



Introduction to TouchDesigner

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Some good sources of information

- Getting started with TouchDesigner
 - https://derivative.ca/UserGuide/Getting_Started_With_TouchDesigner
- First things to know about TouchDesigner
 - https://derivative.ca/UserGuide/First_Things_to_Know_about_TouchDesigner
- Learning TouchDesigner
 - https://derivative.ca/UserGuide/Learning_TouchDesigner
- User guide
 - https://derivative.ca/UserGuide/Main_Page
- User guide in WIKI format
 - https://docs.derivative.ca/Main_Page
- Scripting TouchDesigner with Python
 - <https://docs.derivative.ca/Category:Python>
- Download page
 - <https://derivative.ca/download>
 - I'll be using the non-commercial version
- TouchDesigner glossary
 - https://derivative.ca/UserGuide/TouchDesigner_Glossary
- Some useful introductory videos
 - <https://derivative.ca/community-post/norway-workshop-videos-creative-projection-week-2016>
- More things to know about TouchDesigner
 - https://derivative.ca/UserGuide/More_Things_to_Know_about_TouchDesigner

Main source for this lecture

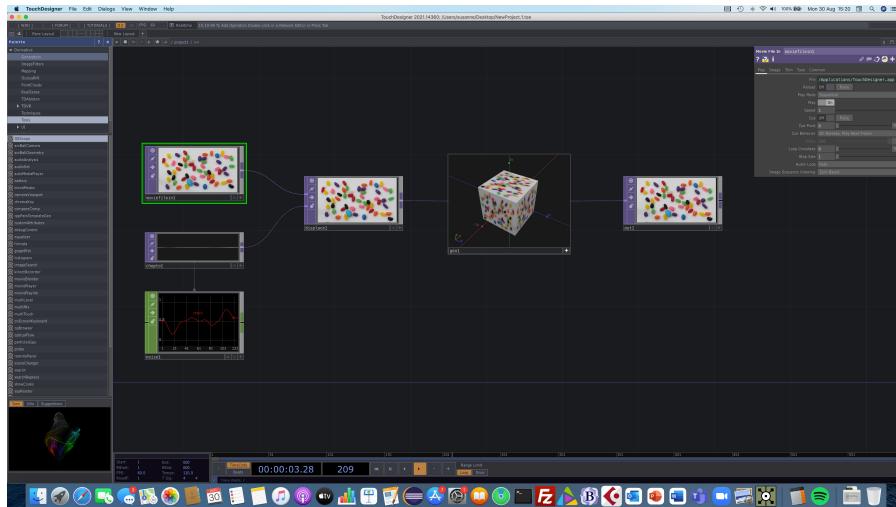
- First things to know about TouchDesigner
 - https://derivative.ca/UserGuide/First_Things_to_Know_about_TouchDesigner

What is TouchDesigner and what can it do?



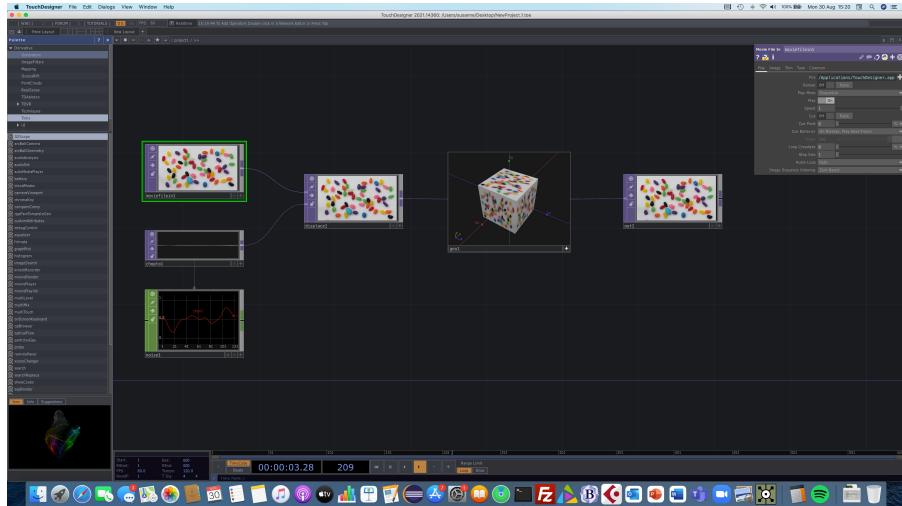
- A visual programming environment for creating real-time interactive multimedia content
- Can be used for
 - 2D image and movie generation and filtering
 - Motion tracking, audio, animation and control signal processing
 - Realtime 3D surface processing and generation
 - Projection mapping
 - Application building (including building user interfaces)
 - High-performance media systems
 - Lighting and live shows
 - Creating virtual and augmented reality environments
 - Networking (with OSC)
 - ... and much more
- For examples of projects built using TouchDesigner, see, for example
 - <https://derivative.ca/showcase>

Getting started with TouchDesigner



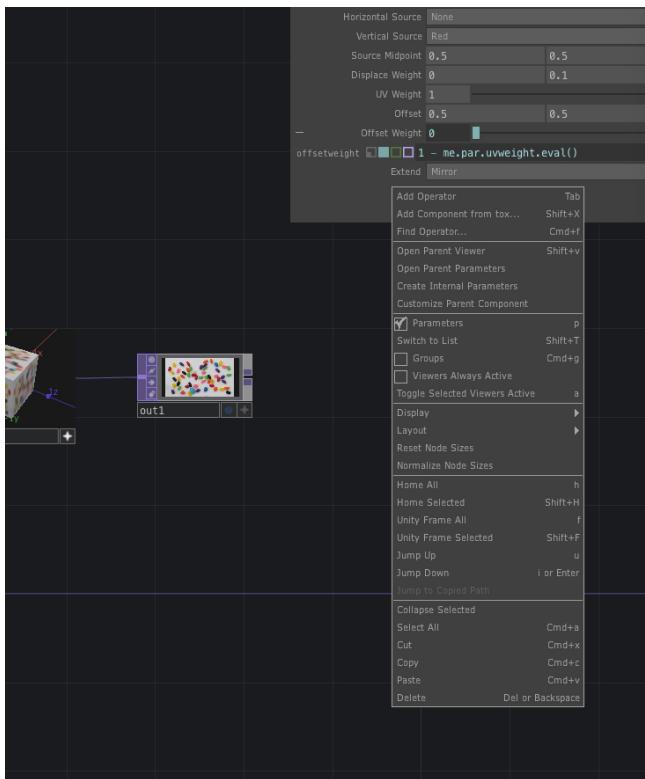
- Download TouchDesigner from the downloads page
 - <https://derivative.ca/download>
 - You can use the non-commercial version, you need to make an account so you can get a key after installation
 - Install in the obvious way
 - When using the first time, you'll need to use the Key Manager Dialog to guide you through the process of getting a license
- See
https://derivative.ca/UserGuide/Install_TouchDesigner for troubleshooting installation

Starting TouchDesigner



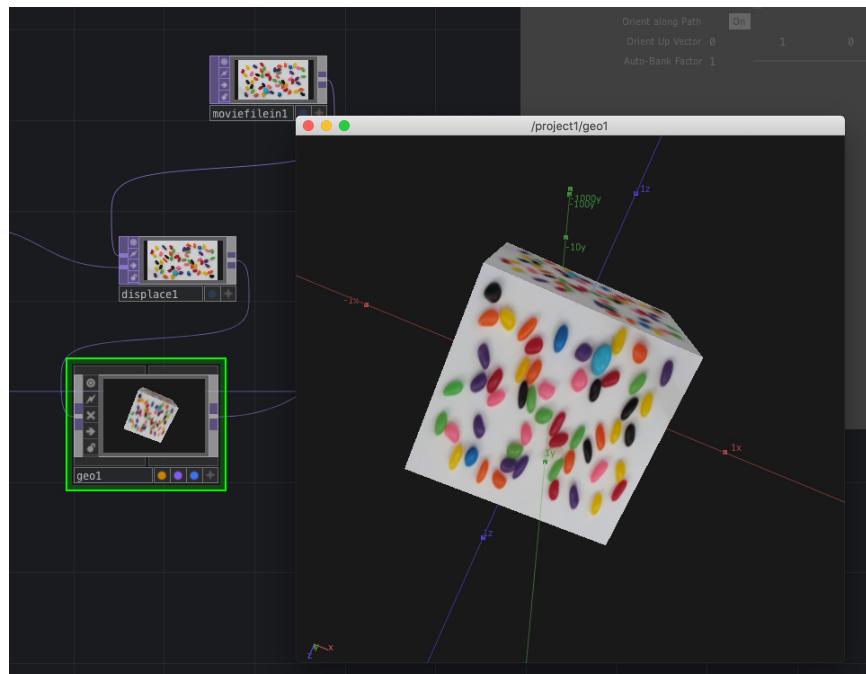
- Best to use a 3-button mouse, preferably with a roller wheel
- When TD starts, you'll see the build of your version on the splash dialog
- Starts with a default network that is already running
- You can pause the network by pressing the pause button
- On the left is the Palette browser, which you can close with cross in its top right corner
- The network consists of a number of *operators* that are wired together
- One of the operators is selected and its parameters are shown in the dialog in the top right of the main window

Pan, zoom and center the network



- Pan by clicking and dragging with the LMB on an empty area in the network
- Zoom by rolling the middle roller or by holding the MMB and dragging left and right
 - You can also use Alt-right click if you don't have a MMB
- **Home (center)** entire network by pressing 'h'
 - Use Shift-h to home just the highlighted node
- Pressing the RMB on an empty area of the network brings up the network menu
- You can zoom inside a component by continuing to zoom when it fills the screen

Selecting and moving nodes (operators)



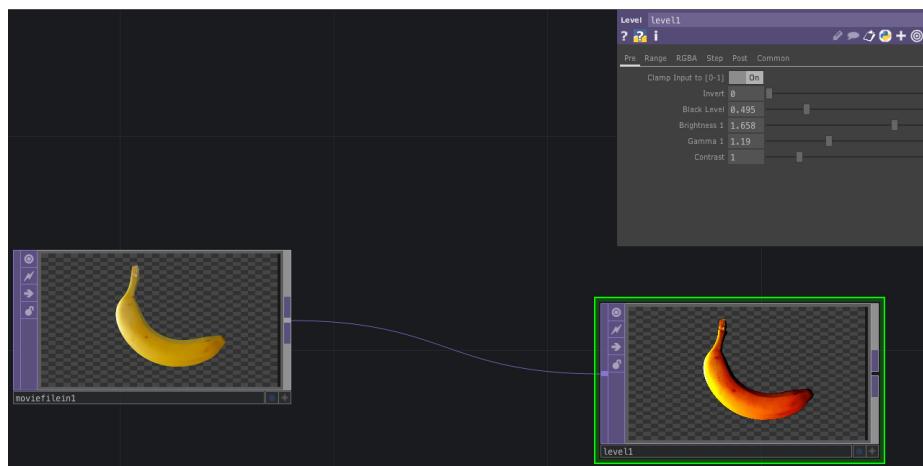
- Left-click and drag to move a node (its wires go with it)
- Right-click in an empty area of the network and drag to box select one or more nodes
 - Left-click on one of the selected node to move all of them in parallel
- Right-click on a node to get its node menu
 - Only get node menu if node's viewer is not active
 - You can bring up a separate view window for a node by right clicking and selecting "View"
 - You can interact with the View window by zooming, dragging, tumbling, etc.
- Delete a node by selecting it and pressing delete

Operators are either generators or filters



- If we double-click on an empty network, we get the **OP Create Dialog**
 - “OP” is short for “operator”
 - Another word for operator is “node”
 - OPs with a darker background are generators (e.g., Movie File In)
 - Generators create new data or import data from files, programs or devices
 - Ops with lighter background are filters (e.g., Level)
 - Filters modify the data from an incoming operator

Adding an image generator and a filter



- Use the OP Create Dialog to add a Movie File In operator to an empty network
- Right click its right-hand connector, which brings up the OP Create Dialog again, and select the Level OP, which is a filter
- You now have a generator operator (moviefilein1) sending its output to a filter (level1)
- Play with the sliders in the parameters dialog in the top right of the screen to see the effect that the Level filter has on the image that is imported using the Movie File In operator

Operator families



- There are six families of operators, shown on different pages in the OP Create Dialog
 - COMP – Components: Object components (3D objects), panel components (2D UI gadgets) and misc components
 - Components contain other operators
 - TOPs – Texture Operators: 2D image operations
 - CHOPs – Channel Operators: motion, audio, animation, control signals
 - SOPs – Surface Operators: 3D points, polygons and other 3D primitives
 - MATs – Material Operators: materials and shaders
 - DATs – Data Operators: operators containing text, such as scripts, XML, tables

Adding operators



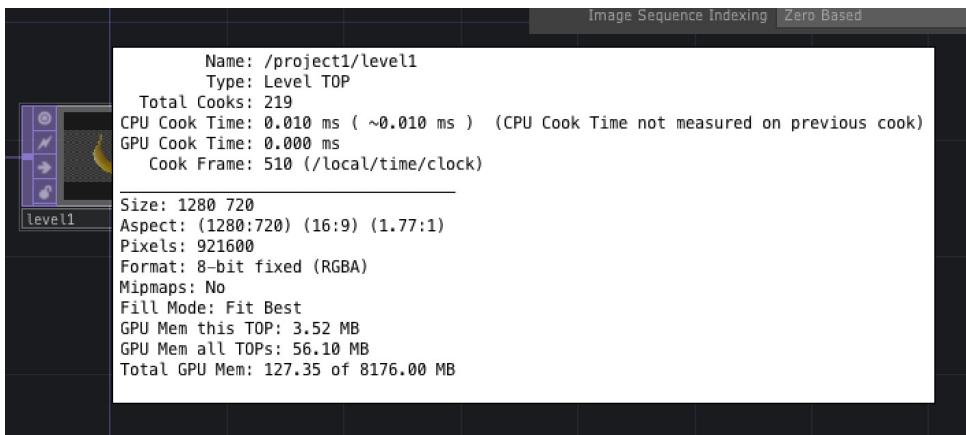
- Let's add some operators from different families
 - Monochrome TOP
 - Pattern and Noise CHOPs
 - Sphere SOP
 - Phong MAT
 - Geometry COMP (prepares SOP and MAT for 3D rendering)
 - Slider COMP (a 2D gadget for building control panels)
 - Monitors DAT

Connecting nodes with wires



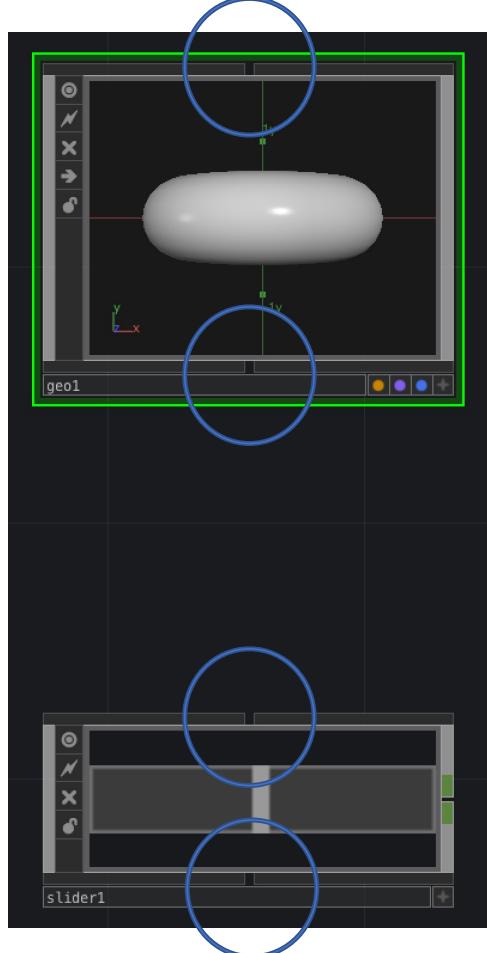
- Inputs on the left, outputs on the right
- Connect output of level1 to mono1
 - Left-click on output of level1, release, left-click on input to mono1
 - Or left-click on output, drag and release on input
- Create a Tile TOP and insert **between** the Level and Monochrome TOPs
 - Right click output of level1 and select Tile TOP
- Create a new branch by right clicking on an existing wire and selecting “Add operator”
 - Add an Edge TOP as a second output from the level1 TOP
- Remove a wire by clicking on its destination input and then on empty space in network
 - Can also right click on wire and select “Disconnect”

Wires, data flow and cooking



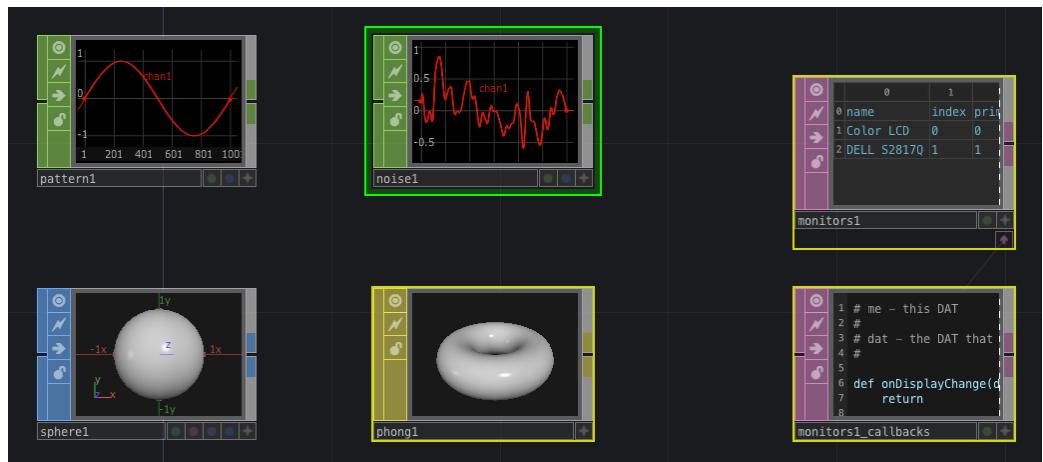
- Data flows along wires from node outputs to node inputs
- For example, when select level1 TOP and adjust its parameters, data flows out of its output node to tile1 and edge1
 - You can see the wires animate while the data is flowing
- Data flows through a wire when an upstream node is **cooking** (i.e., doing some computation)
- Middle click on a node to bring up its Info dialog
 - Info dialog shows how many times a node has cooked, e.g., tile1 had cooked many times, but moviefilein1 has only cooked once
 - Can also bring up Info dialog by right clicking on a node and selecting “Info” from the pop-up menu

Top and bottom connectors



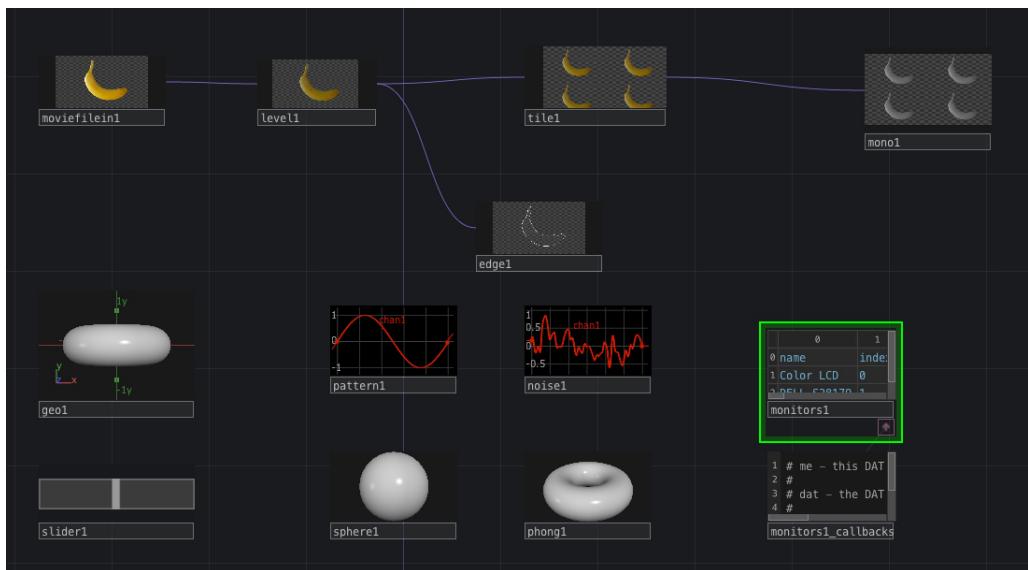
- 3D components have connectors on their tops and bottoms that can be used to arrange them into a hierarchy
- 2D components also have these connectors – in this case, they are used to arrange them into control panels
- No data flows along these top and bottom connectors – data only flows through the inputs and outputs on the sides of the nodes

Current nodes and selected nodes



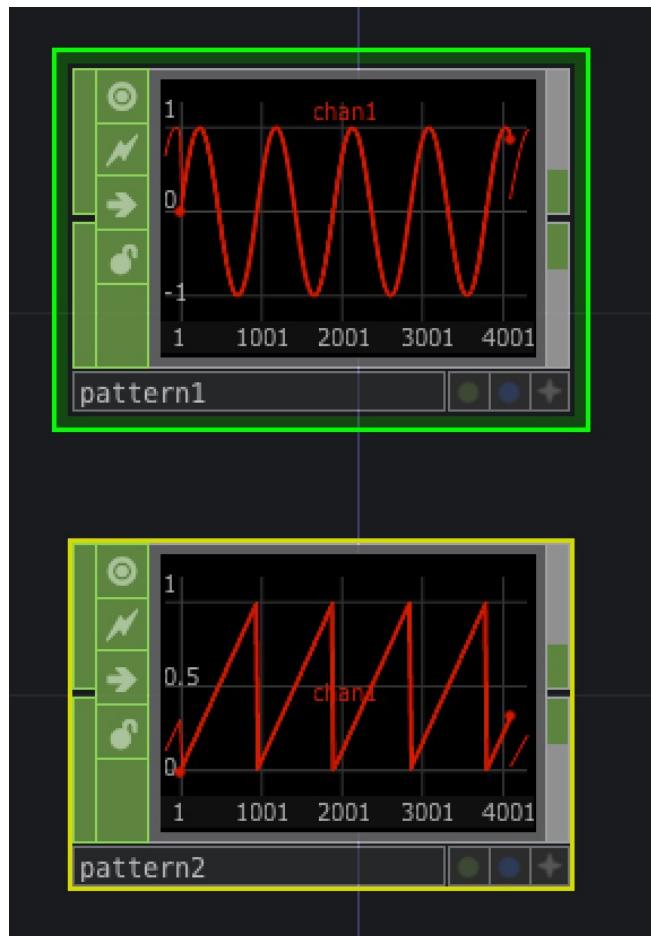
- Clicking on a node gives it a green border and makes it the “current” node
- Selected nodes that are not the current node have yellow borders (e.g., when you box select several nodes)
- You can apply a single operation simultaneously to all selected nodes (e.g., delete them)
- You can undo the previous operation with Ctrl-Z (or Cmd-Z on a Mac)

Node viewers



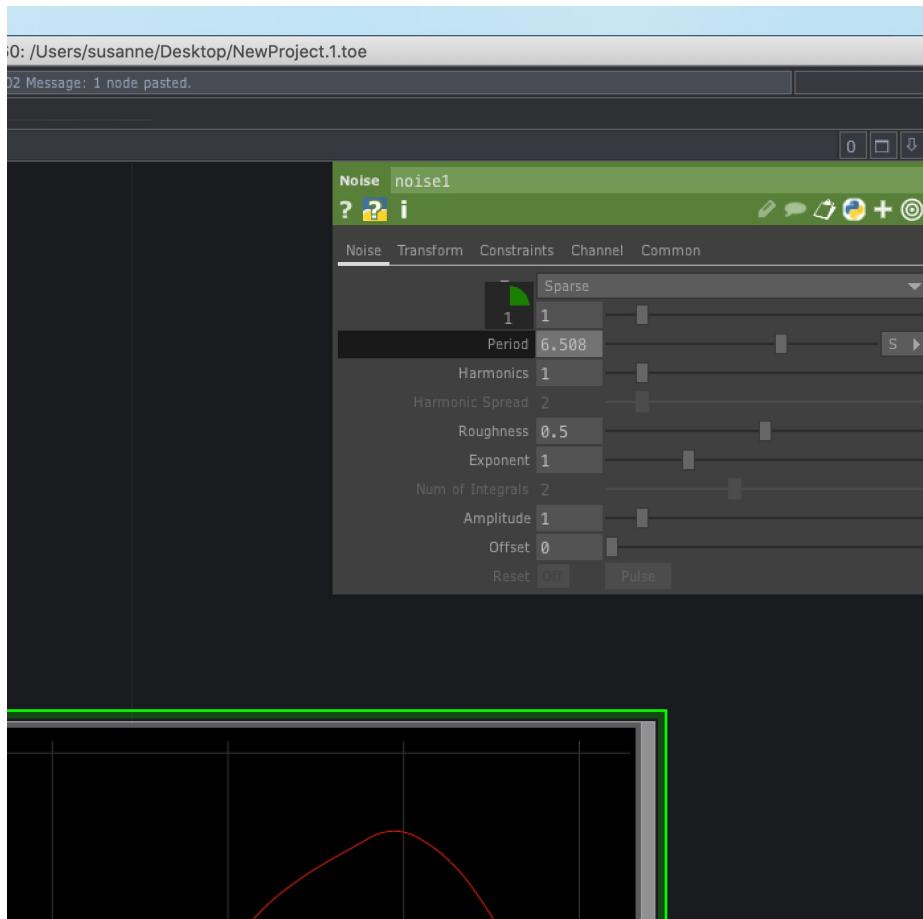
- If you click Viewer active flag, then border is removed and you can interact with content of node and inspect content more closely
 - Middle click and drag left/right to zoom content of node
 - Right click to get a menu of viewing options
- Alt-A or Option-A puts all node viewers temporarily into Viewer Active state
- Can make all viewers active by selecting “Viewers always active” from the right-click network menu
- Pressing ‘a’ toggles viewer active flag for selected node
- When a node has its viewer active, you can access its menus and move it around by clicking on its name bar at the bottom

Adjusting node parameters



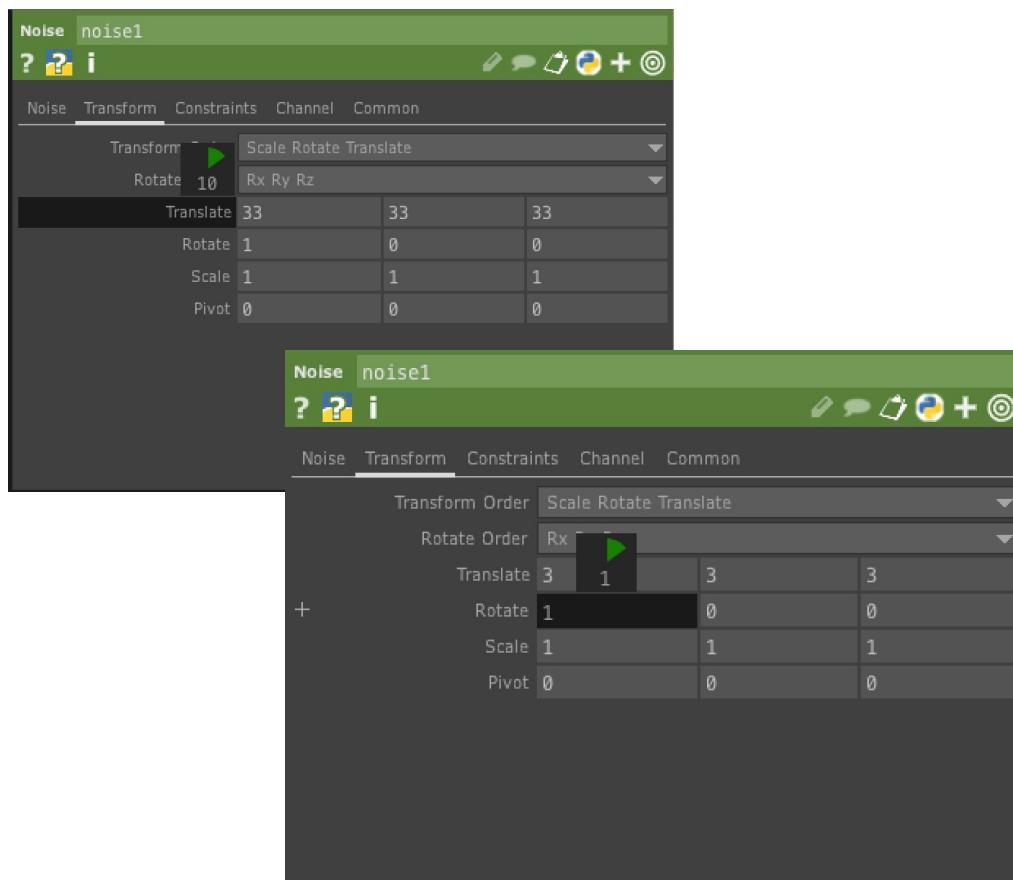
- Parameter dialog in top right-hand corner shows parameter values for the currently selected node
 - You can hide or show it by pressing 'p'
- You can also show parameters of a node by right clicking and selecting "Parameters..."
- Can change value of same parameter in multiple selected nodes
 - Make a copy of pattern1 and make the new Pattern node's type "Ramp"
 - Select pattern1 and pattern2
 - Change the value of the "Number of cycles" parameter
- To reset a single parameter to its default value, right click on the parameter in the Parameter dialog and select "Reset parameter"
- To reset all parameters to their default values, right click and select "Reset all parameters"

Value ladders



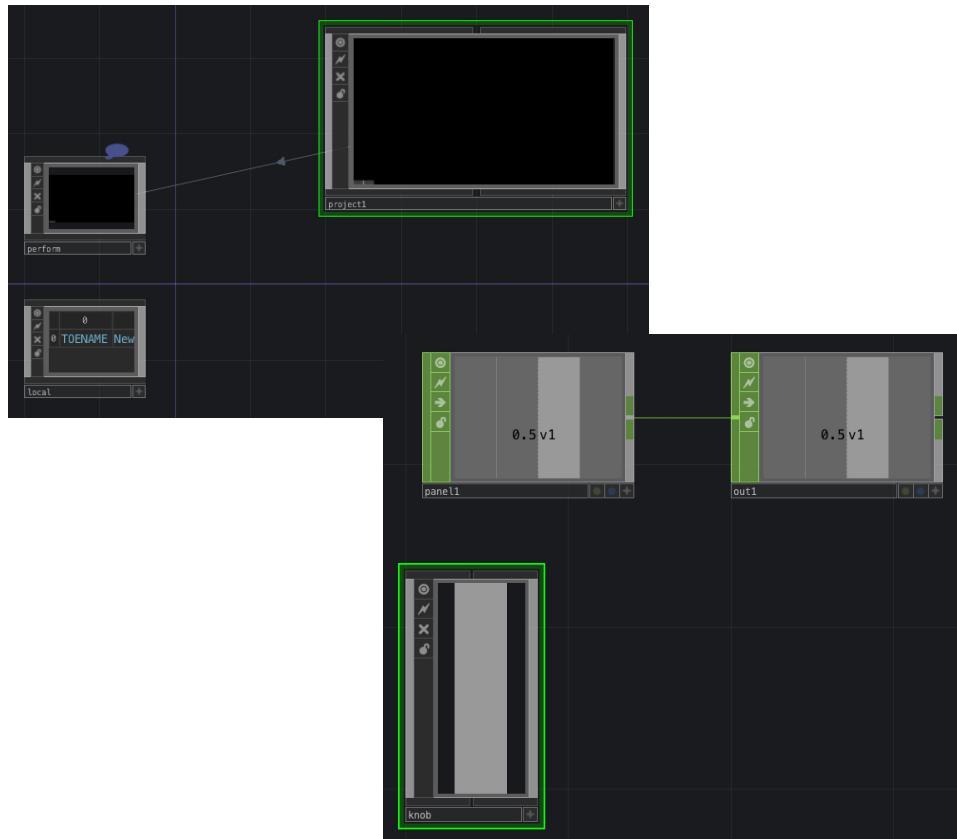
- You may find value ladders useful for changing the values of parameters
- Left-click on a parameter name in the Parameter dialog and wait a moment – a value ladder appears
 - You can also bring up the value ladder immediately by middle-clicking on the name of a parameter
- Select one of the values in the ladder to choose the order of magnitude
- Then drag left or right to "fine-tune" the value

Value ladders for multi-dimensional parameters



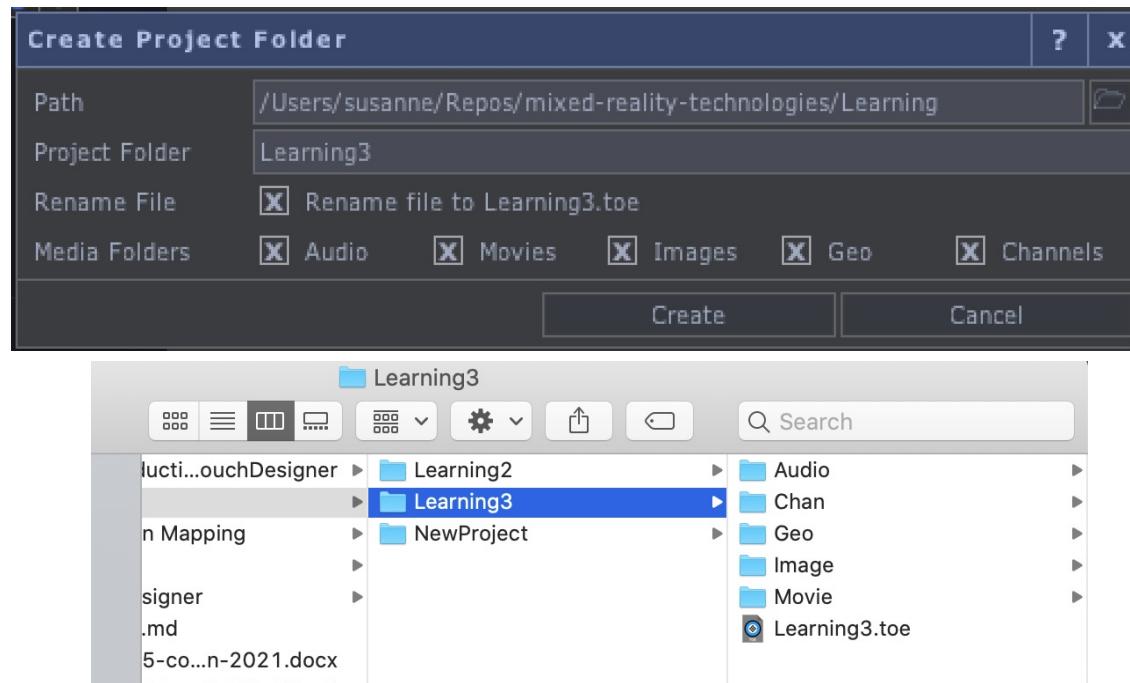
- If you click on a single component of a multi-dimensional parameter, then the value ladder changes just the value of that component
- If you click on the name of a multi-dimensional parameter, then the value ladder changes all the components for that parameter

Components



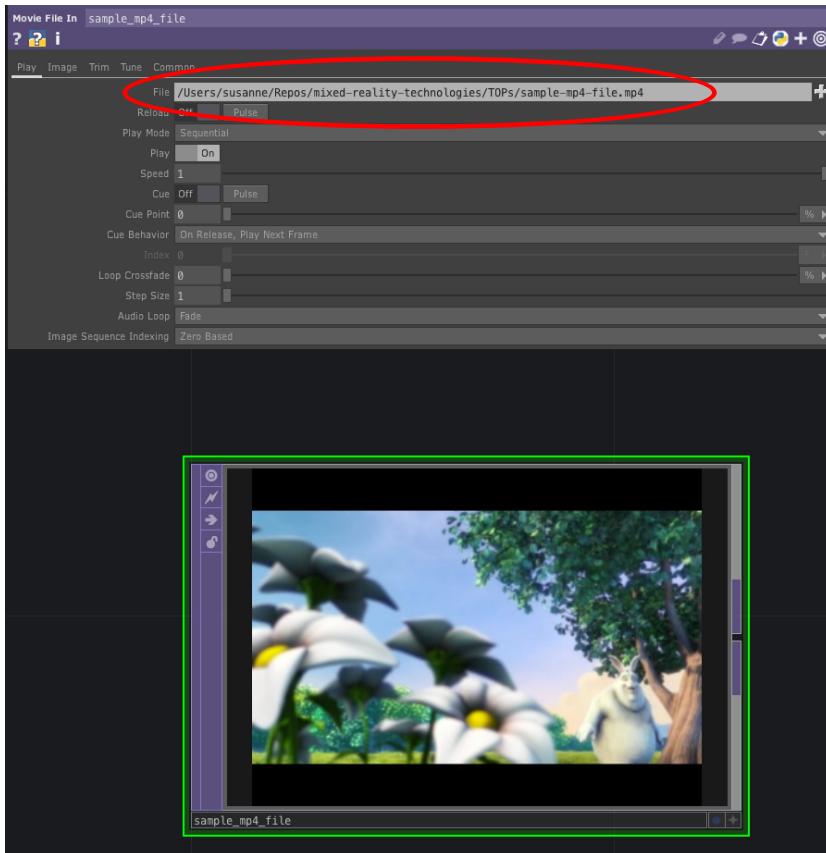
- A Component node contains a network
- Every network lives inside a Component
- If you zoom out far enough, you go outside the project node that contains the network that you've been editing
- If you zoom into the project1 node, you re-enter the network that you were editing before
- If you zoom into a component node, then you go inside it and enter the network that it contains
 - Try this with the geo1 or slider1 components
- You can go inside a selected component by pressing 'i' (for 'inside')
- You can get out of a component by pressing 'u' (for 'up')
- You can also enter a component by double clicking it so long as its viewer is not active

Remember to save your work frequently



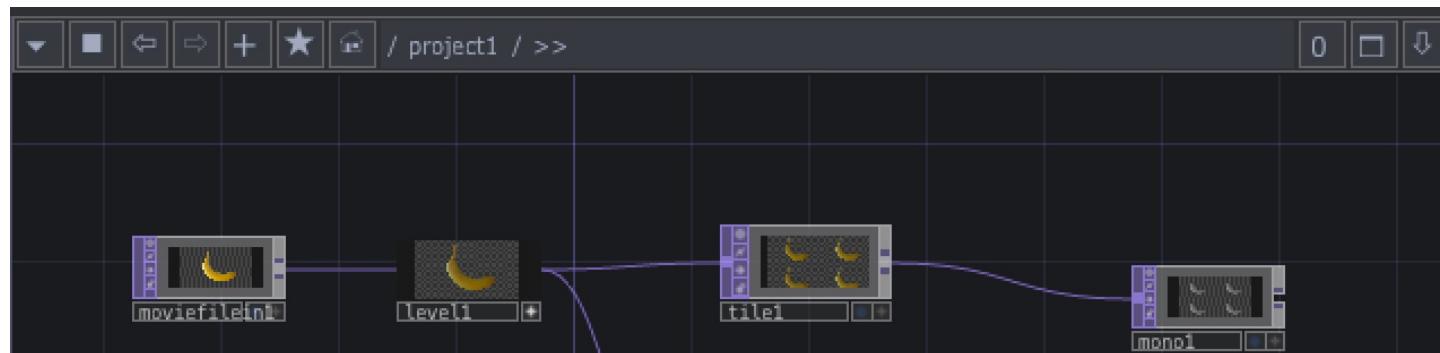
- When creating a new project, you can choose to have TD create folders for the different types of files that might be present in your project

Getting media into TouchDesigner

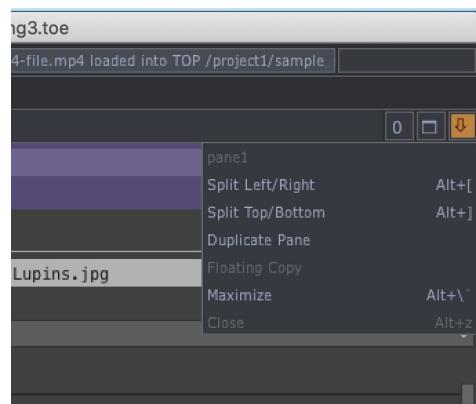


- You can import images, movies, audio, FBX and TouchDesigner Components (TOX files) into TouchDesigner
 - See https://derivative.ca/UserGuide/File_Types for details about what file formats are accepted
- You can simply drag images, movies and audio files from your Finder or File Explorer directly into a network
- You can also place a Movie File In TOP in your network and then enter the path to the file that you want to import into its “File” parameter
- You can also open a media file from the Explorer/Finder into TouchDesigner, but this will start a new instance of TD and open the file in an appropriate node

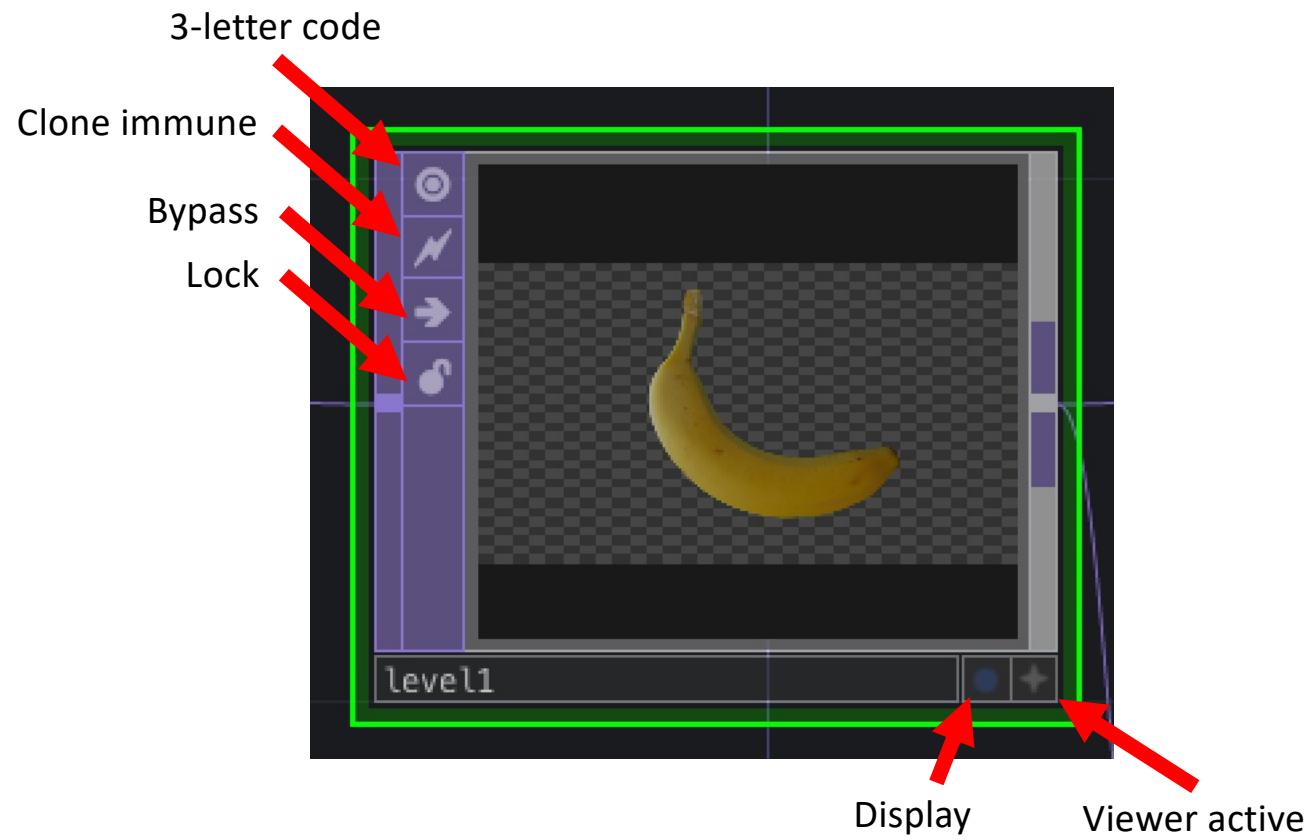
Split panes and pane types



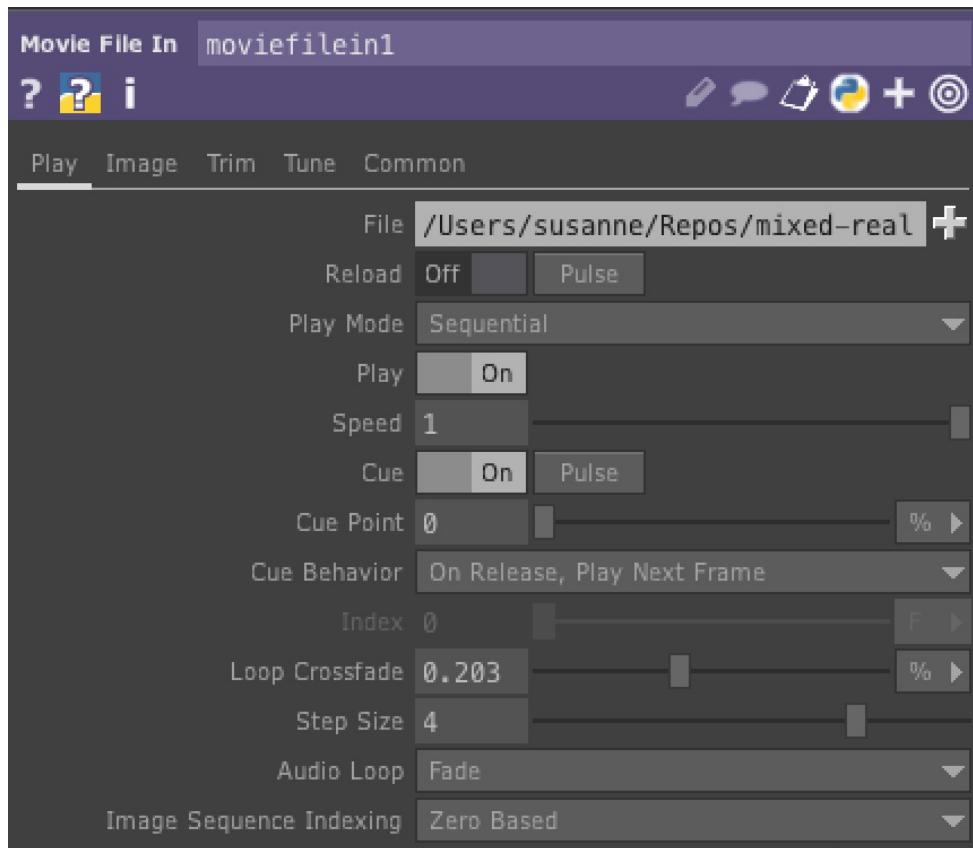
- At top of every pane is the Pane bar
 - Split pane menu
 - Maximise pane
 - Link pane menu
- Network path shows location within network
- Pane type on left allows you to change the type of a pane
 - Network editor is what we've been using
 - Panel type lets you interact with the panel components (e.g., sliders)
 - Geometry viewer lets you interact with 3D scenes and objects



Flags

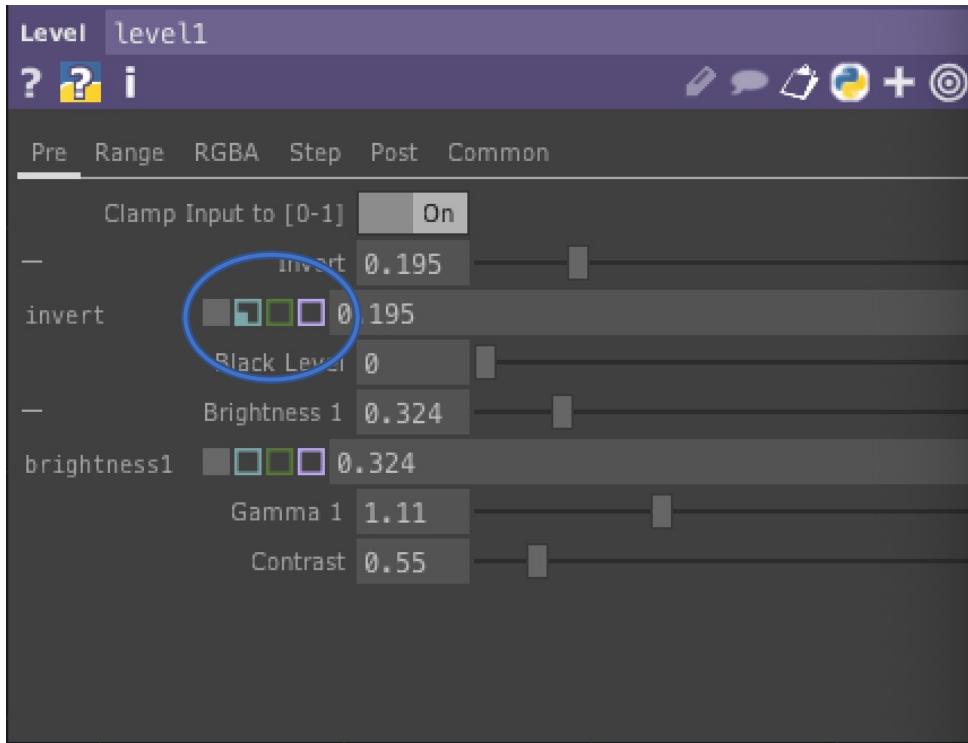


Parameters



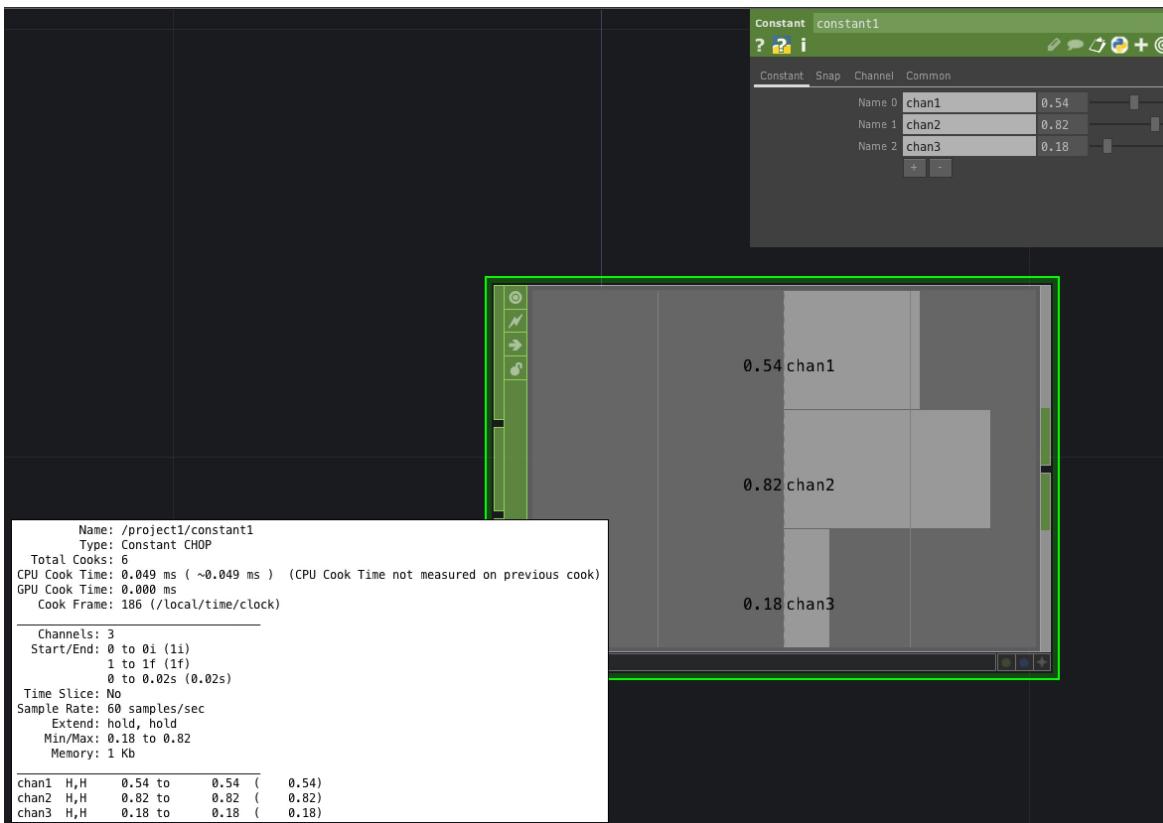
- Operators process and output data
- Output of an operator depends on inputs, parameters and possibly current time
- Common types of parameters are integers, floating point values, Boolean toggles, menus, text strings, node paths, pulses that tell an operator to do something just once
- A parameter may be a unidimensional value or it might be an array of 2, 3 or 4 values
 - E.g., a color is an array of either 3 or 4 values: red, green, blue and possibly alpha

Parameter modes



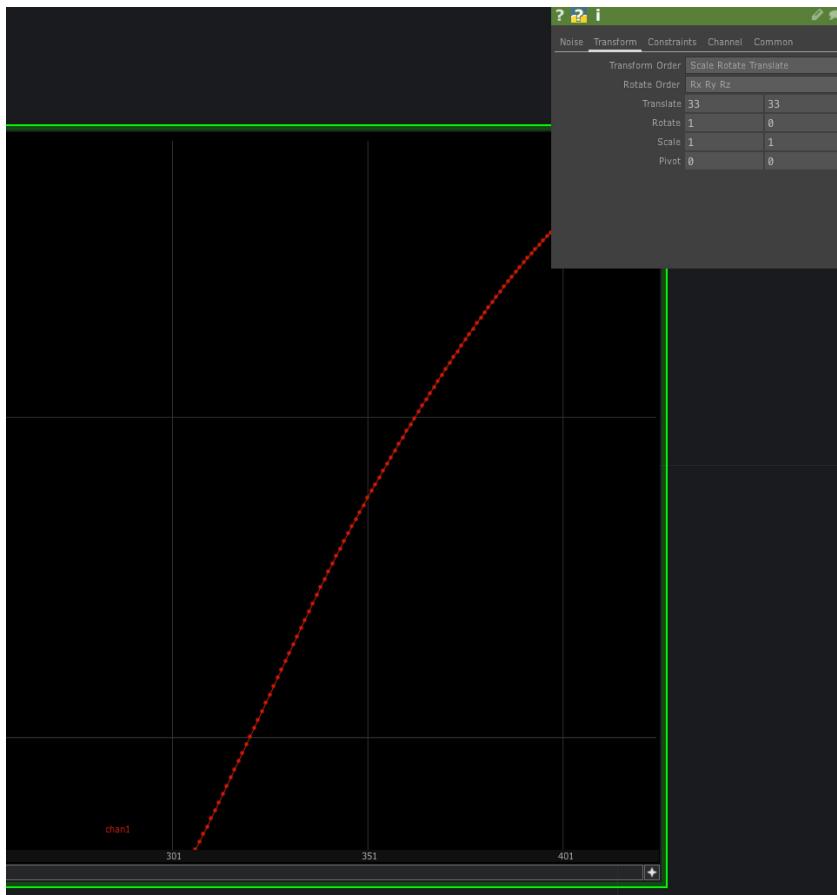
- Each parameter is in one of 4 different **modes**
 - **Constant mode**: a specific constant value, entered either by typing the value or by using a slider or selecting a value from a drop-down list
 - **Expression mode**: can be a python expression
 - **Export mode**: values come from import from a CHOP
 - **Binding mode**: causes the values of two or more parameters to bound so that changing one of them changes all of them

CHOPs (Channel Operators) output streams of numbers



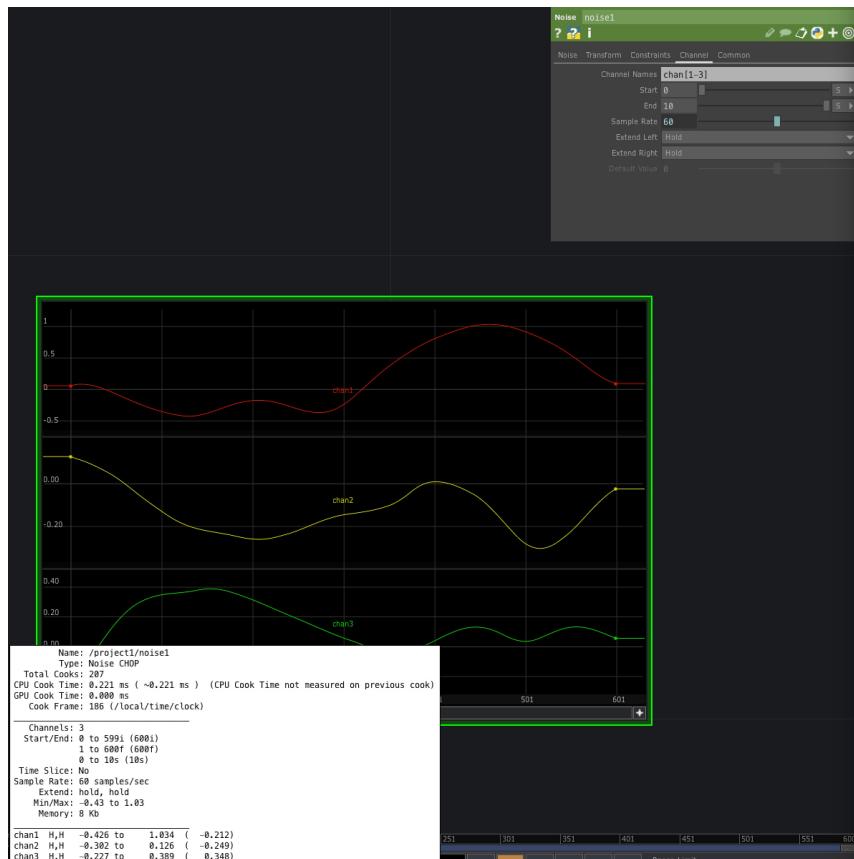
- A channel operator (CHOP) generates one or more **channels**, each of which is a sequence of numbers, called **samples**
- For example, a constant CHOP has 1 channel and 1 sample
 - You can add additional channels to a Constant CHOP
- Middle click on the Constant CHOP to bring up its info dialog
 - See that there are 3 channels and each channel has 1 value

Noise CHOP generates multiple values



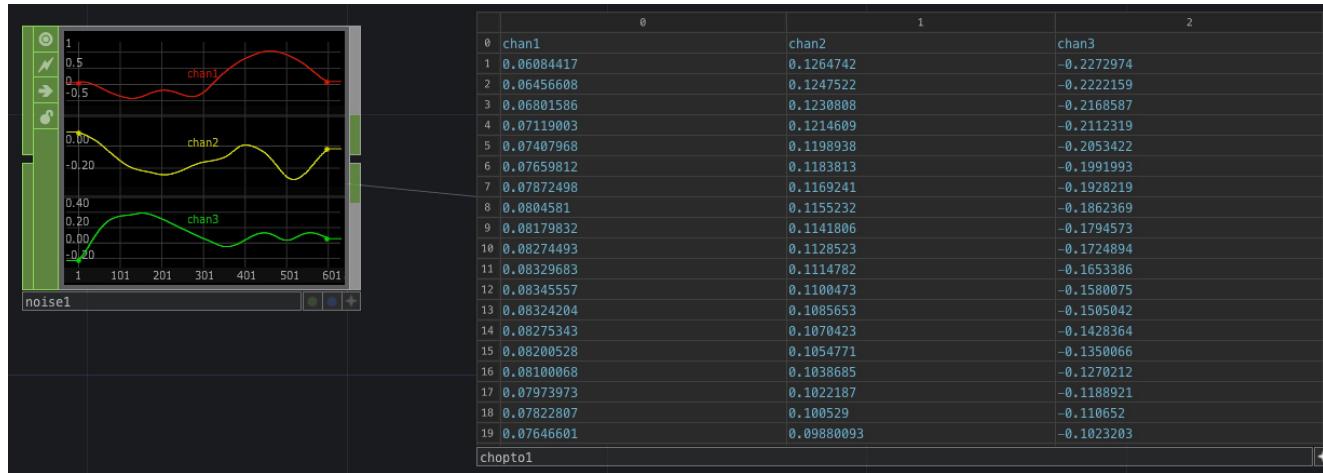
- A Noise CHOP generates a single channel with many samples
 - Make viewer active
 - Right click and select “Dot per Sample”
 - Zoom in to see dots, which represent the separate values in the channel
 - Press in Viewer active mode to home the channel

Noise CHOP can have multiple channels



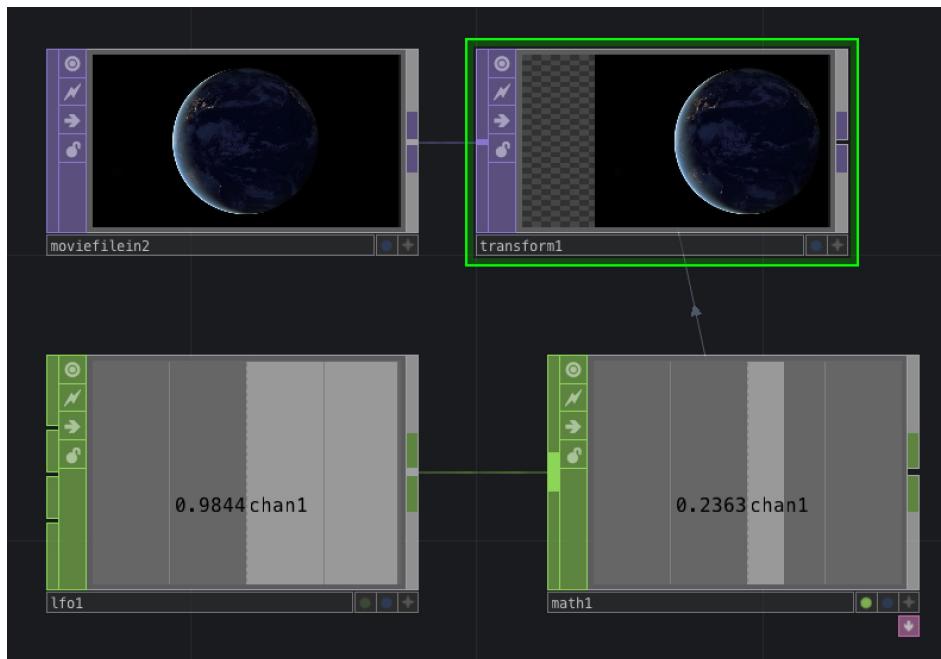
- Can add multiple channels to a Noise CHOP by changing Channel Names parameter to an array
 - E.g., chan[1-3] produces three channels, each with 600 samples
 - You can verify this by looking at the info dialog, where it states that Start/End is 0 to 599i

Using a “CHOP to” DAT to view the values generated by a CHOP



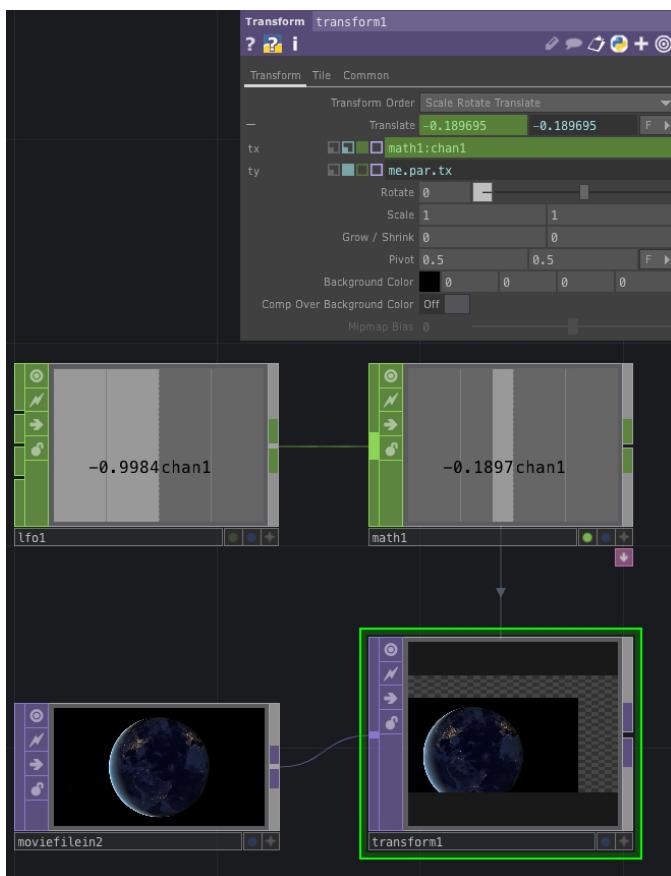
- To view the sample values generated by a CHOP
 - Add a “CHOP to” DAT to your network
 - Drag the Noise CHOP onto the new CHOP to DAT
 - You’ll see a table in the DAT showing all the values generated by the Noise DAT
 - If you turn the “Include Names” toggle off, then the column headers are not included
- You can do the same with, for example, a Constant CHOP
- CHOPs generate and process signals that can represent a wide variety of different things, such as motion, audio or a control signal from an external device (e.g., a Leap Motion or a Kinect)

Exporting CHOP channels to operator parameters



- We'll use the values generated by an LFO CHOP to translate a movie from side to side
- We'll need an LFO CHOP, a Math CHOP, a Movie File In TOP and a Transform TOP
- Select an input file for the Movie File In TOP
- Connect the Movie File In TOP to the Transform TOP
- Connect the LFO CHOP to the Math CHOP
- Make the Math CHOP's viewer active
- Select the Transform TOP so you can see its parameters
- Click on the Math CHOP's viewer and drag to the Translate parameter of the Transform TOP
- Select “Export CHOP” from the pop-up menu that appears
- Adjust the range of the output of the Math TOP by going to its Mult-Add page and adjusting the Multiply slider
- Adjust the speed of the oscillation by changing the value of the frequency parameter of the LFO
- You can stop the export by clicking on the Export flag (green dot) at the bottom of the Math CHOP

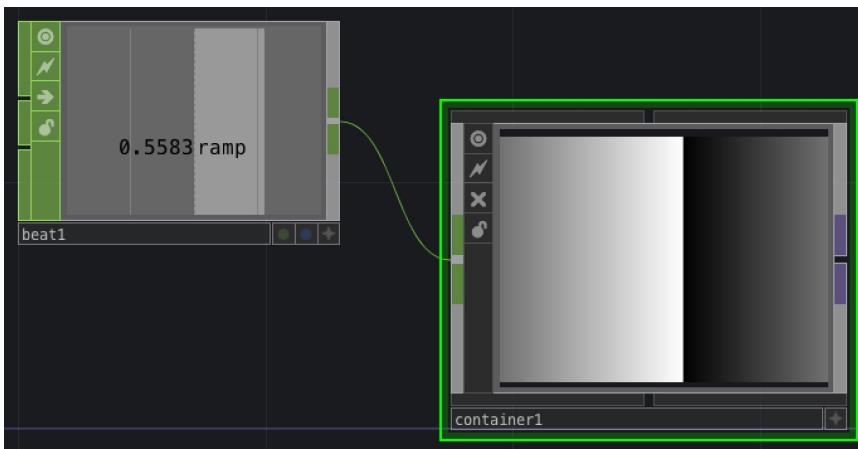
Using Python expressions in parameters



- Expressions can be used instead of channels or constant values in parameters and scripts
- The preferred language is Python
- If we click on the name of the Translate parameter of the transform1 TOP, we see that the tx variable gets its values from math1:chan1 – this is the export from chan1 in the math1 Math CHOP
 - The fact that this is an export is indicated by the filled green square to the left of the value text box
- Now let's put an expression in the ty variable, e.g., $0.2^{**} 2$, which means the square of 0.2 in Python
 - You'll see that the blue box is filled to the left of the value, indicating that this is now a Python expression
- Change the expression in ty to me.par.tx to have the movie also oscillate up and down at the same rate as it moves from left to right
 - Access the value of a parameter in the same OP using me.par.name where name is the name of the Python variable associated with the parameter
- See https://derivative.ca/UserGuide/Python_Tips for some commonly used techniques for using Python expressions in TouchDesigner

Components with inputs and outputs

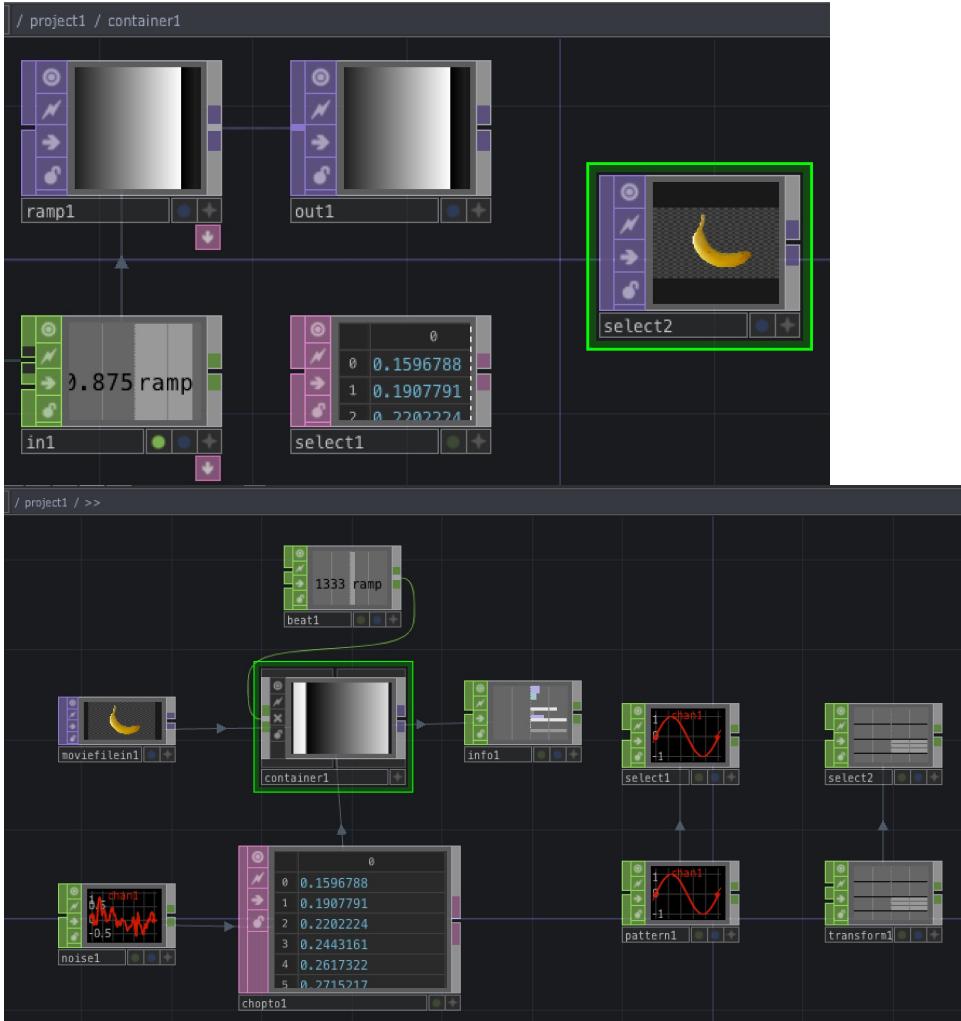
- Each component operator contains an entire network of nodes
- A component can take an input and generate an output
- Let's create a custom Component that takes a CHOP input and generates a TOP output
 - First we create a Container COMP
 - Inside the Container CHOP we place a Ramp TOP
 - Connect the output of the Ramp TOP to the input of a new Out TOP
 - Place an In CHOP inside the Container COMP
 - Go back outside the Container COMP
 - Create a Beat CHOP and connect its output to the input of the Container COMP
 - Go back inside the Container COMP – see that the In CHOP is now receiving input from the Beat CHOP outside the container
 - Export the In CHOP channel to the Phase parameter of the Ramp TOP
 - Go back outside the Container COMP
 - On the Container's Look page, set the Background TOP parameter to be the name of the Out TOP that it contains – indicate this with its path, ./out1



Node paths

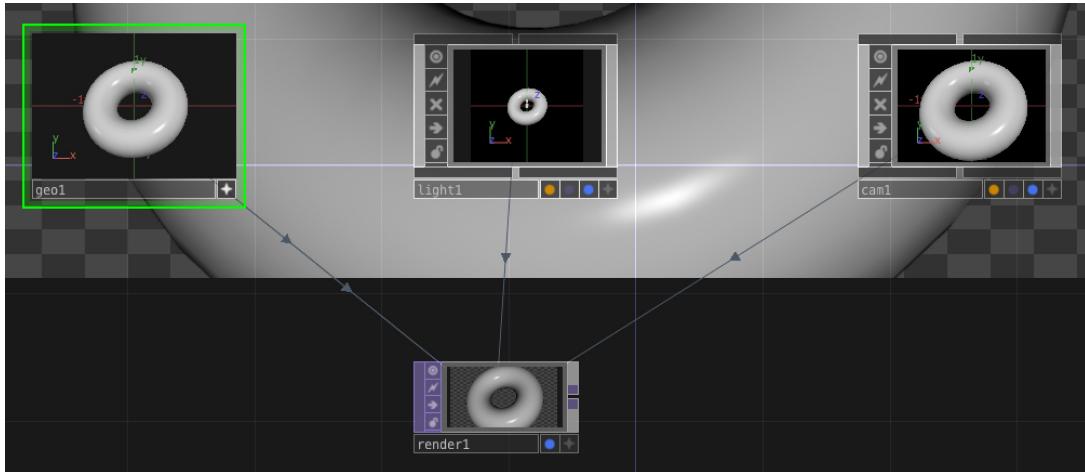
- Node paths work just like paths in file systems, except that operators correspond to files and components correspond to folders
- The address bar shows the path to the network being shown in the network editor
- Click on the home button to take you to the root component ('/')
- So:
 - / is the root component – an absolute path begins with the forward slash
 - A path that does not begin with a forward slash is a relative path – it tells you how to get to the selected node or network from your current position
 - ./ is the current component, so ./out1 means the node called out1 in the current component
 - ../ refers to the parent component, so ../chopto1 means the node called chopto1 in the parent network – i.e., you need to go ‘up’ one network and there you will find chopto1
 - Just giving a node name, e.g., transform1, identifies the node with that name in the same network as the node where the path is being written

Some practice with node paths



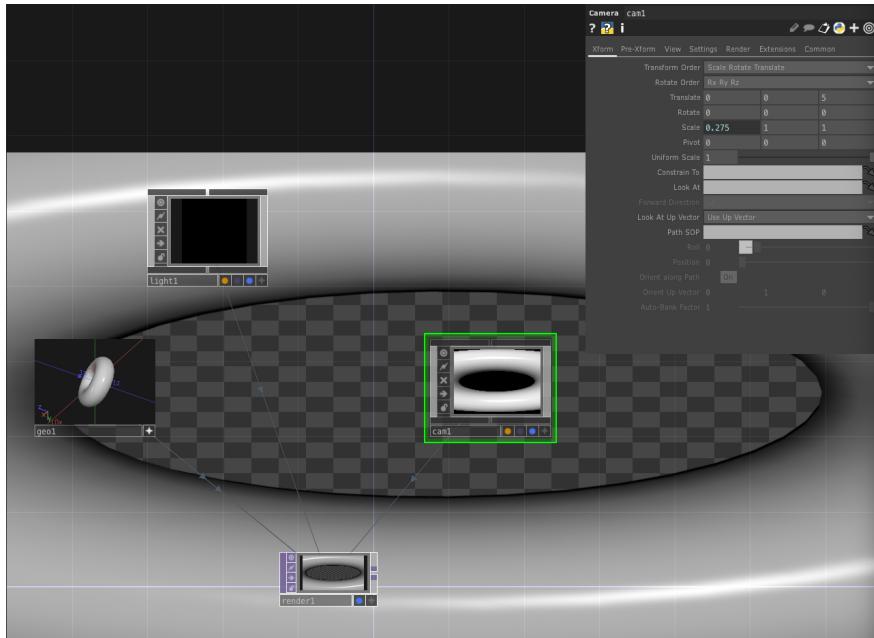
- select1 CHOP refers to another CHOP – if you write /project1/pattern1 in the CHOP parameter, this is the absolute path to the pattern1 node
- select2 TOP refers to a TOP – set its TOP parameter to transform1 to refer to the transform1 node using a relative path
- info1 CHOP gives information about an operator – set its operator path to container1/out1 to get it to show info about the out1 TOP inside the container1 COMP, which is in the same network as the info1 CHOP
- container1 has its Background set to ./out1, which refers to the out1 TOP inside it
- select1 DAT inside container1 has its DAT parameter set to ..//chopto1 which is a relative path referring to the chopto1 CHOP in the network containing container1

Rendering a 3D scene



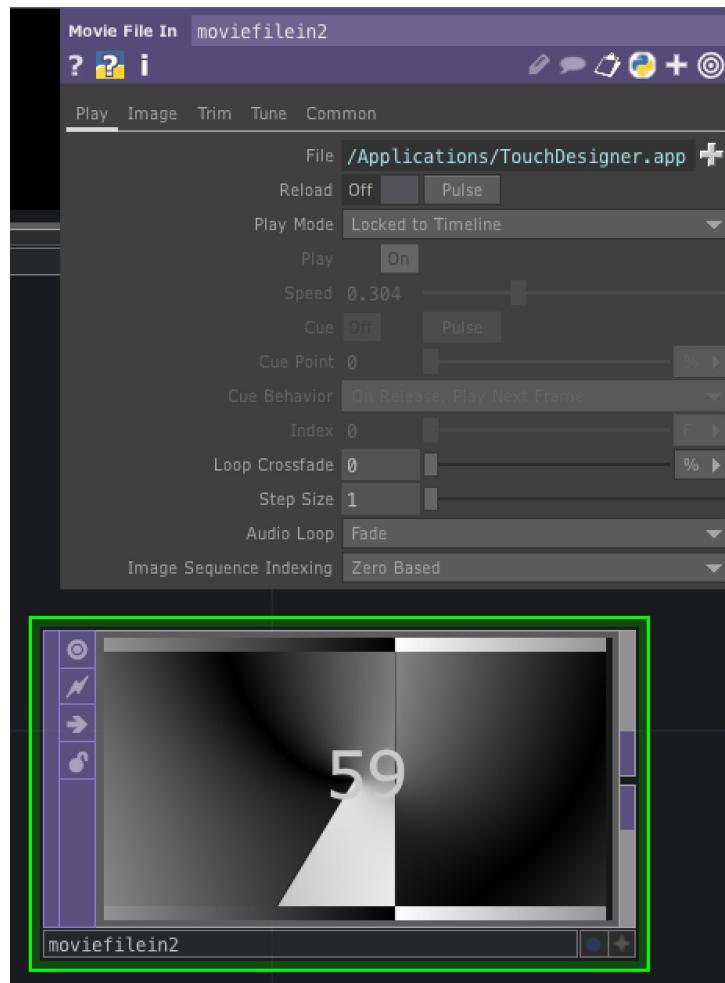
- You render a 3D scene by using a Render TOP that takes input from Geometry, Light and Camera components
- By default, Render TOP has following values for Camera, Geometry and Lights:
 - Camera: cam1
 - Geometry: * (all in current network)
 - Lights: * (all in current network)
- When you add Camera, Lights and Geometry components, Render TOP automatically establishes connections with them

Rendering a 3D scene



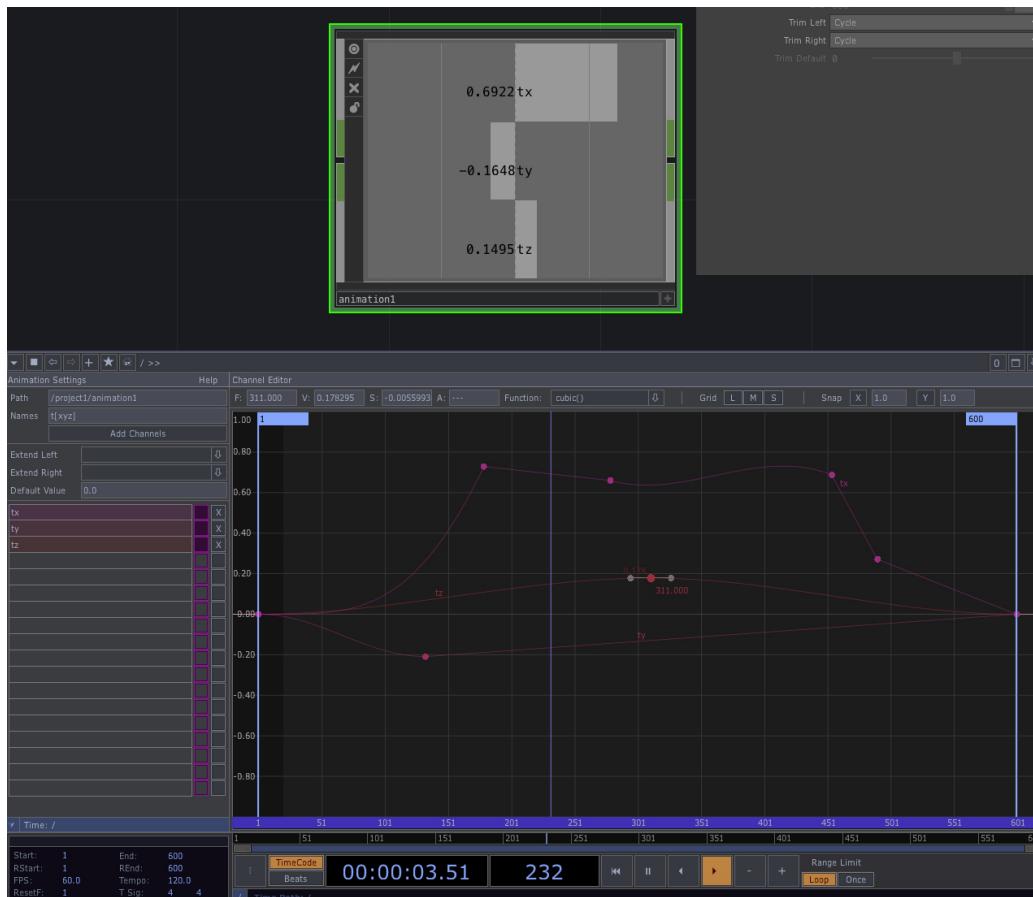
- You can change parameter values of the Geometry component to transform it by translation, rotation, scaling etc.
 - Note that tumbling the geometry in an active viewer does not change the rendering
- Experiment with using `absTime.frame` to continuously change angle of rotation
- You can also carry out geometric transformations on Lights and Cameras.

The Timeline



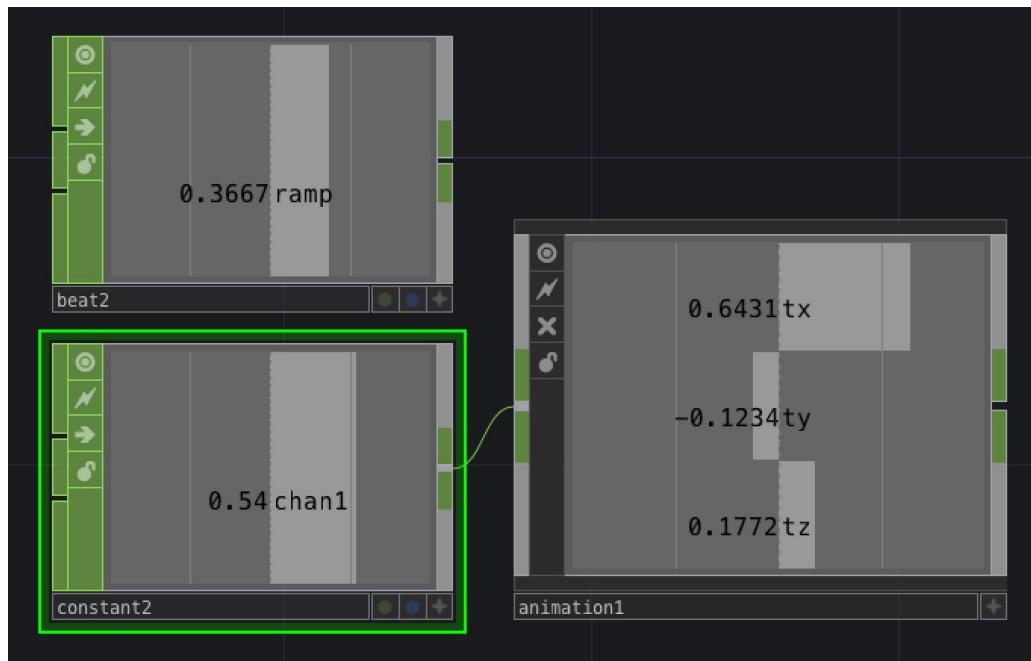
- FPS in bottom left corner of Timeline is number of frames TD tries to advance per second
- Actual FPS is given at the top of the screen and may be less because of time taken to carry out processing
- The Timeline lets you play (>), reverse play (<), pause (||) and step forward (+) or backward (-)
 - Spacebar toggles play and pause
- Timeline loops back when it reaches the end, but TD is mainly event-driven with a free-running clock, so what you build does not need to be bound to the time-line
 - e.g., a constant CHOP, set to 1, connected to a Speed CHOP increases continuously, Speed CHOP restarts when you press its Reset parameter
- Place a Movie File In TOP and have it load the count.mov movie
- By default, play mode is Sequential, which means movie is not tied to the Timeline
- If you change play mode to “Locked to Timeline”, you’ll see that it restarts when the Timeline restarts

Using the Animation Editor



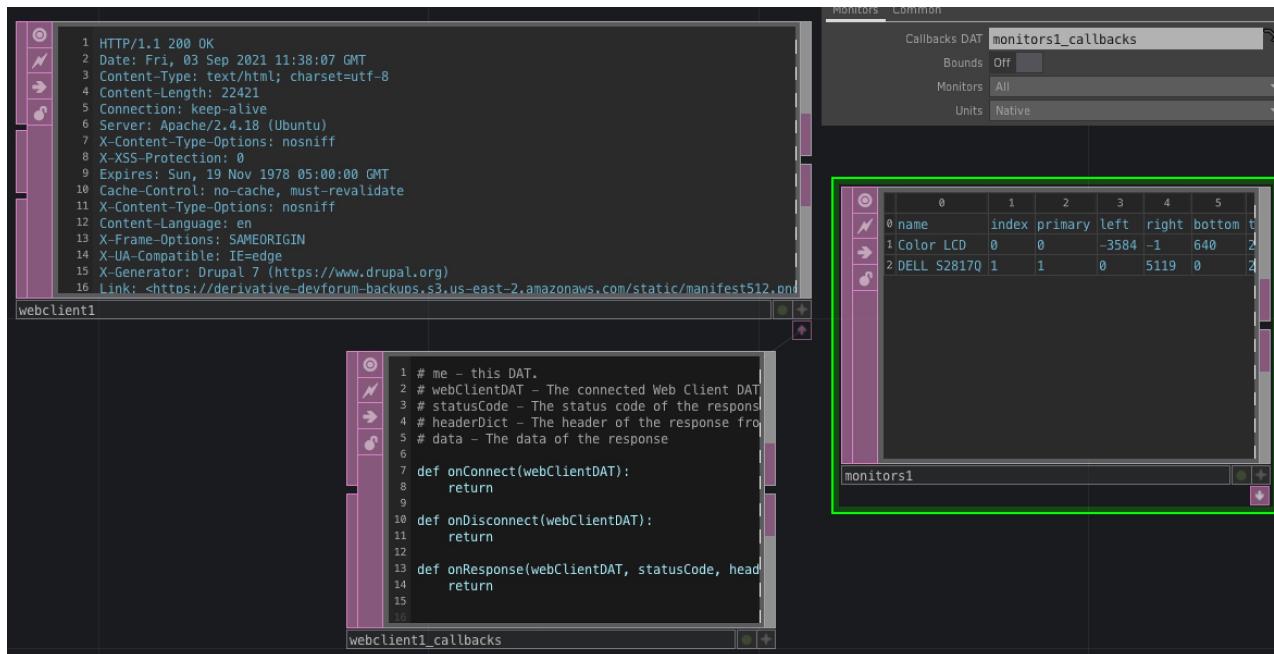
- Create Animation Component, right click and select “Edit animation”
- Click “Add Channels” – three channels are added, tx, ty and tz
- Each channel has 600 frames by default if the Type parameter on the Range page of the properties is set to “Timeline”
- Keyframes are indicated by dots on the channel lines in the editor
- Add a keyframe by pressing Alt-LMB on a channel curve
- Control type of interpolation between two consecutive keyframes by selecting that segment of the curve and selecting the type from the Function drop-down box
- You can watch the changing values in the channels in the Animation component’s viewer

Controlling animation index with an input channel



- We can control the speed of an animation independently of the Timeline by connecting a CHOP to the Animation Component's input
- Set the Play Mode of the Animation COMP to "Use Input Index" and the "Input Index Unit" to Fraction
- Connect a Beat CHOP to the input of the Animation Component
 - You can change the speed by changing the Period parameter of the Beat CHOP
- Now connect a Constant CHOP to the input of the Animation COMP
 - You can now scrub through the animation using the chan1 property slider in the Constant CHOP

DATs are powerful text-manipulation operators



- Data Operators (DATs) let you store and manipulate text in your networks
- DATs can be used to hold scripts that run when an event occurs
- For example,
 - create a Web Client DAT and press the Request button – the DAT loads the HTTP Response sent from the server whose URL is given in the URL parameter
 - Create a Monitors DAT – shows information about the monitors currently connected to the system
- If you click on the pink button at the bottom of the node, it shows some call back functions that you can override to customize the behaviour of the DAT

Sweet Sixteen Operators

SWEET 16 TOPS

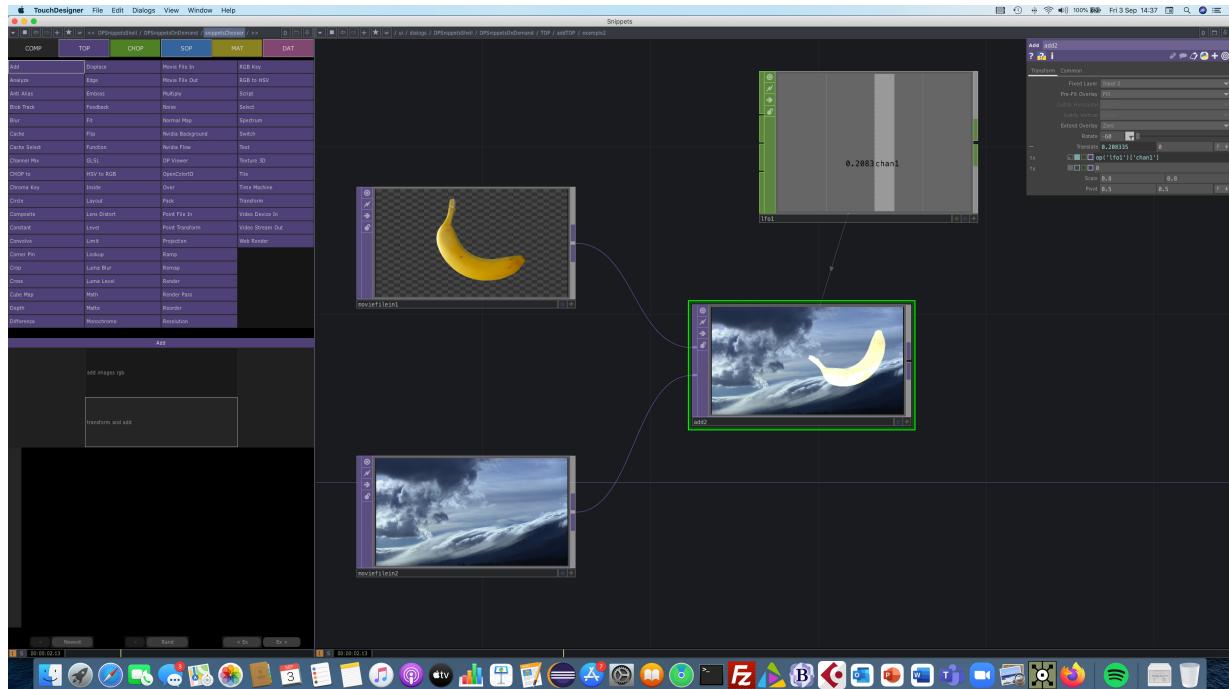
The following 16 TOPs are commonly used, we recommend familiarizing yourself with them.

TOP	Purpose	Related TOP
Movie File In	Read movies, still images, or a sequence of still images.	Video Device In , Movie File Out
Ramp	Create vertical, horizontal, radial, and circular ramps.	Constant , Noise
Level	Adjust contrast, brightness, gamma, black level, color range, opacity.	Luma Level
Transform	Translate, scale, rotate, multi-repeat tile, background fill.	Flip
Over	Place and shift one image over another based on the alpha of one image.	Cross , Multiply
Text	Text generation with variety of fonts.	Luma Blur
Blur	Blur.	
Composite	Combine multiple images with variety of operations like under, difference.	
Render	Render 3D objects, lights and camera into an image.	
CHOP to	Convert CHOP channels into scanlines of an image.	
Resolution	Change the resolution of an image and smooth-filter down.	all TOPs alter resolution
Crop	Crop image to smaller resolution.	Corner Pin , Fit
Select	Selects an image from the same network or a different network.	Switch
Reorder	Re-order the channels of an image.	Channel Mix
Cache	Hold a static or dynamic sequence of images and output one of them.	Feedback
Displace	Use red-blue of one image to warp another image.	Time Machine

All TOPs are documented in the [Category:TOPs](#).

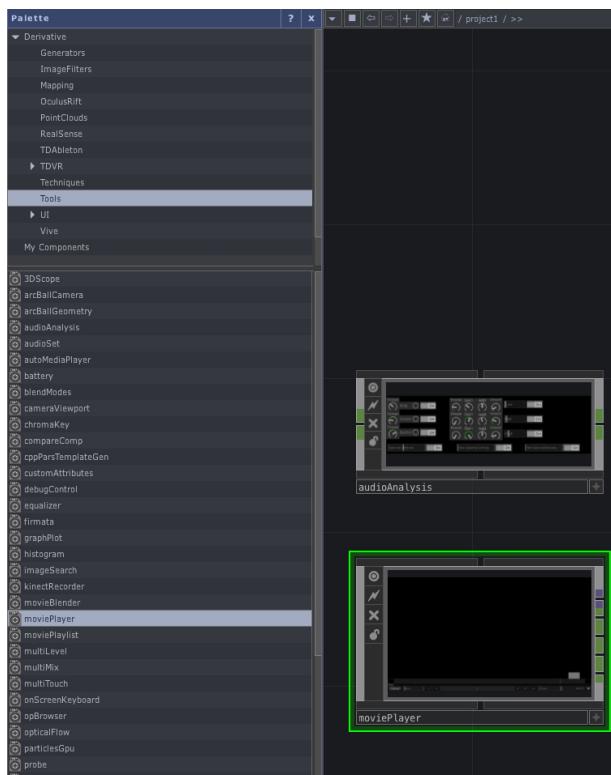
- If you bring up the OP Create Dialog, you'll see that there are hundreds of operators
- But typically you'll only use a small subset of these
- There's a set of "Sweet Sixteen" operators for each operator type that are the ones that Derivative thinks are the most commonly used
- We'll work through these Sweet Sixteen operators over the coming lectures so that you have a chance to familiarize yourself with them

Operator snippets



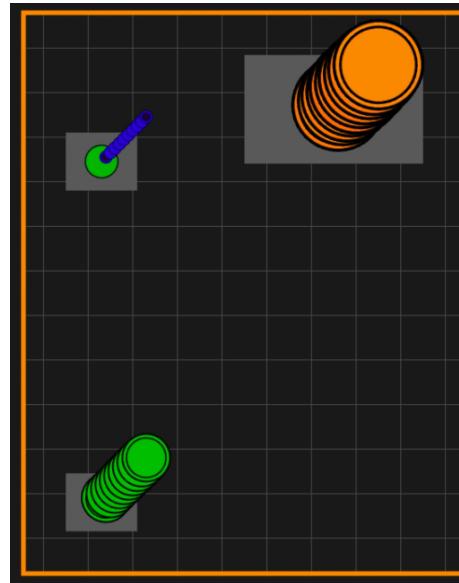
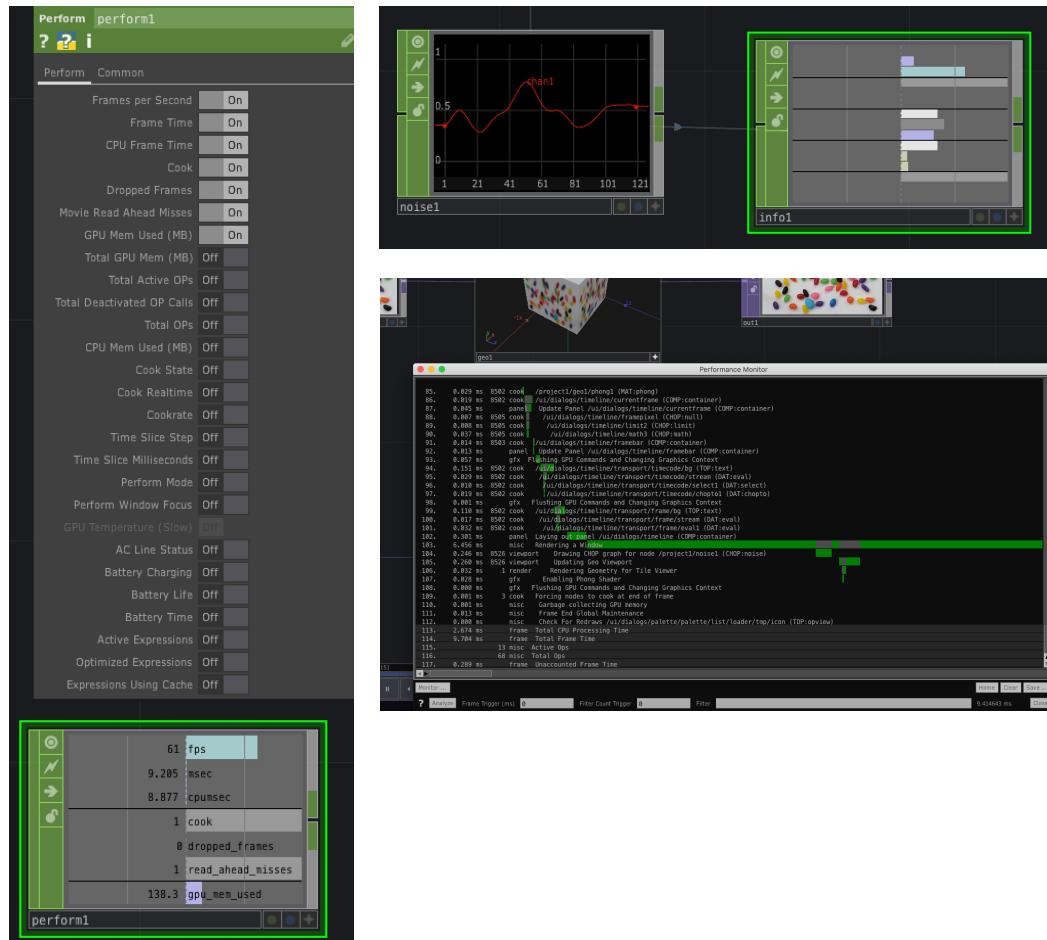
- TD comes with a large library of small example networks that illustrate the use of individual operators
- You can access this library of Operator Snippets from the Help Menu
- This opens a new TD window with a palette on the left where you can select from hundreds of small examples

Getting pre-made components



- You can get pre-made components from the Palette Browser
 - Open the Palette Browser by clicking on the  button at the top left of the main window or with the Alt-L shortcut
- You can also store your own components in the Palette
- Components can be stored as .tox files for interchange
- UI/gal gives a gallery of 20 pre-made customizable gadgets for building control panels
- You can also get components from the Shared .TOX Components Forum
 - <https://forum.derivative.ca/c/shared-tox-components/12>

Monitoring the performance of your network



- Dialogs -> Performance Monitor
 - Click on Analyze to get a detailed analysis of the activity of the network over the course of a single frame – shows which nodes cooked and how long they took
 - NB only reports on CPU activity
 - Middle-click on a node to see whether it is cooking and how much processor time it is using
 - The Perform CHOP shows a real-time graph where you can decide which information is shown
 - The Info CHOP can be used to show real-time info on any node that you drop on it
 - The Probe (Palette > Tools > Probe) gives you a graphical display of the activity in your network

Some quick tips and good habits

- Click on the bulls-eye circles in a parameter dialog to see which parameters are non-default. This is very useful for understanding other people's networks.
- **Color Code Nodes** - With your cursor over the network, press "c" to bring up the color swatch. Select some nodes. Click any color in the color swatch. This only affects the node's appearance in the network.
- **network overview** - With your cursor over the network, press "o" to bring up the a miniature node map at the bottom left of the network. You can click on it to pan the network.
- Ctrl+f (Command+f on macOS) will bring up a **Find bar** that will let you type node names that you may be looking for. Names that match what you type are highlighted and centered.
- To look at nodes another way, with your cursor over the network, press "t" in the network and it will switch to "**table**" mode where you see all the nodes in a list. You can pick one via the left column, press "t" again, and to go back to the network and see that node highlighted in the network.
- When you **don't have a mouse**, zoom and scroll the network editor by pressing the keyboard shortcuts Ctrl+=, Ctrl+-, Ctrl+up, Ctrl+down, Ctrl+left, Ctrl+right (all with Command+ on macOS).
- In OP Create, you can create **nodes-in-a-row** faster by using Shift-click, and create nodes in a branch using Alt-click on the OP Create menu.
- Node names are **case-sensitive**, so `level1` is different from `Level1`.
- The idea of "**Absolute Time**" is a clock that counts up forever and doesn't loop to 0 like the timeline. This gives smooth always-changing values: `absTime.frame` , `absTime.second` s.
- Use Null operators when referencing or exporting - you can then insert additional operators before the Null to modify your network without having to change your reference or export location
- The **Status Bar** is located at the top right of TouchDesigner's main window and provides information about recent operations. It may display a message to indicate success/failure of events, or display a hint to tell you how to use a tool. Keep an eye on it. (The python code `ui.status = 'My message'` can be used to place a line in the status bar.)
- use the **Info DAT** or **Info CHOP** on a node to see some of its internal states and possibly troubleshoot.
- It is common practice to use **Shift-Spacebar** to stop, but in Designer Mode, you can use Spacebar.
- You can turn on/off auto-homing in **SOP viewers** and **Geometry** viewers. In Preferences -> Geometry turn the options on and then Accept, which makes sure you always see your 3D geometry in-view.
- **replace an existing wire** by clicking on the output of the new source and clicking on the wire you want to replace.