HOUDINI FOUNDATIONS

TERRAIN GENERATION

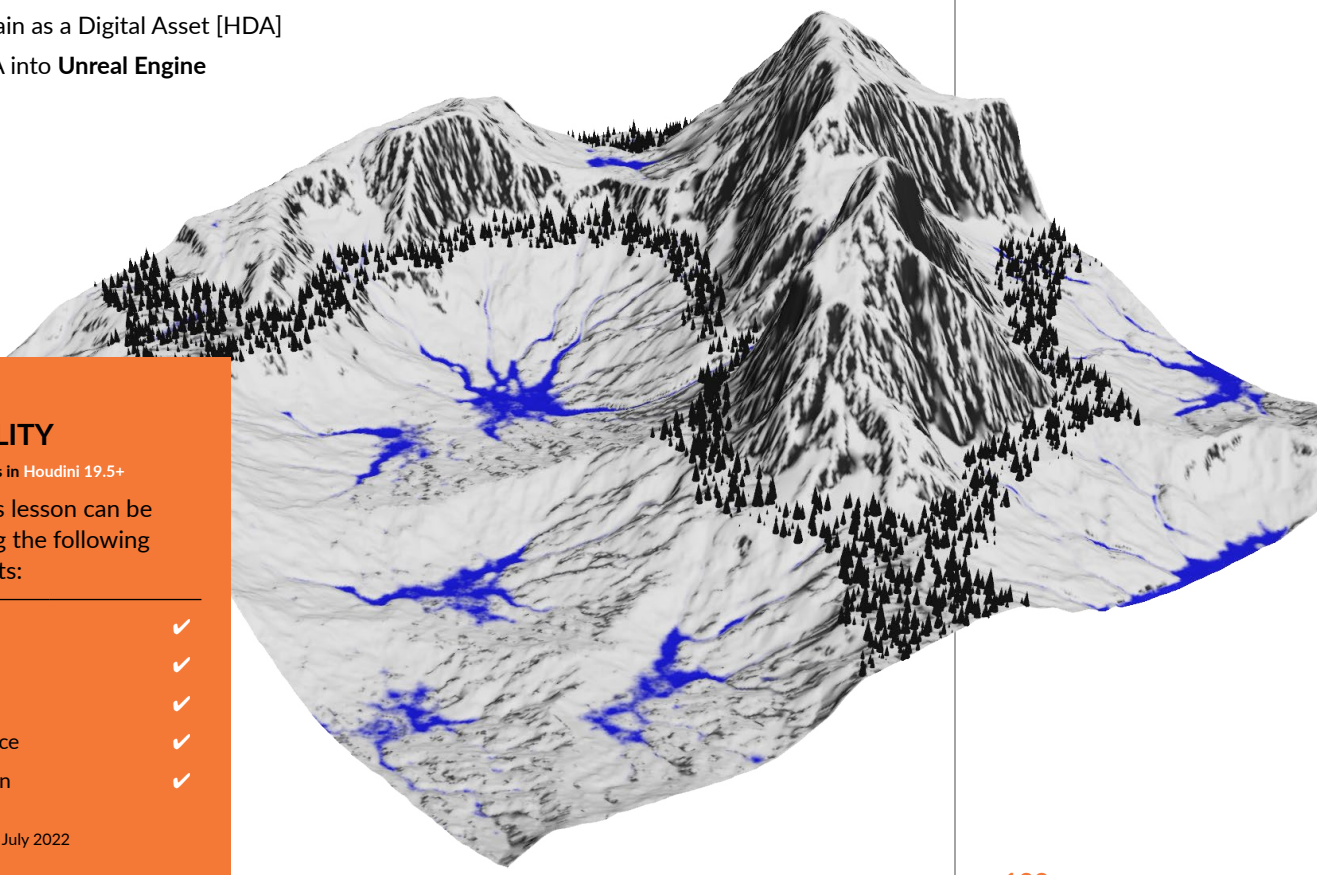
Houdini includes a dedicated toolset for generating and shaping terrains. These tools represent terrain using 2D volumes, called **heightfields,** where each voxel contains the height of the terrain at a particular grid point. The Houdini viewport lets you visualize 2D heightfields as 3D surfaces. You can also set up mask fields that can be used to focus your edits to specific parts of the terrain. In this lesson, you will build up terrains using patterns, noise and erosion then export the results for use in a game engine.

LESSON GOAL

Create a landscape using the Heightfield tools in Houdini and bring it into Unreal Engine or Unity.

WHAT YOU WILL LEARN

- How to create a Terrain using **heightfields**
- Add **patterns**, **noise** and **distortions**
- Create **Masks** using terrain features
- How to create **Scatter Points** on heightfield
- How to set up Instancing using **Terrain Scattering**
- **Export** the Terrain as a Digital Asset [HDA]
- Import the HDA into **Unreal Engine**



LESSON COMPATIBILITY

Written for the features in Houdini 19.5+

The steps in this lesson can be completed using the following Houdini Products:

Houdini Core	✔
Houdini FX	✔
Houdini Indie	✔
Houdini Apprentice	✔
Houdini Education	✔

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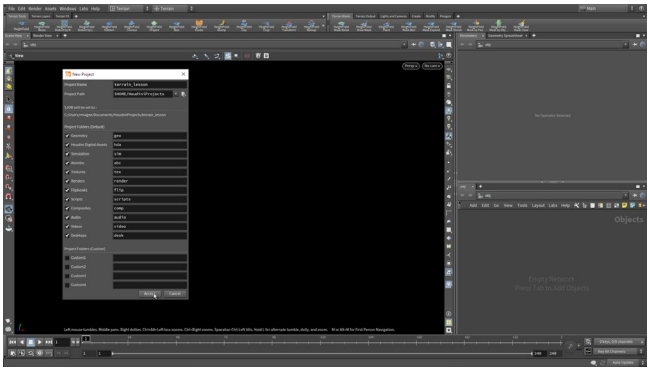
PART ONE

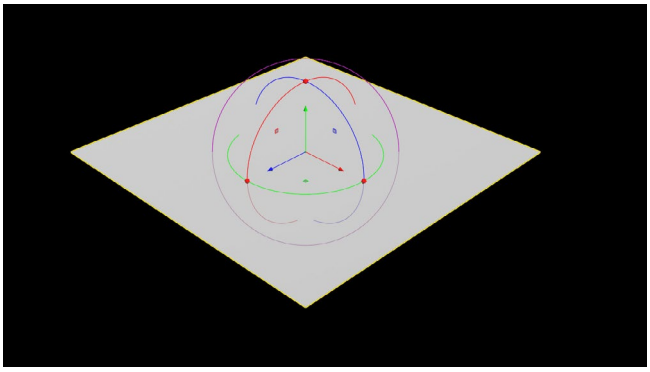
Shape the Terrain using Heightfields

To create terrains in Houdini, you will work with heightfields. You will start with a blank heightfield then add some noise and distortion to define the basic look of the landscape. As you work, you can tweak parameter values on the nodes while layering in details.



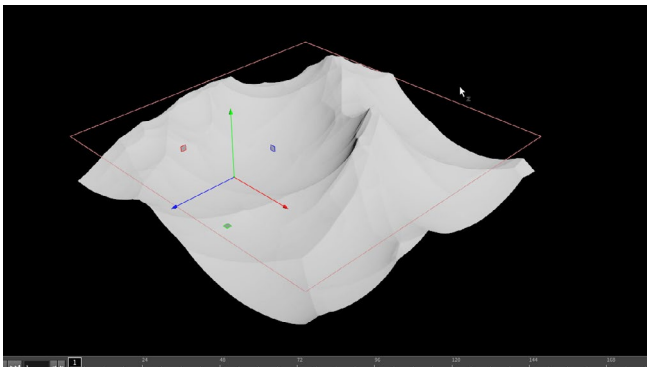
01 Go to the **Desktop** selector and choose **Terrain**. This will give you shelf tools and radial menus focused on terrain. Turn off the **Reference Plane** using the button at the top of the **Display options** then **press d** in the viewport and from the **Background** tab set **Color Scheme** to **Dark**.

Select **File > New Project.** Set the **Project Name** to *terrain_lesson* and press **Accept**. Select **File > Save As...** You should be looking into the new *terrain_lesson* directory. If not then click on $JOB in the sidebar and you will be looking at the directory. Set the file name to *terrain_01.hip* and click **Accept** to save.



02 From the **Terrain Tools** shelf, click on the **HeightField** tool. Press **Enter** to place it at the origin. Press **Spacebar H** to show the whole heightfield.

This defines a 1000 x 1000 grid with a grid spacing of 2.

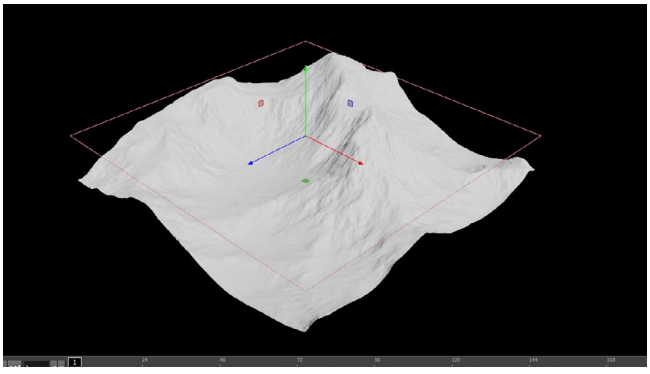


03 Use the main radial menu (**hotkey c**) to select **Deform > Noise**. Set the following:

- **Noise Type** to **Worley Cellular F1**
- **Amplitude** to **360**
- **Offset** to **20, 0, 300**

This kind of noise gives you a good starting point for your terrain.

Use the main radial menu to choose **Deform > Blur** to access the **Heightfield Blur** tool. Set the **Radius** to **20**. This softens the edges to make them feel worn by time.

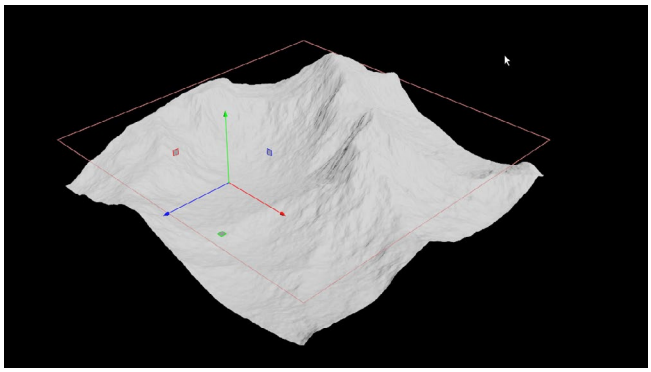


04 Use the radial menu to choose **Deform > Distort**. Set the following:

- **Amplitude** to **40**
- **Element Size** to **220**

This node moves the existing values around by advecting them through a noise field. You can use the parameter values proposed here or explore on your own to get a look that you like better.

Houdini's procedural approach would even allow you to come back later and change the parameter values to see how different settings affect the outcome.



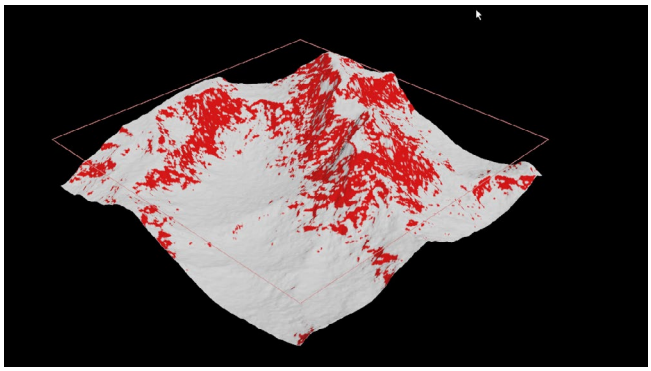
05

Use the radial menu to choose **Deform > Noise**. Set the following:

- **Amplitude** to **10**
- **Element Size** to **20**.

Select the last four nodes in the Network view then click on the **Network box** icon to add a Network box. Adjust its edges to shape the box then click in the top bar and name it *Shape the Terrain*.

Network boxes make it easier to read the network especially if you share your file with other artists.



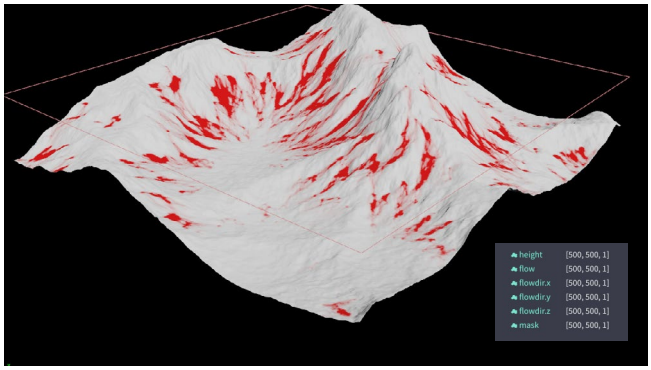
06

Use the radial menu to choose **Mask > Mask by Feature**. Set the following:

- **Min Slope Angle** to **35**
- **Max Slope Angle** to around **60**

This lets you focus on areas on the side of the mountain.

If you were to go back and change the shape of the terrain feeding into this node then the mask would update accordingly.

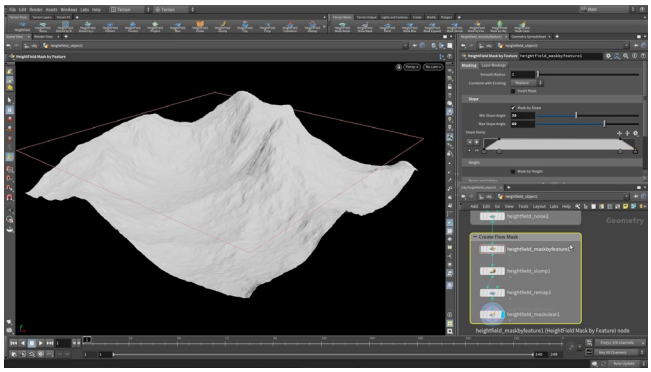


07

From the radial menu, choose the **Erode > Slump**. Set **Spread Iterations** to **75**.

The *heightfield_slump* node creates a type of erosion that moves unstable piles of rubble into a more stable configuration. It affects the Mask layer and also outputs to the **Flow** and **Flow Direction** layers.

If you **MMB-click** on the node, you can see which layers are being created. You can **MMB-click** on an earlier node in the chain for comparison.



08

From the **Terrain Tools** shelf, choose the **Heightfield Remap** tool. Set **Layer to Remap** to **Flow** then click on the **Compute Range** button. Set **Output Max** to **1** to normalize these values. Use the radial menu to choose **Mask > Clear Mask**. This clears the mask layer so that you can use it to create more layers in your setup.

Select the last four nodes in the Network view then click on the **Network box** icon to add a Network box. Adjust its edges to shape the box then click in the top bar and name it *Create Flow Mask*. **Save** your work.

HEIGHT LAYERS

The data passing through a geometry network can contain multiple height fields. In the terminology of Houdini's terrain tools, these are called height layers. For example, a tool might use one height layer to represent bedrock and another to represent loose soil on top. The default height layer is named height.

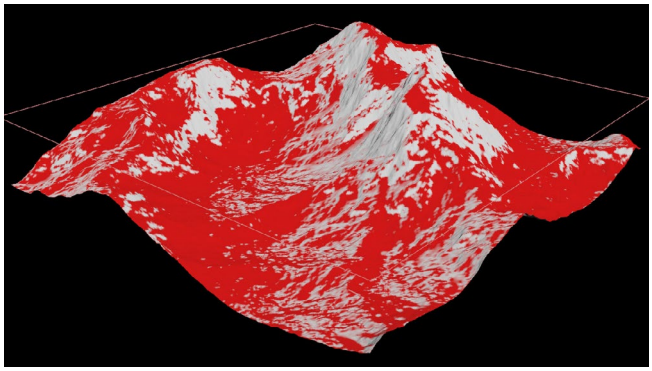
Each voxel contains a "selected-ness" value, called a mask layer. Most terrain nodes take a second input that can contain a mask layer to control which parts of the terrain the node will modify. The default mask layer is named mask and is displayed as a red tint on the 3D surface.

height	[500, 500, 1]
flow	[500, 500, 1]
flowdir.x	[500, 500, 1]
flowdir.y	[500, 500, 1]
flowdir.z	[500, 500, 1]
mask	[500, 500, 1]

PART TWO

Add and Visualize Mask Layers

You can set up layers on your terrain by first populating the mask then copying that information to a particular layer. You can do this more than once to add more layers. These layers can be used later to visualize key aspects of the terrain.



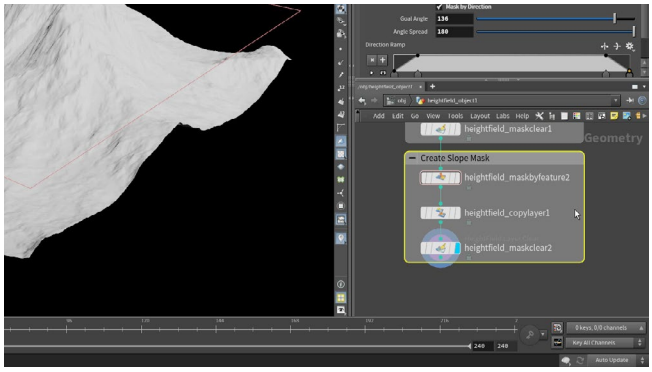
01 From the radial menu, choose **Mask > Mask by Feature**. Under **Mask by Slope,** set the following:

- **Min Slope Angle** to **0**
- **Max Slope Angle** to around **45.**

Turn on **Mask By Direction** then set:

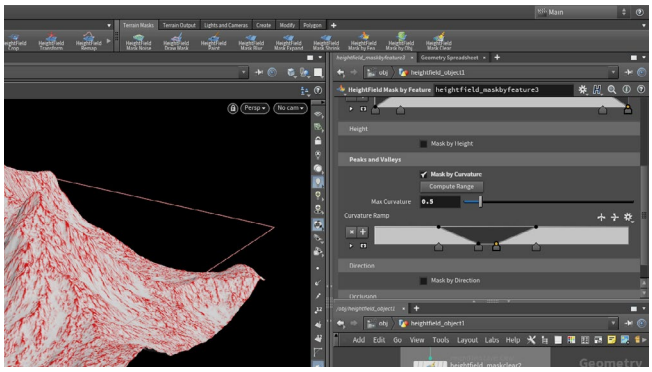
- **Goal Angle** to around **136**
- **Angle Spread** to **180**.

These settings cover a larger area of the terrain including the valleys.



02 From the radial menu, choose **Layer > Copy Layer**. Leave the **Source** set to *Mask* and set the **Destination** to *slope*. By copying the mask to a new layer, it leaves you free to clear the mask and use it for other tasks.

From the radial menu, choose **Mask > Clear Mask**. This again clears the mask layer so that you can use it to create more layers in your setup. Add a network box to organize your nodes and call the box *Create Slope Mask*.



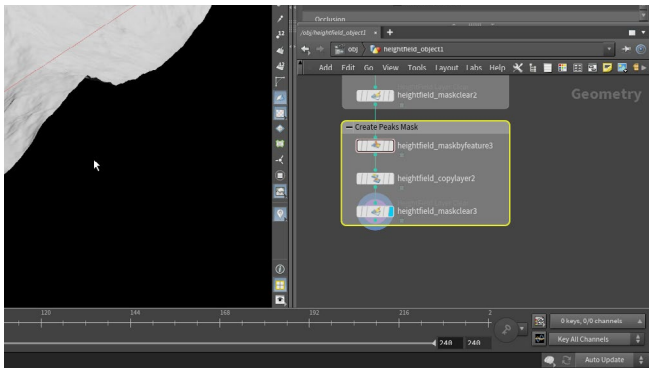
03 Use the main radial menu to select **Mask > Mask by Feature**. Under **Mask by Slope,** set the following:

- **Min Slope Angle** to **0**
- **Max Slope Angle** to around **70.**

Turn on **Mask By Curvature** and set**:**

- **Max Curvature** to **0.5.**

Next move the **Curvature Ramp** points in towards the center to find the peaks of the terrain. This gives you a very detailed mask that you can use to find the peaks of all the key features in the landscape.



04 From the radial menu, choose **Layer > Copy Layer**. Leave the **Source** set to *Mask* and set the **Destination** to *peaks*. Afterwords, choose **Mask > Clear Mask**. This again clears the mask layer.

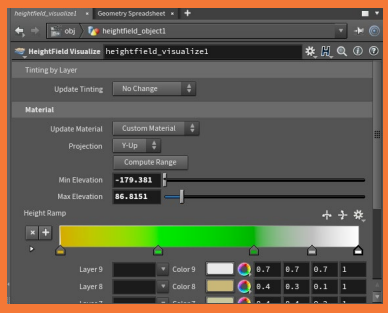
You now have three layers that have all been derived from masks. Add a network box to organize your nodes and call the box *Create Peak Mask*.

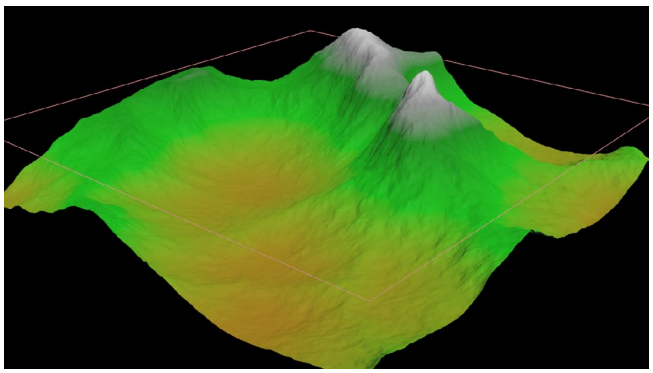
You will use these in the next step to visualize the terrain.

VISUALIZING HEIGHTFIELDS

To visualize your heightfields, you start with a ramp that is assigned to the overall height of the terrain. You start by **Computing the Range** that the ramp will apply to then you can adjust the colors in the ramp itself to visualize your landscape.

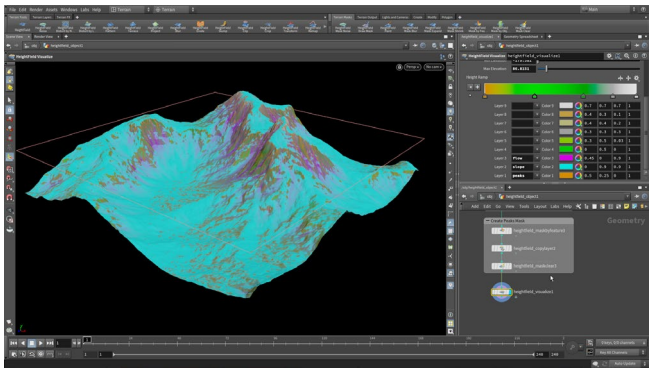
You can then add colors to the various layers that will sit on top of the ramp. This lets you create a richer look for your scene.





05 From the radial menu, choose **Visualize > Heightfield Visualize**. Click on the **Compute Range** button to align the visualization with the current heightfield range.

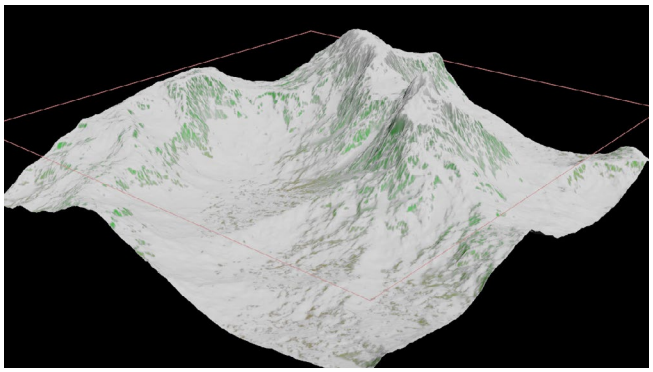
This sets the ramp visualizer to go from the base of the terrain to its peaks. You can see how the ramp looks in the 3D view where the mountain tops are highlighted in white.



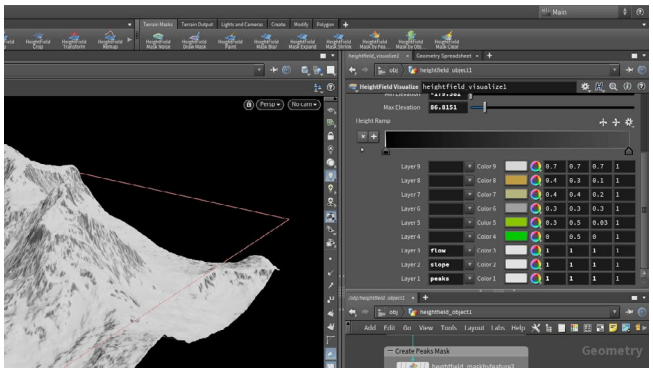
06 Under the ramp widget, set the following:

- **Layer 1** to *peaks*
- **Layer 2** to *slope*
- **Layer 3** to *flow*

The default colors are now visible in the 3D view using the three layers you built up using masks. You will now use these to define the look of the terrain.



07 Set all three of these layers to **white**. [1, 1, 1] This gives a snowy look to the landscape. You can use these layers for any number of different features, but for this mountain, snow is the look that you want to emphasize.



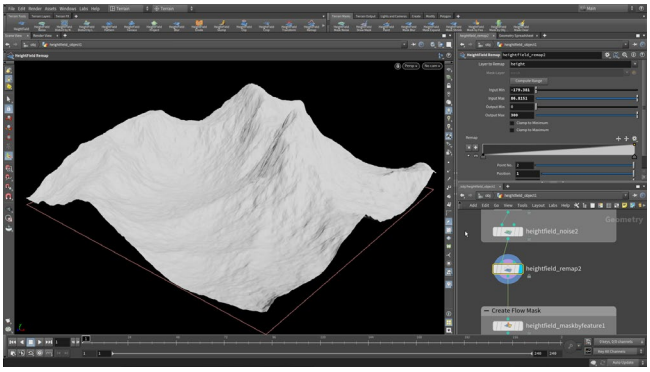
08 In the **Height Ramp**, select and remove all the markers except two. Set the one on the right to black and the one on the left to dark grey. This creates a darker look under the snowy layers which helps the dark areas pop out visually.

Save your work.

PART THREE

Remap and Erode the Terrain

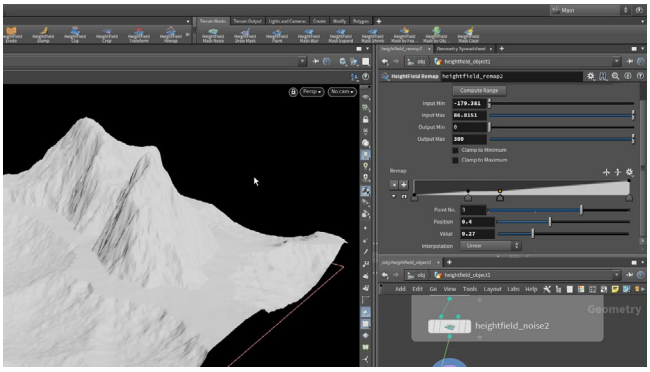
Right now some of the heightmap is below 0 and some is above. You are going to use a Remap node to change the range and then use the ramp on that node to add a ridge around the mountain. You will then erode the landscape to add new layers to the terrain.



01 Find the **Heightfield Noise** node at the end of the Shape by Terrain Network box. Turn on its **Display Flag** and click to select his node.

From the **Terrain Tools** shelf, click on the **Heightfield Remap** tool. Click on the **Compute Range** button. To reframe the heights, set the following:

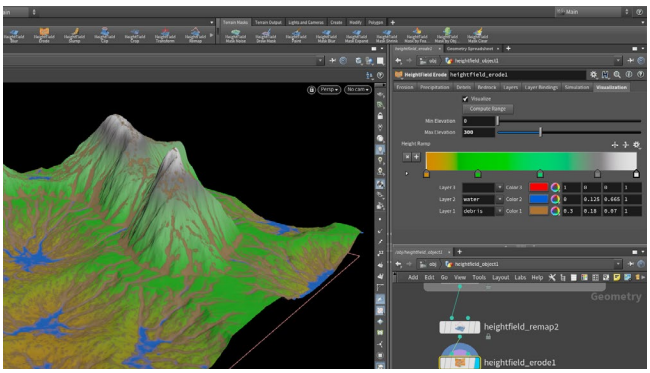
- **Output Min** to **0**
- **Output Max** to **300**



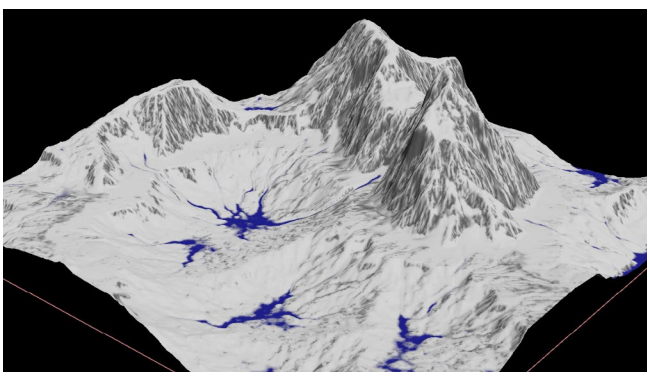
02 Using the **Remap** ramp, add points in the middle then add and adjust the following points:

- **Point 2** has a **Position** of **0.25** and a **Value** of **0.25**
- **Point 3** has a **Position** of **0.4** and a **Value** of **0.27**.

This creates a ridge running along the base of the mountain.



03 Choose **Erode > Erode**. Click on the **Visualization** tab and click the **Compute Range** button. Press **Play** to watch the terrain erode. **Stop** around frame **15**.

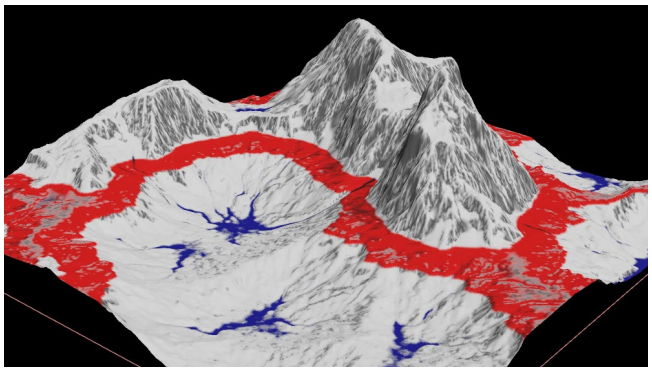


04 Set the **Display flag** back to **Heightfield Visualization** node at the end of the chain. Set **Layer 3** to *water* which is a layer that is coming from the *erode* node and change its **color** to a **blue**. This will bring out some of these areas in the visualization.

PART FOUR

Scatter points on the Terrain

To add trees and rocks, you will mask out the new plateau area then set up a special terrain scatter that will use this mask. These scattered points will then be used to copy instanced cones designed to represent trees. These will be replaced later in Unreal.



01

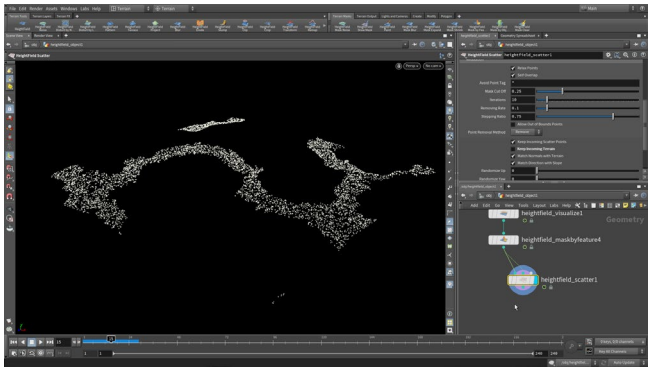
Use the radial menu to choose **Mask > Mask by Feature**. Set the following:

- **Min Slope Angle** to **0**
- **Max Slope Angle** to **50**

Turn on **Mask by Height** and set the following:

- **Min Height** to **70**
- **Max Height** to **85**

This should highlight the plateau created with the *remap* node. If not then tweak these values until you isolate this area in the Mask.

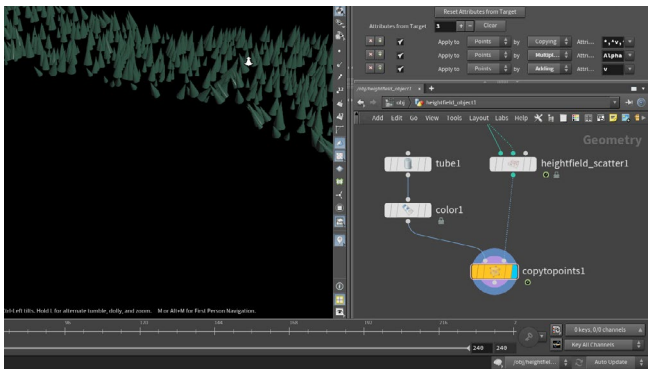


02

In the Network editor **RMB-click** on the output of the *maskbyfeature* node and start typing **scatter...**

Place the **Heightfield Scatter** down and set turn on its **Display flag**. Now wire the output of the *maskbyfeature* node into the second input of the *scatter* node to restrict the points to the area defined by the incoming mask.

Set **Coverage** to **0.05**. Turn **off** the **Keep Incoming Terrain** option.



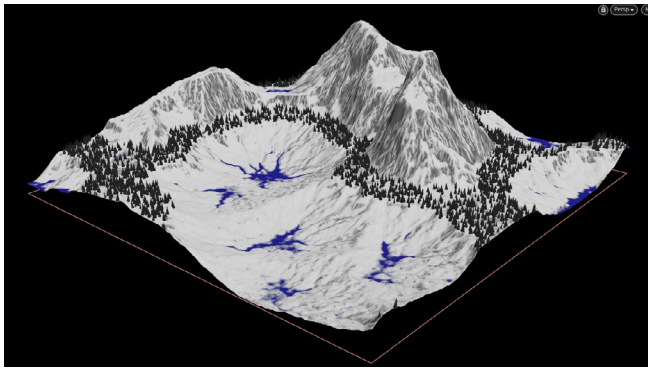
03

In the Network Editor, press **tab** and begin to type **Copy to Points** and click to add this node. Click the **Pack and Instance** check box to turn it on. Wire **Heightfield Scatter** into the second input of **Copy** then set its display node.

In the Network Editor, add a **tube** node down then feed it into the first input of the *copytopoints* node. Set the following:

- **Radius** to **0, 2** and **Radius Scale** to **1**
- **Height** to **10** and **Center** to **0, 5, 0**.

Add a **color** node after the *tube* to make the trees **green**. Add a **Merge** node and feed *Heightfield Visualize* and *copytopoints* into it.



04

Go back to the *heightfield_scatter* node and turn off the **Match Normals with Terrain** and **Match Direction with Slope**. This will ensure that all the trees are pointing up.

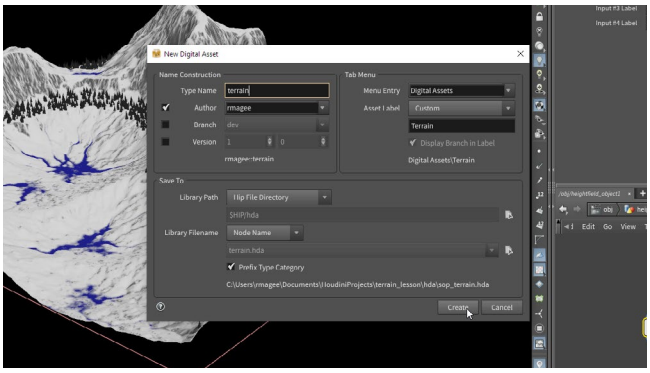
Now change **Random Up** to **10** to create some variation in their direction and set **Randomize Yaw** to **20**. You cannot see the effect of this but if you replace the tree later you will see random rotation.

The Scale of the trees is controlled by **Variability**. Change the **Range** to **1, 2** to create random scales these two values.

PART FIVE

Open the Terrain in Unreal

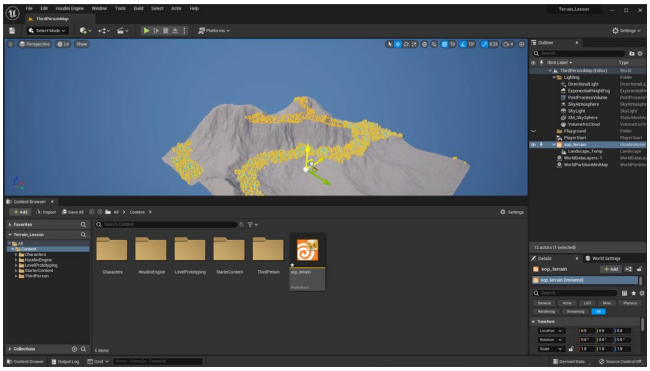
To bring the landscape into game engines such as Unreal Engine or Unity, start by creating a Houdini Digital Asset. Once you have the Houdini Engine plug-in set up properly, then this asset can be loaded into the game editor with the copied tree stand-ins importing as instanced objects. When you import the terrain into Unreal Engine, the heightfields will be recognized as a landscape. You can also import the asset into Unity using the Houdini Engine plug-in.



01 Select all the nodes in the Network editor. Click on the Create **Subnet from Selected Button**. **RMB-click** on the new subnet and choose **Digital Asset> Create New**.

Set the **Type Name** to *terrain* and turn off **Branch** and **Version**. Set **Library Path** to *HIP File Directory* and **Library Filename** to *Node Name*.

Click **Create**. The **Edit Type Properties** window opens up. Click **Accept** to close this window.



02 Open Unreal Engine and from the main panel click on the **New Project** tab and choose the **Third Person** template. Click **Create Project.** When it opens, delete the default geometry so that it doesn't get in the way of your terrain.

From the Content Browser, click **Import to Game** and find the *terrain.hda* asset file. Drag the asset from the **Content Browser** to the 3D workspace. Set the **ThirdPersonCharacter** up to a **Translate Z** of around **10,000** then press **Play** and walk around the terrain.

03 Go to the **Houdini Instanced Inputs** section and expand *terrain1_1*. This is the cone instance which you can replace with content from within Unreal.

In the Content Browser, open **StarterContent > Props**. Drag the *SM_Bush* prop over to the **Houdini Instanced Input**. Set the **Scale Offset** to **5, 5, 5**. The geometry is instanced to the points then randomly scaled and rotated just like the cones.

In the outliner, select the **Landscape** node under **terrain**. Beside **Landscape** material, click on the menu and find a grass material. Press **Play** to explore the Terrain.

CONCLUSION

You can also use the terrain layers to create texture maps that you can work with to define the look of your landscape. You can do this using the **Heightfield Output** node. You can then use these channels to build a material in the Unreal Engine that references the features of the landscape.

This quick look at the terrain features in Houdini will open up a wealth of possibilities for artists creating landscapes for their games then populating them with details such as rocks and trees.