Chapter 1:

Geometry Nodes is a relatively new system for non-destructive modeling. It is a system that provides advance workflow for creating and modifying geometry. It is aggregated to the modifier stack allowing integration with other Blender systems. It is very similar to shading nodes in the way it inputs and outputs its data via noodles.

The system was first introduced in Blender 2.9x, however starting with the release of Blender 3.0, the whole system received an overhaul. Please keep in mind that many of the examples in this book will not be compatible with Blender versions prior to 3.3. Please note that Geometry Nodes is continually being updated so future versions of Blender may contain changes.

This book assumes that the reader has a general familiarity with Blender and 3d modeling in general. The book makes the assumption that the reader will know how to navigate in different workspaces, change editor and mode types, and use modifiers. If that is not the case, then I highly recommend that you get some knowledge in these areas before proceeding.

Before we get started, download the starter and finished blend files for all the chapter of this book. The project files for this book are hosted on GitHub. The address is: https://github.com/rbarbosa51/GeometryNodesByTutorials. On the Github page, click on the green Code button and from the dropdown, choose Download ZIP. Many projects have external dependencies that are required in order to follow along with the tutorials. When opening files ensure that you also select Load UI as the chapter files have simplified UIs that will assist you in your learning journey. For this chapter download Chapter1Start.blend and Chapter1Final.blend files.

Let's get started! First, open the Chapter1Start.blend file and go to the Geometry Nodes Workspace. Make sure that the default cube is selected. You should have a workspace that looks like Figure 1-1.

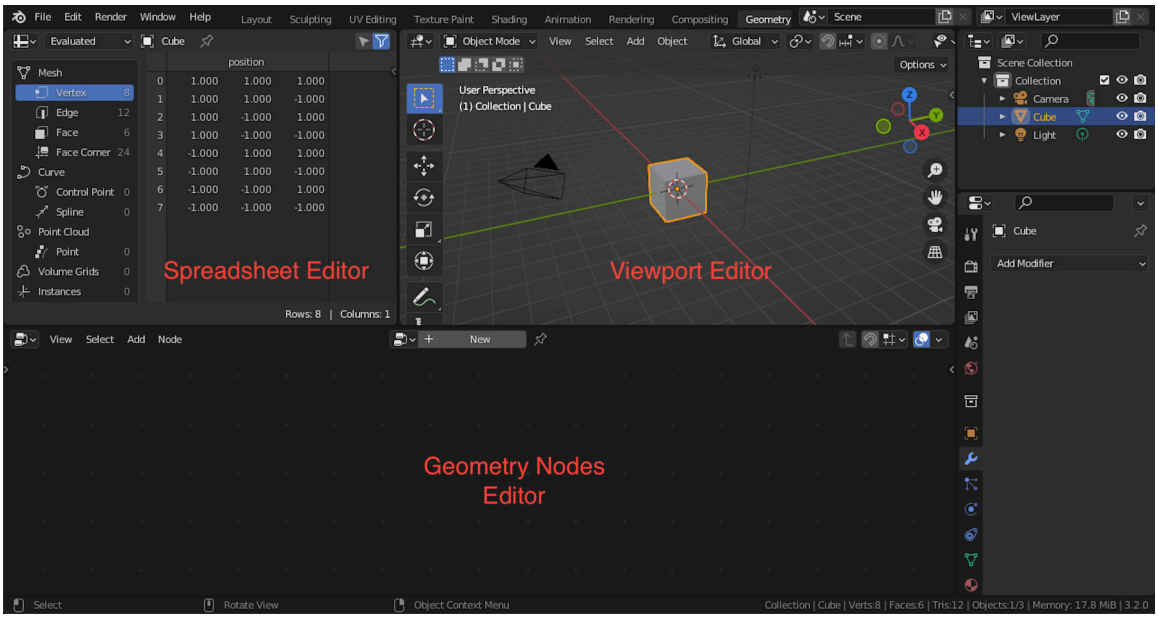

Figure 1-1

This workspace is composed of three editors: the spreadsheet, the 3d Viewport, and the Geometry Node editor. For the majority of the projects in this book, we will only use this workstation. Alternatively you can always split the Layout workspace and change the editor to Geometry Nodes.

With the Chapter1 object selected, press the *New* button on the Geometry Nodes editor. You will be see that there will be two nodes connected to each other by a green cable (Figure 1-2). You will also notice that on the modifier tab there is now a new modifier on the stack. The Geometry Nodes pipeline is just another modifier and just like any other modifier you can disable, delete, or rearrange within the modifier stack.

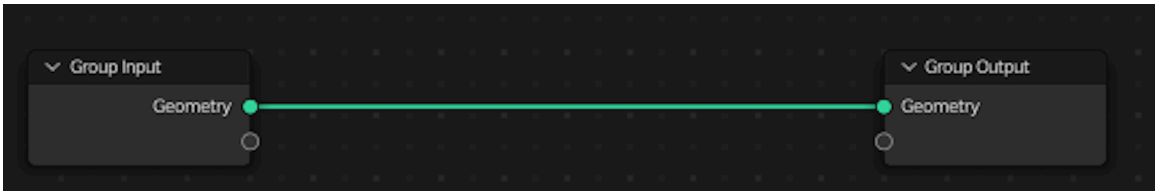

Figure 1-2

The two nodes are the **Group Input** and **Group Output**. This configuration is called a node tree. The Group Input imports all the points (vertices) of the original object. You do not always need to use the original geometry. As an experiment, disconnect the **Group Input** from the **Group Output**. This is done by either pressing Ctrl and right clicking and dragging to cut the line, or by clicking, holding, and dragging from one of the sockets.

Now that you disconnected the two nodes, look at the output of the viewport; you should see that it's empty. Now you are going to add a new mesh primitive. To add nodes, you can go to the Menu->Add and then select the desired nodes. In this particular case we will be adding a Mesh Primitive->**Cylinder**. Connect the **Cylinder** node to the **Group Output** (Figure 1-3) and you should now see that your default cube became a cylinder (Figure 1-4).

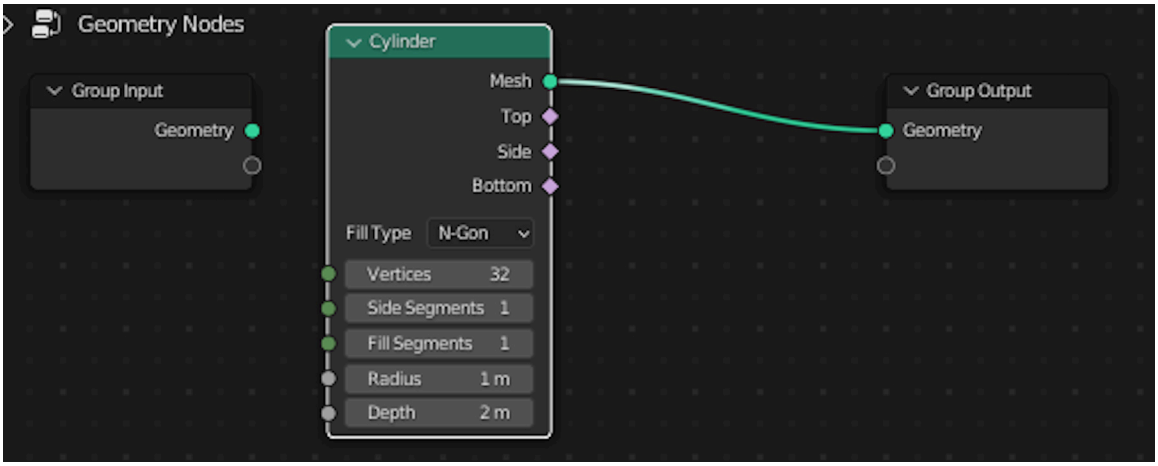

Figure 1-3

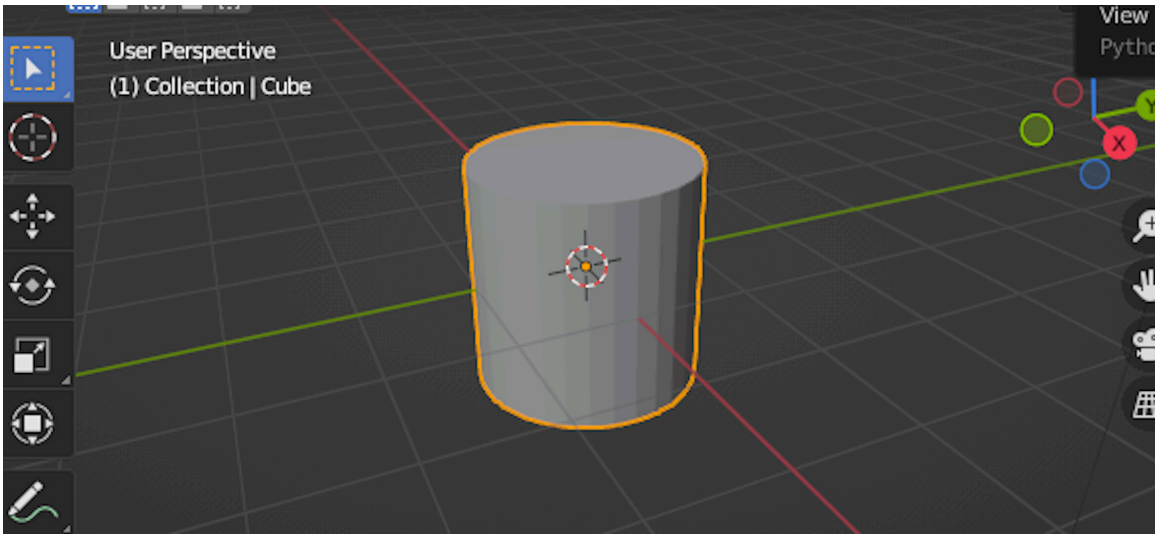

Figure 1-4

Change the viewport to Edit Mode and now you should still see the cylinder as well as the default cube. Should you try to make changes to the object in Edit mode, you will notice that you are still editing the original vertices of the default cube. Should you choose to undo the changes, just remove the modifier and you should get the original default cube. If you need to export whatever you made in

Geometry Nodes, you will have to apply the modifier to “make them real”.

On the modifier tab, remove the geometry node modifier. Then click the New button again to make a new geometry node modifier. You should have gone back to having a **Group Input** connected to a **Group Output** like Figure 1-2. This can be helpful if you ever want to start over and discard a previous node tree.

A way to add nodes is by using the keyboard shortcut: Shift-a. This should give you the same options as the menu, however if you hit the s key on the keyboard, you can now perform a string search for nodes. Use this method to look for a **Subdivide Mesh**. Once you get it, just drop it on the green connection (noodle) and it will automatically connect in between the **Group Input** and **Group Output** (Figure 1-5).

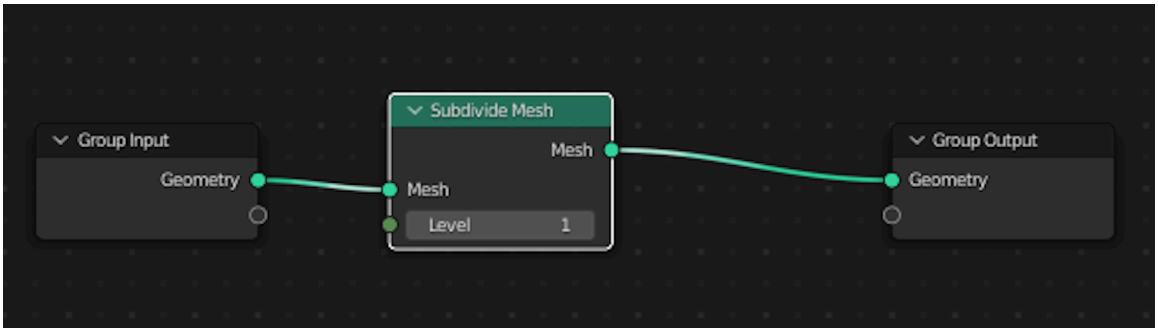

Figure 1-5

Now look at the Spreadsheet editor. You should see all of the vertices, edges, and faces of the object. This is an incredibly useful tool that you may choose to employ in order to troubleshoot problems with your node trees. On the Geometry Node editor, change the value of the *Level* of the **Subdivide Mesh** to 2. Observe the changes in the Spreadsheet. Repeat the process by changing the *Level* value to 3 and subsequently back to 2. Again, observe the changes in the Spreadsheet editor. The spreadsheet keeps track of the new data. The spreadsheet is incredibly useful in many scenarios, but keep in mind that it is readonly.

Toggle the visibility of the Chapter1 object (make invisible). Select Chapter1Two object and make visible. You will notice that the Chapter1Two object already has a Geometry Nodes modifier, and there are already unconnected nodes in the node tree. These nodes will have the node name followed by a number in parenthesis. The way the examples in this book will work is by connecting the nodes by the numbers. This should simplify and clarify the instructions that you must follow.

As a first example, grab (as previously described) a node named **Join Geometry(3)**, and connect it in between the **Group Input(1)** and **Group Output(2)**. Connect the **Subdivide Mesh(4)** in between the **Group Input(1)** and **Join Geometry(3)** nodes. Get an **Ico Sphere(5)** node and place it above the **Subdivide Mesh(4)** node. Change the *Radius* value to 1.5m and then make a connection from the right green *Mesh* output socket to the **Join Geometry(3)** node. See Figure 1-6 to see how its supposed to look. Pay attention to the viewport, you have a brand new geometry thats the combination of the two objects (Figure 1-7).

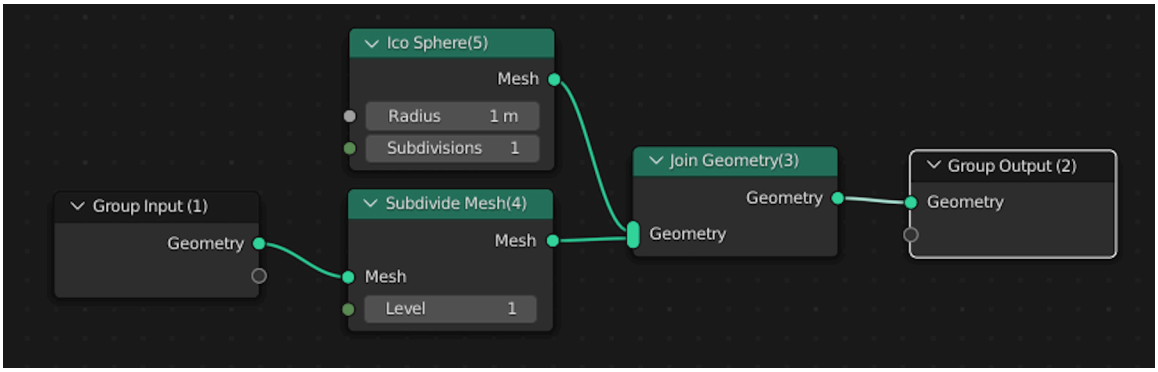

Figure 1-6

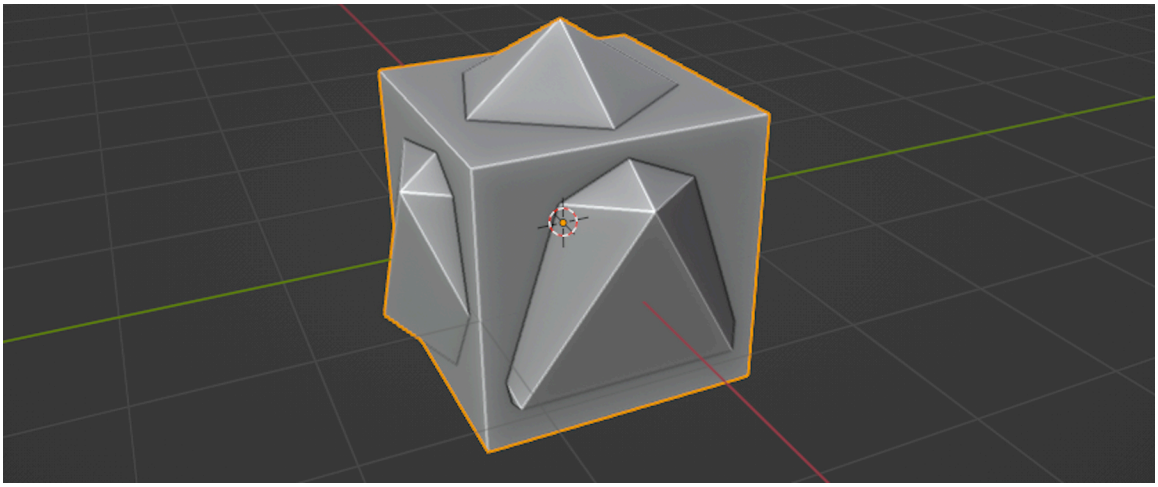

Figure 1-7

Sometimes, you want to cancel the effects of a node without having to disconnect it. For that there is the mute option. Select the **Ico Sphere(5)** node by clicking on it. Now press the m key on the keyboard. This mutes the node; nullifying all changes. The node should now be dark grayed out, and the *Ico Sphere* geometry should disappear from the viewport. Alternatively you can also mute/unmute by using the Menu->Node->Toggle Node Mute. Unmute the **Ico Sphere(5)** node.

You also have the ability to minimize nodes. You can do this by clicking on the chevron next to the node's name. This can be very useful, when you no longer need to make changes to a node, and need the space.

In addition to minimize nodes, you can also rename the nodes entirely. With the mouse cursor over the geometry nodes editor, press n (or toggle Menu->View->Sidebar) key. This will open the sidebar. Depending on how you have your system configured you could have multiple tabs in the sidebar. These tabs are the Node and Group. On the Node tab, you can rename the nodes as we well as change the color of the nodes. These changes are cosmetic and do not change the functionality or function of the nodes. However, on very complex projects this could allow you to easily identify components and have a better organizational flow. The downloaded files will already have custom labels with numbers that you will use to follow along. You can change the labels either in the Sidebar or by pressing F2. I recommend that you do not change the labels for these tutorials, as the label's numbering system are a key components of these book's lessons. The other tab is the Group. The Group tab includes the input and output values of the Group Input and Group Output nodes.

As a test, go to the *Group tab* and add the + button in the *Inputs*. Name this new input as *Input*. Leave the values as they are. From the Outputs, click on the + button. Change the name to Output, and leave the type and values as they are. Now look at the Modifier tab. You should see that you have new interfaces. See Figure 1-8. This is the way that we can input or output external data to and from Geometry Nodes.

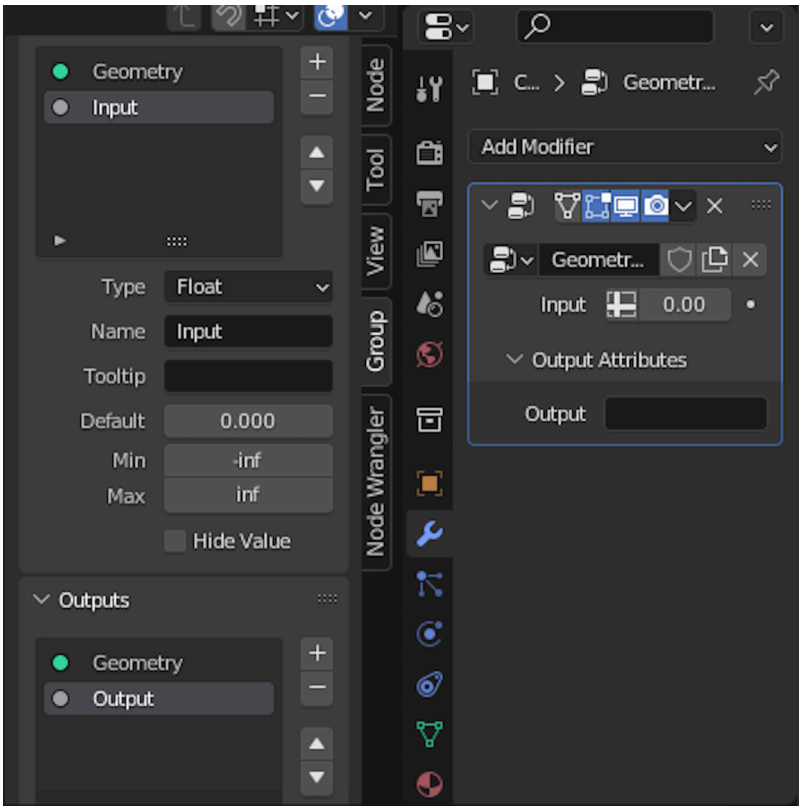

Figure 1-8

One thing that you need to take into consideration is that adding so many connections (noodles) can make your node tree look like a spaghetti bowl. This can make it very difficult to describe or troubleshoot what your node tree is doing. For this reason there are two organizationals tools the **Frame** and the **Reroute**.

The **Frame** does not modify any data, it just helps you organize your node tree. Add a **Frame(6)** to your node tree, and place it near the **Ico Sphere(5)** node. Now drag the **Ico Sphere(5)** node and drop it inside the **Frame(6)**. The **Frame(6)** should have resized. Now maximize the **Ico Sphere(5)** node and you should see that the **Frame(6)** expands even further. Grab the **Subdivide Mesh(7)** node and drop it inside the **Frame(6)**. Select the **Frame(6)**. Open the Sidebar, and to the Node Tab. Change the label of the **Frame(6)** to *Frame Example*. Your node tree should look like Figure 1-9.

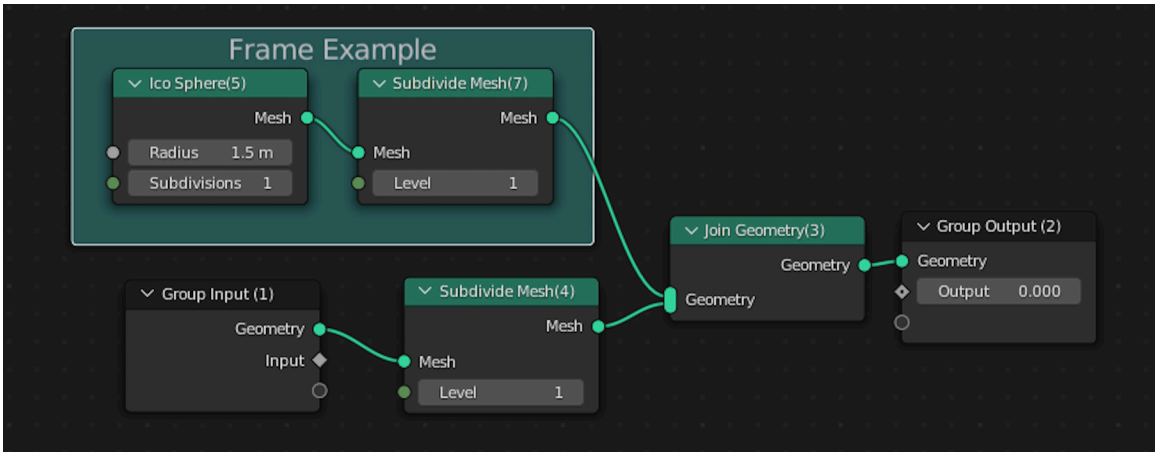

Figure 1-9

The other organizational tool is the **Reroute**. Add a **Reroute** to the node tree and place it on an empty space. The reroute is just a yellow diamond shaped point. Now click on the **Reroute**, press G on the keyboard, this allows you to move it. Drop the **Reroute** on the noodle in between the **Subdivide Mesh(7)** and **Join Geometry(3)** nodes. Now disconnect the **Group Input(1)** from the **Subdivide Mesh(4)**. Grab, hold, and drag a connection between the **Group Input(1)'s** *Geometry* socket and an empty space before the **Subdivide Mesh(4)**. From the resulting search box, type **Reroute**. Drop the **Reroute** on empty space. Now drag a new connection from this **Reroute** to the **Subdivide Mesh(4)**. Now you have **Reroute** in between the nodes. You can click on the Reroutes press G and move them to other locations in order to make your node tree more organized. Unless explicitly stated, this books chapters will not force you to use either Reroutes or Frames. However it is highly recommended that you do. See Figure 1-10 for an example of the node tree so far.

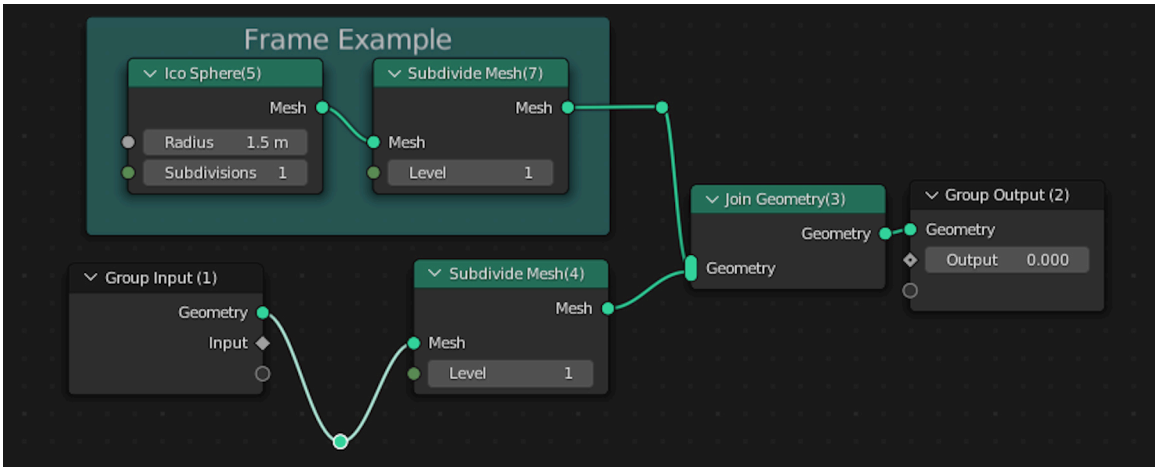

Figure 1-10

The nodes have two types of inputs or outputs sockets. These are sockets have either circular or diamond shape. These sockets can also have different colors. Understanding what each socket can input or not is the key to understanding geometry nodes data flow.

Each socket has a color that represent the data type that it accepts. As an experiment, disconnect the **Subdivide Mesh(4)** from the **Reroute** (Leave the Reroute in place). Now connect the **Group Input(1)'s** *Input* socket to the *Mesh* socket of the **Subdivide Mesh(4)**. You will notice that the noodle turned red (Figure 1-11). A red noodle means that there is an error in the connection. Some socket values are interchangeable some are not. If Blender can interpolate the results, it will usually allow the connection. A green socket receives or outputs Geometry, a Gray socket receives or outputs a Float value. Purple is for Vectors. Pink is for Boolean values, and dark green is for Integer values. See Figure 1-12.

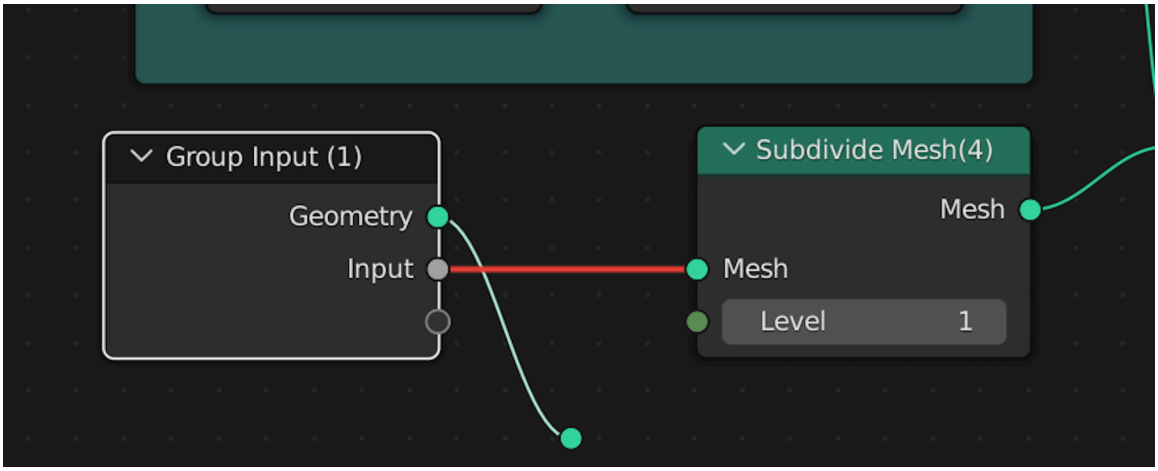

Figure 1-11

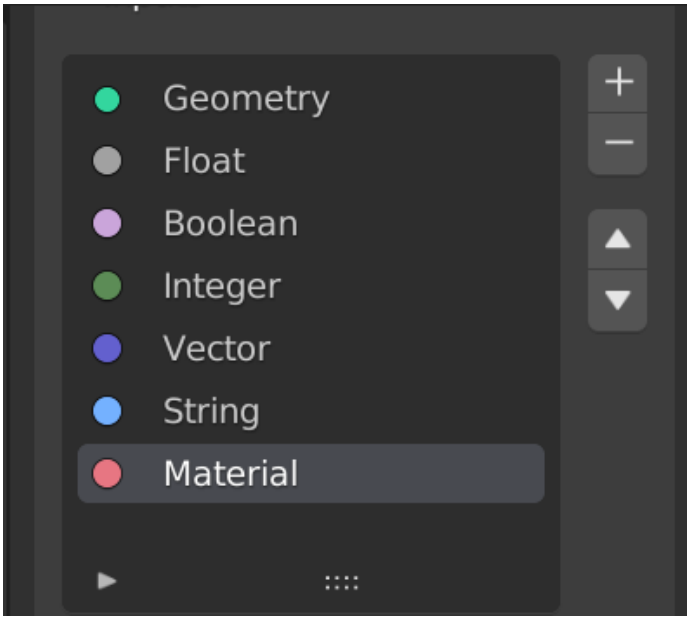

Figure 1-12

As stated previously there are two types of connection sockets: diamonds (Fields) and circular (Data Flow). Data Flow connections receive one and only one value that gets passed to nodes to be used as is. Field connections need to be computed and can have multiple values depending on what it is. In its most simplest terms, Fields are functions that get computed on demand.

Reconnect the **Reroute** to the **Subdivide Mesh(4)** node. Your node tree should once again resemble Figure 1-10. Add the following three nodes to the node tree: **Set Position(8)**, **Position(9)**, and **Vector Math(10)** nodes. Connect the **Set Position(8)** node in between the **Subdivide Mesh(4)** and **Join Geometry(3)** nodes. Connect the **Position(9)** node to the first vector socket of the **Vector Math(10)** node. The **Vector Math(10)** node has a mode drop down; from it choose *Scale*. Change the *Scale* value to *0.1*. Connect the **Vector Math(10)** outbound (right) vector socket to the *Position* socket of the **Set Position(8)** node. See Figure 1-13 for node tree comparison.

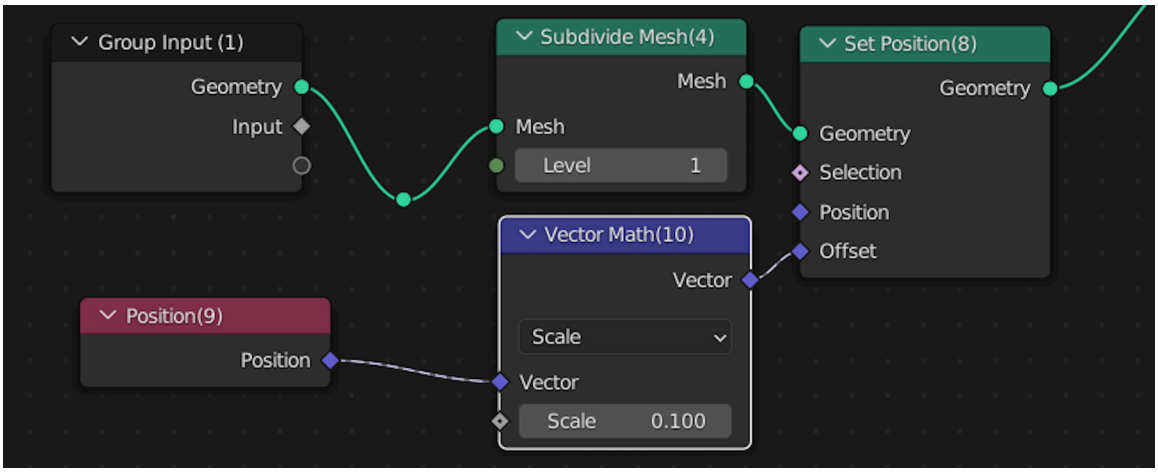

Figure 1-13

The **Set Position(8)** node needs to compute data to from the attached nodes. Hence the data flow moves from **Group Input(1)** to the **Subdivide Mesh(4)**, then to the **Set Position(8),** where it needs to calculate fields before proceeding to the **Join Geometry(3)** and then its final destination: the **Group Output(2)**. You may have also noticed that Fields noodles have an intermittent pattern. See Figure 1-14 to see an example workflow.

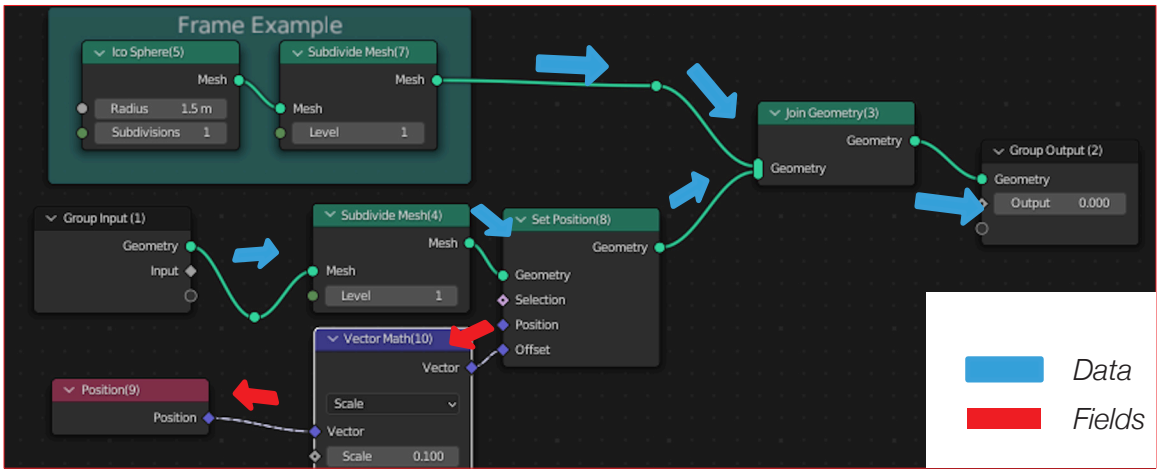

Figure 1-14

This might seem like a lot but in this book we will practice a lot and you should come out with a very good understanding on most of the nodes. As previously stated, on the chapters of this book, the nodes will already be laid out on the starter files. You will follow along by connecting the nodes by their respective numbers. This is solely so we can concentrate on the functionality of the nodes. Some chapters have components, materials, and other objects that are necessary to proceed with the lesson. Therefore, it is necessary that you download all of the chapters from GitHub. This book will use bold when naming nodes in order to make instructions more simple to follow. It will also use italics when referring to the nodes sockets.

Compare your node tree and render results with those of the downloaded Chapter1Final.blend file.