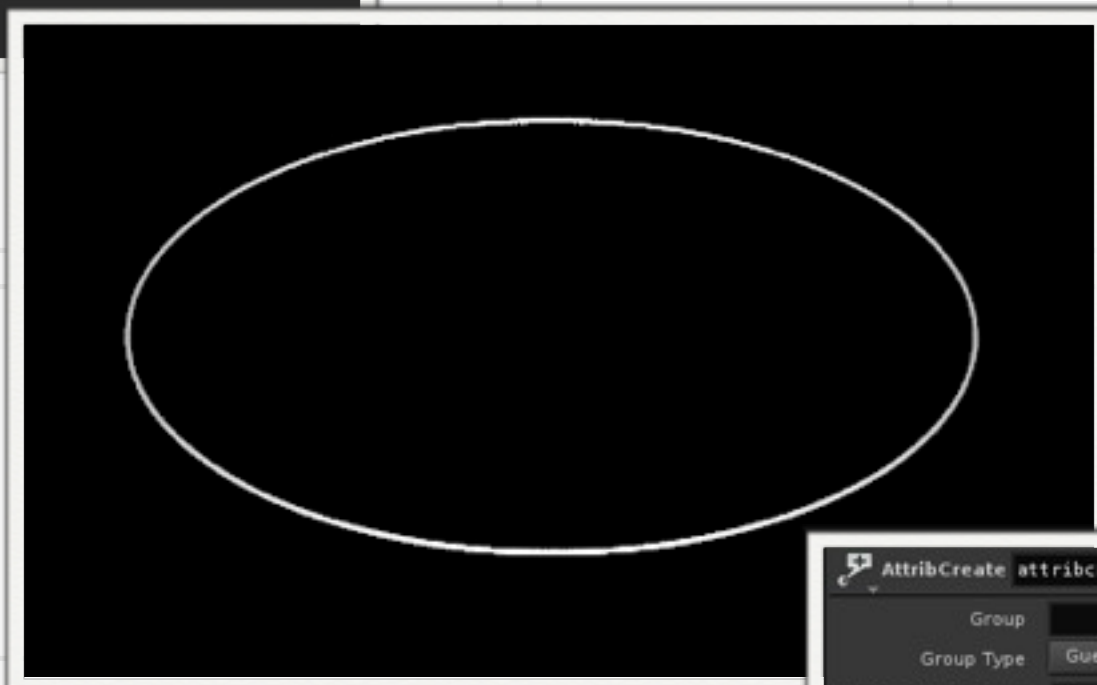
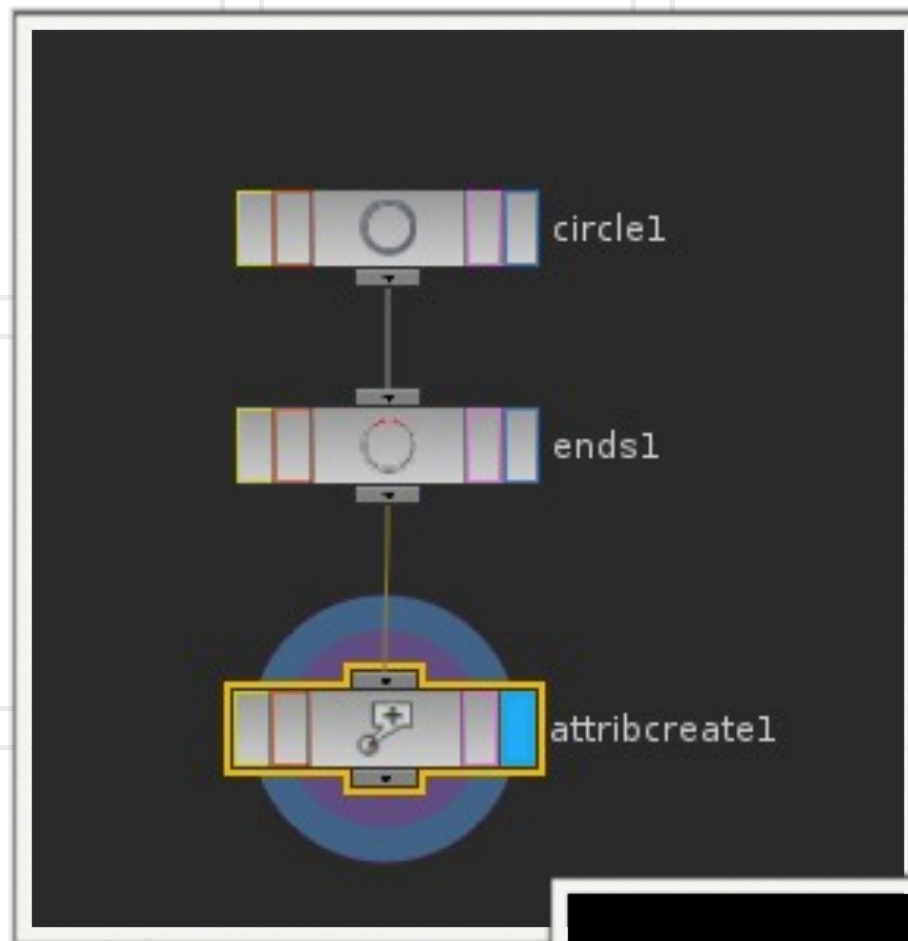
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The Setup (cont.)



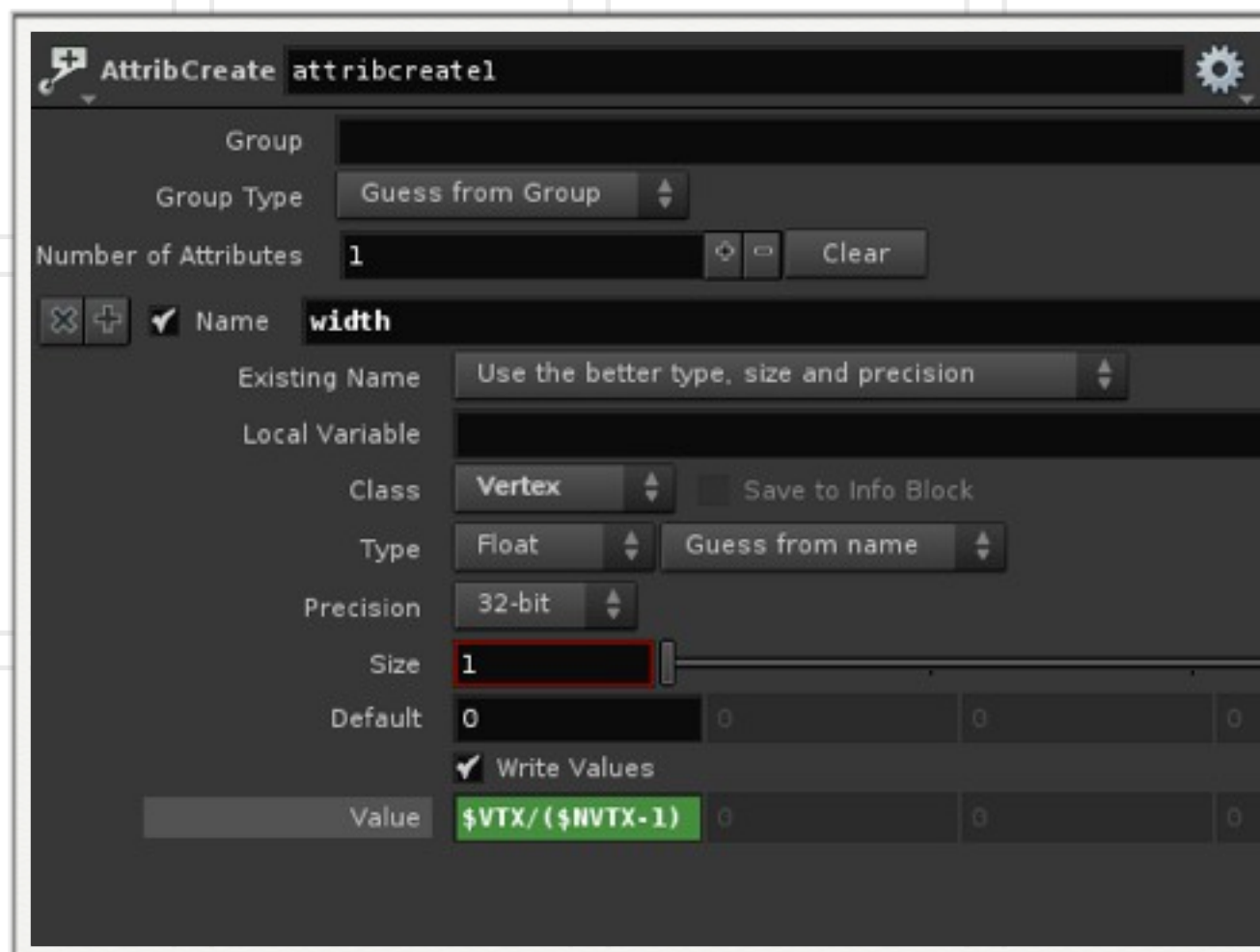
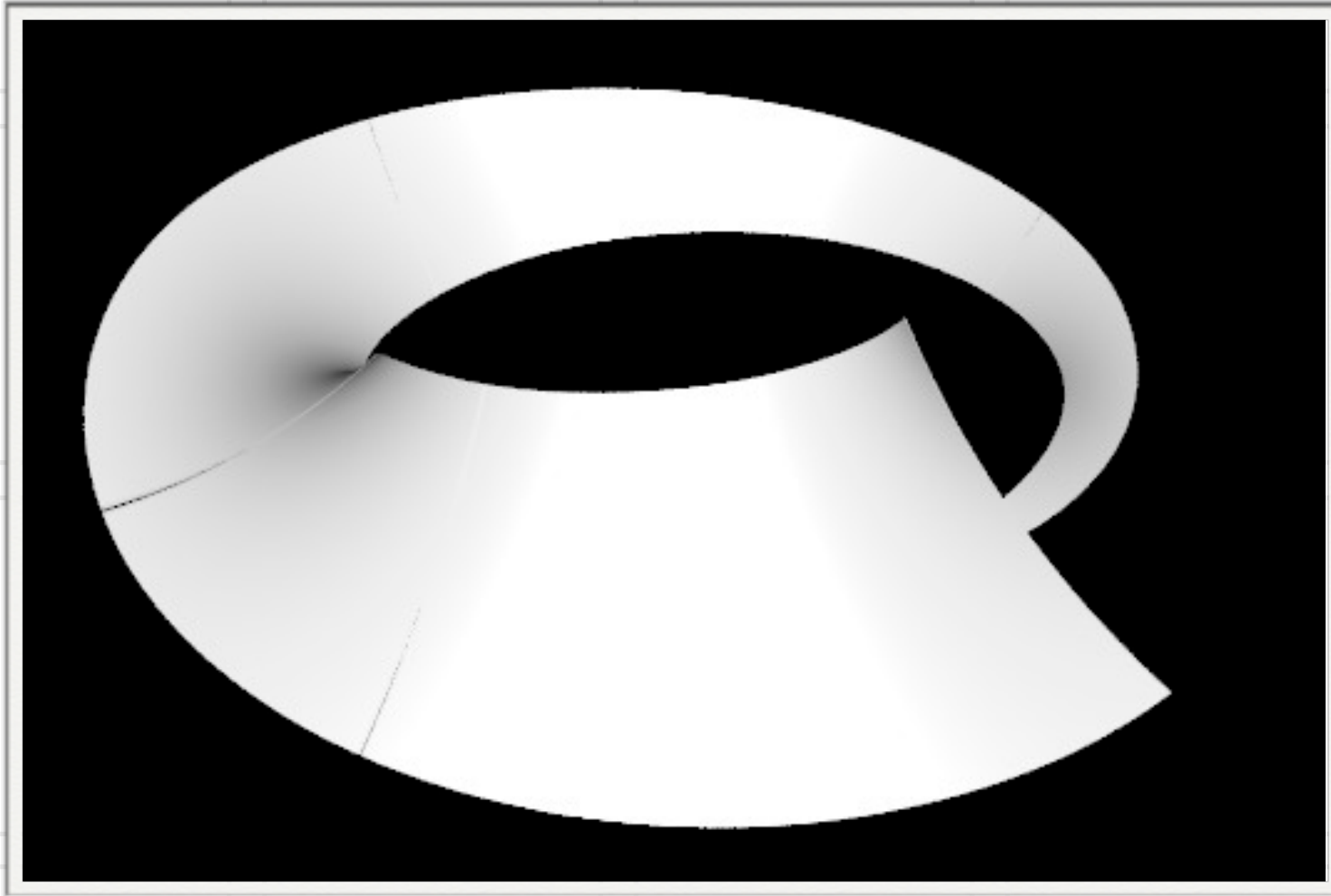
- ▶ Dive back into the circle
 - ▶ Append and Ends SOP to the Circle
 - ▶ Close U - Unroll
 - ▶ Remember Unroll disconnects the first from last point
- ▶ Render
 - ▶ A Curve is Rendered!

The Setup (cont.)



- ▶ But can we control the Curve?
 - ▶ Append an Attribute Create
 - ▶ name - width
 - ▶ The render disappears
 - ▶ Class - Point
 - ▶ Value 0.01
- ▶ A Curve is Rendered!

Can we shape the Curve?



- ▶ Change the Class to Vertex
- ▶ In the Value type the Expression
 - ▶ $\$VTX/(\$NVTX - 1)$
 - ▶ We are dividing the vertex number by the total number of vertices to give us a width ranging from 0 to 1
- ▶ This is how we will go about creating Grass



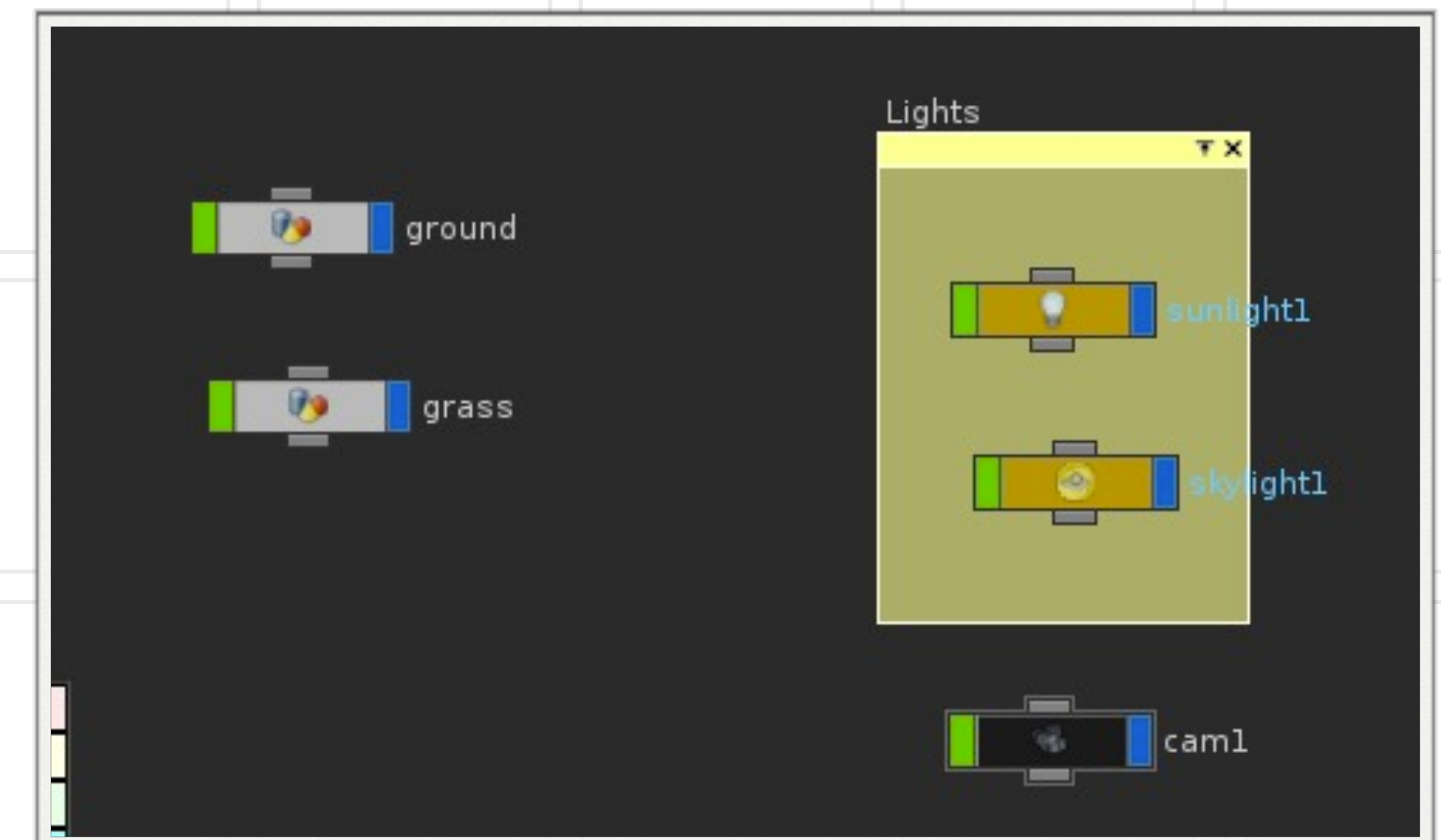
Setting Up the Testbed for Grass

Sub Title

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Basic Setup

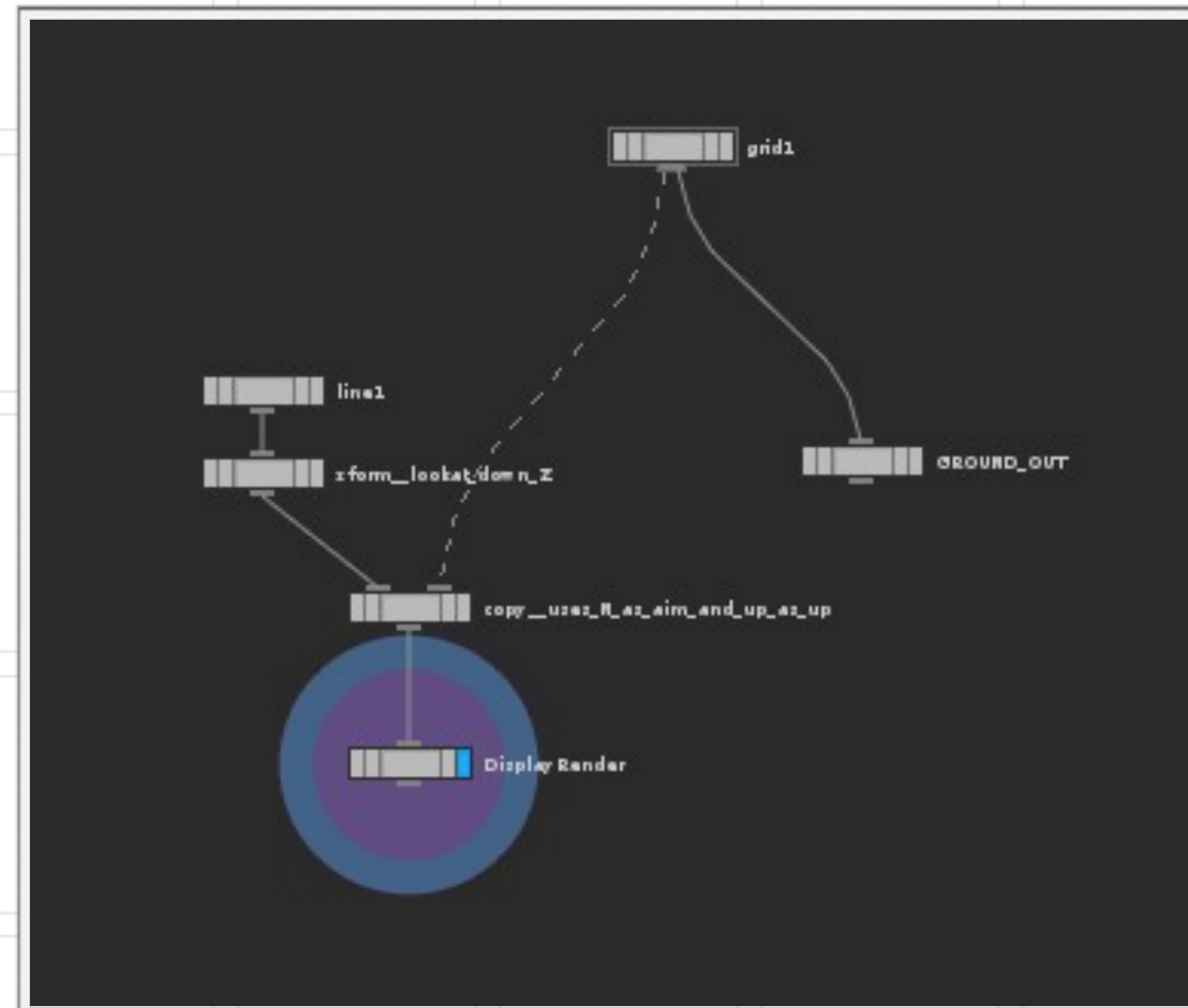
- ▶ Drop Down a Sky Light
- ▶ Drop Down a Grid
 - ▶ Size 4x4
 - ▶ Rename to “grass”
- ▶ Drop Down another Grid
 - ▶ Size 4x4
 - ▶ Rename to “ground”
- ▶ Position a camera in the Scene



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Basic Setup (cont.)

- ▶ Dive inside the Grass
- ▶ Drop down a Line
 - ▶ Primitive Type - NURBS
 - ▶ Divisions - 6
 - ▶ Order - 4
- ▶ Append a Transform
 - ▶ rot-x = 90
- ▶ Append a Copy
 - ▶ Template - Grid
 - ▶ Primitives to Copy





Adding the Attributes to Shape the Blade

What do we want to control?

Blade Thickness (variable along length)

Blade Min Height

Blade Max Height

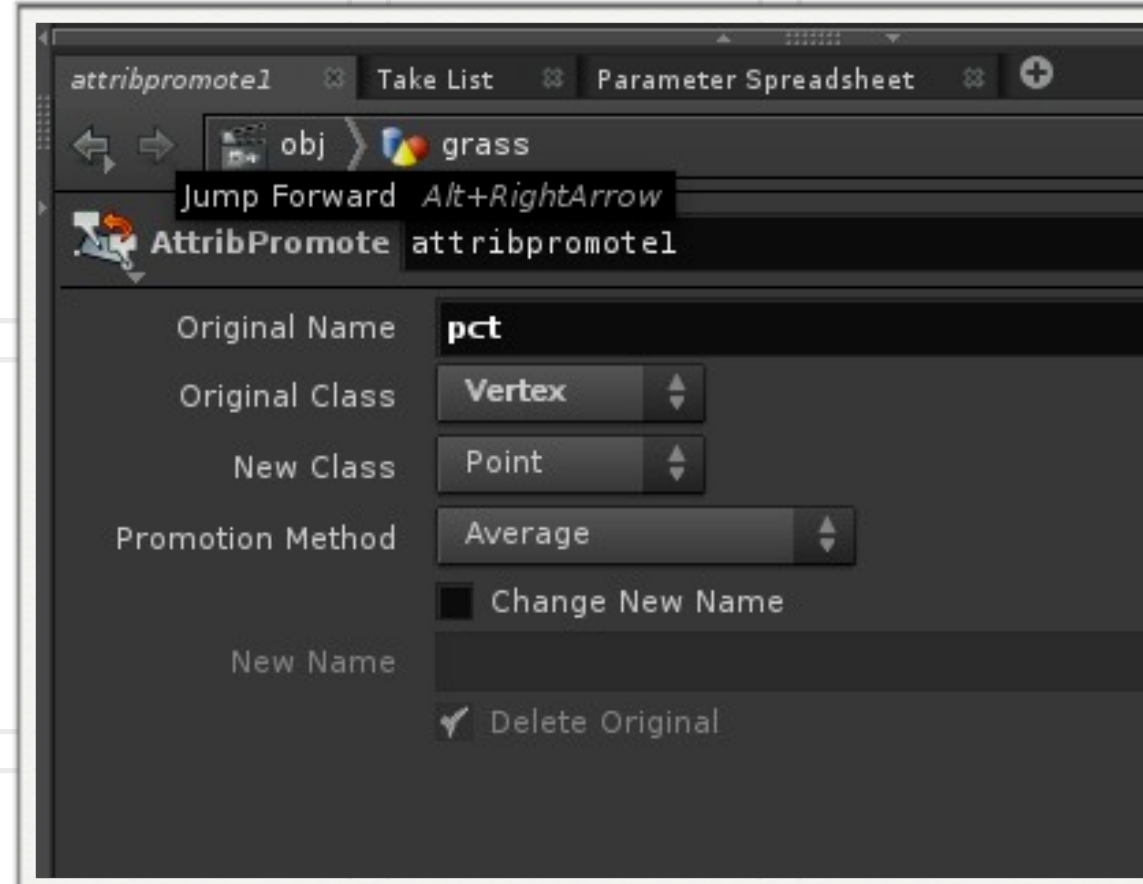
Blade Bend

Blade Twist

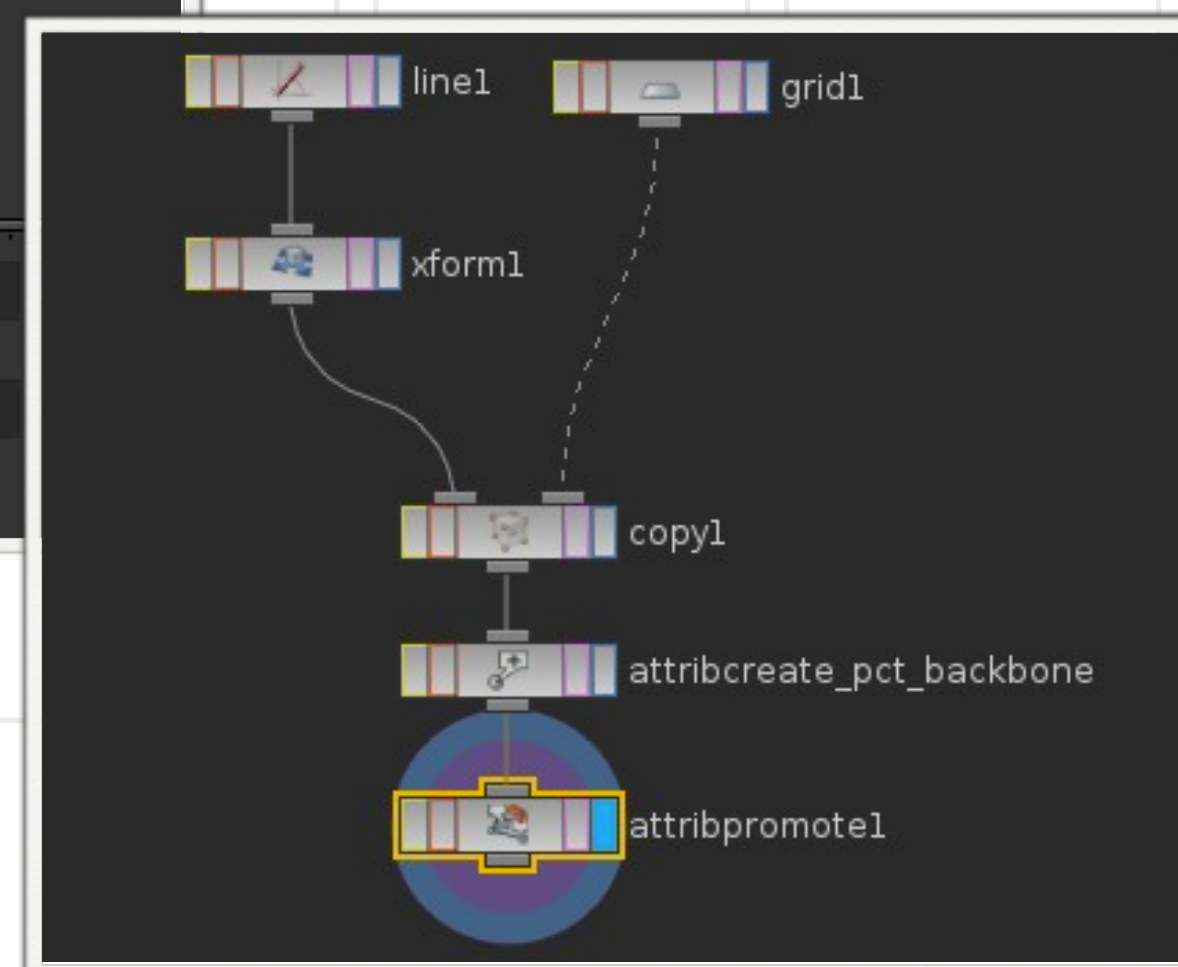
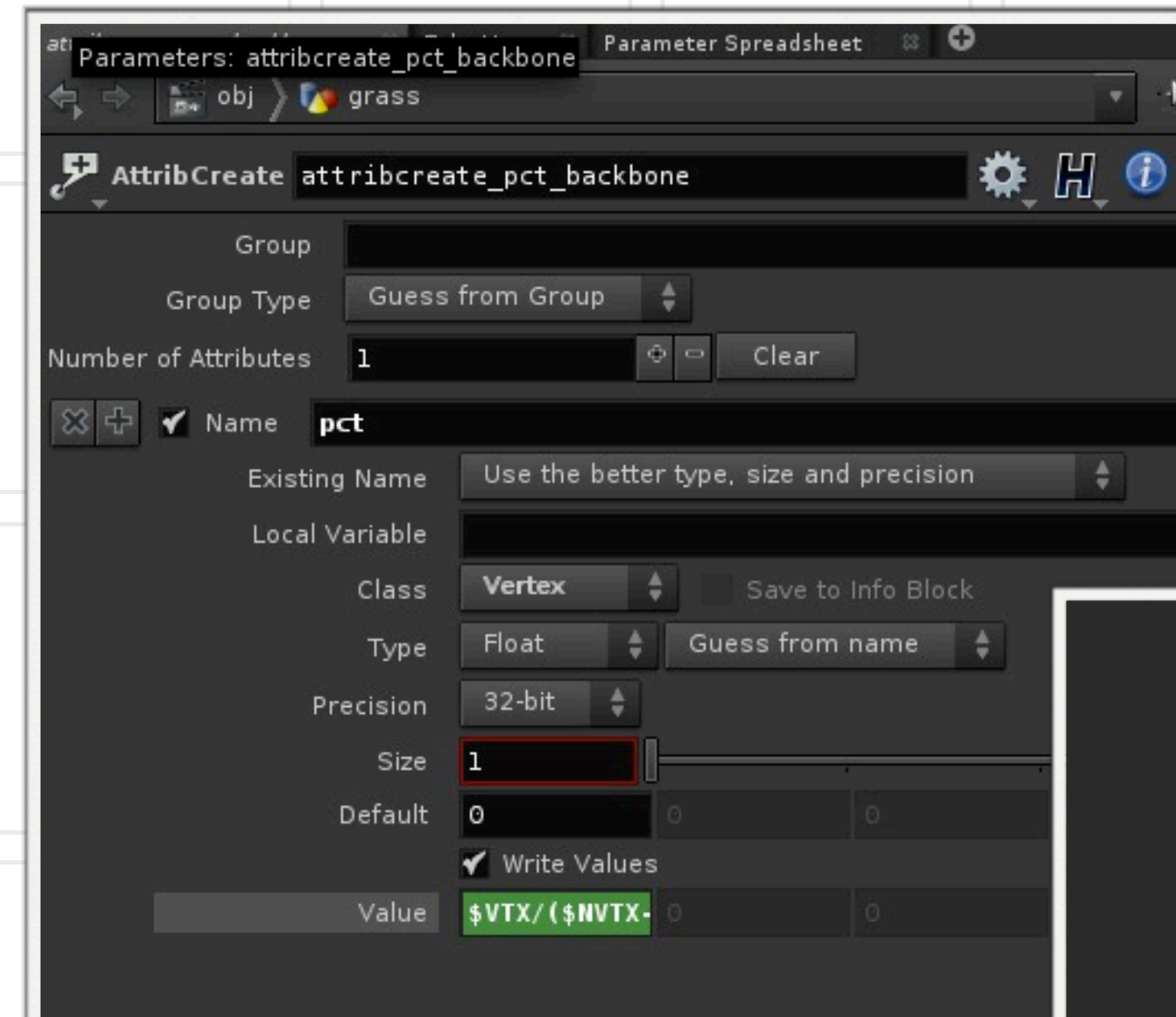
Blade Rotation

Blade Up Vector

Add a few Attributes

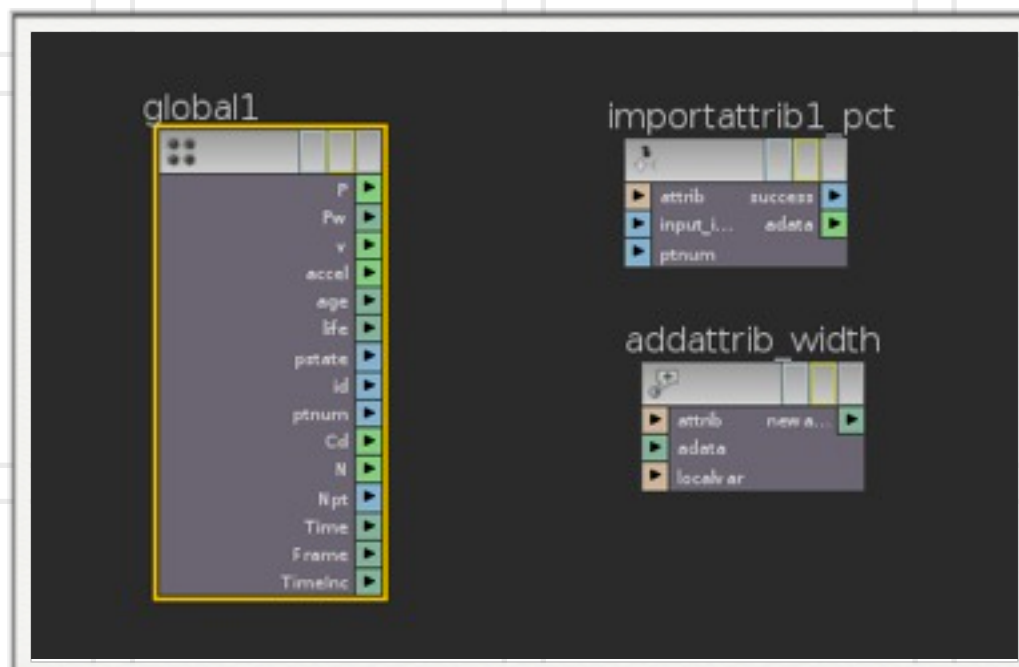
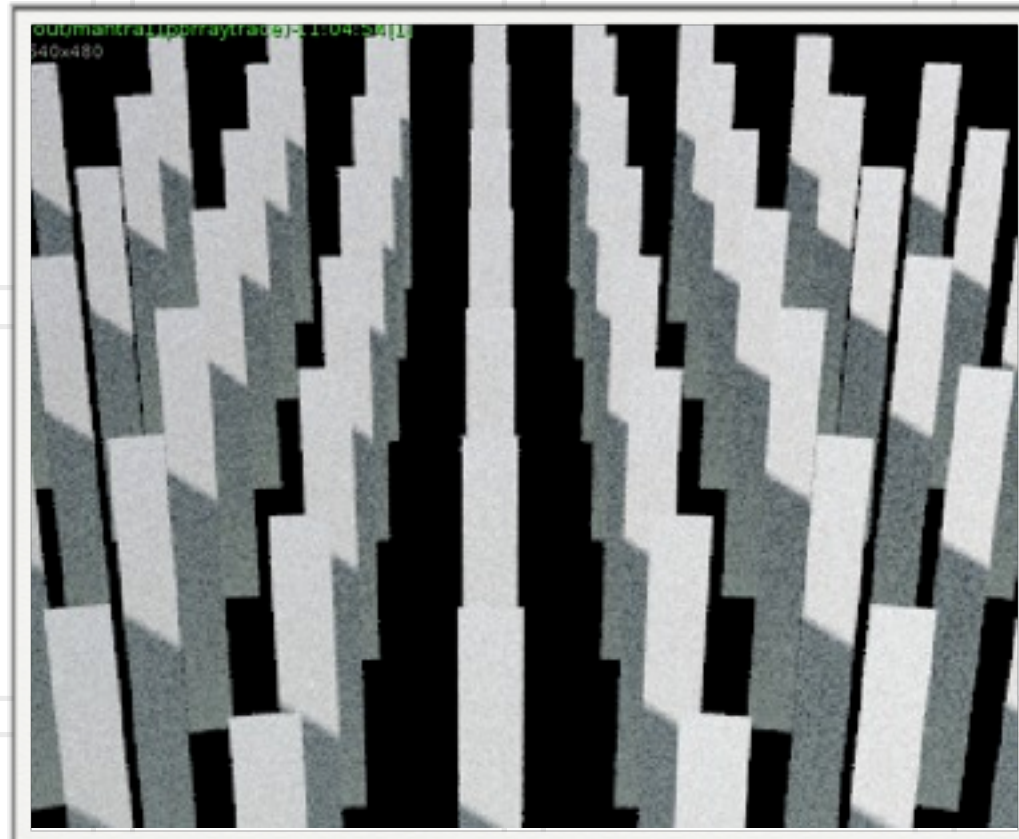


- ▶ Append a Attribute Create
 - ▶ name - pct
 - ▶ class - vertex
 - ▶ value - $\$VTX/(\$NVTX - 1)$
- ▶ Append a Attribute Promote
 - ▶ Original Name - pct
 - ▶ Original Class - Vertex
 - ▶ New Class - Point



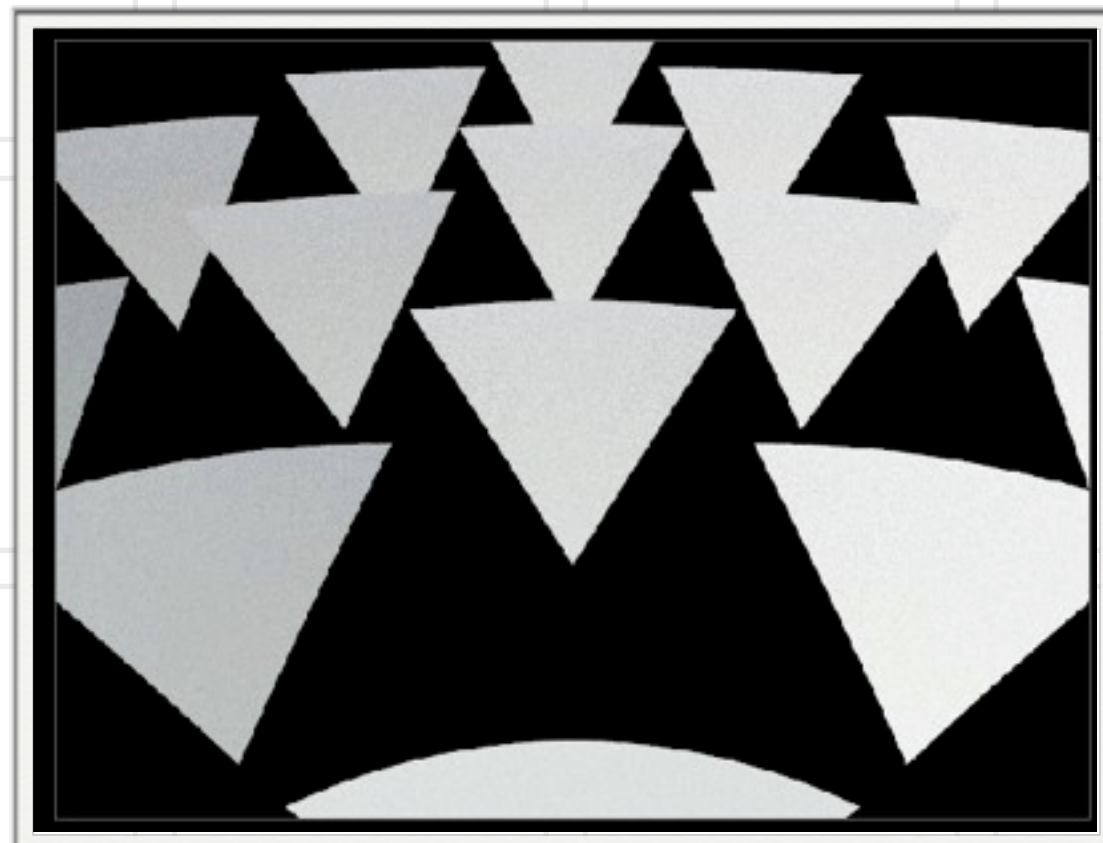
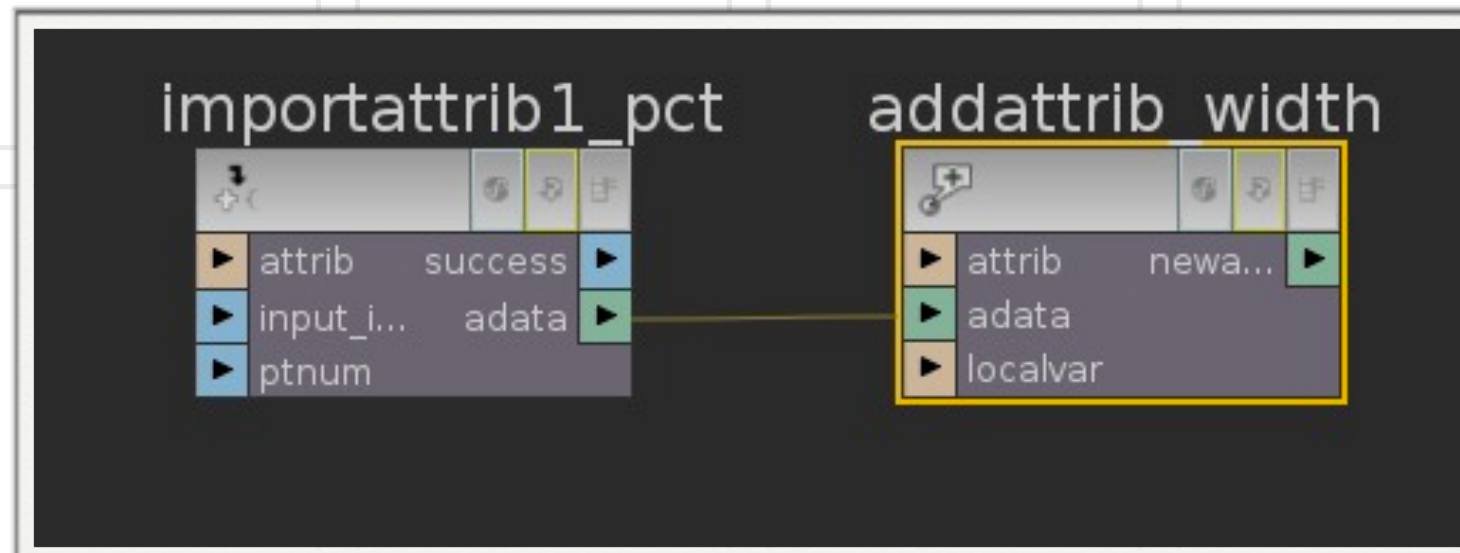
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Define Attributes in VOPSOP



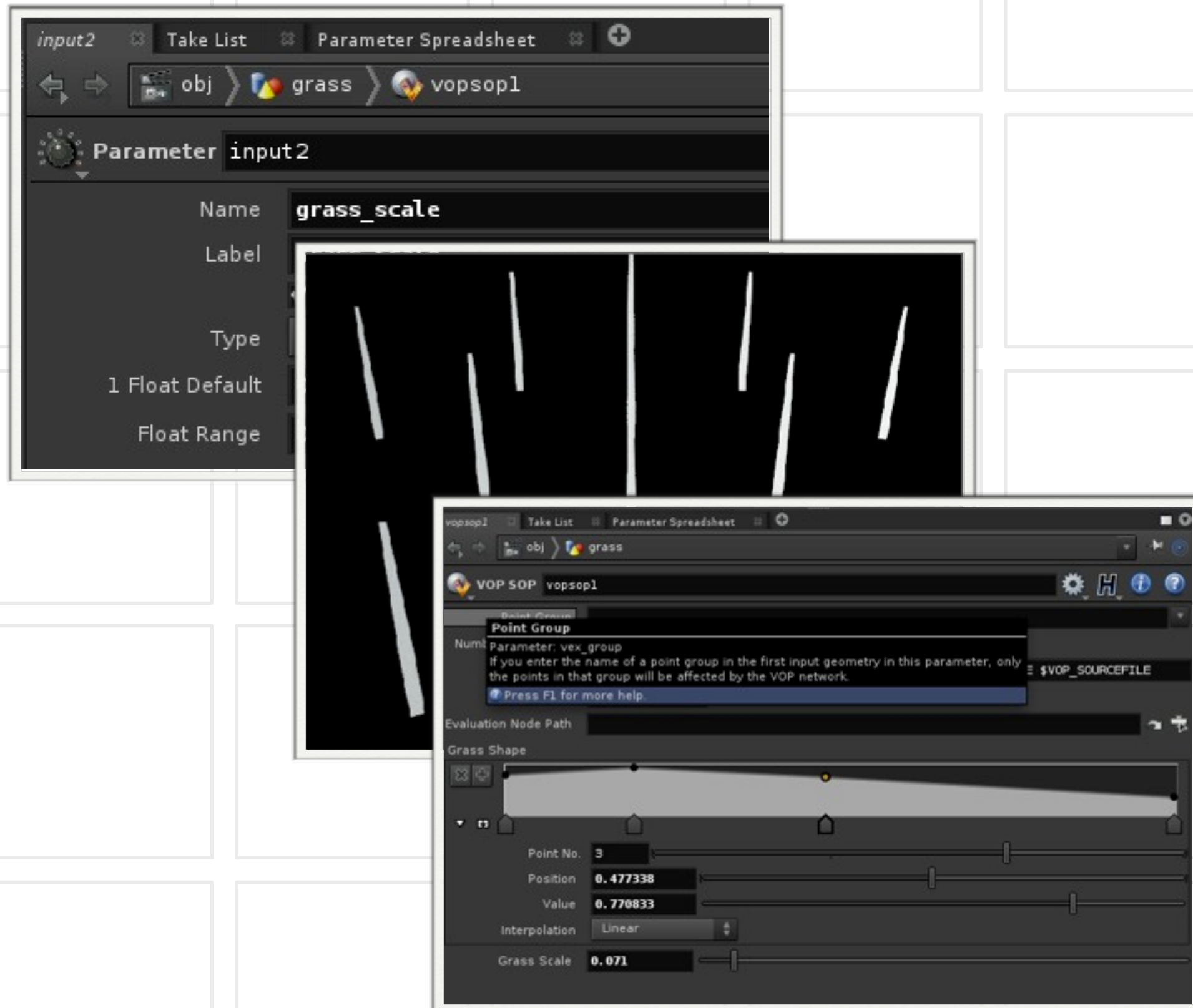
- ▶ Append a VOPSOP and Dive inside
- ▶ ImportAttribute - pct
- ▶ AddAttribute
 - ▶ name - width
 - ▶ type - float
 - ▶ Give it a size for now - 0.2
- ▶ Render

Define Attributes in VOPSOP (Cont.)



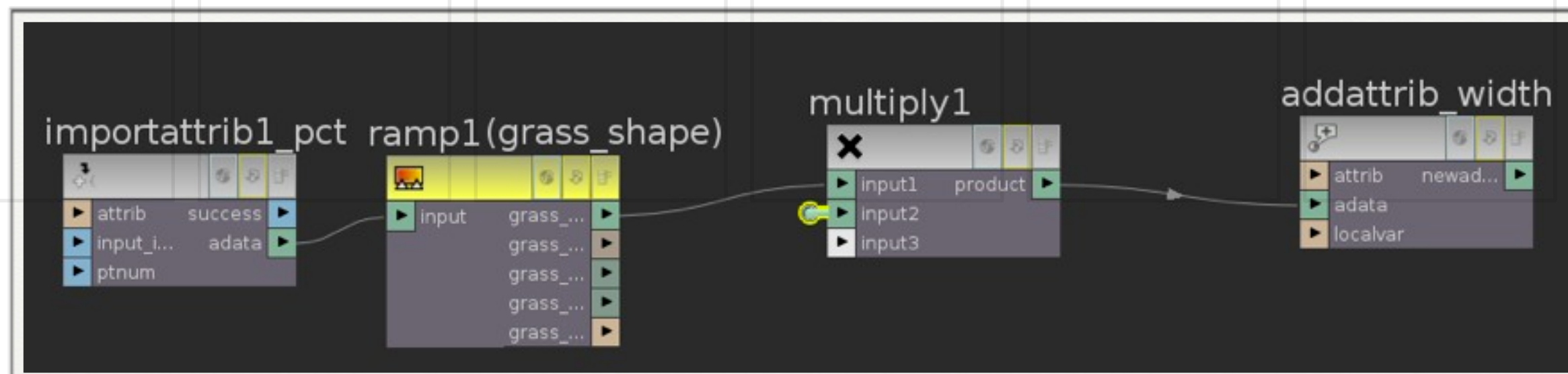
- ▶ Wire up the pct (backbone) to width
- ▶ Render
- ▶ Notice two things
 - ▶ Variable Width
 - ▶ All curves “Oriented” toward camera
- ▶ First Let us shape the blades with a ramp

Shaping the Blades



- ▶ In the VOPSOP drop down a Ramp Parameter VOP
 - ▶ name - grass_shape
 - ▶ label - Grass Shape
 - ▶ Type - Spline
- ▶ Append a Multiply (We want a global scale to the shape)
 - ▶ Wire it up - ramp to multiply
 - ▶ Promote Second Input
 - ▶ name - grass_scale
 - ▶ label - Grass Scale
 - ▶ Go up and Shape blades

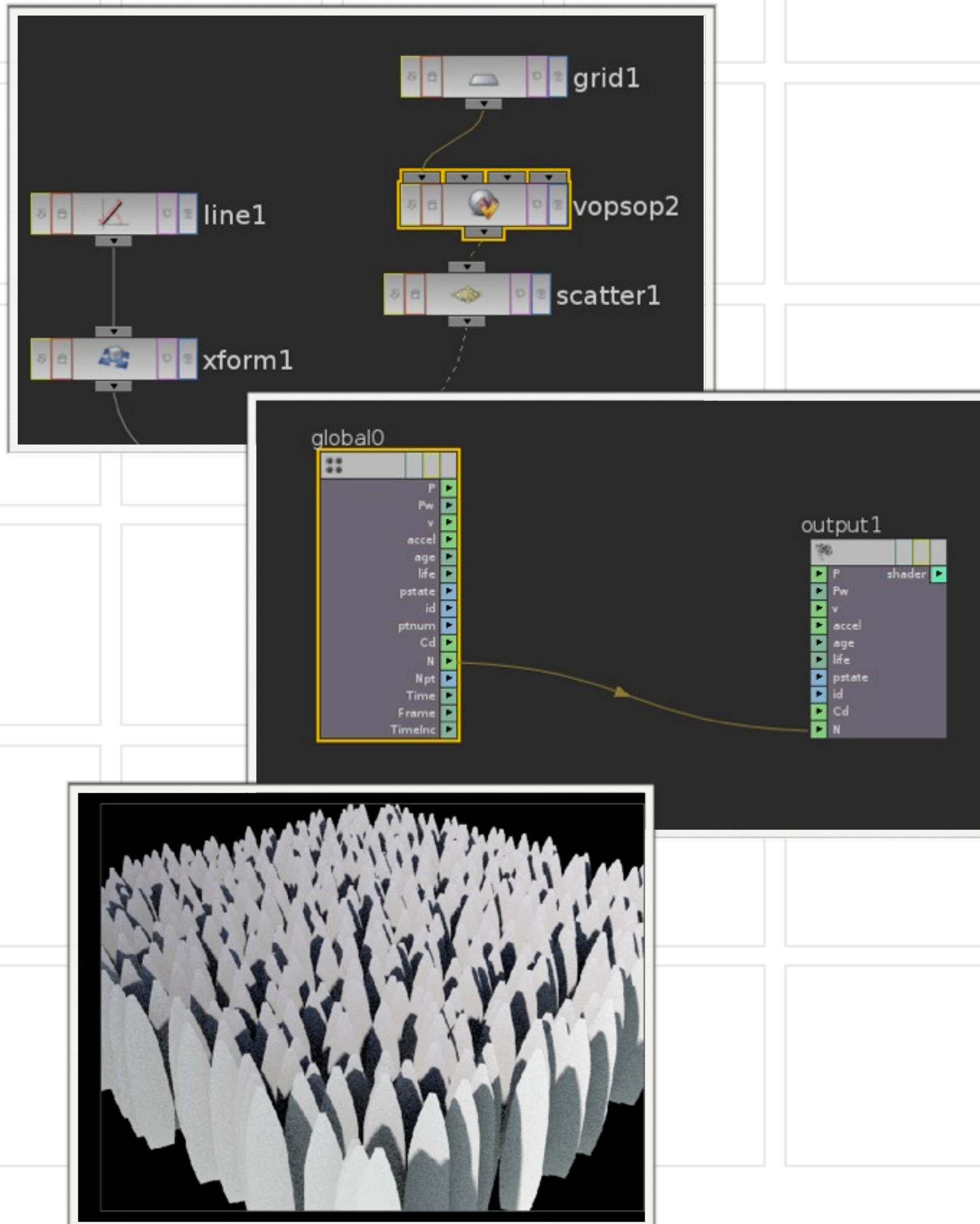
Shape it into
a blade of
grass



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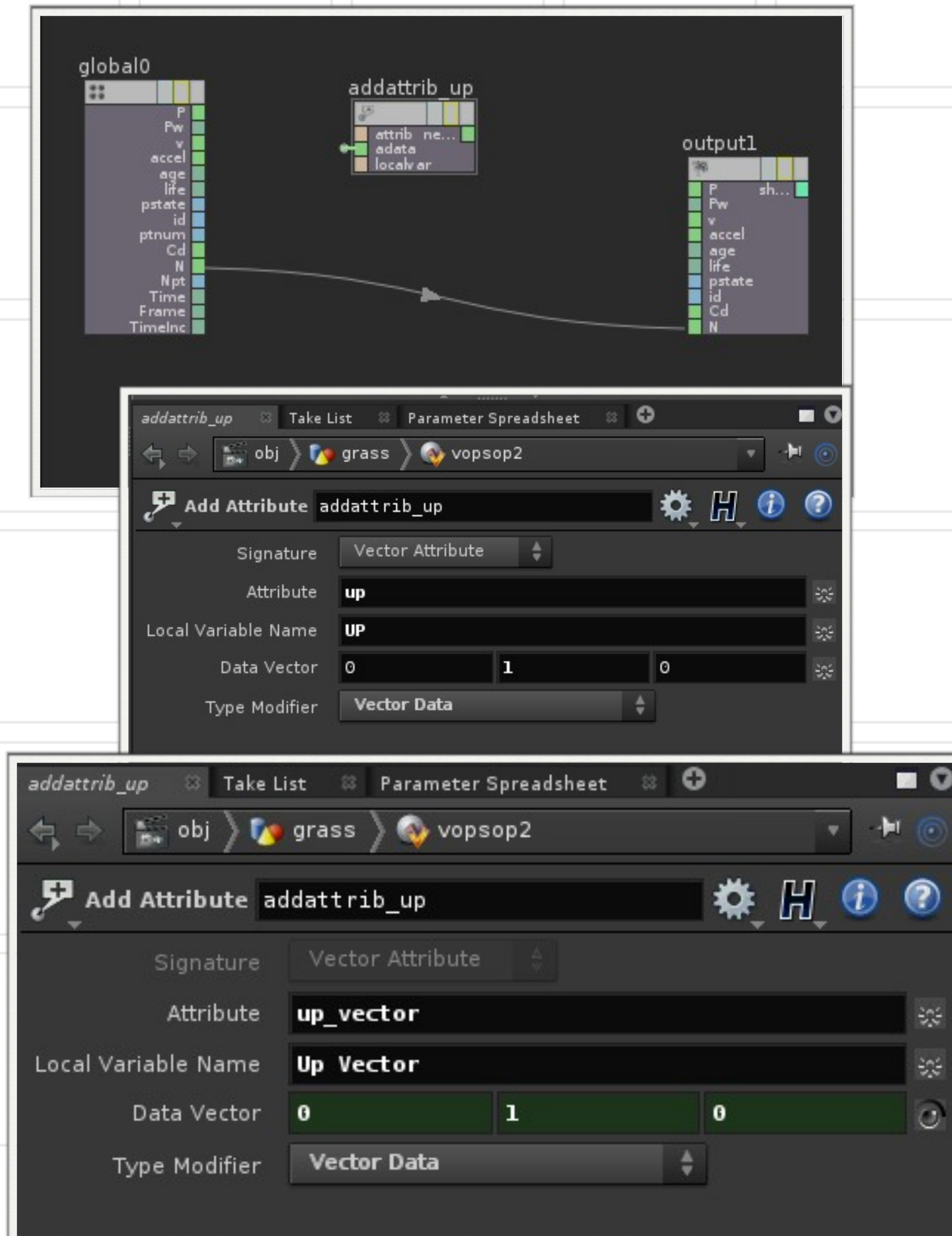
Normal Vector & Up Vector

- ▶ Append a Scatter SOP after the Grid SOP
 - ▶ Notice the Grass Blades flat on the ground
 - ▶ We can fix this by adding a Normal Vector
- ▶ Append a VOPSOP to the Grid SOP
 - ▶ Dive inside - Wire Normal to Normal



Normal Vector & Up Vector (cont.)

- ▶ Drop down an Add Attribute to the VOPSOP
 - ▶ name - up
 - ▶ Label UP
 - ▶ value - 0,1,0
 - ▶ Type Modifier - Vector Data
- ▶ Promote the adata
 - ▶ name - up_vector
 - ▶ Local Variable Name - Up Vector



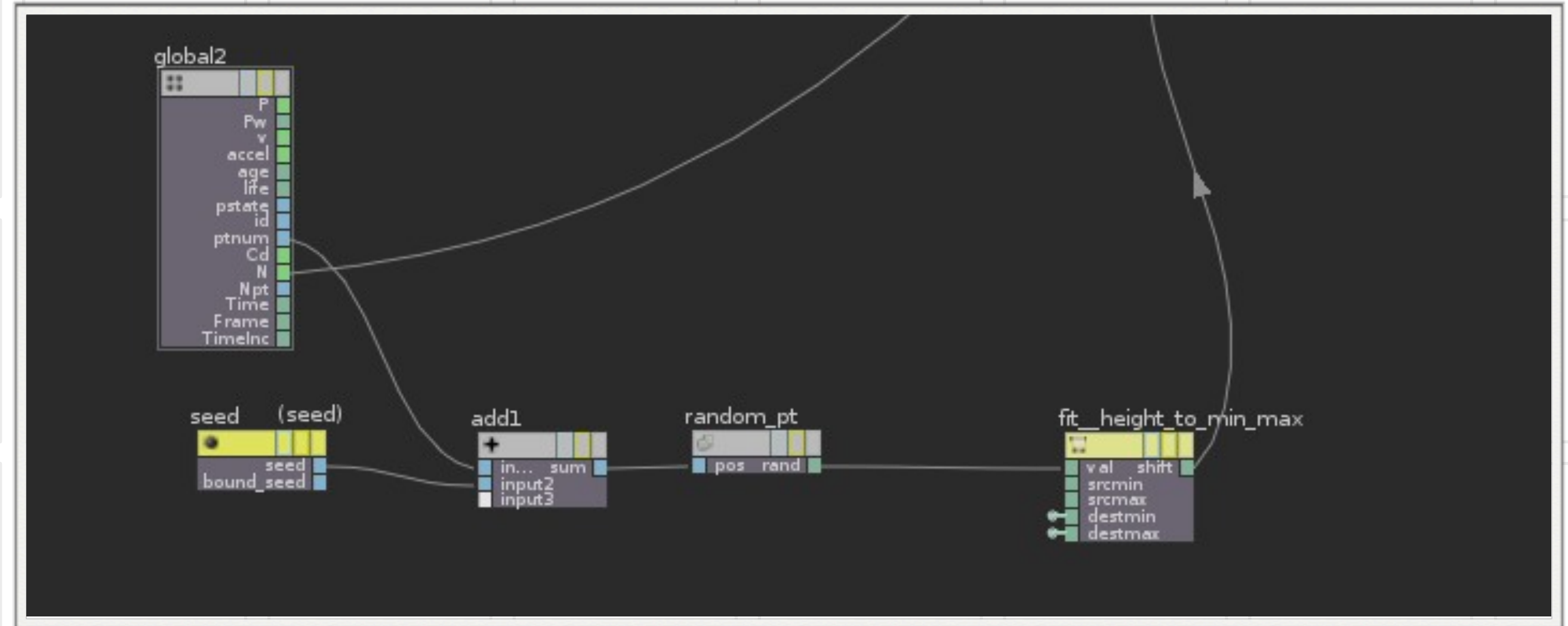
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Why Not Use a Card with Alpha?

Alpha slows down rendering
Shaping curves very efficient in Mantra

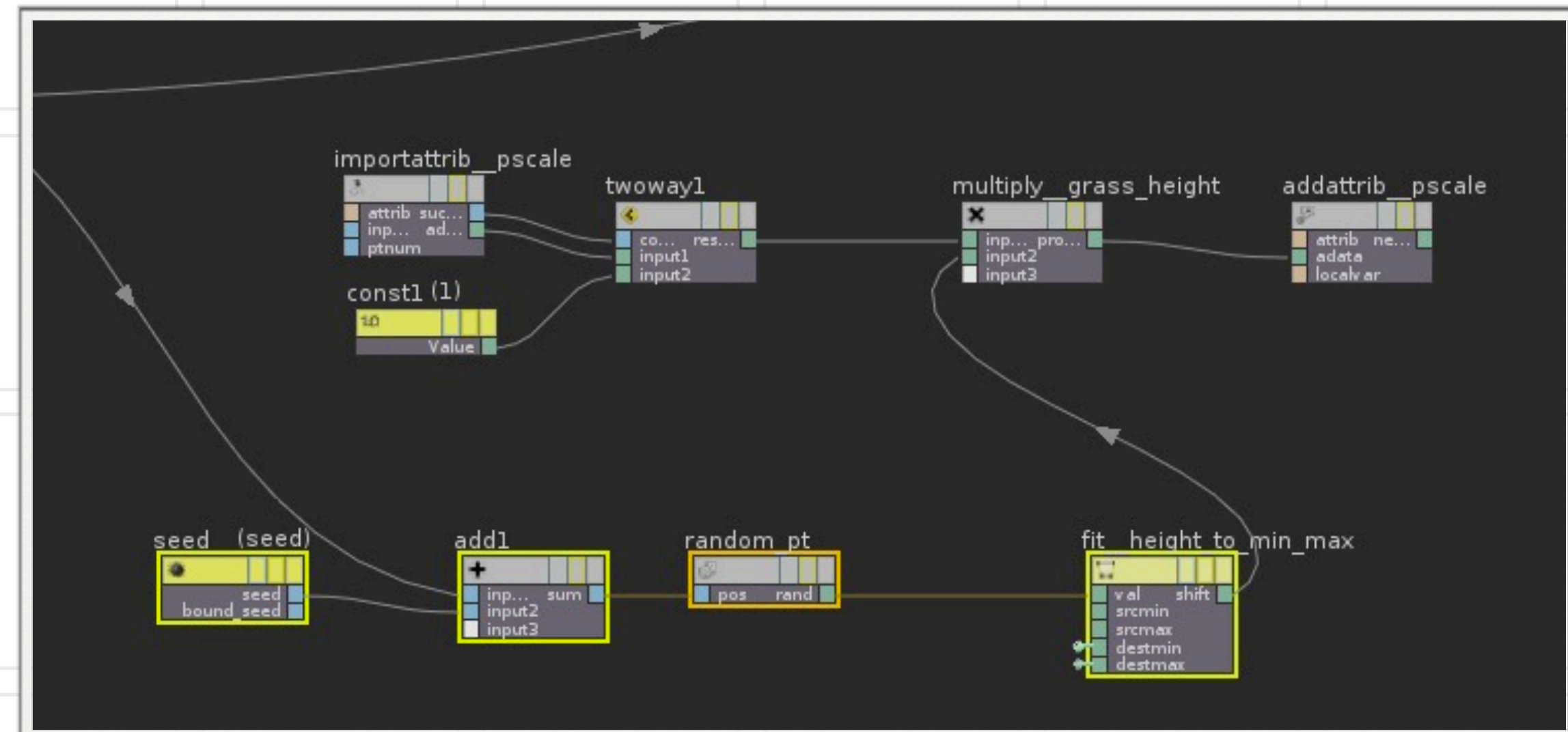
Controlling Random Size

- ▶ Let us start with Size
 - ▶ Drop down a parameter
 - ▶ name - seed
 - ▶ Label - Seed
 - ▶ Range - 0..100
 - ▶ Add to Ptnum and bring into Random VOP
 - ▶ Output Random to a Fit Range
 - ▶ Source Min, Max - 0,1
 - ▶ Promote Destination Min, Max



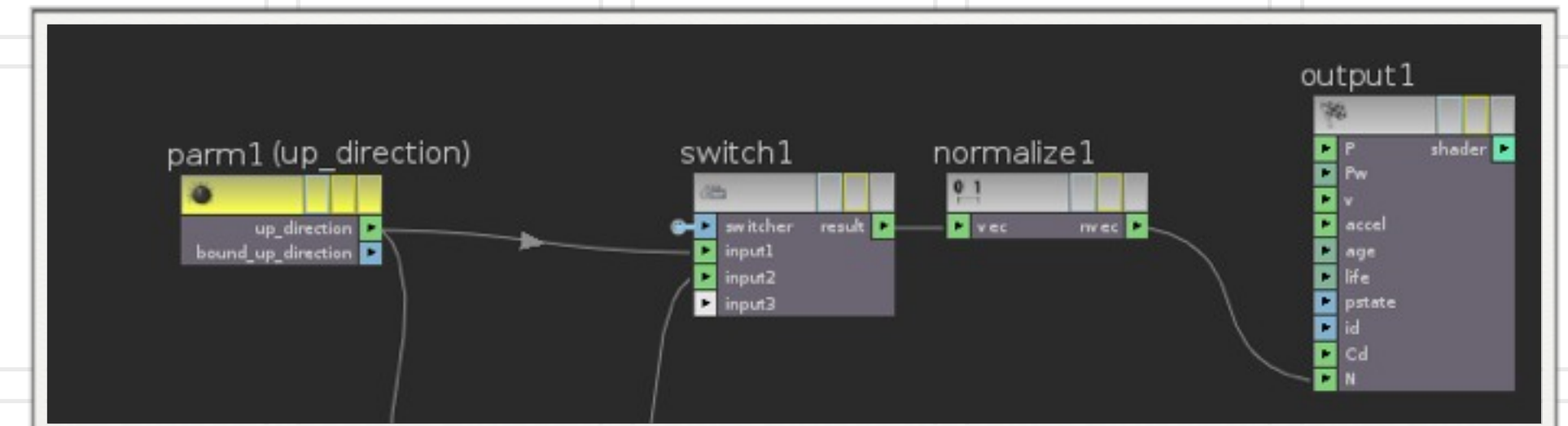
Controlling Random Size (cont.)

- ▶ Import Attribute - pscale
 - ▶ Drop down a Two Way Switch
 - ▶ We need to make sure pscale is present
 - ▶ success of pscale to condition of switch
 - ▶ adata to input 1 of switch
 - ▶ Drop down a constant - value 1
 - ▶ Wire to input 2 of switch
 - ▶ Drop down a Multiply
 - ▶ Input 1 - output of two way
 - ▶ Input 2 - output of Fit Height
 - ▶ Drop down an Add Attribute
 - ▶ Attribute is pscale



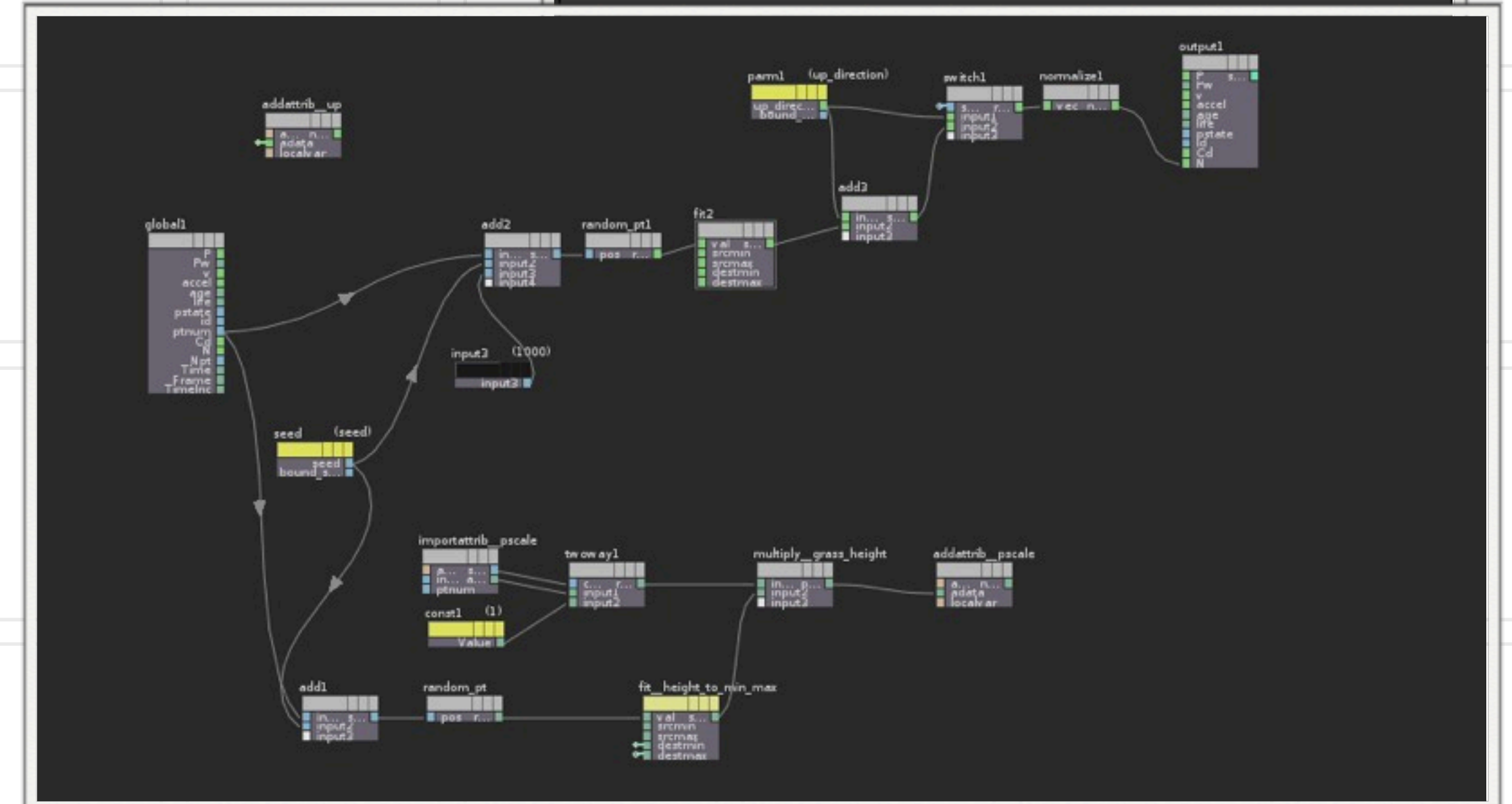
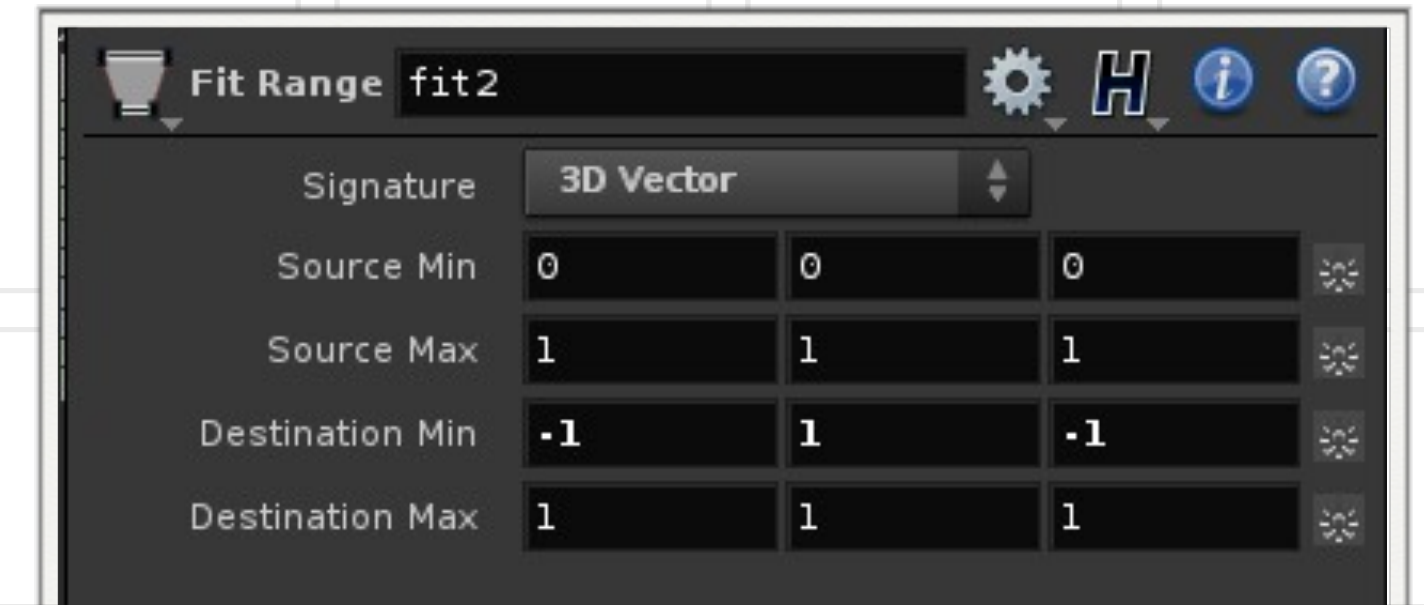
Controlling Random Direction

- ▶ Drop down a Switch (Do we want random or straight grass)
 - ▶ Promote the Switcher
 - ▶ Name - random_up_direction
 - ▶ Label - Random Up Direction
- ▶ Wire the Up Direction Vector to the First Input of Switch
- ▶ Append a Normalize to the Switch
- ▶ The Output of the Normalize wire to N of Global Output

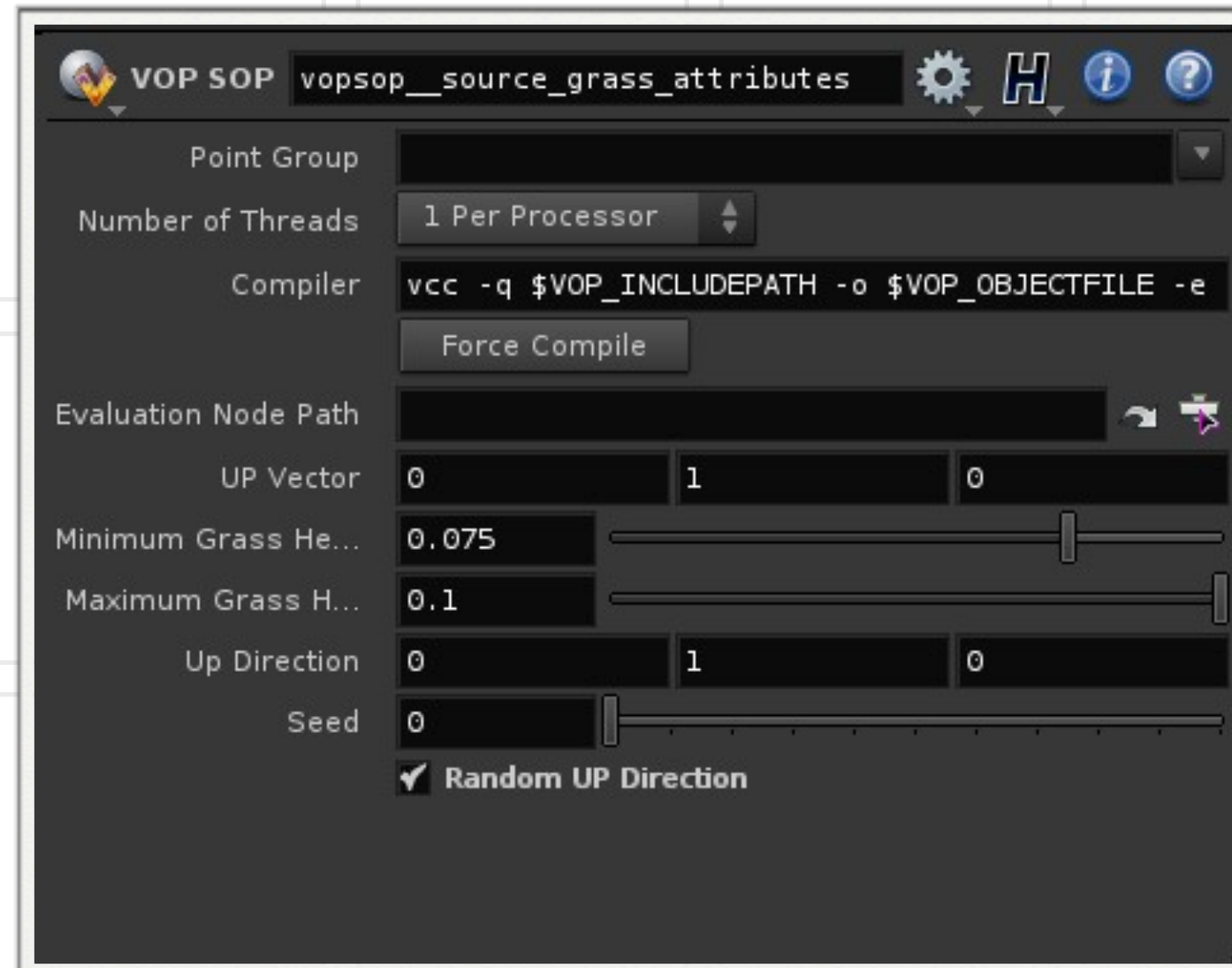


Controlling Random Direction (cont.)

- ▶ We took care of the straight grass condition. Now let us do the rand direction grass
- ▶ Drop down an Add SOP
- ▶ Wire the PtNum and Seed Outputs to the Add
 - ▶ Drop down a Constant - make some large value
 - ▶ Wire to Add
- ▶ Wire the output of the Add to a Random VOP
- ▶ Fit the output to a negative to positive 1
- ▶ Drop down an Add
- ▶ ADD THE UP_DIRECTION AND THE FIT JUST CREATED
- ▶ Wire the Add to input 2 of the Switch



Results of VOPSOP



- ▶ Random Orientation & Size
- ▶ and of course shape is still working



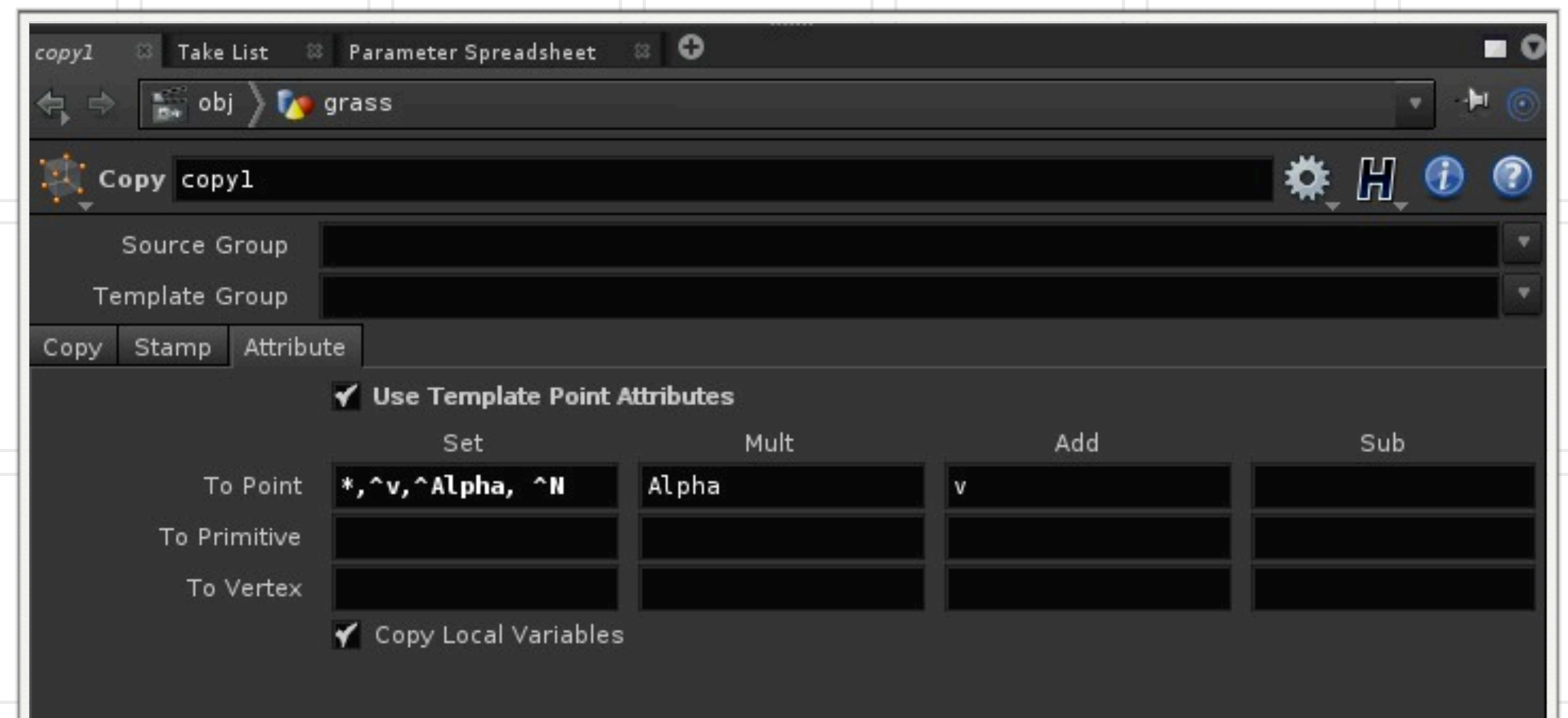
Creating Orientation, Twist, and Bend

and putting it into an if statement

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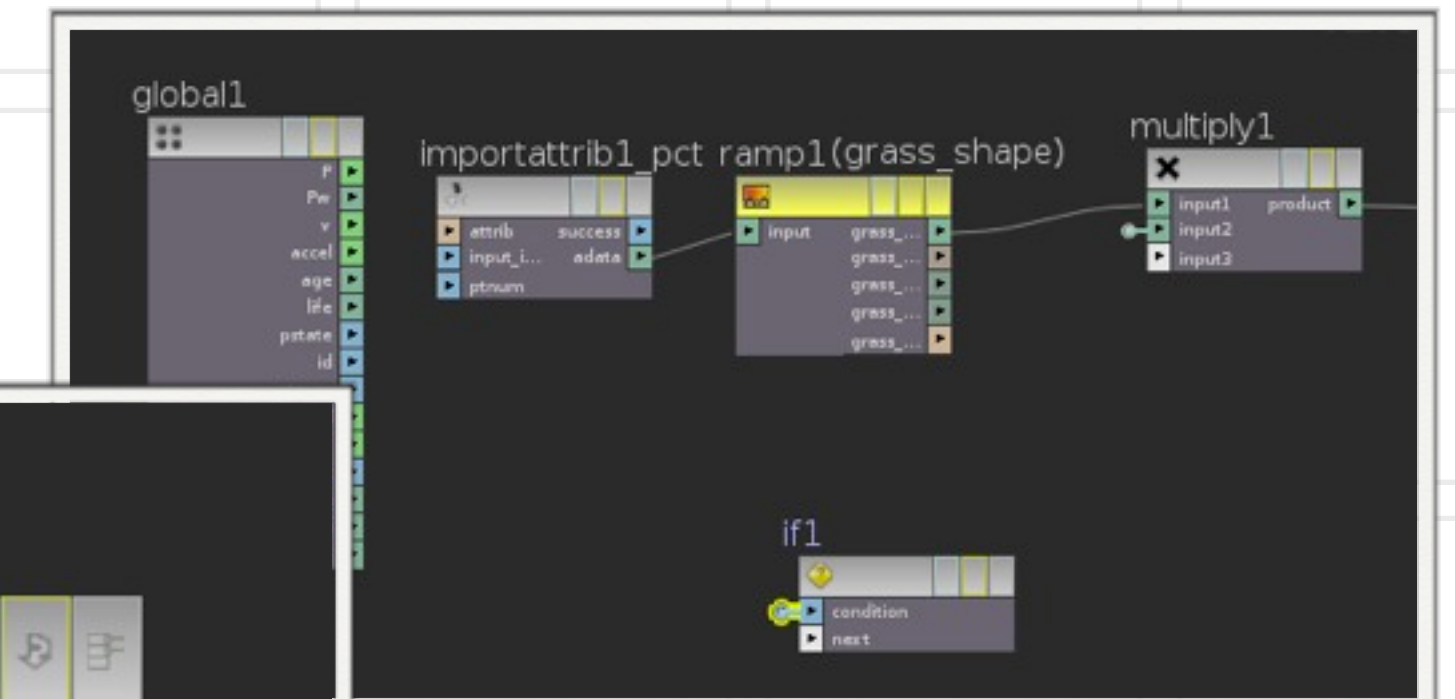
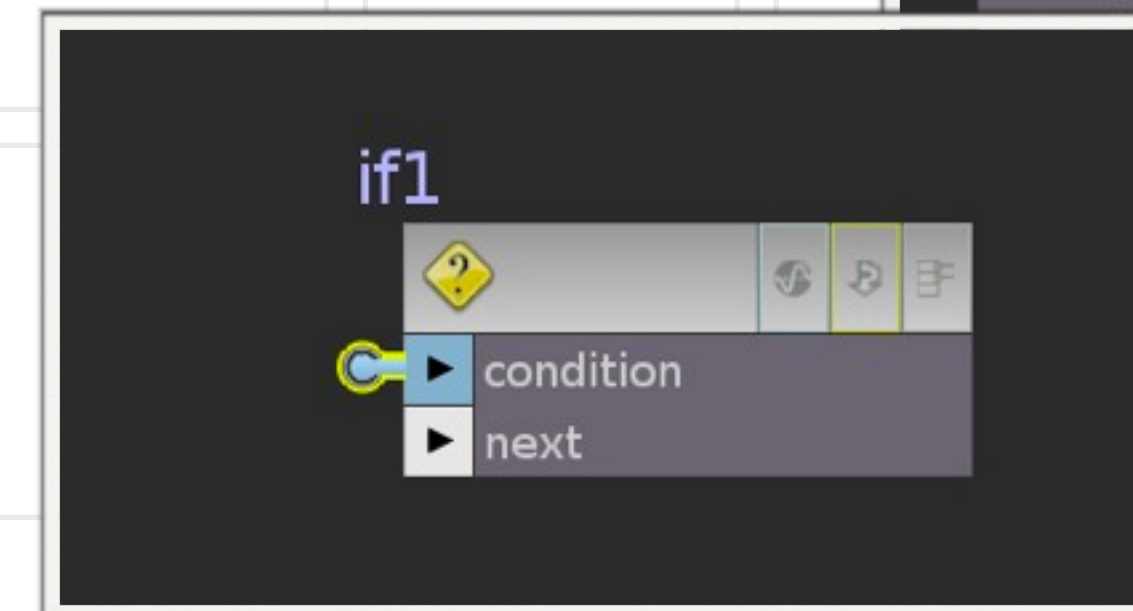
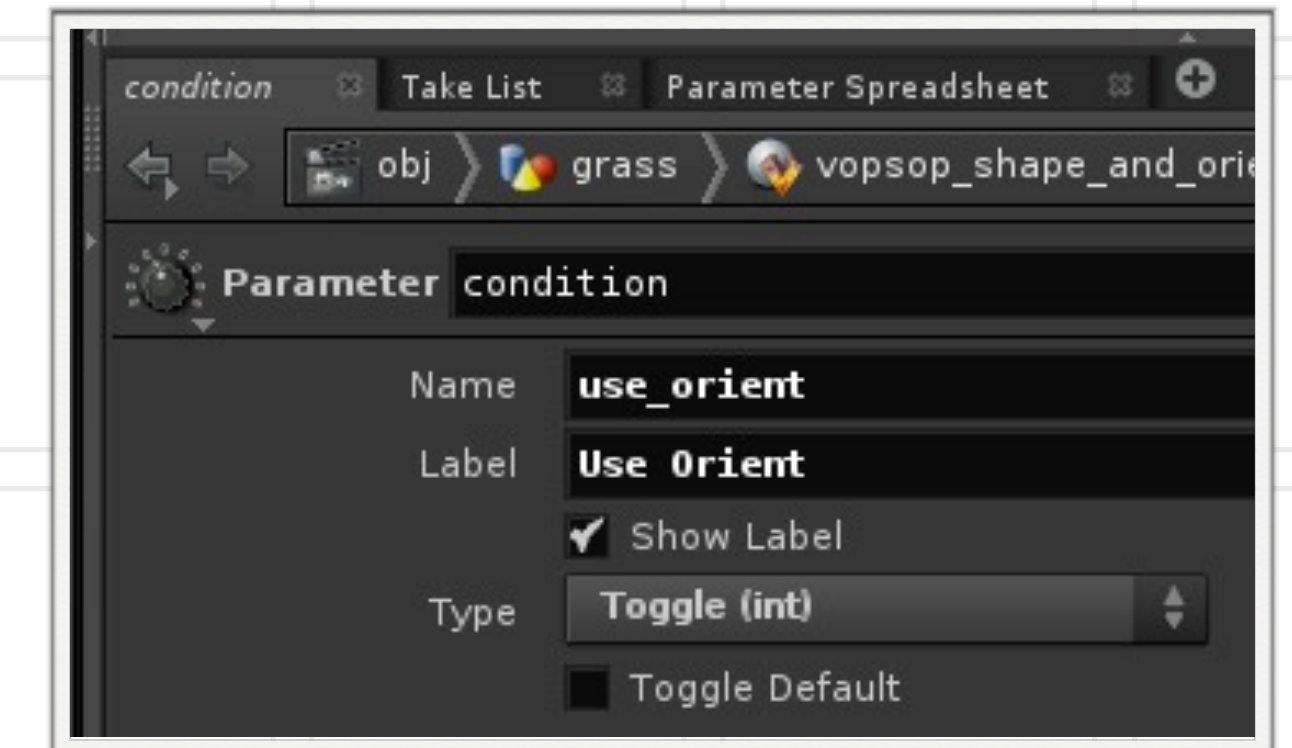
Adding Orient

- ▶ We will need the Up Vector
- ▶ In the Copy SOP go to the Attributes Tab
 - ▶ Select - Use Template Point Attributes
 - ▶ We do not want to bring along surface normals - ^N
- ▶ Now the Up Vector comes along for the ride



Adding Orient (cont.)

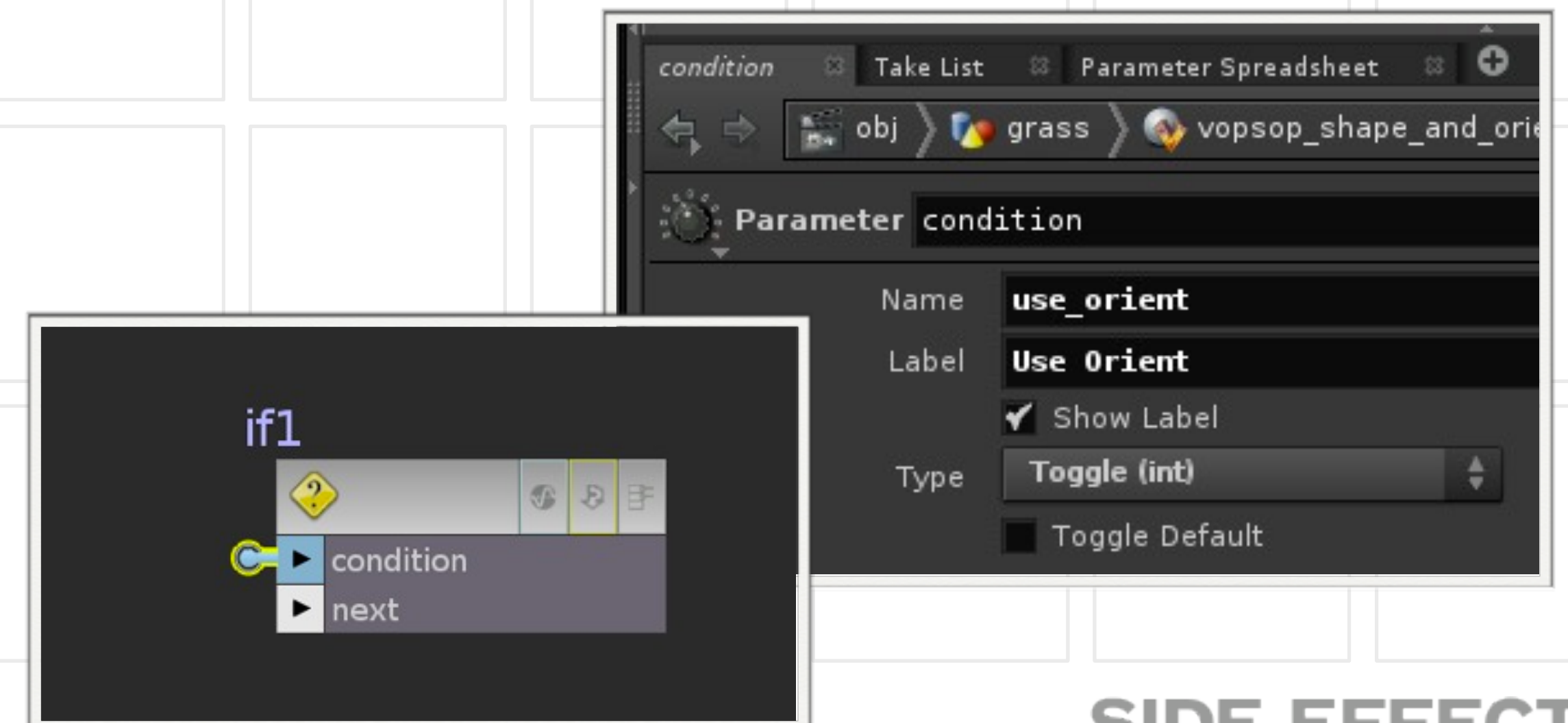
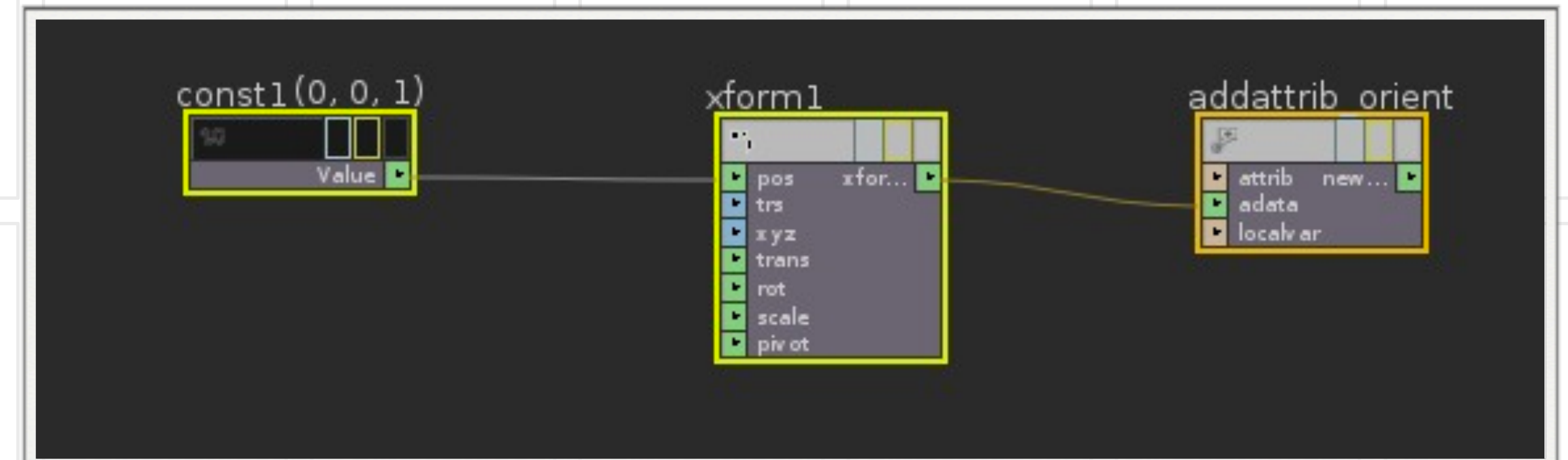
- ▶ Drop into the same VOPSOP as the grass shape tool
- ▶ Drop down a if_then-Block VOP
 - ▶ We want the user to determine if the artist wants an orient attribute
- ▶ Promote the condition of the if_then_Block
 - ▶ name - use_orient
 - ▶ Label Use Orient
 - ▶ Type - toggle (int)



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Adding Orient (cont.)

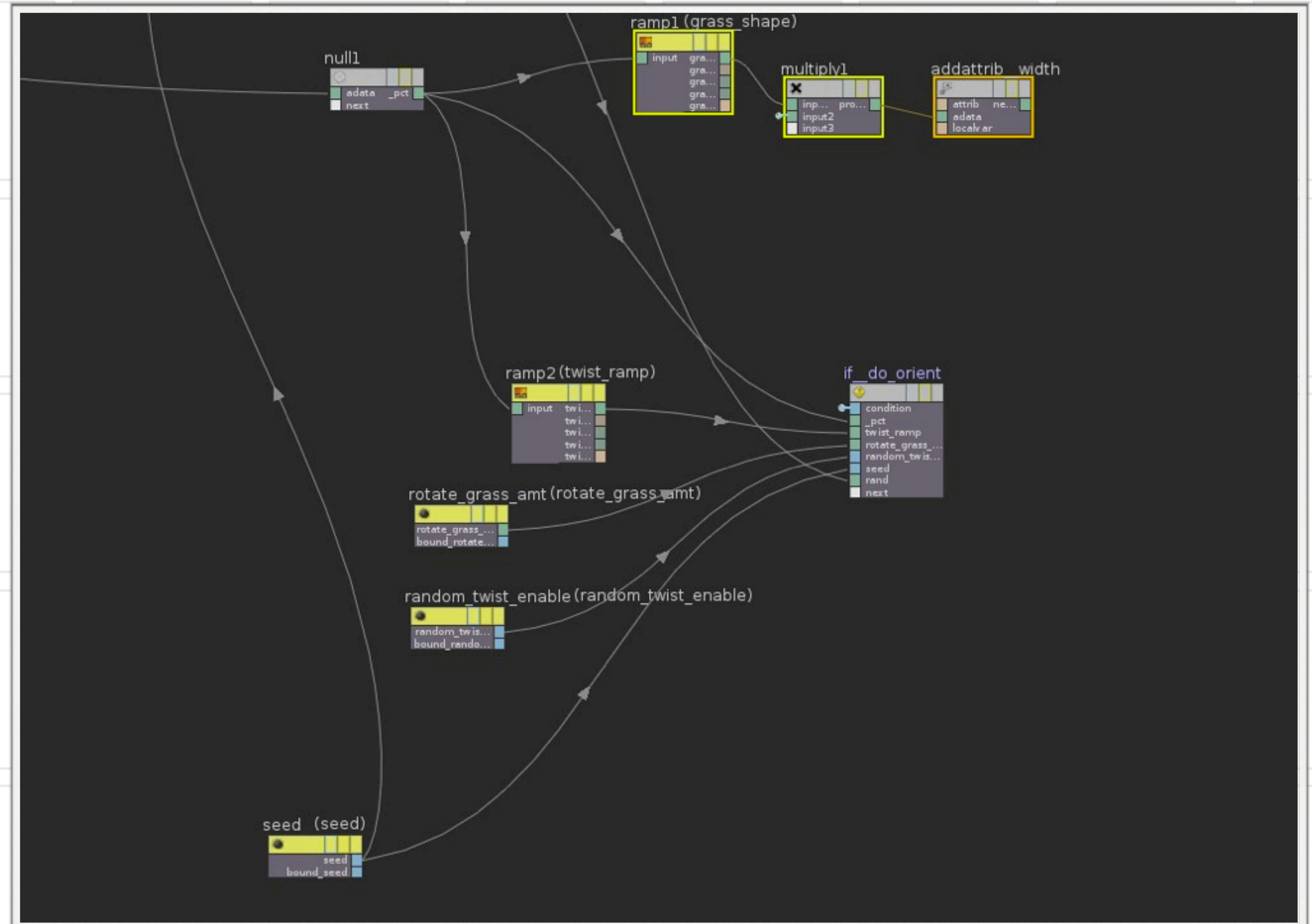
- ▶ Dive inside the if_then_Block
- ▶ Add Attribute
 - ▶ Attribute - orient
 - ▶ Local variable name - ATTRIBUTE
- ▶ Drop down a Constant VOP
 - ▶ Type - Vector
 - ▶ Value - 0,0,1
 - ▶ Constant Name - _orient
- ▶ Drop Down a Transform Matrix
 - ▶ Wire everything up
- ▶ Rotate y in the transform and see results



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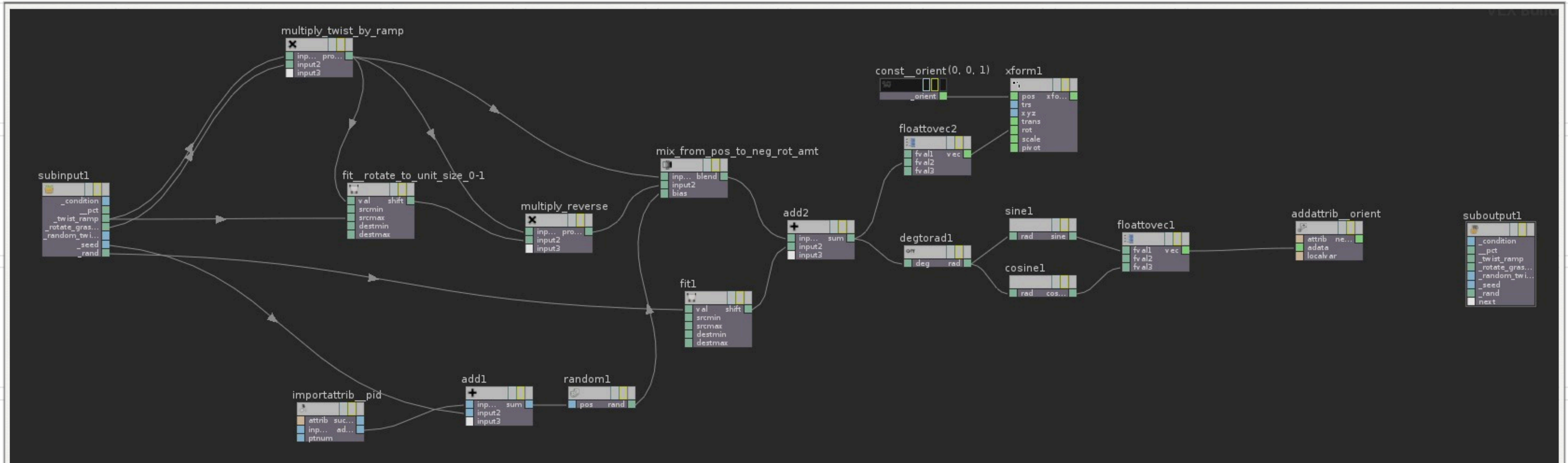
Twist & Orient - The Real Thing

- ▶ We want to setup all the Twist and Orient Parameters outside the if statement
- ▶ Need a parm for
 - ▶ twist
 - ▶ rotate
 - ▶ enable twist
 - ▶ seed value



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Twist & Orient - The Real Thing (cont)



► Inside the If Statement - Overview

What Is Going On?

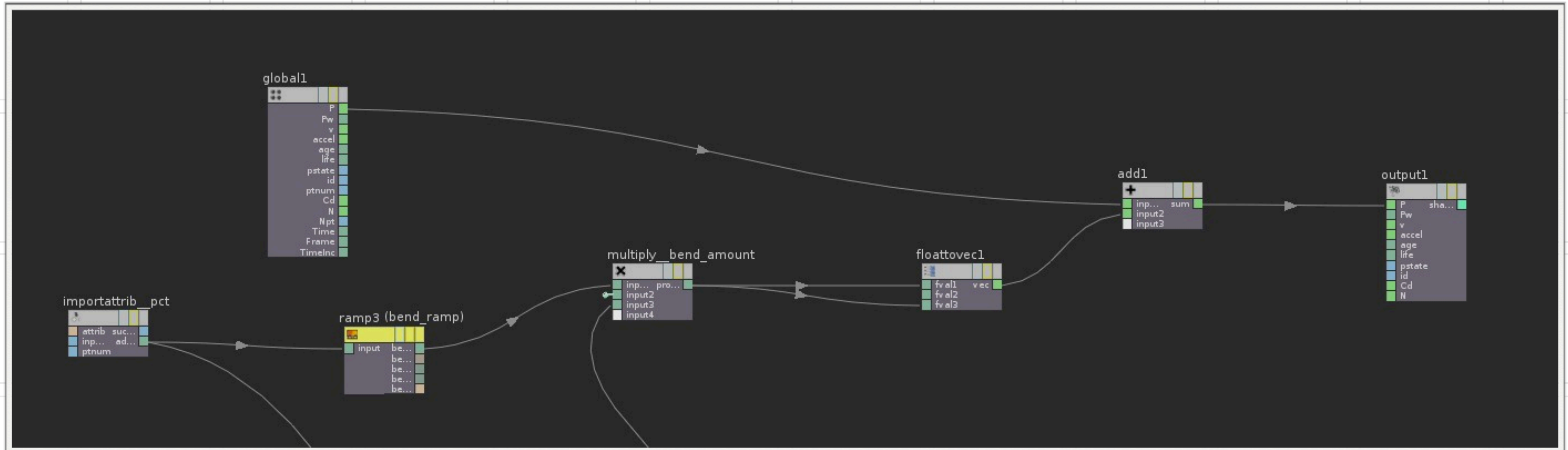
Two tracks - Calculate rotation and twist then add them together for final output

Generate a different random value based on seed and pid

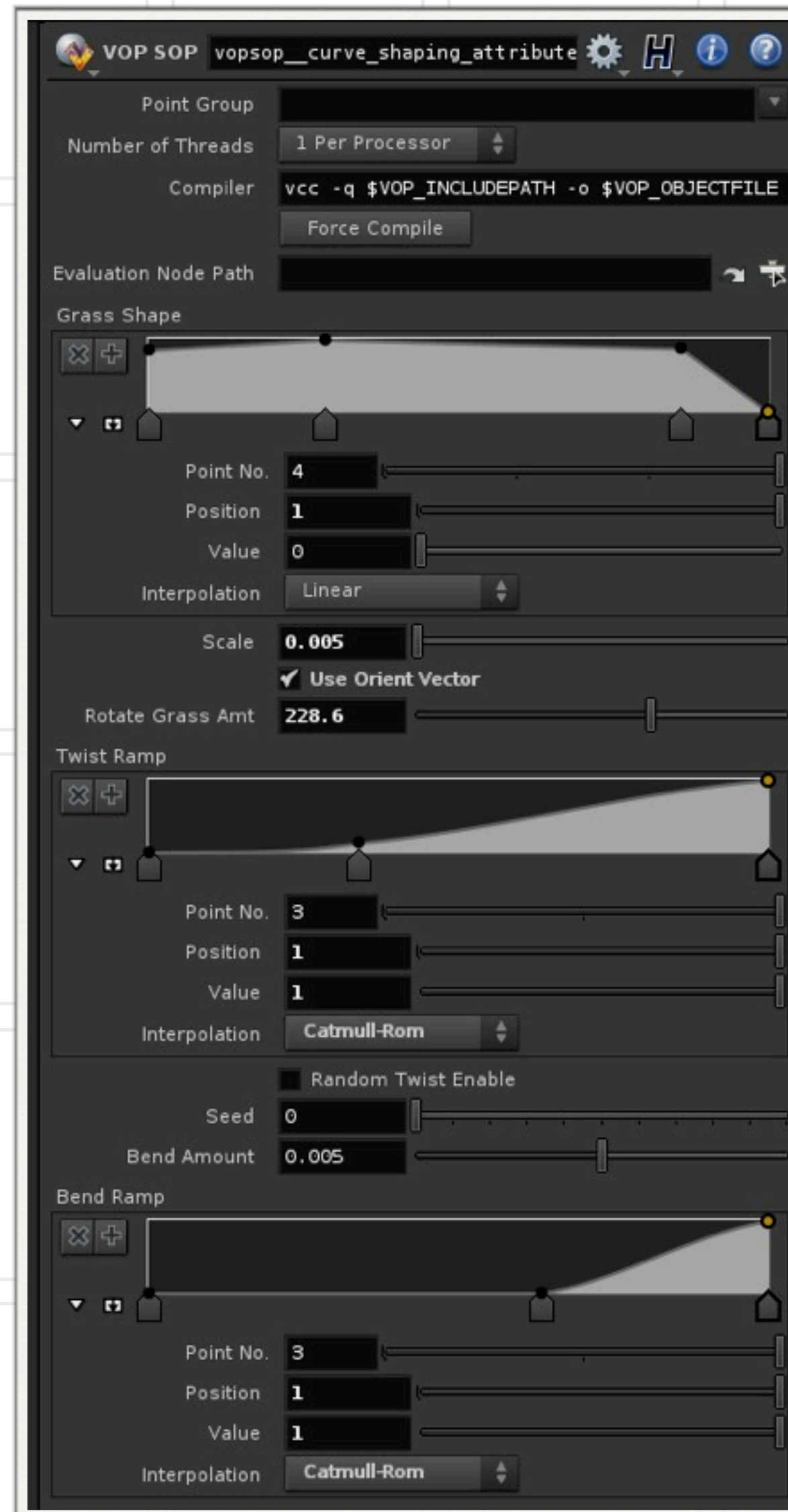
Use that to mix the twist and rotate

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Bending the Grass



Final User Interface



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Grass Shader

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Goals of Shader

Start with the Leaf Shader

Blend between two shades of Green

Have a front side and back side to the shader

- ▶ Front side - darker green, more waxy (more specular)

Have a Spine (darker Green)

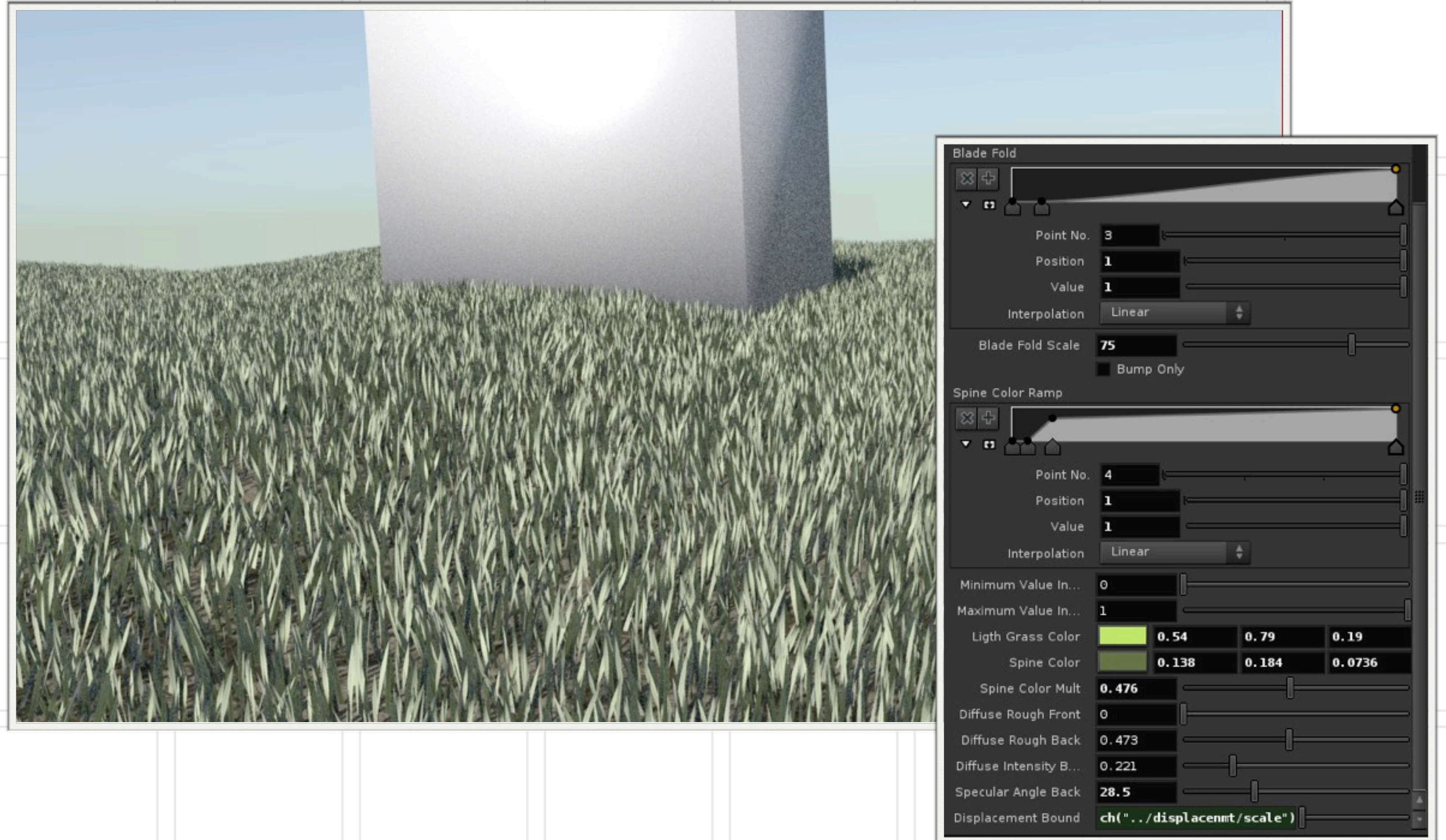
Create a Fold - Displacement from outside of blade to spline

Subsurface Shading - free with Grass shader

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What We Will Do

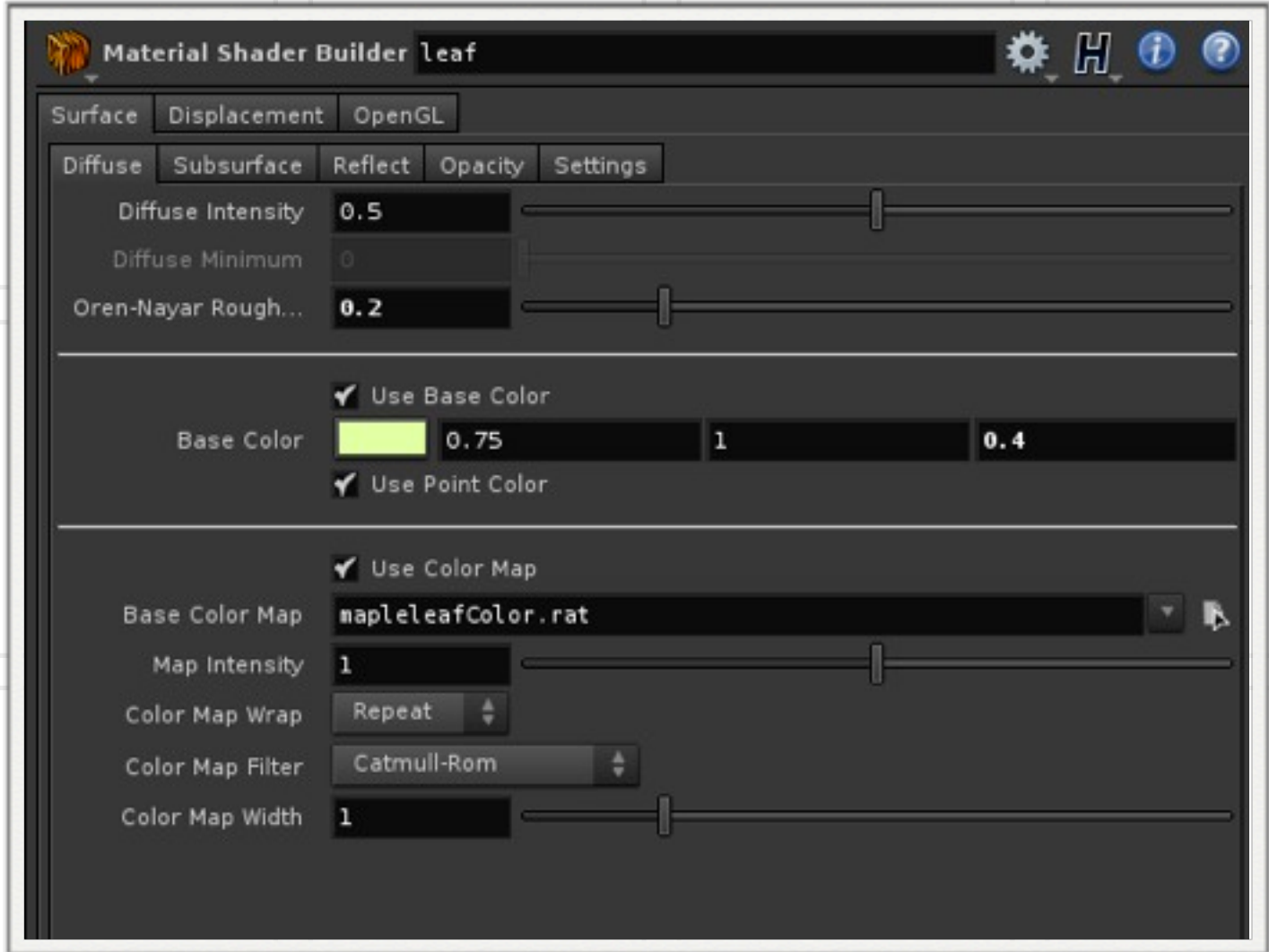
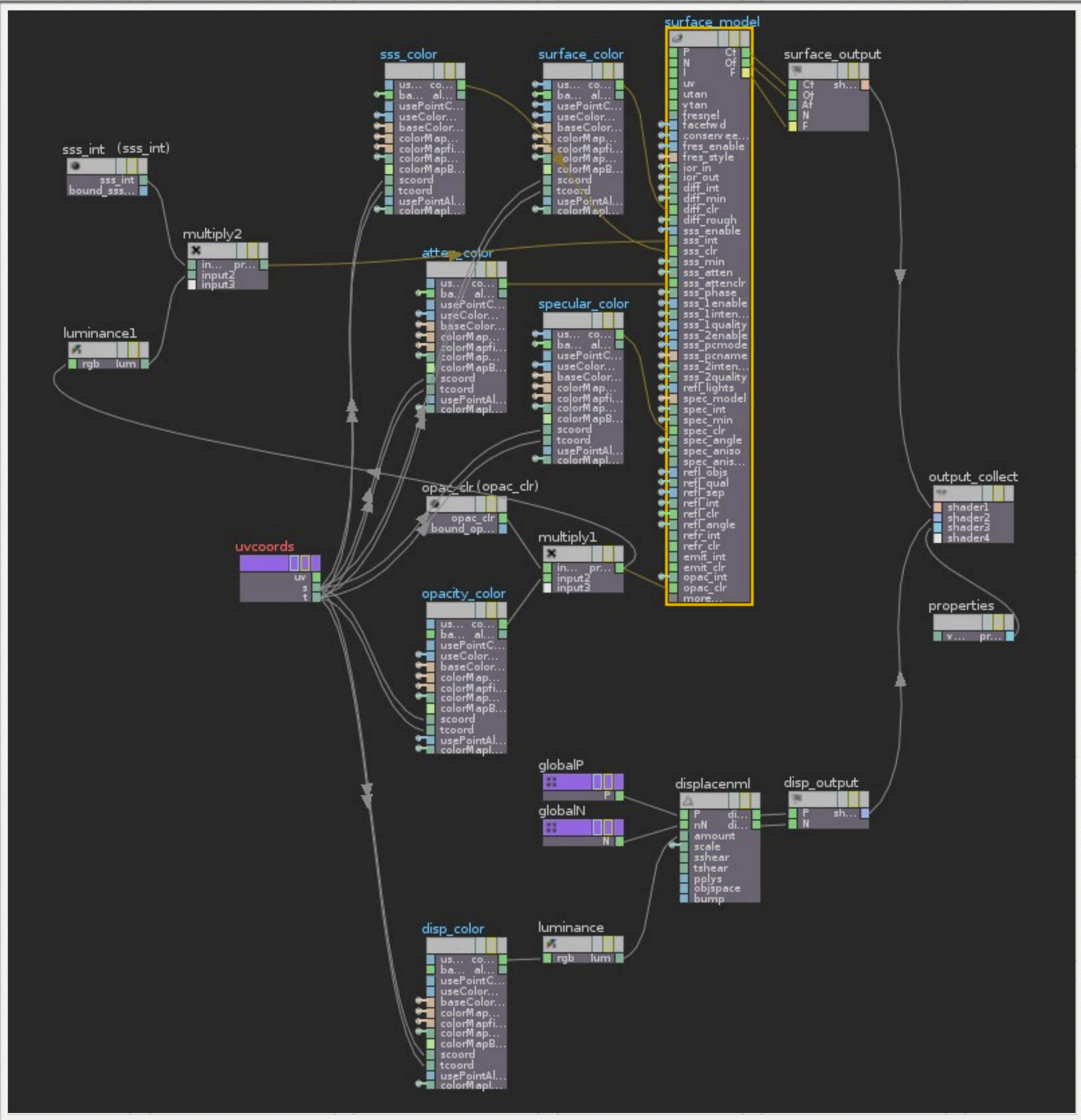
- ▶ We will add attributes and logic to the Leaf Shader to create a custom grass shader
- ▶ Add as new User Interface Section to the Leaf Shader



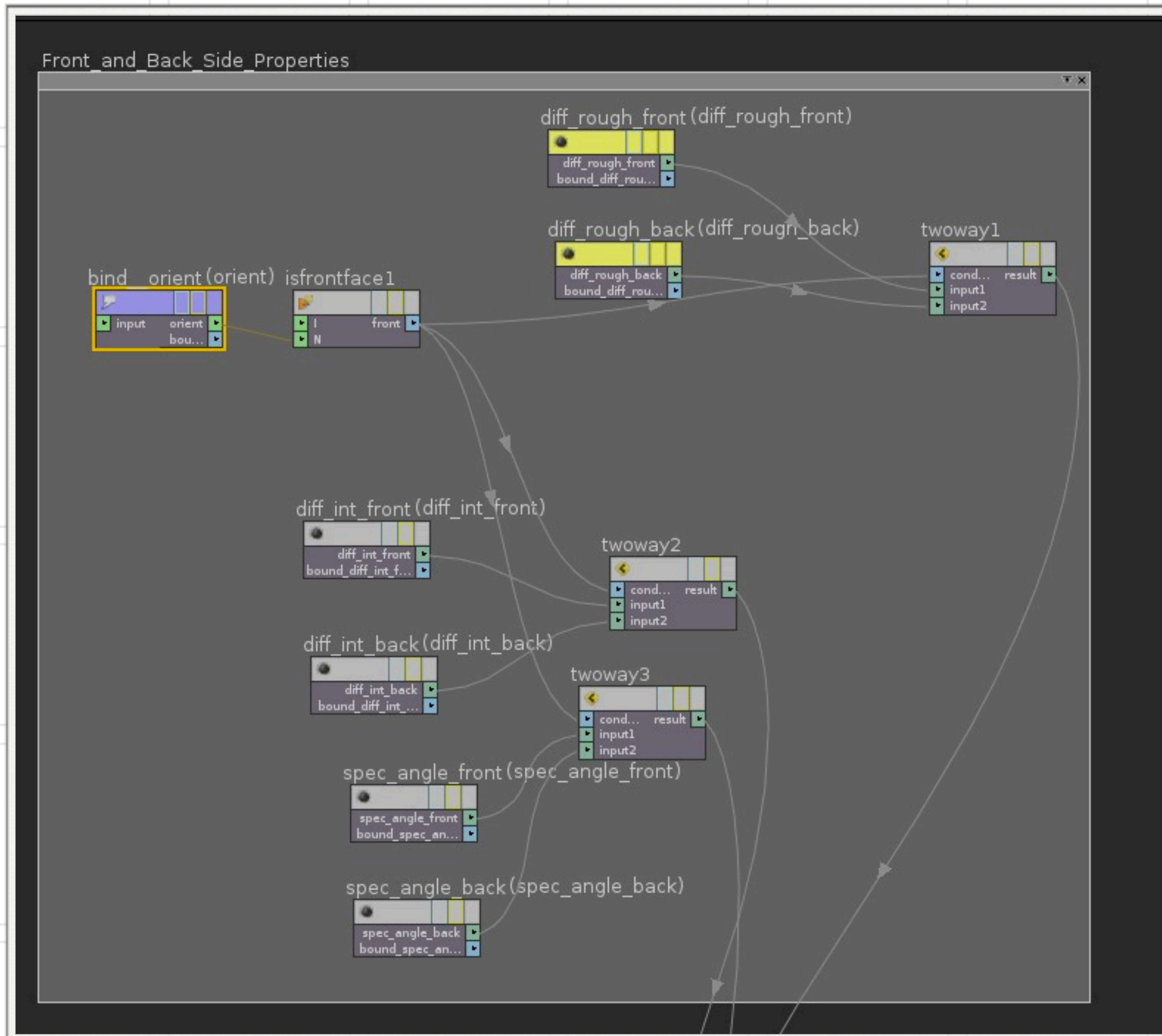
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Look at the Leaf Shader

- ▶ Disable - Use Color map
- ▶ Dive Inside. Look at different components of SHOP Network

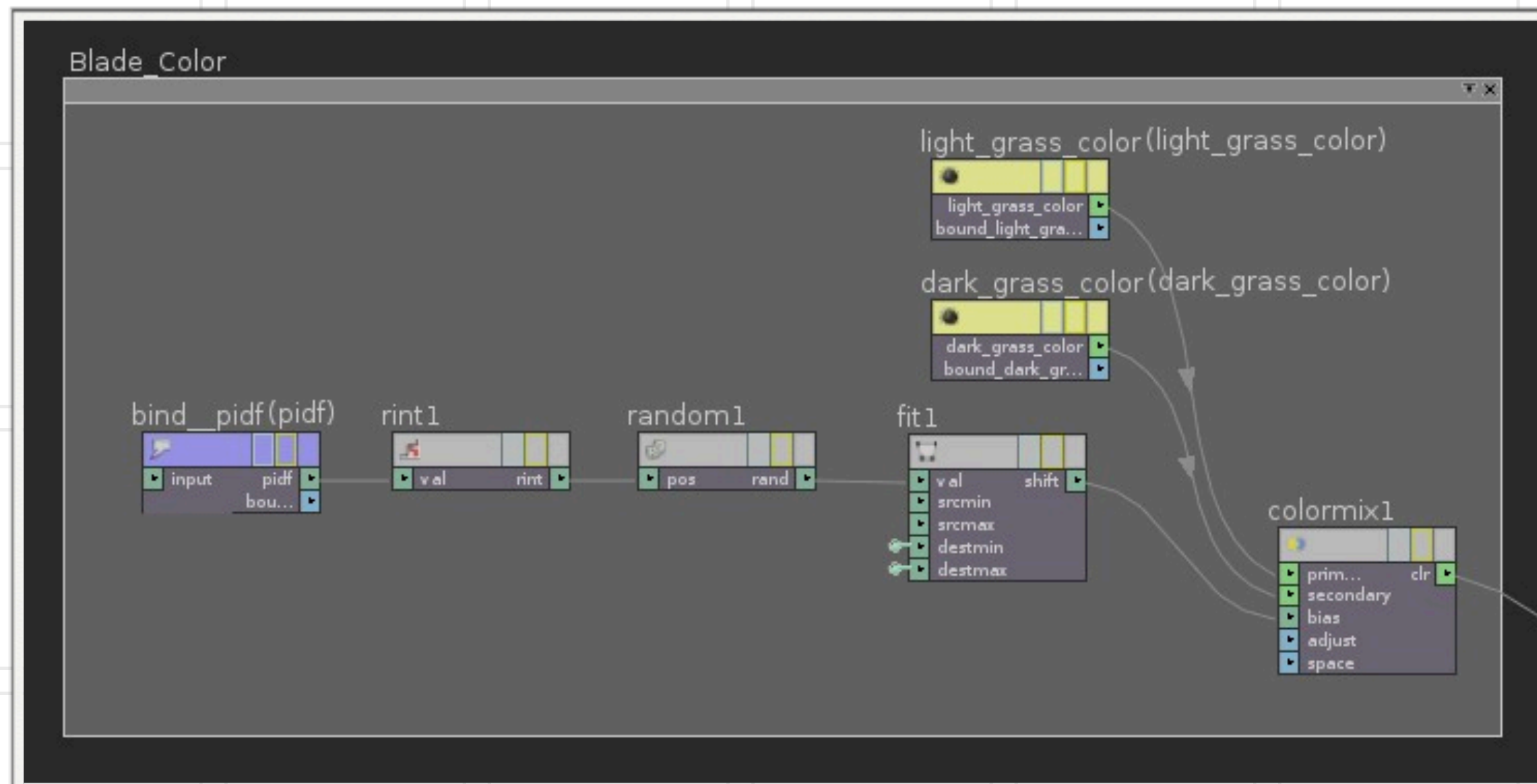


Adding Two Sided Shader



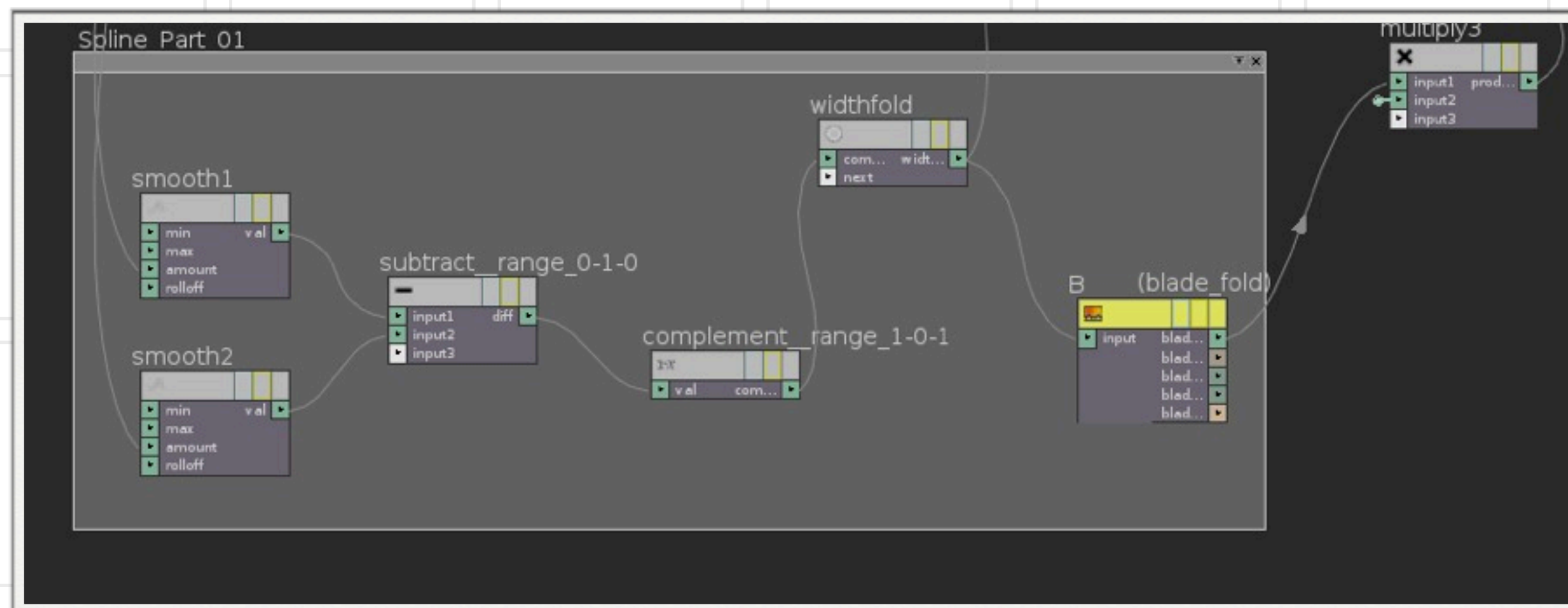
- ▶ Bind the Orient Attribute
- ▶ Key to this operation is the isFrontFace Node
- ▶ Use a Two Way Switch to switch between
 - ▶ roughness
 - ▶ diffuse intensity
 - ▶ spec angle

Adding Blade Color



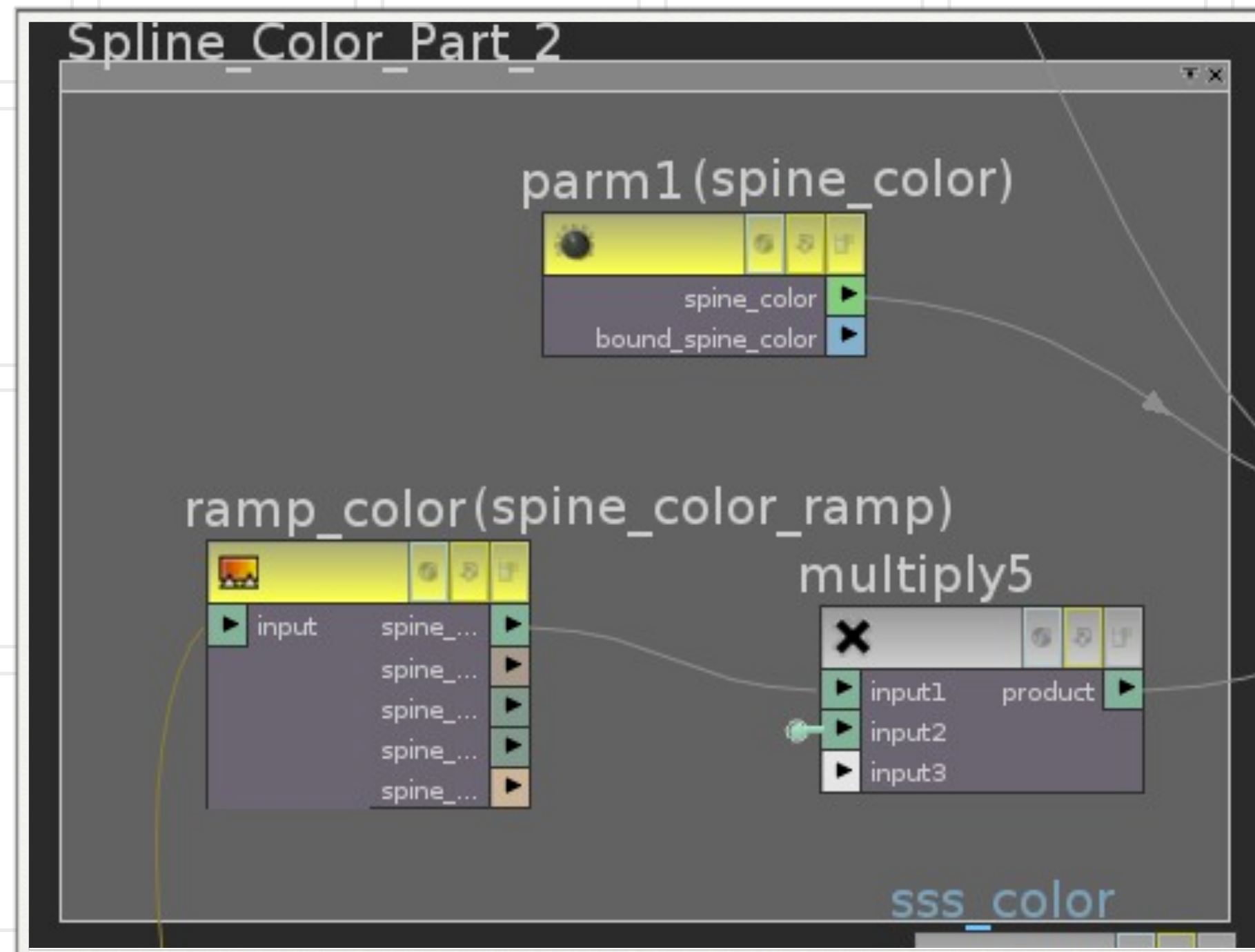
- ▶ Use the pdf as a seed to randomize color
- ▶ Use the Fit to constrain color range (if you want)
- ▶ Create a light color and dark color for mixing
- ▶ Use a Color Mix to blend based on random value

Spine Color and Displacement - Part 01



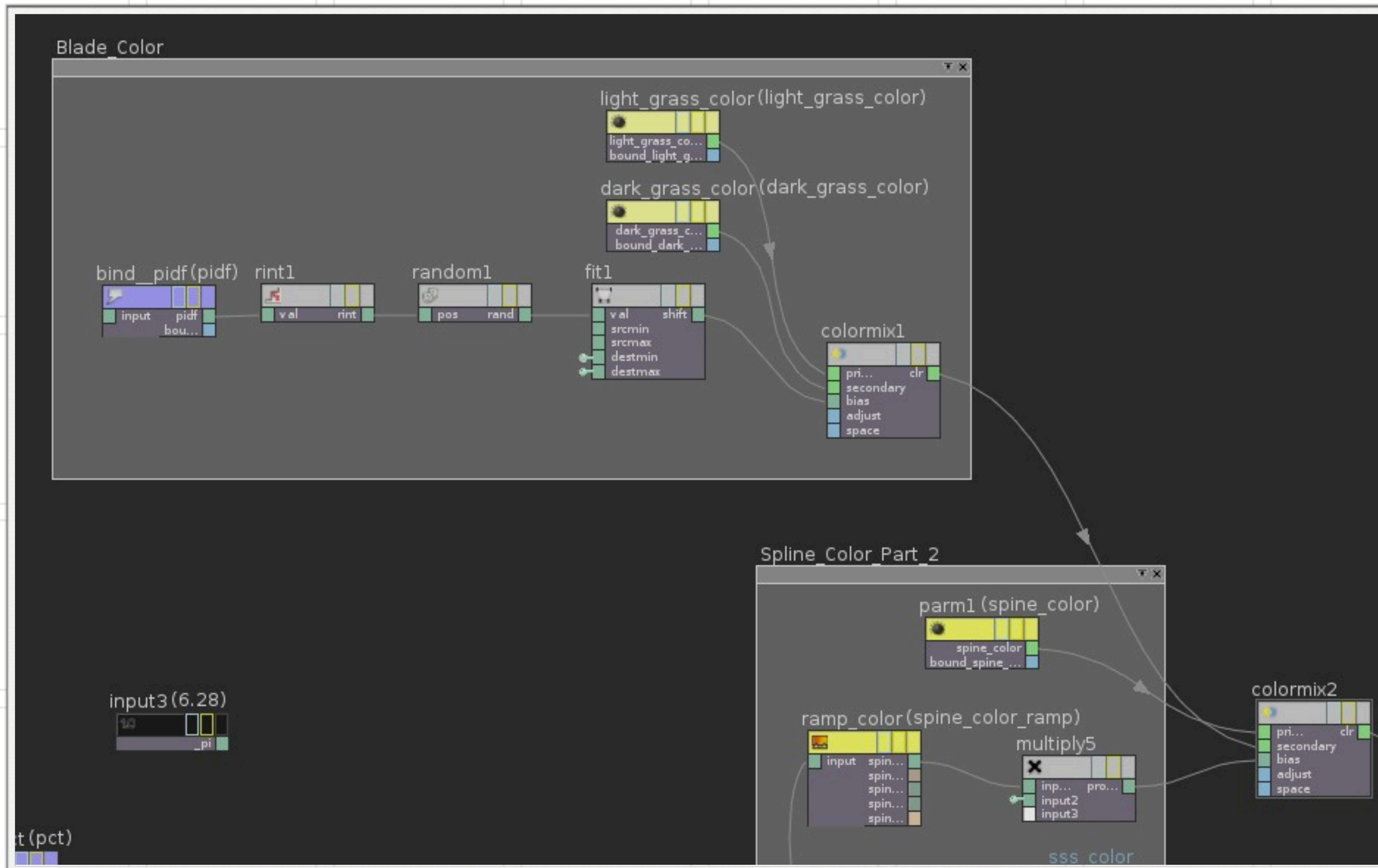
- ▶ We are going to use two smooth operation to smooth between light and dark. Then subtract the two to get the actual spine
- ▶ We will use this gradient for both color and displacement

Spine Color and Displacement - Part 02



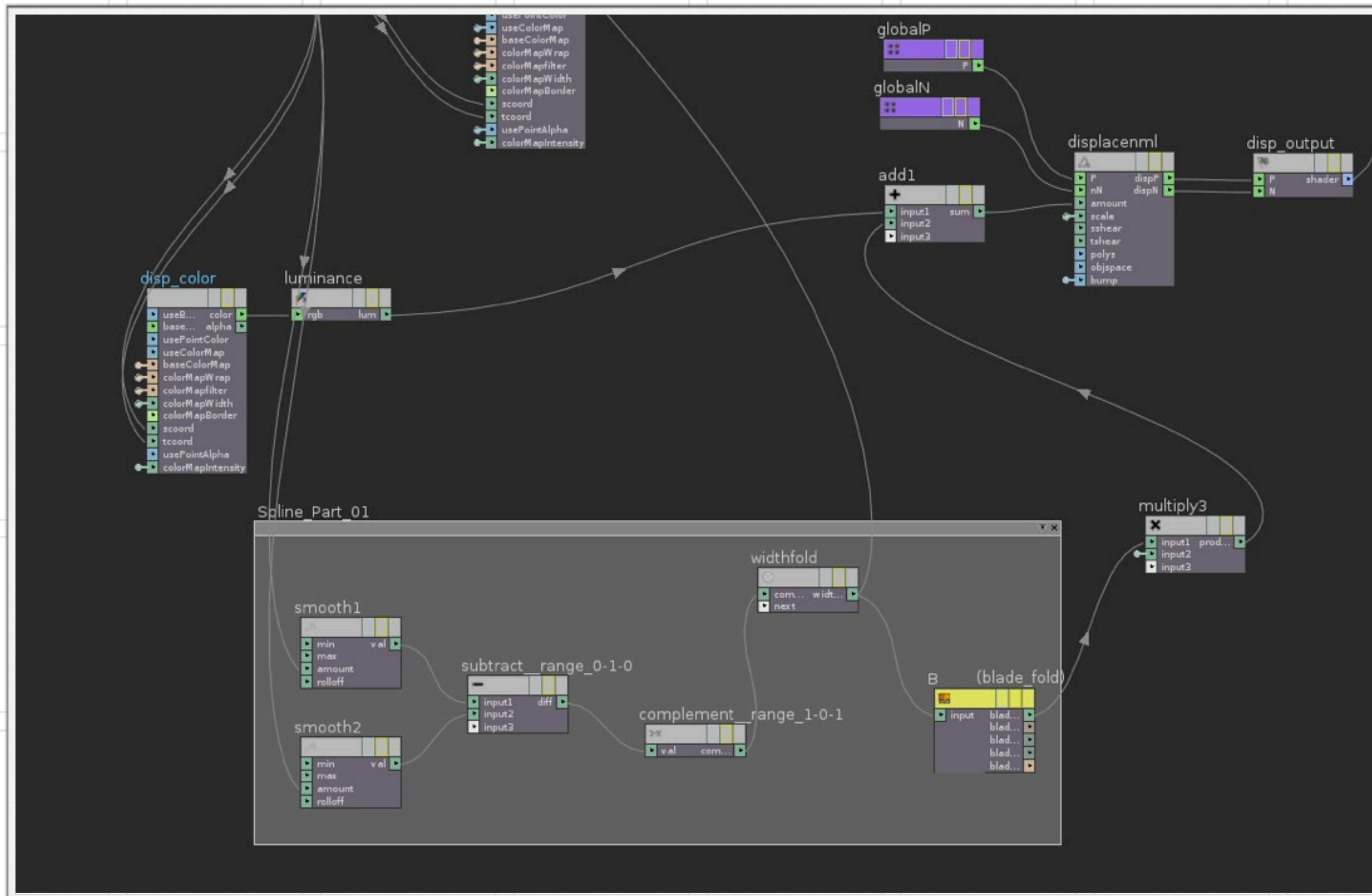
- ▶ We now use the Spine gradient created in Part 01 as the input into a spline ramp
- ▶ We will then multiply it by a value to specify how dark we want the spine

Mixing the Colors



- Now we mix the spine color with the blade color to get the input into the base color of the surface color

Displacement



- Take the luminance and add it to spine for displace along normals



End Module 05

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