Chapter 21:

In this chapter, we are going to create dynamic terrain topology. We will further explore uses for outbound attributes, that will allow us to use dynamic colors based on the height position of a dynamic terrain.

Download the two Chapter 21 files from https://github.com/rbarbosa51/GeometryNodesByTutorials/tree/main/Chapter21 . Open the Chapter21Start.blend file so you can follow along.

On the Geometry Nodes Workspace, select Chapter21 object. You will not use the default cube geometry, so there is no need for it to be connected. Disconnect **Group Input(1)** from the **Group Output(2)**. Grab a **Grid(3)** node, and connect it to the **Group Output(2)** node. On the **Grid(3)** node, change the *Size X* and *Size Y* to 20. Then change the *Vertices X* and *Vertices Y* to 100. This will create a plane with a lot of vertices (10,000 to be exact). As stated in previous chapters, turn on the Timings overlay and do exercise caution. Should your system slow down turn down the number of Vertices X and Vertices Y. Your node tree should resemble Figure 21-1.

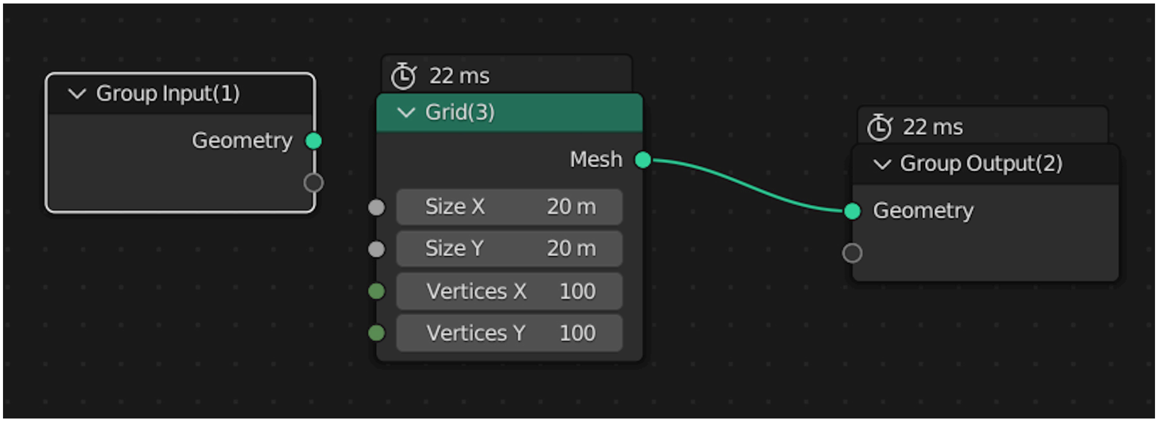

Figure 21-1

Insert a **Set Position(4)** node in between the **Grid(3)** and the **Group Output(2)** nodes. Make two connections between the **Grid(3)'s** *Vertices X* and *Vertices Y* on two empty sockets in the **Group Input(1)** node. See Figure 21-2.

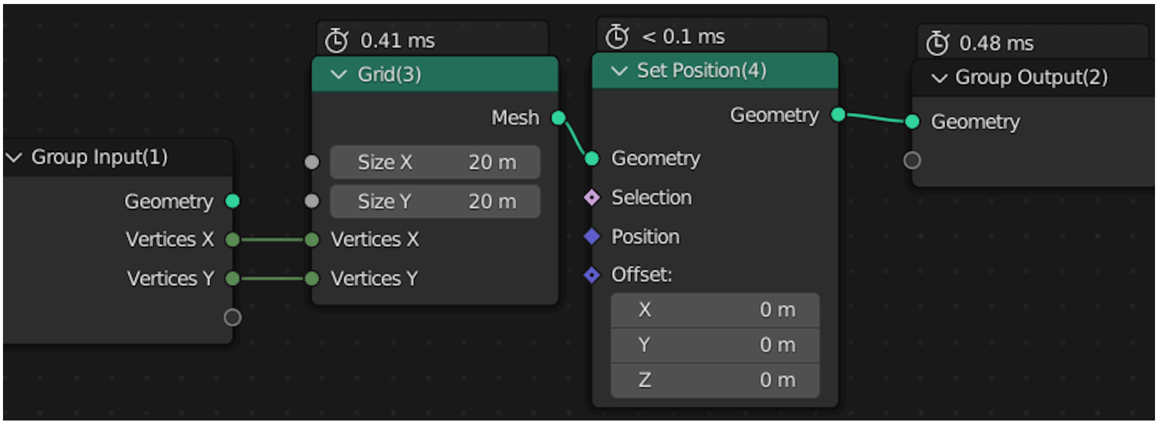

Figure 21-2

Connect a **Position(5)** node to a **Separate XYZ(6)** node. Connect the *X* and *Y* outbound sockets of the **Separate XYZ(6)** node to a **Combine XYZ(7)** node. Take the *Vector* output of the **Combine XYZ(7)** and connect it to the **Set Position(4)'s** *Position* socket (Figure 21-3). By default, the **Set Position(4)'s** *Position* socket already receives the object's position. We just separated the *X* and *Y* values from the *Z* value, and passed it back to the **Set Position(4)'s** *Position*.

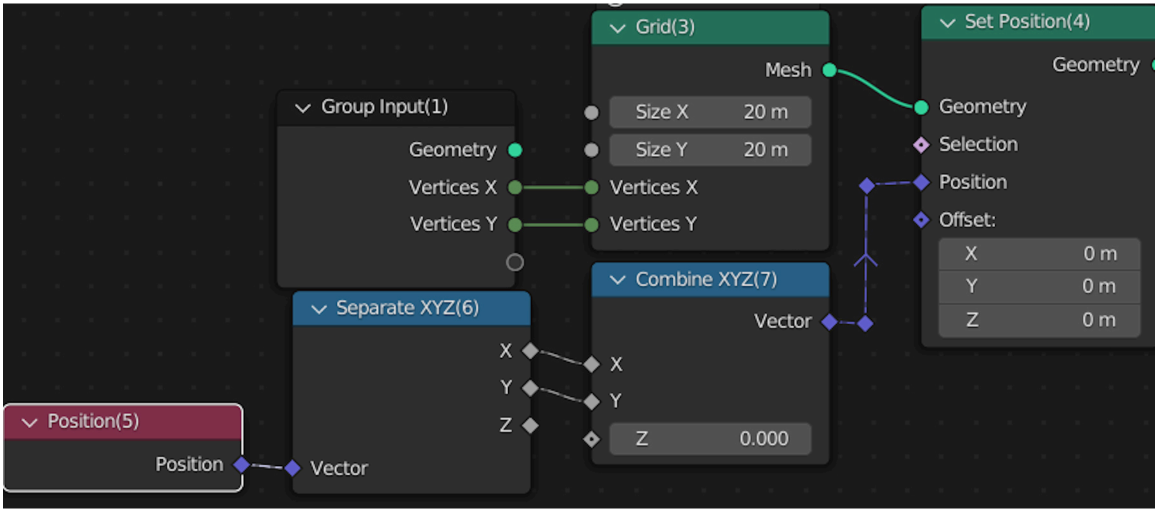

Figure 21-3

Grab a **Combine XYZ(9)** node and connect the *X* and *Y* inbound sockets to an empty sockets in the **Group Input(8)** node. Rename this two new group interfaces in the **Group Input(8)** as *X Scrolling* and *Y Scrolling* respectively. Grab a **Vector Math(10)** node and leave its function as Add. Connect the **Position(11)** node to the first *Vector* socket of this **Vector Math(10)** node. Connect the **Combine XYZ(9)** node to the second *Vector* socket of the **Vector Math(10)** node. See Figure 21-4.

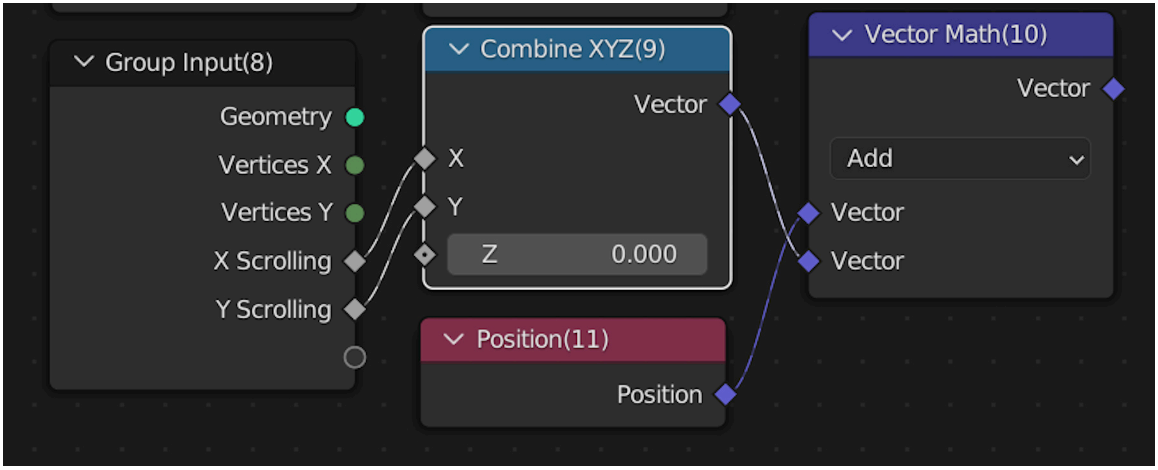

Figure 21-4

This will allow us to add to the X and Y of the current position before we distort the values in a **Noise Texture(12)** node. Connect the **Vector Math(10)** node to the *Vector* socket of the **Noise Texture(12)** node. For the time being do not modify the values of the **Noise Texture(12)** node. Connect the **Noise Texture(12)** output *Fac* socket to a **Math(13)** node. Set this **Math(13)** node function to *Subtract*. Set its secondary *Value* to 0.5. Add another **Math(14)** node and set it's function to *Multiply*. Connect the previous **Math(13)** node value to the first *Value* of this **Math(14)** node. Grab another **Group Input(15)** node and make a connection between an empty socket and the second socket of the **Math(14)** node. Rename this interface as *Height Variance*. See Figure 21-5. Finally connect the outbound *Value* of the **Math (14)** node to the *Z* socket of the **Combine XYZ(7)** node thats connected to the **Set Position(4)** node. See Figure 21-6. To view what we have done, change the 3d viewport shading to wireframe. Then zoom in on the plane. You should see something that looks like Figure 21-7.

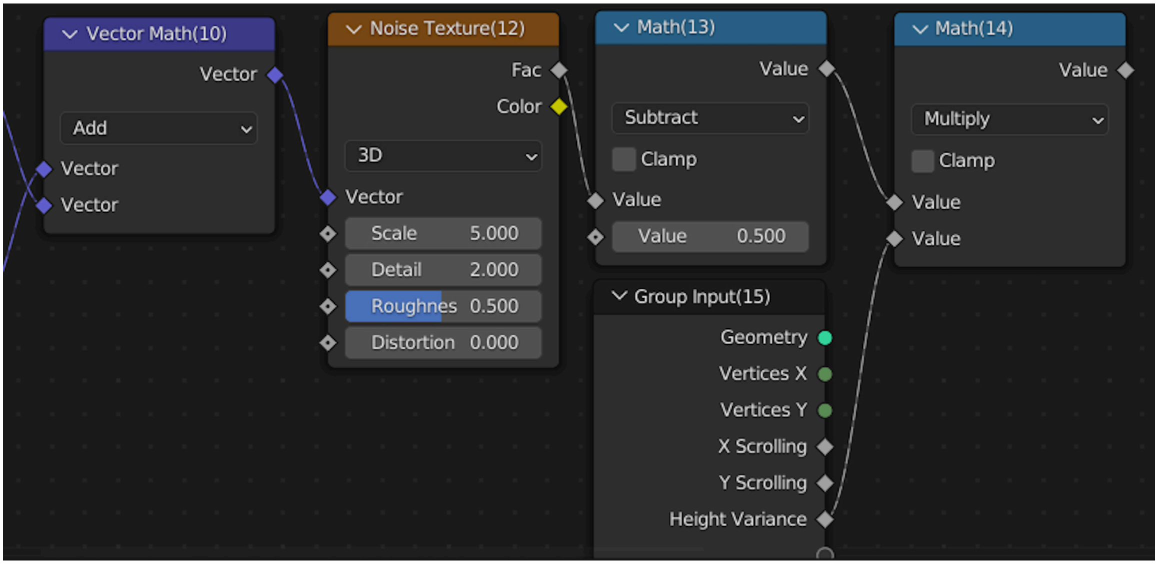

Figure 21-5

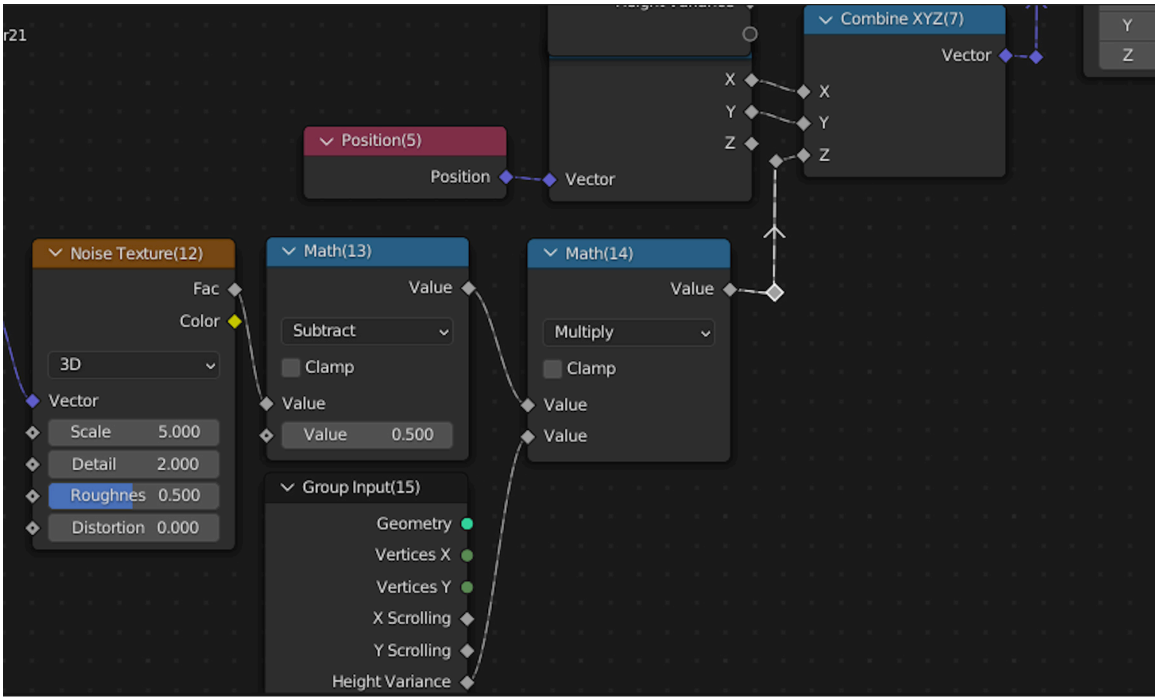

Figure 21-6

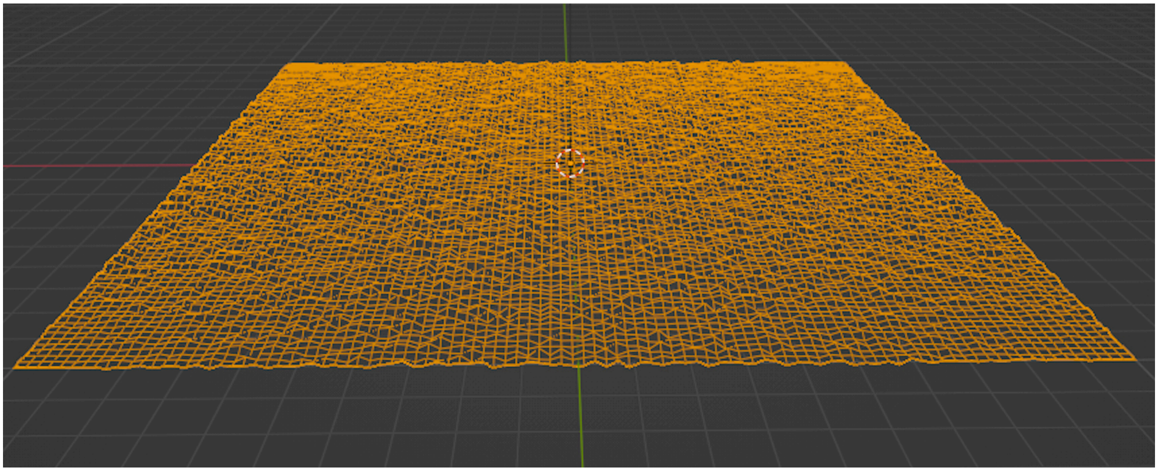

Figure 21-7

The best way to explain this is by tweaking the values and experimenting with the results. Set the viewport shading to Solid. On the modifier's tab, change the Modifier's value of the Height Variance to 10.0. The results should resemble Figure 21-8. On the **Noise Texture(12)** node, scroll thru the *Scale* values. Go from 0.0 to 2.0 and see how much it changes. Set the *Scale* value to 0.2. Scroll thru the *Details* values. Go from 0.0 to 3.0, and observe the changes. Leave the *Details* set to 0.8. Experiment by scrolling thru the values of the *Roughness* and *Distortion*. Leave both at 0.0. You are free to modify these values, but leave them back at these prescribed settings once done. Your scene should resemble Figure 21-9.

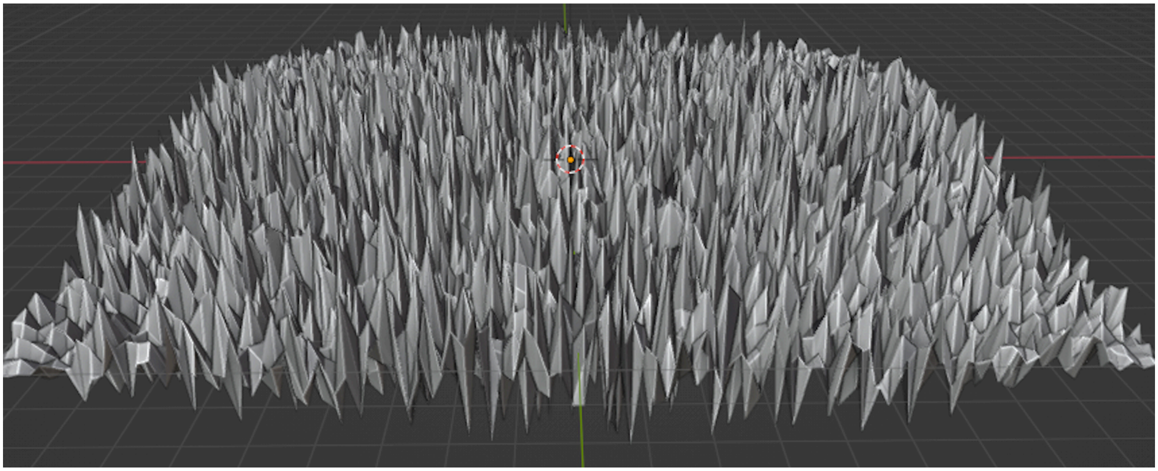

Figure 21-8

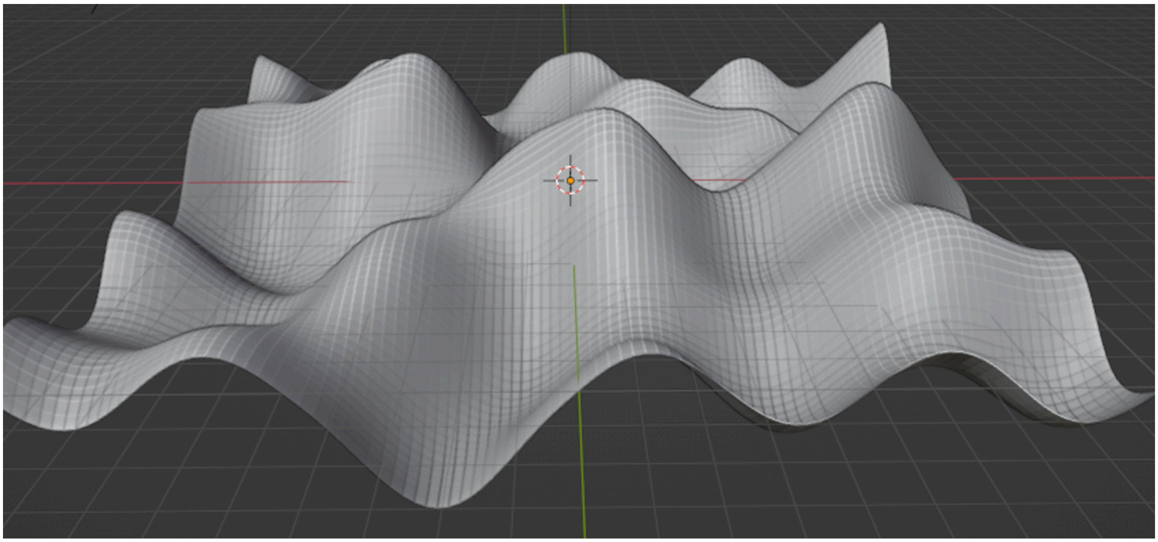

Figure 21-9

Experiment by modifying the values of the X Scrolling and Y Scrolling. You should see that the waves move uniformly either left or right depending on the X Scrolling values. You might have as well noticed that the waves move up and down depending on the Y Scrolling. Leave the values of the X Scrolling to 10.0 and Y Scrolling to 5.0. Later you can change them.

In a previous chapter we saw how to grab the value of attributes. Now we are going to analyze these values. On the Spreadsheet Editor, change from Evaluated mode to Viewer mode. Make a secondary connection from the **Set Position(4)'s** *Geometry* outbound socket to an **Attribute Statistic(16)** node. Grab another **Position(17)** node and connect it to the *Attribute* socket of the **Attribute Statistic(16)** node. Make tertiary connection from the *Geometry* outbound socket of the **Set Position(4)** to a **Viewer(18)** node (I recommend that you use reroutes). Grab a **Separate XYZ(19)** node and connect the *Z* socket to the *Value* of the **Viewer(18)** node. See Figure 21-10.

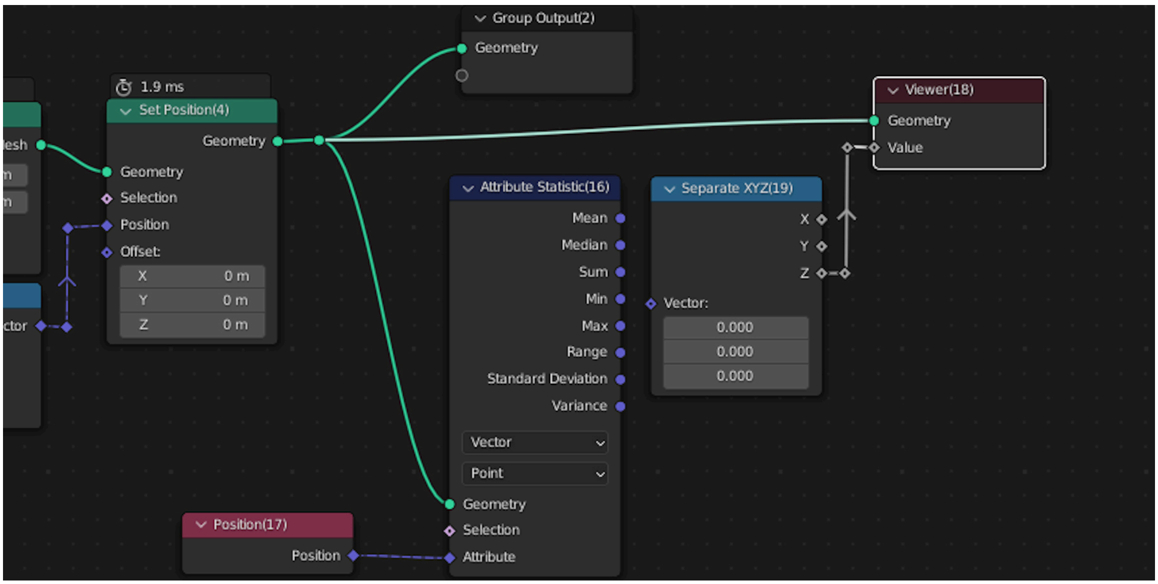

Figure 21-10

Now from the **Attribute Statistic(16)** node make a connection from the *Mean* socket to the **Separate XYZ(19)** node. Look at the Spreadsheet and under that column named *Viewer*. Pay attention to the value. Now on the Modifier tab, change the Height Variance value from 10 to 50. Scroll thru values in between and observe the values in the Spreadsheet change. The mean is the sum of all the values divided by the total number of vertices. Set the Height Variance back to 10. On the **Attribute Statistic(16)**, disconnect the *Mean* and connect the *Min*. You are now viewing the lowest value of all vertices. Do the same thing but this time with the *Max* socket. You are viewing the highest value of all the vertices.

We are interested in the Max and Min values. We will export these values to the Shading Nodes workspace as attributes. Disconnect the **Viewer(18)** node, you can set it to the side or delete it. Connect the *Min* socket of the **Attribute Statistic(16)** node to the **Separate XYZ(19)** node. Connect the *Max* socket to another **Separate XYZ(20)** node. Make a secondary connection the **Position(17)** node to a third **Separate XYZ(21)** node. See Figure 21-11.

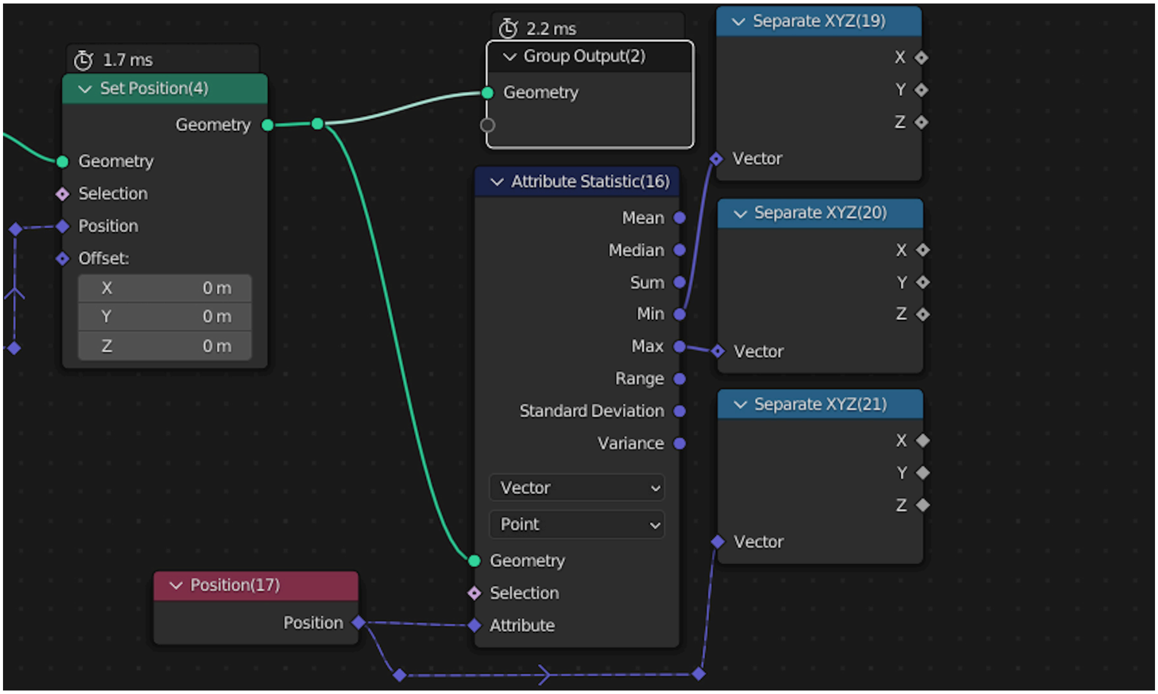

Figure 21-11

Disconnect **Group Output(2)** from the **Set Position(4)** node. Make a secondary connection between **Set Position(4)'s** *Geometry* socket and **Store Named Attribute(22)'s** *Geometry* socket node. From the **Store Named Attribute(22)** make a connection to another **Store Named Attribute(23)** node. Make a connection from this new **Store Named Attribute(23)** node to another **Store Named Attribute(24)** node. Finally connect the **Store Named Attribute(24)** to the **Group Output(2)** node. Your node tree should resemble Figure 21-12.

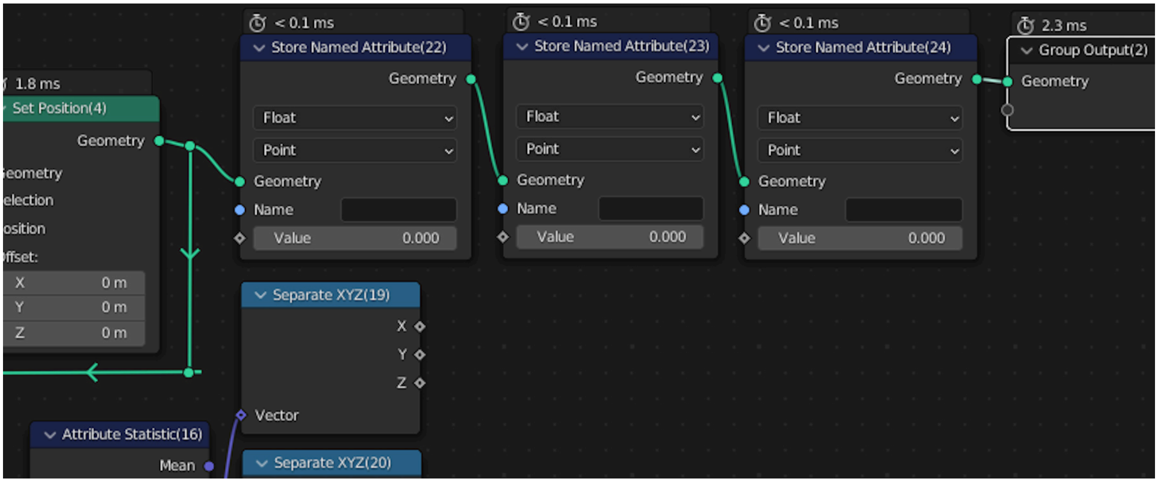

Figure 21-12

In the Name field of the **Store Named Attributes(22)(23)(24)**, you are going to write the following: ***(22)*** - *Min*, ***(23)*** - *Max*, ***(24)*** - *HeightVariance*. Drag a connection between the Separate XYZ(19)'s Z socket to the Value socket of the Store Named Attribute(22) node. Drag a connection between the Separate XYZ(20)'s Z socket to the Value socket of the Store Named Attribute(23) node. Finally, drag a connection between the Separate XYZ(21)'s Z socket to the Value socket of the Store Named Attribute(24) node. You might want to use reroutes to beautify your node tree. Your node tree should now resemble Figure 21-13.

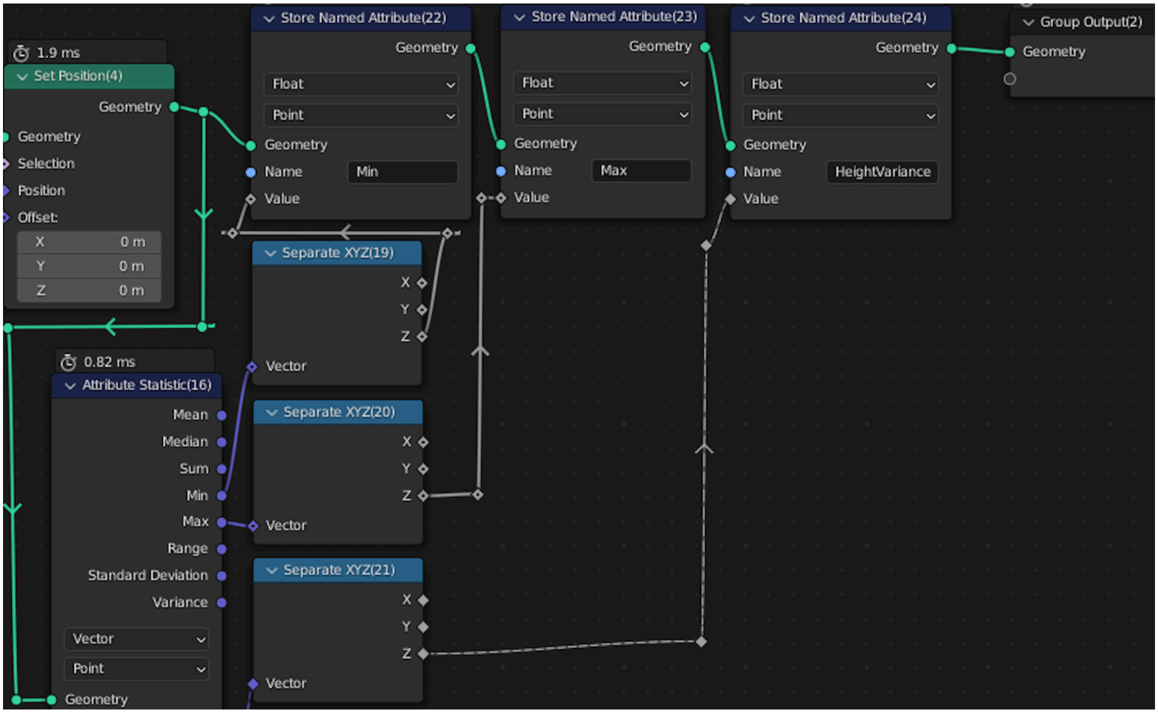

Figure 21-13

The purpose of the **Store Named Attribute** node chain is to name and then export attributes to be used outside (Shading Nodes). We exported the minimum and maximum Z values of all 10,000 vertices. This will be used in a map range node to modify color values based on the individual vertices Z position.

Before we can use these attributes, we need to add a **Set Material(25)** and **Set Shading Smooth(26)** nodes. Connect the **Set Material(25)** to the connection between the **Store Named Attribute(24) node** and the **Group Output(2)** nodes. Set the **Set Material(24)** node material to the pre made *Terrain* material. Connect the **Set Shading Smooth(26)** between the **Set Material(24)** and **Group Output(2)** nodes. Your node tree should resemble Figure 21-14.

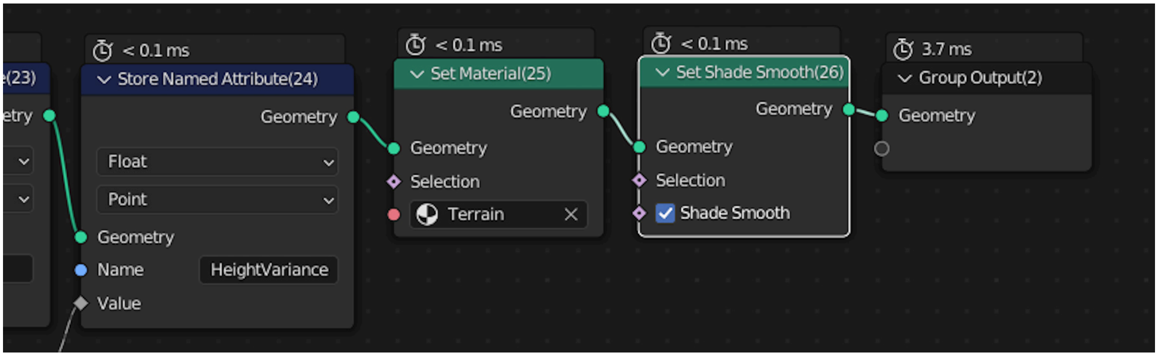

Figure 21-14

Go to the Shading Workspace. The Terrain material should be pinned. You should see three **Attribute** nodes already pre-connected. They are connected to a **Map Range** node, who in turn is connected to a **Color Ramp** node that provides the *Base Color* for the **Principled BSDF** shader. On the **Attribute(27)'s** *Name* field write *HeightVariance*. On the **Attribute(28)'s** *Name* field write *Min*. On the last **Attribute(29)** node, write *Max* on the name field. See figure 21-15.

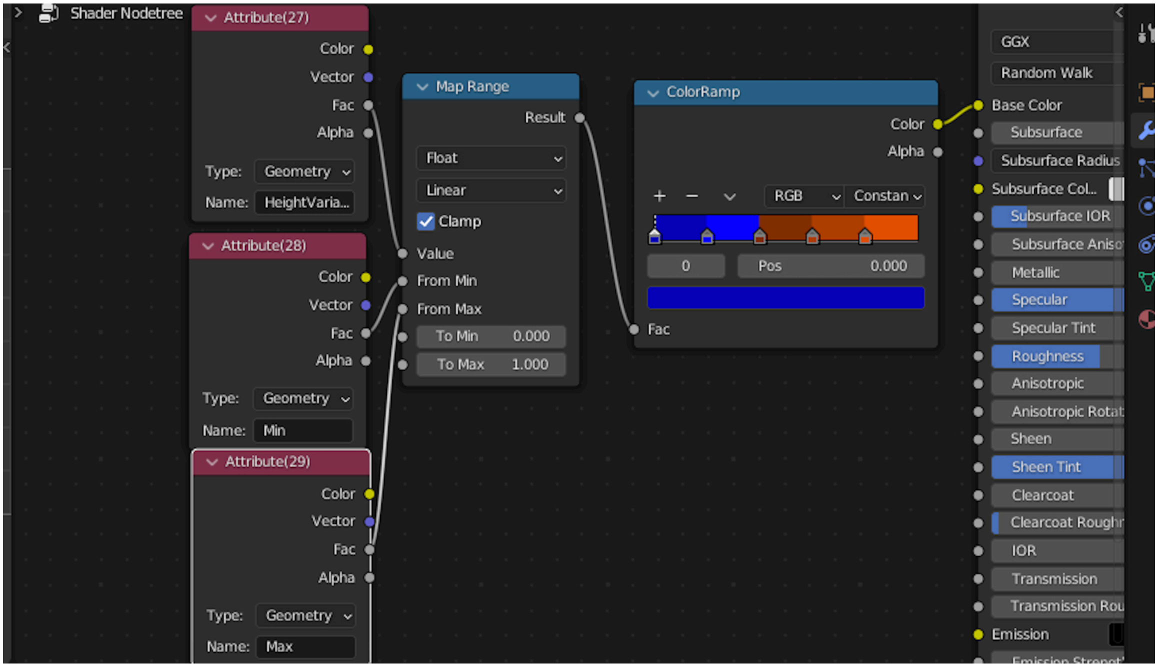

Figure 21-15

In a nutshell, the **Attribute** nodes receives the value of the minimum and maximum values we passed from the Geometry Nodes workspace, and then we map them to a range from 0.0 to 1.0. In other words, the minimum vertex value becomes 0 and the maximum vertex value becomes 1.0. We then map lower values to dark blue and blue. The higher values get mapped to brown and light brown.

Go to the Layout Workspace. The final result will look like Figure 21-16. Play with the values on the modifier's interface, and find some values that you find aesthetically pleasing.

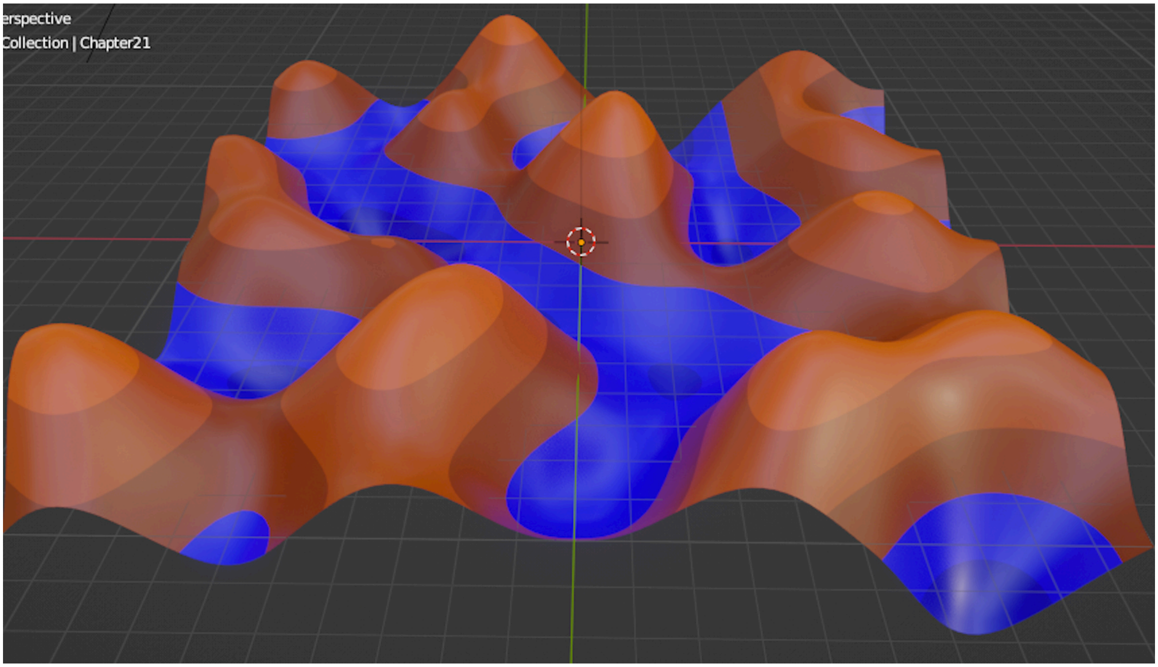

Figure 21-16

Compare your results and node tree with those of the downloaded Chapter21Final.blend file.