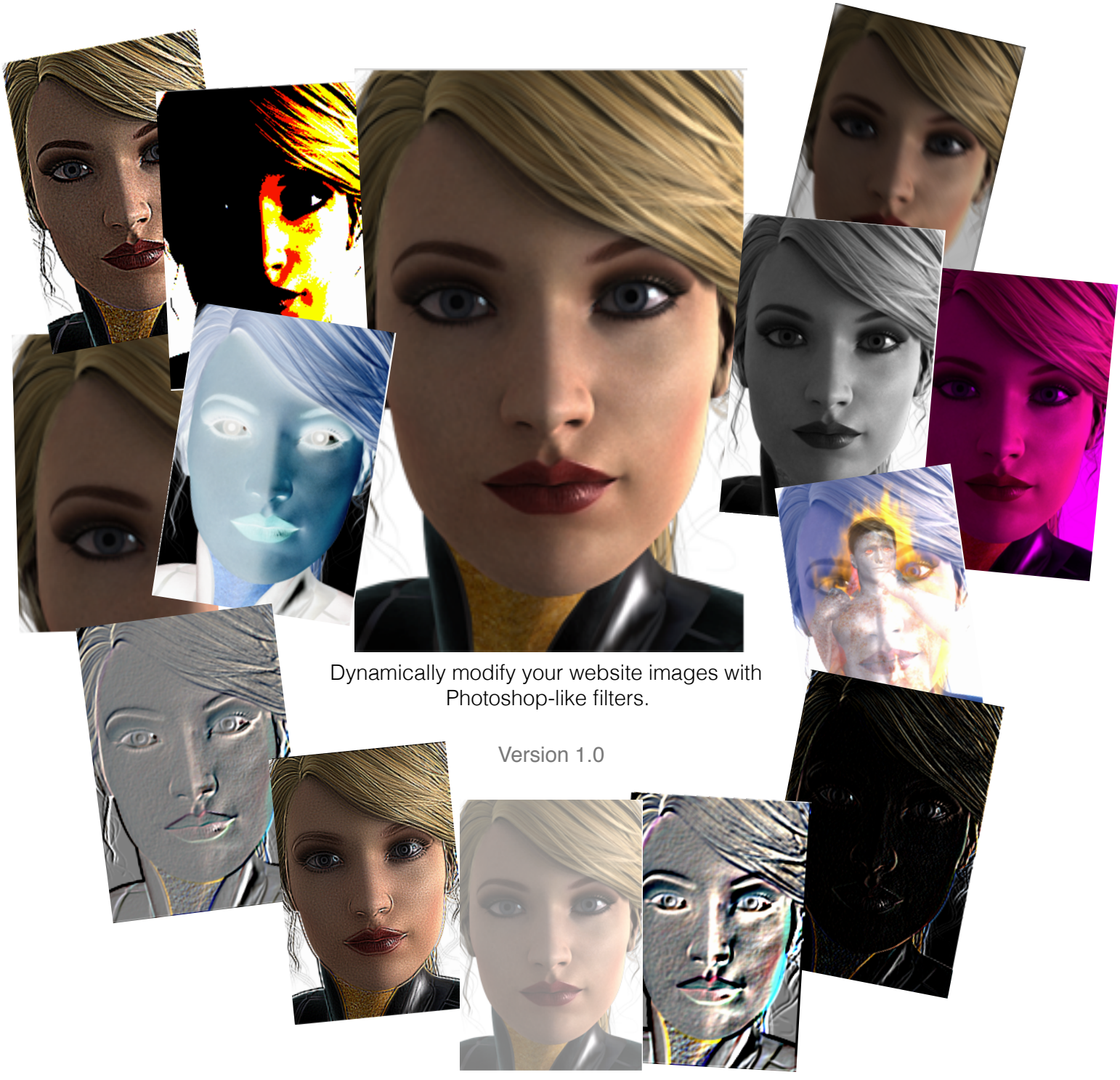
Filters



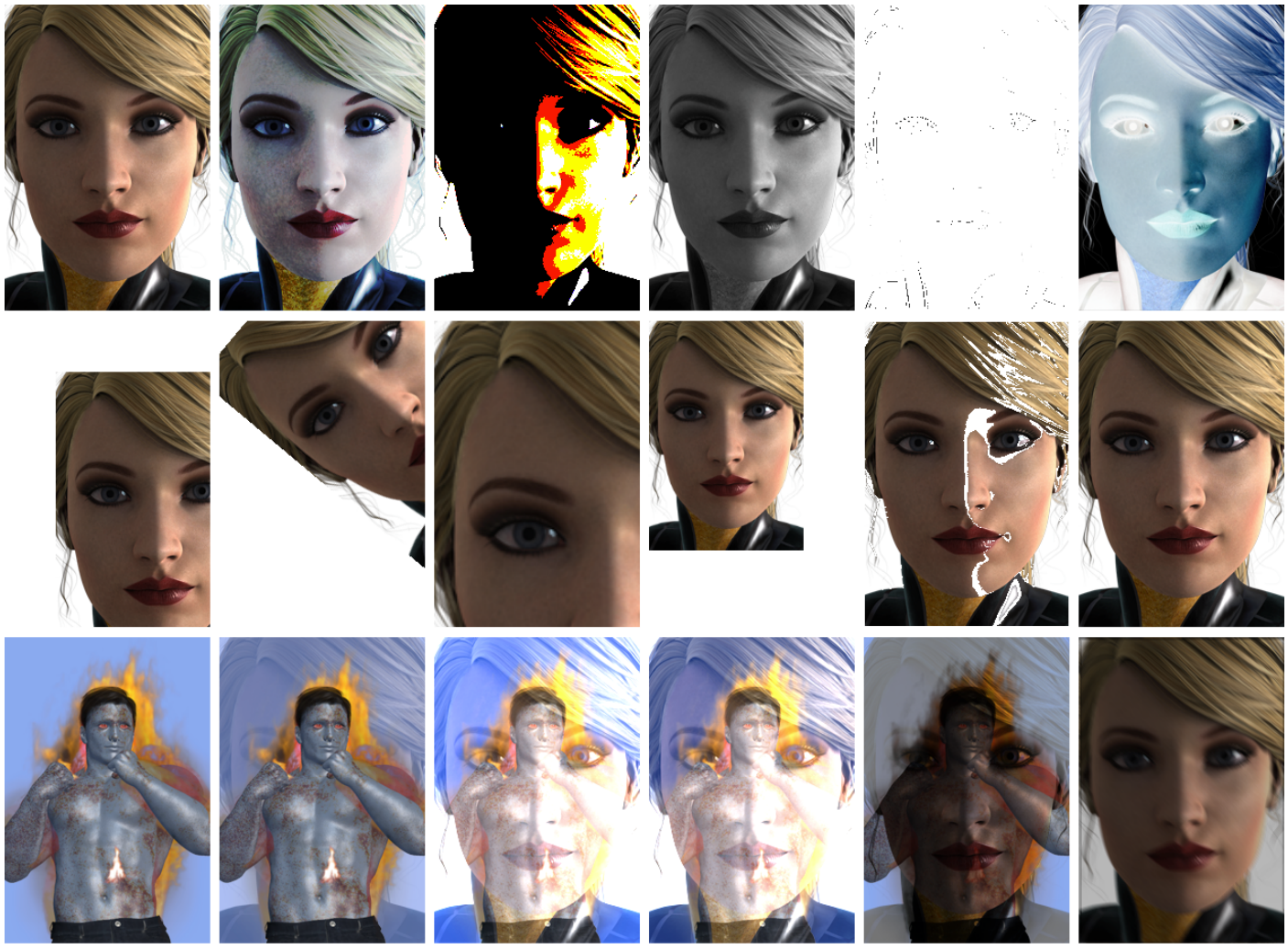
Dynamically modify your website images with Photoshop-like filters.

Version 1.0

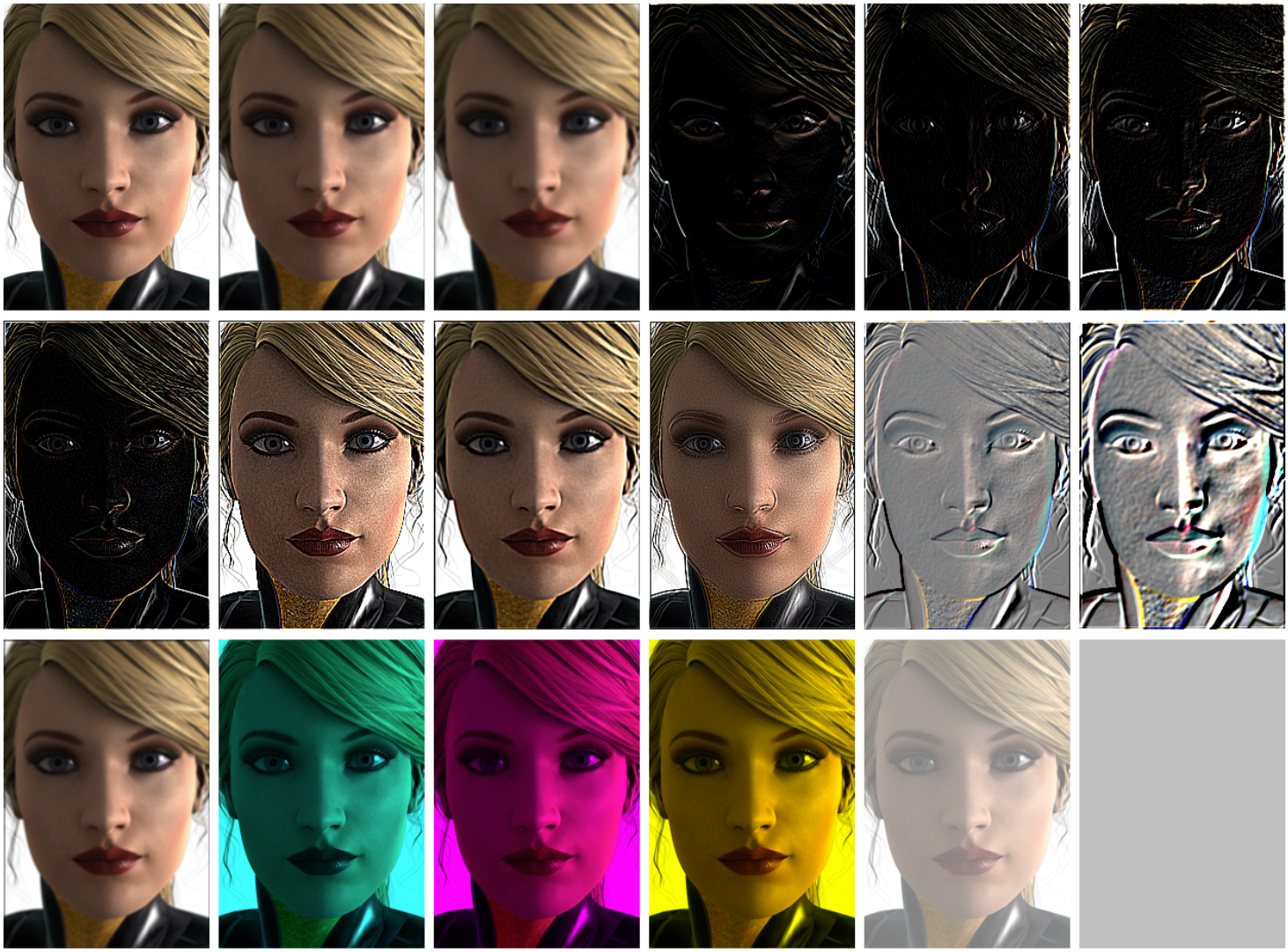
Written By David Leeper, author
of the Filter JavaScript library.
May, 2015.

The Filters 4
Using Filters 6
Basic Usage 6
Web Worker Usage 7
Progress And Log Messages 9
The Code 11
Comparing Float Values 11
Colors 11
Creating Colors 11
Comparing Colors 11
Color Class Data Members And Color Normalization 12
Converting Colors To And From Strings 12
Color Math Functions 13
Color Operations 13
Views 13
Creating Views And Working With Their Width And Height 14
Getting And Setting Pixel Color In A View 14
Converting View Images To And From Strings 14
Drawing An Image In A CanvasView 15
Masks, Factors, And Bias 15
Filters 16

The Filters



Top Row	Middle Row	Bottom Row
Original	Translate	Pic Used For Blending
Equalize	Rotate	Blend: CROSS
Threshold	Scale Bigger	Blend: ADDITIVE
Grayscale	Scale Smaller	Blend: ADDITIVE ALPHA
Detect Edges	Erosion	Blend: Multiplied
Invert	Bilinear Interpolate	Motion Blur



Top Row	Middle Row	Bottom Row
Original	Find All Edges	Mean
Blur 1	Sharpen 1	Assign Channel Value: Red
Blur 2	Sharpen 2	Assign Channel Value: Green
Find Horizontal Edges	Edges	Assign Channel Value: Blue
Find Vertical Edges	Emboss 1	Assign Channel Value: Alpha
Find 45 Degree Edges	Emboss 2	Assign Channel Value: RGBA

Using Filters

Basic Usage

Filters uses images displayed in canvas tags. The general usage pattern is one canvas serves as the original and a second canvas displays the result of the filter. An example is provided below.

```
1 <html xmlns="http://www.w3.org/1999/xhtml">
2 <head>
3    <title>My Web Page</title>
4
5    <script type="text/javascript" src="./filters.js"></script>
6    <script type="text/javascript">
7
8    function equalize(inView){
9         var filters = new Filters();
10        var oCanvasEqualize = new
11             CanvasView(document.getElementById(
12                  "CanvasEqualize"));
13
14        filters.equalize(inView, oCanvasEqualize);
15   }
16
17   function initDraw() {
18        oCanvasOriginal = new
19             CanvasView(document.getElementById(
20                  "CanvasOriginal"));
21
22        oCanvasOriginal.drawImage("pic.png", equalize);
23   } // initDraw
24   </script>
25 </head>
26 <body onLoad="initDraw();">
27   <canvas id="CanvasOriginal" width=201; height=300;
28        style="position: absolute; left: 0px; top: 0px;”>
29   </canvas>
30   <canvas id="CanvasEqualize" width=201; height=300;
31        style="position: absolute; left: 210px; top: 0px;”>
32   </canvas>
33 </body>
34 </html>
```

The code is explained below.

Line 5: The filters.js script is included.
Lines 27-32: The canvas tags are declared
Line 26: `initDraw()` is called after the page loads.
Lines 17-23: The canvas containing the original image is loaded into a `CanvasView` object. The original image, pic.png, is loaded. Once the image is loaded a function named `equalize()` is called, receiving the `CanvasView` object as a parameter.
Lines 8-15: A `Filters` object is created and the destination canvas is loaded into a `CanvasView` object. The equalize filter is called, passing the original `CanvasView` and destination `CanvasView` as parameters.

Web Worker Usage

Support for web workers, functions that run in the background, is built into Filters. Using web workers allows your site to remain quick and responsive to user input while the filters process. If you're processing lots of filters, you'll want to use web workers. An example is shown below.

```
1 <html xmlns="http://www.w3.org/1999/xhtml">
2 <head>
3 <script type="text/javascript" src="./filters.js"></script>
4 <script type="text/javascript">
5 function equalize(inView) {
6     var oCanvasView = new CanvasView(
7          document.getElementById("CanvasEqualize"));
8     var worker = new Worker('filters.js');
9
10    worker.addEventListener('message', function(e) {
11         var data = e.data;
12
13         switch (data.cmd) {
14         case 'ResultEqualizeFilter': {
15              oCanvasView.imageFromString(data.msg);
16              break; // switch
17         } // case
18         case 'Progress': {
19              if (data.msg) {
20                   document.getElementById(
21                   "CanvasEqualizeProgress").innerHTML =
22                   data.msg + "%";
23              }
24              break; // switch
25         } // case
26         case 'Log': {
27              console.log(data.msg);
28              break; // switch
29         } // case
30         default: {
31              alert('Unknown command: ' + data.msg);
32         } // default
33         }; // switch
34    }, false);
```

```
35    worker.postMessage({
36          'type': 'Filter',
37          'cmd': 'Equalize',
38          'width': inView.getWidth(),
39          'height': inView.getHeight(),
40          'imageString': inView.imageToString()
41    });
42 } // equalize
43
44 function runFilters(inView) {
45    document.getElementById(
46          "CanvasOriginalProgress").innerHTML = "100%";
47    equalize(inView);
47 } // runFilters
48
49 function initDraw() {
50    var oCanvasView = new CanvasView(
51          document.getElementById("CanvasOriginal"));
52
53    oCanvasView.drawImage("pic.png", runFilters);
54 } // initDraw
55
56 </script>
57 </head>
58 <body onLoad="initDraw();">
59    <canvas id="CanvasOriginal" width=201; height=300;
60          style="position: absolute; left: 0px; top: 0px;">
61    </canvas>
62    <canvas id="CanvasEqualize" width=201; height=300;
63          style="position: absolute; left: 210px; top: 0px;">
64    </canvas>
65    <table style="top: 20px; left: 420px; position: absolute;">
66          <tr>
67                <td>1 Original</td>
68                <td id=“CanvasOriginalProgress">0%</td>
69          </tr>
70          <tr>
71                <td>2 Equalize</td>
72                <td id=“CanvasEqualizeProgress">0%</td>
73          </tr>
74    </table>
75 </body>
76 </html>
```

The code is explained below.

Line 3: The filters.js script is included.
Lines 59-64: The canvas tags are declared
Lines 65-74: A table is declared. This optional and will be used to show the progress of each filter.
Line 58: `initDraw()` is called after the page loads.
Lines 49-54: The canvas containing the original image is loaded into a `CanvasView` object. The original image, pic.png, is loaded. Once the image is loaded a function named `runFilters()` is called, receiving the `CanvasView` object as a parameter.
Lines 44-47: The progress for loading the original image is marked at 100% complete. The `equalize()` method is called to set up the web worker.
Lines 6-7: A `CanvasView` is created, referencing the canvas used to display the result of the filter.
Line 8: A new web worker is created. The worker uses the filters.js script.
Lines 10-34: A listener for the web worker is created. It handles the result, progress, and log messages sent by the worker. Notice on line 15 that the web worker returns the resulting image as a string, which we then load into the canvas with the `imageFromString()` method.
Lines 35-41: The parameters need to run the filter are passed to the web worker. Notice the image is passed to the web worker as a string using the `CanvasView`'s `imageToString()` method.

THE RESULTS OF THE WEB WORKER IN THE BROWSER.

Progress And Log Messages

Support for progress notifications, and log, warn, and error messages are built in to the Filters class. To use this functionality, just set the `progress`, `log`, `warn`, and `error` members of the `Filters` class to functions that process these messages. These functions will receive the name of the filter and the message as parameters.

Note that web workers set theses functions automatically and pass the information back to their callers as messages. See lines 18-29 of the web worker example code above for an example of how to handle these messages.

An example of setting the functions manually is shown below.

```
1 var filters = new Filters();
2 filters.progress = function (name, msg) {…}
3 filters.log = function (name, msg) {…}
4 filters.warn = function (name, msg) {…}
5 filters.error = function (name, msg) {…}
```

The Code

To use Filters, include filters.js in your HTML page. To import filters as a web worker, create a Worker and pass the string ‘fitlers.js’ as a parameter.

Comparing Float Values

Comparing float values can be problematic due to the fact that two floats can be equal for several decimal places, but have unequal values in decimal places so small you don’t care about the difference.

To deal with this issue, Filters includes a function named `isKindaSortaEqual()`, which compares two numbers for equality within a given tolerance. An example is shown below.

```
1 var float1 = 0.00000001;
2 var float2 = 0.00000002;
3 var tolerance = 0.005;
4
5 // The following line will return true.
6 isKindaSortaEqual(float1, float2, tolerance);
```

Colors

Colors are an important part of working with Filters. At a minimum, it’s a good idea to know how to create colors and compare them.

Creating Colors

The colors constructor takes a red, green, blue, alpha, and transparent value. The red, green, and Blue values range from 0 to 255. The alpha value ranges from 0.0 to 1.0. The transparent value is a boolean true or false. If transparent is true, the color will not be displayed regardless of the other color values.The alpha and transparent values are optional, with alpha defaulting to 1.0 and transparent defaulting to false.

```
1 // Creating a yellow color.
2 var color = new Color(255, 255, 0, 1.0, false);
```

Comparing Colors

The color class provides the `isEqual()` method for comparing colors.

```
1 var color1 = new Color(255, 255, 10);
2 var color2 = new Color(255, 255, 0);
3
4 // The following line will return false.
5 color1.isEqual(color2);
```

The `isEqual()` method is implemented using `isKindaSortaEqual()`. This allows you to specify a tolerance for the comparison, as shown below.

```
1 var color1 = new Color(255, 255, 10);
2 var color2 = new Color(255, 255, 0);
3
4 // The following line will return true.
5 color1.isEqual(color2, 10);
```

Color Class Data Members And Color Normalization

The color class has the following data members which you can access:

* `r` - The red value of the color.
* `g` - The green value of the color.
* `b` - The blue value of the color.
* `a` - The alpha value of the color.
* `transparent` - The transparent value of the color (true or false).
* `normalized` - The normalized value of the color (true or false).

A normalized color has color values between 0.0 and 1.0. A color that is not normalized has color values between 0 and 255. The alpha value is always normalized, but the `r`, `g`, and `b` values may or may not be, based on the value of `isNormalized`.

To obtain the normalized or 255 version of a color, use the `getNormalizedColor()` and `get255Color()` methods. To translate individual values, such as the `r` value, you can use the `xlate255ColorToNormalizedColor()` and `xlateNormalizedColorTo255Color()` methods.

```
1 var colorNormalized = myColor.getNormalizedColor();
2 var color255 = myColor.get255Color();
3 var red = xlate255ColorToNormalizedColor(myColor.r);
4 var r = xlateNormalizedColorTo255Color(red);
```

Converting Colors To And From Strings

It's often useful to be able to convert colors to and from strings, especially in an HTML environment. To support this, the Color class provides the following methods.

* `toString()` Converts the color to a string of the format rgb(r,g,b). If the Color's transparent member is true, the return string will contain only the word "transparent".
* `fromString()` Converts a string in the format provided by `toString()` back to color values and assigns them to the color.
* `toStringWithAlpha()` Converts the color to a string of the format rgba(r,g,b,a). If the Color's transparent member is true, the return string will contain only the word "transparent".
* `fromStringWithAlpha()` Converts a string in the format provided by `toStringWithAlpha()` back to color values and assigns them to the color.
* `toOpacityString()` Converts the color to a string of the alpha value.

* `fromOpacityString()` Converts a string in the format provided by `toOpacityString()` back to color values and assigns them to the color.
* `toFilterString()` Converts the color to a string of the format filter:alpha(opacity=alphaValue), where alpha value is the color's `a` value multiplied by 100.
* `fromFilterString()` Converts a string in the format provided by `toFilterString()` back to color values and assigns them to the color.

Color Math Functions

You can assign, add, subtract, multiply, and divide a color by a number, as shown below.

```
1 myColor.assignNumber(0);
2 myColor.addNumber(10);
3 myColor.subtractNumber(10);
4 myColor.multiplyNumber(2);
5 myColor.divideNumber(2);
```

You can also add and subtract two colors.

```
1 myColor.addColor(otherColor);
2 myColor.subtractColor(otherColor);
```

A color can be clamped to insure that it is within its minimum and maximum allowed values.

```
1 myColor.clamp();
```

Color Operations

The Color class supports a few basic color manipulation methods. These are `invert()`, `grayscale()`, and `blend()`. The `blend()` method requires a second color to blend and has four variations: `CROSS`, `ADDITIVE`, `ADDITIVE_ALPHA`, and `MULTIPLIED`.

```
1 myColor.invert();
2 myColor.grayscale();
3 myColor.blend(otherColor, Color.blendOperation.CROSS);
4 myColor.blend(otherColor, Color.blendOperation.ADDITIVE);
5 myColor.blend(otherColor, Color.blendOperation.ADDITIVE_ALPHA);
6 myColor.blend(otherColor, Color.blendOperation.MULTIPLIED);
```

Each of these operations, `invert()`, `grayscale()`, and `blend()`, have corresponding filters that work on the entire image.

Views

Views are used to work with HTML canvas information. Filters provides two view classes: `MinimalView` and `CanvasView`.

`MinimalView` is a memory-only representation of image data that provides the minimal functionality needed to filter images. `MinimalViews` are used by web workers to run filters.

`CanvasView` will be used in your code to wrap an HTML `canvas` object.

Creating Views And Working With Their Width And Height

The constructor for the `MinimalView` class takes a width and height parameter that defines the size of the image the view contains. The constructor for the `CanvasView` class takes a HTML canvas object that is wrapped by the view.

```
1 var oMinimalView = new MinimalView(width, height);
2 var oCanvasView = new CanvasView(
3          document.getElementById("MyCanvas"));
```

For both class, you can get and set the width and height using the `getWidth()`, `setWidth()`, `getHeight()`, and `setHeight()` methods.

Note that the `setWidth()` and `setHeight()` methods do not change the image data contained in a `MinimalView` class and will clear the image data contained in a `CanvasView` class.

```
1 var width = oCanvasView.getWidth();
2 var height = oCanvasView.getHeight();
3 oMinimalView.setWidth(100);
4 oMinimalView.setHeight(100);
```

Getting And Setting Pixel Color In A View

Use the `getColor()` and `setColor()` methods to get and set pixel colors in a view. Both take an X and Y coordinate that specifies the pixel in the view. The `getColor()` method returns the that pixel's color or null if the coordinates are outside the view. The `setColor()` method takes a third parameter specifying the color to set at the given pixel in the view. You can also use the `fill()` method to fill a view with a single color.

```
1 var oColor = oCanvasView.getColor(xLoc, yLoc);
2 oCanvasView.setColor(xLoc, yLoc, otherColor);
3 oCanvasView.fill(oColor);
```

Converting View Images To And From Strings

Like colors, the images in a view can be converted to and from strings. Note that the string contains the view's width and height and a view will only read in a string with the same width and height. The `imageToString()` and `imageFromString()` methods are used to do the conversion.

```
1 var imageData = oCanvasView.imageToString();
2 oCanvasView.imageFromString(imageData);
```

Drawing An Image In A CanvasView

The `drawImage()` method is used to draw an image file, such as a .png file, in a `CanvasView` object. This method takes as parameters a `URL`, and an optional `then` function, and `xOffset` and `yOffset`. Once the canvas draws the view the `then` function will be called, passing the `CanvasView` object as a parameter.

```
1 oCanvasView.drawImage("pic.png", function(inCanvasView) {…},
2     xOffset, yOffset);
```

Masks, Factors, And Bias

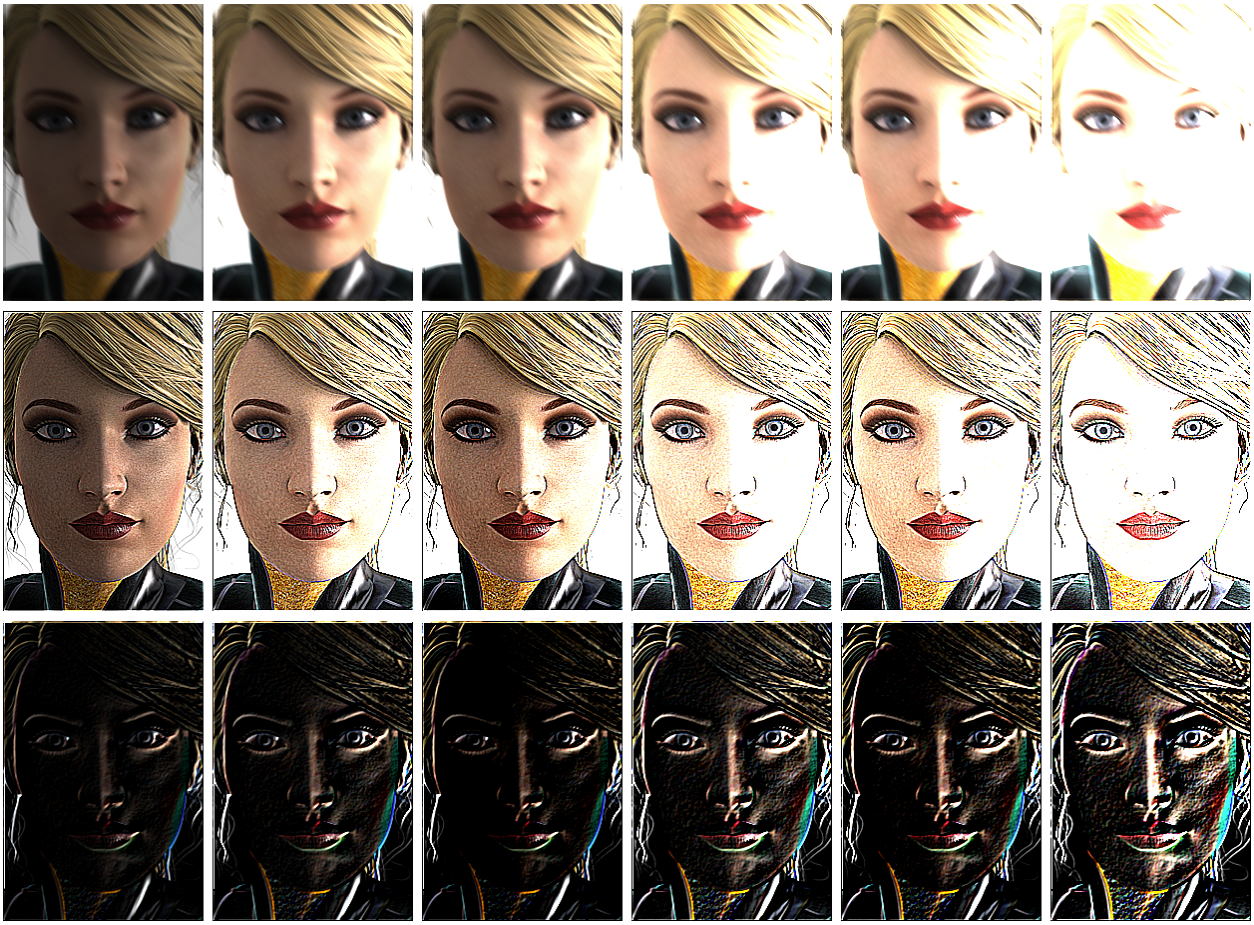
The `maskFilter()` method of the `Filters` class is a generic filter that accepts a mask, a factor, and a bias to perform a variety of different types of filters. Understanding how these pieces work allows you to get the most out of the `maskFilter()` method.

A mask is a two dimensional array of numeric values that are multiplied against the red, green, and blue values of the image. Think of the mask as having its center overlay the current pixel. Every pixel covered by the mask array has its value adjusted by the numbers in the array cell that covers it. The values for all these colors are then merged together to get the value for the current pixel.

The factor is used to multiply the red, green and blue values of the current pixel. The bias is added to the red, green and blue values of the current pixel. Masks, factors, and bias do not change the alpha value of any pixels.

The `Masks` class contains all the masks, factors, and bias values that come with Filters.

`blur1`	`blur1Factor`	`blur1Bias`
`blur2`	`blur2Factor`	`blur2Bias`
`motionBlur`	`motionBlurFactor`	`motionBlurBias`
`findHorizontalEdges`	`findHorizontalEdgesFactor`	`findHorizontalEdgesBias`
`findVerticalEdges`	`findVerticalEdgesFactor`	`findVerticalEdgesBias`
`find45DegreeEdges`	`find45DegreeEdgesFactor`	`find45DegreeEdgesBias`
`findAllEdges`	`findAllEdgesFactor`	`findAllEdgesBias`
`sharpen1`	`sharpen1Factor`	`sharpen1Bias`
`sharpen2`	`sharpen2Factor`	`sharpen2Bias`
`edges`	`edgesFactor`	`edgesBias`
`emboss1`	`emboss1Factor`	`emboss1Bias`
`emboss2`	`emboss2Factor`	`emboss2Bias`
`mean`	`meanFactor`	`meanBias`



Top Row	Middle Row	Bottom Row
MotionBlur	Sharpen1	Emboss1
MotionBlur Factor * 2	Sharpen1 Factor * 2	Emboss1 Factor * 2
MotionBlur Factor * 2 Bias - 20	Sharpen1 Factor * 2 Bias - 20	Emboss1 Factor * 2 Bias - 20
MotionBlur Factor * 4	Sharpen1 Factor * 4	Emboss1 Factor * 4
MotionBlur Factor * 4 Bias - 20	Sharpen1 Factor * 4 Bias - 20	Emboss1 Factor * 4 Bias - 20
MotionBlur Factor * 8	Sharpen1 Factor * 8	Emboss1 Factor * 8

You can create you own masks to develop custom filters. You can use custom values for factor and bias to modify the results of existing filters.

Filters

The `Filters` class is the heart of the filters package. Each filter is presented in the table below along with the parameters the filter expects.

Filter	Parameters	Notes
copy	inSourceView, inDestinationView	Copies the source view to the destination view.
histogram	inView	Provides a HistogramResult of the view.
sumHistogram	inHistogram	Accepts a HistogramResult and sums it, returning a new HistogramResult.
blend	inSourceView, inBlendView, inDestinationView, inBlendMode	Accepts a source and blend view. These are blended using the blend mode and the results placed in the destination view.
bilinearInterpolatePixel	inView, inX, inY	Performs a bilinear interpolation on a single pixel and returns a Color containing the result.
bilinearInterpolate	inSourceView, inDestinationView	Performs a bilinear interpolation on the source view, placing the results in the destination view.
equalize	inSourceView, inDestinationView	Equalizes the source view, placing the results in the destination view.
threshold	inSourceView, inDestinationView, inThreshold, inNewHigh, inNewLow, inThresholdAlpha	Performs a threshold on the source view, placing the results in the destination view. The inThreshold color specifies the threshold. Colors with a higher value are replaced with the inNewHigh color. Colors with a lower value are replaced with the inNewLow color. Each red, green, and blue component is checked separately. inThresholdAlpha is a boolean indicating if the alpha value should also be thresholded.
grayscale	inSourceView, inDestinationView	Grayscales the source view, placing the results in the destination view.
invert	inSourceView, inDestinationView	Inverts the source view, placing the results in the destination view.

Filter	Parameters	Notes
assignChannelValue	inSourceView, inDestinationView, inChannels, inValue	Assigns a given value to the specified color channels (r, g, b, or a). The result is placed in the destination view. The inChannels parameter is a string indicating which chamomiles should be affected. The string contains one or more of: r, g, b, or a. The inValue is the new value. If the alpha channel is affected, inValue will be divided by 255 before applying it to that channel.
detectEdges	inSourceView, inDestinationView	Detects edges in the source view, placing the results in the destination view.
translate	inSourceView, inDestinationView, inOffsetX, inOffsetY, inFillColor	Moves the source view and places the result in the destination view. The inOffsetX and inOffsetY parameters indicate how much to move the view. The inFillColor parameter is used to fill any space that opens up because of the move. NOTE: The HTML 5 Canvas element has a translate method that translates drawings done AFTER the call to translate. The Filters translate method translates images drawn BEFORE the call to translate.
rotate	inSourceView, inDestinationView, inRotationPointX, inRotationPointY, inAngle, inFillColor	Rotates the source view and places the result in the destination view. The inRotationPointX and inRotationPointY parameters indicate the center point of the rotation. The inAngle parameter indicates how much to rotate. The inFillColor parameter is used to fill any space that opens up because of the move. NOTE: The HTML 5 Canvas element has a rotate method that rotates drawings done AFTER the call to rotate. The Filters rotate method rotates images drawn BEFORE the call to rotate.

Filter	Parameters	Notes
scale	inSourceView, inDestinationView, inXScale, inYScale, inFillColor	Scales the source view and places the result in the destination view. The inXScale and inYScale parameters indicate how much to scale the view. The inFillColor parameter is used to fill any space that opens up because of the move. NOTE: The HTML 5 Canvas element has a scale method that scales drawings done AFTER the call to scale. The Filters scale method scales images drawn BEFORE the call to scale.
erosion	inSourceView, inDestinationView, inErosionColor, inThreshold, inTolerance, inNeighborColor, inReplacementColor	Performs the erosion operation on the source view and places the results in the destination view. Each pixel has its neighboring pixels compared with the inNeighborColor. If the number of neighbors equaling the inNeighborColor color is greater than inThreshold, the original pixel is replaced with inReplacementColor. The comparison between a neighboring pixel and inNeighborColor uses inTolerance to allow for a range of colors to be considered equal.
maskFilter	inSourceView, inDestinationView, inMask, inFactor, inBias	Applies inMask, inFactor, and inBias to the source view, placing the results in the destination view. See the Mask class for masks, factors, and biases provided.