MULTIMEDIA PROJECT
2723QCM

2019

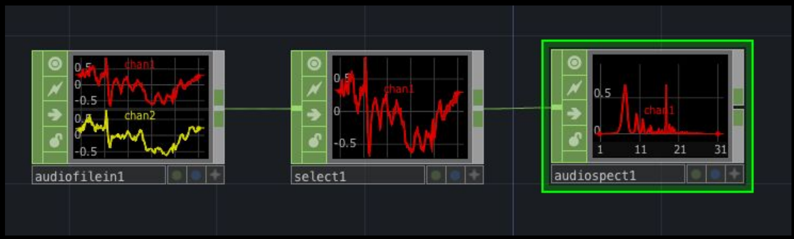
(week 4)

3D SPECTROGRAM - AUDIO LANDSCAPE

In this tutorial we will create a 3-dimensional visualisation of sound much like a spectrogram of amplitude against frequency. Some techniques and processes introduced here have already been explored in previous tutorials so you should be able to move through the steps very quickly. I'm intentionally repeating aspects that might seem obvious at this stage so that you can use this as a standalone worksheet without having to reference to previous tutorials. Let's get started!

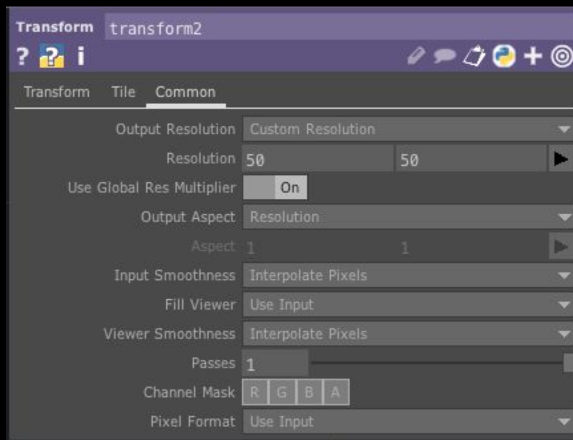
1) Start by creating a new network. Select and delete all of the default operators to start from and empty network. First we need to create the audio input. We will start with an audio file so that we get constant sound into our network. Press tab in your keyboard and navigate to the CHOP tab to create an 'Audio File In". By default, "Audio File In" opens with an audio already loaded. For the purpose of this tutorial, we will work with this audio file, but experiment in changing this source into other audio files or even to a mic audio input (CHOP Audio Device In).

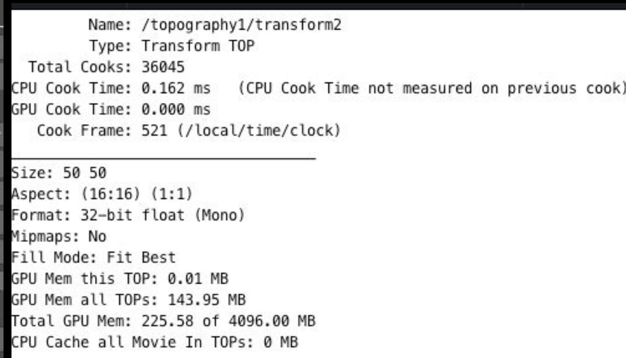
2)Next, connect a 'Select' CHOP to the output of your audio source. While the 'Select' operator is being selected, press the letter 'P' in your keyboard to open up the Parameter Settings Window. Under the 'Channel Names' parameter, type 'chan1' so that we only look at a single channel of our audio source. Next connect 'select1' to a CHOP 'Audio Spectrum'.

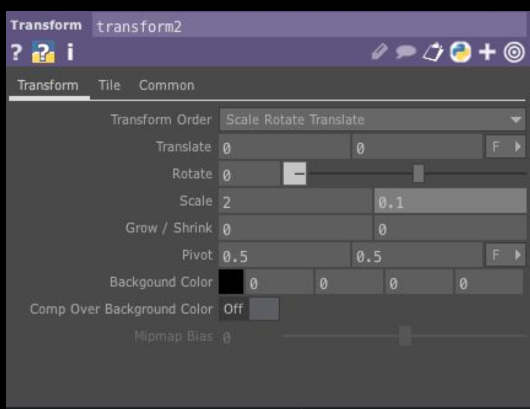


3)To make this spectrum have more depth we need to create some texture operators (TOPs). This will allow us to work with our GPU (Graphics Processing Unit) and make processing much more efficient. Right-click on the output of the 'audiospect1' and create a 'chopto' TOP to convert the samples coming out of the 'Audio Spectrum' CHOP into TOP pixels.

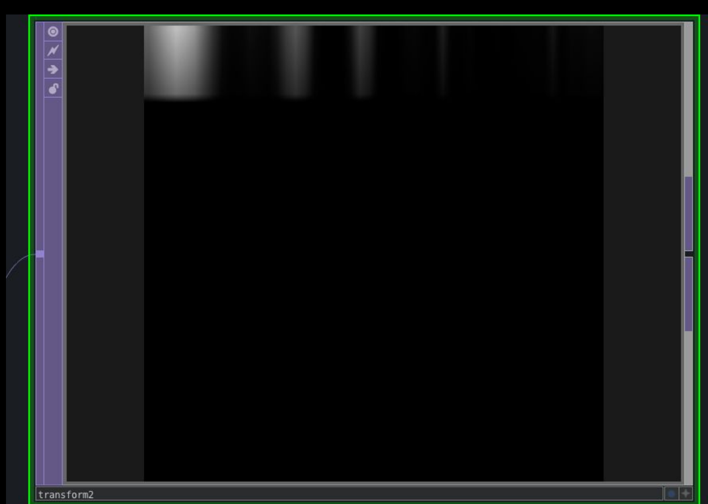
4)Next, right-click on the output of 'chopto1' and create a 'transform' TOP.
We need to change the resolution of the 'transform' TOP. Under the 'transform1' settings, navigate to the 'Common' tab, change the 'Output Resolution' from "Use Input" to "Custom Resolution" and change it 50 x 50 pixels. Also, change the 'Output Aspect' to "Resolution". Now we are visualising an output that is 50 x 50 pixels, instead of 16384 x 1 pixels coming out of 'chopto1' (Right-click on operators and select "Info…" to compare resolution under "Size").







5)As we are interested in a more narrow view of the spectrogram we need to scale the height to 0.1 under the ‘Scale’ settings under the ‘Transform’ tab.



6)Next, we need to translate the result in the Y axis so that it moves to the top of the ‘transform’ window. To achieve this, change the Y-axis of ‘Translate’ to ‘0.5’.You should be looking at something like the screenshot on the left.

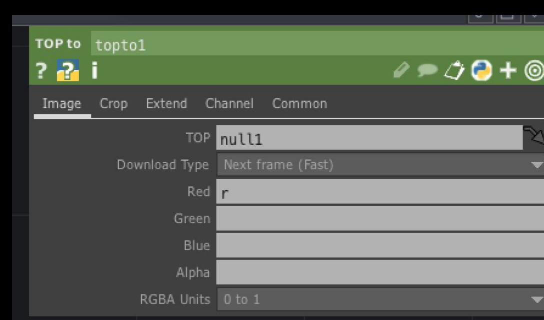
What we are trying to achieve here is to create something like a waterfall effect so that we have our spectrogram at the top of the window. With the use of some feedback, we will be able to generate the effect of this frequencies translating downwards.

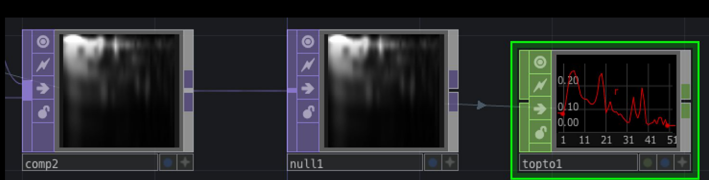
To achieve a feedback effect, follow the following steps which are pretty much the same as we did with the Oscilloscope tutorial:

7)Right-click on the output of the 'transform1' TOP and create a 'feedback' TOP. Then, from it's output, create another 'transform' TOP. On the parameters of this 'transform2', change the Y-translate to -0.01 so that it moves downwards. Next, create a 'level' TOP and connect it to your newly created 'transform'. Then, create a 'composite' TOP to combine what we are receiving from the 'transform1' with what we are receiving from the 'level1'. For this connect 'level1' to one of the inputs of 'comp'1 and 'transform1' to the second input. Then, under the settings of 'comp1' set the 'Operation' to "Add". Finally, to complete the feedback loop, select your 'comp1' and drag it on top of your 'feedback' operator.

You should now see a trail of the audio dropping downwards like a waterfall. To create a smoother transition of this trail, under the 'Post' tab, of the 'level1' settings and the 'Post' tab, change the opacity to something like 0.98. Finally, in case we want to make any changes later, let's finish this part of the network with a 'null' TOP connected to the output of your 'comp'.

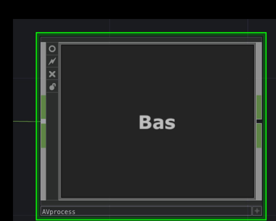
8)Now, we are going to convert this TOP data back to CHOP by connecting a 'topto' CHOP to the output of our 'null1'. Under the 'topto' settings, under the 'Image' tab, we only need 1 colour channel as we are only working with white pixels at this stage. This means that we can get rid of Green, Blue and Alpha, by leaving Red as the only channel.





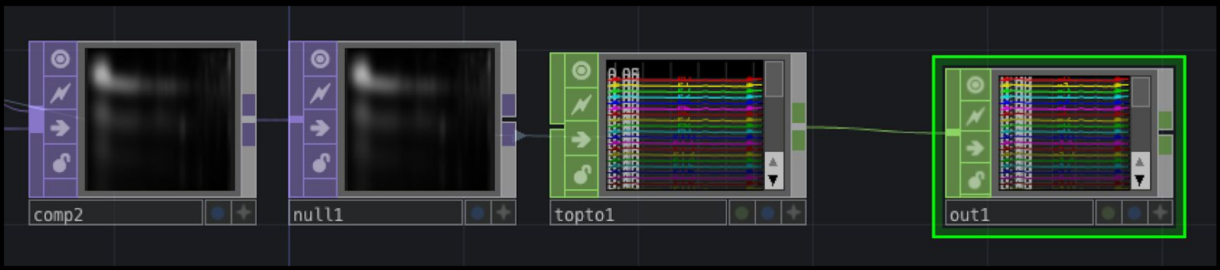
Also, under the 'Crop' tab, we want to change from sampling a single 'Row(U), to sampling the 'Full Image'.

9)Now, let's organize this part of the network into a single collapsed folder. To do this, by holding SHIFT (or right-click drag to select),

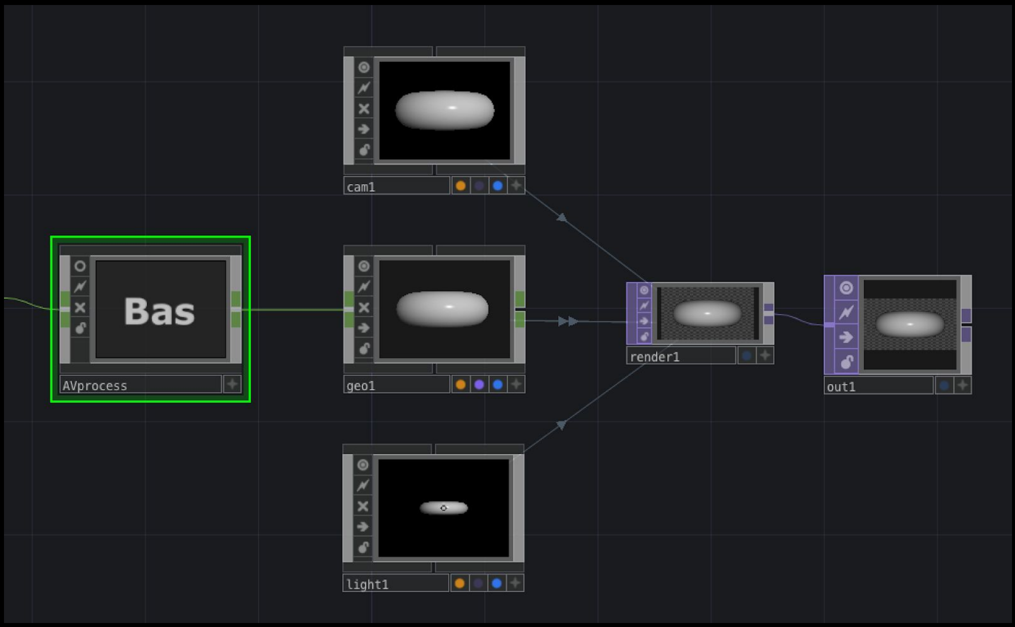


select all of the operators from the ‘audiospect1’ CHOP on the left, to the ‘topto’ CHOP. While all of the operators are selected, RIGHT-CLICK anywhere on your network’s background and select “Collapse Selected”. This creates a ‘Base’ COMP that contains all of our operators. To make this more clear, let’s rename this ‘Base’ COMP to “AVprocess”.

Now, navigate inside ‘AVprocess’ by double-clicking on it, and create an ‘Out’ CHOP connected to the output of ‘topto’. This will create an output so that we can connect our “AVprocess” to the second part of out network.

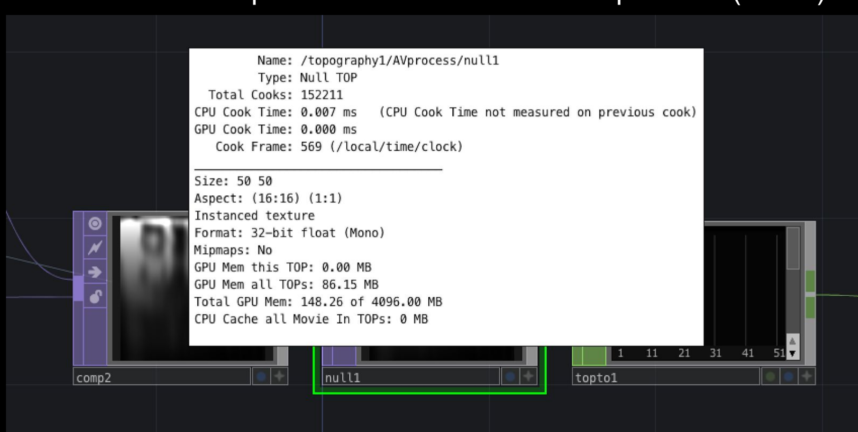


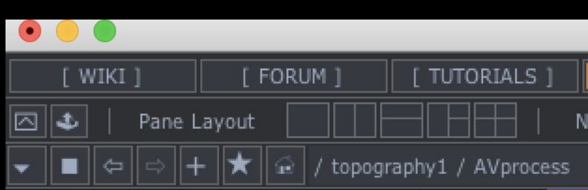
10)Now, let's navigate outside of ‘AVprocess’ to start creating the 3D render part of our network. For this, we will need to create 4 basic operators which are essential for creating any 3D graphics: 1) COMP ‘Geometry’ 2) COMP ‘Camera’ 3) COMP ‘Light’. To create the ‘Geometry’ COMP, right-click on the output connectors of the ‘AVprocess’ COMP operator, navigate to the COMP tab, and select “Geometry”. This should create the operator automatically connected to the “AVprocess” base. Now, create a ‘Render’ TOP which should automatically generate a connection with ‘cam1’, ‘light1’ and ‘geo1’. Finally, to output our render, create an ‘out’ TOP connected to the ‘render1’.



11)Next, we are going to work inside our geometry ‘geo1’ to create the SOP operators that we need to convert the TOP data coming from ‘AVprocess’ into a 3D-surface. Double-Click on the geometry operator, now called ‘geo1’. By double-clicking (or pressing ‘i’ while selecting the node) you should enter inside a new network. This network is made up of ‘in1’, ‘out1’ and ‘torus1’. Delete the torus1’ operator and create more space between ‘in1’ and ‘out 1’ so that we can create other operators. To generate 3D data we are going to use a ‘Grid’ SOP. Press ‘tab’, navigate to SOP and select ‘Grid’.

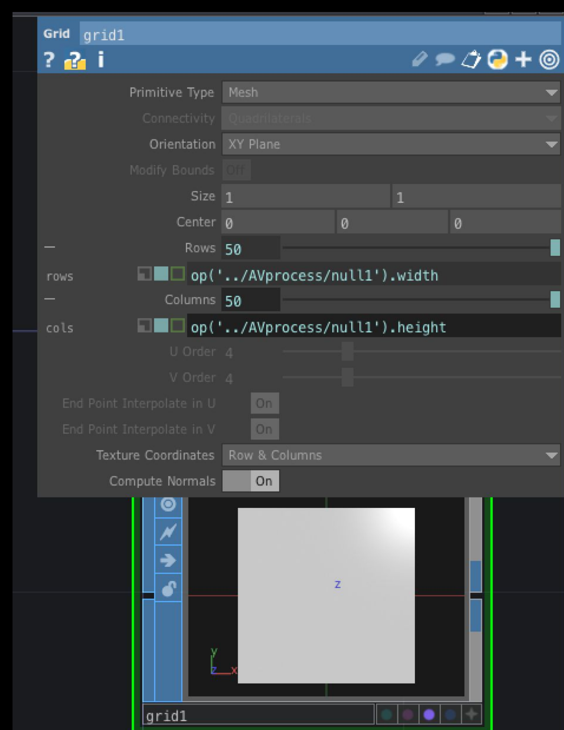
12)Now, we want this ‘Grid’ to have the same dimensions as our output TOP inside our ‘AVprocess’ network. Navigate to this network, RIGHT-CLICK on ‘comp1’ or ‘null1’, select ‘Info…’ and you will see the dimensions are 50 x 50 (50 Rows x 50 Columns). We want this same dimension to be set in our ‘grid1’ so that we can match the number of rows and columns with the number of pixels used in the Texture Operators (TOPs).



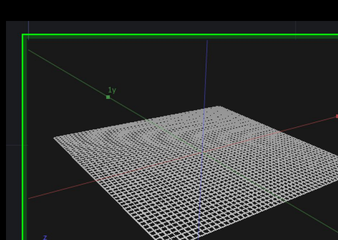


To make things a little easier, first split your screen into two panels so that we can see two locations of the network simultaneously. To split the screen into different views, select and different ‘Pane Layout’ on the top-left corner of your TD window. For the purpose of this tutorial, select the 2nd layout which divides the screen into 2 vertical windows. On the right window navigate inside the “Avprocessing” network. On the left window, navigate inside our ‘geo1’. Your screen should be looking something like the screenshot below:

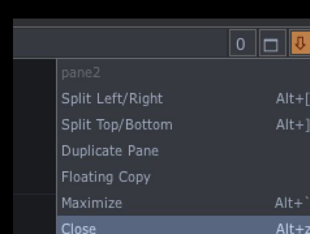
13)Now, we want to match the dimension of our ‘grid1’ with the one in our ‘null1’. To achieve this, navigate to the settings window of ‘grid1’. Expand the ‘Row’ parameter by clicking on the ‘+’ symbol on the left, and click on the aqua-colour square where you can write an expression. We need to write an expression so that we can make the ‘rows’ of grid look at whatever dimension we have on the width of ‘null1’. Type the following expression: **op('../AVprocess/null1').width**
Now, copy paste it on the ‘cols’ parameter and replace ‘width’ with ‘height’: **op('../AVprocess/null1').height**



Now, the dimension of ‘grid1’ is always going to correspond the dimension of the output of our texture operator inside our ‘Avprosessing’ network. To visualise how that grid is looking a little better, select the ‘grid1’ operator, click the letter ‘A’ on your keyboard to enable Viewer Active, and then click ‘W’ to turn on the grid view. Now you can drag inside this operator and you can see the grid rotating on its 3-axis.



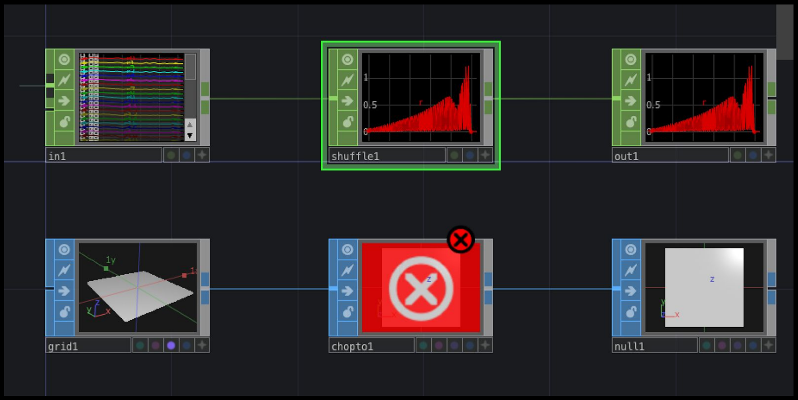
Now you can close the panel (window) on the right by clicking on the arrow facing down on the



top-right corner of the window and selecting ‘Close’.

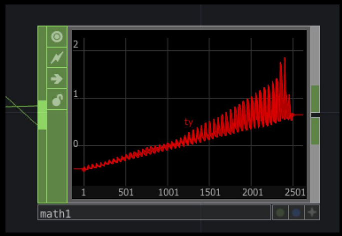
14)Back inside the ‘geo1’ network where we have our grid, right-click on the output connectors of the ‘grid1’ operator (ensure the operator in not on viewer mode) and create a SOP “CHOP to”. Then create a SOP ‘Null’. As this SOP ‘Null’ will be our output, ensure that render is activated by clicking on the magenta circle next to the name of the operator.

15)To start working with the samples we are receiving from our audio source, after the ‘in1’ operator, insert a ‘Shuffle’ CHOP. ‘Shuffle’ will allow us to re-organize this channels in a way that will be more useful before converting them into SOP data. Navigate into the parameters window of ‘shuffle1’ and select the ‘Method’ “Sequence Channels by Name”. As you can see, the samples are looking more like a proper spectrum visualiser.

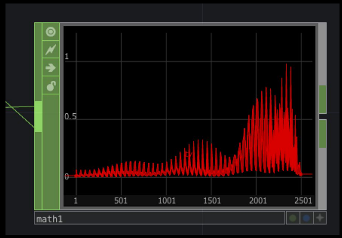


16)What we want to do now is to replace the Y-axis of ‘grid1’ with the CHOP data that we are receiving from ‘shuffle1’. To do this, we need to convert the data coming from ‘grid1’ into CHOP data. RIGHT-CLICK on the output of ‘grid1’ and create a ‘sopto’ CHOP. Now, let’s connect this into a ‘Select’ CHOP to select the Y-axis from this grid. Navigate to the settings window of ‘select1’ and under the ‘Channel Names’ parameter, type: ‘ty’

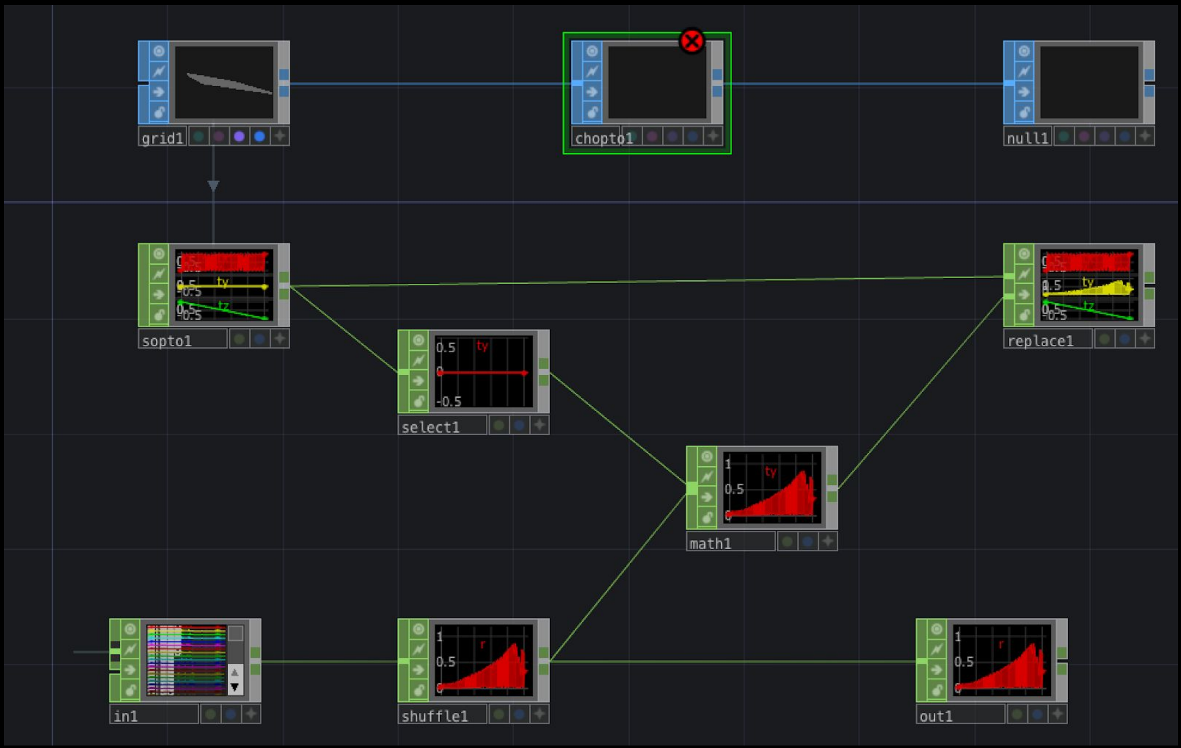
17)Next, we want to add what we have coming out of our ‘Shuffle’ CHOP with the points that we have selected from our grid. To achieve this, connect the ‘select1’ operator to a ‘Math’ operator, then, connect the ‘shuffle1’ output into the 2nd input of ‘Math’ and under the ‘Combine CHOPS’ parameter of ‘math1’, select ‘Add’. You should now see a tilted spectrum. To make this horizontal, without a tilt, we have to change the ‘Orientation’ parameter of ‘grid1’ from “XY Plane” to “ZX PLane”.



18)Next, we want to replace the original organization of points coming from ‘sopto1’, with the data we have resampled coming out of ‘math1’. To achieve this, we need to create a ‘replace’ CHOP. Connect the output of ‘sopto1’ to the first input of ‘replace’. Then, connect the output of ‘math1’ to the second input of ‘replace1’. We are replacing the original points coming from the Y-axis of ‘grid1’ with the data coming from the resampling we have done with the ‘Math’ operator.



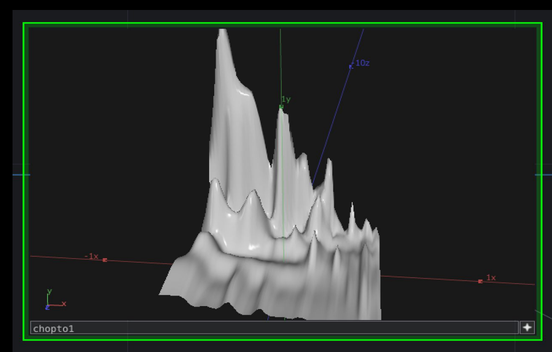
To understand the flow of data a little bit better, organize your network in the following way:



To summarise what is going on here: First we made a grid, then we turn this into a series of channels (‘sopto’), which is basically an array of numbers, then we selected the Y-channel from here (‘select1’), then we re-organised the set of samples coming out the texture operator (‘in1/

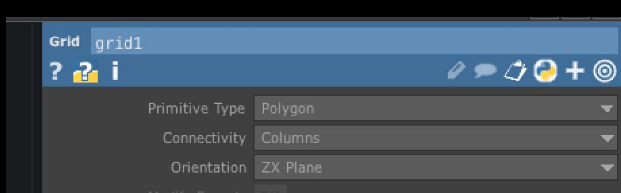
shuffle1'), added the Y-channel ('Math1') with our shuffled and then we replaced what was coming of the original Y-channel with the result of the re-sampled data('replace1'), Now, just in case we make any changes, connect a 'Null' CHOP to the output of 'replace1'. Next, select 'null2' and drag it on top of 'chopto1'.

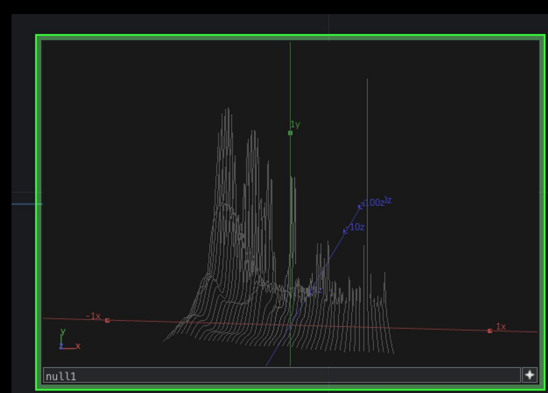
Now you should be able to visualise a 3D-version of our spectrum. if you make the 'chopto1' viewer active, you will be able drag and move around the 3-axis of the spectrum.

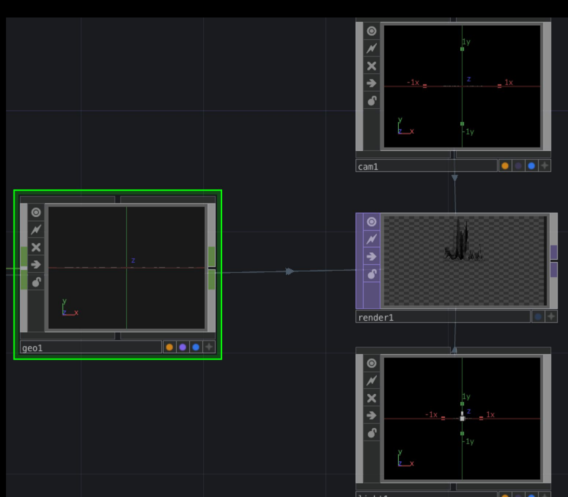


19)As you can see, this surface does not have much depth to it and this is because it doesn't have any normals being computed. To activate the computation of normals in the 'chopto' SOP, turn 'Compute Normals' ON.
You should now see a much more interesting 3D-representation of the spectrum with all of the lighting and details being visualised.

Finally, in the parameters window of our grid, change the 'Primitive Type' to "Polygon" and the 'Connectivity' to "Columns".

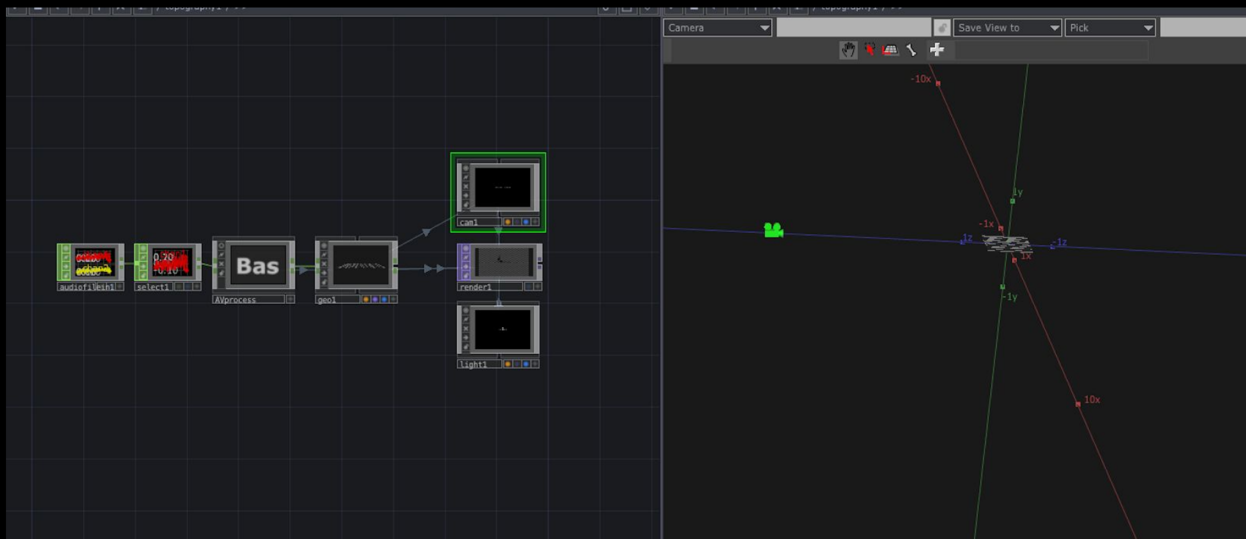




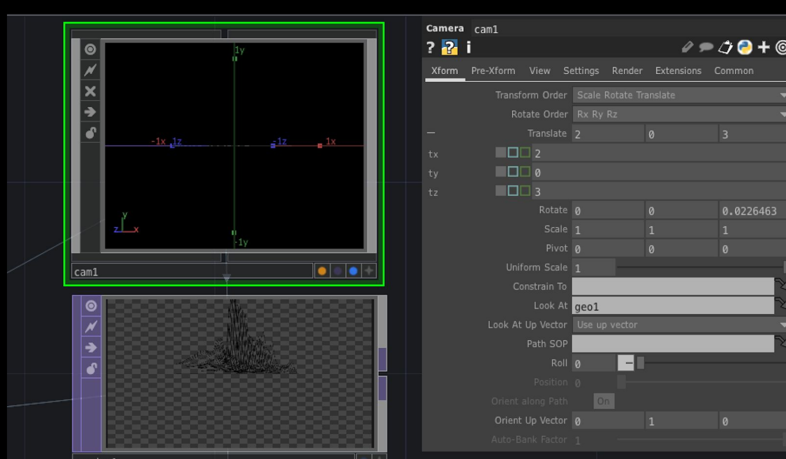


20)Next, navigate out of 'Geo' back to our main network. We need to make the 'camera1' to look at what is going on in 'geo1'. Select, 'cam1' and then drag 'geo1' into the 'Look At' parameter of 'cam1'. To visualise in real time while we adjust the parameters of the camera, split your screen again into 2 vertical panels. On the right panel, on the top left corner, change the panel type to 'Geometry

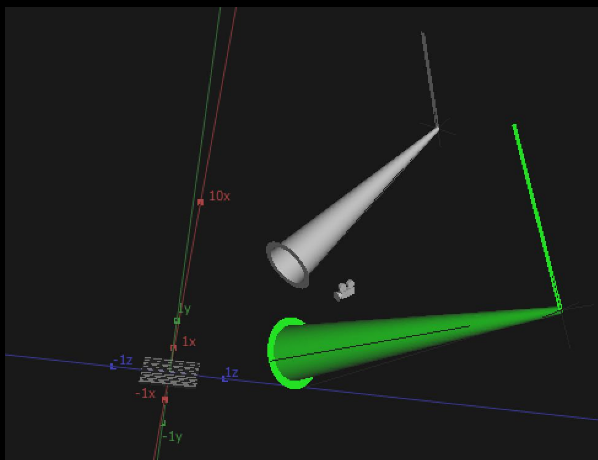
Viewer'. Now press A and drag around until you see the camera looking at what it's being rendered.

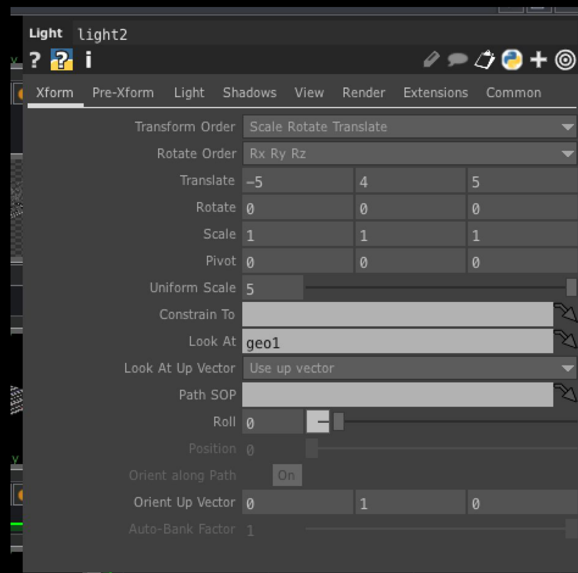


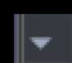
Now you can see in real time how the camera moves in relation to the render according to the parameters you change, and you can also see how the render changes accordingly. In the 'Xform' settings of 'cam1', 'Translate' the camera to '2' in X, '1' in Y and to '3' in Z. See how the render changes while you make these changes.

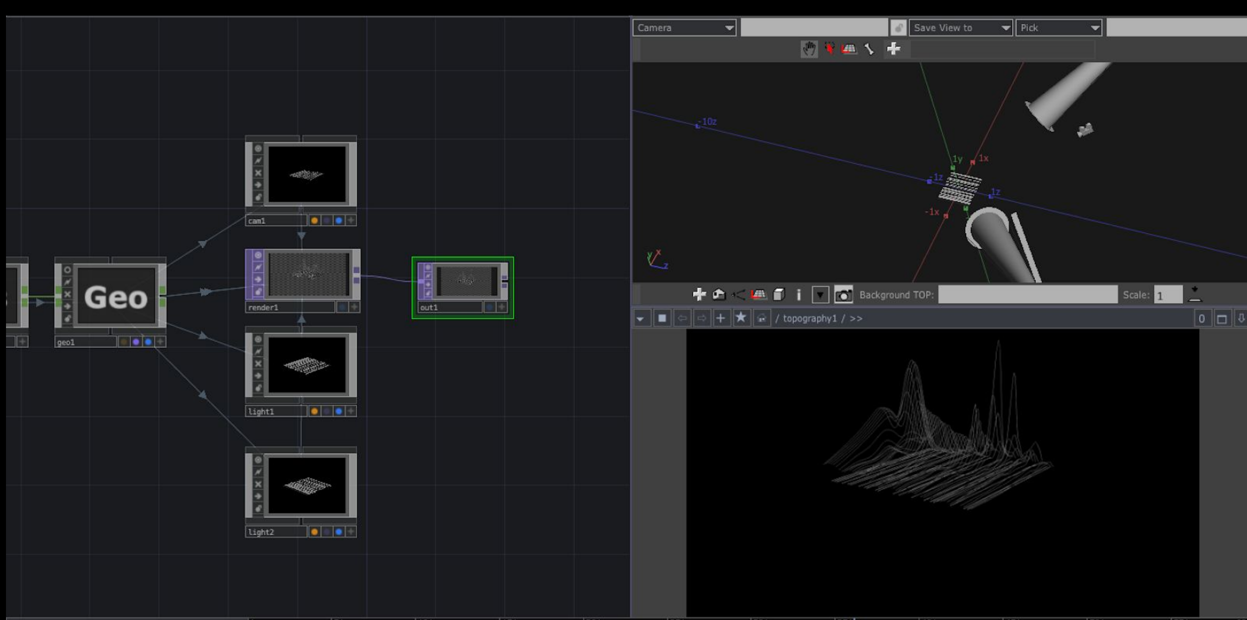


21)Next, we are going to experiment with the lights. You should already have one 'light1' COMP. Create a 2nd light so that we can have a bit more flexibility with the lighting aspect of the render. Change the 'Uniform Scale' of both lights to '5', making them a little easier to see. Also, let's make both lights 'Cone Light' by navigating to the 'Light' tab, and changing the 'Light Type' parameter. In the same way as we did with the camera, we want the lights to look at the geometry by selecting each light and dragging 'geo1' into the 'Look At' parameter, under the 'Xform' tab. Next, we want to translate the camera into different positions to create two high-angle lights. For 'light1' translate to '5', '4', '5', and 'light2' to '-5', '4', '5'.





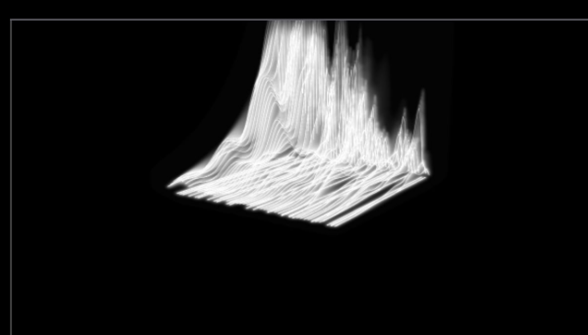
Now, let's split the right panel into a top-bottom layout so that we visualise our final render a bit better in our lower panel. To do this split, go the top-right corner of the current pane, select the arrow facing down , select 'Pane Options', and select 'Split Top/Bottom'. To make the lower pane be the output panel, select the small arrow on the top-left of this panel  and select 'Panel'.



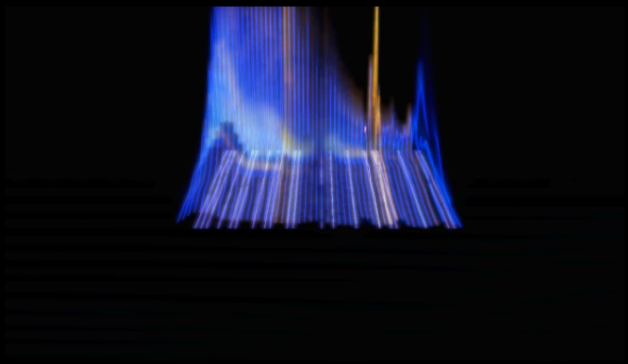
At this stage, you should be looking at a basic 3D render of the spectrum on the lower-right panel. To make this a little more interesting, we are going to create some feedback, which will allow us to expand the possibilities of control as we have already done inside our ‘AVprocess’ network.

22)First, lets go back to a single panel view by closing the panels on the right. Make some space between ‘render1’ and ‘out1’. Next, roll-over the magenta cable that is connecting ‘render1’ and ‘out1’. When rolling-over, the cable should turn yellow. Right-click on the yellow cable and select ‘Insert Operator’, then navigate to TOP/Feedback and create it. Repeat the same process by right-clicking on the connection between ‘feedback1’ and ‘out1’ to insert a ‘Blur’ TOP, and the same for inserting a ‘Level’ TOP. Next, to combine the data coming from ‘render1’ with the one coming from ‘level1’, create a ‘Composite’ TOP by inserting it between ‘level1’ and ‘out1’ by following the same process as above. Next, connect your ‘render1’ to the second input of ‘comp1’. Finally, select the ‘comp1’ operator and change the ‘Operation’ parameter to ‘Add’. This will add the data coming from ‘render1’ with the one coming from ‘level1’. To complete the feedback loop, drag the ‘comp1’ operator into the ‘feedback1’ operator.

To improve the balance between the feedback and the original, we need to adjust some parameters. First, inside the parameters window of ‘level1’, under the ‘Post’ tab, adjust the ‘Opacity’ to around ‘0.95’. This will make the feedback opacity to fade-out smoothly allowing for the current render to be clearly visualised. Also, navigate to the ‘Pre’ tab and change the ‘Black Level’ to ‘0.001’, creating a nicer contrast.



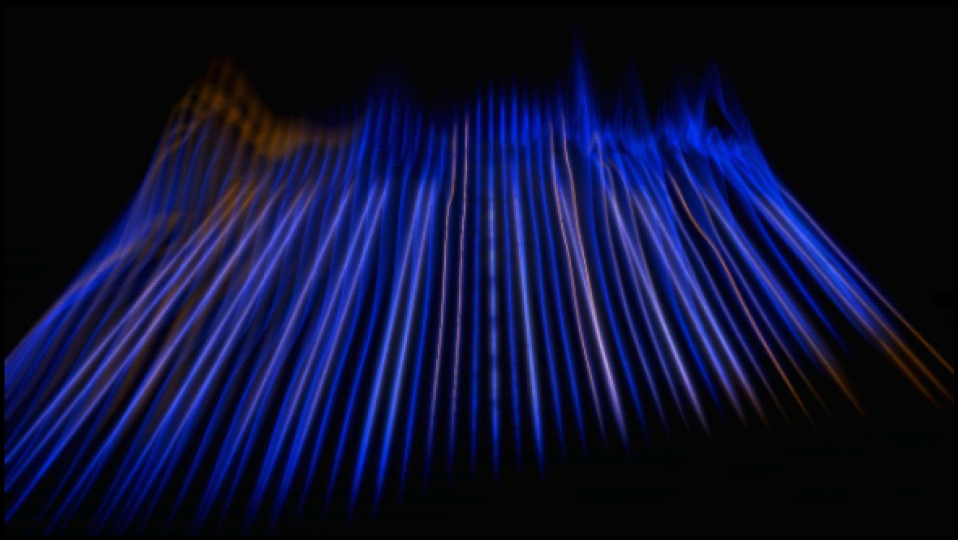
You should now be looking at a much more interesting render of our spectrum on the lower-right panel.



23)Next, let's make some adjustments to the lights so that we can clearly differentiate between the two different lights and so that we can add a more interesting scene for our spectrum. Start by changing the colour of 'light1' to orange, for example, and the colour of 'light2' to blue. To change the colour you have to navigate to the 'Light' tab on the 'Parameter Settings' and click on the coloured square next to 'Light Color'. Now it's a lot easier to understand how the positioning of the lights are affecting the render. Explore changing the position of the lights by further changing their translation under the 'Xform' tab.

You can also experiment with the camera position. For the purpose of our 'topographic' look, let's translate the camera position so that we get more of a front view. Select 'cam1', and then change the 'Translate' to '0', '1', '3', accordingly.

24)Next, let's make some adjustments to our 'geo1'. We want to change the scale parameter to make it a little bit deeper by changing the scale of the Z-axis (third box from the left) from '1' to '3'. Also, scale it's width or X-axis (first box from the left) from '1' to '2'. This is looking a lot more like a topographic view of our audio spectrum.



To get a better view of the depth of this, let's change the position of the camera so that it's a bit further away and looking from a bit of an angle from one of the sides. For example, change the translate of the camera to something like '2', '1', '4'.

25) Finally, open up the scope of our lights by changing to the 'Cone Delta' to something more like '40'. This is located under the 'Light' tab of the lights parameters. Continue to change the parameters of your lights and your camera to achieve different results.

Well Done!

This tutorial is based on Matthew Ragan's Tutorial "Topography 1, with a few elements taken from his "Oscilloscope" tutorial, previously studied.
https://www.youtube.com/watch?v=PXDOES__p70