



# Processing 2D Images and Videos with Texture Operators (TOPs)

## Part 1

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# Texture Operators (TOPs)

<https://docs.derivative.ca/TOP>

COMP	TOP	CHOP	SOP	MAT	DAT	Custom
Add	Feedback		Movie File In	Point File Select	Substance	
Analyze	Fit		Movie File Out	Point Transform	Substance Select	
Anti Alias	Flip		Multiply	PreFilter Map	Subtract	
Blob Track	Function		Ncam	Projection	SVG	
Blur	GLSL		NDI In	Ramp	Switch	
Cache	GLSL Multi		NDI Out	RealSense	Syphon Spout In	
Cache Select	HSV Adjust		Noise	Rectangle	Syphon Spout Out	
Channel Mix	HSV to RGB		Normal Map	Remap	Text	
CHOP to	Import Select		Notch	Render	Texture 3D	
Chroma Key	In		Null	Render Pass	Threshold	
Circle	Inside		Nvidia Background	Render Select	Tile	
Composite	Kinect		Nvidia Denoise	Reorder	Time Machine	
Constant	Kinect Azure		Nvidia Flex	Resolution	Touch In	
Convolve	Kinect Azure Select		Nvidia Flow	RGB Key	Touch Out	
Corner Pin	Layout		Oculus Rift	RGB to HSV	Transform	
CPlusPlus	Leap Motion		OP Viewer	Scalable Display	Under	
Crop	Lens Distort		OpenColorIO	Screen	Video Device In	
Cross	Level		OpenVR	Screen Grab	Video Device Out	
Cube Map	Limit		Ouster	Script	Video Stream In	
Depth	Lookup		Ouster Select	Select	Video Stream Out	
Difference	Luma Blur		Out	Shared Mem In	Vioso	
DirectX In	Luma Level		Outside	Shared Mem Out	Web Render	
DirectX Out	Math		Over	Slope	ZED	
Displace	Matte		Pack	Spectrum		
Edge	Mirror		Photoshop In	SSAO		
Emboss	Monochrome		Point File In	Stype		

- TOPs are image operators that provide real-time GPU-based compositing and image manipulation
- Used for
  - Preparing textures
  - Compositing streams, images and movies
  - Building control-panel elements
  - Manipulating 32-bit floating point data
  - ...and lots of other stuff
- Support many formats, including floating-point image formats for working with HDR images

# Texture Operators (TOPs)

<https://docs.derivative.ca/TOP>

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Cube Map	Limit		Ouster	Script	Video Stream In	
Depth	Lookup		Ouster Select	Select	Video Stream Out	
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- All renders and composites occur offscreen with TOPs
- Data can be scaled to any resolution, limited only by hardware
- TOPs can hold point cloud data where each pixel holds 32-bit XYZ coordinates
  - Right-click on viewer and select *View as Points*
- Non-commercial limited to 1280 x 1280 resolution

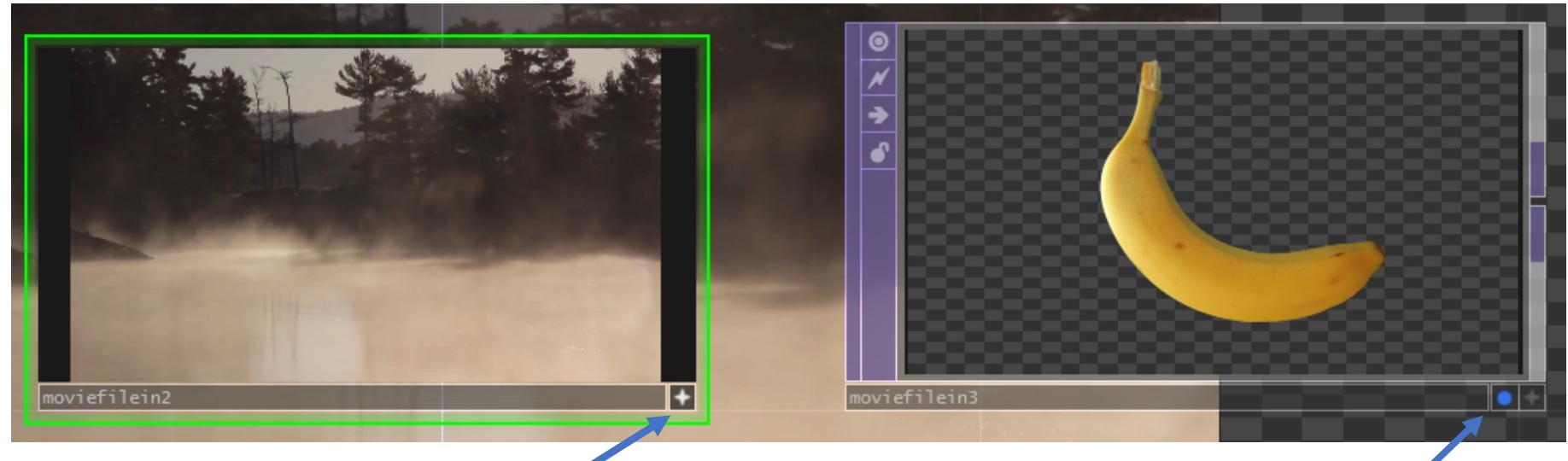
# Texture Operators (TOPs)

<https://docs.derivative.ca/TOP>

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Add	Feedback		Movie File In	Point File Select	Substance	
Analyze	Fit		Movie File Out	Point Transform	Substance Select	
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- 127 TOPs in the OP CREATE dialog
- Some are greyed out in the non-commercial version
- Ones with a darker background generate textures
- Ones with lighter background filter textures to produce new textures
- All TOPs documented at:  
<https://docs.derivative.ca/Category:TOPs>

# TOP flags

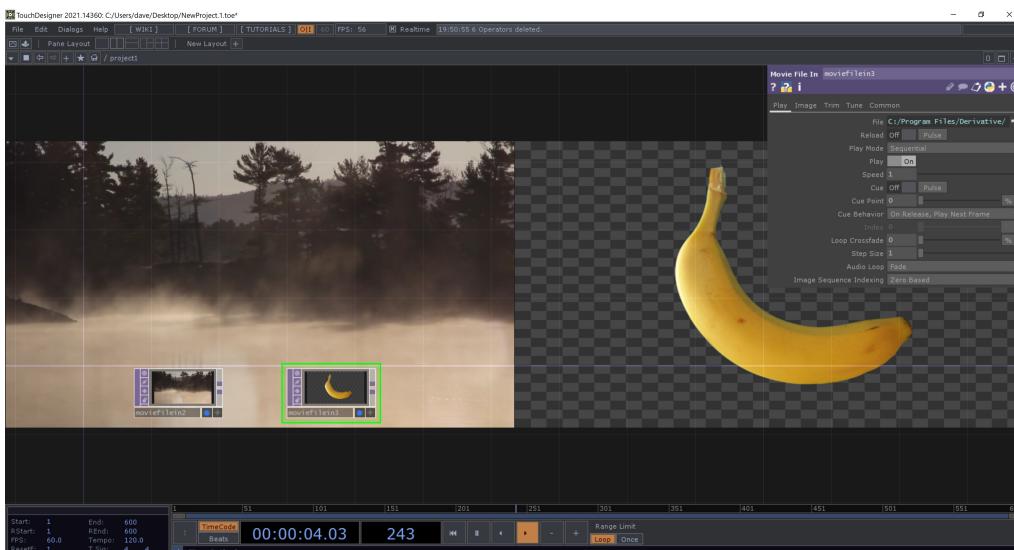


Viewer active flag

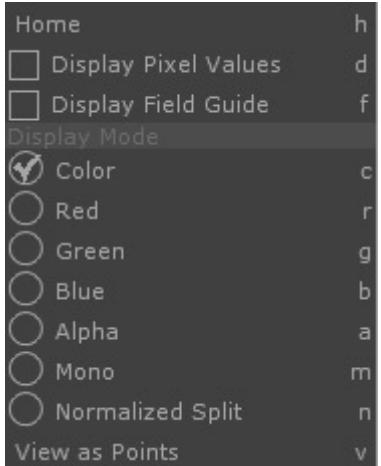
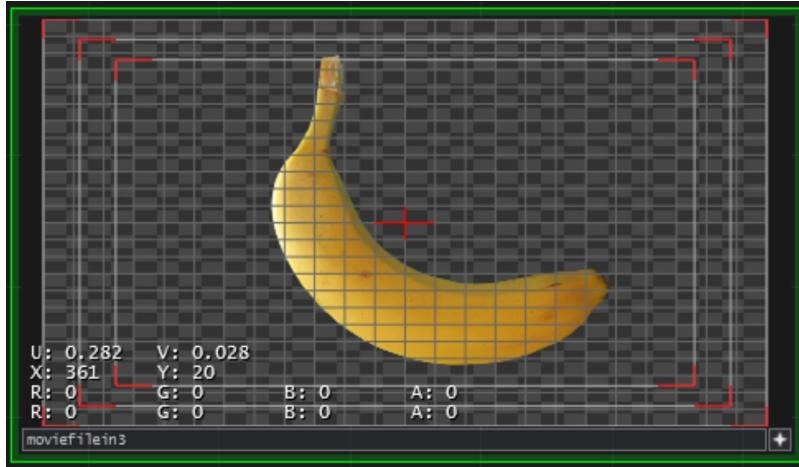
Display flag

- A TOP has two *flags* in its bottom right-hand corner:

- Display flag
  - Displays TOP output as background of network pane
  - Turning on display flag on multiple TOPs causes all of them to be displayed side-by-side as the background
- Viewer Active flag



# TOP Viewers



- TOPs have interactive *Node Viewers*
  - Need to have Viewer Active Flag on in order to interact with a TOP's node viewer
- If alpha channel present, then you'll see a grey checkerboard background
  - Turn off in TOPs tab in Preferences, accessible through the main Edit menu (or the TouchDesigner menu on a Mac)
- LMB: move around inside a viewer
- MMB: zoom in and out (or Option-RMB, then drag left and right)
- "h": recenter image in viewer
- RMB: opens viewer options menu
  - Let's you see each color channel separately or in parallel or view the contents of the TOP as a set of points

# Sweet Sixteen TOPs

[https://docs.derivative.ca/TOP#Sweet\\_16\\_TOPs](https://docs.derivative.ca/TOP#Sweet_16_TOPs)

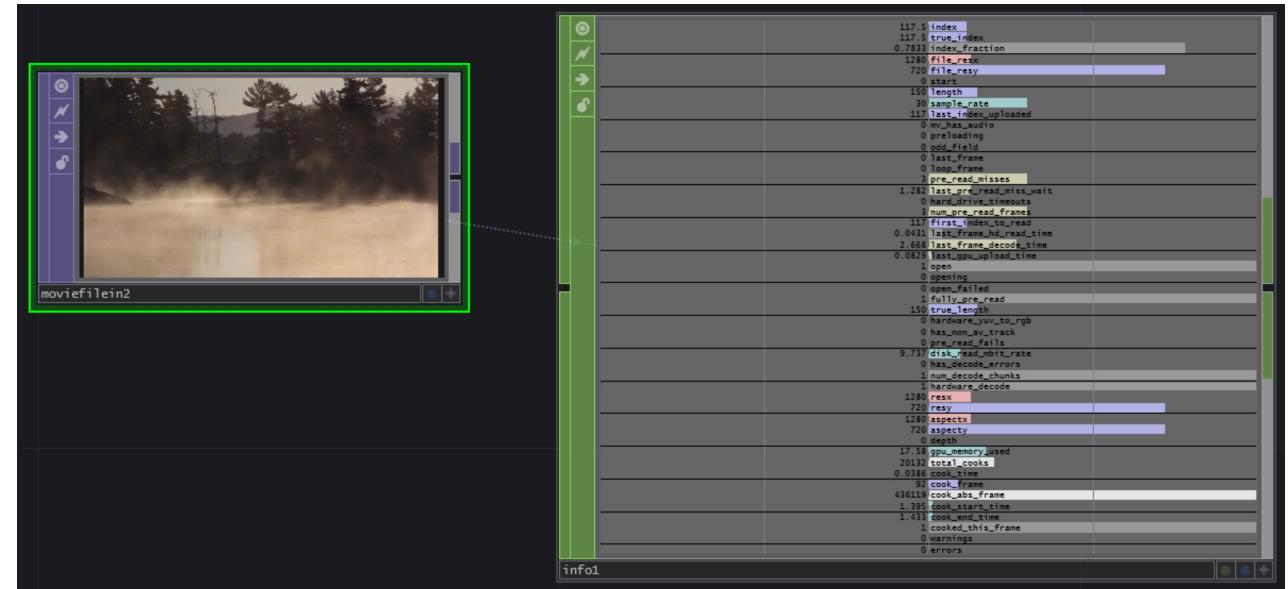
- The Sweet Sixteen TOPs are a set of 16 TOPs that are commonly used

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

# Movie File In TOP

[https://docs.derivative.ca/Movie\\_File\\_In\\_TOP](https://docs.derivative.ca/Movie_File_In_TOP)

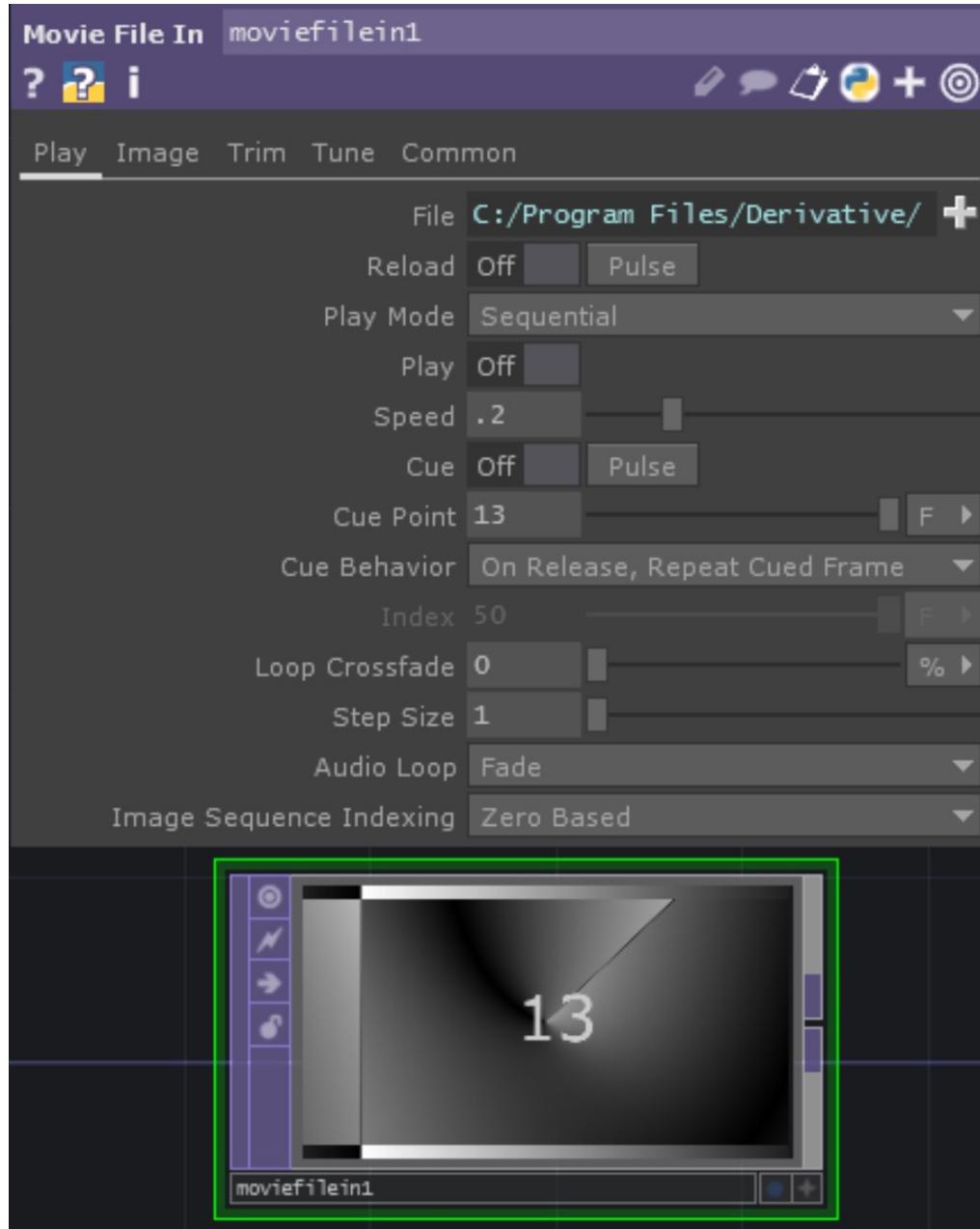
- Used to load movies, images or sequences of images
- Reads following image formats: jpg, gif, tif or bmp
- Reads following movie formats. .mov, .mp4, .mpeg, .avi, .wmv, .dpx, Cineform, Hap Q, Hap Q with Alpha
- Supports NotchLC codec, EXR files, some .swf and .flv Flash files, DXT1, 3 and 5 compressed DDS file
- Can specify location as a URL to fetch movies or images from the web
- Can view state of a Movie File In TOP by dropping it on an Info CHOP



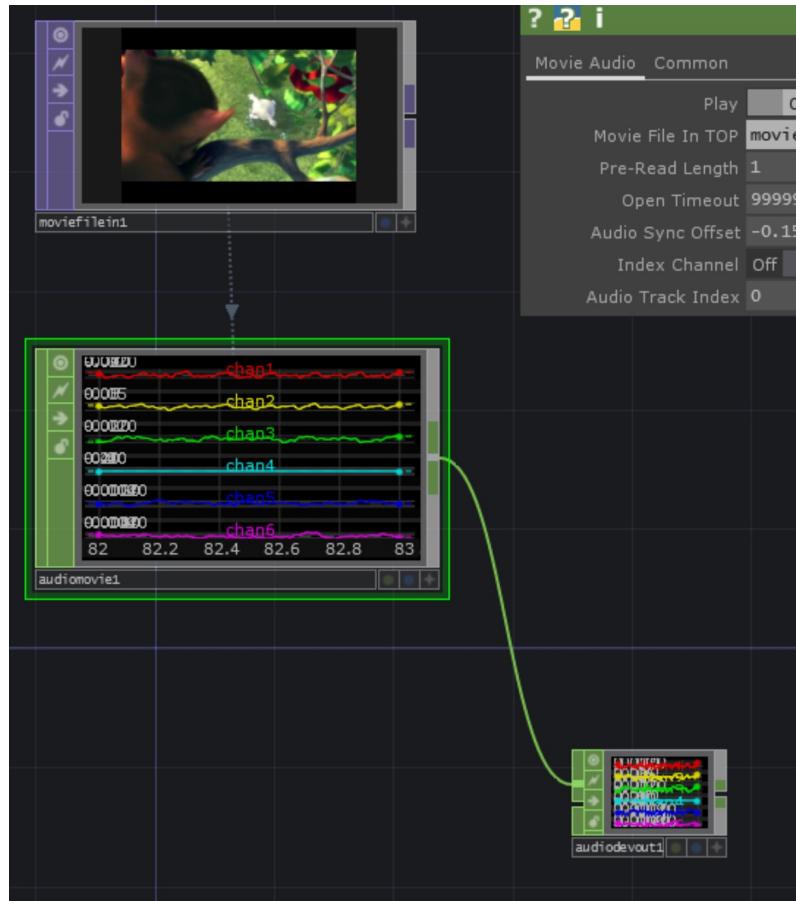
# Movie File In parameters: Play page

- Play page

- **File:** Path and name of image or file to load; file types are given in [https://docs.derivative.ca/File\\_Types](https://docs.derivative.ca/File_Types); specify files on internet using a URL
  - Give name of a folder to load all images in folder as if they are one movie; all files must be the same resolution; order is alphanumeric; override sample rate on Trim page to playback sequence at any frame rate
- **Reload:** Forces image or movie to reload, press pulse to instantly reload the file or the first file in a folder of images
- **Play mode**
  - *Sequential:*
    - Runs movie at a speed determined by Speed parameter
    - If displaying a folder, then displays each file for a period determined by Speed parameter
  - *Lock to Timeline:*
    - Restarts presentation when Timeline restarts
  - *Specify Index:* Set Index parameter type to I, then gives just index of file in collection being displayed; if type set to F, then file shown determined by position of frame in whole cycle.
- **Play:** On or off (not available when Locked to Timeline)
- **Speed:** Determines speed of display of movie or collection of files
- **Cue:** Only works with Sequential, jumps to cue point when on; pulse button returns to cue point
- **Cue point:** Can be expressed as percentage, index, frames or seconds
- **Index:** used with play mode Specify Index to explicitly set movie position
- **Loop crossfade:** crossfades beginning and ending of movie to get smooth transition
  - If use Trim options, then crossfades Trim Start with Trim End positions
- **Step size:** Sets number of frames to skip between displaying frames



# Playing movies with audio



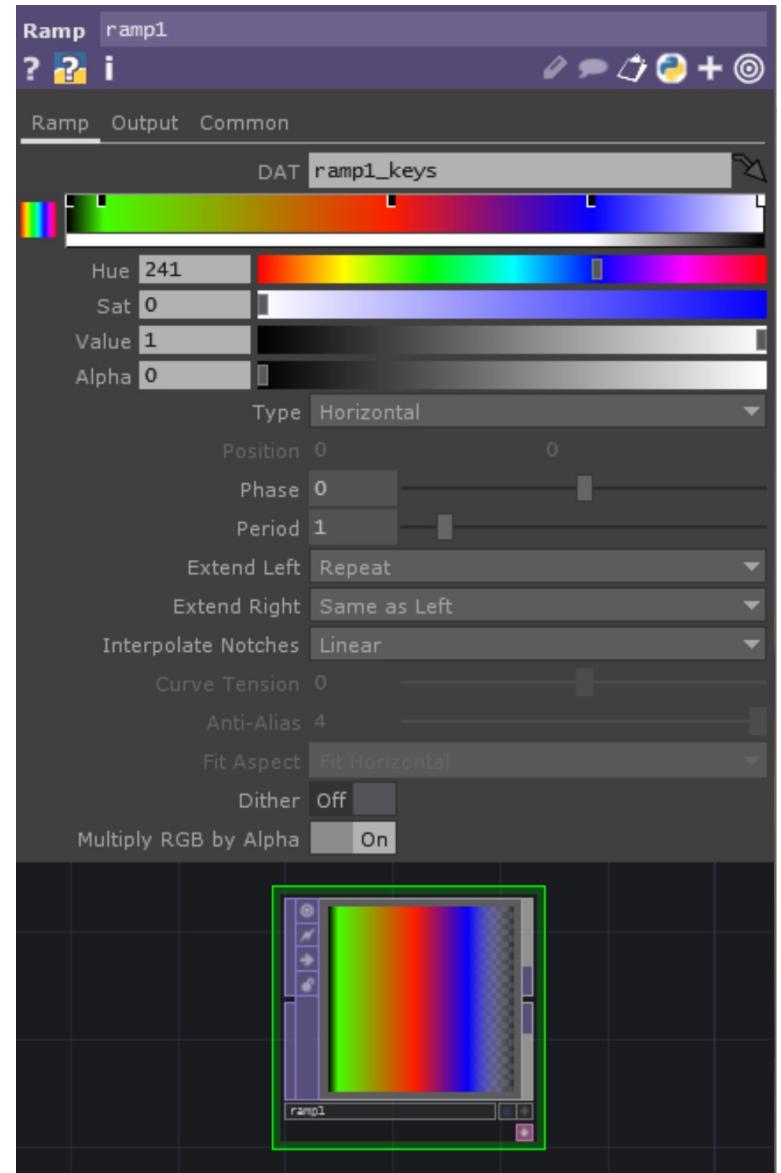
- Attach a Movie File In TOP to an Audio Movie CHOP by dragging the Movie File In TOP onto the Audio Movie CHOP
- Then attach the Audio Movie CHOP to an Audio Device Out Chop
- Make sure that the Device parameter is referring to the right speakers or headphone and that the Driver parameter is using the correct driver

# Ramp TOP

[https://docs.derivative.ca/Ramp\\_TOP](https://docs.derivative.ca/Ramp_TOP)

```
dat_ramp1_keys_td_5592_63.py x

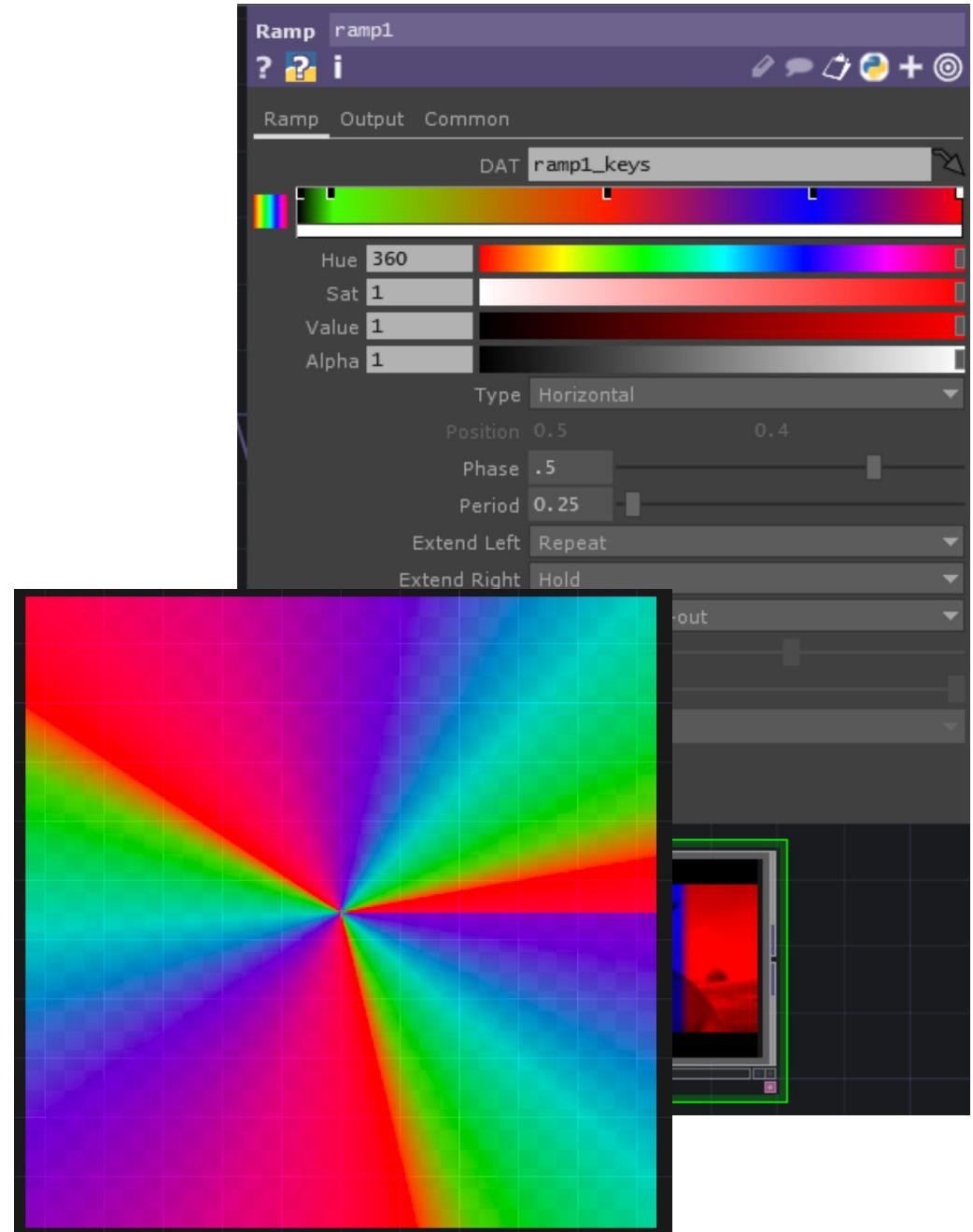
pos r g b a
0 0 0 0 1
0.05289673 0.2666667 1 0 1
0.465995 1 0.1166626 0 1
0.7531486 0.01666689 0 1 1
1 1 1 1 0
```



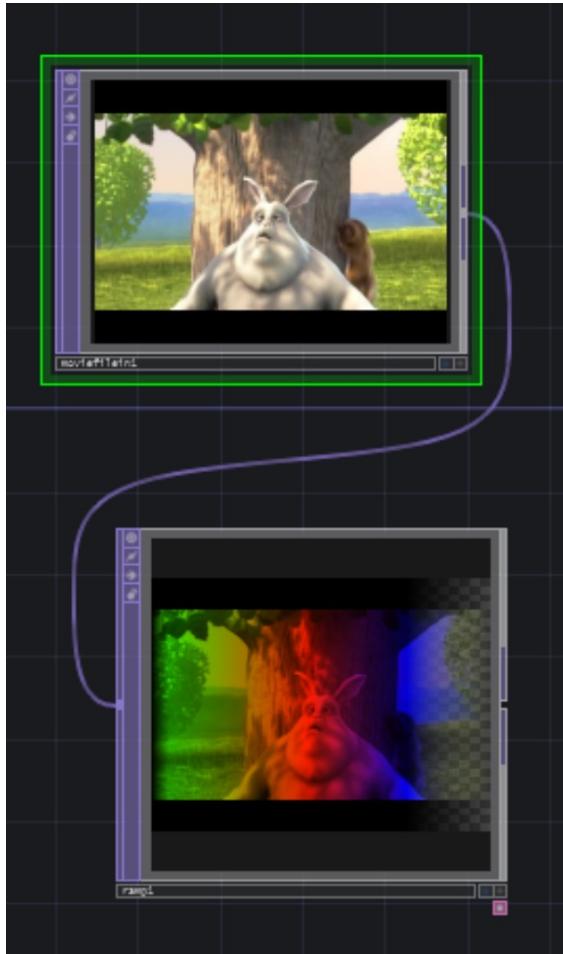
- Allows you to interactively create vertical, horizontal, radial or circular ramps
- Use the ramp bar and color-picker to add keyframes and define the colors at those frames
- Drag a keyframe off the ramp bar to remove it
- Data for ramp is held in DAT specified in DAT parameter
  - Each row represents a color keyframe entry in the ramp
  - Use Option/Alt - A to scroll in DAT

# Ramp TOP parameters

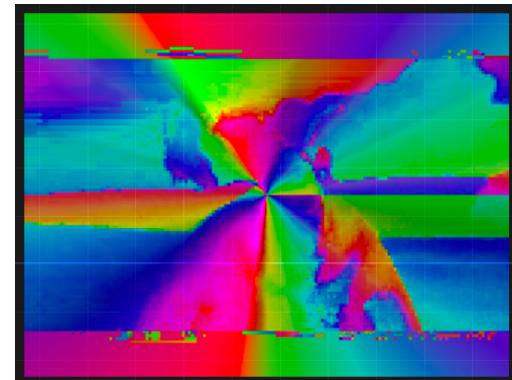
- Ramp page
  - **Type:** vertical, horizontal, radial, circular
  - **Position:** sets centre position for radial and circular ramps
    - (0,0) is centre, (.5,.5) is approx top right corner
  - **Phase:** starts the ramp shifted by a proportion of its period
  - **Period:** determines width of one period of ramp in image/movie, so smaller period means more repetitions of the ramp



# Ramp TOP parameters



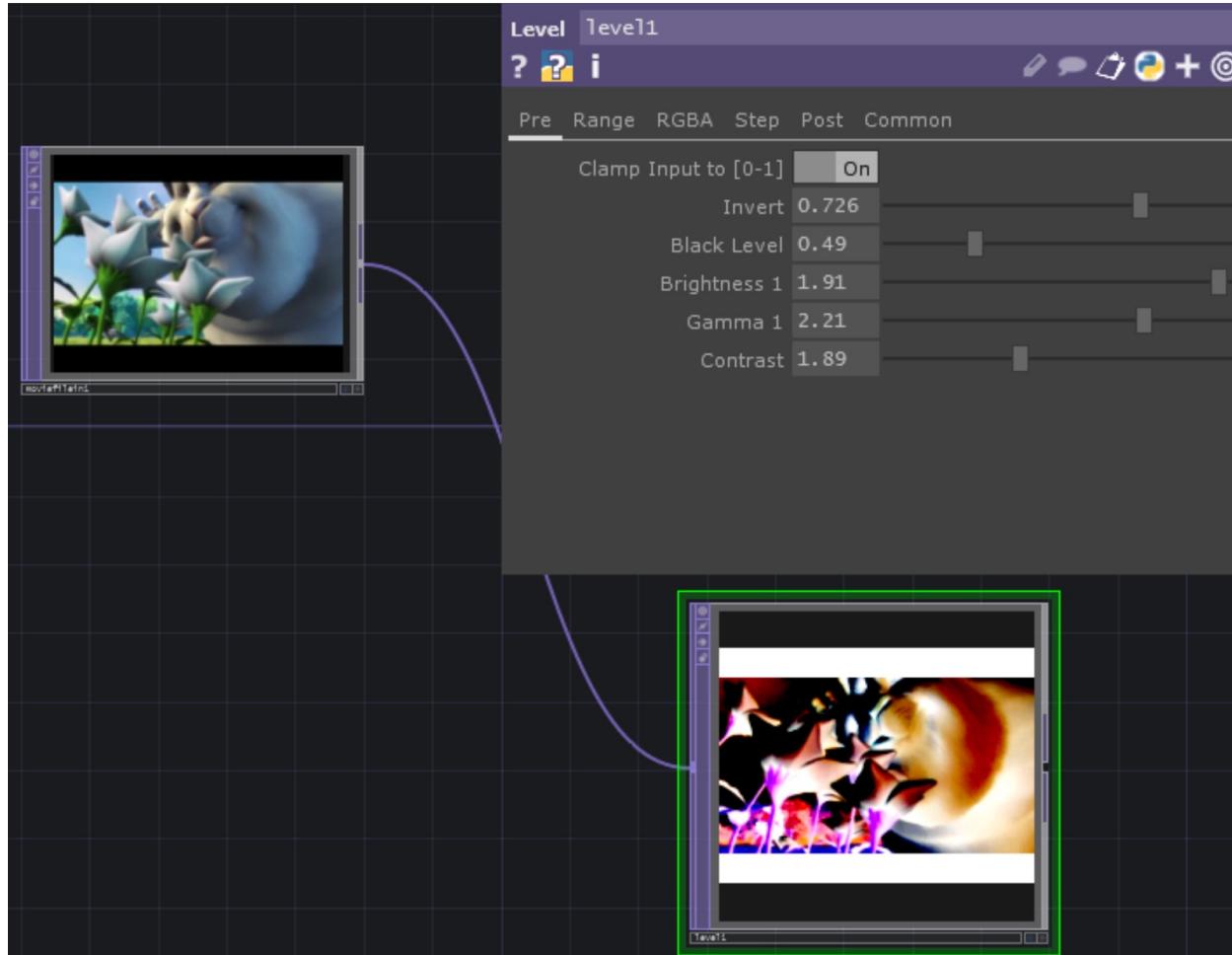
- Output page
  - **Comp with Input:** if on, composites input movie or image with ramp
  - **Operation:** Choose the composite operation that is performed
  - **Swap order:** Swaps order of composite with input
    - See effect by using Over or Chroma difference operation



# Level and Luma Level TOPs

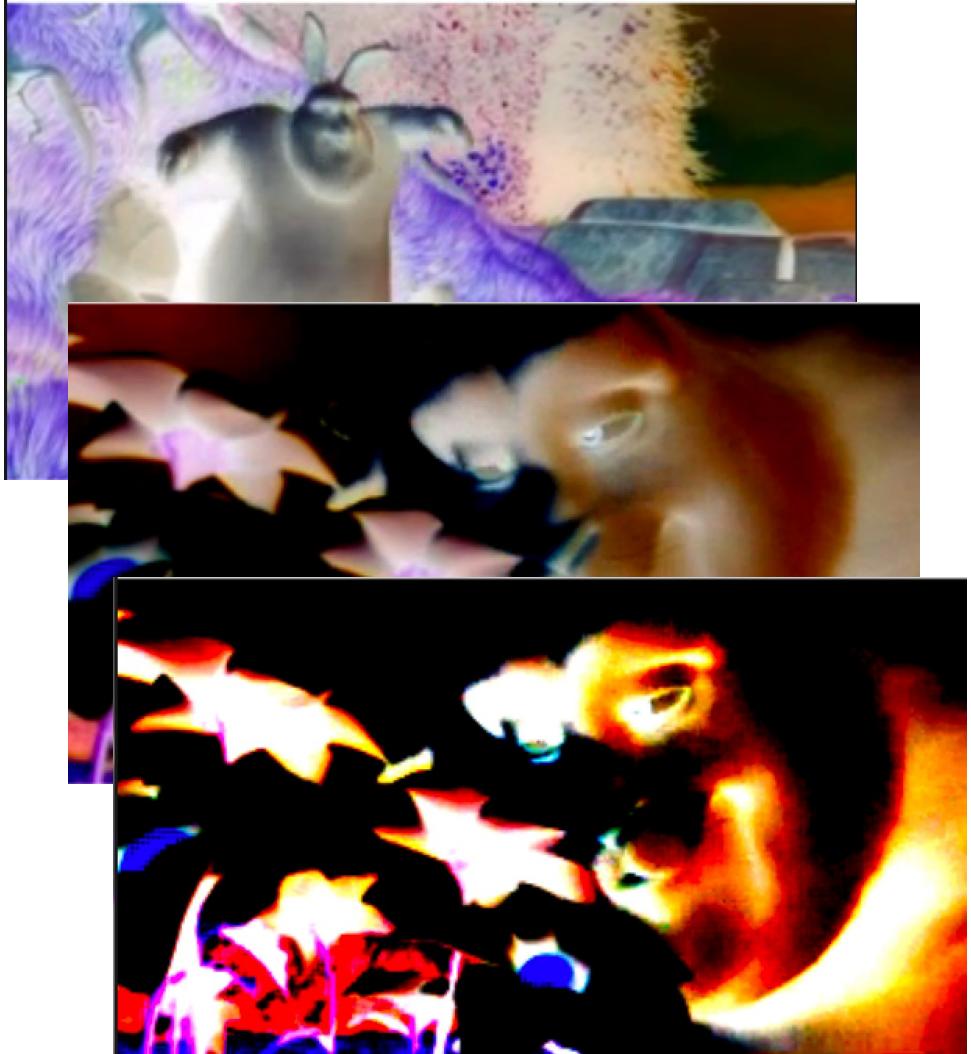
[https://docs.derivative.ca/Level\\_TOP](https://docs.derivative.ca/Level_TOP)

[https://docs.derivative.ca/Luma\\_Level\\_TOP](https://docs.derivative.ca/Luma_Level_TOP)



- Level TOP adjusts contrast, brightness, gamma, black level, color range, quantization, opacity and more
- Luma Level TOP preserves hue and saturation more accurately

# Level TOP Parameters – Pre Page



- **Clamp Input to [0-1]:** clamps pixel values to be within the range 0 to 1 (do not use with higher bit depth floating point pixel formats)
- **Invert:** inverts colors, so that black becomes white and colors are inverted across the color wheel (red -> cyan, blue -> yellow, green -> magenta, etc.)
- **Black level:** blackens any pixel with a value below the given value
- **Brightness 1:** Brightness is mean of RGB channel values for a pixel. Increasing brightness adds amounts to these channels to maintain relative amounts of R G and B, but raising average
- **Gamma 1:** Gamma is relationship between brightness of a pixel on the screen and its numerical value. Defined by a curve. Changing gamma changes relationship between R, G and B because eyes are not equally sensitive to red, green and blue
- **Contrast:** applies a scale factor to the RGB channels – brightens lighter areas and darkens darker areas

# Level TOP – Range Page



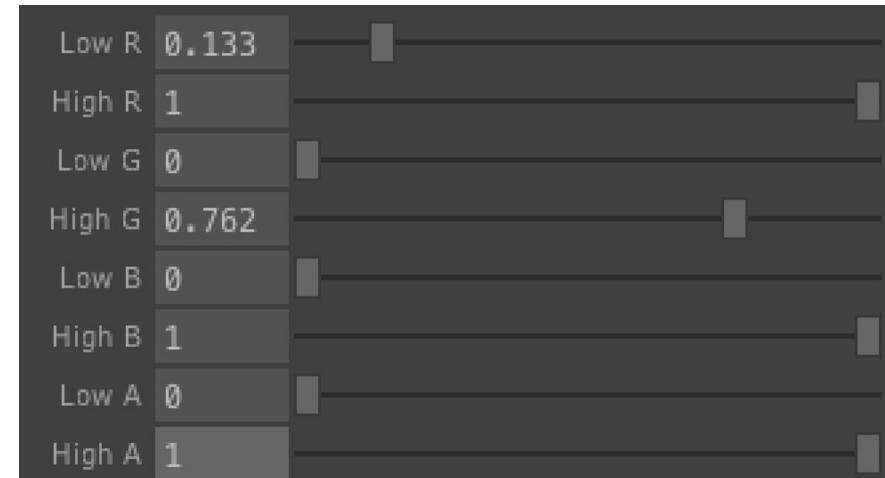
In Low	0
In High	1
Out Low	0
Out High	1

- **In Low** – Everything below this level is black in the output
- **In High** – Everything above this level is white in the output
- **Out Low** – Everything between In Low and Out Low is at the value of Out Low
- **Out High** – Everything between In High and Out High is at the value of Out High



In Low	0.1
In High	0.8
Out Low	0.3
Out High	0.6

# Level TOP – RGBA Page



- Lets you clamp the minimum and maximum values of each channel in the image or video

# Level TOP – Step Page



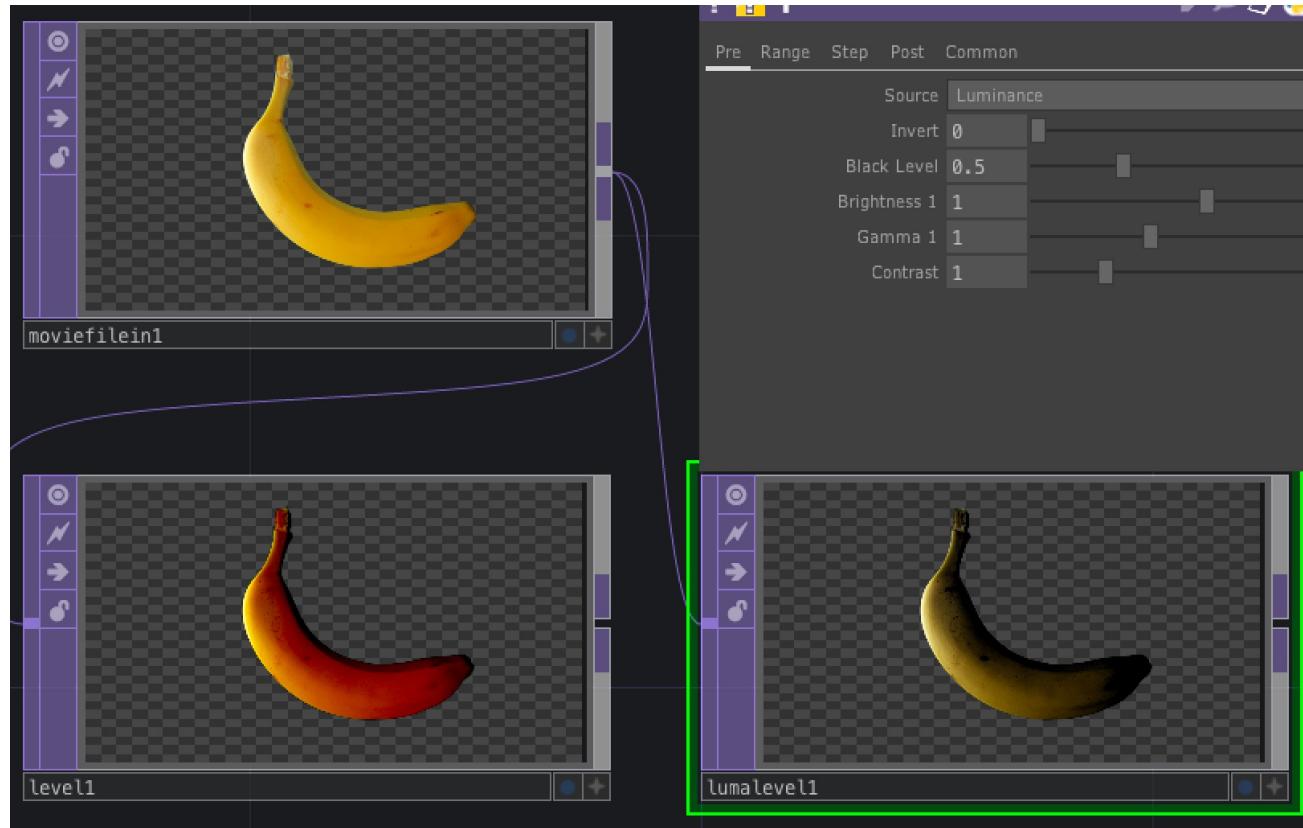
- “Stepping” is also known as “posterizing”
- **Apply Stepping** turns stepping on
- **Step size** – Posterizes image into bands” or “stripes” – divides range of values into bands of this size and replaces every pixel with a value within a band with the midpoint of that band
- **Threshold** – shifts the lowest edge of the lowest band by the given amount (so -1 shifts all bands below 0, making the image disappear)
- **Clamp Low/High** – clamps all values below/above the given value to the given value
- **Soften** – blurs the boundaries between the value bands

# Level TOP - Post page



- Parameters controlling second phase of processing by Level TOP
- **Gamma 2** – a second gamma correction, added after Range, RGBA and Step page adjustments have been made
- **Opacity** – adjusts opacity of image or video
- **Brightness 2** – second brightness filter, added after Range, RGBA and Step
- **Clamp** – clamps pixel values to this value or lower
- **Clamp Low/High** – clamps image's min/max values (where "value" is in the sense of "hue, saturation and value")

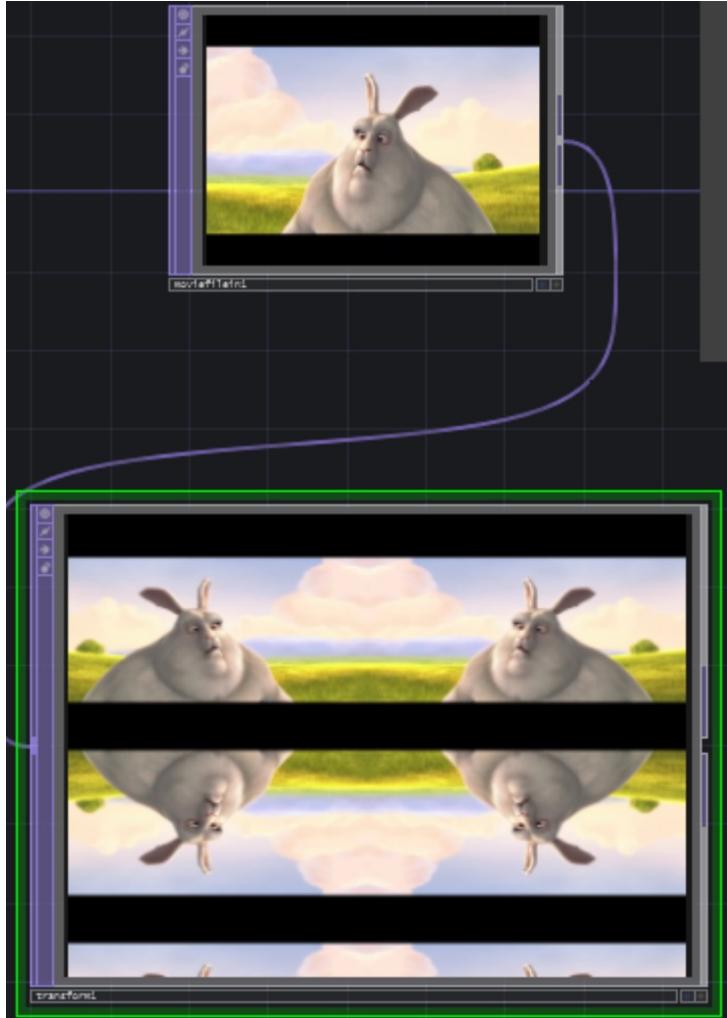
# Luma Level



- Has similar parameters to Level, but maintains hue and saturation more accurately when using Gamma and Black Level

# Transform TOP

[https://docs.derivative.ca/Transform\\_TOP](https://docs.derivative.ca/Transform_TOP)



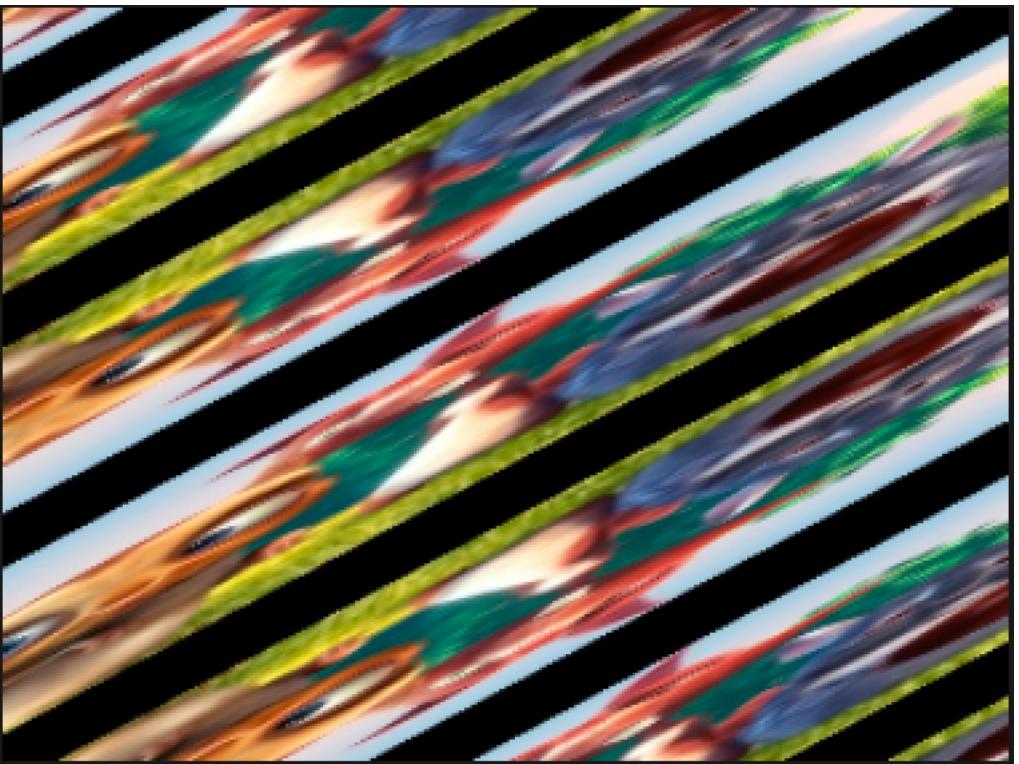
- Applies 2D transformations to a TOP image or video (e.g., translate, scale, rotate, and multi-repeat tiling)
- Background can be filled with solid color and alpha.
- Tiling can be mirroring or repeating

# Transform TOP – Transform Page



- **Transform Order** – determines the order in which the transformations are applied (e.g., “translate scale rotate” or “rotate scale translate”)
- **Translate** translates by the two values in the x and y direction respectively
- **Translate Unit** – F = fraction, P = pixels, A = fraction aspect
- **Rotate** – rotate by the given number of degrees
- **Scale** – separate stretch factors for x and y axes
- **Grow/Shrink** - Changes width and height by adding the specified number of pixels
- **Pivot** – for defining the centre of rotation and scaling
- **Background color** - color applied behind the foreground image. Background becomes visible when image is translated, scaled or sometimes rotate
- **Comp over Background color** – Fill any area with the background color if it has alpha less than 1
- **Mipmap Bias** – Indicates bias towards using certain mipmap levels:
  - 0 – the levels that would normally be used
  - negative prefers higher levels (larger textures)
  - positive prefers lower levels (smaller textures)

# Transform TOP – Tile Page

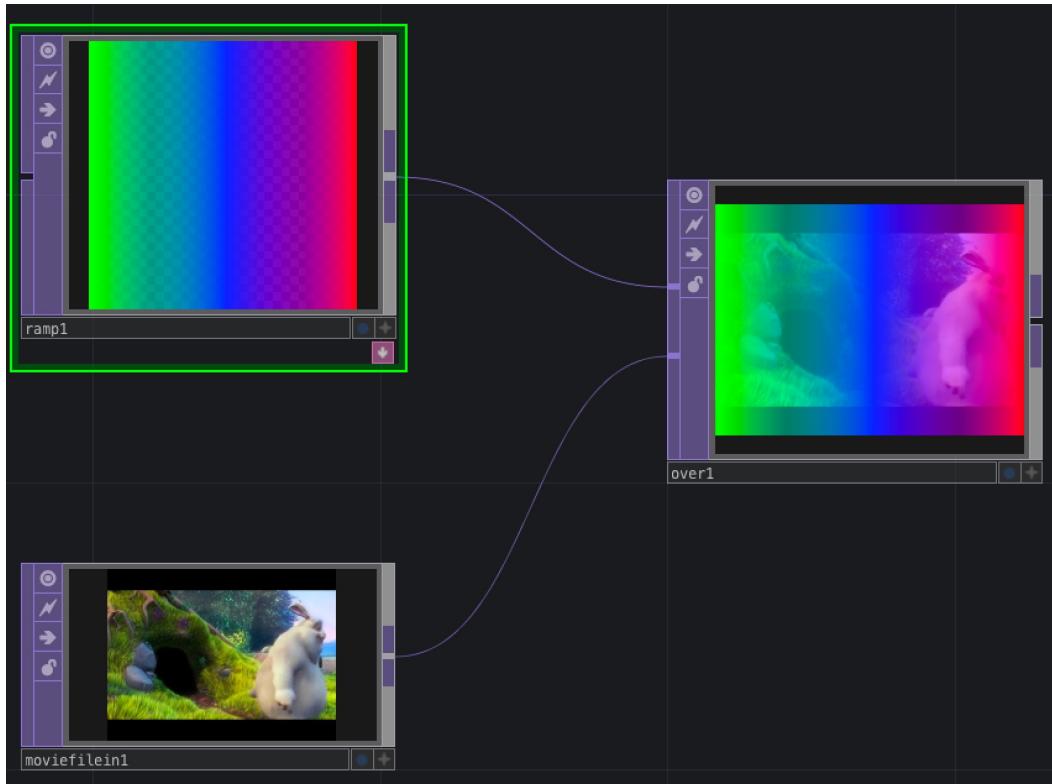


- **Extend**

- **Hold** – extend pixel color at boundary over remainder of window
- **Zero** – no extension – uncovered areas of window are transparent
- **Repeat** – tile image to cover window
- **Mirror** – repeat and reflect
- **Limit Tiles, Tile U and Tile V** – gives limit to the number of times to repeat the image when tiling (negative is down and to the left)

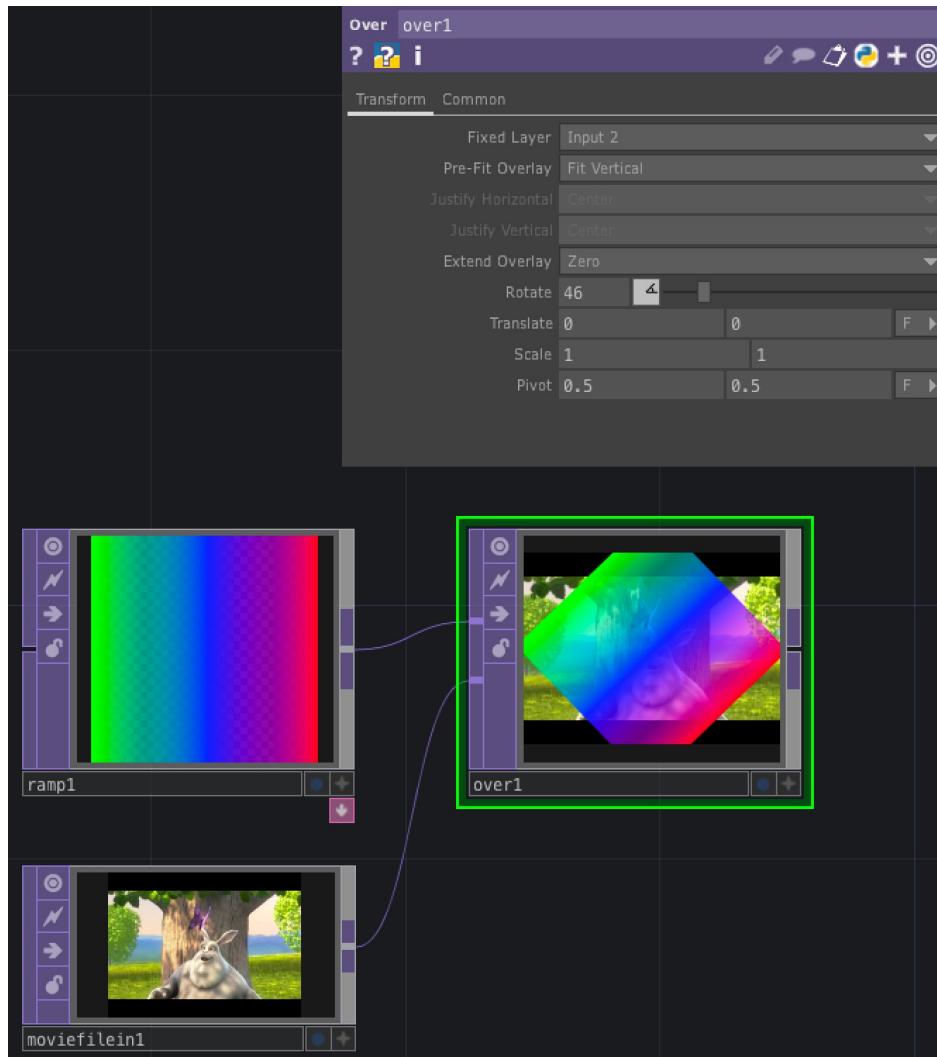
# Over TOP

[https://docs.derivative.ca/Over\\_TOP](https://docs.derivative.ca/Over_TOP)



- Places Input 1 over Input 2
- Alpha of Input 1 determines what you can see of Input 2

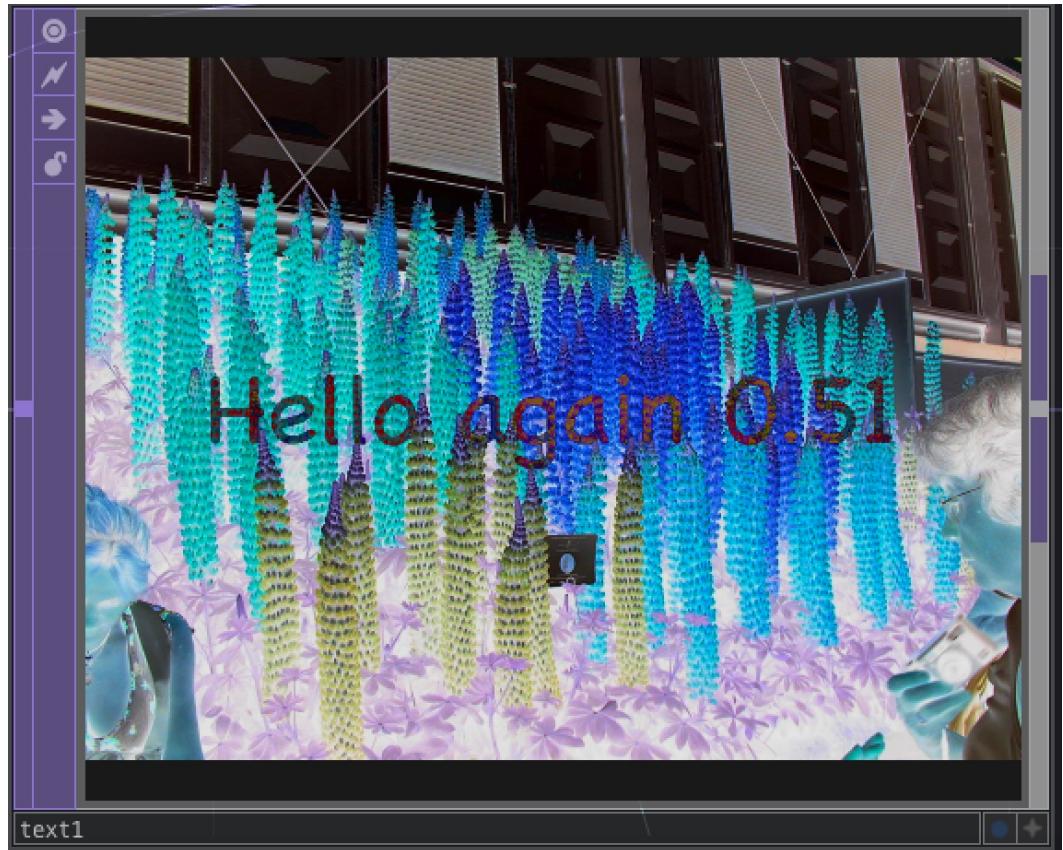
# Over TOP – Transform Page



- **Fixed Layer** – determines which layer is fixed and which is adjustable by using the parameters on the Transform page
  - Resolution and aspect ratio of final composite is that of the Fixed Layer
  - But remember that Input 1 is always on top!
- **Pre-Fit Overlay** – determines how Overlay layer (not Fixed Layer) fills the composite
- **Justify Horizontal/Vertical** – specify the horizontal/vertical alignment of the Overlay layer
- **Extend Overlay** – sets extend or repeat conditions of the Overlay
- The remaining parameters only affect the Overlay:
  - Rotate, Translate, Translate Units, Scale, Pivot, Pivot Units – work similarly to Transform TOP

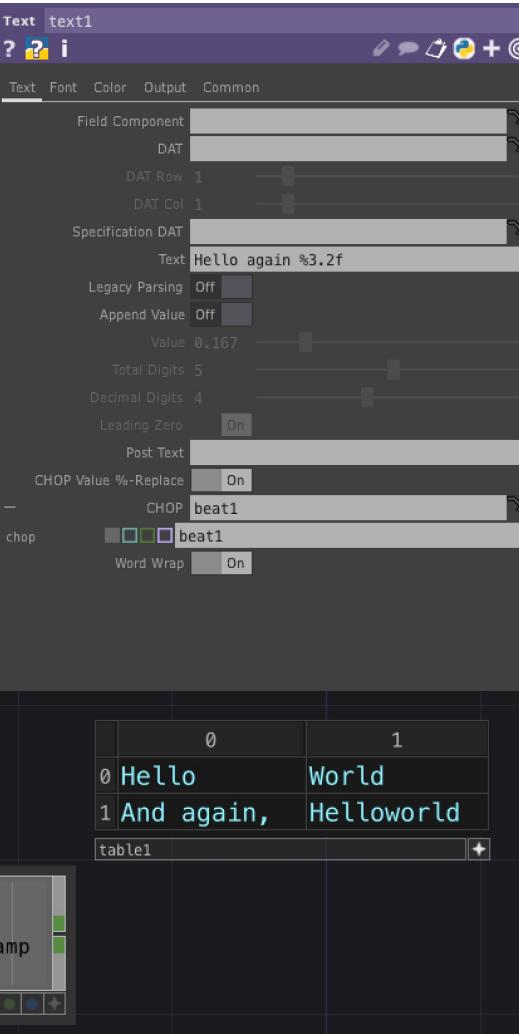
# Text TOP

[https://docs.derivative.ca/Text\\_TOP](https://docs.derivative.ca/Text_TOP)



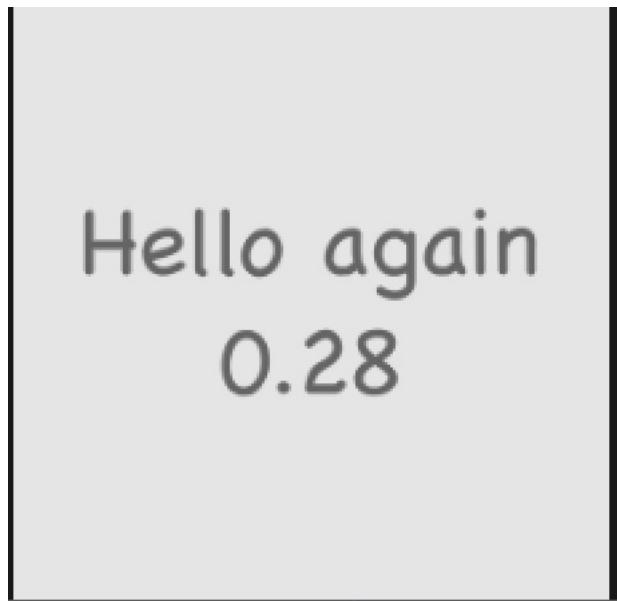
- Text TOP is for displaying text in an image or video
- Allows for multiple fonts, sizes, colors, borders, character separation and line separation
- Text can be displayed as bitmaps, anti-aliased lines or filled polygon characters
- Any TrueType font can be rendered and Unicode is supported
- Can format lines of text and numbers in decimal or floating point format, reading values from a CHOP using special formatting characters
- Can render text strings from a Table DAT, via the specification DAT parameter

# Text TOP – Text Page



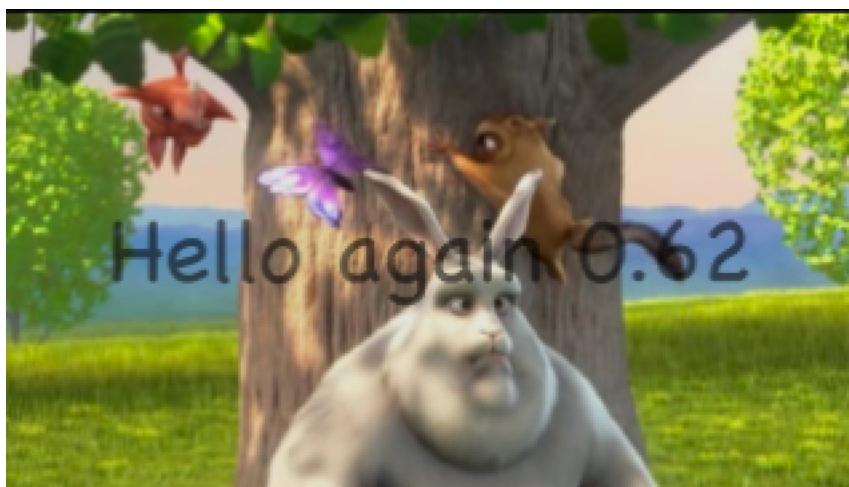
- **Field Component** – Specifies a Field COMP operator to use as the source of the text
- **DAT** – specifies a DAT to use as the source of the text
  - Either drag and drop a DAT onto this field or manually enter the DAT's path
- **DAT Row/Col** – row and column index of the cell in a DAT Table to use
- **Specification DAT** – a Table DAT that specifies position of the text
  - Has at least three columns: x, y and text to draw at the position
- **Text** – A string of text to display. Can be optionally followed by a numeric value and another string (defined in Value and Post Text parameters)
  - If you want special characters (e.g., \n, \t), use a Python expression
- **Append Value** – enables appending of the value in the Value parameter
- **Value** – the value to append to Text
- **Total Digits** – Number of digits in Value
- **Decimal Digits** – Number of digits after the decimal point
- **Post Text** – Text string appended after Text and Value
- **CHOP value %-Replace** – allows for portions of the Text string to be replaced with values specified using the syntax for C's printf statement:  
  %[flags][width][.precision][type]
  - Drag and drop a CHOP onto this field
- **Word Wrap** – wrap text so it stays within the TOP's borders

# Text TOP – Font and Color Pages



- Allow you to control the appearance of the text

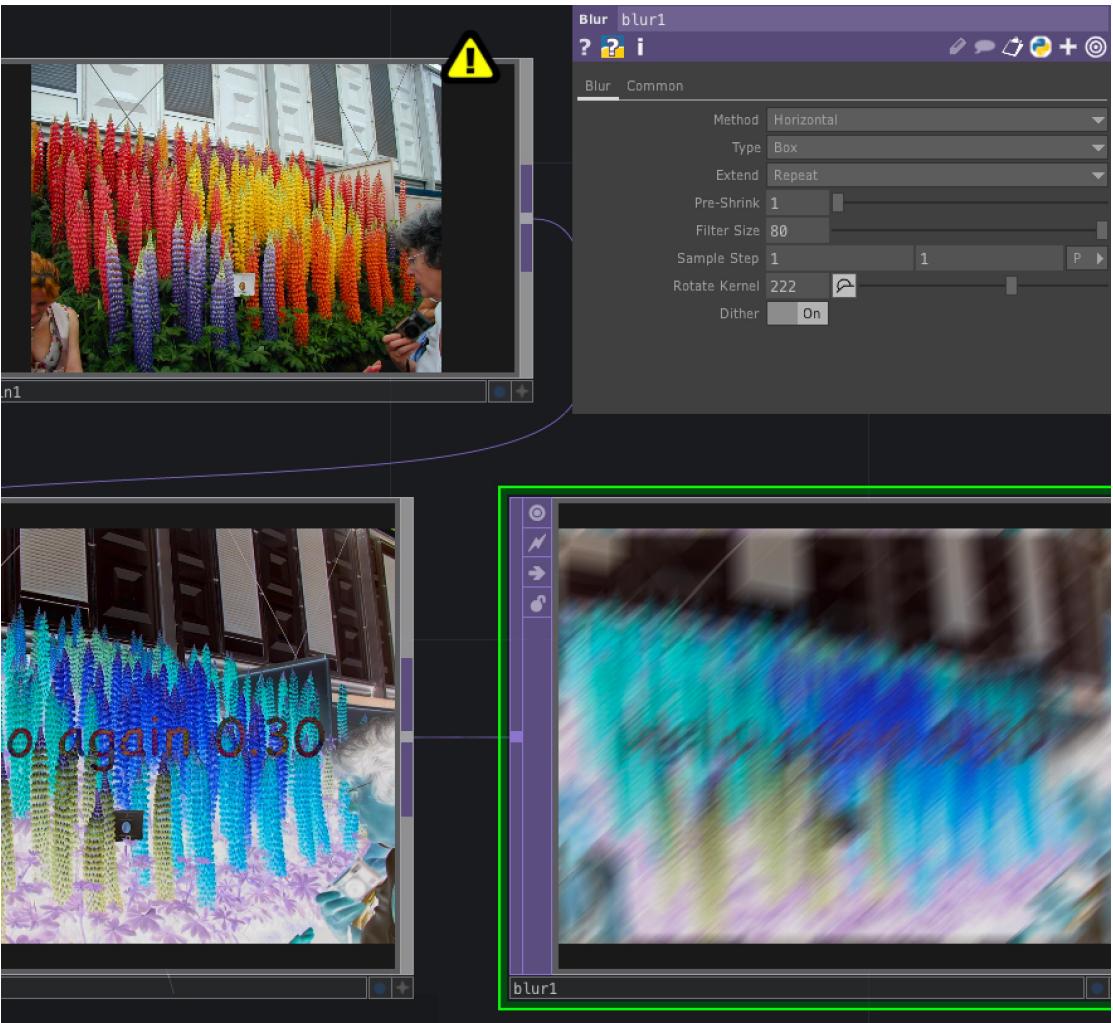
# Text TOP – Output page



- Controls compositing of text with input image
- **Comp Over Input** – composites input with an image
- **Operation** – choose which composite operation to use to combine the text with the image
- **Swap Order** – Swaps the order of the composite with the input

# Blur TOP

[https://docs.derivative.ca/Blur\\_TOP](https://docs.derivative.ca/Blur_TOP)



- Blurs image with various kernel filters and radii
- Can do multi-pass blurs and horizontal-only or vertical-only blurs
- Can use Pre-shrink to optimize performance when blurs are high
- **Method** determines how blur is applied
- **Type** determines function used to create the blur
- **Extend** sets extend conditions that determine what happens at edge of image
- **Pre-shrink** reduces image's resolution before applying blur
- **Filter size** is the amount of blur in pixels
  - Can use `me.par.resolutionw/100 * n` to give an  $n\%$  image blur
- **Sample Step** – determines number of pixels away from current pixel sampled to blur the image
- **Rotate Kernel** – rotates the blur filter (noticeable when Method is horizontal)
- **Dither** – enabling makes 8-bit blurs look smoother